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Communication Engineering
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RADIO-ELECTRONIC *Engineering* SECTION

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RADIO & TELEVISION NEWS

JULY, 1954

DEPARTMENTS

Many tests and double checks are made on RCA tri-color kinescopes during production. Here, a skilled technician at the company's Lancaster, Pa., plant electronically checks phosphor-dot brightness as the tubes approach the end of the production line.

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Vibration stress analysis.


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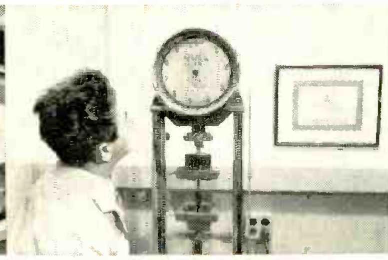

Quantitative checking of weld strength.


Hermetic terminals on microscope check.


Chemical section analyzing new materials.

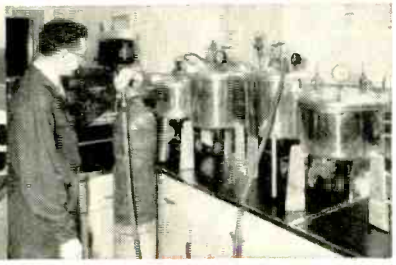

Microscope analysis of dissected units.


Calibration to primary standards.

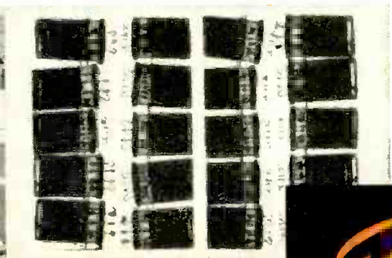

Pilot plant hydrogen annealing.


Seal tests under extremes of cold, heat, and altitude.


Abrasion and mercury tests on magnet wire.


Pilot plant run on encapsulating material.


Corrosion testing on insulating materials.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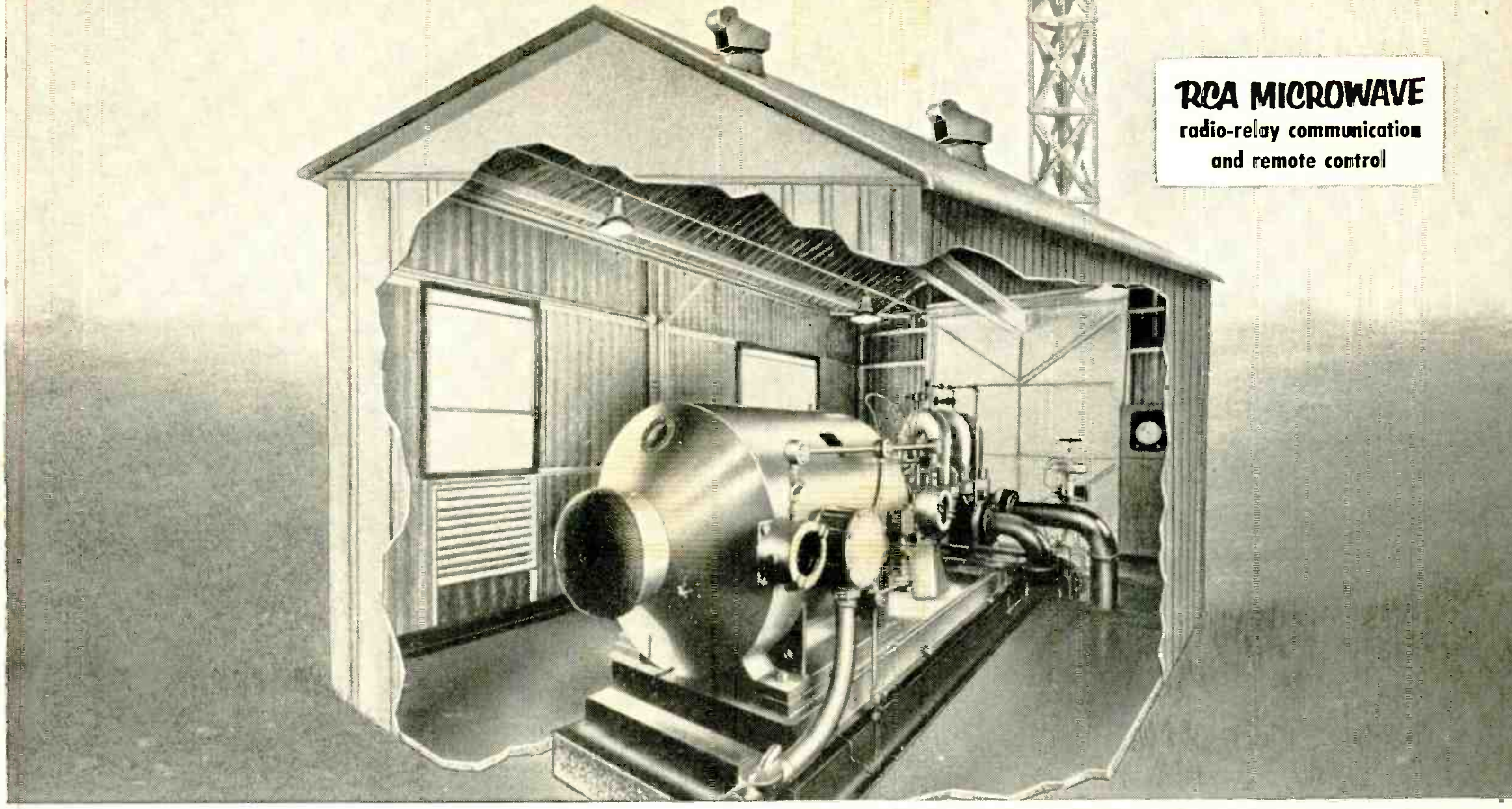

Cutaway of Sunray remote-controlled station pump room. Pneumatically operated pump-discharge motor valve and controller are in background

What makes SUNRAY's unattended booster stations *tick?*

Sunray Oil Corporation's 960-mc RCA Microwave system makes them "tick" by remote control. Three unattended booster pump stations have stepped up the capacity of Sunray's 97-mile refinery-facilities pipeline between Sunray Village (Duncan) and Allen, Oklahoma, by as much as 25%—*without requiring bigger pipe.*

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Operator at control console at regular pump station also controls remote stations. Telemeter charts provide continuous record of both local and remote station operation over 24-hour period

Remote-station control building contains radio cabinet (right); cabinet for relays, switches and starting equipment (center); controls for local operation (left). Stand-by generator is in background

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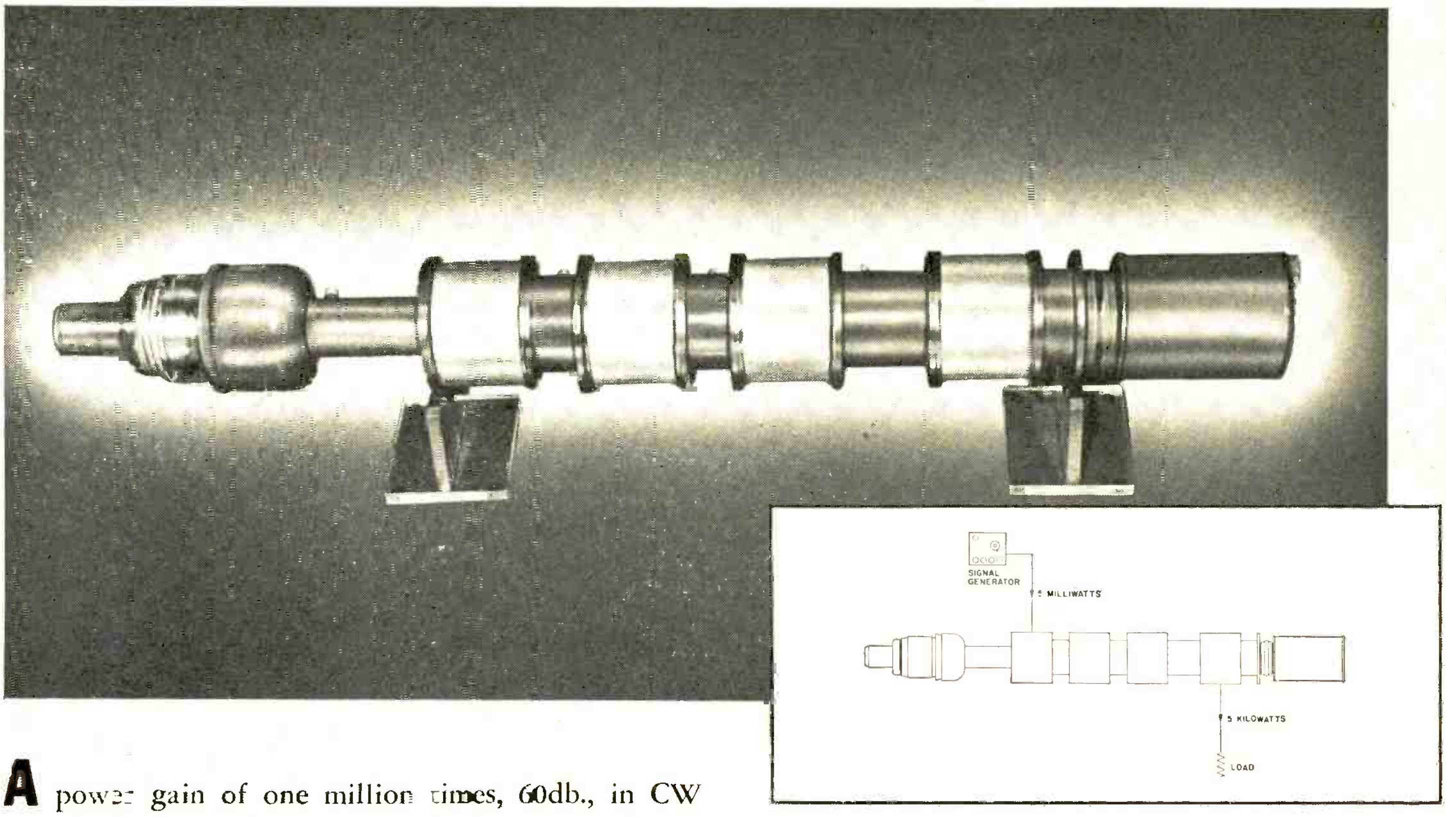

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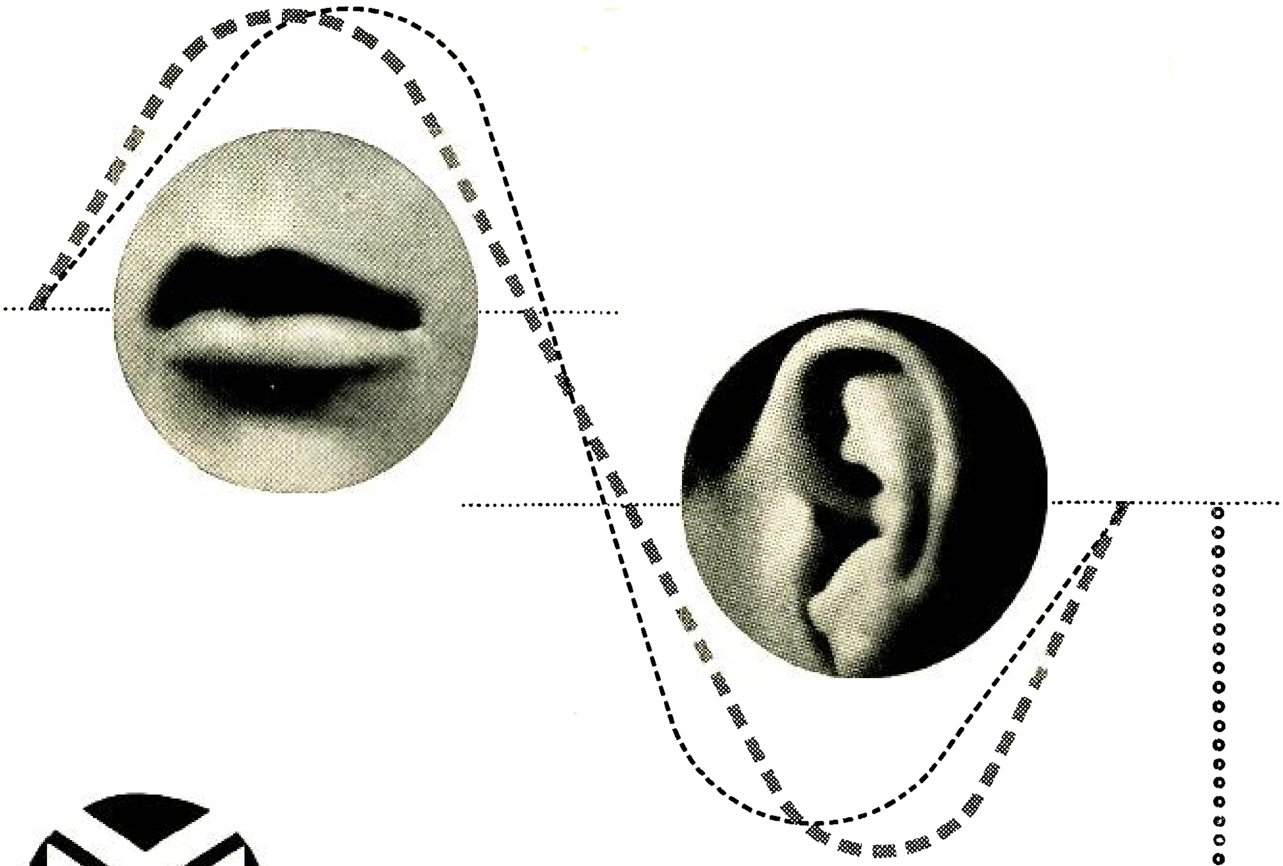


Fig. 1. Aerial photographer with camera and view finder installed in an airplane.

AERIAL RECONNAISSANCE FOR MICROWAVE SURVEYS

Optimum microwave path and site selection is simplified by the use of aerial techniques.

By **MARC SHELDON** and **L. A. DICKERSON**

Microwave Services, Inc. Lockwood, Kessler & Bartlett, Inc.

THE HISTORY of aerial survey begins with photography from kites and balloons in the 19th century, and continues in the early 20th century with visual and photographic reconnaissance from airplanes. Such methods gained important impetus from World War I when aerial reconnaissance proved its strategic and tactical value in military operations. The art progressed further in the 1930's in the United States when instruments were added to the aerial cameras, so that it became possible to obtain more precision-type data from photographs which had previously been treated as maps.

During World War II, application of plotting instruments in connection with aerial survey experienced a tremendous expansion, and American manufactured equipment became available for the first time. Immediately after the end of World War II, considerable refinement and growth took place as many of the wartime electronic developments were coupled with the instruments used in aerial plotting. In order to show how aerial methods fit into the survey picture, the general objectives of microwave survey will be briefly reviewed at this point.

Survey Objectives

In locating stations in a microwave relay system, the general objectives are as follows:

1. The minimum number of relay stations consistent with the designated points of communication and satisfactory over-all operation should be specified.
2. Sites should be selected which involve minimum expense for: rental or purchase of land; site improvement (e.g., drainage); access road construction; commercial power installation; towers (minimum height) to have positions of minimum weather hazard (e.g., extremes of wind or ice) and locations favorable for other considerations of the communications system (e.g., v.h.f. coverage).

Obviously, these optimum conditions will rarely occur conjointly at particular sites. It is necessary, therefore, to strike the best balance among them in locating relay stations.

The facts which the survey should bring out are:

1. Elevations and positions of terrain features between fixed points of communication should be determined, covering an area band sufficiently wide to include all locations which may be considered for sites and all points which may constitute obstructions on the final path.
2. The nature of the terrain in this band should be known, including information concerning tree heights, bodies of water, character of earth surface, and similar factors which will affect both clearance and propagation conditions.
3. Man-made features, such as roads, buildings, railroads, and power lines,

Fig. 2. Portion of a "photo index." This reproduction is approximately one-seventh the scale of original photographs.

are more important in the vicinity of proposed sites than on intermediate portions of the path (except insofar as they influence clearance considerations). In the immediate area of a proposed site, detailed data concerning subsurface conditions for access roads, land availability, drainage, etc., should be gathered.

The determination of when the use of aerial methods in microwave survey is advantageous, and which method is to be preferred under which conditions, will become fairly clear as the methods are discussed in detail. However, the following general statements will apply in most cases:

1. In terrain where travel is difficult, aerial methods offer obvious advantages over ground methods of survey, including that of speed.
2. Some ground work is required in conjunction with all types of aerial survey, the kind and amount depending on the particular aerial method used and the terrain in question.

Visual Reconnaissance

To obtain a general impression of the nature of the terrain to be surveyed, regardless of the eventual method of survey to be used, a visual aerial reconnaissance can be very valuable, and can generally be undertaken at minimum cost. The route is usually flown at low altitudes, and spot photographs may be taken of significant terrain features. Such reconnaissance is especially valuable if the area under consideration is scantily mapped; it may help determine what type of final survey should be made.

Visual aerial reconnaissance is valuable for more than terrain information. Such important data as the road network of an area, power facilities, and the like can be observed directly and by inference. The general condition of the land and the use to which it is being put may provide valuable information as to the ease and cost of securing a site. For example, a site in an uncultivated, sparsely populated section could probably be obtained at a much lower figure than a similar site in a more populous urban area, or in rich farmland.

The object of the reconnaissance is to gather as much information as possible that will aid in narrowing the choice of potential station sites. Of the necessary information, the most difficult to obtain from this type of reconnaissance is terrain elevation data.

One technique which has been used to select probable paths is to take the airplane up to a point where the horizon is about 30 miles, and head it in the general direction of the required path. By careful sighting on terrain features in the distance, and using experience as a guide to the nearer and farther points (distant hills take on different colors from closer ones), likely hills or other high points may be noted. The plane can then fly to such points to identify them, and these can later be checked as potential sites by more accurate methods.

Advantages and Disadvantages

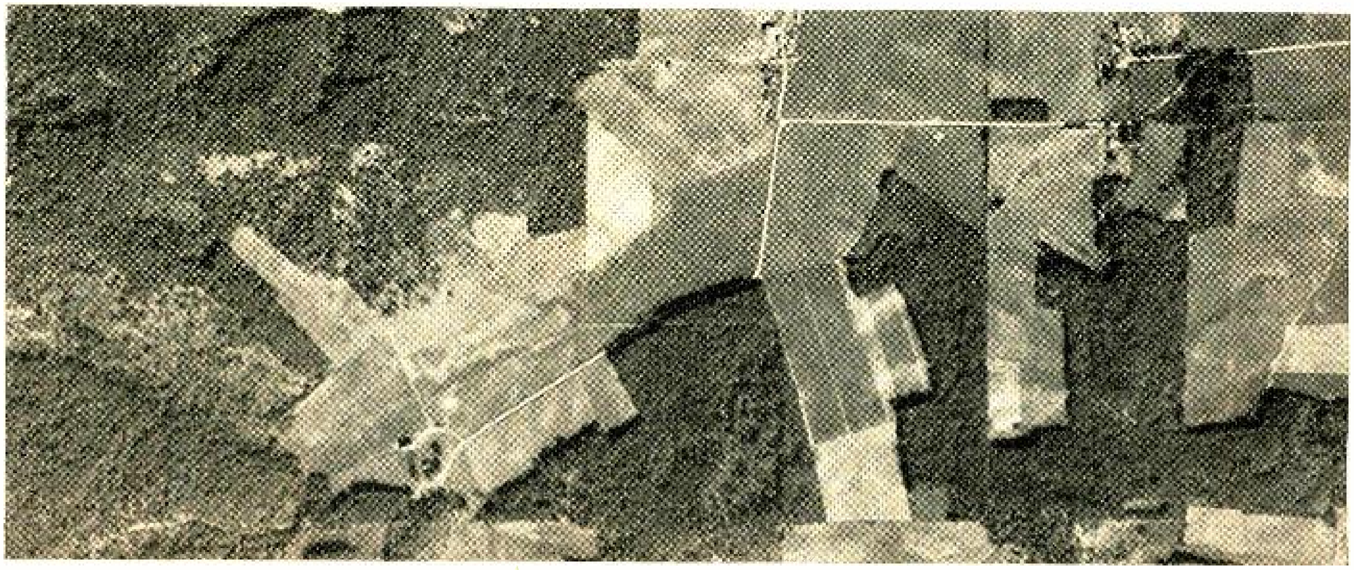
Visual aerial reconnaissance finds its application during the reconnaissance phase of the microwave survey. It has several significant advantages. It is low in cost and is readily available, since small plane transportation may be rented at most airfields at very reasonable rates. No special equipment need be installed in the plane. It is probably the fastest way to get a general impression of unmapped or poorly mapped terrain, and is usable under most weather conditions.

Two obvious disadvantages of a visual reconnaissance are that it produces only very approximate quantitative data, and that it produces very little in the way of a record of its work. Such a record is limited to written observations on map or paper and the few photographs that may be taken on the flight. The application of visual reconnaissance is believed to be limited to the following cases: unmapped areas where existing data gives no general information as to the nature of the topography and culture; areas well-mapped topographically, where more general information may be needed on vegetation and culture not usually shown on the map; and well-mapped areas where tentative paths have been selected from the maps and where a check is needed along critical points of the paths for possible obstructions, reflecting bodies, facilities at designated sites, and like information.

Photographic Reconnaissance

Although aerial photographic reconnaissance is strictly a reconnaissance rather than a final type of survey, it provides a wealth of data that will aid the engineer in reducing the number of suitable paths for each microwave hop to a relative few, which can then be finally checked by other means. This is accomplished by "covering" the area of interest with vertical aerial photographs, a stereoscopic study of these photographs, and a correlation of this study with other existing information.

Fig. 3. Enlarged photograph of an area in Wisconsin. Scale of original, 1:60,000; of this reproduction, 1:15,000.



In the field, the work involved in the aerial photographic method consists of covering the entire area of interest in a systematic manner with vertical aerial photographs. Although oblique aerial photographs may be of some value in a few special cases, their use is quite similar to visual aerial reconnaissance and they will not be considered further here. For vertical photography, an aerial camera is mounted in an airplane with the axis of the camera pointing vertically downward through an opening provided in the floor of the plane.

Figure 1 shows a view of such a camera mounted in an airplane. The mounting provides for small adjustments in the position of the camera to maintain it as closely as possible in the vertical position, and provides for large rotations around its optical axis to adjust for the drift angle of the plane. This is the angle between the actual heading of the aircraft and the resulting ground track, and is the result of cross winds. By reference to level bubbles mounted on the camera, the operator is able to keep the camera axis vertical within about one degree. With tilts of such small magnitude, the resulting photographs closely approximate planimetric maps of the area covered. As the plane flies along a line as straight as possible and at as constant an altitude as possible, the camera operator makes successive exposures. The time between exposures is so arranged that each exposure overlaps the area of the preceding one by 55 to 60%. If more than one strip, or flight, of photographs is required to cover the area of interest, parallel strips are flown and so placed that the area covered by one side laps the adjacent one by 20 to 30%.

There are a number of different types of aerial cameras suited to reconnaissance work. As the purpose is usually to reconnoiter as large an area as possible with a minimum of flying effort, it is desirable that the angular field of coverage of the camera be as large as possible. At the same time, it is desirable that the focal length of the camera lens be great enough so that the resulting images are of a usable size. The optimum combination at present is provided by a camera having a focal length of six inches and exposing a negative nine inches square. This camera covers an angular field of about 93° across the diagonal and about 74° across the width of the negative.

In choosing the altitudes for flying reconnaissance photography, a compromise of two objectives is involved. It is desirable that the altitude be as high as possible, as each photograph will cover more area, and economy in flying and later use of the photographs is thus achieved. Conflicting with the high altitude, however, is the scale of the resulting photographs. As altitude goes up, the scale of the photographs goes down in a linear proportion. The scale must be large enough so that the desired information can be secured from the photographs. On the average, a flying height of 20,000 feet above the ground will be found optimum. At this height, the scale of the photograph is 1:40,000 or about 3300 feet to the inch. A single flight at this height covers a strip of ground about six miles wide, and photographs are exposed at intervals of about two and a half miles.

Brief reference should be made here to the effects of weather on securing the required photographs. The reconnaissance planes are only flown at times that clouds are completely absent, when the ground is not covered with snow, and when the sun is at an altitude of about 30° or more. In the northern portion of the United States, this prevents flights being made in some two or three months of the winter. Cloudless conditions vary with season and location but the need for such conditions is not as great a hindrance as it might appear. On the average, suitable conditions can be expected to occur about every two weeks, and in the worst areas a suitable day may be expected to occur about once a month. One such day is usually sufficient to cover an area for microwave purposes.

Use of Photographic Data

After the processing of the aerial negatives and the preparation of contact prints on paper, the remainder of the reconnaissance work takes place in the office. The overlapping photographs are matched one to another and stapled onto large panels of wallboard or similar material. They may be retained in this form for work purposes, but it is usually more convenient to copy the boards down to about one-fifth size. Prints made from such copies are known as photo indexes and actually constitute a composite picture, or mosaic, of the area of interest having the properties of a rough planimetric map. (Figure 2 shows a reduced portion of such a photo index.) The individual aerial photographs are then taken off

(Continued on page 29)

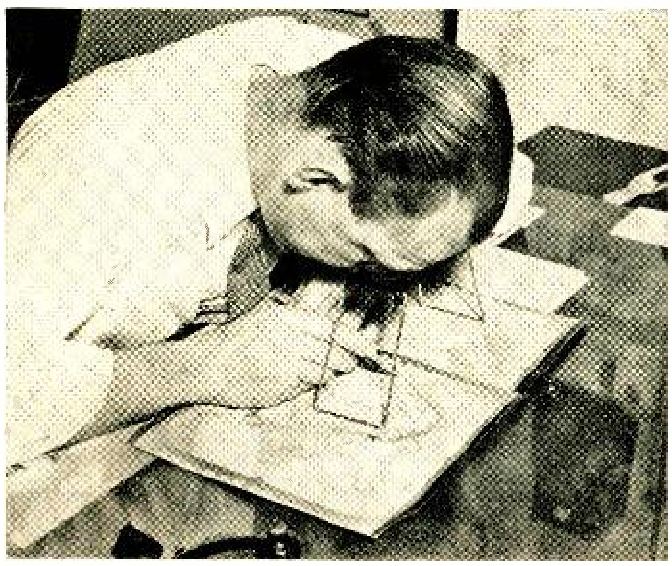


Fig. 4. Folding pocket stereoscope being used for a detailed study of aerial photographs.

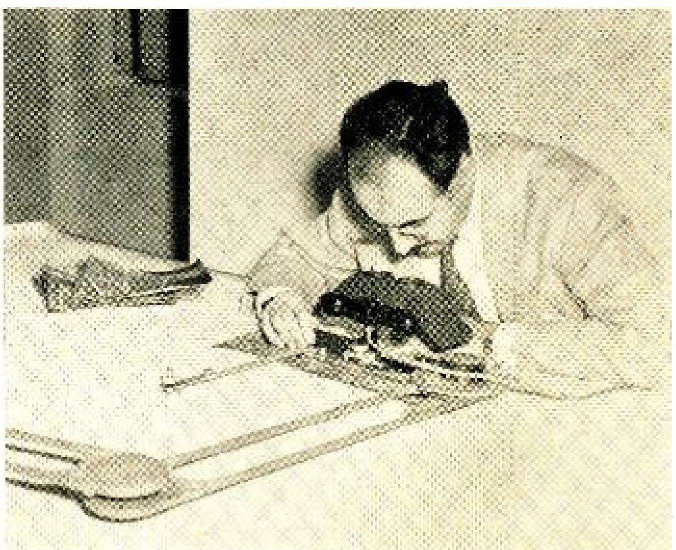


Fig. 5. Stereocomparagraph being used for elevation measurements on aerial photographs.

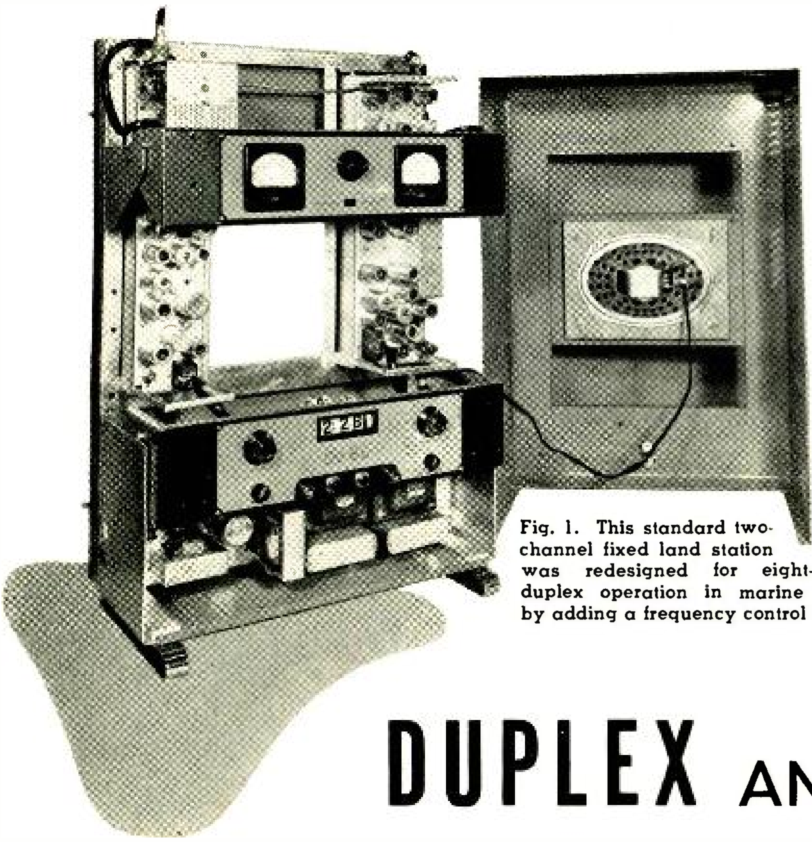


Fig. 1. This standard two-channel fixed land station was redesigned for eight-channel duplex operation in marine service by adding a frequency control chassis.

Equipment and channel allocation problems involved in the redesign of existing communications systems to include duplex and multichannel operation in v.h.f. marine service.

By **WILLIAM ORNSTEIN**

Canadian Marconi Company

DUPLEX AND MULTICHANNEL MOBILE EQUIPMENT

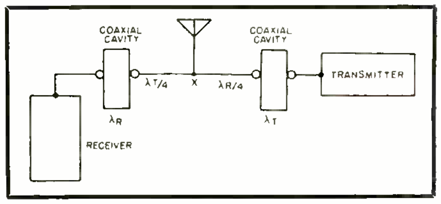


Fig. 2. Use of two coaxial cavities for a common antenna working duplex system.

PROVISION for duplex operation and multichannel facilities is frequently encountered in the specification of v.h.f. mobile communication systems. The normal requirement is that such features be provided by modification of standard designs without undue increase of cost, size or power drain. Moreover, it is important that the basic performance characteristics of the equipment be maintained after the addition of these new facilities. This paper will describe some practical design solutions to the above system requirements as developed to meet the needs of v.h.f. marine service. It is believed that the techniques employed in meeting v.h.f. marine requirements will be equally applicable to similar land mobile equipment.

Due to the relative newness of marine v.h.f. service, channel allocations and usage have not been standardized as yet for all areas. However, certain requirements are common in all cases, as follows:

1. The equipment employed must be capable of operation on a minimum of eight channels with provision for rapid channel change.
2. One frequency is normally employed as an international safety and calling frequency which is continuously monitored by all vessels when the equipment is not otherwise in use.
3. One or two channels are so-called public correspondence channels used for ship-to-shore communication. These channels often work into telephone company exchanges and are generally operated duplex.

Table 1[1] lists the transmitting and receiving frequencies which have been proposed for one such system, namely, shipboard installations on the Great Lakes. With some modification, similar arrangements are being used on the Canadian west and east coasts. While a total of eleven channels are shown on this table, any given installation would not in general require more than eight channels. These would normally include channels 1, 2, 7 and 8 and four of the remaining channels.

It should be noted that the transmitting frequencies lie in the range of 156.3 to 157.4 mc., with a total spread of 1.1 mc. However, receiver frequencies lie in two groups: channels 1 to 6 and W, X and Y cover the channel 156.3 to 157.2 mc. with a spread of .9 mc., while channels 7 and 8 cover the range of 161.9 to 162.0 mc. with a spread of .1 mc.

In the case of the transmitter, the entire group of channels can be handled by crystal switching only, without necessity of retuning or switching tuned circuits. In the case of the receiver, the frequency range is 5.6 mc., which is a wider band than the receiver front end can be designed to handle without deterioration of other performance characteristics. It is, therefore, necessary to adopt special design measures to permit rapid switching of the receiver to any one of the allocated channels.

Several interesting problems were raised in the design of equipment for this service, and some of the solutions adopted will now be described under "Duplex Operation" and "Multichannel Systems."

Duplex Operation

As normally employed, the term "duplex operation" implies that at each end of a radio communication link the transmitter and receiver are capable of simultaneous operation without prohibitive interference by a transmitter to the adjacent receiver. While all transmitters and receivers of the system may function simultaneously, it is more usual in mobile systems to employ "press-to-talk" duplex, i.e., while both receivers function simultaneously, the transmitters are only energized when required for communication. An alternative method of operation is voice-operated carrier by which the transmitters are energized when speech level is applied to the modulation circuits.

Unlike normal simplex operation, a duplex radio link of necessity requires two channels. The basic design problem in a duplex system is the maintenance of normal receiver performance in the

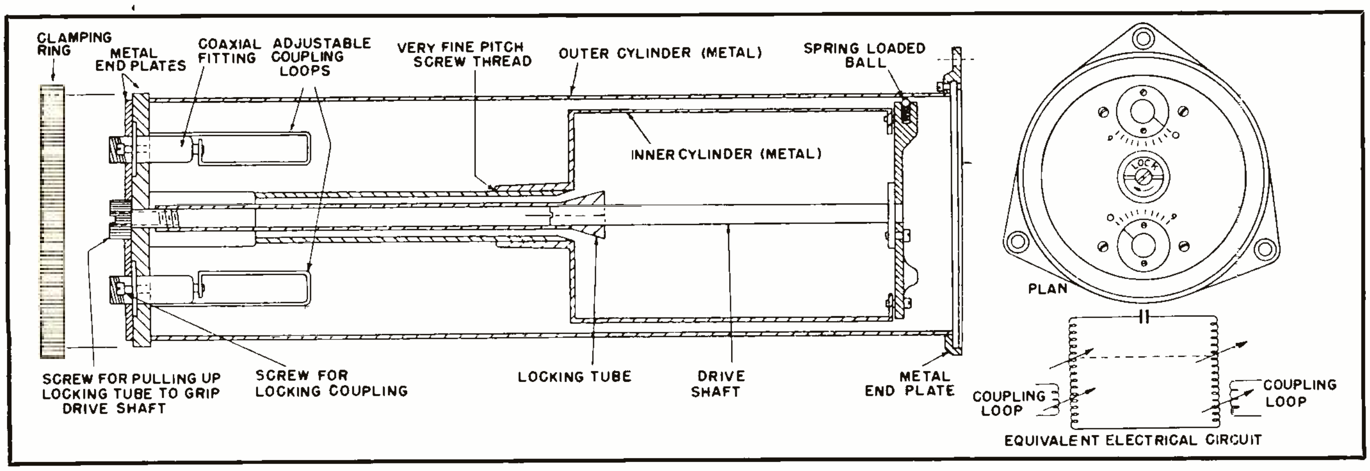


Fig. 3. Tunable coaxial cavity for 140-200 mc., including plan view and equivalent electrical circuit.

immediate proximity of a simultaneously operating transmitter. This problem will in general become more acute as the frequency separation between transmitter and receiver becomes less. Most existing duplex systems employ frequency separations of the order of 4-5 mc.; however, this figure may well be narrowed in the future if suitable widely spaced channels are not available in a given area. Although the present application involves duplex operation with frequency separations of the order of 5 mc., some consideration will be given to the problem of closer frequency spacing.

Two basic requirements must be met if optimum receiver performance is to be maintained in duplex operation. First, the receiver must suffer minimum deterioration in its ability to receive the desired signal when there is simultaneously impressed across its input circuit a large signal at the frequency of the adjacent transmitter. The figure of merit of a receiver for duplex working is determined by how narrow a frequency spacing can be tolerated for a given level of interfering signal or, alternatively, how large an interfering signal can be tolerated for a given frequency separation. A satisfactory method of measurement of this characteristic is the RTMA Selectivity Test[2] for land mobile receivers, which calls for the use of two signal generators modulated at different audio frequencies and tuned respectively to the desired and interfering channels. A second requirement is that the transmitter and associated antenna system must introduce minimum interfering signal into the receiver input circuit.

The first requirement is a problem of receiver design which will not receive detailed consideration here. Obviously, spurious response and desensitization by strong interfering signals should be held to a minimum, and front end selectivity—particularly between antenna and first r.f. tube—should be as high as possible. If both receiver and transmitter are in a common housing, as is normally the case, both units should be carefully shielded to reduce interference due to the transmitter induction field. The second requirement involves maximum isolation of the transmitter output circuit from the receiver input circuit. The simplest solution to this problem is the use of separate antennas for transmitter and receiver, sufficiently well separated to insure that the mutual coupling between antennas is held to the desired minimum. In many cases, however, particularly in mobile applications, this solution is not practical; it is certainly not the most economical.

While some systems in the field do employ separate receiver and transmitting antennas, the present tendency is to use common antenna systems with some form of isolation introduced between the transmitter and receiver feeding a common antenna. Two schemes for achieving such isolation will be described here. The first is most suitable when appreciable differences are involved between transmitter and receiver, while the second is most suitable for close frequency spacings. The crossover frequency separation at which both schemes become equally effective is approximately 1-2 mc. For large frequency separations, tunable coaxial cavity filters are employed in the circuit of Fig. 2. It will be noted that one filter tuned to the transmitter frequency is inserted in the transmitter feed line at a distance of one-quarter the receiver wavelength from point X, and that similarly a filter tuned to the receiver frequency is inserted in the receiver feed line at one-quarter the transmitter wavelength from the point X (the junction of the transmitter and receiver feed lines). Each cavity reflects back to this junction a high impedance at the undesired frequency and a normal load impedance at the desired frequency; thus, energy from the transmitter is filtered out of the receiver branch and energy from the antenna is filtered out of the transmit-

Table 1. Great Lakes supplemental v.h.f.-FM radiotelephone system.

Function	Channel Designation	Frequency (mc.)
Safety calling, continually monitored	1	156.8
Navigation Channels		
General intership, all vessels	2	156.3
Coast Guard working	3	157.2
Port operations	4	156.6
Second intership, large vessels	5	157.0
Third intership, small vessels	6	156.7
Operational Channels		
Tug dispatch	W	156.9
Fishing and construction craft	X	156.5
Ferries	Y	156.4
Public Correspondence		
Ship-to-shore, duplex	7	157.3 transmit 162.0 receive
Ship-to-shore, duplex	8	157.4 transmit 161.9 receive

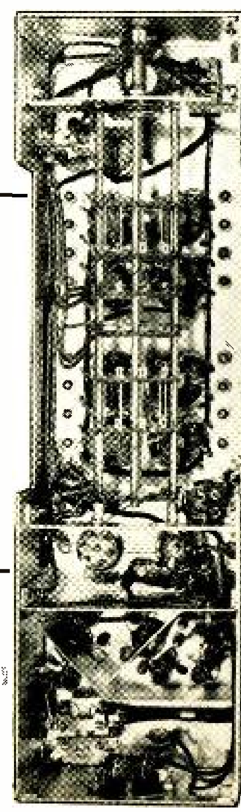


Fig. 4. View of the underside of the frequency control chassis. →

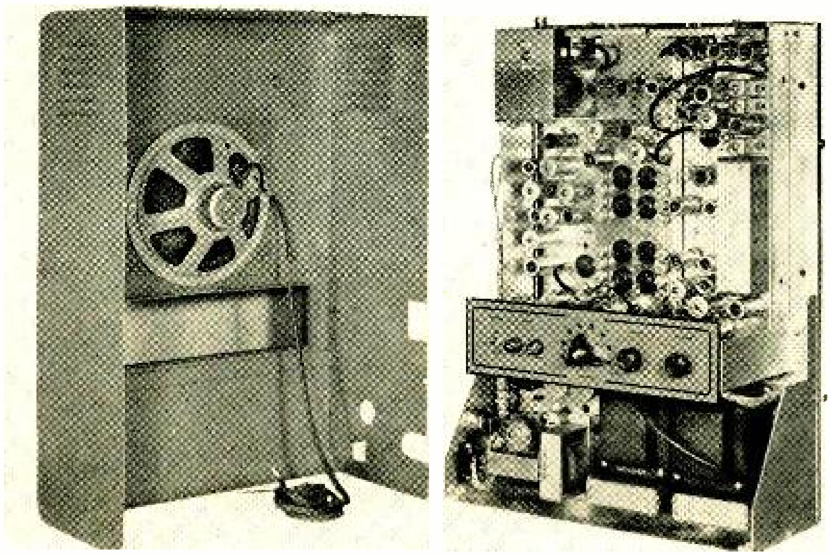


Fig. 5. Eight-channel marine equipment showing the frequency control chassis.

ter branch at the receiver frequency. This system increases in effectiveness as the difference between transmitter and receiver frequencies is increased.

Figure 3 shows a cross-sectional view and the equivalent circuit of a typical cavity. The coupling loops which terminate in coaxial fittings are rotatable, so that a compromise can be achieved between insertion loss and selectivity as required by the particular system. In general, the transmitter cavity is set up for minimum insertion loss to allow maximum power radiation from the antenna, while the receiver cavity is set up for maximum selectivity to insure minimum interference from the transmitter at the expense of somewhat reduced sensitivity.

The cavities employed in the 150-mc. band are 15½" long and 5½" in diameter, covering a frequency range of 140-200 mc. These cavities are capable of dissipating approximately 25 watts without appreciable temperature rise. The coupling loops can be rotated through 90° to obtain the desired filter characteristic. It will be noted that the drive shaft for frequency adjustment is recessed into the interior of the cavity, requiring a special tool for adjustment, and that a locking nut is provided at the end of the cavity to lock this adjustment once it has been made. The adjusting tool employed carries a rough frequency calibration engraved along its length.

Fig. 6. Response of coaxial tunable cavity filter for two loop positions.

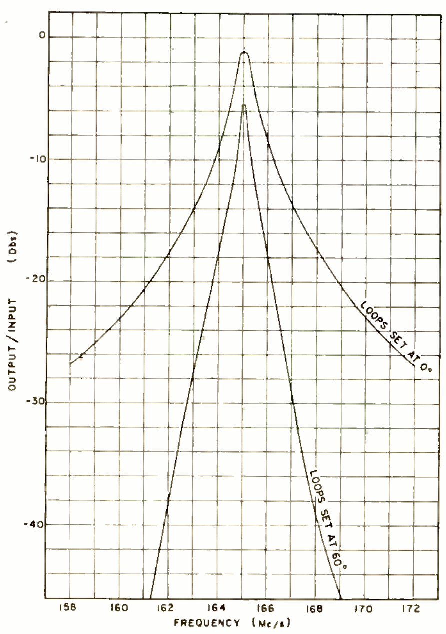


Figure 6 shows two selectivity curves. The first, with the loop set at 0°, gives an insertion loss of 1.2 db at the desired frequency and an attenuation of 20 db for frequencies 4 mc. removed from the desired frequency. The second, with loop set at 60°, gives an insertion loss of 5.5 db and an attenuation of 46 db for frequencies 4 mc. removed.

A typical calculation will demonstrate how the transmitter and receiver performance is affected by the requirements of duplex operation when using cavity filters for isolation. Consider the case of a particular receiver with .5-μv. sensitivity for 12-db signal-to-noise ratio in a duplex system employing 4-mc. frequency separation. This receiver requires an interfering signal 90 db above .5 μv. to produce a 6-db deterioration in signal-to-noise ratio. Assume that the two cavities of Fig. 2 are employed with coupling loops set at 60° for the receiver cavity and 0° for the transmitter cavity. The total attenuation from transmitter to receiver will be approximately 70 db, including the effect of the quarter-wave line in the receiver branch. The transmitter power could, therefore, be 160 db above the desired signal of .5 μv. at the receiver terminals without producing a deterioration of signal-to-noise ratio in excess of 6 db. Now, 0.5 μv. in 50 ohms is 0.5 x 10^{-14} watts. The permissible level of the transmitter power is therefore 50 watts. It should be noted that the effective level of transmitter power will be only 45 watts due to the transmitter cavity, while the receiver sensitivity for 6-db signal-to-noise ratio will be lowered from .5 μv. to 1.0 μv. by the receiver cavity.

Although no actual installations have been made using duplex operation at small frequency separations, a method has now been developed by *Marconi's Wireless Telegraph Company of England* which appears to be a promising solution to this problem when common antenna working is employed. This method uses a twin-*T* network as the isolating device, shown schematically in Fig. 7. It will be seen that there are three coaxial terminations in this circuit. When the network is set up at some given rejection frequency f_0, a large attenuation is obtained between *A* and *C*, whereas attenuation from *A* to *B* and *C* to *B* is approximately 3 db. If the frequencies of signals applied to *A* and *C* are very nearly the same, an isolation of 90 db is possible.

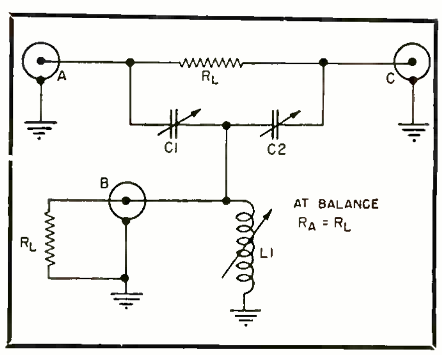
A number of problems in the use of the twin-*T* network should be pointed out. First, the 3-db loss suffered in the transmission of power from *A* to *B* or *C* to *B* represents a transmitter power loss of 50% inherent in the use of the device, as well as a corresponding loss in receiver sensitivity. Moreover, the initial balance of the circuit may be affected by changes in antenna characteristics due to the effects of weather, temperature and proximity of other objects. On the other hand, the twin-*T* network has the advantages of low cost and an effectiveness of isolation which increases as the transmitter and receiver frequencies approach each other.

Multichannel Systems

It is a common requirement of v.h.f. mobile systems that two or more channels be available for both transmission and reception, the desired channel be-

(*Continued on page* 26)

Fig. 7. Twin-T v.h.f. filter network.



TV OUTAGE ALARM

By **GEORGE WASLO**
Station WKRC-TV

Failure of either visual or aural carriers actuates an alarm and starts a clock which times the outage.

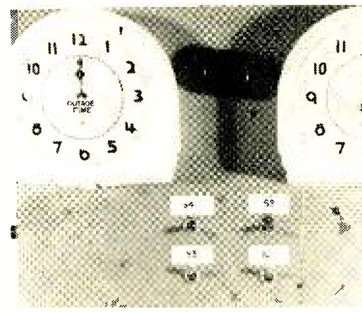


Fig. 1. Front view of system, showing the two clocks and the four switches.

MANY MANUFACTURERS of AM, FM and TV broadcast transmitters use components and circuits in their equipment which insure a minimum amount of lost air time. Further, automatic resets have been incorporated so that in the event of a momentary overload due to line surge, lightning or other reasons, the transmitter will automatically return to the air after a few seconds. In case of a sustained outage, there are usually no means available to record the time a station is off the air or the duration of "off air" time. When such failures occur, it is the engineers' duty to get the transmitter back in operation with a minimum of lost air time and its attendant financial losses.

Quite a few years ago, a simple circuit made its appearance in broadcast circles for alarm and outage purposes. However, the circuit was for a single r.f. carrier. With the advent of FM and TV, it becomes almost a necessity to have multiple alarm and time systems, especially when there are two aural carriers to monitor along with a visual carrier.

The circuit shown schematically in Fig. 2 has been developed for use at WKRC-TV. Any inventive engineer can make further modifications and adaptations to fit a particular site and mode of operation. One possible addition is the installation of a counter when failures are frequent due to line surges and other reasons.

A 12" x 17" x 3" aluminum chassis was used for this circuit, painted with gray lacquer to match associated transmitting equipment. Employing this large-size chassis left more than adequate room to install additional modifications as they are needed. All remote wires enter the chassis from the wall, and no exposed wiring is evident except two RG-8/U coaxial lines coming from pickup probes in visual and aural transmitter outputs. See Fig. 1.

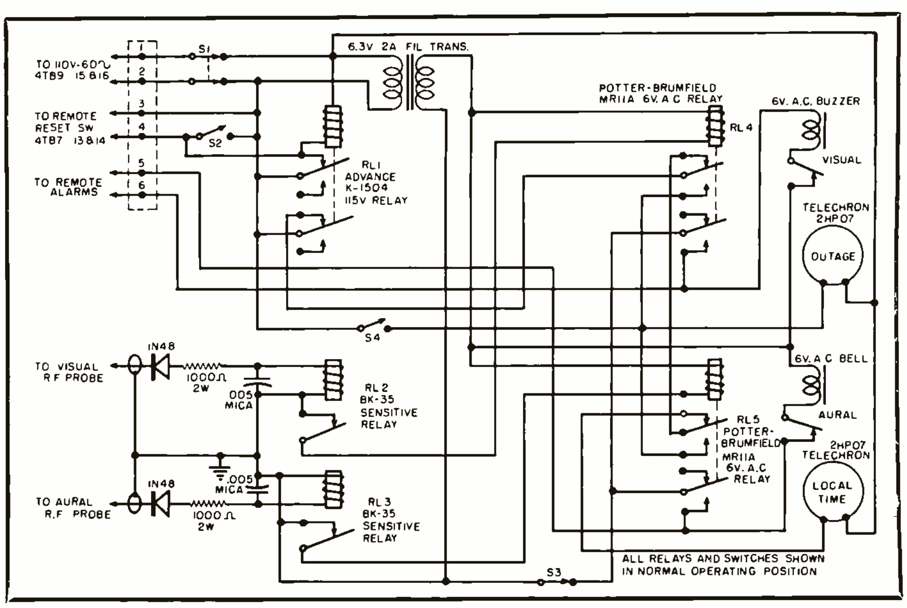
At top left is an outage clock which runs when either or both visual and aural transmitters fail. At top right is a local time clock, synchronized with a local or *Western Union* clock during the time of operating, which stops the second that failure occurs. Between the clocks, on the underside of the chassis, is a visual alarm buzzer. Switch S_4, at top left, is an outage clock reset. The outage clock should be reset to 12:00:00 each time after return to the air. Switch S_2, at top right, a local time start, is a momentary switch actuating a modified relay wired for self-locking. S_2 will not start the local time clock unless both visual and aural carriers are on. Switch S_3, at bottom left, is an alarm control for both visual and aural outage alarms. Throwing S_3 to the off position does not stop the outage clock from running during a failure. This switch was installed as a working convenience during a sustained outage and eliminates the noise of alarms while repairs are being made. It must be turned on during normal operation in order to insure a positive audible warning when failure occurs. Switch S_1, at bottom right, is the main power switch to the alarm system. Provision is made at WKRC-TV for the remote switches (the air clock switch and main power switch) to be controlled from an operating console. Also, terminals are available for installing remote alarm buzzers in the workshop or blower room.

Five minutes prior to the completion of a day's programing, at a time when the local time clock sweep hand is at 00, the main a.c. switch is thrown off and then back on again. Momentarily throwing this switch off removes the locking relay energizing voltage and thereby stops the local time clock. After turning on visual and aural transmitters the next morning, the "sign-on" engineer can preset the hour and minute hands of the clock, then can turn it on by a local time switch (or auxiliary switch on the console) at the correct time.

If a failure has occurred during the preceding day, S_4 is thrown on. This switch starts up the outage clock. When the sweep second hand is straight up, the switch is turned off and the other hands of the clock reset to coincide at 12:00:00. The main a.c. switch is thrown off prior to the "sign-off" of both visual and aural transmitters. Such a procedure forestalls the possibility of alarms ringing and the outage clock running.

The unit is mounted on the wall by means of screws similar to the type used to hang curtain rods in the home. This type of mounting facilitates easy servicing of relays and diodes. Adjustments are made by setting the probe in the r.f. line so that the BK-35 relays will become de-energized if the visual or aural carriers drop 30%.

Fig. 2. Schematic diagram and parts values for the TV outage alarm.



AUTOMATIC RECORDING SWITCH

By **JULIUS SMITH**

Staff Engineer, KTRH

Station break time between network programs is utilized to start a tape recorder automatically by means of the "Auto-Record" switching device.

ONE OF THE tasks of a multiple-duty broadcast station employee is that of tape-recording a network program for delayed playback. It is usually necessary to start the tape recorder during the period when station identification is being given and the local business being run. As the man on duty is pretty busy concentrating on the break, he sometimes temporarily forgets to start the recorder, thereby missing the first few seconds of the program or possibly the entire program. The "Auto-Record" does triple service: it provides (1) complete automatic starting of tape recorders at the proper time, (2) an audio reminder to start recorders not wired for automatic starting, and (3) an audio alarm when the network fails and again when it returns, thus calling the failure to the attention of the person attending the machine and making it possible to prepare a fill for playback time.

The Auto-Record has done an excellent job of solving the problem of tape recorder starting at Station KTRH. A flick of a switch presets the Auto-Record any time during the program preceding the program to be recorded, and at the proper time the unit will start the tape machine recording. It puts to work the period of silence between programs on the network to actuate a program-operated relay which starts the recorder in time to record the program following the period of silence.

Figure 1 shows the simple two-tube circuit. The network program is fed into the Auto-Record, where the audio is rectified and supplied as bias to the grids of a 12AU7 control tube, V_2, which has the plates connected in parallel. As long as there is program present, V_2 is biased to cutoff and the relay is open. When the program stops, the bias on V_2 begins to decrease and V_2 begins to draw current. When this current reaches four or five mils, the plate relay closes and applies a 117-volt a.c. control voltage to the control voltage bus. Individual tape recorders are started by separate relays located within each machine which are actuated by this control voltage.

The plate relay is wired to a terminal block to provide a selection of connections. A source of 117-volts a.c. controlled voltage is available at terminals 1 and 2 as normally "off" and at terminals 3 and 4 as normally "on." Terminals 5 and 6 provide a set of normally open contacts, while 7 and 8 offer a set of normally closed contacts. No one installation will need all the combinations, but they are available for possible use.

There are no special instructions necessary for construction. Parts layout is not critical, but an idea of how the parts were placed in the original unit may be obtained from the photographs. The chassis was formed from the aluminum base of an old transcription disc. Dimensions of the original were about 5" x 8".

Input transformer T_1 is a 3:1 interstage with a 10,000-ohm primary. Thus, it is possible to place the Auto-Record across the network line without loading. Tube V_1 (a 6AT6) provides a stage of audio amplification, and its diodes also rectify the audio to provide a d.c. voltage that is proportional to the signal input. This d.c. voltage is fed to the grids of V_2 via choke CH_1 which provides filtering action and at the same time has a low d.c. resistance. This low resistance makes it possible to have a short attack time, causing the plate relay to open as soon as program is applied to the unit. The short attack time is useful in signaling the return of program. A resistor can be used, but a slight delay will be experienced.

C_2, the 1-μfd. capacitor from the grid of the control tube to ground, provides the delay necessary to prevent the relay from closing between words or during normal pauses in programs. This is the only part that requires attention in its selection. A capacitor with a low leakage should be chosen, not an electrolytic capacitor. Low leakage allows the maximum holdover time to be as large as possible. The capacitor used here was a surplus oil-filled paper unit, but a good stock capacitor—such as a *Mallory* CB605 or equivalent—will give excellent results. The 3-megohm

Fig. 1. Schematic diagram and parts for the Auto-Record. The plate relay may also actuate an alarm.

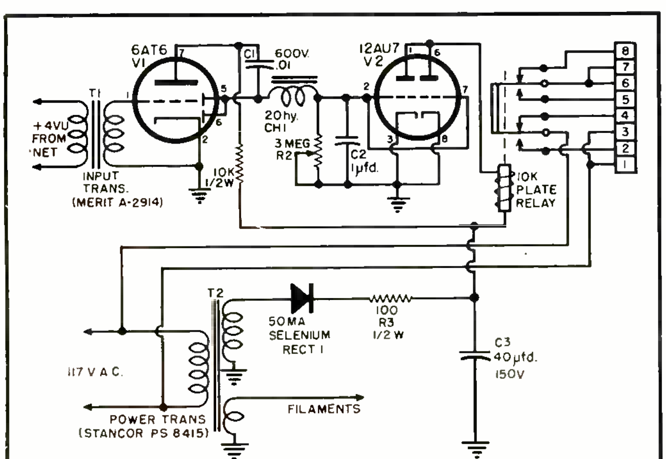
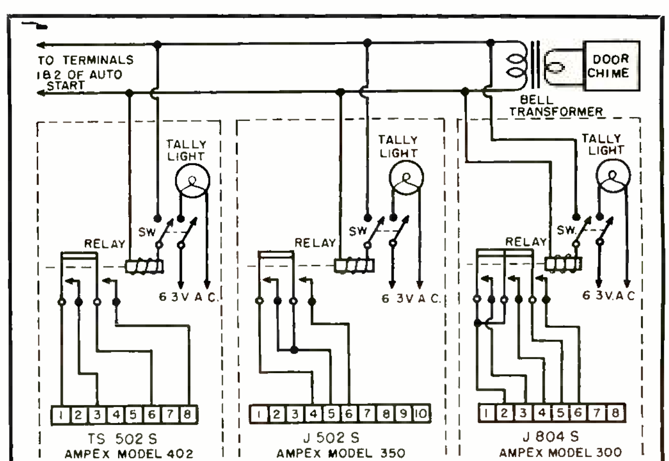
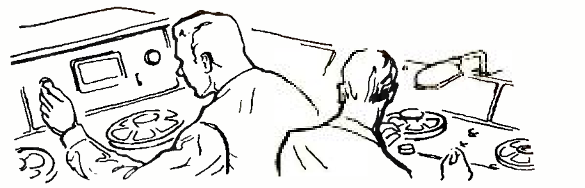


Fig. 2. Multiple machines (in this case, various *Ampex* models) may be controlled with one Auto-Record.





variable resistor across C_2 serves to control the holdover time. On the original unit, the holdover time was adjustable between zero and 20 seconds with an input level of +4 vu. Holdover, of course, will depend on input level.

The power supply, a simple half-wave type utilizing a small power transformer like the ones used in television boosters, provides isolation of the a.c. line. The rest of the components are common stock items.

On programs closing with music, the CBS and MBS networks provide a music fill to within 15 seconds of the start of the next program. Stations affiliated with these networks should adjust the resistor R_2 so that the plate relay closes 7 to 10 seconds after program stops. ABC and NBC provide no such fills; therefore, R_2 can be adjusted for a longer holdover as an added precaution against false starts. In general, false starts have not been a problem here.

Connection between the Auto-Record and the tape machine will vary with each installation. The start relay and "on-off" switch *SW* (Fig. 2) may be located within the tape machine or installed near the control console, the latter method being preferred here. Some manufacturers provide a socket already wired for remote manual control, a plug for which can easily be made. Shown in Fig. 2 is a possible connection for several different models of *Ampex* tape machines; it will be seen that only one Auto-Record is required to control any number of machines. Fig. 3 shows a connection for a Magnecorder; wiring

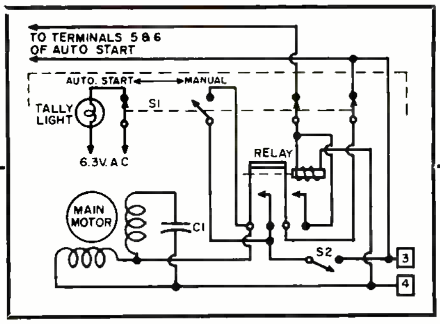


Fig. 3. Method of connecting the Magnecorder Model PT6 for automatic starting.

appearing within the dotted enclosure is located in the machine proper, while numbered block-type terminals refer to the like-numbered terminals in the manufacturer's instruction book.

On machines that require mechanical engagement of drive mechanisms when the unit is started, such as the Magnecorder PT6, etc., it will be necessary to place the relay contacts in series with the capstan drive motor and connect holding contacts to keep the relay engaged after the control voltage is removed. Notice in Fig. 3 that terminals 5 and 6 of the Auto-Record are being used. Use of these terminals is suggested to simplify the relay holding circuit. Switch S_1 can be a four-pole double-throw wafer-type with only the necessary sections used. Capacitor C_1 and switch S_2 are original parts of the Magnecorder and are shown to help identify the connections. To preset the machine, the mechanical drive should be engaged and the manual-automatic switch turned to "automatic." Then, at the proper time, the Auto-Record closes the contacts and the machine starts recording.

In each of the installations of Fig. 2, the tally light is operated from a 6.3-volt supply. The light goes on when the switch marked *SW* is thrown for automatic operation. Thus, when the light is on, the recorder is ready to be controlled by the Auto-Record unit. If a 117-volt light is desired, the power for the light can be obtained from a convenient outlet on the recorder being controlled. By taking this voltage from the recorder, only one pair of wires is required to connect the Auto-Record to the tape machine.

If the start relay and "on-off" switch are located at a position near the console or remote from the tape recorder, it will be advisable to have tally lights both at the control location and at the recorder proper. The light at the control location serves as a warning that the recorder is ready to be controlled by the Auto-Record unit. This additional tally light can be connected very simply in parallel with the tally light shown.

The immediate attack time allows the plate relay to open the instant program is resumed. This makes it possible to attach a door chime to the control bus, as per Fig. 2, to signal not only when the network pauses longer than the preset interval but also at the instant that program returns. A door chime that sounds a different tone when the voltage is removed than when it is applied should be used. Then, one tone can be heard when the period of silence exceeds that to which R_2 is set and a different tone heard when the network program returns.

Credit should be given to the KTRH Engineering Department and especially to Duke Thornton, the man who installed the Auto-Record for use at Station KTRH.

Fig. 4. Underchassis view of the Auto-Record with various components identified (see Fig. 1).

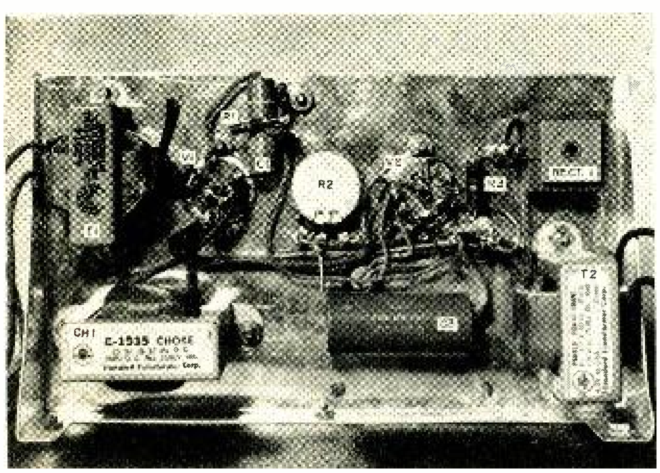
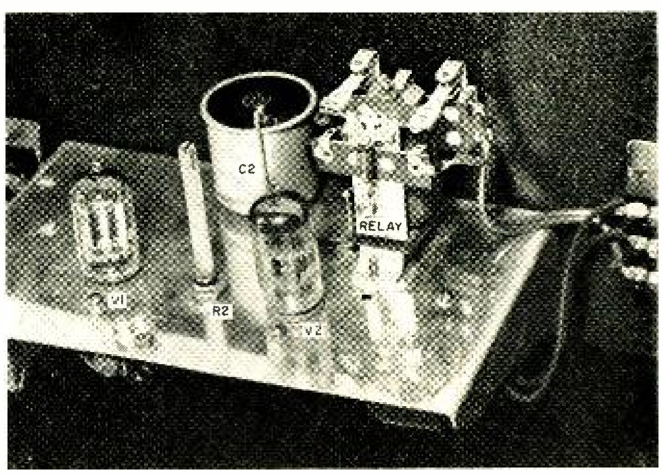


Fig. 5. Top chassis view of the completed unit, showing location of the tubes and plate relay.



SPECIAL U.H.F. TEST EQUIPMENT

An analysis of equipment and techniques for making tests and measurements in the 300-3000 mc. region.

JUST as the microwave region requires its own series of specialized test equipment, development work in the u.h.f. band calls for certain special instruments and techniques. For instrumentation and equipment purposes, it is convenient to divide the u.h.f. band into a lower portion extending up to 1300 mc., and an upper portion including the *S* band up to 3000 mc. This article will deal primarily with the lower u.h.f. band, but most of the instruments and techniques to be discussed are also applicable in the upper band.

Generally available test equipment includes signal sources and frequency and gain measuring devices. In addition to standard laboratory equipment, the author has found that very special devices are required for accurate and efficient measurements in the u.h.f. band. Some novel instruments will be presented here, together with their use for precision measurements and the degree of accuracy which can be achieved.

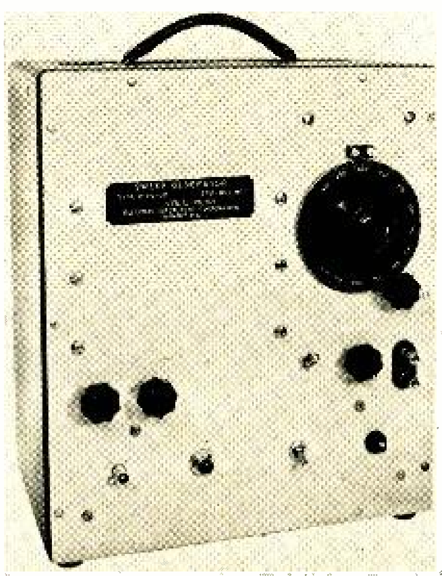
The major contribution to efficiency in measurement is a newly developed wide-band approach which involves measuring, observing and recording the various circuit characteristics not at a single frequency but over a relatively wide band of frequencies instantaneously. Single frequency measurements have their place, too, especially when extreme accuracy is required. The great advantage of a wide-band system is that it allows the determination of sideband responses, image rejection, and wide-band impedance characteristics. A wide-band sweep frequency technique has recently been described and the necessary test equipment indicated[1].

Most laboratory development projects have as their goal some eventual equipment design. Accuracy of the laboratory measurements will be partially dictated by the accuracy required from the final equipment. This does not mean that if a 1% frequency tolerance is desired on final equipment the same tolerance can be applied to the laboratory measurement preceding it. Instead, it has been found good practice to make the laboratory measurement two to ten times as stringent as the final equipment tolerances dictate. The reason for this will be self-evident when the cumulative effect of the usual production tolerances is considered. In general, therefore, it is necessary that laboratory measurements even on breadboard models be quite accurate and tolerances in every direction be tightened as much as possible. The following equipment has been chosen for maximum accuracy as well as for stability and efficient operation.

Signal Sources

Three basic signal sources are available in the band from 225 to 1300 mc. The simplest type is a test oscillator, such as the test oscillators made by *General Radio Company*, which provides good frequency calibration but only approximate amplitude control. A refinement of this type of signal is obtained with a signal generator such as *Measurements Corporation's* Model 84, or *Hewlett-Packard Company's* Models 608, 610, 612, or similar equipment which provides signals with good frequency accuracy as well as calibrated output amplitude. Pulse or sine-wave modulation from internal or external sources is also available in most signal generators. Frequency accuracy is of the order of ±0.1%, slightly less than that of a really good test oscillator, while amplitude accuracy is usually determined by an output meter and attenuator and is quite well defined. It has been found that the attenuator accuracy is excellent, especially at the lower frequencies, but a slight loss in accuracy can be expected at the upper frequency limit of the generator. Both of these types of signal sources are suitable for such measurements as single frequency gain, image rejection, impedance and standing wave ratio. Measurements can be made in conjunction with an output meter, slotted line or an impedance bridge.

Fig. 1. Commercial sweep frequency generator with range of 470 to 890 mc.



The third type of signal source, a sweep frequency generator, is fairly new and unique. Principles of sweep frequency testing and visual alignment which are accepted in the broadband i.f. and v.h.f. region have now been extended to the u.h.f. band[1]. Three types of wide-band sweep generators have been developed to cover the important bands from 225 to 1275 mc. Figure 1 shows the external appearance of the *Kollsman* Type 2144-02 sweep generator which covers the u.h.f. television range, 470 to 890 mc., in a single sweep band. Other models cover ranges from 225 to 420 mc. and from 850 to 1275 mc., each in a single sweep. While such generators are primarily used for bandpass response measurements, they are also applicable for impedance, VSWR and attenuation measurements.

For impedance and VSWR measurements, a long line and the reflections from it are used in conjunction with the wide-band sweep generator and oscilloscope to give a presentation indicative of the degree of mismatch at the end of the line; 50, 75 or 300Ω impedance measurements can be made by this method depending on the type of transmission line used.[1]

Impedance Levels

One of the important considerations in any laboratory test setup is the impedance level to be used. The most frequently employed are the 50Ω and 75Ω unbalanced and 300Ω balanced levels. Most items of test equipment are designed for the 50Ω impedance level although some units, especially in the television field, operate at 75Ω. U.H.F. television tuners, however, use a 300Ω balanced input fed by 300Ω transmission line and 300Ω u.h.f. television antennas. Whenever it is desired to use a 50Ω system with test equipment having a different impedance level, an impedance transformer is required. Several companies furnish 50 to 75Ω coaxial impedance transformers and a 75 to 300Ω

By **WALTER H. BUCHSBAUM**

Kollsman Instrument Company*

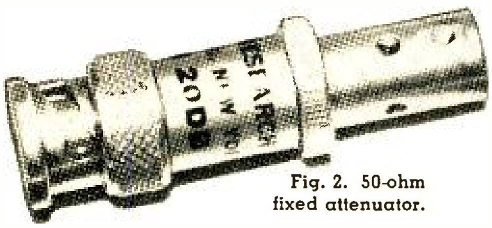


Fig. 2. 50-ohm fixed attenuator.

balance-to-unbalance matching device. A 50 to 300Ω balun for use in the u.h.f. television band has been described[2].

Military applications, as well as aircraft navigational aids, employ a 50Ω coaxial system using either type BNC or type N connectors. Most of the signal sources mentioned in the previous section have a 50Ω output impedance and can be used directly with the conventional 50Ω coaxial system.

Attenuation

For many measurement and test setups, it is essential that individual fixed attenuators of known values be used. Such attenuators are also required as loads for crystal diode detectors in order to provide a 50Ω impedance at the detector input. Other applications include reducing VSWR on coaxial systems, making comparative gain measurements, reducing spurious radiation, etc. At frequencies below 1000 mc., fixed pads like the one shown in Fig. 2 and made by *Applied Research, Inc.*, are particularly suitable. The pad in Fig. 2 consists of a male and female type BNC connector with a resistive attenuator network located internally.

The *Kollsman* Type 2146-01 variable precision attenuator is shown in Figs. 3 and 4. This attenuator consists of 12 separate, easily interchangeable attenuator pads, mounted in a turret structure similar to that used in a popular TV tuner. When making relative gain or loss measurements, the turret attenuator is especially useful since it has zero insertion loss and can be switched to any predetermined, precise value of attenuation. The Type 2146-01 unit has steps of 0, 3, 6, 9, 12, 15, 20, 30, 40, 50, 60, and 70 db. Other combinations up to 100 db are also available. A further refinement of this turret attenuator is a model featuring two turret assemblies connected in series and using concentric shafts and a decade counting dial; one turret contains 1-db steps while the other contains pads in 10-db steps, permitting the user to select from 0 to 100 db in accurate 1-db increments.

Frequency Measurement

For accurate frequency measurements in the u.h.f. band, three methods are available. The most precise method involves the use of a coaxial slotted line and a precision scale. The unknown frequency is fed into this line and the half wavelengths are determined by measuring between adjacent null points. Accuracy of the frequency measurement here depends largely on the precision of the mechanical measurement. This, in turn, can be quite close if a scale having vernier adjustments is used.

The second precise frequency measurement technique involves heterodyning the unknown frequency with one originating in a crystal-type frequency meter. A crystal-controlled harmonic-type secondary frequency standard such as the TS173 is particularly useful, as are some other secondary frequency standards made by commercial suppliers or available from government surplus.

The third method of measuring frequency accurately involves a cavity similar to resonant cavities used in microwave work. Figure 6 shows the inside of a typical u.h.f. cavity-type frequency meter, the *Kollsman* Type 2145-02. A small 50Ω impedance loop couples energy into a quarter-wavelength, resonant, shorted coaxial line. To vary frequency, the open end of the line is capacity-tuned over the desired band. The variable capacitor, clearly shown in Fig. 6, is calibrated by hand either with the slotted line method or with a precision heterodyne frequency meter. Once calibrated, only extreme variations in temperature or physical distortion will change the frequency characteristic of this type of wavemeter. The rugged construction, a cast body and hard soldered capacitor blades, provides excellent rigidity and stable frequency calibration.

One special advantage in using this cavity-type of frequency meter is that a whole set of them can be connected in series, as shown in Fig. 5, to provide accurate markers at a number of fre-

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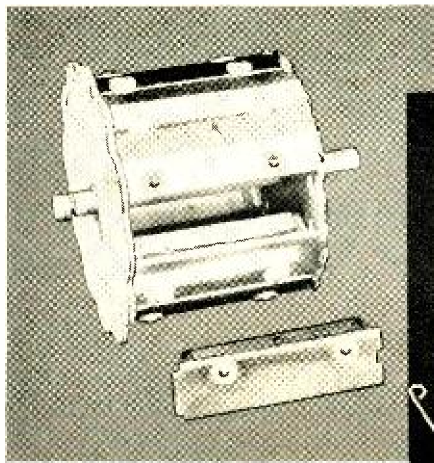


Fig. 3. Rotor of turret attenuator.

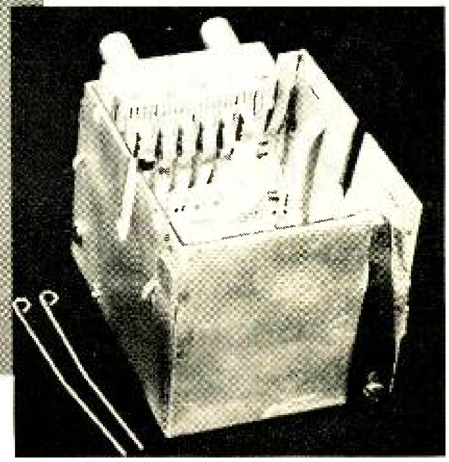


Fig. 4. Enclosure for turret attenuator.

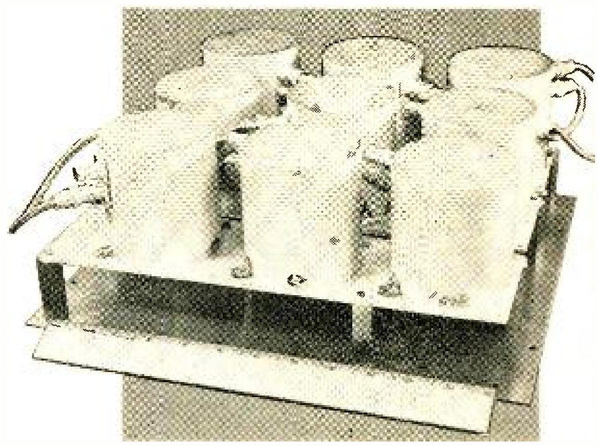


Fig. 5. Multiple frequency marker assembly.

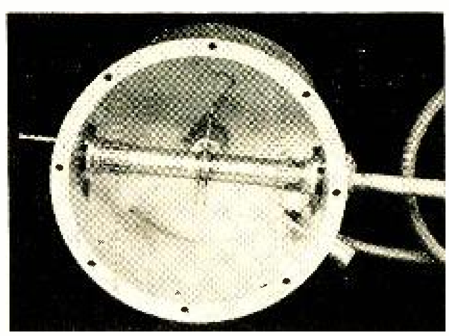
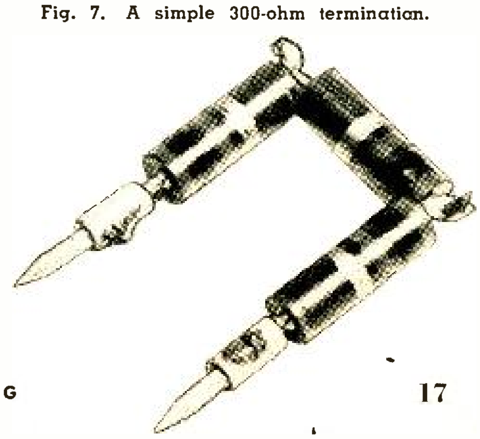


Fig. 6. Interior of cavity-type marker.

Fig. 7. A simple 300-ohm termination.



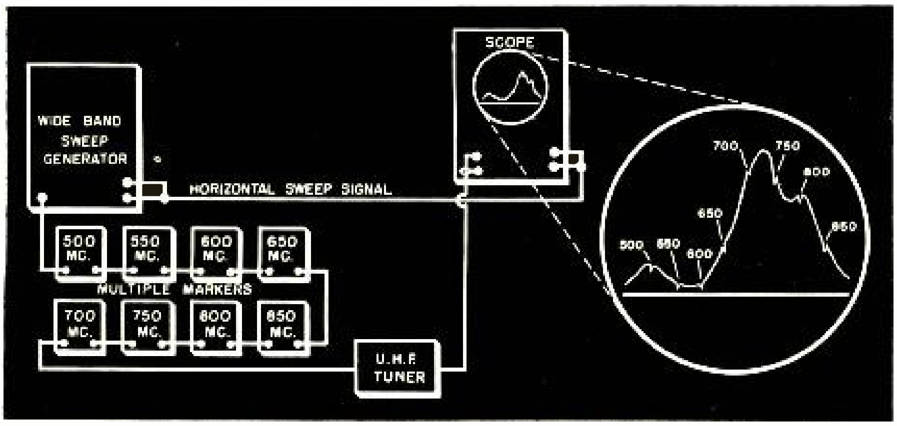


Fig. 8. Test setup for making use of the multiple marker equipment.

quencies. The arrangement of multiple markers, each set to a desired discrete frequency, is particularly useful in applications where a wide sweep width and alignment at several points are required. A typical application of this arrangement is in production line testing of u.h.f. television tuners, a block diagram of which is shown in Fig. 8.

300-ohm Equipment

In u.h.f. television receivers, the 300Ω balanced system is used almost exclusively for antennas, transmission lines and tuner input circuits. In order to make measurements on these devices, signals from 300Ω sources and various items of 300Ω test equipment are required. For precise impedance measurements, a 300Ω balanced Lecher wire system with a movable detector is very useful, but an accurate device of this nature is extremely difficult to construct. As a substitute, it is possible to use a conventional 50Ω slotted line, a 50 to 300Ω balun and various 300Ω attachments. The drawback to this arrangement is the fact that the balun itself is usually not perfect and its VSWR may either be added to or subtracted from the VSWR of the item under test. In order to measure the VSWR of the balun itself, it is necessary to terminate it in a good 300Ω load.

The author has found the 300Ω termination illustrated in Fig. 7 to be one of the best obtainable with standard available components. Use of three resistors in series results in a reduction of the capacity inherent in any single resistor. The 300Ω termination is supplied with connecting pins—the coaxial male pins of BNC connectors—which mate with the contacts in the *Kollsman* Model 2B balun[2]. If the total resistance of this combination is within ±1Ω of 300Ω, a VSWR of 1.05:1 for the termination can be achieved over the entire u.h.f. band. Use of a single film-type resistor of special u.h.f. construction with very short leads will rarely result in less than 1.10:1 VSWR.

Figure 9 shows an assortment of 300Ω components commercially available from *Microlab*. This series contains a balanced 300Ω detector, termination and attenuators of varying values. Special 300Ω balanced connectors, male and female for the attenuator, are utilized in a series arrangement of the various components. The 300Ω connectors have excellent u.h.f. impedance characteristics and are very helpful in avoiding wire or solder connections which often cause impedance mismatch.

Equipment Limitations

Accuracy and validity of all measurements and tests in the u.h.f. region are limited by the type of equipment and the test methods used. Frequency accuracy is limited not only to the degree of accuracy inherent in the frequency measuring device, but also to the degree of reading accuracy. In general, it is the latter which causes the most difficulty. In the slotted line frequency measurement method outlined above, the limitation lies in the accurate location of the minimum points, and then in the precise reading of the mechanical scale in thousandths of an inch. One way to minimize the reading difficulty is to use a vernier gage, usually employed for height or depth measurements in precision machining operations, to read the displacement between nulls. In the heterodyne frequency measurement method, the limitation in accuracy—in addition to that of the crystal—lies in the reading of the frequency dial. Parallax, the error due to looking at a hairline through a plastic index, is one of the chief trouble-makers in this respect. Needless to say, the cavity-type frequency meter is also limited in accuracy both by its own calibration and by the width of the absorption response curve or the cavity *Q*.

The most serious limitations in accuracy of measurement, however, occur when impedances are measured. Any connector, or length of cable, placed between the output of the slotted line or other impedance-measuring device and the item under test will itself introduce some mismatch. Depending on the polarity, this mismatch effect may make the total reading worse or better. An investigation into the effective mismatch in the region from 400 to 1000 mc. revealed that two of the worst offenders were the UG-349/U and UG-349A/U adapters from type N to BNC connectors, while type N or BNC connectors alone have fairly good 50Ω characteristics up to 1000 mc. In order to go from a type N to a type BNC system, it was found most helpful to use intermediary connectors of the *General Radio* coaxial type. Thus, two adapters were used, one type N-to-*General Radio* coaxial unit and then a *General Radio* coaxial-to-BNC unit. VSWR of 1.04:1 was recorded for this combination as against 1.09:1 for the conventional type N-to-BNC adapter. In the course of this investigation, most commercially available 300Ω twin lead connectors were tested; an inherent mismatch of at least 1.3:1 at 900 mc. was determined for even the best type.

Another serious limitation in some types of measurements is the fact that radiation, especially in the u.h.f. TV band, is quite considerable when open lines are used. In the case of 300Ω tubular twin lead, the radiation from the cable itself was found to be so considerable that a spacing of at least three feet between adjacent cables was required when 10 mw. of r.f. energy was applied. It was also found that the 300Ω balanced system would be seriously unbalanced if a ground plane were brought to within three inches of the tubular

(*Continued on page* 25)

Fig. 9. A 300-ohm detector, termination, and a 20-db attenuator.

COMMUNICATION REVIEW

MICROWAVE RAILROAD EQUIPMENT

Microwave radio relay equipment designed to meet the specific requirements of railroads is now available from the Engineering Products Division of the *Radio Corporation of America*, Camden, N. J. Both the RCA CW-20 and the RCA CW-5 systems are designed to work with standard railroad-type telephone and telegraph carrier equipment, in conformity with the tentative microwave specifications of the Association of American Railroads.

The RCA CW-20, which operates in the 2000-mc. band, is intended for long-haul multichannel backbone microwave radio relay. Utilizing conventional single-sideband suppressed-carrier channeling equipment, the RCA CW-20 will handle up to 24 voice channels, plus a service channel, in systems more than 1000 miles in length.

As a companion line, the RCA CW-5 operates in the 950-mc. band for short-haul service, and will handle up to six voice carrier channels. The CW-5 series can be used for leg circuits to extend a small number of channels from a 2000-mc. backbone microwave system to intermediate way stations.

D.C. POWER SUPPLY

Tech Laboratories, Inc., has announced a mobile transmitter power supply called the "RODIC" Type RO-2. This unit represents a completely new concept in converting low d.c. voltages to those levels required in mobile and marine transmitter operation. Operating from a 6-volt battery, it has two

filtered outputs available: 520 v. at 320 ma., or 330 v. at 320 ma.

Engineered for completely automatic operation, the "RODIC" offers many advantages: 75% efficiency, 5 to 8% regulation, and low starting current with no surge whatever. The rugged, compact unit provides instant starting and stopping, long operating life, and ease of maintenance. For further information, write to *Tech Laboratories, Inc.*, 8 E. Edsall Blvd., Palisades Park, N. J.

COMMUNITY RADIO NETWORK

Several communities in Lake County, Illinois, have joined in a countrywide radio network to facilitate police and fire communication. Police stations and many volunteer fire departments are

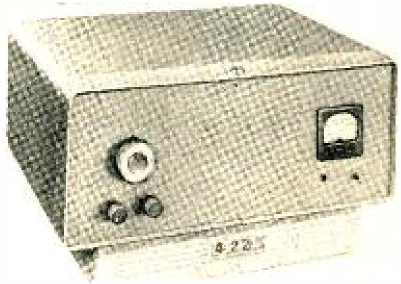
linked to a master transmitter and receiver located near Libertyville, Ill. Selective coded controls enable the station to eliminate all towns not concerned with specific messages and to include those that are involved.

The communications system at Libertyville is run by Harry Quandt, World War I Navy radioman, who originally designed, engineered and helped to finance the equipment. If the public power should fail, the system is automatically kept in action by a 10-kw. *Kohler* electric plant. More than 75,000 calls were handled during 1953.

FM TWO-WAY RADIO

"Fleetway" two-way radio, now being produced by the *Connecticut Telephone & Electric Corp.*, Meriden, Conn., for operation in the recently allocated 450-460 and citizens' band, incorporates a major advance in radio circuit design—the patented Lister circuit. It offers the first true FM transmission and reception in mobile radio, resulting in noise-free "broadcast quality" speech and better coverage in congested areas than previously possible.

Two models are currently available—a 4-5 watt model for under-the-dash or trunk-mounting, and a 25-30 watt



fixed station (shown in the photograph). The Lister circuit uses a starting crystal oscillating frequency of approximately 75 mc. instead of the usual 6 mc., which enables the transmitter to reach 450 mc. with a frequency multiplication of only six instead of the usual 24 times or more; elimination of these stages substantially reduces the number of components and leads to a complete departure from conventional radio design.

GLOBAL SYMPOSIUM

The first Symposium on Global Communications, sponsored by the Institute of Radio Engineers' Professional Group on Communication Systems, was held in Washington, D. C., June 23-25. Technical papers on various aspects of world-wide communications were presented in two full-day sessions by commercial, military, and other specialists in the field. On the third day of the meeting, field trips were conducted to nearby commercial and military communications centers.

MOBILE TRANSMITTER TUBE

A beam power tube has been announced by the Tube Department of the *Radio Corporation of America*, Harrison, N. J., which is designed for use in compact, low-power mobile transmitters and in emergency communications equipment operating from 12-volt storage batteries. Having an ICAS plate-dissipation rating of 13.5 watts, the RCA-6417 can be operated with full input up to 50 mc. and with reduced input to 175 mc.

Because of its high transconductance, and a plate characteristic favorable to the generation of a high harmonic output, this tube is particularly useful in the doubler and tripler stages of transmitters. Its high perveance makes possible high power output at relatively low supply voltages.

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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

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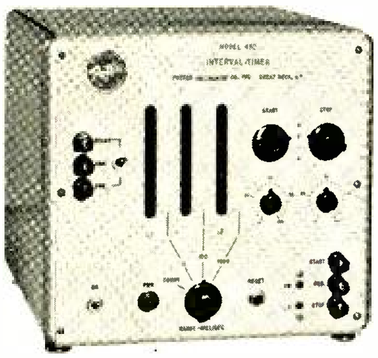
NEW PRODUCTS

INTERVAL TIMER

Designed by *Potter Instrument Company, Inc.*, 115 Cutter Mill Rd., Great Neck, N. Y., for industrial as well as laboratory use, the Model 432 is a pre-



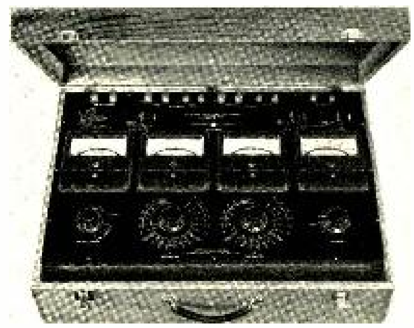
cision instrument for measuring short time intervals. Three ranges are provided: 0.01 to 9.99, 0.1 to 99.9 and 1 to 999 milliseconds. In addition, the unit serves as a high speed totalizing counter with a count capacity of 999, and as a secondary frequency standard with outputs of 100, 10 and 1 kc., and 100, 10 and 1 cps.

In making a time-interval measurement, three electronic decades count the number of time-base pulses occurring during the unknown interval. A choice of three different time-base frequencies is provided: 100, 10 and 1 kc. All time-base signals originate in a 100-kc. crystal-controlled oscillator.

A.C. TEST SET

Engineers in research and development laboratories often find themselves in need of measuring equipment capable of giving a complete picture of 60-cycle voltages, currents, power and power factor. The *Sensitive Research Instrument Corporation* has announced a universal "60" a.c. test set which fills this need with a compact, rugged, and accurate set of instruments designed to be used together.

There are four separate instruments in this test set together with their necessary switches: two wattmeters, a voltmeter and an ammeter. These instruments create 36 ranges in watts from 5 to 2000 watts full scale (which can be used down to power factors of 10%), seven current ranges from 10 ma. to 10 amp. full scale, and four



ranges in volts from 30 to 300 volts full scale.

A four-page descriptive bulletin is available on request from the *Sensitive Research Instrument Corporation*, Dept. 122A, 9-11 Elm Ave., Mount Vernon, N. Y.

ANALOG COMPUTER

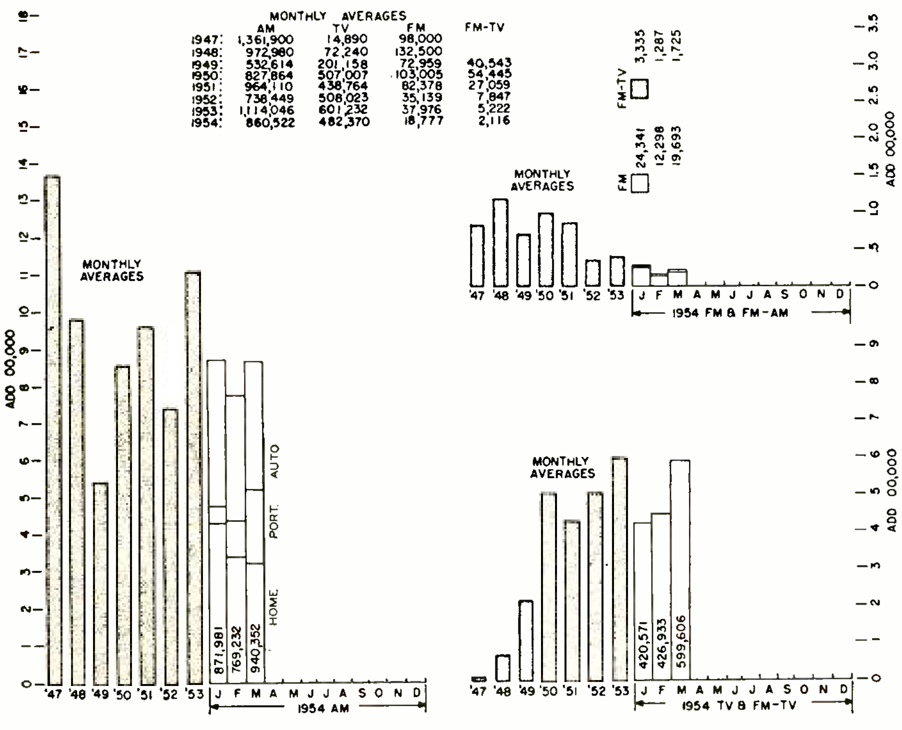
Electronic computation is made economical enough for use wherever differential equations are studied by the *Donner* Model 30 analog computer. This portable "electronic slide-rule" contains ten stable high-gain amplifiers, a fully regulated power supply, and provision for applying five independent initial condition voltages. It is capable of solving most constant-coefficient differential equations of both linear and nonlinear types which are encountered in engineering problems.

Plug-in printed circuit problem boards are a special feature of the Model 30 computer. Accuracy of problem solutions is determined by the

precision of components installed on the problem board by the user; with proper component values, ultimate accuracy of the Model 30 is approximately 0.1%. Full details are given in Technical Bulletin No. 301, available

TV-AM-FM SET PRODUCTION

Information based on latest reports from RETMA.



from *Donner Scientific Company*, 2829 Seventh St., Berkeley 10, Calif.

COMPARISON BRIDGE

In Type No. 1010A, *Freed Transformer Company, Inc.*, presents a comparison and limit bridge which may be used in both laboratory and production testing. Test frequencies of 60 cps, 1 kc. and 10 kc., and ranges of 5% and and 20% are available. The voltage across the unknown can be varied from .1 to 10 volts.

This instrument is completely self-contained and a.c. operated. The face contains a visual null indicator with a high gain selective amplifier. Suitable for use in noisy locations, the small size and light weight of the Type 1010A permit it to be moved easily and set up wherever necessary.

For further information, write to the *Freed Transformer Company, Inc.*, 1715 Weirfield St., Brooklyn 27, N. Y.

TIME DELAY PASSIVE NETWORK

The Type 303 continuously variable time delay passive network, announced by *Advance Electronics Co., Inc.*, 451 Highland Ave., Passaic, N. J., is suitable for use as a time delay matching device in TV systems, a variable time delay for pulses, or for the precision measurement of small time intervals. Both the bandwidth and the transient response are excellent. Rise time is less than 7% of the time delay at any point, and the overshoot is less than 2%.

This instrument consists of an input amplifier, an output amplifier, and a continuously variable delay line; time delay may be adjusted continuously by the front panel dial. Ten different types of delay lines are available, the shortest one being 0 to 0.05 μsec. and the longest one 0 to 0.8 μsec. Accuracy can be maintained within ±1% after calibration.

MODULAR MOUNTINGS

Mycalex modular mountings permit semiautomatic assembly of electronic equipment with standard components

(*Continued on page* 31)

NEW LITERATURE

REGULATED POWER EQUIPMENT

General information on the operating principles of *Sorensen* regulated power equipment and specific data on each instrument are given in Catalog No. 254, available from *Sorensen & Co., Inc.*, 375 Fairfield Ave., Stamford, Conn. Included in the standard line of instruments are: electronic a.c. voltage regulators, regulated d.c. sources and B-supplies, electronic frequency changers, inverters, magnetic amplifier d.c. sources, and related equipment.

SOUND MEASUREMENT

The *General Radio Company*, 275 Massachusetts Ave., Cambridge 39, Mass., has released a 12-page two-color bulletin on the measurement of sound in industry, government, psychology, hygienics and medicine.

Included in the complete line of *GR* sound and vibration measuring equipment are: a sound-level meter and its standard accessories; a sound-survey meter; sound analyzer for narrow-band measurements, octave-band noise analyzer for wide-band measurements; a vibration meter and vibration analyzer. Specifications are given, and photographs illustrate applications as well as equipment.

SCREEN ROOM FILTERS

Attenuation characteristics of six different models of standardized and stocked screen-room filters are given in a bulletin which is available on request from *Aerovox Corporation*, New Bedford, Mass. This bulletin deals with a line of single-, double- and triple-section filter units developed and produced by *Acme Electronics, Inc.*, subsidiary of *Aerovox Corporation*.

COMPONENT CASTING

"Precision Casting Facilities" shows visually the various steps taken by *Airtron, Inc.*, in casting microwave and radar components—from processing the plaster molds and cores to the completed precision unit. The text of this four-page circular stresses the ability

SILICON JUNCTION TRANSISTORS AVAILABLE

ENGINEERS attending the National Airborne Electronics Conference at Dayton, Ohio, May 10-12, were greeted with a surprise "first" by *Texas Instruments Incorporated*, 6000 Lemmon Ave., Dallas 9, Texas. Dr. G. K. Teal, of that company, presented a paper entitled "Some Recent Developments in Silicon and Germanium Materials and Devices," and closed with the announcement that the silicon transistors described were now commercially available. Apparently this company has "scooped the field," as it were, as most other manufacturers report that the commercial production of silicon transistors is months and even years away from realization.

The units in production are *n-p-n* grown-junction triodes, with a *p*-layer thickness of .001" or less. At room temperature, the basic characteristics of the silicon units are somewhat similar to those of the *Texas Instruments* grown-junction germanium Type 201 transistor. Basic differences are higher alpha cutoff for the silicon transistors (1.2 to 7.5 mc. or more) and a somewhat lower collector resistance. However, the silicon units maintain their characteristics up to temperatures of 150°C and higher, thus overcoming one of the major limitations of germanium units. The table below shows a comparison between an average silicon triode and a representative germanium triode.

These silicon triodes outperform germanium triodes of similar design by a factor of 3 with respect to power-handling capabilities. Present units are rated at 250-mw. dissipation at 25°C ambient, and 125 mw. at 100°C ambient. When the metal case enclosing such a silicon transistor is attached to a chassis for additional heat dissipation, power-handling capabilities of 1.0 to 1.5 watts at 25°C ambient can be realized.

Comparison between silicon transistor characteristics and the characteristics of a representative germanium transistor.

Parameter	Silicon Triode	Germanium Triode (*Type* 201)
I_{co} at RT, $V_c = 5$ v.	$\leq$0.4 μamp.	4.0 μamp.
I_{co} at 150°C, $V_c = 5$ v.	20-50 μamp.	very high
r_e	25-50 ohms	22 ohms
r_b	100-300 ohms	170 ohms
r_c	0.6-1.2 meg.	1.8 meg.
a	0.90-.98	.96
f_{aco}	1.2 to >7.5 mc.	1.1 mc.
noise	16-22 db	23 db

of the *Airtron* plaster mold casting process to maintain tolerances of ± .002" per inch of dimension.

Copies of "Precision Casting Facilities" may be obtained free of charge by writing directly to *Airtron, Inc.*, Dept. A, 1103 W. Elizabeth Ave., Linden, N. J.

MICROWAVE RELAY SYSTEMS

Form B.315 on television relay systems and Form B.33 on associated microwave accessories have been released by the Engineering Products Division, *Radio Corporation of America*, Camden 2, N. J.

Features of the Types TTR-1B transmitter and the TRR-1C receiver are presented in the system catalog, while various accessories such as a regulated power supply, attenuating coupler, antenna ring mounts, reflectors and reflector mounts are covered in the accessories catalog. Each catalog contains a table of suggested relay equipment and accessories for complete microwave relay systems.

RELAYS

Illustrating and describing standard relays, the *Leach* 44-page, two-color loose-leaf catalog also suggests some of the many modifications which can be made to accommodate special requirements. Details include characteristics, schematics and dimensions. For a copy of this relay catalog, write to *Leach Relay Co.*, Division of *Leach Corporation*, 5915 Avalon Blvd., Los Angeles 3, Calif.

COIL-WINDING MACHINES

Geo. Stevens Manufacturing Co., Inc., Pulaski Rd. at Peterson, Chicago 30, Ill., has issued a 46-page catalog, No. 54, which illustrates and describes machines for winding practically every kind of coil, including toroidal, transformer, bobbin, repeater, solenoid, resistor, armature, variable pitch, space-wound, lattice-wound universal and field coils. Various accessories are also covered.

MAGNETIC SERVO AMPLIFIERS

Bulletin S235-1-54, offered by *Magnetic Amplifiers, Inc.*, 632 Tinton Ave., New York 55, N. Y., summarizes in table form its standard line of 60- and 400-cps magnetic servo amplifiers. Also listed are magnetic amplifier servo systems and their servo performance. Many new amplifiers as well as new servo systems have been included in this bulletin.

U.H.F. Test Equipment

(*Continued from page* 18)

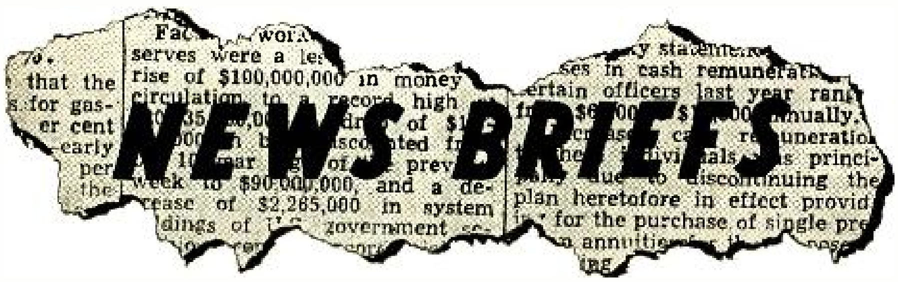
300Ω twin lead. Flat ribbon-type twin lead, commonly used in v.h.f. transmission lines, was found to be completely unsuitable for u.h.f. signals. Attenuation values of as much as 10 db at 900 mc. for a 60-foot length of flat 300Ω twin lead were measured. For the same length of tubular twin lead, only 2-db loss was encountered.

Conclusion

U.H.F. measurements of laboratory quality and precision require not only carefully thought-out techniques but also a number of specialized pieces of test equipment. Some of these items can easily be constructed with the resources usually found in a radio laboratory while other items are commercially available. The financial outlay required for accurate measuring devices is relatively low.

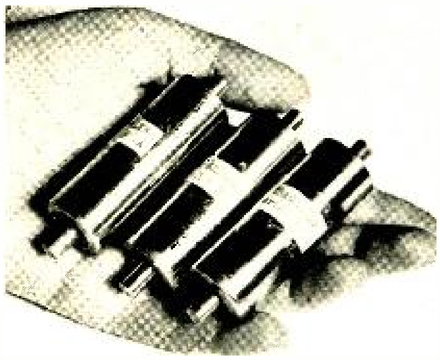
REFERENCES:

1. *Buchsbaum, Walter H., "Frequency Sweeping Technique for U.H.F.,"* RADIO-ELECTRONIC ENGINEERING, *May*, 1954, *p.* 5.
2. *Bogner, R. D., "A Balun for U.H.F. TV,"* RADIO-ELECTRONIC ENGINEERING, *January*, 1954, *p.* 5.



ATOMIC BATTERY

Development of a unique atomic battery which uses radioactive tritium as the source of initial power has been announced by *Tracerlab Inc.*, 130 High St., Boston 10, Mass. According to



Alexander Thomas, nuclear physicist responsible for the development, there is practically no danger associated with the use of the tritium isotope because the beta rays it emits are so weak that they can be completely absorbed by a piece of newspaper. Units produced experimentally at *Tracerlab* can give up to 400 volts at very low current, and are expected to have many commercial and military applications.

The principle of the battery is quite simple. When a cylinder smaller than a conventional flashlight battery is filled with the radioactive medium which surrounds pairs of metal plates having different surface electrical characteristics, the radioactivated current reaching the plates delivers a voltage in proportion to the difference in the electrical characteristics.

VOLUME TRANSISTOR PRODUCTION

Volume production of a power transistor—one of the first high-output transistors to become commercially available—is planned by the *Minneapolis-Honeywell Regulator Company.* A new division is being established to handle transistor production and sales, and production facilities are being set up in the company's main factory in Minneapolis, Minn., following several months of pilot-line operations.

The new unit already has been used by *Minneapolis-Honeywell* to build the first transistorized fuel measuring system in the aircraft industry, a system said to be 75% lighter and 86% smaller than a vacuum tube system of comparable accuracy, while using less than half as much power.

FACILITIES AT OHMITE

Through its Ohmite laboratory, Armour Research Foundation of Illinois Institute of Technology, Chicago, Ill., is able to offer industry and the general public many services in the area of precision electrical measurements. The laboratory has facilities for: dielectric constant and dissipation factor measurements on insulating materials; measurement of properties of magnetic materials; a.f. and r.f. measurements; calibration of standard cells, standard resistances, shunts, inductors, capacitors, d.c. and a.c. instruments; conductivity measurements; and oscillographic recordings.

COLOR TV CAMERA

Servicing and replacements can be accomplished with simplicity and speed on the new "3-V" camera developed by *Radio Corporation of America*, Camden, N. J., for televising color film and slides. The lens mount of each of the three vidicon chassis swings out of the way on a gate hinge to allow for replacement

of the vidicon pickup tube. All other elements of the circuit are readily accessible when the single over-all housing is removed from the top of the camera, exposing all three vidicon chassis (one not shown) and the light-splitting optical system in the right foreground.

In operation, the two dichroic mirrors split the original full-color image into three parts, consisting of the blue, green and red portions respectively, and reflect or transmit one of these partial images to each of the vidicons.

NEC APPOINTMENTS

Dr. R. M. Soria, director of research at the *American Phenolic Corporation*, Cicero, Ill., has been elected president of the 1954 National Electronics Conference, Inc., and Mr. R. R. Batcher, New York, has been elected chairman of the board of directors. The tenth annual conference will be held October 4, 5 and 6 at the Hotel Sherman in Chicago, Ill.

Multichannel Equipment

(*Continued from page* 12)

ing selected by the equipment user by merely operating a channel selection switch. This requirement is normally filled by selecting the desired channels within a given small bandwidth so that the process of channel change involves crystal switching only, without the necessity of readjustment or switching of any tuned circuits. In most 150-mc. mobile equipment, it is normally possible to change frequencies in this manner within ±500 kc. of some center value without appreciable deterioration of transmitter or receiver performance. As has been pointed out previously, the requirements of the marine v.h.f. equipment make this simple approach possible in the case of the transmitter, but not in the case of the receiver—where a spread of 5.5 mc. exists between the limits of the received channel allocation.

Figure 1 is a view of a standard two-channel fixed station for land mobile service with the cover removed, showing the transmitter, receiver and power supply chassis. This is the unit which was chosen for redesign to meet the previously mentioned eight-channel application. The multichannel version of this equipment is basically the original unit with the addition of a frequency control chassis, shown in Fig. 4. This chassis employs eight crystal ovens using a total of 16 crystals, the desired crystals being selected by a multiwafer rotary switch running the length of the chassis. Sixteen coaxial air trimmer capacitors are employed in parallel with the crystals to permit exact frequency adjustment of the unit in the field. It had originally been intended to use standard JAN CR27U crystals requiring a circuit loading of 32 $\mu\mu$fd.; however, the additional capacitance of the switch wiring and netting capacitors has made it necessary to use crystals manufactured for circuit loading of

38 μμfd. Figure 5 shows the complete eight-channel marine equipment with the cover removed, with the frequency control chassis midway between the transmitter and receiver.

The transmitter and receiver oscillators are transferred to the frequency control chassis with switch selection of up to eight crystals for each oscillator. In the transmitter section, the oscillator output is fed directly to the modulator stage on the transmitter chassis. In the receiver section, the output of the oscillator follows two alternative paths, depending upon which of two frequency bands the channel selected lies in. The frequency control chassis carries in duplicate the v.h.f. front end and frequency multiplier stages employed on the receiver chassis. For the channel allocation scheme previously described, the front end on the receiver chassis would cover the frequency range of 156.3 to 157.3 mc., while that on the frequency control chassis would cover the range of 161.5 to 162.5 mc. If the receiver channel selected lies in the first band, the oscillator output feeds into the following multiplier stage on the receiver chassis; whereas if the channel selected lies in the second band, the oscillator output is fed into the succeeding multiplier stage on the frequency control chassis. A relay on the frequency control chassis transfers the received signal to whichever of the two receiver front ends is being employed, while at the other end of the chain the outputs of the two mixer circuits are paralleled across the input of the common first i.f. amplifier on the receiver chassis.

It has been possible in practice to obtain satisfactory performance on all eight channels, both in laboratory tests and in actual field service, without deterioration of any of the main operational parameters. Moreover, eight-channel duplex installations of the above design are only 50% higher in cost and require little more space than equivalent single-channel simplex units.

In conclusion, the writer would like to express his appreciation to the v.h.f. development groups of the *Canadian Marconi Company* and *Marconi's Wireless Telegraph Company of England* for much of the information contained in this article—particularly to Mr. P. R. G. Cahn, project engineer of the Canadian company, and Messrs. Cranston and Keller of the British company, who furnished much of the information on duplex operation.

REFERENCES:

1. *Jansky and Bailey, Consulting Radio Engineers, Washington, D.C., "Studies of VHF-FM Radio-Telephone System for Great Lakes Service."*
2. *Radio and Television Manufacturers' Association of Canada, "Minimum Standards for Land-Mobile F.M. Transmitter and Receivers."*

TECHNICAL BOOKS

"ELECTRONICS: A Textbook for Students in Science and Engineering" by Thomas Benjamin Brown, Professor of Physics, The George Washington University. Published by *John Wiley & Sons, Inc.*, 440 Fourth Ave., New York 16, N. Y. 545 pages. $7.50.

The content, order of arrangement, and the mode of presentation of this textbook have been planned to meet most effectively the needs of the classroom and the laboratory. It represents a practical course in electron tube theory, in which the emphasis is placed upon physical analysis of the performance of electron tubes and circuits rather than upon study of all possible types.

Properties and fundamental applications of thermionic tubes in which current is space-charge limited are discussed in detail, and descriptions of laboratory and demonstration experiments are made an integral part of the text. All circuits are kept as simple as possible, so that basic electronic theory will not be confused with circuit theory. On the other hand, theories concerning the physical processes taking place inside electron tubes are developed more fully than is usual in books at this level.

"INTRODUCTION TO ELECTRIC FIELDS" by Walter E. Rogers, Associate Professor of Electrical Engineering, University of Washington. Published by *McGraw-Hill Book Company, Inc.*, 330 West 42nd St., New York 36, N. Y. 333 pages. $7.50.

This book was written specifically as a text for electrical engineering students who have not had any previous experience with formal vector analysis or elementary differential equations. Its purpose is to present Maxwell's equations as a logical summary of some real analytical experience in the use of vector methods of solving problems in electrostatics and magnetostatics.

Topics include: vector analysis, electrostatic fields from the viewpoint of Coulomb's law, potential and potential gradient, the electric field in current-carrying conductors, electrostatic fields from the viewpoint of Gauss's law, the method of images, dielectrics and insulation, divergence and the equations of Poisson and Laplace, the magnetostatic field, time-varying electric and magnetic fields, and vector potential.

Aerial Reconnaissance

(*Continued from page 9*)

the boards and used singly or in small groups for close study of the areas covered. The photo index serves as a rough map and as an index of the relative positions of the individual photographs. It also provides a good base upon which to record the critical items developed in the reconnaissance.

To be of most value, the aerial photographs and indexes are used in conjunction with all other data that can be assembled for the area being studied. These data include all possible maps of the area, information on the existing survey control in the area, location of power lines, etc. An engineer experienced in topographic mapping from aerial photographs can then prepare a fairly complete study of the areas in question to serve the needs of the engineer designing the microwave system.

Now, examine the type of reconnaissance data that can be secured and the ways in which it can be secured. Figure 3 is an enlargement of a portion of an aerial photograph covering an area in Wisconsin taken at a height of 30,000 feet. The first important item, which should be fairly evident, is the road network. Such photographs show clearly the roads in the area in rough map form. Thus, it may be readily determined how accessible a proposed tower site is for construction and maintenance. Stereoscopic study of overlapping pairs of photographs also enables the determination of feasible routes across the country into desirable sites away from roads. Cultural development, buildings, etc., are also quickly apparent on the photographs.

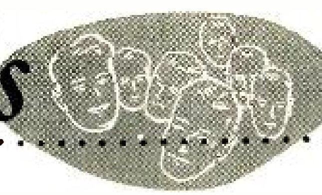
With power line data at hand, it is usually possible to locate the position of such lines on the photographs and determine the availability of power. In some parts of the country, it is possible to determine where property lines are likely to be located on the photographs, and an estimate may be made of the likelihood of securing rights-of-way and easements. The photographs show clearly the existence and location of forested areas and bodies of water, and their effects on microwave installations may be readily evaluated.

Probably the most important information required is that concerning the elevations of the terrain and objects on the terrain, and it is here that the photographic reconnaissance is weakest. However, even here the experienced topographic engineer can provide a wealth of information, some of qualitative value only but with approximate quantities in other cases. In a few cases, this information may result in a definite indication of the most feasible horizontal location for the microwave path.

The key to securing elevation information by the photographic reconnaissance method is an orderly correlation of all existing elevation data with the topographic features appearing on the photographs. To develop these topographic features completely, stereoscopic viewing and study of the aerial photographs is essential. With the three-dimensional view, it is possible to identify the high and low ground, the trees that are high and those that are low, the buildings that are of ordinary height and those of extraordinary height, etc. This viewing may be compared with the viewing of 3-D movies or the results of amateur stereo photography. The view obtained from vertical aerial photographs is similar except that heights are greatly exaggerated since the two overlapping views are taken some two and a half miles apart. One is able to recognize the heights of features amounting to as little as five feet. Figure 4 shows an engineer using a pocket stereoscope.

From the photographs, it is possible to outline quite easily the drainage network—which is in the low ground—and the drainage divides, which are on high ground. It can easily be seen where the pronounced high points of interest are situated, and where the high structures and vegetation are located. The greatest difficulty arises in estimating quantitatively the elevations of the features seen.

Personals



GEORGE W. BAILEY, executive secretary of the Institute of Radio Engineers since 1945, has now been elected president of the Armed Forces Communications Association. During World War II, Mr. Bailey served in Washington, D. C., as chief of the Office of Scientific Personnel. An internationally known amateur radio operator, he was president of the American Radio Relay League and of the International Amateur Radio Union from 1940 to 1952.

ROBERT L. HENRY has received the Arthur S. Flemming Award for 1953, given by the Washington Junior Chamber of Commerce to the outstanding young man in the Federal Government in the field of science and technology. At the National Bureau of Standards, Mr. Henry developed and directed the design system for automatic machine production of electronics—"modular design of electronics"—upon which the whole foundation of "Project Tinkertoy" is based.

L. F. HICKERNELL, chief engineer of *Anaconda Wire & Cable Co.*, New York, N. Y., has been nominated as a director of the American Institute of Electrical Engineers. A member of the Board of Directors since January, 1953, Mr. Hickernell has served the AIEE in many capacities during the last two decades. Earlier this year he was chairman of the Technical Program Committee for the Winter General Meeting of this organization.

HARRY W. HOUCK has been elected president of *Measurements Corporation*, Boonton, N. J., a subsidiary of *Thomas A. Edison, Incorporated*. Mr. Houck joined *Measurements Corporation* shortly after its formation in 1939, and has been responsible for its operation since 1941. When it was purchased in 1953 by *Thomas A. Edison, Incorporated*, he became vice president and general manager. Mr. Houck holds a number of patents in the electronics field.

JAY T. NICHOLS was recently appointed chief engineer of the *Pentron Corporation*, Chicago, Ill.; his present projects include the development of magnetic recorders for both the commercial market and the government services. Before joining *Pentron*, Mr. Nichols served on the staff of the Armour Research Foundation in the development and use of instrumentation. He was previously associated with *Western Electric Company, Inc.*

SIMEON WESTON, former chief engineer of the *Amperex Electronic Corporation*, has now been elected executive vice president of *Lambda Electronics Corp.*, 103-02 Northern Blvd., Corona 68, N. Y. Mr. Weston has also been associated with *Federal Telephone and Radio Company*, *Radio Navigational Instrument Corporation*, and *DeJur-Amsco Corporation*. He is a graduate of the NYU College of Engineering and Stevens Institute of Technology.

There is no fixed guide that can be given to indicate what accuracies may be achieved in this work. By use of a very simple measuring attachment to the small stereoscope (see Fig. 5), it is possible to determine heights of features such as cliffs, buildings, tanks, etc., to an accuracy of about four or five feet. However, in microwave work, the concern will more likely be that of the terrain elevation at some point with respect to terrain elevations some ten or more miles away. In determining elevation differences over such great distances, no simple measuring device working on flat paper prints can be of much value.

Advantages and Disadvantages

The aerial photographic reconnaissance method has two principal advantages: the first is the complete record of the great amount of information it brings into the office for subsequent study, and the second is the relatively good approximation it provides in determining horizontal positions for features of interest.

Offsetting these two advantages are three principal disadvantages. First, the cost of securing photographs is more than nominal, and a plane must be specially equipped with a camera and an experienced operator to make these photographs. The second disadvantage is that the effects of weather may produce some delay in getting under way with the work; this drawback may be partially offset by the fact that once the photographs are obtained, the office phase of the reconnaissance may proceed independently of weather conditions. The third drawback is the relatively low accuracy obtainable in approximating elevations for features of interest.

Application of this method will generally be confined to those areas where there is no topographic mapping, or where existing topographic mapping is very poor. When preliminary studies or reconnaissance indicate a need for a fairly wide exploration of such areas, this method will usually provide the cheapest and fastest means.

CALENDAR
of Coming Events

JULY 8-12—Convention on Industrial Electronics, Oxford, England, sponsored by The British Institution of Radio Engineers.

AUGUST 25-27—WESCON (Western Electronic Show and Convention), Pan-Pacific Auditorium and Ambassador Hotel, Los Angeles, Calif.

OCTOBER 4-6—National Electronics Conference, Hotel Sherman, Chicago, Ill.

New Products

(*Continued from page 23*)

and without requiring costly or complex assembly setups. Latest printed circuit and dip-soldering techniques are employed, and among the features of the glass-bonded mica insulation used in these mountings are low electrical loss factor, high dielectric strength, complete dimensional and age stability, and very high arc resistance.

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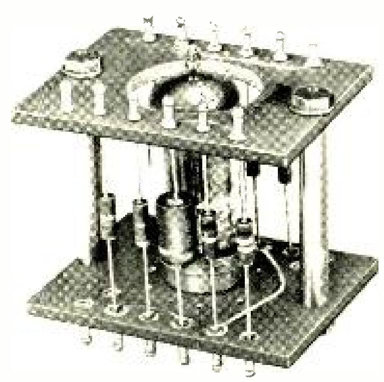

fabricated to individual requirements. Address inquiries to J. H. DuBois, Vice President-Engineering, *Mycalex Corporation of America*, Clifton Blvd., Clifton, N. J.

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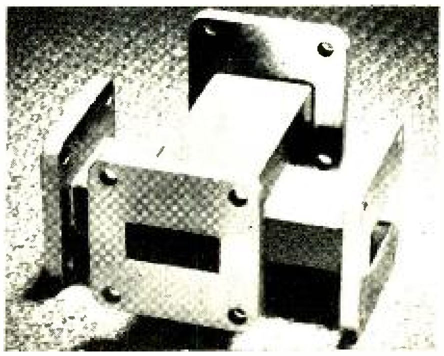

soon be available. Write *Microwave Development Laboratories, Inc.*, 220 Grove St., Waltham 54, Mass., for complete details and catalog information.

PHOTO CREDITS

PAGE	CREDIT
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16, 17 (Figs. 3, 4, 5, 6, & 7)	Kollsman Instrument Co.
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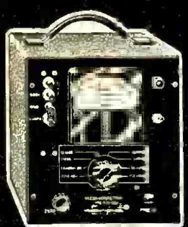

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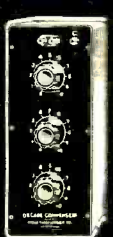

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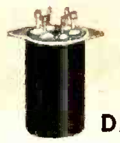

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MPT-11	Blocking oscillator, Interstage coupling or low power output	1.0/1.0/1.0	1.0-5.0	.002	2.0	500	DM-01
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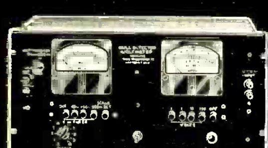

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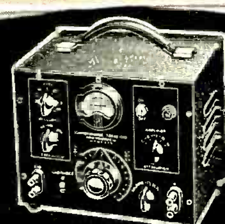

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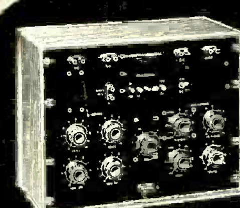

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