COMMUNICATIONS

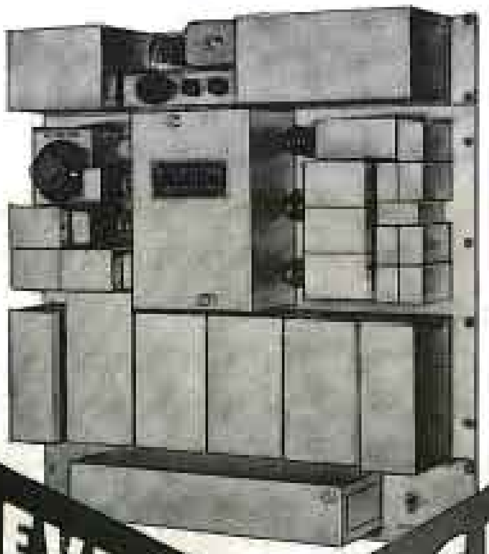
INCLUDING "RADIO ENGINEERING" AND "TELEVISION ENGINEERING"

JANUARY

* CIVIL AIRCRAFT RADAR
* FM BROADCAST MONITOR DESIGN
* AIRLINE TV-RECEIVER INSTALLATION TESTS

1949

DEPENDABLE



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With more and still more telecasters it's Du Mont TV camera equipment because of outstanding

DEPENDABILITY

DU MONT Type TA-124-B

Image Orthicon Chains

Many TV stations either on the air or under construction, are Du Mont-equipped throughout. That means the Du Mont Type TA-124-B Image Orthicon Chain for studio and remote pick-ups, alike.

But of even greater significance is the growing use of Du Mont cameras and auxiliary equipment by TV stations originally using other makes of equipment; by intra-store television demonstrations; by wired television installations; by movie producers experimenting with television production possibilities; by TV training schools; by government agencies both here and abroad.

The Du Mont advantages are many: Split-second action through quick set-up; finger-tip controls; superlative image pickup with precise electronic viewfinder checkup; accessibility for time-saving inspection and immediate maintenance; handy matched units, jiffy-connected, for all required power, synchronizing, amplifying and monitoring functions, plus the latest camera effects.

But the outstanding characteristic of this popular Du Mont Type TA-124-B Image Orthicon Chain is DEPENDABILITY. That, in the final analysis, is the all-important consideration. For "The show must go on," regardless.

$$SD+QW=\frac{D}{FWFT}$$

(Simple Translation)

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Installing TV receiving antenna atop the Castle at the peak of Whiteface Mountain in New York State for pickup of WRGB, Schenectady, signals, 120 airline miles away.
(Courtesy General Electric)

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SNOW-FIGHTERS GO SMASHING THROUGH MOUNTAIN PASSES OF WASHINGTON!

Motorola 2-way FM keeps plows on the road in constant communication with central dispatcher's office (lower right). The famous Lock-In Tube's superiority makes it the ideal choice for equipment on the road, in the air, on the rails—for marine radar, FM and television.

Motorola FM and Sylvania Lock-Ins help man the husky plows!

BATTLING through giant drifts, the snow-plows of the State of Washington's Department of Highways force their way through high, remote mountain passes to open the roads for traffic. Automotive equipment couldn't have a tougher assignment.

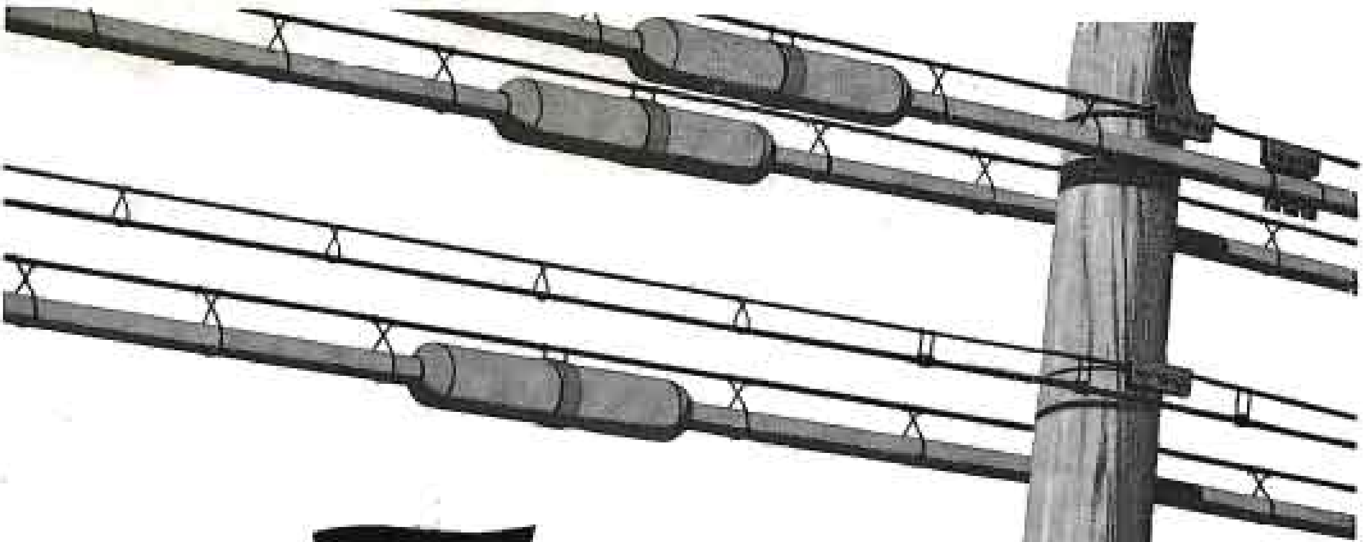
To keep the plows in constant touch with Department Headquarters, Washington counts on Motorola 2-way FM. And for tubes that will stand up under the most severe conditions, Motorola counts on Sylvania Lock-Ins in its mobile units. These tubes stay firmly in place, no matter how rough the going.

There's no warping or weaving of elements. Connections are short and direct; there are few welded joints, no soldered ones. Top location of getters cuts down losses . . . separation of getter material from leads reduces leakage.

See Sylvania Distributors, or write Radio Tube Division, Emporium, Pa.

SYLVANIA ELECTRIC

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



The case of the Creeping Sleeve

Lead sheathing on telephone cable meets many stresses — the tug of its own weight, wind pressure, contraction and expansion from cold and heat. Then, too, there's the pressure of nitrogen gas put in Long Distance cable to warn of sheath breaks and keep out moisture.

And, sometimes, lead is subject to "creep"— a permanent stretching — even when the stress is but a fraction of the normal tensile strength. Creep is especially likely at the lead sleeves used where two lengths of cable are joined. The sleeve may stretch and break open exposing telephone circuits to the elements.

So Bell Laboratories scientists have developed methods to test and control creep. In a special testing room, weights are applied to scores of samples of lead, under controlled conditions. Exact records of the amount of creep are obtained with a precision instrument.

Years of careful study have produced a lead composition which resists creep and yet has all the other properties required of sleeves. This means better telephone service for you and helps give that service at lowest possible cost. It is an example of the way Bell Telephone Laboratories scientists study and improve every part of the great telephone plant.

BELL TELEPHONE LABORATORIES

EXPLORING AND INVENTING, DEVISING AND PERFECTING, FOR CONTINUED IMPROVEMENTS AND ECONOMIES IN TELEPHONE SERVICE.

COMMUNICATIONS

LEWIS WINNER, Editor

JANUARY, 1949

TV and FM Receiving Antennas

THE RECEIVING ANTENNA has become, with the current accelerated interest in TV and FM broadcasting, as vital a factor at the station as the transmitting array. The *uhf* and *vhf* broadcaster has found that the receiving antenna is quite an item for relaying, monitoring, field tests and other special-purpose studies.

There seems to be an endless variety of types which have been and can be used. Particularly popular is the yagi directional combination. In one series of 514-mc tests, involving ghost studies, both the yagi, a five-element affair, and a half-wave dipole were used, with the yagi being found to have a field gain of 2.4 over the dipole and a beam width of approximately 60° between half power points in the horizontal direction.

During recent tests conducted by WABD between New York City and Oxford, Connecticut, approximately fifteen miles northwest of New Haven, a four-element yagi with a voltage gain of 1.82 over a standard dipole was used very successfully. The antenna, mounted on top of an eighty-foot pole situated atop a hill 750 feet above sea level, providing an overall height of 830 feet above sea level, fed a healthy constant signal from the channel *5* station.

Helical antennas have also been found to be quite satisfactory. According to tests at the Naval Research Lab, these antennas which serve as endfire radiators, are easily matched and broadband in performance. They appear to offer possibilities of greater gain and directivity than are normally realized. The helical type antenna radiates a circularly polarized wave, and thus requires helical types at the transmitting and receiving points for maximum effectiveness, although it has been found that horizontal or vertical linear receiving antennas can be used for helical antenna signal pickup.

Receiving antennas are playing quite a role in the carrier sync TV system project now being tested between WNBW and WNBT. Two units are involved in this setup, one being located at RCA Labs in Princeton, N. J., and the other at WNBT with two receiving antennas at Princeton, a dipole and reflector to pickup N. Y. and a bridged dipole and reflector for WNBW (Washington) signals. At Princeton the equipment consists of two narrow band superhet receivers. The voltage from a local oscillator is applied to the first detectors of both receivers and thus the frequency difference between the two incoming signals is retained. The output signals from two *if* amplifiers are mixed in a phase discriminator, the output voltage of which is a measure of the phase difference between the two incoming carriers. Then the output voltage of the phase discriminator is used to frequency modulate an *rc* oscillator ± 300 cycles about a mean frequency of 1000 cycles. This FM 1000-cycle tone is a control signal which is transmitted over a normal telephone line, which when received in New York is reconverted by a frequency discriminator to a control voltage corresponding to the output of the phase discriminator on the output of the two receivers in Princeton. This control voltage is applied to a reactance tube in the transmitter crystal circuit so as to shift the crystal frequency as much as ± 300 cycles. The frequency shift of the 1000-cycle tone is used to change the frequency and phase of the New York carrier to maintain a fixed phase relationship between the New York and Washington carriers as noted at Princeton.

FM stations are also becoming aware of the virtues of receiving antennas. At WIBW, for instance, chief engineer Marquardt installed a 16-element job to serve as a link between the station in Topeka and a remote point in Kansas City. A complete analysis of this interesting setup will appear in an early issue of COMMUNICATIONS.

There is also quite a relationship between the receiving and transmitting antenna, particularly on the *vhf* and *uhf* bands. Reporting on this point at a recent FCC hearing, T. T. Goldsmith, Jr., said that with standard dipoles, the voltage delivered to an ultrahigh receiver is only about ⅛ as great as that delivered to a standard TV model. This is due to the fact that the *uhf* half-wave dipole is ⅛ the length of the *vhf* model. Thus, in order to obtain equal voltages at the receiver input, the *uhf* antenna would be required to have a power gain 8^2 or 64, Goldsmith pointed out. Power gains of most *vhf* antennas are around two to four. Therefore the *uhf* antenna would be required to have a gain of 200 to 300, a condition which would become quite a problem at 900 mc. During the CBS color tests, an antenna with a gain of 16 was used. With this type of antenna the field strength, under average conditions, would have to be two to four times as great for the ultrahighs as the veryhighs and in rough terrain, ten to twenty times as great. Thus, said Goldsmith, these figures indicate that effective radiated powers of four to four hundred times as great, depending on terrain, will be required at the ultrahighs as on the low bands for comparable coverage.

With the ultrahighs destined to become a factor in TV reception, it certainly appears as if antennas will have to receive ultra careful consideration from the design and application engineer.

The receiving antenna used with the TV set at home is also an item which merits close study by the telecaster. For it is the antenna, most often, which will snap in the signal to the satisfaction of the TV set owner and add a satisfied viewer to the telecaster's audience.

Receiving antennas have really grown up and become towering fellows of importance to every TV and FM broadcaster.—L. W.

Putting a Station On the Air Is Often Quite a Job

250-kw Dickinson, North Dakota, Station Successfully Put On the Air Despite Hardships of an Extremely Cold Winter, Basic Equipment and Transportation Delays, Accessory Shortages, Incompetent Antenna Tower Work and a Telephone Strike.

by QUINTIN V. PROCHASKA

Chief Engineer, KDIX

When we received our *cp* some months we were faced with many shortage and installation problems.

The tower base and anchors for the guy wires of our three-hundred-foot tower had been put in during the winter. To thaw the earth for this operation straw had been placed on the ground, then covered with coal slack and allowed to burn for two days. Digging then followed, cement poured and then covered with an additional large quantity of straw.

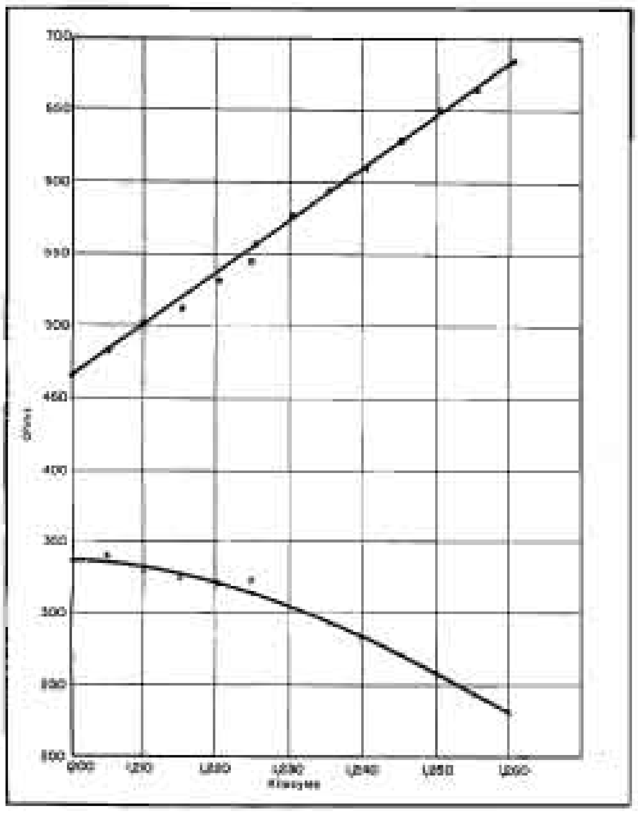
Due to the shortages of building materials, we were obliged to search for suitable housing and succeeded in locating a country school house which was moved in to serve for the transmitter building. The basement was dug by thawing the earth in the same manner used to prepare for the tower base and anchors.

While awaiting arrival of the tower we began planning of the studio. Space was leased on the second floor of a building in downtown Dickinson. Although we had not received our console or other equipment we did have the junction boxes and proceeded with this installation. Thus all the wiring was completed a long time before the arrival of the equipment.

As the spring of '47 neared the transmitter site was alternately frozen hard or muddy. The tower had arrived and then the tower construction crew began putting it up. As the ground thawed the laying of the radials for the ground system was begun.

To install the radials we used a tractor[1] with attached hydraulic lift plows. The mold-boards were removed and a narrow piece of steel was bolted on the beam. To the back of the point was placed a small steel pulley. By the use of the hydraulic lift and adjustments the steel rooter could be lowered into the ground about eight inches and also lifted clear of the ground. A wire reel was bolted on top of the plow and after a little experimenting we found the ideal approach; first reeling out one length of wire, going back and then running in the length laid out and at the same time running out another length of wire. By anchoring the wire at the tower base we were able to cut the wire into the ground with a narrow

[1] Ferguson.



KDIX antenna resistance and reactance measurements. Antenna measures 575 + j306 at 1230 kc; antenna current is 0.66 ampere for 250 watts.

Control room with the W.E. 40-A console. To the left of console is an announce booth for news broadcasts.

The author checking meter readings on the KDIX transmitter[2]. The regular transmission line is ⅞" and the spurs ⅝" both filled with dry air. The open mounting of transmitter and racks facilitates servicing.

slit made in the ground and immediately closed serving to cover the wire and holding it in the ground.

The transmission lines were run above ground even though they were soft drawn copper and could have been safely put in underground. This was done because the best we could get for tower lights and remote meter circuits was ordinary lead-shielded cable. Since we wanted to run these cables above ground it was decided to run the transmission line similarly. There had been reports that gophers enjoyed eating lead shielding. We haven't had any experience with gophers eating the lead shield, but observations made in this section of the country have indicated that the lead does deteriorate in around five years, possibly due to some chemical content of the soil. The lead-shielded cable was not run in conduit due to its scarcity and expense. For economy sake we fed only 110-*v ac* to the tower for tower lighting. This does cause a considerable voltage drop, which if severe enough results in a slight dimming of side lights when the flashing beacon is operating. However, the procedure permits the use of a thermocouple instead of a diode rectifier for remote antenna current monitoring. The change in voltage between the time the tower lights are off and operating would be sufficient to alter the *dc* output of a rectifier. This could be corrected of course by running out a separate line for the rectifier. It would have been considerably better to have a 220-*v ac* line to the tower with an isolation stepdown transformer, since besides eliminating the voltage-drop, possibilities of feeding back *rf* into the power lines would have been minimized.

We were not too pleased with the construction gang work in installing the conduit and tower lighting circuits. Evidently to speed up their work the boys threaded the conduit lengths onto the wire until they had 100' lengths, the distance between the tower lights, then slipped in wood chips to hold the conduit from slipping, pulled up lengths and then turned each individual length to couple them together. They neglected to ream the ends of the conduit which naturally cut the wires. And the wood chips they had placed in the conduit made it exceedingly difficult to pull the wires out of the conduit when we were forced to replace them.

Another rush construction-gang item that caused us grief appeared in the tower where one side of the hot lead was shorted to the tower. This was not noticed until the construction gang were well on their way. The tower lights and the code beacon worked fine, but the tower of hot 110 *v ac* leading to ground was causing plenty of damage.

We were quite anxious to get started with our equipment test broadcasts and we thought that the hot lead problems could be solved by reversing the connections at the junction boxes and using the shorted wire as the common. This was tried, and even though the common was grounded immediately after leaving the tower lighting choke, enough *ac* voltage fed through the antenna tuning to cause the trans-

(*Continued on page 31*)

[2]Transmitter is a Gates 250C-1; modulation monitor, limiting amplifier and line amplifier are also Gates products. Frequency monitor is made by Doolittle.

Airline TV Receiver

TV receiver mounting used in haywire trial. The inverter used in the power supply is shown in this view.

Floor Model 12" Direct Viewing TV Receiver Tested on Commercial Airline During Runs Between Washington and Norfolk, Washington and Chicago, and Detroit and Washington, Found to Provide Excellent Results. Pair of Straight Dipoles Cut to Channel 10, With 72-Ohm RG 25/U Coax, Mounted on Top of Fuselage and Belly Center Line Near Passenger Door in Rear. Aircraft Inverter Used For Power.

by WILLIAM S. SMOOT

Radio-Electronic Project Engineer
Capital Airlines

The forward top antenna.

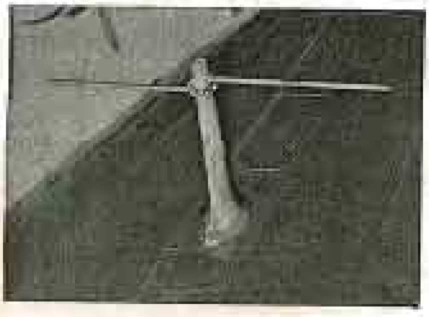
TELEVISION IN AIRCRAFT is not new. The military have used the technique tactically but their craft were designed in anticipation of such special equipment. Commercial airlines, however, were skeptical of the results which TV could provide on a regular run, and specifically for passenger entertainment. Preliminary tests by one receiver manufacturer[1] in a Beech 18 executive transport indicated, however, that the results would be very satisfactory. Accordingly we decided to conduct a test aboard our airliner during a run. We were quite gratified at the results. Passenger comments and hostess reactions were most favorable.

Receiver Mounting

The receiver was a floor model Philco home receiver incorporating a 12" direct viewing screen. Initially a temporary installation was made in the cargo compartment where the receiver was tied down with cargo straps and *haywired* in for a test run.

The following night it was relocated against the forward cabin bulkhead immediately to the right of the aisle. A platform was built to lift the cabinet high enough to permit good visibility back into the cabin above the heads of other passengers. Its height just permitted the receiver to clear the overhead baggage rack. Constructed of ¾" plywood approximately 22" high, it had a recessed deck (slightly less than 1" below the top) to couch the base of the receiver cabinet. The platform deck was built of two plywood floors with sponge rubber between for cushioning to absorb shock and vibration. The cabinet was attached to the platform deck with long wood screws through from the bottom, and the platform was bolted to the cabin floor. After being securely mounted the platform was painted maroon which blended well with the cabin interior.

Aft bottom antenna.



Power Supply

To eliminate the necessity of a special power supply an aircraft inverter was used. The input driving voltage was obtained from the regular *28-v dc* ship supply. A 50-amp trip-free circuit breaker was located in the panel above the electrical circuit breaker box on the left of the companionway in the

Final mount for the receiver in the plane. Speakers were mounted in the light-baggage compartment near the ceiling of the plane.

Installation Tests

Time	Station	Channel	Location	Altitude	Antenna	Pic. Q	QSA	QRM	Remarks
09:18	....	All	Washington	4000	F & A	....	..	..	..
09:20	WMAR	2	....	4000	AFT	G	5	G	G
09:20	WMAR	2	Mt. Vernon	4000	FWD	Fuzzy	4	G	G
09:25	WBAL	11	....	4000	FWD	G	5	G	G
09:25	WBAL	11	Doncaster	4000	AFT	G	5	G	G
09:25	WNBW	4	Doncaster	4000	FWD	G	4	G	G
09:40	WNBW	4	....	4000	AFT	G	5	G	G
09:45	WBAL	11	Bowling Green	4000	Both	Snow	4	G	F
09:45	WMAR	2	....	4000	Both	Snow	4	G	F
09:50	WNBW	4	Dawn	4000	AFT	G	5	G	G
09:50	WMAR	2	....	4000	Both	Snow	3	F	F
09:50	WBAL	11	....	4000	Both	Snow	3	F	F
09:55	WMAR	2	Richmond	4000	Both	Noisy	1	U	U
09:55	WBAL	11	Richmond	4000	Both	Noisy	1	U	U
10:00	WNBW	4	Richmond	4000	AFT	Noisy	3	F	..
10:00	WNBW	4	....	4000	FWD	Noisy	4	F	..
10:02	WNBW	4	....	4000	FWD	Noisy	3	F	..
10:03	WNBW	4	....	4000	AFT	Noisy	1	P	U
10:05	WNBW	4	Williamsburg	4000	AFT	Noisy	3	F	..
10:05	WNBW	4	....	4000	FWD	Noisy	1	U	U
10:05	BALT.	2–11	....	4000	Both	Noisy	1	U	U
10:10	WNBW	4	James R. Bridge	4000	Both	Noisy	1	U	U
10:10	WNBW	4	James R. Bridge	4000	Both	Local Int.	1	U	U
10:20	WNBW	4	....	2000	Both	Local Int.	1	U	U
10:20	BALT.	11–2	....	1500	Both	Local Int.	1	U	Int.
10:30	....	..	Norfolk	....	....	....	..	..	Touchdown

Table 1

Typical TV receiver tabulated test log of the initial flight from Washington to Norfolk. Column three is the channel selector position number; four is the location over which the craft flew; column five shows the *altitude* above mean sea level (not above terrain); six is the antenna to which the receiver was connected (whether forward top or aft belly dipole); *PIC Q*, in column seven, is the picture quality; eight, *QSA*, signal strength (5 = excellent, 4 = good, 3 = fair, 2 = poor, 1 = unreadable); column nine, *QRM*, an index of general interference; and ten, general observation notes.

The *G*, *F*, *P*, etc., used in the several columns represent good, fair, poor, etc., respectively.

forward cargo compartment. The output is single phase, 400-cycle *ac* tapped at 26 *v* and 115 *v*; the latter was, of course, used for the system. To divorce the television equipment from the ship's *ac* supply an additional inverter was installed in the ship's radio rack. Although the television equipment was designed for 60 cycles, its performance on 400 cycles was equally satisfactory; the large 60-cycle components merely ran cooler.

Antenna

Mobile TV experiments have suffered mostly because of propagation and antenna system difficulties. An airplane is the embodiment of the dream of a *sky hook* for an antenna; the only problem being its speed.

As antenna engineers know only too well the resultant is always a compromise. In some cases the compromise may be with the apartment-house owner; with aircraft it is with space, weight, stress, drag, efficiency and appearance. The frequencies involved in television are definitely an asset. As the wavelengths are short it follows that the antenna dimensions are small and consequently efficiency is readily attainable. Every square inch of added area protruding into the airstream decreases speed. Every ounce of added weight on the aircraft reduces useful load. A combination of drag and weight creates stress in the structure. Someone's baggage may have to be left if space is not available. Appearance is an additional common denominator whether on a building or an aircraft.

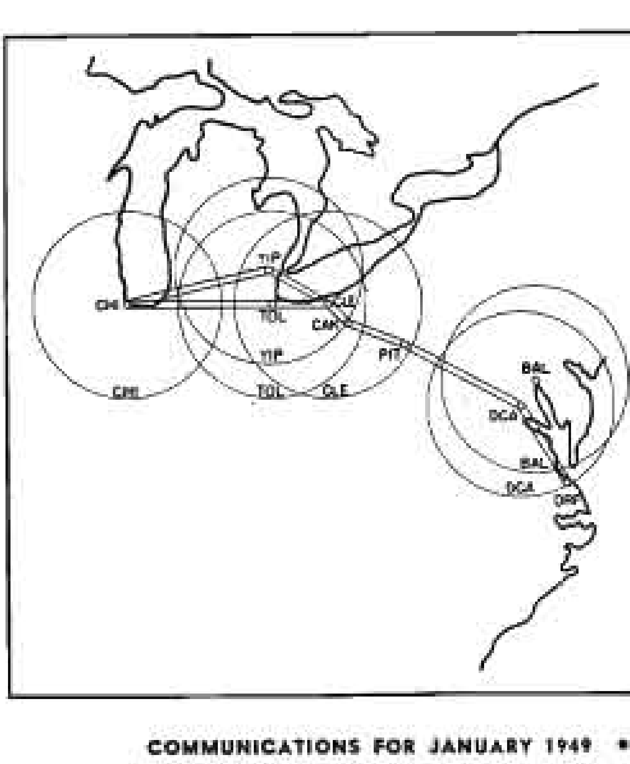
The antenna system we decided to use consisted of two arrays. One antenna was mounted on top, forward slightly left of center, on the fuselage, and the other on the belly center line near the passenger door in the rear.

Each was a simple straight dipole, mounted on a molded hollow plastic mast drilled to accommodate two ½" elements of stainless steel tubing. Ealch element, which extended 13" beyond the side of the mast, was cut for channel 10, and cleared the skin by 13" with ½" spacing between the element ends within the mast. The dipole elements were placed parallel to the surface of the earth and at right angles to the line of flight. The hollow mast permitted feeding of the transmission line through from within the airframe to the dipole. A 72-ohm RG-25/U coax transmission line was used, a coaxial switch located at the receiver being used to select either antenna.

To provide sound distribution to the entire cabin it was necessary to install additional amplifier and speakers. The speakers were 8" *pm* type. By locating three of them on the overhead baggage rack and using the receiver's

(*Continued on page 34*)

Route map. Trips were made from Washington (*DCA*) to Norfolk (*ORF*) and Norfolk to Washington, Washington and Chicago (*CHI*) and then to Detroit (*YIP*) and Detroit back to Washington. Circles in this map indicate a 150-mile radius.



¹Philco.

Civil Aircraft Radar

Closeup of radar and radome used in Southwest Airways plane. The rear of the indicator unit comes to within 8" of its transmitter-receiver.

Lightweight aircraft radar in nose of DC-3 aircraft. (*Courtesy Allison Associates*)

THE PROBLEMS of cost, weight, space, primary electrical power, complexity and maintenance have until recently restricted the use of airborne radar to military aircraft. Several months ago a comparatively lightweight (60-pound) civil aircraft radar[1] was developed and successfully tested in a DC-3 plane. The instrument requires no change in structural members of the airplane, mounting brackets for the radar being bolted to the existing airframe. The lower half of the nose cap is replaced with a molded plastic section that is transparent to microwaves. Except for a small *cr* indicator in the cockpit, the unit is self-contained and includes a dual reflector which is an integral part of the transmitter-receiver mounted above it.

At present, as the first step, radar is feasible in any aircraft where the engine is not mounted in the nose. It can be completely accommodated within the nose of the fuselage without in any way interfering with the slipstream because of protuberances.

Radar Versus Payload

The largest transcontinental types of commercial airliners used by scheduled airlines cost as much as $1,500,000 or more. This high investment for a common carrier carrying half a hundred passengers and a small amount of cargo can only be financially justified by covering long distances in short periods of time and by quite constant flying service. Even then, the value of each pound of weight in an aircraft when compared to passenger or cargo fares has been estimated to be as high as $175 per pound per year. Another estimate quoted to the author has been $2,000 per pound for the life of the aircraft. Even the lightweight radar would therefore represent a payload loss of approximately $10,500 per year. The economics of commercial aviation are such, however, that this amount of payload lost to radar can readily be offset by such advantages as:

(*1*) The aircraft can navigate more correctly and ideally to reduce flying time aloft between any two points. Safety is promoted because radar facilitates orderly operation. In addition, it represents a definite saving in the cost, bulk and weight of engine fuel.

Extra Fuel Economies

(*2*) Aircraft without radar normally carry sufficient reserve gasoline to not only reach scheduled destination, but also enough additional fuel to reach an alternative airport plus forty-five minutes extra flight. If radar will safely permit a small reduction in reserve fuel carried, even only fifty gallons, there would be a saving of about 325 pounds in weight, or a saving in weight equal to about five times the weight of the entire radar installation. On the basis of the same $175 per pound per year figure, there would result a net saving in pay load of $46,375 per year per plane. This estimate figure can be a little less or much more depending on the size of the aircraft and the type of service in which it is engaged.

(*3*) The general expectation is that radar also can result in a reduction in plane insurance rates. Insurance rates are based on accident experiences and costs. If this saving, in the end result, does not in itself meet the cost of the radar system during the life of the aircraft, it should more than meet the entire cost of radar maintenance and repair.

(*4*) The availability of radar will also mean that take-offs and landings will be possible for a percentage of the occasions where aircraft either have to be grounded or forced to travel to an alternative airport; an alternative airport means great inconvenience to passengers, adverse effect on passenger patronage, delay in delivery of air mail, putting the crew in the wrong city for relief purposes, etc. In any event, it disrupts airline plane schedules. During certain periods of the year and in some localities, the possibilities for maintaining flight services may reduce airline revenue losses to easily justify the cost of radar equipment.

(*5*) Radar can also eliminate or greatly reduce the likelihood of collision aloft regardless of visibility. While the records to date on commercial airlines show no collision between aircraft, thanks to CAA flight rules, there have been a number of instances where aircraft have crashed into mountains during poor visibility. Such mountains, for example Leguna Mountain in southern California (elevation about 9,000 feet) can be de-

[1]Allison Associates.

tected on the radar for approximately 80 miles. Radar also eliminates uncertainty when an aircraft must, very frequently, travel into or through a cloud bank.

(*6*) Radar plays a role in maintaining passenger patronage during periods of bad weather or adverse visibility. It is not uncommon to have many empty seats in an aircraft during the winter months.

(*7*) Radar affords the pilot a means of detecting solid and non-solid density variations ahead including rain, clouds and even birds. Typical examples may be mountains for eighty miles, cities for forty miles, thunderstorms about thirty miles and other aircraft about twenty miles. Smoother flights with less discomfort to passengers and crew, and less stress on the aircraft is possible, too, by avoiding storms and heavy cloud formations picked up well in advance by radar.

(*8*) Since other aircraft are in motion, they can be well defined on the radar with respect to fixed objects. This information is particularly useful when planes are stacked over an airport coming in for instrument landing. When, as often happens, a plane in the stack gets *lost* or confused, other aircraft equipped with radar can take suitable precautions as well as acquaint non-radar points of the situation.

(*9*) Most of the radio aids to aviation today are dependent on the existence of facilities and the cooperation of facilities on the ground, such as illustrated at right, below. Radar can function without the presence or availability of any facilities on the ground or in other aircraft. It does not require the cooperation of the object it detects.

(*10*) Other advantages will definitely manifest themselves as radar is more widely adopted in civil aviation. Primarily radar will offer the pilot an alternative as well as a check against the shortcoming of other radio or other aids now in use aboard the aircraft. It will also help in assuring the pilot that ground-located aids to aviation are functioning properly. No aid to aviation, either airborne or ground-located is completely infallible.

Examples where radar may be helpful in coping with shortcomings of existing equipment and aids are:

(*a*) The danger of collision when there are many airports in one area and visibility is poor.

(*b*) The danger of *180° ambiguity* when signals are received on a loop antenna as is the common practice for direction finder operation. Any loop antenna without elaborate and properly functioning *sense* provisions will pick up *every* signal equally as well at

Recently Developed Lightweight Equipment, Which Can Be Mounted in Nose of Plane, Affords Many Desirable Flight Control Features: Blind Flight Navigation, Obstacle Detection Warning, Selection of Obstacle, Tree Terrain and Thunderstorm Detection and Survey. Radar Setup Also Helps Overcome Problems of Existing Equipment and Aids Such as 180° Ambiguity, Magnetic Compass Error, Night Effects, Signal Warpage, False Cones of Silence, etc.

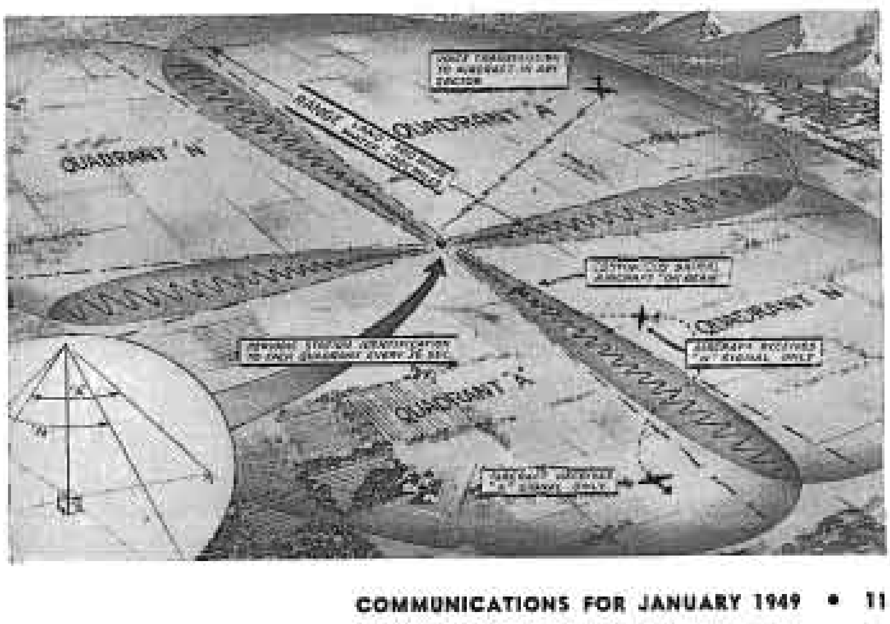
by SAMUEL FREEDMAN
New Developments Engineer
DeMornay-Budd, Inc.

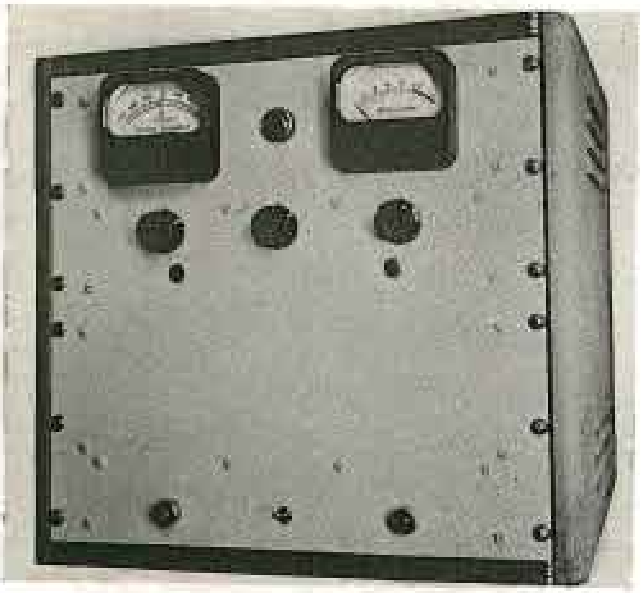
two points of the rotatable antenna. One of these will always be the correct direction while the other will always be exactly 180° out.

(*c*) When a gyro type of compass is unavailable or inoperative, the magnetic compass may be the sole direction-indicating reference device aboard the aircraft. The magnetic compass is subject to errors. Magnetic variations exist because the earth is not uniformly magnetized. It may vary in some geographic localities by many degrees depending on local influence. The magnetic variations distort the magnetic field to produce so-called *isogonic lines*. Such a line connects geographic points of identical magnetic variation. Every electrical circuit, metallic part and relative aircraft motion and angle further causes compass error or deviation aside from magnetic variation. A variation of 11° greater than the compass reading normally exists in the vicinity of New York. A variation of 18° less than the compass reading normally exists in the vicinity of San Francisco. It will be something else in every other part of the world. The direction finder, a mainstay in commercial airliners, is dependent on the compass accuracy. In the case of radar, the compass is helpful for reference purposes. However, safe navigation is possible by relative bearings of the aircraft heading versus the right-left object response indications. It does not have to depend on homing

(*Continued on page 26*)

A radio range having four courses with facilities for voice transmission and periodic station identification. Radar is invaluable in implementing these aeronautical aids because it requires no cooperation of ground located facilities. (*Courtesy U. S. Air Forces*)





An FM

Figure 1
The FM broadcast monitor described by Martin Silver.

In maintaining a continuous check on the characteristics of FM program signals, which also meet FCC requirements, it is essential to employ a monitor which can measure frequency, per cent modulation, noise level and distortion.

In Figure 1 appears a view of a monitor designed to provide such services. In operation, the signal can be examined when the switch is on position 3 (Figure 2), where the signal is mixed with that of a crystal-controlled local oscillator so that a 210-*kc* difference frequency is obtained. The 210-*kc* sine wave is then fed through several limiter stages and is transformed into a square wave. The square wave, in turn, is applied to a counter which functions as both a demodulator and a frequency measuring device. One output of the counter is registered on the frequency meter and can be read on the front panel.

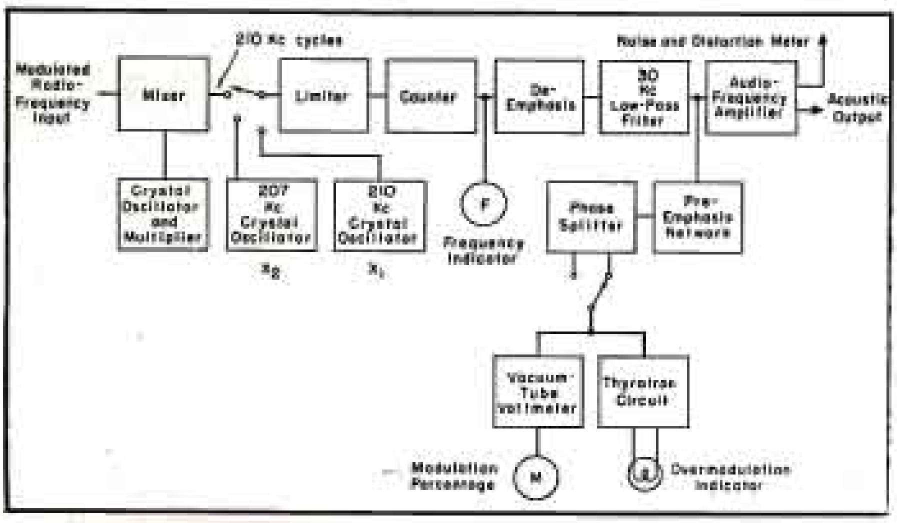
The other counter output, an audio signal, is then fed into two separate circuits after the 210-*kc* components are filtered out. One circuit measures the distortion and noise level of the signal and the other determines the per cent modulation.

Local Oscillator and Mixer

The output is converted into a 210-*kc* signal by mixing it with a crystal controlled-local oscillator frequency that is exactly either 210 *kc* above or below the transmitter frequency. The frequency of the crystal, which is kept in a crystal oven to assure precision control, is selected to be 1/24 of the final desired frequency. It is then multiplied 24 times through three multiplier stages and fed into one grid of the mixer tube. These multiplier stages are all conventional and require no elaboration.

The 210-*kc if* carrier is passed through a filter to remove a 100-*mc*

Figure 2
Block diagram of the monitor.



component and is fed into the limiter stages. To obtain a high degree of linearity in the counter an absolutely square wave input is imperative, and it is the function of the limiter to transform the sine wave into a square wave form. This is done by successively cutting of the peaks of the amplified signal.

Limiters

Limiter circuits are familiar to all engineers in the field as is the danger of free oscillation when high gain limiters are used. Due to this latter fact a special limiter circuit had to be developed. Briefly there are two types of limiters. In one, the high gain type, the grid bias is such that the tube will saturate beyond a certain positive value of impressed signal. The plate current in this circuit will follow the impressed signal up to a certain point and then flatten out as saturation is reached. In the other type of limiter circuit, the low gain type, the grid bias is such that beyond a certain negative signal voltage the tube cuts off. Here again the plate current follows the signal until it is cut off. This latter circuit is also known as a *clipper*.

High Gain Limiting

For the purpose of obtaining a square wave form the high gain limiting action is preferable. However, particularly when several of these stages must be cascaded, a very slight amount of feedback in the circuit can cause self oscillation. To overcome the danger of feedback and yet utilize high-gain limiters a stage of low gain limiting is inserted between two high-gain stages. Thus the signal is first passed through a high gain limiter,

Broadcast Monitor

Experimental FM Monitor Measures Frequency, Per Cent Modulation, Noise Level and Distortion of FM Transmitter. Has an Inherent Distortion of Less Than 1/4 Per Cent, Noise Level 80 db Below Full Modulation and Frequency Measurement Accuracy of ±100 Cycles at 100 Mc.

by MARTIN SILVER
Federal Telecommunication Labs.

than a low gain limiter, and finally through another high gain stage.

Counter

In counter circuit the voltage output is directly proportional to the impressed frequency, the output being measured by a voltmeter which can, consequently, be calibrated in terms of frequency of the impressed signal. In this unit the *zero* frequency is 210 *kc* and the meter is calibrated from –3,000 to +3,000 cycles.

The parameter that is constant in the counter is the slope of the voltage-frequency line. The voltage output for any given frequency, however, may vary either by design or as a result of changes in ambient conditions. For example, the voltage output of a 210-*kc* signal can be 10 or 20 volts depending on the circuit elements or may vary from a fixed voltage of 10 to 10.5 volts over a period of time. What does remain absolutely constant is the slope of the voltage-frequency curve; that is the voltage output of all other frequencies will vary by the same amount the 210 *kc* signal did.

For this reason the unit must be calibrated periodically to assure maximum accuracy. In Figure 2, X_1 and X_2 are standard calibration crystals, X_1 with a frequency of 210 *kc* which sets the *zero* on the meter. X_2 has a frequency of 207 *kc* and is used to check the –3,000 cycle reading. The frequency measurement accuracy of the counter right after calibration is ±100 cycles, while the *long time* accuracy is 300 cycles. *Long* time covers a period of several days and it means that the operator does not have to calibrate the meter each time he wants to check the frequency.

A schematic diagram of the counter is shown on Figure 3. The grid of the tube is so biased that when the negative part of the square wave is impressed on it, the tube cuts off while on the positive part of the cycle the tube conducts. When the signal is negative, C_1 charges up through R_3, and the germanium rectifier, to the full B+ voltage. The *rc* constant of the circuit is such that the capacitor will completely charge up during the negative half cycle with time to spare.

During the positive half cycles, the tube conducts causing an immediate drop in voltage across C_1 which then proceeds to completely discharge through the other germanium rectifier and frequency meter. Here again the *rc* constant is such that capacitors completely discharge during the positive half cycle with time to space. This process is repeated with each cycle.

The total current flowing through the frequency meter in one second is the integral of all the current pulses that flow through the meter in one second.

Since the design of the circuit is such that each cycle contributes the same amount of current, which we can call *I*, the total amount of current flowing through the circuit in one sec-

Figure 3
Schematic of the counter used in the monitor.

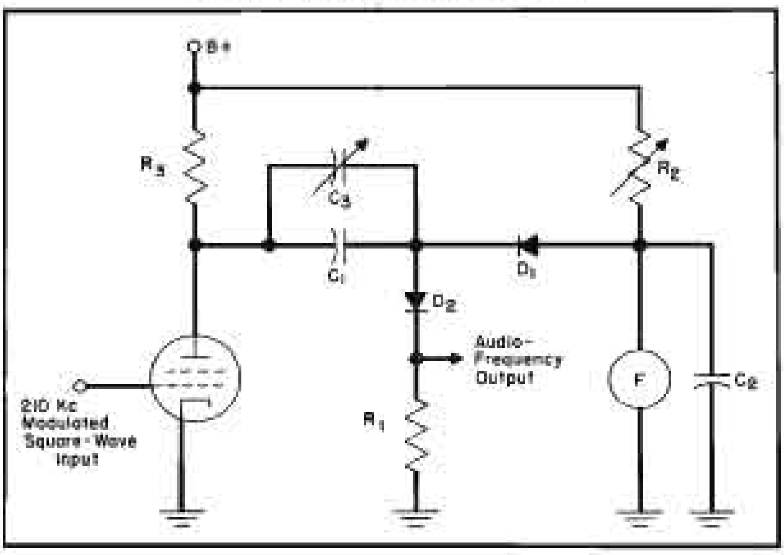
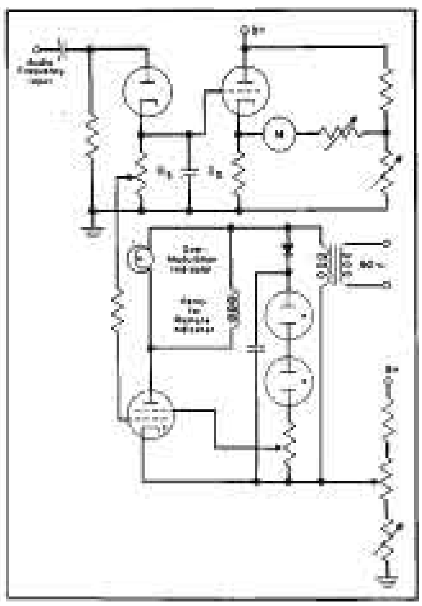


Figure 4
The monitor detector circuit.



ond is I times the number of pulses per second. The number of pulses per second is equal to the frequency of the impressed signal; thus the current and consequently voltage output is directly proportional to that frequency.

This will be absolutely linear if the capacitor completely discharges and recharges during each cycle, and the .02% variance off linearity of this circuit indicates the degree in which complete charge and discharge does not take place. To achieve this exacting result germanium rectifiers were used in place of vacuum tube rectifiers because the space charge in a vacuum tube varies indiscriminately and will change the magnitude of the pulse constant I in the same manner.

When a 210-*kc* signal is impressed on the grid of the counter tube a negative voltage is generated across the frequency meter. This meter, incidentally, has a high degree of inertia so that it is sensitive only to average values of current. The negative voltage thus generated is nullified by a bucking voltage controlled by R_8, the zero set resistor. When the meter is calibrated, R_8 is set so that the voltage across it is exactly equal to the negative voltage induced by the counter. As a result the net voltage across the voltmeter is zero.

The magnitude of the pulse constant I is directly proportional to the size of C_1. The larger the capacitor the more current per unit pulse. To adjust the sensitivity, a variable capacitor C_8 was placed in parallel with C_1. After zeroing, the 207-*kc* signal is fed to the counter. The meter reading is adjusted to read -3,000 cycles by means of a sensitivity control.

If the transmitter is on the correct center frequency, a 210-*kc* signal will be fed to the monitor, and a zero reading will result. If the frequency is off, this fact will also be noted on the meter in the form of a definite number of ± cycles. Of course, since the signal is frequency modulated, the frequency is varying all the time; however, the meter is not sensitive to rapid variations and measures only the average or center frequency.

The selection of the 210-*kc* zero frequency was based on an engineering compromise. This frequency can not be too low, otherwise separation of the audio signal, via filtering, from the carrier will not be possible. On the other hand, for maximum counter linearity and sensitivity, this frequency should be as low as possible. This is true since the longer each half cycle the more complete the charge and discharge of the capacitor.

Let us consider now what happens

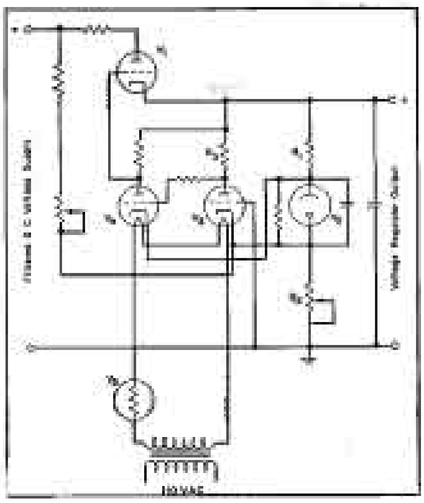


Figure 5
Voltage regulation circuit used in monitor.

through the circuit that charges the capacitor. Here, too, the current, and consequently the voltage across R_1, is proportional to the frequency. However, since there is no inertia in the system, the R_1 voltage is always proportional to the instantaneous frequency impressed on the grid of the counter and therefore acts as a demodulator. In this way the frequency modulated signal is transformed back to the audio signal.

This signal is then passed through a filter to remove the *if* signal. This filter attenuates a 60-*kc* signal 80 db, with respect to 1,000 cycles. The output of the filter is fed into two separate circuits; one measures the noise level and distortion the other the per cent modulation.

Noise Level and Distortion Measurement

The audio signal is then examined for noise level, distortion and per cent modulation, one circuit measuring the noise level and distortion and another the per cent modulation. In the former circuit the audio is passed through a 75 microsecond deemphasis network and then to two cascaded, inverse-feedback audio amplifiers. The amplifiers are carefully designed to limit distortion to less than .2% and have an audio response flat between 50 and 5,000 cycles to within 1 db from the 75 microsecond deemphasis curve. Without deemphasis the response is flat within 1.0 db from 50 to 15,000 cycles.

The output of the audio amplifiers can be fed into either a 600/150-ohm program monitoring circuit or into a high impedance load for noise level and distortion measurements. When fed into the 150/600-ohm load, the output is 0 *dbm* and 7 *v* into the high impedance load. Assuming the use of proper test equipment the distortion measurement capability is -52 db and a noise level capability of -80 db below 100% modulation.

There are two means of determining the per cent modulation. In one case a vacuum-tube voltmeter is used to measure the peak audio signal to provide the modulation directly in per cent and in the other circuit, a *flasher* goes on whenever the per cent modulation exceeds a certain level set by the operator. This latter circuit uses a thyratron which fires when the peak audio voltage exceeds a predetermined value.

The audio signal received from the 60-*kc* filter is first fed to a phase-splitting network before being applied to the above circuits. This enables the operator to measure the per cent modulation of either positive or negative half of the cycle. The phase-splitting circuit consists of a triode, with both a cathode and a plate output, each of course being exactly 180° out of phase from the other. A switch selects the desired output and feeds it to the detector circuit.

The detector circuit consists of a diode and a R_4 C_8 network (Figure 4). The time constant of the network is such that the voltage across C_8 is kept at a near peak audio level for 1/60 of a second. That is, during the positive half cycle the capacitor charges up to the peak audio voltage fed across the diode. Then during the negative half cycle it discharges only slightly so that a near peak voltage is maintained. The reason for this will become evident subsequently. This voltage is applied to both the vacuum-tube voltmeter and the thyratron circuit.

Thyratron Flasher Circuit

A 60-cycle voltage, obtained through a transformer whose primary is the 117 *v*, 60-cycle input, is applied to the plate of the thyratron. The thyratron will fire only during the positive half of the cycle and when the grid has a determined positive bias (depending upon the setting of the cathode bias resistor). When it fires, the tube draws current and the flasher lights up. When the plate voltage goes negative, the tube is extinguished and will fire again during the positive half cycle only if the grid still has the required minimum positive bias. The function of the R_4 C_8 circuit is to maintain the audio voltage at peak value long enough to fire the tube; that is, at least 1/60 second since the plate voltage may have just passed beyond the firing

(Continued on page 27)

TUBE *Engineering News*

Design and Application Notes on the Transitrol, Which Provides Direct Automatic Frequency Control.

Automatic frequency control using a separate reactance tube is an exceptionally desirable feature at *uhf*, minimizing many problems caused by local oscillator drift due to warm-up, line voltage fluctuations, etc.

In typical electronic *afc* setups the oscillator tuned circuit is shunted with the plate-to-cathode impedance of the reactance tube, a phase splitter supplying quadrature voltage to the control grid of the reactance tube. The plate impedance then has a reactive component whose magnitude is determined by the grid bias, which is in turn supplied by a suitable discriminator circuit so as to correct for any frequency deviations.

At *uhf* the simple reactance tube does not always function satisfactorily because interelectrode capacitances and transit-time effects are sufficiently large to interfere with the operation of the quadrature circuits. There is also the plate resistance of the reactance tube which may load the tuned circuit excessively.

Most receivers do not employ the reactance tube method, though, because of the extra tube required. Lately the double triode (6J6) has been satisfactorily applied with one-half of the tube functioning as oscillator and the other half as controlled reactance. Actually this circuit involves an extra tube since the second triode unit would otherwise have been available for other purposes, perhaps as a mixer.

Recently, however, there has been developed an afc tube which combines the functions of oscillator tube and controlled reactance into a single unit. Describing this tube at the recent IRE-RMA Rochester Fall meeting J. Kurshan of RCA Labs said that the new tube operates on the principle of controlling the transit time of the electrons; for ease in reference, the words *transit time* and *control* were combined to provide the name for the tube, *transitrol*.

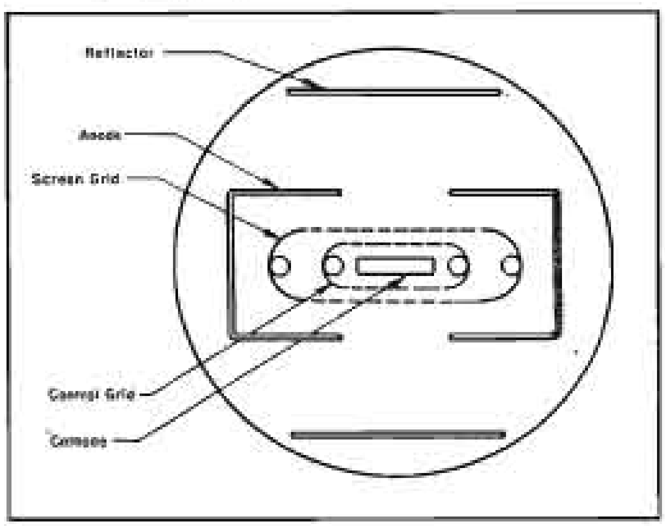
Kurshan reported that the idea of the *transitrol* occurred to Ed Herold on observing a troublesome effect often found in frequency converter operation. For instance in pentagrid converters, the two inner grids are part of the oscillator circuit and the *rf* signal is introduced on the third grid. Thus, when *avc* voltage is also applied to the grid *3*, it may change the oscillator frequency. Accordingly, said Kurshan, this effect is caused by electrons which are reflected from the area of this negative signal grid back to the oscillator section where they interact with the electrodes and the space charge, and if the frequency is sufficiently high, the transit time may be an appreciable fraction of an oscillation period, the resulting phase delay causing the returned electron current to have a large reactance component. Since the number of returned electrons as well as their transit time vary with the signal grid bias, a variable susceptance is introduced across the oscillator circuit. In converter tube design efforts are made to eliminate this unfavorable interaction. In the *transitrol*, this transit-time effect is used to control the frequency of an oscillator.

Analyzing the general behavior of the tube qualitatively, Kurshan said that some of the emitted electrons go directly to the anode and have small transit angles. Accordingly they contribute only to the g_m or transconductance of the tube and are important in maintaining oscillations. The electrons which pass the anode on the way out from the cathode are reflected and eventually reach the anode with large transit angles. Generally, declared Kurshan, these transit angles contribute both to the g_m and to the b_m or transsusceptance of the tube; varying the reflector potential alters the transit angle and hence the transsus-

(*Continued on page 33*)

Figure 1

Cross sectional view of oscillator tube for transit time control described by J. Kurshan at the recent Rochester Fall Meeting. In operation electrons leave the cathode, pass through the control grid, are accelerated by the screen grid, then returned by the reflector finally to land on the anode. If the reflector potential is just a little less than that of the cathode, the electrons are turned back right at the surface of the reflector giving rise to a relatively long trajectory between the control grid and the anode. When the reflector is made more negative, reflection occurs closer to the anode and the transit time is reduced.



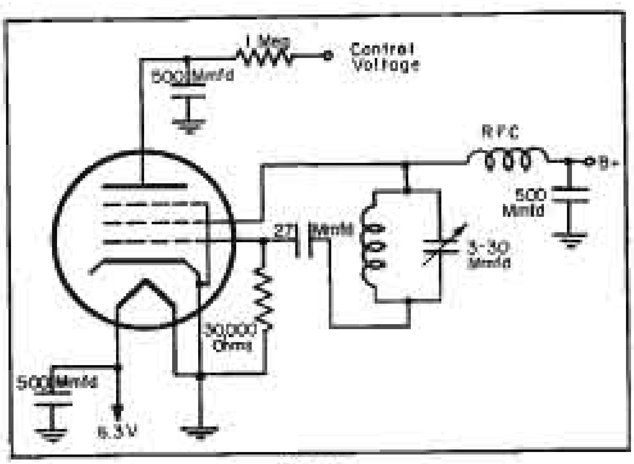


Figure 2

Test circuit for transitrol tubes. This is a Colpitt's oscillator using the interelectrode capacities for feedback. Such an arrangement, employing a grounded cathode, is the simplest to use at the higher frequencies. It avoids heater chokes or bifilar windings, but does require that neither end of the tuned circuit be at ground potential, which may be a disadvantage for some applications.

Adding An Aural System To A Studio Modulation Monitor

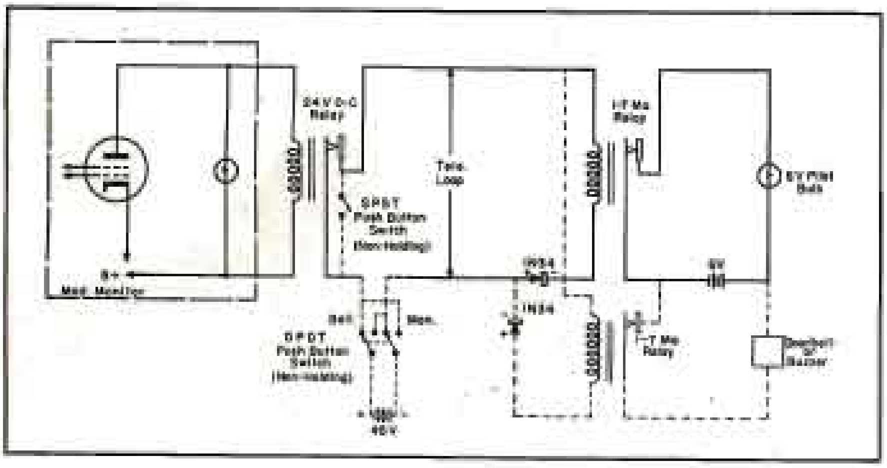


Figure 1

The original monitor circuit, with the added circuits shown in dashed lines.

by WILLIAM J. KIEWEL

Chief Engineer
KROX, Crookston, Minn.

In the August issue of Communications appeared a description of a studio modulation monitor designed at our station which has proved very effective in maintaining a constant audio level into our transmitter. This monitor operates on our spare audio loop, but is connected through a jack panel so as to allow instant changeover if the spare is needed for program. Another circuit has now been added on the same loop for announcer-warning purposes, which has saved us the expense of a loop through the telephone office.

Use of Light

Our transmitter-studio telephone uses, as other stations do, a light instead of a bell for signaling. This eliminates the danger of a bell getting on the air. However, it was found difficult to contact the announcer in a hurry if he had stepped out of his booth or was not watching the signal lights. And, if the announcer was using his mike, he could not answer the phone and perhaps be advised of transmitter or other station problems. It was deemed necessary, therefore, to install an audible signal system. The problem was the operation of either the modulation light or the bell on a signal loop. A ground could not be used with either wire.

Revamped Circuit

The original monitor circuit, with the added circuits in dashed lines, appears in Figure 1.

At the transmitter end a *dpdt* push-button switch was installed to reverse polarity on the existing 45 *v* battery. A *spst* switch was then placed across the points of the 24 *v* relay. Both of these switches are push-button non-holding types to eliminate any possibility of ringing the studio bell in error. Both switches must be depressed to provide bell ringing.

Germanium Crystals

At the studio end a 1N34 germanium crystal[1] was placed in series with an existing 1- to 7-ma relay operating the modulation light. A second relay of the same type, in series with another 1N34 crystal, polarized oppositely from the first, was then added across the first relay. The bell, in series with the existing 6 *v* battery was wired across the points of the second relay.

Polarity Problem

The choice of modulation light or warning bell depends upon the polarity of the 45 *v* battery since the germanium crystals will allow current to flow only through the relay which is properly polarized.

Operation of Switch

To operate the bell it is only necessary to push the *dpdt* switch, reversing the battery polarity, and then to push the *spst* switch completing the circuit across the relay points. The original polarizing is done in a few minutes by the cut-and-try method.

Improvised Single-Loop Circuit on Monitor Provides Operation of Audible Signal in Studio to Contact Announcer for Program Correction, Warning of Possible Transmitter Trouble or Phone Calls.

[1] *Warning*: 1N34 crystals pass only 22.5 ma.

View of the completed console installation. It will be noted that a third unit appears in the middle between the two consoles. This position facilitates control by either operator. A switching system is provided so that either operator can feed either the AM or FM, or both lines by the simple throwing of a switch. The unit does not employ relays and includes a signal system in both consoles which notifies the operator which of the lines he is feeding at the moment.

Moving Studio Equipment While On the Air

by F. E. BARTLETT

Chief Engineer
KSO and KSO-FM

Unique Plan Adopted to Permit Installation of Speech Input Consolette Without Disurbing On-the-Air Schedule.

There are usually many problems involved in the installation of broadcast station speech input equipment. When it becomes necessary to make such an installation, and at the same time continue broadcast operations through the existing facilities, the problems increase. And when the installation involves a revamping of the old setup, at the same time to provide dual-station operation, the situation becomes quite complex.

In an earlier article[1] appeared a discussion of a method used to install a speech-input setup in such a situation. The procedures used to install the associated consolette[2] and the manner of providing program continuity while making the installation are offered in this paper.

Our particular installation consisted of a console mounted on top of a standard 60″ walnut office desk. All input and output wiring for this console was carried through a group of conduits running from the speech rack to this desk and buried in a concrete floor. Each end of these conduits was placed in a metal box buried in the floor and flush with the floor level. At the speech rack end the racks were mounted immediately above the box. The other end, directly under the back of the desk, was covered with a metal plate to which was connected a number of flexible conduits[3] through which the wires were carried up under the desk, through it's top and into the console mounted on top of the desk. It was impractical to attempt to remove the console from the desk and, of course, the 60″ desk was not long enough to mount two consoles side by side. We therefore decided to continue to use the desk as a base for the consoles, but enlarge it by building two *wings*, one at each end. In our particular case these wings were extended straight out from the ends of the desk, although in some cases it might prove advantageous to angle them slightly forward so as to make a shallow *U* arrangement. The wings were simple flat tops bolted securely to the ends of the desk, flush with the desk top, and supported at their outer extremities by gas-pipe legs fastened to the floor and the top with pipe floor-flanges. To give the installation a bit of styling and in addition provide for cleanliness, the entire table-top was eventually covered with a metalized table-top fabric material which was advertised as being impervious to cigarette burns, acid stains, etc.

After the size of the desk top had been enlarged to accommodate the two

Continued on page 35

[1] Communications: November, 1948.
[2] The particular console involved (RCA 76B2) has, of course, certain methods of connection, termination, etc., which are peculiar to this instrument only. However, the same method of approach may be applied to fit the needs of the situation involved.
[3] Greenfield.

Super Power FM (349 Kw)

At the controls of WTMJ-FM (left to right): Phillip B. Laeser, chief engineer of WTMJ-FM and WTMJ-TV facilities and W. B. Fletcher, RCA Service Corp. engineer.

WTMJ-FM engineer, Raymond Herndon, with a 7C24 which is used in the 10-kw stage at the left and also in 3-kw and 1-kw stages as shown in center rack. The modulator is in the right transmitter rack.

The power control and circuit breaker panel of the FM transmitter. Unit is adjacent to the 50-kw amplifier units.

THE FAMOUS MILWAUKEE FM station which went on the air nearly nine years ago, with the call letters W55M, and today is one of the nation's most powerful FM operators, radiating 349 *kw*, employs many unique transmitting plant[1] and antenna[2] facilities.

Antenna System

The antenna system, located some one thousand feet in elevation above the city of Milwaukee, features an eight-element antenna located on top of a 550' tower[3] providing a 25,000 to 30,000 microvolt signal.

The antenna system is fed by two 3⅛" coax transmission lines using flange couplers. The antenna is split using one transmission line to feed the top 4 elements and the remaining line to feed the bottom four elements. Phasing between the two groups of antennas is accomplished in the transmitter room. With this dual transmission line system failure in one of the antennas or transmission line sections cannot disrupt radiation, since it is possible to cut out the defective section and continue transmission on the remaining one-half of the system at one-half transmitter power.

Power Amplifiers

The transmitter building, a two-floor brick building, is located about 130' from the base of the tower.

The transmitter has three power amplifiers which provide 50 *kw*. To obtain this power, two 25-*kw* amplifiers and one 20-*kw* driver amplifier are used in grounded grid circuits. A considerable amount of generated power is fed through the amplifier from each of the preceding driver stages. This is reflected in the output circuits as an apparent increase in the overall efficiency of the amplifier. In the instance of the two final 25-*kw* amplifiers, which are coupled together to feed the antenna, the efficiency factor under normal grid drive conditions for 50-*kw* operation is 85 per cent.

Antenna Power Controls

A feature of the transmitter is the power cut back switch allowing instantaneous transfer of the antenna to the 10-*kw* stage. This operation thereby removes all power from the 50-*kw* circuits leaving the equipment safe for the personnel to service in the event of equipment failure. Another feature of the transmitter is the reflectometer which is mounted on the transmission line leading to the antenna. This instrument measures the relative power output of the transmitter and also indicates the degree of the reflected energy from the antenna system. In the event of an antenna or transmission line failure causing the reflected energy to increase beyond a predetermined set safe value, the re-

[1] RCA BTF-50A. [2] RCA. [3] Blaw-Knox.
[4] General Radio 804 B.

At WTMJ-FM

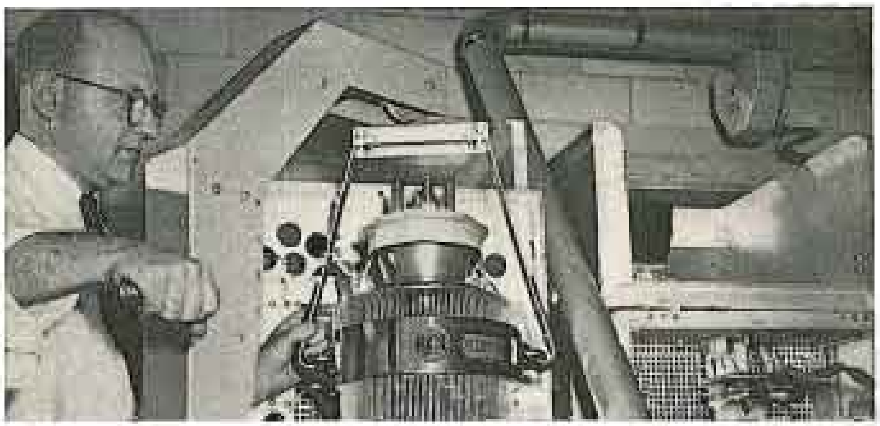
flectometer in connection with its associated equipment will immediately cut off the transmitter power, thereby safeguarding and protecting the antenna system from burnout.

Noise Level Measurements

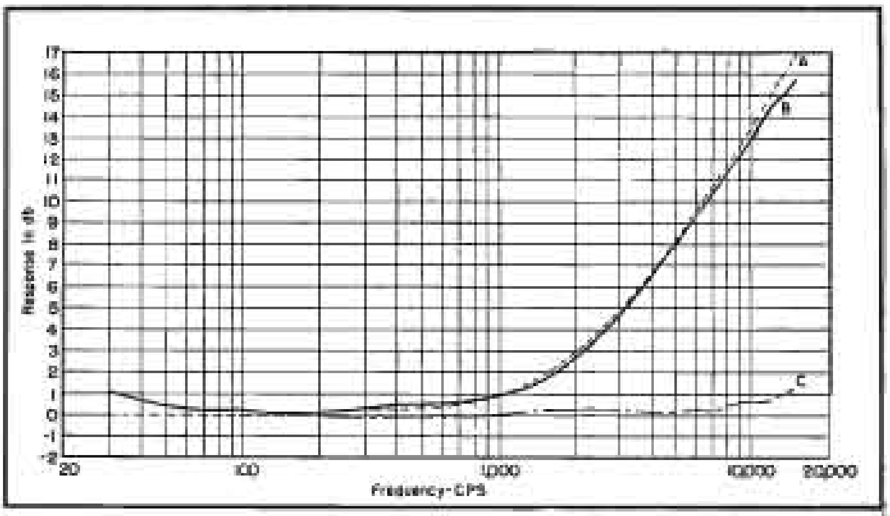
Measurements taken on the transmitter have indicated that the AM noise level runs better than 52 *db* and the FM noise level better than 65 *db* which includes studio and a twenty-six mile circuit of the Wisconsin Bell Telephone Company program line.

Harmonic Checks

Harmonic checks have indicated that the second harmonic content at 186.6 *mc* measured one-half mile from the transmitter and compared to a standard signal generator[4], was found to correspond to 120 microvolts, a value considered not to be objectionable to other services.

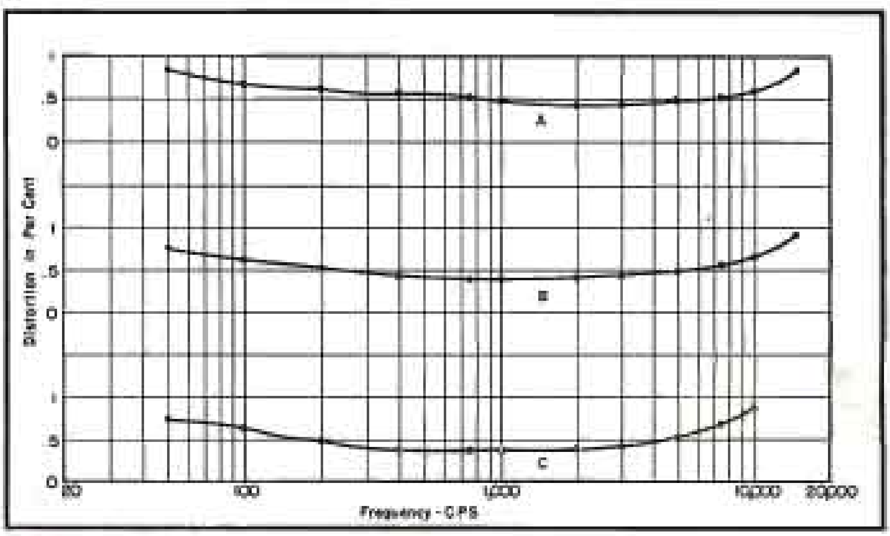


A. B. Van Alstyne, WTMJ transmitter supervisor, using a tube hoist to remove one of the 5592 power amplifier tubes.

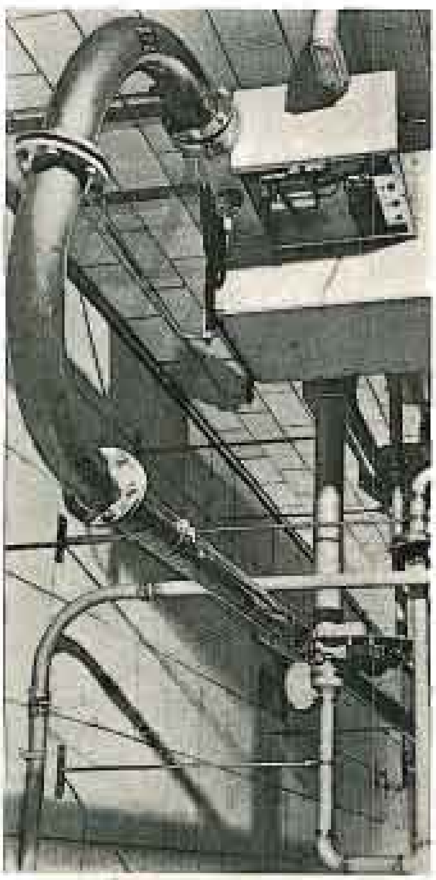


Audio frequency response at 100% modulation on a G.E. BMIA modulation monitor (without de-emphasis) from the input of transmitter speech amplifier to output of transmitter. *B* represents the audio-frequency response curve (shifted to 1000 cps reference and inverted); *A* is the standard preamp curve, and *C* is the standard preamp curve subtracted from the measured audio response curve.

Measurements made from input of transmitter speech amplifier to output of transmitter. All measurements made with a GR 1932-A distortion meter and a limiting amplifier. Curve at *A* is at 100% modulation; *B*, 50% modulation and *C*, 25% modulation.



The harmonic filter, transmission line monitor, and coax line to the 25-kw amplifier and output to the antenna system. Also shown are the cutback switches and wiring ducts.



Corrosion In Multiple Layer Wound Coils

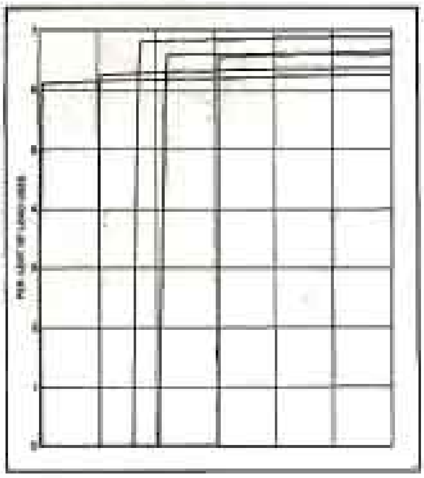
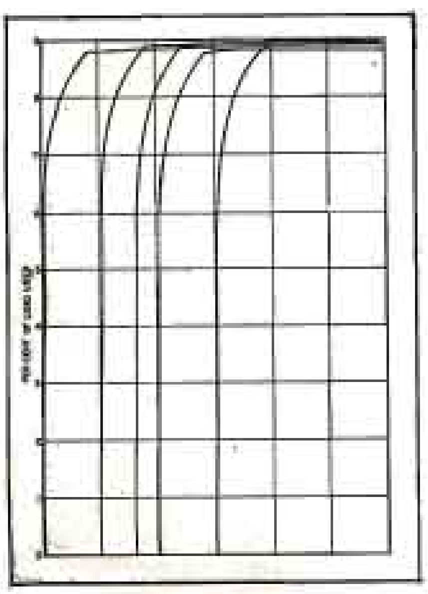


Figure 1
Corrosion test plot of paper back tape wire on Scott Tester (backing of positive lead under test.) Spacing between jaws was 4" and a No. 2 loading on movable carriage was used. A sample calculation revealed that the tensile strength was .61 × 2 = 1.22 and elongation was .05/4 = 1.2%.

Figure 2
Another plot of a paper backed tape wire, this one covering the negative lead. Spacing and loading were identical to that used for the Figure 1 plot. In a sample calculation the tensile strength was .877 × 2 = 1.754 and elongation was .75/4 = 19%.



Report on Progress Made in Overcoming Chemical, Electrolytic and Galvanic Corrosion, Major Cause of Most Opens in Coils.

by HOWARD ORR

Works Laboratory
General Electric Company
Fort Wayne, Ind.

OPEN CIRCUIT FAILURES of layer wound coils, such as used in control devices, transformers, reactors, relays and telephone equipment have caused engineers and service men quite some concern for many years. The problems caused by these failures became so acute that about ten years ago the problem of open circuits in spool-type coils was earnestly attacked on an industry-wide basis.

Much time and effort was spent in analyzing open circuit failures in layer wound coils in an endeavor to determine the cause of the *open*. Analyses of service complaints, and test records indicated that coils making use of small diameter wire were the most serious offenders. The other and most important fact established by these analyses was that by far the largest percentage of *opens* were caused by corrosion. It has been further established that failures are more numerous and occur in a shorter period of time in humid atmospheres.

With these facts as a basis, considerable progress has been made in the past ten years in overcoming these corrosion problems.

One of the early facts established and now accepted on an industry-wide basis is that corrosion within a coil, perhaps best defined as the gradual alteration and disintegration of an electrical conductor by chemical reaction, falls into three classes—chemical, electrolytic, or galvanic.

Chemical Corrosion

Chemical corrosion is disintegration and separation of a conductor, and is caused by the chemical action of an acid or alkali on the copper. It is usually detected by greening and piling up of disintegration products at a localized point in the conductor. This usually occurs at lead joints or some rupture point in the insulation film on the wire, and most commonly in an area where ingress of moisture is greatest.

Potential on a coil is not necessary for chemical corrosion; thus it often occurs while the coil is at rest and not energized. While at rest, a coil is not heated by electrical losses, and moisture can easily be wicked in. Once inside a coil structure, it can combine with chemical salts, which are in the coil as impurities, to produce the acidity or alkalinity which actually corrodes the conductors.

Impurities and Moisture

How impurities with which moisture combines to form corroding agents get into coils is an interesting problem. First, for consideration are the materials used in conventional multiple layer coil construction. Essentially, these materials are (*a*) paper; (*b*) film coated magnet wire; (*c*) tape; (*d*) and, very often, insulating varnishes. The paper is used in construction of the coil form and is usually wrapped into tubular shapes, square, or round and held together with glue. Other paper is used as a dielectric between layers of wire, and in suitable form as a wrapper over the actual winding, being held in place with cotton or pressure sensitive tape. Various methods of anchoring leads to coils often make use of gummed paper and tapes, or pressure sensitive tape.

Unless the quality of all materials entering into coil construction is carefully controlled, chemical corrosion will take place.

Paper is made by digesting or cooking wood chips or small pieces of cotton rags under pressure in a solution usually consisting of calcium bisulphite or a mixture of sodium hydroxide and sodium sulphite, depending upon the type of paper being made.

After properly aging the digested wood or rags, they are placed in a beater where hydration of the individual fibers takes place. Before actual hydration of the fibers is started, the stock must be washed entirely free from alkali if an electrical grade of paper that will not cause chemical corrosion is desired. If any residual acid or alkali remaining in the digested pulp is neutralized chemically, the resultant paper cannot be guaranteed not to cause chemical corrosion. Therefore, it is absolutely necessary that all acid or alkali be thoroughly washed out and no residual salts remain. Various paper-making processes use different digesting solutions, but the same importance in washing to neutral is necessary, no matter what cooking solution is used.

Addition of sizing agents to paper, such as alum and rosin for imparting strength, increased stiffness, density and minimizing moisture pickup, is very apt to contribute to chemical corrosion. Therefore, the use of a size is not recommended in insulating papers.

Essentially, the same sort of treatment as applies to paper holds good for cotton cloth and tapes. Many excellent techniques and processes have been developed by the paper and textile industries for obtaining neutral end products.

The activating medium causing chemical corrosion in a coil in which the construction materials have not been controlled is moisture. Moisture enters the coil through minute cracks and voids, and by capillary or wicking action. Once inside, it combines with residual salts remaining in the construction materials, forming mixtures or solutions which in turn will chemically corrode the copper wherever it is contacted. Air-borne impurities in the form of gases are carried into the coil, which also combine with moisture in the coil to produce corroding agents.

Many times air-borne impurities enter the coil in the form of CO_2 or other gases, which form corrosive acids or alkali solution with moisture, and in turn cause some chemical corrosion.

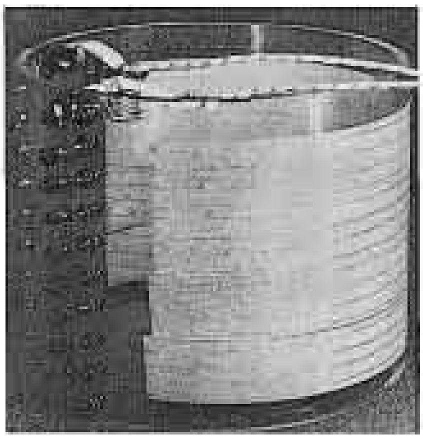


Figure 3
Plastic cylindrical drum, approximately 6" in diameter, with specimens of wire tested for corrosion.

Another, and perhaps the most common source of chemical corrosion, is that caused by the careless use of corrosive soldering fluxes such as zinc chloride. In attaching terminals and leads to coils, it is absolutely necessary that all excess flux be cleaned from all soldered joints if chemical corrosion is to be avoided.

The wire is stripped of its insulation at the places the joints are made, and corrosive solutions formed by moisture and residue from flux directly attack the bare copper at these points. Many a coil stored in a humid atmosphere has had badly corroded terminals and lead connections when removed from its package just because excess soldering flux was not completely removed after the soldering operation.

Varnish treatments are sometimes the cause of chemical corrosion, although this cause is fast disappearing because of the progress and understanding of insulating varnish manufacturers. Varnishes containing resins with high acid number are corrosive to bare copper, and attack before they are oxidized or polymerized. Drying oils used in varnishes can become acid in reaction with age, which in turn may produce corrosion within a coil. The *ph* value of dried varnish films will lower with age, and when in combination with moisture can form small amounts of acids which attack and corrode the conductor. It has been demonstrated, however, that insulating varnishes can be formulated that will not exhibit a lowering of *ph* value of the dried film with age.

In order that chemical corrosion can be eliminated or minimized in layer-wound coils, it is very necessary that all materials used in the manufacture be controlled, that care be exercised in operations such as removing excess soldering flux, and that moisture resistance be provided to shield out or at least minimize the ingress of water into the coil.

Electrolytic Corrosion

By far the most troublesome and complicated corrosion problem in multiple layer-wound coils is that caused by electrolytic action. This type of corrosion is readily produced in coils carrying *dc* potentials; in fact, electrolytic corrosion can almost be forgotten in *ac* coils. However, *ac* operated coils with *dc* currents superimposed on them, and coils having interrupted *dc* impressed on them are easy victims of this type of corrosion, and the smaller the wire diameter the more serious the problem becomes.

The exact cause of electrolytic corrosion has been debatable for a long time, but one important fact has been definitely established and accepted. That is, that moisture must be present for the formation of corrosion. One of the commonly accepted theories is that the moisture dissolves the salts or bases existing in the coil construction materials as impurities, thus forming electrolytes and establishing leakage paths between potential gradients within the coil.

The *dc* flowing in these leakage paths produced the well-known plating action, in which positive ions are discharged on the negative electrode or cathode and negative ions are discharged on the positive electrode or anode. For every negative ion which flows to the positive electrode, a chemically equivalent amount of copper is taken away from the positive and eventually migrates or flows to the negative electrode. Thus, the positive electrode becomes pitted and shows a definite weight loss.

Not all of the copper torn away from the positive electrode flows to the negative electrode. A portion of it remains, and when this is in contact with the carbon dioxide of humid air, it forms basic copper carbonate. This is the greening usually seen and which forms the basis for visually judging the amount of corrosion. It should be thoroughly understood, however, there can be no ion migration without current flow.

Leakage paths may be established over the surface of the coils from terminal to terminal, or through insulation from one conductor to another where potential gradients exist, or between conductor and frame through the insulation. Many corrosion failures have been located deep in a coil structure, far from outside surfaces, where a leakage path had formed between the copper of the conductor and ground.

[To Be Continued]

The Industry Offers

ANDREW ISOLATION TRANSFORMER

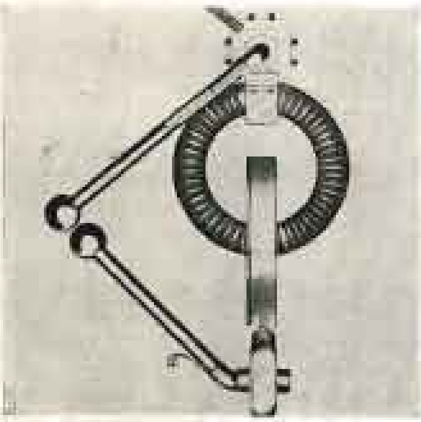
An air insulated transformer, Isoformer, for supplying 60 cycle lighting voltages to tower lighting circuits without providing an *rf* path to ground, has been announced by the Andrew Corp., 363 East 75th St., Chicago 19. The Isoformer is particularly useful in 10 kw and higher power installations as well as on towers with high base impedances.

Unit is composed of a primary wound on a toroidal laminated silicon iron core and a ring shaped secondary winding which encircles a portion of the primary. The windings are insulated from each other by an air gap. The effect of such construction enables the transformer to withstand high voltages between windings, to limit the effect of supply voltages and to extend tube life.

Two 120-volt primary windings are each provided with 10 per cent undervoltage taps. The primaries are connected in parallel for 120-volt operation or in series for 240-volt operation. The 110-volt secondary winding is provided with a 10 per cent overvoltage tap.

Each Isoformer is provided with a ball gap lightning arrestor to protect the unit from lightning damage. Mounted by means of standard pipe fittings and any of numerous mounting arrangements are possible with the fittings provided.

Available in two models: 2015 for maximum lighting loads of 1.5 kw, and 2030 for maximum loads of 3 kw.



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IRC HIGH-VOLTAGE RESISTOR

A high-voltage resistor, type BTAV, which it is said will withstand surges up to 6,000 volts, has been announced by IRC.

* * *

JENSEN HYPEX PROJECTORS

A Hypex projector, VH-241 ST-789, which has an acoustic path length of 54" and a useful frequency response range from 140 to 6,000 cps, has been announced by Jensen Manufacturing Co., 6601 S. Laramie Ave., Chicago 38, Ill. Voice coil impedance is 16 ohms; power rating is 25 watts maximum speech and music signal input.

The driver unit, an integral part of the assembly, has a phenolic diaphragm and Alnico 5 magnet and is completely enclosed yet can be removed and replaced if necessary. The connecting cable is passed through a rubber grommet into a terminal box and the leads attached to the screw terminals.

* * *

ELECTRO-VOICE MICROPHONE DESK STAND

A shockproof microphone desk stand, model 426, has been developed by Electro-Voice, Inc., Buchanan, Michigan.

A shock mount, with dual Lord shear-type mountings, is built into the base.

Designed with adapter to fit standard ⅝"-27 thread microphones.

Desk stand complete with shock mount is 6¼" long, 4¾" wide, 4⅛" high.

FAIRCHILD CUEING AMPLIFIER

A cueing amplifier, 633-A2, for transcription turntables has been developed by the Fairchild Recording Equipment Corp., 88-06 Van Wyck Boulevard, Jamaica 1, N. Y. Using push-pull stages and inverse feedback, the amplifier is said to have a frequency response of 70-15,000 cps, ±1½ db.

Amplifier will supply 3 watts of audio to a loudspeaker. Wide choice of voice coil impedances is available. A high impedance output is also provided for feeding one or more headsets. A transformer input, 10,000 ohms, permits grounded or ungrounded bridging across any low impedance line without reflecting a mismatch. Amplifier is 7" x 6" x 4½".

* * *

FTR MULTICHANNEL MICROWAVE TELEPHONE LINK

A multichannel FM 900 to 940-mc microwave radio link, FTL-13-A Intelink, capable of simultaneously transmitting more than seven two-way telephone conversations, has been developed by Federal Telephone and Radio Corporation, Clifton, N. J.

Each system, comprising one transmitter and one receiver terminal requiring a single assigned carrier frequency, constitutes a one-way broad band communications circuit. Two such links, operating in opposite directions over the same path on two separate radio carrier frequencies, provide a two-way circuit adaptable to signal transmission on a four-wire basis.

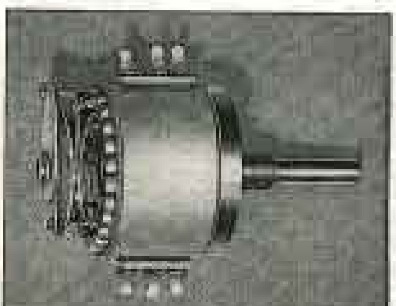
The equipment is capable of transmission of signals in the 200 cycle to 40 kc range.

* * *

SHALLCROSS VU METER MULTIPLIER

A 1¾" diameter vu meter multiplier has been announced by the Shallcross Mfg. Co., Collingdale, Pa. Unit provides five step *straight T* performance in a control size normally limited to ladder and potentiometer circuits. A pair of extra terminals are said to increase the utility of this unit, since in the *off* position the multiplier network is automatically disconnected from the line which it normally bridges, and the vu meter, isolating both.

The *Vu* meter is connected to the auxiliary pair of terminals on the multiplier when in the *off* position, thus enabling the meter to be used for volume indication on another line, for tube checking and other purposes. Two standard attenuation ranges are available: 0 (1 mw) to +16 and off in 4 vu steps, and +4 to +20 vu and off in 4 vu steps. Spacing between adjacent positions is 30°.



RCA CHANNEL 7 to 13 TV TRANSMITTER

A 500-watt channel 7 to 13 transmitter has been announced by the RCA Engineering Products Department.

The transmitter (Type TT-500B) combines all the necessary components for the transmission of both visual and aural signals within two identical cabinets which can be installed as one unit measuring 58" wide, 33" deep, and 84" high.

Monitoring facilities are provided in a desk console which consists of two units: one for monitoring picture quality and waveform, the other for monitor switching.

A feature of the transmitter is its use of a coax tank circuit in the power stage which has no movable electrical contacts. It is tuned by varying the length of a set of metal bellows. Another feature is the use of four small tetrodes in parallel.

A clamp circuit type of *dc* insertion is used in the grid circuit of the modulators. This circuit clamps on the *back-porch* of the horizontal synchronizing pulses.

* * *

E. F. JOHNSON VARIABLES

A line of variables, type 167, featuring ceramic soldering of stator terminals, mounting posts and rotor bearings has been announced by E. F. Johnson.

Variables are available for communications equipment operating up to 500 mc.

Has beryllium copper contact spring, silver plated; split sleeve rotor bearings; steatite end plates, 3/16" thick, 1⅜" square; ⅛" diameter aluminum tie rods; stainless ⅛" diameter steel shafts.

Variables are already available in fifteen sizes and capacities with spacing of either .030" or .080".

* * *

BLILEY ELECTRIC CRYSTAL TEMPERATURE STABILIZER

A crystal temperature stabilizer, type TCO-1, designed for use with Bliley type BH6 crystal units (1 to 100 mc range) which mount in an internal socket, has been announced by the Bliley Electric Company, Erie, Pennsylvania. Unit is said to be capable of providing frequency stability down to ±.0001% while crystal temperature is maintained within ±2°C. The standard unit is supplied for operation at 75°C±2°C and is equipped with a 6.3 volt heater rated at 5.5 watts.

* * *

G. E. EXPANDED SCALE VOLTMETER

An indicating voltmeter with an expanded scale has been announced by the G. E. meter and instrument divisions as an addition to the AB-15 line.

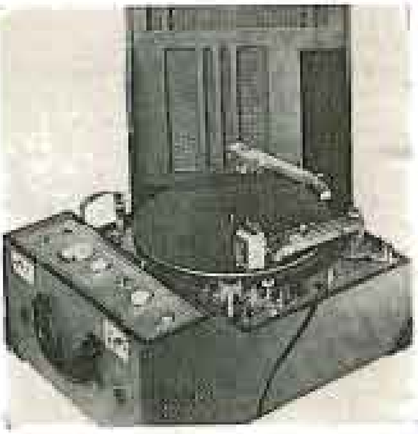
Meter has a scale 7.1" long spanning 250° about the center. The scale is expanded over the most frequently used range, from 90 to 130 volts. Accuracy is said to be ± ½ per cent in the range of 105 to 125 volts and ± 1 per cent over the entire expanded range.

Meter is housed in liquid-resistant 4¾" x 4¾" x 4¾" case.

News Briefs

PRESTO RECORDING MICROGROOVE EQUIPMENT

Two microgroove recorders, types K-10 and Y-3 and microgroove phono record player, 18 series, have been announced by the Presto Recording Corp. The microgroove recorders are modifications of the Presto K-8 and Y-2 types, and will do standard recording as well as microgroove.



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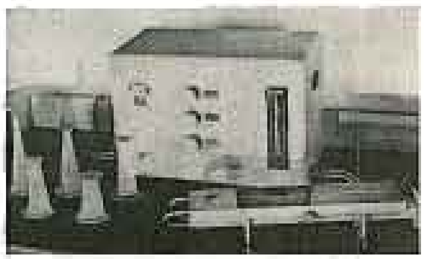
DE MORNAY BUDD MICROWAVE CALORIMETER

A calorimeter which is said to permit measurement of absolute *rf* power between 2,600 and 26,500 mc has been announced by DeMornay Budd Inc., 475 Grand Concourse, New York 51, N. Y.

Said to give an accuracy of approximately 2 watts at average power readings of 100 to 500 watts.

The heart of the apparatus is a compartmented glass water load internally connected inside a waveguide section that absorbs the entire energy. The limit of power measurement is that amount which causes circulating water in the water load to release dissolved gases at about 60° C (140° F).

By increasing the rate of water flow and recalibration, it is possible to increase the amount of absolute *rf* power measurement.



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MOON TURBO-GENERATOR

Steam-turbo generators for use with 2-way radiotelephone communication systems for ship-to-shore, caboose-to-engines, etc., have been announced by Moon Manufacturing Co., 116 N. Jefferson, Chicago 6, Ill.

Unit is 31⅝" long by 17¼" high by 16" wide, and has automatic sight-feed oilers with flat compensation and automatic over-speed cut-off valve. Units now in use are 1 kva, 110 volt, 60 cycle, single phase, ac.

For complete details address William Ruth, plant manager.

* * *

KELLOGG SWITCHBOARD KEY-BX TELEPHONE SYSTEM

A *Key-BX* wiring plan system, No. 6-2-20, has been introduced by the Kellogg Switchboard and Supply Company, 6650 S. Cicero Ave., Chicago 38.

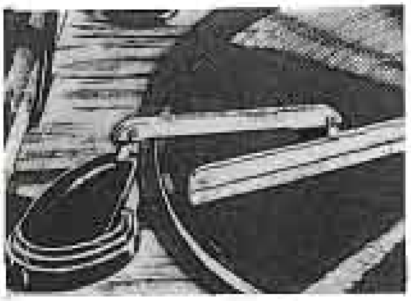
The system is a wiring plan scheme which eliminates the necessity of floor type or cordless PBX switchboards requiring an attendant to handle outgoing, incoming and intercom calls.

Equipment permits one to six trunks to a common battery manual or dial exchange; up to 20 telephone stations within the business office or building; and one or two intercom circuits for talking between individuals, or for conference calls between several individuals.

AUDIO DEVICES CHIP CHASER

A *chip chaser*, which is said to prevent a recording chip or thread from getting tangled up under the recording stylus, has been developed by Audio Devices, Inc., 444 Madison Ave., New York 22, N. Y. Consists of a lightweight, aluminum-backed strip of felt, attached to and supported by a heavy cast-iron base. In operation, the device is placed beside the recording turntable, with the felt strip laid across the recording disc. The chip from the cutting stylus is automatically guided in to the center of the disc, where it winds around the center pin. The felt strip is pivoted so that it can be tilted up out of the way when not in use.

Available in two sizes: one for use with all turntables up to 12" in diameter, and one for 16" turntables.



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ADVANCE COAX RELAYS

Two 2 15/16" coaxial relays have been added to the relay line manufactured by the Advance Electric and Relay Co., 1260 West Second St., Los Angeles 26, Calif.

Relays are designed to maintain a voltage standing-wave-ratio ranging from 1.04:1.00 at 60 mc to 1.40:1.00 at 300 mc, with a maximum rating of 250 watts. They are built for use with 50 ohm RG cable.

* * *

RCP TEST UNITS

A combination 'scope and sweep generator, Tee Vee 90, for TV work has been announced by Radio City Products Co., Inc., 152 West 25th Street, New York City.

The 'scope has deflection sensitivity of 100 microvolts rms, horizontal and vertical. Has its own sinusoidal sweep generator. Sync is provided for internal positive or line frequency.

The sweep generator has continuously variable bandwidth from 50 kc to 6 mc with range of 4.5 to 30 mc.

Attenuation of *rf* is continuously variable and and output is applied through low loss coaxial cable. Traveling detector probe is included for observing signal at any point of the *rf* circuit under test.

Tubes used include *one* 3BP1; two 7GT; two 6X5; one 884; one 6SN7 and one 7A4.

* * *

STACKPOLE SLIDE SWITCHES

Two slide switches have been announced by The Stackpole Carbon Company, St. Marys, Pa. One type, SS-26, is a single-pole single-throw switch and another, type SS26-1, is single-pole double-throw. Both are rated at 1 ampere at 125 volts *dc*, or 3 amperes at 125 volts *ac*. Both are 1⅛" long x 17/32" wide and are equipped with 11/32" black trigger as standard.

* * *

WILKOR PRODUCTS MINIATURE RESISTORS

A line of small *Carbofilm* resistors, specially designed for miniature electronic units, has been produced by Wilkor Products, Inc., 3835 West 150th Street Clevland 11, Ohio. Available in sizes from ¼ to 1 watt, in values from 20 ohms to 5 megohms and with tolerance of ½ to 1%.

The smallest resistor in the line measures 1/16" diameter over caps, ⅜" overall length, with 1½" tinned copper leads. They can be supplied insulated.

* * *

MALLORY VIBRATOR

A vibrator, type 1501, which is applicable to FM receivers, *push-to-talk* transmitters and others uses where power in excess of the capabilities of present standard vibrators is required, has been announced by P. R. Mallory & Co., Inc., 3050 E. Washington Street, Indianapolis 6, Ind.

INDUSTRY ACTIVITIES

The Fourth Annual Spring Meeting sponsored jointly by the RMA and the IRE in the interest of transmitter and transmitting tube engineers will be held at the Benjamin Franklin Hotel, Philadelphia, Pa., April 25, 26, and 27, 1949.

The tentative program includes visits to the Philadelphia Navy Yard; WPTV, and the RCA plant at Camden, N. J. The annual banquet will be held Tuesday evening, April 26.

The Sprague Electric Company, North Adams, Mass., through the Herlec Corporation, a wholly owned subsidiary, has, after extended negotiations with Du Pont and the Signal Corps, acquired possession of an automatic machine for the production of vitreous enamel capacitors. The machine was under development for approximately 5 years by Du Pont and later by its subsidiary, the Remington Arms Co. It was completed during the war for the Signal Corps for the production of capacitors to take the place of mica units which were in short supply due to the difficulty of importing mica from India.

Furst Electronics has moved to new quarters at 12 S. Jefferson St., Chicago 6, Illinois.

PERSONALS

Paul Hatenyi, founder and former president of Solar, has been retained as a consulting engineer by Aerovox Corporation, New Bedford, Mass.

Leonard Kebler, chairman of the board of Ward Leonard Electric Co., Mount Vernon, N. Y., has been reelected a board member of the National Industrial Conference Board for the forthcoming year.

Dr. W. W. Wetzel, former assistant director of the Minnesota Mining & Manufacturing Co., central research laboratories, has been appointed technical director for the recording tape unit.

Assistant research director will be **Dr. Lew W. Cornell**.

Earl E. Eldredge has been appointed chief engineer of the Press Wireless Manufacturing Company, Inc., Hicksville, Long Island and West Newton, Mass.

Eldredge was formerly chief engineer at Erco Radio Laboratory.

Walter H. Stellner is now Motorola vice president of merchandising and **Elmer H. Wavering** has been named vice president of product design.

W. H. Stellner

E. H. Wavering

John N. Fricker has joined the office of the president of Airborne Instruments Laboratory, Mineola, N. Y., as director of engineering services, and **Robert B. Beetham** has become executive assistant to the vice president in charge of research and engineering.

Dr. Cledo Brunetti, former chief of the engineering electronics section in the U. S. Bureau of Standards, has joined the staff of Stanford Research Institute as associate director.

Robert L. Westbee now heads production and distribution of *Scotch* electrical tapes and *Scotch* sound recording tapes produced by Minnesota Mining and Manufacturing Co. 900 Fauquier Avenue, St. Paul 6, Minnesota.

Leonard G. Taggart is now director of purchasing for Sylvania Electric.

Civil Aircraft Radar

(*Continued on page* 11)

beacons on the ground to find its way to an airport.

Modern aircraft liners employ two direction finders aboard each aircraft to get a fix for the determination of distance in addition to bearing. Radar can determine distance as well as bearing single-handed without any other assistance. It could, if necessary, permit the elimination of the second radio direction finder.

(*d*) Radar is valuable during *dead reckoning* types of flight when landmarks are invisible. In fact, dead reckoning is not even necessary since the pilot can see prominences on the earth in the form of mountain tops, radio towers, tall buildings, city outlines, sea coastline, river banks and lake shapes.

(*e*) *Night radio effects* have always interfered with accurate determination of radio bearings on the medium or low radio frequencies still in use. These effects are caused by signals from the homing or reference ground station arriving by numerous radio paths of unequal length. The radio signal portion that comes direct or straight-line reaches the aircraft direction finder loop antenna sooner than the same instantaneous transmitted energy which first struck the ionosphere and reflected back. All energy, other than direct path, will be false in radio bearing indication. Since the reflected energy may aggregate as much or more than the direct path energy, radio bearings at night are less accurate or inaccurate. This phenomena is caused by variations in the density of the ionospheric layers as well as the height of those layers above the earth. During the day the ionospheric layer or layers have higher ionic density due to the sun, absorbing waves striking it. At night, the ionic density is lower due to the absence of the sun in that area, and thus waves are much less absorbed and tend to reflect back to confuse reception of direct path signals. These reflected signals, depending on their phase or instantaneous wave condition may add or subtract the direct path energy to produce extremes between zero and abnormally strong overall signals. The reflected or superfluous waves reach the aircraft direction finder at variable elevation angles such as 10° to 75°. These errors due to night effects continue from about an hour before sunset to an hour before sunrise. It is more serious over land than over water. Whenever the complex ionospheric reflections equal or exceed the strength of the direct path signals, then the radio bearings are unreliable and *must not be used*.

(*f*) *Mountain or terrain errors* cause false radio bearings to be received aboard the aircraft, because of reflective paths which signals may take from the ground at any time, aside from night ionospheric effects. Each mountain or terrain variation can bounce off signals at an angle which if received aboard aircraft will result in false radio bearing indication.

(*g*) *Radio warpage* is another peculiar problem with which to contend. The presence of metal in the vicinity of radio antennas aboard aircraft causes waves to be warped. Since propagation varies in different mediums, it will be different in behavior where more of the plane metal structure stands between the ground transmitting station and the aircraft antenna, than in such directions where less metal (such as none of the wing) is in the path. In practice, this condition causes an incoming signal to come from a different direction than the actual direction. Radio warpage can normally be determined and calculated when a plane is first put into service. Thereafter, the radio direction finder bearing scale must be inherently corrected automatically or reference must be made to a correction chart furnished the aircraft. The amount of correction (degrees to add or subtract from the indicated bearing) will vary for all angles of the aircraft with respect to the ground station.

(*h*) *False cones of silence* are still another problem. When a pilot guides his aircraft over a radio range or airways route, he finally arrives over the radio range station itself. When directly overhead, it is normal to lose the signal or encounter a *cone of silence*. This is useful in finding the destination. However, false cones of silence can also be noticed when an aircraft flies over irregular terrain such as a deep canyon or an abrupt change in terrain. It is particularly bad in mountainous terrain where signal variations might be mistaken for a *cone of silence*. When heavy static in the atmosphere, common in the tropics during summer or anywhere during a lightning or other storm, hampers reception, *cones of silence* may be unidentifiable in the background, regardless whether real or false. To avoid confusion between true and false *cones of silence*, the pilot must carefully listen for four consecutive events characteristic of a true *cone of silence* over a radio range. These are sharp signal increase, dead spot, signal surge, and signal fade finally returning to normal level again.

(*i*) There are also the *radio range errors* which often exist. The basis for the airways radio ranges are the *A* (dot-dash) and *N* (dash-dot) indications. If the pilot is right on course, these two signals merge to produce a solid tone. There are four serious types of errors which aircraft encounter when they fly the present radio ranges: (*1*) *Swinging beams* due to night effects caused by signals bouncing off the ionosphere in addition to being received direct; (*2*) *bent or scalloped beams* near the end of a multiple course or where reflections develop from irregular terrain; (*3*) *multiple beams* where pilot hears several sets of *A* and *N* signals and cannot decide whether he is following correct direct-path signals or indirected-path reflected signals; and (*4*) *reversed signals* where the *N* is coming in louder than the *A* or vice-versa. The latter is caused by the limiting or saturating action of the receiver to very strong signals while still amplifying properly on weak or average signals.

(*j*) *Static of any kind* whether resulting from lightning, advancing storm, the *armature* effect of an aircraft flying through the earth's magnetic field above the earth, poor electrical continuity of various metallic members of the aircraft, *St. Elmo's Fire* or corona effect, etc., more or less hamper reception on the lower or medium radio frequencies used in aviation. Static diminishes with an increase of *rf* employed. At present all aircraft radio operations are conducted between 278 and 132,000 *kc*. The lightweight radar operates on over 9,000,000 *kc* where static is no problem.

(*k*) *Ground-located landing systems* of the *GCA* (*Ground Controlled Approach*) and *ILS* (*Instrument Landing System*) types are recent developments designed for major airports. There has been quite a technical controversy as to their relative merits between equipment manufacturers, CAA, pilots and others. Notwithstanding their advantages and shortcomings, they do not replace radar in aircraft. They are intended for bringing aircraft in to a landing when visibility is poor. GCA does it by radar observations from the ground and oral radiotelephone instructions to the pilot. *ILS* does it by the plane carrying special equipment on two frequencies with the plane coming down on a 3° equi-signal path. Airborne radar is still desirable or necessary for the flight between terminal airports and as a check against the landing system indications or instructions.

[To Be Continued]

FM Monitor

(Continued from page 13)

point when the peak audio is applied to the grid.

However, the grid bias can not remain at the peak audio for much longer than 1/60 second, otherwise the thyratron would fire even though the per cent modulation has gone down. For this reason the R_6 C_6 time constant is such that the capacitor discharges only slightly after a 1/60 second so that it is at near peak, but decays as rapidly the design will permit thereafter, so that it will not fire the thyratron beyond several cycles unless another high audio voltage is applied to the detector.

When the operator wants to know the actual per cent modulation rather than whether it exceeds a certain value, a vacuum-tube voltmeter is used to measure the peak audio voltage. The vacuum-tube voltmeter uses a conventional bridge circuit, the vacuum tube acting as one leg of the bridge, to obtain an overall per cent modulation measurement accurate to within 5%.

To achieve the low noise and distortion levels an unusually good power supply was necessary. Ripple voltage had to be kept within .2 millivolt at 275 *v dc* and the output had to remain constant independent of any changes in the *ac* input. A schematic of the voltage regulation circuit used to meet these requirements appears in Figure 5.

The filtered *dc* voltage is applied across V_1 and the circuit is so designed that the cathode potential is 275 volts. Let us assume that, due to a change in line voltage, this voltage increases. This increase in voltage is reflected across R_2 (R_1 in this circuit is a dropping resistor and V_2 is a constant voltage dropping tube).

The potential across R_2 provides the cathode bias for V_3 and when it is increased the current flowing through the tube is decreased. A decrease in current reduces the voltage drop in R_3 and consequently increases the potential of the V_3 plate. The plate of V_3 is, in turn, tied to the grid of V_4 and the rise in potential causes an increase in V_4 current. This decreases the potential of the plate, due to R_4, also therefore decreasing the grid bias of V_1 which is tied to the plate of V_4. A decrease in the grid potential of V_1 increases the voltage drop across the tube decreasing the cathode potential. The circuit is so designed that the increased voltage drop is exactly equal to the voltage increase starting this cycle, so that there is no net change.

A Composite Audio Preamp

High Quality Preamp With Its Own Power Supply, Designed For Transmitter-Location Application, Has a Gain of 71 db and a Noise Level Below 0 dbm of — 64 db.

by HERBERT G. EIDSON, Jr.

Chief Engineer, WIS and WIS-FM
Technical Director, WIST

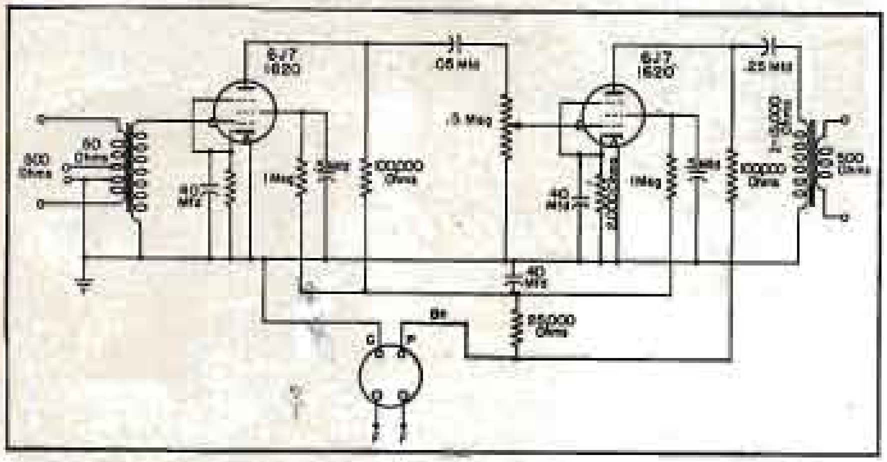


Figure 1
Composite audio preamp designed by Edison.

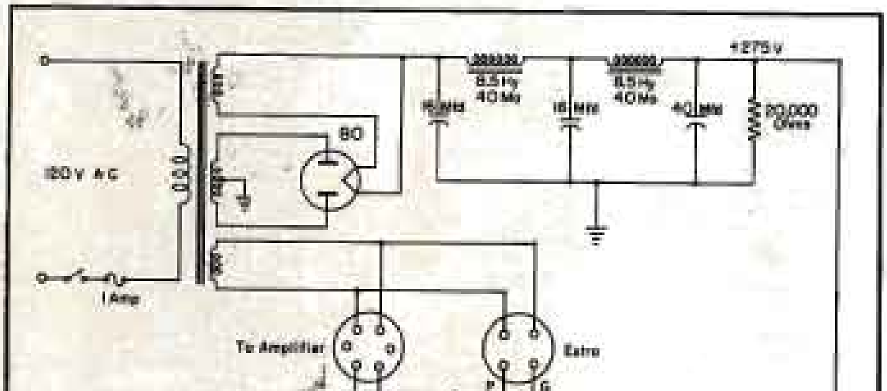
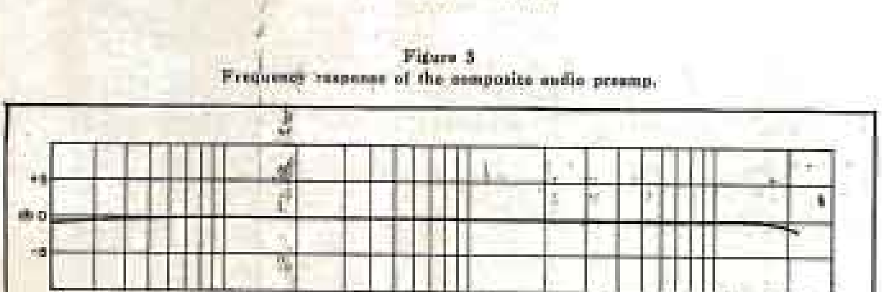


Figure 2
The preamp power supply.

Figure 3
Frequency response of the composite audio preamp.



It is often desirable to have a high-fidelity preamp at the transmitter location. We found the need for such a unit a few months ago and decided to design one which would afford *very high* quality. The result of our effort is shown in Figure 1, the amplifier having a -64 db noise level below zero *dbm*, gain of 71 *db*, and distortion of less than 1%.

Amplifier Section

The preamp was built as a two-section affair; amplifier and power supply.

The chassis used for the amplifier was made of zinc coated sheet iron, 7" x 7" x 2".

The 1620 voltage-amplifier tubes (similar to 6J7) were selected due to their very low-noise level and long life. A plate *rc* decoupling network was inserted in the first stage to further filter the rectified plate voltage and to insure that no low frequency *motor-boating* would take place. Gain control was placed in the grid of the second stage rather than the first stage to reduce hum pickup. We used shunt feed in the output stage to prevent plate current from flowing through the primary of the plate transformer and thus improve frequency response and reduce distortion.

With this design we were able to secure an output level of zero *dbm* (approximately -8 *db* with reference level of .006 watt) which was quite high enough to easily excite a program amplifier.

Power Supply Section

The chassis used for the power unit was 7" x 5" x 2" and also made of iron, coated with zinc.

To suppress the 120-cycle ripple from an '80 rectifier, a capacitor input with a brute force *pi* filter was used.

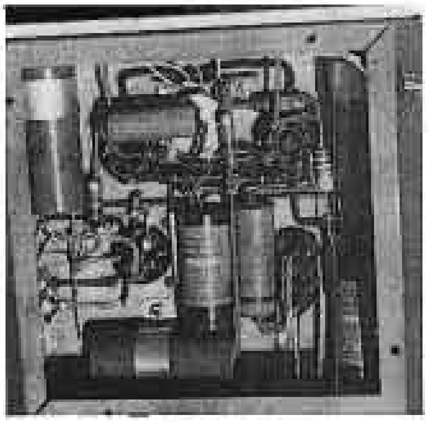
An extra outlet was placed on back of the chassis for supplying power to a second piece of equipment of low current drain, if so desired.

Depending upon the power transformer used, we found that the *dc* voltage will lie between 250 and 300.

An aluminum shield was found necessary between the power supply and the preamp to reduce hum pickup in the first 1620 stage (or 6J7).

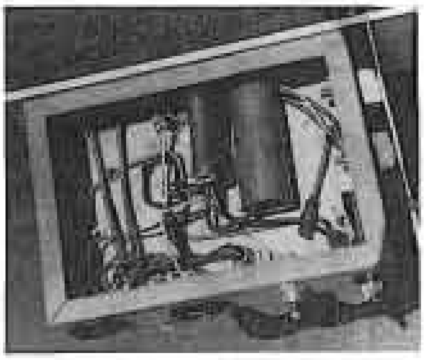
For neatness, the two units were mounted on an iron standard 19" panel and placed *on back* of the ver-

The Eidson amplifier with power supply.



Bottom view of the preamp.

Bottom view of the preamp power supply.



A view of the preamp and power supply mounted in a speech rack. Equipment above is an audio monitor amplifier.

tical channel iron pieces which support other equipment in the speech rack. A blank standard panel was mounted on the front side of the rack. The end result was that no screw heads were visible from the front.

RCA METER PANEL LINE

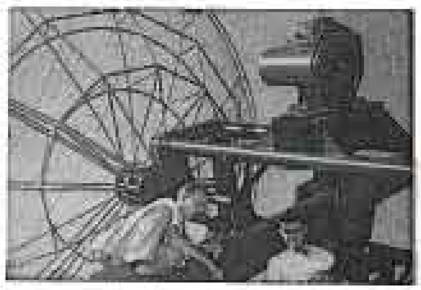
Three meter panels for use with RCA standard broadcast equipment have been announced by the RCA Engineering Products Department.

The panels are the type BI-1A, which provides a convenient means for checking the cathode bias voltages of amplifier tubes; BI-2A, a larger version of the BI-1A; and the MI-11288 vu meter panel, for measuring audio volume levels of audio circuits.

The BI-1A furnishes convenient indication of the operating condition of amplifier tubes and circuits. By means of a rotary selector switch, up to ten circuits may be metered. The BI-2A provides metering for 34 circuits by operation of rotary switches. Both panels measure 3½" h × 19" w.

The vu meter panel will measure audio volume levels from +4 to +40 db in any number of circuits up to ten, and employs a Weston type 30 vu meter. The panel is 3½" h × 19" w.

RADIO-TELESCOPE



Eight-ton radio-telescope with a 17' parabolic reflector-receiver installed at Cornell University to study noise from the sun. Receivers operating at 50, 200, 1400, and 3,000 mc will be used. Checking the telescope in the view above are Professor Charles E. Seeger, left, and director William E. Gordon, of Cornell's radio-astronomy project.

VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

At the recent IRE-RMA Fall Meeting in Rochester: Veteran VWOA member Walter Jablon, vice president in charge of Sales at Espey Manufacturing Corp. (*extreme right*) and his associates, Jack Rosenbaum, vice president in charge of research engineering (*extreme left*) and Dave Levine, engineer in charge of AM and FM receiver chassis design.

Personals

QUARTER-CENTURY certificates of honor were awarded recently to six VWOA members by Radiomarine Corp. of America during an inaugural dinner of their quarter-century club at the Hotel St. Regis, New York City: William F. Aufenanger, Arthur J. Costigan, Harvey R. Butt, Wesley P. Kelland, Charles Carney, and C. J. Pannill. VWOA life member Brig. Gen. David Sarnoff, RCA chairman of the board, was principal speaker at the dinner. Other VWOA members at the affair were O. B. Hanson, H. A. Saul and George F. Scheckien.

From way down under, Australia, has come a request for membership details. The inquirer, J. E. Calt, who belongs to the *First Class Operator's Club*.

LIFE MEMBERS O. B. Hanson, NBC, and Jack Poppele, WOR, attended a special NAB meeting recently to discuss the technical sessions of the forthcoming annual national broadcasting conference in Chicago, April 7, 8 and 9. On behalf of the broadcast group executive engineering committee, Poppele presented a silver bracelet to NAB assistant engineering director Neal McNaughten at the meeting, "in appreciation of services." McNaughten, a former member of the FCC, is a veteran brass pounder, too.

VWOA oldtimers at a recent NAB meeting in New York City during which papers for the forthcoming Chicago conference were discussed (*left to right*): VWOA life member Jack Poppele, vice president, secretary and chief engineer, WOR; ye editor; George Nixon, NBC; Neal McNaughten, assistant director of engineering at NAB; VWOA life member O. B. Hanson, vice president and chief engineer NBC; Robert Morris, ABC; and Scott Helt, Allen B. DuMont Labs.

HONORARY PRESIDENT Doc de Forest sent his best wishes to those at the Fall Meeting via a most interesting letter. Doc said that he would like to hear from any old timer who worked at Manhattan Beach. . . . Everyone missed VWOA life member Haraden Pratt at the meeting. HP, vice president, chief engineer and director of Mackey Radio and Telegraph Company and vice president and director of FTR, has been ill for many months and confined to his home in Long Island. HP has had a colorful career which began way back in 1910, when he was secretary and president of the Bay Counties Wireless Telegraph Association in San Francisco. During the 1910-14 period he was a commercial wireless telegraph ship and shore operator and installer for the United Wireless Telegraph Company and Marconi Wireless Telegraph Company of America at San Francisco. In 1914, after receiving a BS degree in the College of Mechanical and Electrical Engineering, University of California, he was engaged as an engineer in the construction and operation of the 300 *kw* transpacific radio stations at Bolinas and Marshall, California. Between 1915-20 he was with the U. S. Navy, first in charge of the radio laboratory there, then later in charge of construction and maintenance of all high-power naval radio stations. HP joined Federal Telegraph Company in 1920 and for three years was in charge of their factory and construction facilities at Palo Alto, California. From 1925-27 HP was engaged in the construction and supervision of short wave point-to-point radio telegraph facilities for Western Air Express. He joined the Bureau of Standards in '27 and for one year served there in charge of development of radio aids for air navigation. In 1928 HP became chief engineer of Mackey Radio.

Putting Station on Air

(Continued from page 7)

mission line meters and antenna current meter to burn out; there is always some voltage caused in this way but usually with negligible current. After pulling out the leads and replacing them, removing all grounds from the tower, our troubles disappeared. If this voltage had persisted, a large capacitor of sufficient voltage rating could have been placed in series with the antenna lead. This would not have affected the *rf* and yet blocked the low frequency *ac*.

The ground around the transmitter building was a complete mud hole, and the closest we could get to it with a truck with chains was still over a hundred feet. We had to carry the 250-w transmitter by hand from the truck to the building. The equipment racks were among some of the items that had not arrived, and thus temporary racks made of wooden two by fours were constructed and covered with galvanized tin. In these were placed the modulation monitor, limiting amplifier, line amplifier and frequency control unit of the transmitter.

As we could not obtain delivery of a frequency monitor we asked for and

(Continued on page 32)

Studio which has been treated with acoustic celotex, with the floor using linoleum for liveness. The windows can be used for ventilation by opening celotex covered doors.

Putting Station on Air

(*Continued from page 31*)

received authorization to operate without one with the requirement that we submit nightly frequency checks.[8]

After long delays we finally received our console for the studio and turntables and we were now ready to begin equipment tests. Only one problem still existed; we didn't have a telephone or program line. And at that time the telephone company was having a bit of a strike on their hands. After some pondering we managed to get the cooperation of two local amateurs who agreed to furnish us with a contact between the transmitter and a telephone to permit us to put our crystals on frequency via our temporary check service in Minneapolis.

An amateur portable rig was set up in the studio at the telephone and another at the transmitter. Contact was

[8]Phelps Precision Laboratory, Minneapolis, Minn., used for this measuring service.
[9]Wincharger.

Figure 2
View of 300' tower.[9] Ground system consists of 120 radials 400' long and 120 radials 50' long with a 48' square ground screen.

attempted but it was found that we couldn't get through due to a high hill between the studios and the transmitter. Time was passing and we were due on the air at 1 A.M. After a series of quick consultations we found that the city pump house in sight distance of the transmitter building had a phone which could be used. The equipment and phone calls were transferred, and at long last we were able to make contact.

Perhaps half of the population of our fair city were waiting to hear our initial broadcasts.

The first signals came in by phone from Minneapolis with the message: "You are coming in loud and clear, just a minute I'll adjust the loop . . . yes you're 48 cycles high." From the telephone in the pumphouse via amateur radio this message was relayed to me at the transmitter. We quickly adjusted the air gap on the crystal, Minneapolis took another measurement and reported by telephone via amateur radio: "You are now 16 cycles low." Another adjustment was made, the information routed through the unique circuit and the frequency was reported to be on the button. After a few congratulations we continued the procedure and installed the spare crystal exactly on frequency in the same way.

Negotiations had concluded the telephone strike and by the time we had finished our equipment tests the telephone workers had rushed in the program lines and we began our regular broadcast program tests.

Another station had been put on the air in spite of equipment shortages, winter handicaps, and a strike!

Tube Engineering

(*Continued from page 15*)

ceptance, and so changes the oscillator frequency. The amplitude of oscillation will also be affected if the transconductance changes.

Kurshan reported that the tube could also be used in an FM transmitting system. That is, by applying modulation to the reflector electrode, the tube can be used to generate a frequency-modulated signal directly. Although the modulation characteristic is not inherently linear, this device has the advantages of high sensitivity and high impedance. In checking on this application, the tube was connected in standard fashion except that the reflector was bypassed only for *rf* and connected directly (with no amplifier) to a microphone. The frequency deviation was estimated to be about 30 *kc* with negligible distortion, because of the limited portion of the characteristic used.

Airline TV

(Continued from page 9)

self-contained unit we were able to get fair coverage.

The units on the baggage racks were mounted alternately on opposite sides to distribute sound more effectively along the cabin. The receiver speaker served the forward section of seats.

The amplifier was a simple low-power multi-impedance affair operating on 110 *v ac*, having a self-contained power supply which was fed from the television inverter. This unit was mounted on the deck of the receiver platform to facilitate centralized control.

Flight Results

During our flights tabulated test logs were kept. A typical log sheet appears in Table 1, which shows the result of the initial flight from Washington (*DCA*) to Norfolk (*ORF*).

On the inaugural trip from Washington (after the receiver was relocated in the cabin for passenger viewing) the World Series baseball game was received from Washington satisfactorily as far as Pittsburgh, where we picked up the Notre Dame football game which was exceptionally clear and steady. Continuous reception of the ball game would have been possible if it had been carried by the western stations. Over northern Indiana we had miscellaneous short programs which became erratic over the lake near Michigan state line; this cleared as we rode beyond the area, where we found a beat with the Chicago Station.

During the return trip we had good program coverage except for a short time in the Pittsburgh area. Subsequent trips yielded about the same results. Toledo appeared to give greater coverage on the Washington-Chicago run than any other one station.

Due to the success of this project the system is to be further developed for a more streamlined installation and to be extended over more of the fleet. Special attention will be given on future installations to shock mounting and mobility of equipment.

Acknowledgments

We are indeed grateful for the assistance which made this project possible: Joe Zamoiski, whose backing and moral support kept us going through the wee hours; Dick Smith, who did the flight checks and who worked through the nights together with Steve Wasuta (structures project engineer), Bob Brown (chief draftsman), Lan Caldwell (CAP's *boss* engineer), and the men from the Capital night shift *radio* and *metal shops* and the Zamoiski Service Shop; also the cooperation of the hostesses and pilots.

For the preparation of this paper we thank Mrs. Morgan and Miss Phillips for typing and retyping and for the helpful guidance of those in the publicity departments of Philco and Capital and the engineering department of Philco.

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MINIATURE GLASS BASE FORMING MACHINE

Rotary equipment at Western Electric's new Allentown, Pa., plant used to form glass bases for the 408A miniatures.

Studio Equipment

(*Continued from page* 18)

consoles, the one in service was prepared for the move to one end from the center of the table-top. All input circuits were unsoldered from their respective terminals on the console, pulled down through the flexible conduits out of the metal floor box, up behind the desk and then resoldered to the terminals. Since the input circuits consisted only of microphones, turntables, remote lines, networks, etc., it was only necessary to select a time when the particular circuit in question was not in use. A cutover could then be made easily. Most of these circuits were found to be long enough to reach the console in the new position. Those which were judged to be a little short were extended with short lengths of wire connected to them and taped. No particular care was used to achieve neatness since most of these circuits would eventually be replaced anyway.

The output wires from the console were rerouted in the same manner. None of these presented a great problem with the exception of the *Line Out* pair. We were temporarily stumped here since we did not wish to break program service on this. Of course, we could have waited until after sign-off, but we preferred a little extra work to coming in so late at night. We finally achieve the changeover in the following fashion: A length of shielded pair was used, one end being soldered to the terminal block of the console in parallel with the existing *Line Out* pair. This was then run down the back of the desk and fished up through the conduit. The other end of this jumper pair then was prepared for soldering, the *Line Out* pair also being cleaned and prepared for soldering a couple inches short of the terminals. The two were then connected together and soldered, being careful to maintain polarity. Of course, the soldering iron was heated and then disconnected from the *ac* during the actual soldering to prevent *ac* hum during the job. The connection of the old *Line Out* pair to the terminal block was then snipped with the program being carried over the rerouted pair. Securely taped, the ends were pulled down through the conduit and the entire console was free. It was then a simple job to unscrew it from the desk, slide it to one side, install the second console in its fixed position and fasten them down. Switching programs back and forth from one console to the other, by the use of patch-cords, simplified the wiring and completion of the job was only a matter of time and work.

Last Minute Reports...

Tv will be a topic of over a score of papers at the 1949 IRE National Convention which will be held at the Hotel Commodore and the Grand Central Palace in New York City, March 7 to March 10. There'll be four papers on wave propagation: E. W. Allen, Jr. Will discuss *vhf* television and its propagation aspects; K. Bullington will cover propagation variations at *vhf and uhf*; J. Fisher will analyze *uhf* propagation tests; H. H. Aikens and L. Y. Lacy will detail the results of a test of 450-mc urban-area transmission to a mobile receiver; and W. R. Young and L. Y. Lacy will comment on the echoes in transmission at 450 mc from land to car radio units. In a television transmitter session, G. H. Brown, W. C. Morrison, W. L. Behrend and J. G. Reddeck will analyze a method of multiple operation of transmitter tubes particularly adapted for TV transmission at *uhf*. R. C. Moore will report on transient-response tests at WPTZ. The extremely important topic of synchronization of TV stations will be analyzed by R. D. Kell. W. M. Goodall will describe TV by pulse code modulation. In still another TV session T. T. Goldsmith, Jr., will issue a progress report on *uhf* TV. R. P. Burr will disclose a method of measuring the modulation depth of TV signals, and R. B. Janes, R. E. Johnson and R. C. Moore will cover the development and performance of camera tubes. Relay systems will be a topic of another all-important session in which five papers wil be presented: J. Z. Millar and W. B. Sullinger will talk on a microwave system for TV relaying; V. Learned will tell about a synchrodyne phase modulation of klystrons; W. H. Forster will analyze intercity TV air relays; M. Silver, H. French and L. Staschover will detail video design considerations in a TV link; and R. C. Shaw, P. V. Dimock, W. Strack and W. C. Hunter will describe a six-channel urban mobile system with 60-kc spacing. . . . A. P. Frye, chief engineer of WMBI, Addison, Illinois, reveals that his new multi-bay antenna which consists of *32* folded dipoles provides a power increase of *8*. . . . E. C. Frase, Jr. chief engineer of WMCT, the *Commerical Appeal* TV station in Memphis, Tennessee, placed the station on the air in the early part of December. A 750′ antenna, 950′ above sea level, is being used at WMCT, the first TV station in Tennessee. . . . C. Wesley Turner will be technical director of the Video Broadcasting Company which will install TV stations at Portland, Oregon and San Diego, California. The Portland station is expected to go on the air in the early spring of 1949. . . . Dr. Allen B. DuMont reported in his annual message to industry that in '49 the *uhf* bands will undoubtedly become an important factor. . . . George J. Stoetzel, CBS-TV lighting consultant who recently revamped the lighting facilities at the CBS studios, reports that standard fluorescent and incandescent lights can be used effectively in telecast. He says that it is not how much light is used but how it is used. . . . Frank M. Folsom was recently elected president of RCA. Brigadier General David Sarnoff will continue as chairman of the board and remain as chief executive officer of RCA, as well as chairman of the board of NBC and RCA Communications, Inc. John G. Wilson has been elected executive vice president in charge of RCA Victor.

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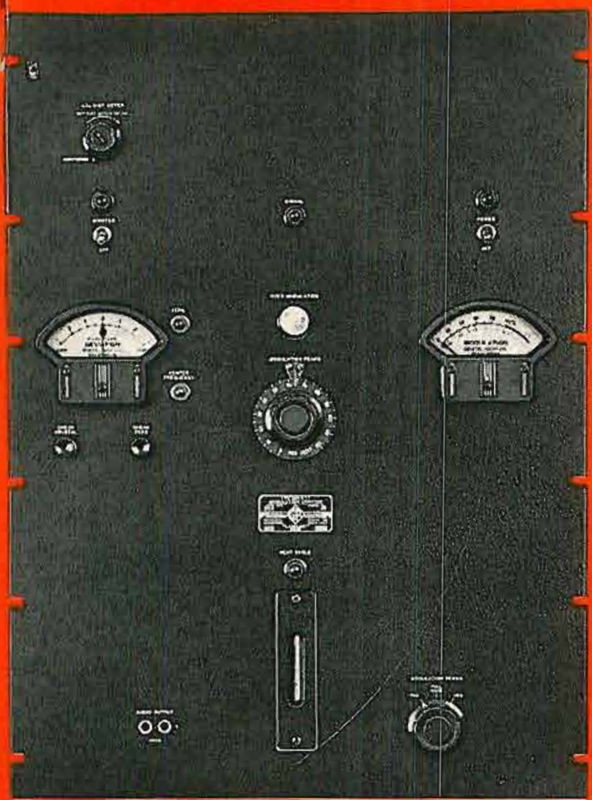
COMPLETE MONITORING EQUIPMENT By GR

for TV and FM TRANSMITTERS



WITH our recent announcement of the Type 1182-T Video Frequency Monitor, complete transmitter monitoring equipment by General Radio Company for TV as well as FM stations is now available. The FM Monitor has FCC approval; the TV equipment meets all of the tentative proposed specifications of the FCC.

Simple to install, practically self-explanatory in operation, direct-reading in frequency deviation, these monitors have the same high accuracy and stability and years of reliable operation ahead of them that all G-R broadcast monitoring instruments have provided since the beginning of broadcasting.

This equipment can be bought with confidence . . . confidence that it will give trouble-free operation with the minimum of routine maintenance. The G-R trade mark insures that.

TYPE 1170-A FM MONITOR

For both FM and audio channel monitoring of TV stations, features: **TRANSMITTER RANGES** of either 30 to 162 Mc or 160 to 220 Mc. **CONTINUOUS MONITORING:** center-frequency indication continuous; requires restandardization only once a day. **REMOTE MONITORING:** equipped with circuits and terminals for remote indicators of Center-Frequency Indication, Percentage-Modulation Meters, Over-Modulation Lamp, 600-Ohm Unbalanced Aural Monitor, Recorder and with the Type 1932-A Distortion and Noise Meter will measure distortion. **HIGH STABILITY:** 200 cycles (2 parts per million) or better with daily check of electrical zero of meter. **LOW INPUT POWER:** 1 volt at high impedance, amplified to several hundred volts for high-level operation. **LOW RESIDUAL DISTORTION:** less than 0.2% at 100 k.c. swing; accurate for measurements to as low as ½ per cent. **75-25 KC DEVIATION** provided with a single internal adjustment for either TV or FM monitoring. **TYPE 1170-A FM MONITOR . . . $1625**

TYPE 1182-T VIDEO MONITOR

For video channels of TV transmitters, features include: **TRANSMITTER RANGE:** 54 to 220 Mc. **DEVIATION RANGE:** 3-0-3 and 6-0-6 kc for all present TV channels. **DEVIATION** from assigned channel is shown continuously on large-scale meter, unaffected by TV video modulation. **HIGH STABILITY:** ± 0.001%. **HIGH ACCURACY:** crystal frequency when monitor is delivered is within ± 0.001% (10 parts per million). Adjustment provided to set monitor in agreement with frequency measuring service. **HIGH IMPEDANCE INPUT CIRCUIT** for channels 2 to 6; coaxial line for channels 7 to 13. **REMOTE FREQUENCY DEVIATION METER** terminals provided. **THREE SPARE CRYSTAL POSITIONS** selected by panel switch. **TYPE 1182-T VIDEO FREQUENCY MONITOR . . . $675**

WRITE FOR COMPLETE ENGINEERING DATA

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