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TELE-TECH

RADIO-TELEVISION-ELECTRONIC INDUSTRIES

DECEMBER, 1951

FRONT COVER: PARABOLIC ANTENNAS ON SQUAK MOUNTAIN—This repeater station in the state of Washington forms a vital link in the PTM (pulse time modulation) microwave system used to operate the power network of the Bonneville Power Administration. It transmits and receives high frequency radio beams in the 1703-1847 MC range to provide instant voice, telemetering, relaying, and video fault-location facilities. The first link, in operation a year, connects all major power stations between the Olympic Peninsula and the Vancouver-Portland load centers. A second link, under contract, will extend the system from the John D. Ross station in the state of Washington to Goshen, Ore., a distance of 128 miles. As in the initial installation, equipment for this link will be supplied by the Federal group of Clifton, N. J., associates of IT&T.

* *ELECTRONIC INDUSTRIES for DEFENSE . . . See articles marked with asterisks*

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TELE-TECH

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HARRY D. WULFORST, *Assistant Editor* — CHARLES DREYER, *Art Director*

DR. A. F. MURRAY, *Consulting Editor*, 4707 Windom Pl., Washington, D. C.

R. C. DAVIES, *News Editor*, National Press Bldg., Washington, D. C.

BUSINESS DEPARTMENT

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TELE-TIPS

TRANSISTOR development will be worth watching, as pregnant of big things for future. There have been recent secret showings of this improved device to the Military. All laboratories are eager for inside info, from the Bell group doing transistor pioneering. Why? Because this little device could, in the years to come, spell the demise of the vacuum tube and transformation of the multi-billion dollar industry which has been built up around electrons in vacuo. Sic semper electronics!

TV IN JAPAN will be operating by next spring, when the million-dollar 10-kw station goes into operation at Ichigaga Heights near Tokyo. Sixteen relay points will be established to cover the island area. The Buddhist group has been chief activator of TV in Japan where sets sell for $60 to $75.

SELENIUM shortage may be eased if the half-million pounds taken annually by the glass industry can be deflected into manufacturing channels for rectifiers. Selenium clears glass of its green hue, and under normal conditions the total raw selenium output is divided about equally between the rectifier and glass industries.

SUPERSONIC free-air telemetered tests are now carried on at Edwards Air Force Base in Muroc Dry Lake, Calif., where a rocket-propelled sled carries an entire airplane model or component parts, faster than sound along a precision track. Radio instruments feed all sorts of data to computers and recorders. Later these data are analyzed for clues to better and faster aircraft. The free-air track is superior to a wind-tunnel for supersonic research because in free-air there are no confining walls to reflect the shock-wave back to the airplane and so confuse results. Stopping the rocket at the end of the track becomes quite a problem when the rocket travels at speeds equal to a rifle bullet. Engineers constructed a water trough 2,000 ft. long. A scoop built into the bottom of the test sled dips up water from the trough and gradually slows it to a stop.

(*Continued on page* 22)

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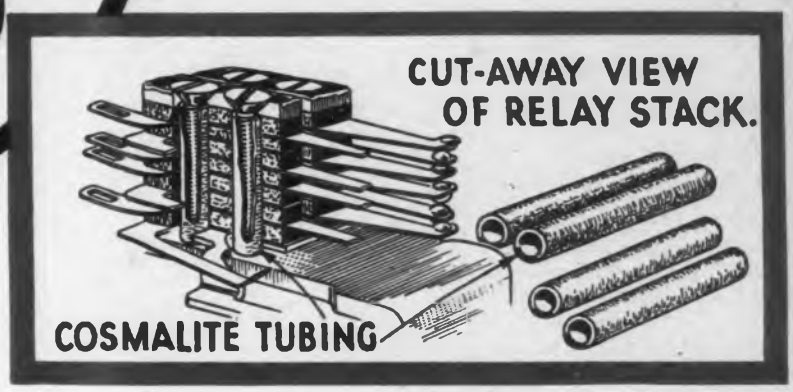

Their S K Relay shown above, is typical of the various Allied Relays in which CLEVELAND CONTAINER tubing provides excellent service.

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TELE-TIPS

(*Continued from page 4*)

TOPSY-TURVY shots are a feature of WPTZ, Philadelphia. Coca-Cola, one of the sponsors, employs a "live" commercial in which a man pours a glass of the soft drink while extolling its virtues. WPTZ director Joe Behar decided he could get more visual punch by having the Coca-Cola pour upward. The camera opens on a long shot of actor Kovacs holding the "coke" and a glass. It dollies in for a close-up on his hands, which are inverted. Just as Kovacs is about to pour, the camera switches to an inverted lens. When the Coca-Cola is poured, it appears to flow upward, filling the glass from the top down. The froth appears to be bubbling out of the bottom of the upside-down glass. The camera then dollies back from Kovacs, switches to a regular lens and catches Kovacs drinking the "coke."

"NTSC—Not the Same as Columbia" is the way an engineer friend of ours explained it to a newspaper man who was asking questions about the compatible color-TV system of the National Television Standards Committee.

HOLD-UP MEN are now passing up bank deposits for the more lucrative contents of factory store rooms, especially nickel. Three armed bandits recently walked into the Mackie Lovejoy Manufacturing Co. plant in Chicago, forced two employees to lie on the floor at gunpoint, and hauled away a heavy load of gray metal bars to a waiting truck. The gunmen escaped with 1,100 pounds of nickel. The holdup was one of 29 such robberies in the Chicago area during the past year. A total of 40,000 pounds of nickel has been stolen, worth about $50,000 on the normal market but about $250,000 by present "gray market" prices.

139,500 MPS!—New technique developed by J. H. Park of the National Bureau of Standards increases "writing speed" of a high-voltage oscillograph to three-fourths the velocity of light. High intensification of the electron beam is obtained momentarily by superposing a steeply rising voltage pulse on the steady voltage applied to the discharge tube of the oscillograph. The resultant increase in the intensity of the trace makes writing speeds up to 9100 inches per microsecond easily visible. These high writing speeds can be used to study rapidly varying electrical surges, such as are caused by

TELE-TIPS

(*Continued from page* 22)

lightning discharges, and to learn more about the insulation breakdown the surges produce.

EDISON MUSEUM—Under the direction of the Edison Foundation, of which Admiral H. G. Bowen is director, the Edison Museum has been opened at Main Street and Lakeside Ave., West Orange, N. J., exhibiting the original library, laboratory and workshop of Thomas A. Edison. Public days are Wednesday through Sunday, 9:30 to 11 A.M. and 1:30 to 4 P.M.

RESEARCH LABS in the general field devote 10 to 20% of their work to fundamental studies, 40 to 60% to development of new products and processes, 30 to 40% to improvement of existing products and processes, reports J. A. Leermakers, Eastman Kodak Co. Keeping laboratory and company people informed of progress requires continuous informal discussion, making written reports available, and holding two kinds of conferences: (1) Discussions of development work, attended by research, manufacturing, and sometimes sales departments. (2) Meetings of laboratory members to report progress to their fellows.

COLOR-TV PATENTS bearing on the Lawrence-tube principle are being cited from several quarters. Latest mentioned in our hearing are the four Schroeder patents conveyed to RCA and said to cover the tube construction and operation recently shown in New York.

SPACE TV-XMITTERS were to have been discussed in a paper by Robert P. Haviland, GE research engineer, before recent meeting of the American Rocket Society, but topic was withdrawn. Haviland had fired the first 2-stage rocket into the 250-mile altitude zone, and it is understood his paper would have outlined eventual methods of setting up "space platforms" revolving around the earth like satellites, which platforms could be used for TV transmitters to cover whole continents with television broadcasts. Eventually—why not now?

CROSSED WIRES AND WATER SUPPLIES—Just an error that can happen to anyone, but it put a local five-station hook-up onto 182 stations from Texas to California! Last month the mayor of El Paso was talking about a local water supply problem and expected his remarks to be heard in the vicinity. But crossed wires and the human factor put him on 182 stations of the Liberty Broadcasting System! It also shows how many station engineers really monitor their transmissions, for it took a phone call from California to inform Liberty of the error. What happened in the cases of the other 181 stations?

"SMELLIVISION"

Editors, TELE-TECH:

In answer to your inquiry on behalf of readers asking about systems of combining odors with television or sound pictures:

In New York, between 1942 and 1946 a Dr. Hans Laube was experimenting with a system of combining movies with appropriate odors. For example, he would show a picture of a wheat-field and flood the room with "the scent of new-mown hay." He had hospital pictures which were made more realistic with the smell of iodiform. He showed pictures of a candy factory and loosed the smell of cooking chocolate. I saw the thing on several occasions and thought that his idea was a good one, provided the odors did not have to be changed too rapidly. Also, after sitting through the demonstration, which lasted about half an hour, I noticed that my clothes had taken up a sufficient amount of odor combination to last about six or seven hours.

I think the device would work very well for a small motion-picture theatre (although the inventor claimed it would do better in larger places) if, as I said before, the changes in odor did not have to be made too radical or too often. Also it would be excellent for an advertisement display. For example, if you could show a bathing beach and release at the same time a salt smell, it would add to the illusion. I had understood that Dr. Laube was experimenting with a small packet arrangement which could be used with television, but he did not get to the point where he demonstrated it to any of his visitors. I understand Dr. Laube finally got discouraged and went back to Switzerland.

It has always seemed to me that he had a very good idea there, but that he had not worked it out sufficiently. For example, he had no proper system for withdrawing the odors promptly, so that there was a tendency to multiply scents rather than to give a new perfume, unmixed, with each picture. I saw his demonstration perhaps three times, and each time, even when I got home several hours later, my wife sniffed at me rather suspiciously! So, there was also the problem of the absorption of the odors by clothing of the spectators.

NAME WITHHELD
at writer's request

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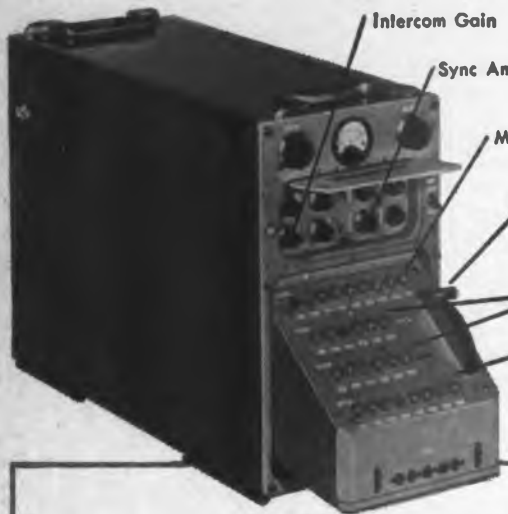

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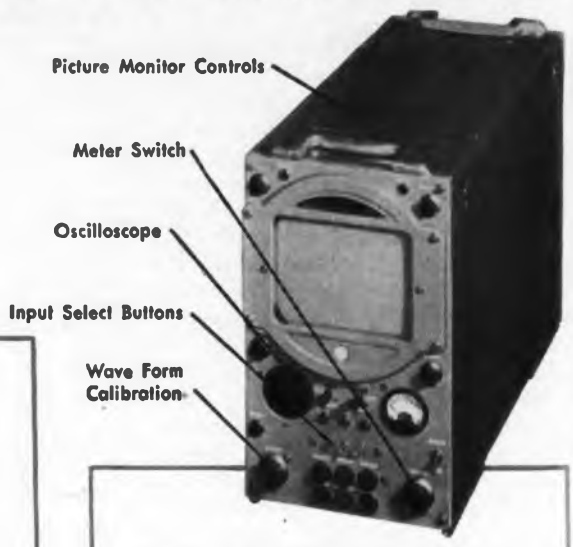

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- Compact, portable
- Ready accessibility of all controls, tubes, circuits

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RADIO-TELEVISION-ELECTRONIC INDUSTRIES

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

Radio Engineers and Management Opportunities

Radio engineers have not taken full advantage of the many advancement opportunities that exist for them in our industry, and business, nor in the big world outside,—else our engineers would now occupy a much broader field than they have achieved and certainly, more would have reached goals at the top.

Analyzing the problem of the engineer in management and industry:

1. **Radio engineers with the training they have been given have good foundations for successful careers in top management;**

2. **As a class, radio engineers have specialized in too narrow a segment of professional activity, with the result that others have gone past them in fields in which they should be supreme;**

3. **Radio engineers have not fully appreciated the number of problems in corporate management in which their particular knowledge would be useful *if* it were supplemented by broader experience in other phases of corporate management. Therefore, they have not fully taken advantage of the opportunities which exist.**

★ ★ ★

To the radio engineer who wants to progress and develop in his relation to the industry, business and the world around him, these words of advice should be offered:

Determine to expand your usefulness.

Learn something of general business problems.

Study budgeting and the control of expense.

Study the principles and practices of sound "costing", or cost determination.

Make yourself an authority on all phases of your business which stem from your usefulness to your company. Suitable recognition will be sure to follow.

The RADARSCOPE Revealing at a Glance

REARMAMENT

TV'S MILITARY APPLICATIONS—There are many military applications of television, valuable in actual combat and for training of armed services' personnel. Television has been used in combat for beachhead reconnaissances, with transmissions from aircraft to naval ships and army shore installations on the progress of military operations as a guide for artillery fire and airplane bombing. Experiments have been conducted under the form of television, known as Teleran, to provide aircraft pilots with a pictorial presentation of approaches and traffic at airports. The British Admiralty recently utilized television to locate a sunken submarine in the English Channel. Telemetering devices are used for tests at a safe distance of atom bombs and guided missiles explosions and to record flight test performance.

MICROWAVE

UTILITY COMMUNICATIONS serving almost 200 miles of power lines have been installed by the Bonneville Power Administration in the Pacific Northwest. The present installation connects the load-dispatching center of the Portland-to-Vancouver area with the Covington, Snohomish, and Olympia Sub-stations. A branch to Seattle (14 miles) will provide communication to the Bonneville district office there and to the load dispatches of the Puget Sound Power and Light Co. and the City of Seattle municipal system. Squak Mountain (pictured on our front cover, and located 14 miles from Seattle, 30 miles from Snohomish, and 54 miles from Olympia) serves as a relay point for these sub-stations. Designed for 23-channel operation, the system is presently being used for voice communication, telemetering and relaying. A notable feature of the equipment is a unique fault-locating device, now undergoing tests, which not only detects power-line faults automatically, but records the date, time and location of each fault within an accuracy of 500 feet.

This microwave system is designed to meet very exacting reliability requirements. The aim is to achieve 100% propagation reliability and, through full standby for r-f equipment with automatic switchover in case of failure, to approach the same goal in equipment reliability. The reason is partly because of the large number of channels that ultimately will be using a single radio facility and partly because of the use of the link for power-line protective relaying. Bonneville, like other utilities, has been faced with an ever-growing need for voice and other intelligence channnels. These channels are required for load dispatching system operation, maintenance, telemetering, power-line relaying, supervisory control, teletype and facsimile, generator-load control and automatic fault-locator devices.

NACA two-stage radio-guided interceptor missile MX-570 taking off at Wallops Island test station, Langley Field, Va.

FCC

CONGRESSIONAL ECONOMY, in the form of recent budget cuts, might be very costly to future TV station owners. Inadequate funds has forced the FCC to cut its legal and engineering staff to the bone. There are 400 TV applications pending, and when the freeze is finally lifted, the rush for channel space will probably double that number. But the Commission's skeleton force will be able to process only a small fraction of the applicants at a time. Most station applicants may have to wait many months for their CP's *after* the freeze is thawed.

MANUFACTURING

"MERRY-GO-ROUND" PRODUCTION—"Sound, alert planning" is essential if industry is to meet its dual obligation to turn out defense goods and still do its share to maintain our civilian economy, declared John W. Craig, Avco-Crosley vice-president, addressing the Society of Advancement of Management. He cited as an example of new technique the "merry-go-round" production system by which Crosley is making complex radio-electronic devices needed in relatively small quantities by the armed forces. In this system, the production line is rotated so that individual workers perform only that work which an average person can do in 60 seconds or less without extensive training. While each employee performs several separate operations before the assembly is completed, each movement in itself is simple, and the handling time of materials is limited to 10 per cent of the total time required for

them to pass across each station, he explained. Mr. Craig urged manufacturers engaged in military production to set up separate organizations within their plants to handle military production operations in order to avoid placing too great a burden on management personnel. "It is axiomatic that we should never undertake to develop while manufacturing," he said, warning that the advantages of a "complete, honest" pilot run in defense production are too often overlooked by manufacturers who are over-eager to get into production quickly. A pilot run not only permits the correction of errors before production begins, but serves also as an on-the-job training program for the highly skilled worker who will teach less experienced men their new jobs.

MOBILE

RADIO COMMUNICATIONS, radio control and radar can be looked to by railroad organizations as the means for-up-to-dating and improving long-distance point-to-point services the railroads now provide. Airlines compete heavily for passenger traffic while trucking firms in many cases provide speedier freight delivery. In the latter case, trouble seems to be that freight cars spend too much idle time in yards waiting for trains to be made up. Individual, unattended, radio-controlled, and electrically powered cars might answer this point-to-point problem. Local car deliveries from the freight yard might also be radio controlled or handled by switch or donkey engines.

UHF

COMMERCIAL UHF-TV will bring tube and converter/receiver manufacturers new headaches when it comes. One of the principal problems will be to obtain low-cost receiving tubes having high gain and low noise performance characteristics at these frequencies. This accounts for many of the current converter designs having the r-f input feed directly into a crystal mixer. Lack of an r-f amplifier stage is also not desirable from the standpoint of oscillator radiation, since any sizeable amount of this will in turn raise interference problems.

ACOUSTICS

NOISE, as well as smoke and appearance control may well become principal factors in the construction of future manufacturing plants throughout the country. A considerable amount of research is now being done on noise insulation of test chambers or plants where jet engines for aircraft are being developed or tested. These engines have much higher noise levels than their reciprocating predecessors and, if tested in the open on the ground, would create considerable annoyance to the local inhabitants. Airborne engines, on the other hand, create new speech intelligibility problems, and these in turn require development of newer microphones, earphones, and audio amplifying equipment. Another field, which apparently is still open to research however, is that of reducing the in-air-noise of aircraft. Thus far, any attempts at muffling or quieting have been found to rob the engine of too much of the power that is required for take-offs.

RECEIVERS

HEARING-AID JACKS, like the earlier well-known "Phono" or "TV" jacks on radios, might be found a worthwhile addition to new radio and TV sets in the future. It has been estimated that there are more than 10 million hard-of-hearing persons in the U. S. or approximately 10% of the adult population. Hearing-aid microphones are not very efficient when the signal sources are greater than 5 ft. away. Through a newly developed miniature volume control it becomes possible for an afflicted person to plug-in across the loudspeaker voice-coil terminals with any desired length of wire and to individually adjust the volume of the hearing-aid to his own desired level, while still retaining a normal room operating level for the loudspeaker. Addition of this convenience would probably not add more than 50 cents to cost of set during manufacture.

TELEMETERING

Depth of snow on remote mountainsides is being continuously reported by FM radio through this Motorola transmitting station. Radio-active metals at ground level activate Geiger counters suspended above maximum snow height. Presence of the snow cuts off radiation reaching counter proportionally to depth and water content of snow pack. In this way an accurate measurement of future melt can be reported to water users in valleys below.

Recent Developments

A review of the semi-conductor junction types feature small

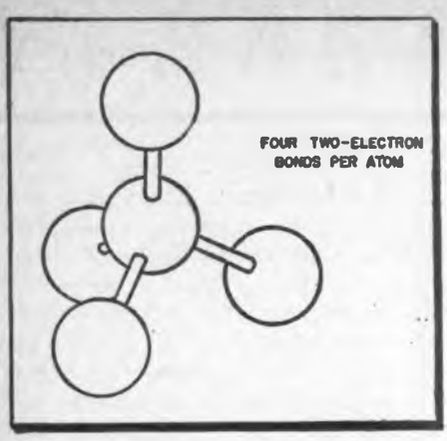


Fig. 1: In a perfect insulator electrons are tied up in interatomic bonds and cannot participate in conduction

By Dr. JOHN S. SABY
Electronics Laboratory,
General Electric Co.
Syracuse, N. Y.

As We Go to Press . . .

Power Transistors Soon?

Important new developments in germanium diode manufacturing techniques have resulted in a design suitable for ac power rectification purposes. These new diodes are reported to have ratings of approximately 350 ma at 130 volts r.m.s., and as such, as capable of providing dc power requirements of the average television receiver, (General Electric type G-10).

Research in this field, accentuated by shortages of selenium, is speedily going forward with a view towards the ultimate development of types capable of handling 2-10 amperes of current. If this can be achieved, new forward steps might well lead to the development of power transistors. In turn, the availability of power transistor types would truly make germanium semi-conductors a direct substitute for vacuum tubes. With the added features of simplicity, long-life, ruggedness, and greater power conversion efficiency, their extensive application in future designs of both receivers and transmitters becomes a certainty.—*Editors.*

THE art of making semiconductor devices is slowly becoming a science. Fundamental studies of the origin, nature, and behaviour of p-n junctions in semiconducting materials have charted paths for this transition. This article may be regarded as a progress report along one of the paths of this development from art to science.

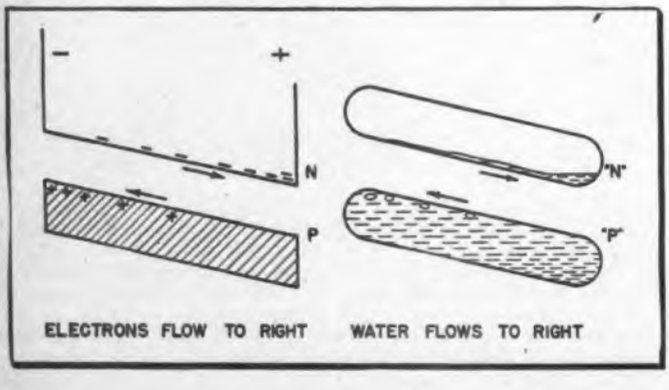
One of the first fruits of the scientific approach to semiconductor work has been the development of the transistor. Let us compare the new p-n junction transistors to the earlier types, and make some guesses as to the extent of future applications. In order to make educated guesses, a physical picture of some of the electronic processes which take place within semiconductors and which determine their properties, will be briefly outlined.

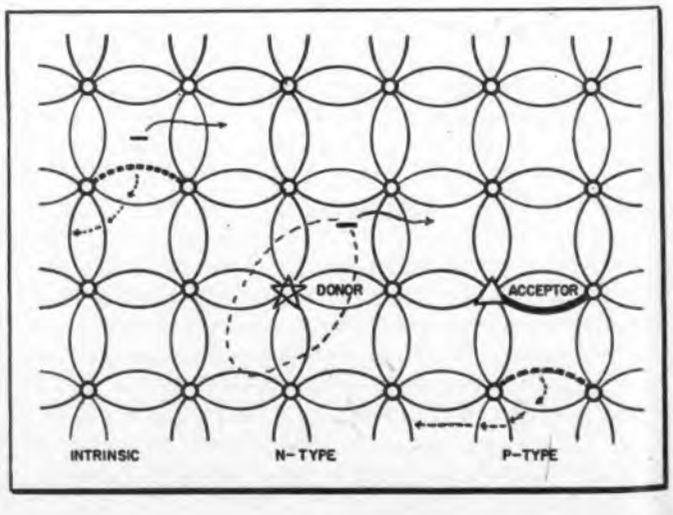
This picture will not be complete or fully accurate as to detail, but will give an essentially correct concept of why these devices work.

A semiconductor has certain electronic properties intermediate between those of metals and insulators. In defining these it is to be noted that metal contains a number of so-called "free" electrons, whereas a perfect insulator has none. All of the electrons in a perfect insulator are tied up in interatomic bonds and cannot participate in conduction (Fig. 1). Conduction is possible, however, at high temperatures when a few electrons are thermally excited. At these temperatures the elec-

Fig. 2: Two conduction processes

Fig. 3: (right) Conduction centers





in Transistors and Related Devices

characteristics and their applications in transistors. New p-n-p size, high gain, low noise, high efficiency and improved stability

trons are torn loose from their bonds and can move about and conduct electricity. The heated insulator has now become what is termed an intrinsic semiconductor. There is no sharp distinction between insulators and intrinsic semiconductors. If the electronic bonds are easily broken, then a noticeable amount of conduction will take place even at room temperature, and the material is called a semiconductor.

Two Conductivity Processes

In reality, two conductivity processes take place simultaneously in an intrinsic semiconductor as shown in Fig. 2. If an electric field is impressed on the semiconductor, electrons will flow from left-to-right in the conduction band, just as the liquid will flow along the bottom of the nearly empty tube when tilted. This type of conduction is called n-type conduction.

Neighboring electrons in the filled band, however, also can jump into the vacancy left by a flowing electron thus leaving new vacancies elsewhere. As the electrons fill up vacancies they drift from left-to-right, the holes move right-to-left, just as the bubbles in the nearly filled tube move right to left when liquid is really flowing left to right. Since the holes move in the opposite direction to that of the electron in an electric field, they can be regarded for some purposes as + charges. This is called p-type conduction.

Another source of holes and electrons are impurity atoms. Atoms with 5 valence electrons, i.e., with one extra valence electron (these atoms are called donors) may enter the lattice substitutionally and contribute to n-type conduction as shown in Fig. 3. Correspondingly, lattice defects or impurity atoms (called acceptors) with only 3 valence electrons instead of Germanium's four can trap electrons, leaving unsatisfied bonds, or "holes", nearby which can contribute to p-type conduction. All these conduction processes are important in germanium. When conduction is principally by conduction-band electrons, a semiconductor is called n-type; when it is principally by holes, it is called p-type. When n- and p-type regions occur in the same crystal, the boundary between the p-type and n-type materials is called a p-n junction.

A p-n junction itself comprises a rectifier which operates roughly as sketched in Fig. 4, where for simplicity the only charges shown are those contributing to conduction: If the p-region is made positive, the holes move right-to-left, electrons move left-to-right. They move toward each other and recombine. The forward voltage need only be enough to keep this current going. If p-region is made negative and the n-region positive, then holes and electrons move away from each other. The region between has its movable charges removed and thereby becomes an insulator.

The back current should be composed mainly of hole-electron pairs created thermally in this region and should be expected to increase rapidly with temperature.

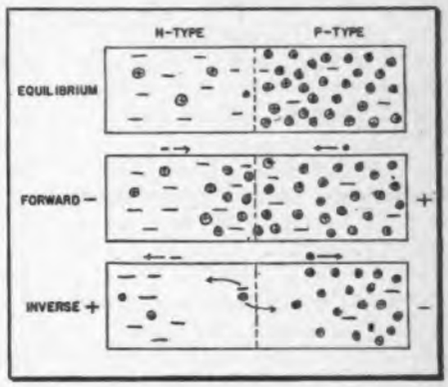
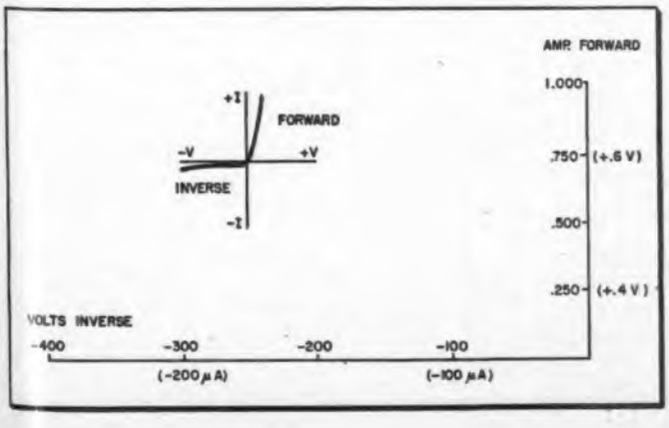


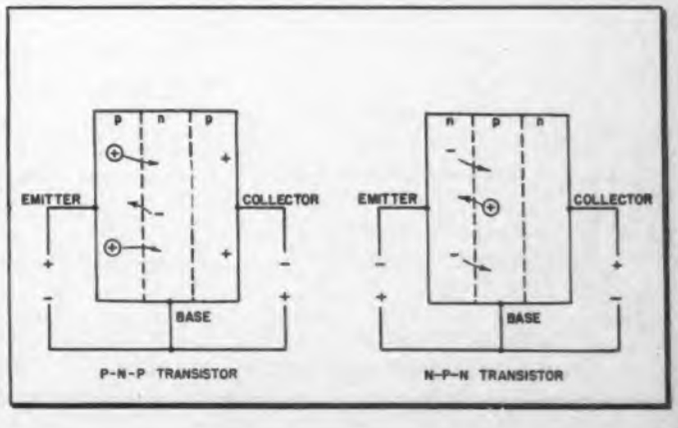
Fig. 4: Rectification by a P-N Junction

Diffusing Impurities

At GE a process for diffusing donor and acceptor impurities into germanium so that n-p junctions can be produced at will has been developed. This process is described by Hall and Dunlap of the General Electric Research Laboratory ("Physical Review", Nov. 1, 1950). Characteristics for a typical rectifier made in this way appear in Fig. 5. Similar units have been made which will withstand inverse potentials greater than 700 volts, drawing less than two milliamperes leakage current. These units can be broken down repeatedly by high inverse voltage without permanent damage. The peak current densities in the forward direction are of the order of

Fig. 5: (left) E-I characteristics in diffused P-N junction germanium rectifier. Fig. 6: (right) P-N junction transistors





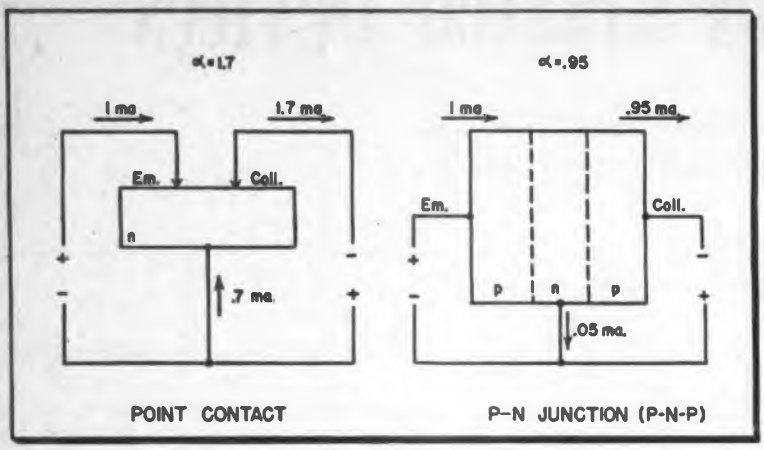


Fig. 7: Comparison of transistors

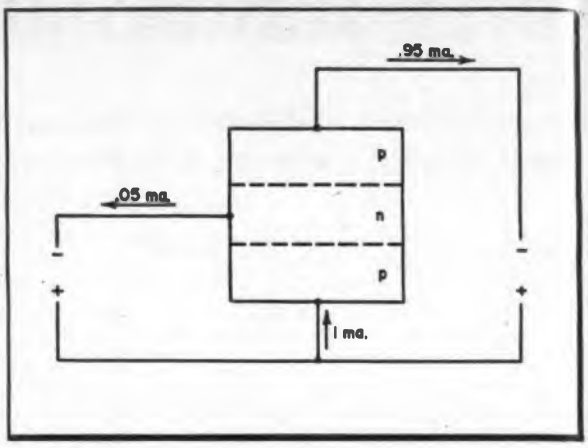


Fig. 8: Circuit current gain $\alpha/(1-\alpha)$

hundreds of amperes per square cm. and the efficiency of these diffused rectifiers is better than 99%. This compares to efficiencies in the 80's for tubes, in the 70's for selenium rectifiers.

Barrier Layer

The p-n junction transistor is a logical consequence of the single p-n junction rectifier. Returning to Fig. 4, note that a p-n junction rectifies by the virtue of a barrier layer which is non-conducting only because there are no carriers in it. If the barrier is thought of as a hindrance to current flow, this hindrance is more analogous to a desert than to a mountain. When carriers are introduced into the barrier region, conduction does take place. One way to introduce carriers is to heat up the device. This however, is not an easily controllable method. Another way is to shine light upon the junction. This can photo-electrically excite hole-electron pairs. A family of photo diodes or photo transistors using this mechanism has come into being. The control method most applicable to electronic circuits, however, is injection of carriers by conduction through a p-n junction.

By a process developed in the Electronics Laboratory of General Electric, based on the diffusion process mentioned above, two p-n junctions are arranged back to back in a single crystal of G_e as shown in Fig. 6. This particular transistor consists of a sandwich of two p-type regions separated by an n-type region. Separate electrical contacts are made to each region. Two diodes are thus formed, back to back. The right-hand diode will be operated in the inverse direction. The left one will be operated in the forward direction, in which hole and electrons flow toward each other. Some of the current flowing across the left p-n junction is in the form of electron flow to the left, some consists of holes moving to the right. In particular, if there is a greater density of holes in the p-type region than of conduction electrons in the n-type region, most of the current crossing the barrier will be in the form of holes. The p-n junction is not a barrier for holes moving from left to right, and most of these injected holes can reach the collector and appear as current in the collector circuit. To put it very simply, the leakage current through the right hand junction has been increased by hole injection through the left hand junction. The ratio of changes in collector current to the changes in emitter current is called alpha. If the collector current were injected 100% as holes, and if none of these recombined with electrons before reaching the collector, alpha would be unity. In practice, however, alpha is never quite unity.

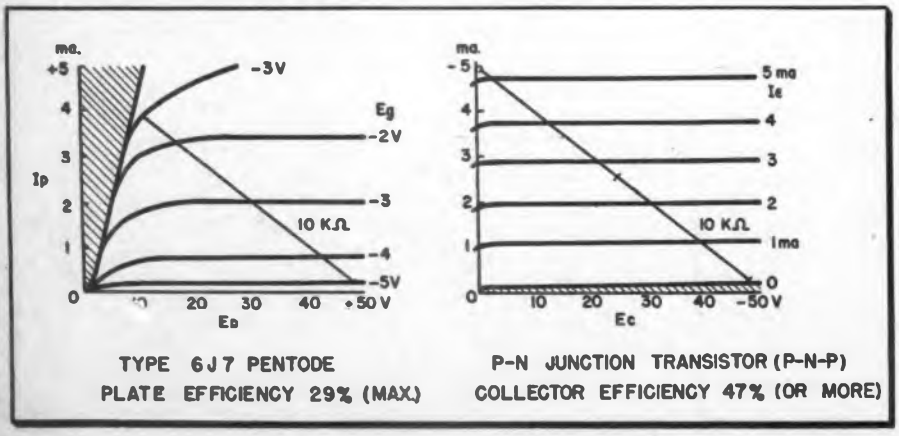
The n-p-n junction transistors operate in a corresponding way shown on the other sketch in Fig. 6. In this case, the emitter injects electrons into the p-type base material, and these electrons are collected by the positively biased collector.

Operating Principles

At this point, a comparison in operating principles with the older point contact transistors is in order. Fig. 7 shows them side by side. In the point contact transistor, as in the new p-n-p types, the emitter injects holes into n-type germanium, and these holes appear in the barrier region of an inverse biased rectifier. In the case of the point contact transistor, however, there is a physical multiplying effect, resulting in more current being collected than was originally emitted, 1.7 times as much for a typical unit, (i.e., alpha = 1.7). Herein lies the fundamental distinction between the two types. The new p-n-p or n-p-n junction transistors have alpha less than unity. When alpha is greater than unity, as in the point contact transis-

(*Continued on page* 58)

Fig. 9: Curves of Class A efficiency—tubes vs transistors



Microwave Hybrids

Isolation, matching and usage characteristics of the "Magic T" and "Rat-race" in waveguide duplexing and mixing

By FRANK BRADLEY
Reeves Instrument Corp.
215 East 91 St.
New York 28, N. Y.

MICROWAVE hybrids are wave guide configurations having two input arms and two output arms. The term hybrid is used because of the high degree of isolation between the two input arms analagously to the hybrid coil of telephone practice. In general, power at either input divides equally between the two output arms while power at one point is attenuated roughly 30 db in going from one input arm to the other input arm (see Fig. 1). Thus two microwave input signals may be coupled into the two input arms without feedthrough, each output being half the sum (algebraic) of the inputs. Fig. 2 shows pictorially the two types of hybrids to be described. Fig. 2a shows the "magic T" or hybrid junction. Fig. 2b shows the "ratrace" or hybrid circle. These are by no means the only hybrid types; they are, however, probably the types most commonly used at present.

The primary radar application of hybrids is in duplexing and in mixing. Duplexing is accomplished in conjunction with a T.R. switch tube to permit transmission and reception by means of a single antenna. Mixing is accomplished using the hybrid to add the signal and local oscillator energy while isolating the local oscillator and signal sources. The use of hybrids is not limited to these applications however. They are useful wherever the sum, difference, or sum and difference of a pair of microwave voltages is needed.

Some basic microwave concepts are necessary to the understanding of hybrids and these therefore, will be discussed in a qualitative way.

Wave Guides

Wave guides are used for the transmission of microwave power because of their relatively large power handling capacity and small power attenuation characteristics compared with cable-type systems; the relatively small cable dimensions required for the transmission of short wavelength energy in the "dominant mode" introduces voltage breakdown problems at high power levels in coaxial cable and the cable dielectric is slightly "lossy." Power may be propagated in wave guide theoretically in an infinite number of "modes" corresponding to the type of wave excited in the guide.

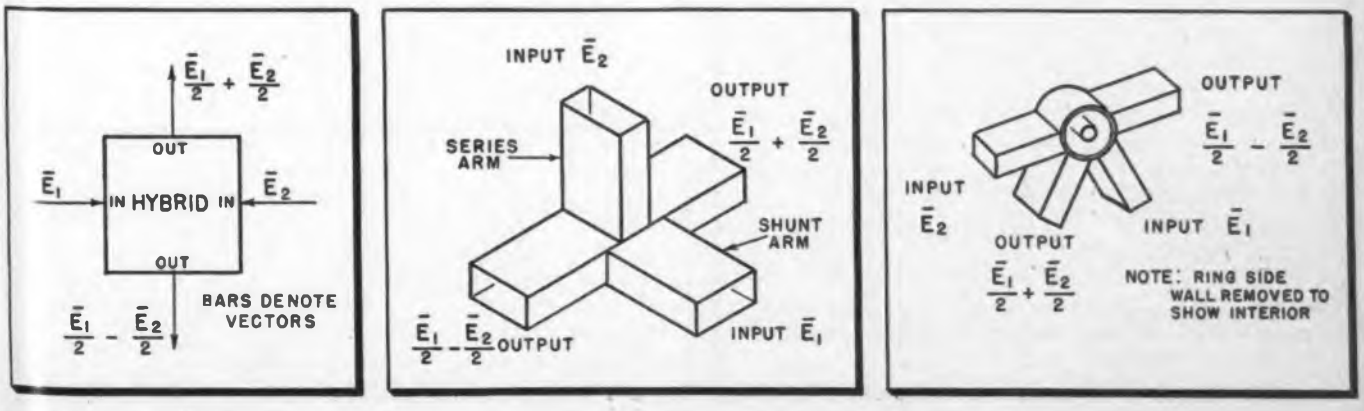
However it is necessary to be able to specify the field distribution at the antenna end of the wave guide and along the guide in order to provide a uniform radiation pattern and predictable characteristics at any point in the guide. It is therefore necessary to control the mode. This is done by constructing the guide so that for a specific frequency or frequency range only the "dominant mode" will be propagated. Then when an irregularity in the guide such as a corner or a slight projection, causes the scattering of the dominant mode wave and the excitation of higher modes at some point, these modes will be attenuated and the energy transferred back to the dominant mode within a very short distance of the discontinuity.

In the case of circular guide it is difficult to maintain polarization of the dominant mode. A slight deformation in the circular cross-section causes resolution of the dominant mode into a pair of dominant-mode waves. The succeeding recombination of the two waves in general changes the polarization. The dominant mode for rectangular wave guide however has its polarization fixed by the unequal dimensions of the guide.

The relative dimensions of a and b with respect to 2 shown in Fig. 3 are sufficient to assure that only the dominant mode will be transmitted with all others being suppressed. Because of the polarization problem, the circular wave guide is used only in short runs and where symmetry is required, for example in rotating joints.

Thus in general, rectangular wave guide of the dimensional characteristics given in Fig. 3 is used. The dominant mode in this case is characterized as the TE_{01} mode, Fig. 4. In the case of rectangular guide, a mode, or distribution of energy designated TE has only transverse

Fig. 1: (left) Block diagram of hybrid. Fig. 2 a: (center) "Magic T" or hybrid junction. Fig. 2b: "Rat-race" or hybrid ring



components of the electric field. Similarly a TM mode has only transverse components of the magnetic field.

The subscript notation indicates the number of half wavelengths or maxima of field intensity which fit transversely into the guide at cutoff frequency. The first number indicates the number of half wavelengths found along the y axis and the second number the half wavelengths along the x axis, (Fig. 3). Thus the TE_{01} mode has no variations in electric field along the narrow face and one maximum along the wide face. The dominant mode is the only propagated mode in Fig. 4 because two half wavelengths will not fit transversely in the guide.

In the remaining discussion the ideal condition of all guides having the same characteristic impedance and each branch being terminated in its characteristic impedance will be assumed. This implies that no reflections will be set up in the guide so as to produce standing waves and so upset the conditions assumed in the following description. A brief description of the effects of standing waves is given in the description of hybrids.

Junctions

Series—The series junction, Fig. 5, consists of a wave guide with a side arm leading out of the wide face. Fig. 5b is a section of the junction showing lines of electric intensity for the TE_{01} mode. The lines are drawn in successive positions of wavefront to indicate what happens to power applied at the series arm. As may be seen from Fig. 5b, equal and out-of-phase signal intensities are propagated in the two guide arms.

Shunt—In the case of the shunt junction, the opening in the guide is in the side wall. Fig. 6b shows successive magnetic lines of force indicating the manner in which power division occurs. It is evident that power leaving the junction in both directions is in-phase.

Hybrids

Magic T—The magic T consists of a common series and shunt junction. Examination of figure 2a in conjunction with Figs. 5 and 6 will indicate that the cross-coupling between the input arms is small. The energy coupled into the shunt arm from the series arm is small since the shunt arm junction is a region of zero electric field intensity. The same is true of energy coupled in the opposite direction from the series arm to the shunt arm although the mechanism can not be simply explained. As discussed previously, energy in the series arm divides in an out-of-phase manner an energy in the shunt arm divides in an in-phase manner, giving the voltage division indicated in Fig. 2a.

If the output arms of the hybrid are not terminated in their characteristic impedance, power will be reflected back into the junction and will be coupled into the input arms in a manner, dependent upon the standing wave set up, resulting in coupling between the inputs. It is thus essential for hybrid characteristics that the arms be so terminated.

Both junctions of the hybrid are mismatched since each input arm feeds two output arms with all arms having the same characteristic impedance. To eliminate the mismatch,

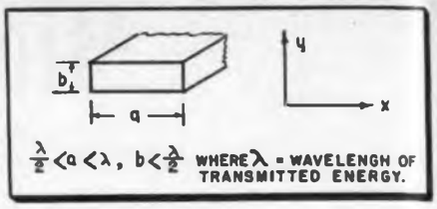


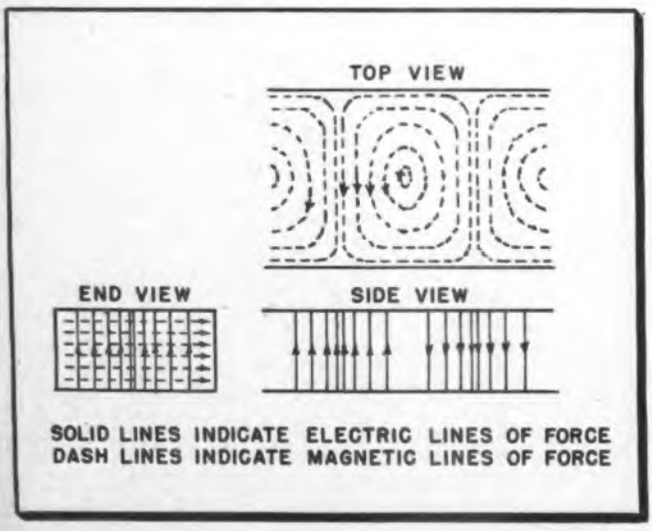
Fig. 3: Waveguide dimensions

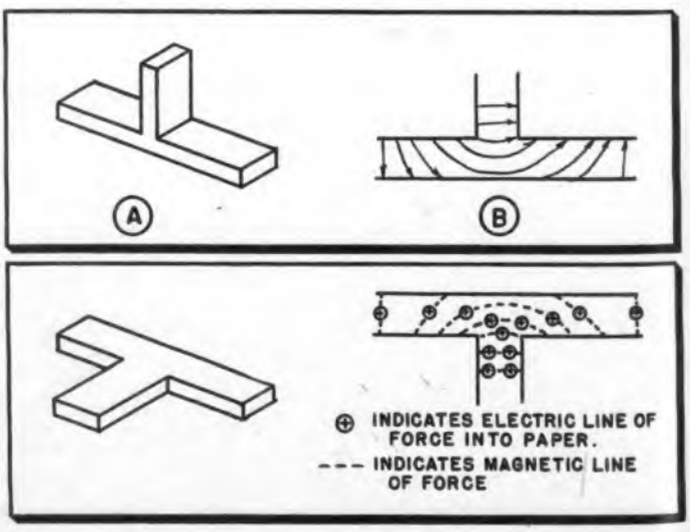
reactance elements consisting of a post and an iris are used. The iris is placed in the series arm and the post in the through run of wave guide directly in front of shunt junction (Fig. 7). The post extends upward into the series arm slightly. The iris is at the series junction and covers approximately one third of the cross-section. The iris functions primarily to eliminate the series junction mismatch, and the post the shunt junction mismatch. This is, of course, an oversimplification since there is a considerable degree of interaction because the post affects both inputs.

Concerning the term reactance. A small projection in a wave guide produces a distortion in the TE_{01} mode in the neighborhood of the projection consisting of the original TE_{01} wave, a pair of TE_{01} "scattered waves," and a group of higher modes. These higher modes are damped out within a very short distance from the projection because the dimensions of the wave guide permit propagation of only the dominant mode.

However in the region of the projection, the storage field of the higher modes exists. If the modes excited are predominantly TM type (Transverse Magnetic), the stored energy is primarily electric and the projection behaves as a capacitance. If the modes are predominantly TE type (Transverse Electric), the stored en-

Fig. 4: (left) TE_{01} mode in rectangular waveguide. Fig. 5a-b: (above right) Energy division in series junction and Fig. 6: In shunt arm





ergy is primarily magnetic and the projection behaves as an inductance.

The frequency sensitivity of the Magic T arises because of the post and iris. The reactance, and consequently the impedance match of the hybrid, varies with frequency, limiting the frequency range over which the hybrid can be operated.

Ratrace—A sectional view of the ratrace is shown in Fig. 8. It consists of a wave guide ring having an electrical length of 1½ λ with four series junctions spaced at quarter wavelength intervals around half of the circumference as shown. Either arms B and D or arms A and C may be used as inputs. Energy coupled into the ring from arm D splits at the ring in an out-of-phase manner, each half of the energy traveling ¾ λ to the diametrically opposite point where it is still out-of-phase setting up within the ring a pure standing wave (zero losses are assumed) having voltage minimums at A and C, and E and voltage maximums at B and F. Total destructive interference occurring at A establishes the voltage minimum and the remaining maxima and minima occur at ¼ λ intervals around the ring. Energy incident at arm B also establishes a standing wave by the same mechanism with maxima at D and F and minima at A, C, and E.

Arms C and A are series connections at voltage minimum (i.e. current maximum) and will thus receive equal large amounts of power from both inputs. Since equal amounts of power are drawn at A and C, the D arm power proceeding past A toward B and past C toward B is equal so that the D-input standing wave is not affected in the region ABC. Similarly the B-input standing wave is not affected in the region CDEFA because equal and out-of-phase energies pass A and C toward E.

Cross-coupling between the inputs is small because each is a series junction located at a voltage maximum (i.e. current minimum) and so ideally draws no power. Thus the essential hybrid characteristic of isolation between inputs is maintained.

Note that energy input to B divides between A and C equally with the energy at both A and C having travelled equal distances. Thus the A and C outputs of the B inputs are in-phase. However the A and C outputs, due to the D input, are out-of-phase because the distance DC and DEFA differ by a half wavelength. Thus the phase relationship indicated in Fig. 2B are justified. A source of reflection in the hybrid ring is the impedance mismatch resulting if the ring and all arms are wave guide

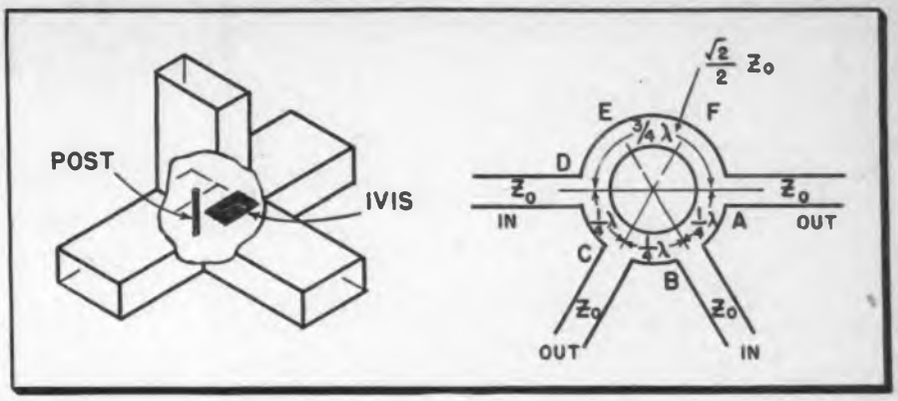
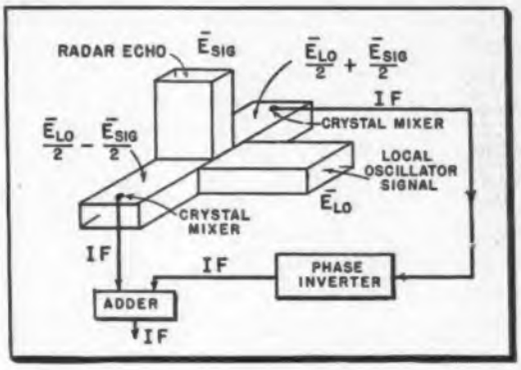
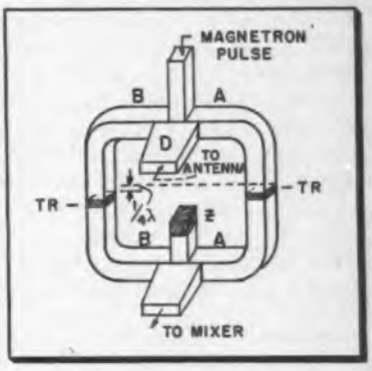


Fig. 7: (left) Interior view of hybrid junction. Fig. 8: (right) Sectional schematic of hybrid ring. Fig. 9: (below-left) Balanced mixer. Fig. 10: (below-right) Duplexer





having the same dimensions. Under these circumstances a generator having an internal impedance of z_o is in series with two loads both having internal impedance of z_o. This is corrected for by reducing the narrow dimension of the wave guide ring to give the ring an impedance of $\sqrt{2/2}$ times the arm impedance.

The ratrace is frequency sensitive by virtue of the ¼ λ critical dimension within the ring which, of course, can only be exact for a specific frequency.

Applications

Balanced Mixer—A balanced mixer which combines signal and local oscillator energy is shown in Fig. 9. By virtue of the power split in the hybrid, each crystal receives equal local oscillator power and equal radar echo power. The radar echo signal i-f is out-of-phase at the two crystals because of the out-of-phase split at the series junction. The local oscillator power is inherently "noise modulated" because of klystron characteristics and the i-f component of this noise modulation appears in the crystal outputs along with the i-f formed by the beating of the radar echo with the local oscillator signal. The local oscillator noise component of the i-f is in-phase at the crystals because of the in-phase split at the shunt junction.

In order that the radar echo i-f signals will add, it is necessary that the crystal outputs be added after a phase inversion. In this case the local oscillator noise components in the output of the crystals are out-of-phase and local oscillator noise cancellation as well as signal addition results. It is, of course, impossible to obtain crystals of identical sensitivities so that complete local oscillator noise cancellation cannot be obtained. However a significant reduction in noise results with an attendant improvement in performance of the receiver.

Duplexer—In order to accomplish duplexing in the most advantageous manner with hybrids it is necessary to use the T. R. tube. This is a gaseous type tube which is maintained at the threshold of ionization by a "keep-alive" voltage impressed across it. The magnitude of voltage present during the transmitter pulse is sufficient to ionize the T. R. tube. In this condition the T. R. is effectively a short across the wave guide and incident transmitter pulse energy is reflected. During the radar echo period however, the T. R. tube is de-ionized and the radar echoes, which are not of sufficient strength to ionize the T. R. tubes, are coupled through into the receiver section of the plumbing.

In the duplexer, Fig. 10, the magnetron pulse is divided between arms A and B of the upper hybrid with

(*Continued on page* 91)

Receiving Antennas

Three-year field tests near Washington, D. C. for UHF operation on basis of electrical

By E. O. JOHNSON and J. D. CALLAGHAN

Radio Corporation of America, Camden, N. J.

REQUIREMENTS for the reception of television signals on the UHF band (470 - 890 MC) are much the same in many respects as on the existing VHF band (54 - 216 MC). For the more difficult fringe areas, or locations where reflections are severe, special types of antennas will be needed, just as they are in VHF.

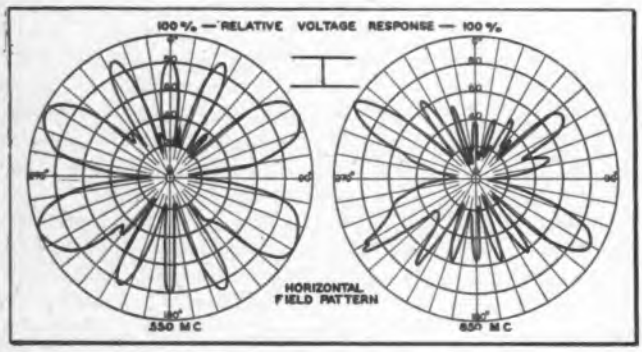
Of the wide variety of special UHF antennas designed and tested during field tests in Washington and Stratford, near Bridgeport, Conn., from 1948 to the present, several types have proved so outstanding in their simplicity, economy, and performance, that it is felt they will find additional widespread use where maximum performance and reliability are primary considerations.

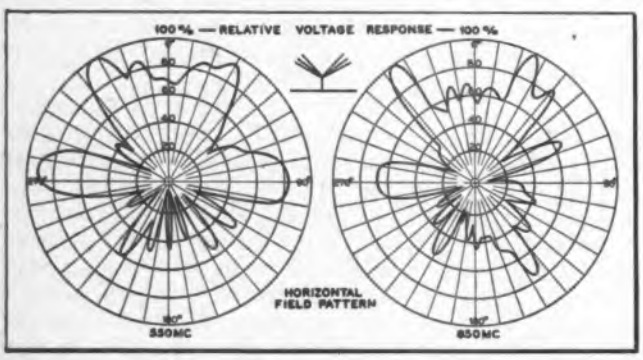
Each of these special types possesses properties peculiar to its individual design, and these types should provide a choice that will meet the requirements of even the most difficult locations.

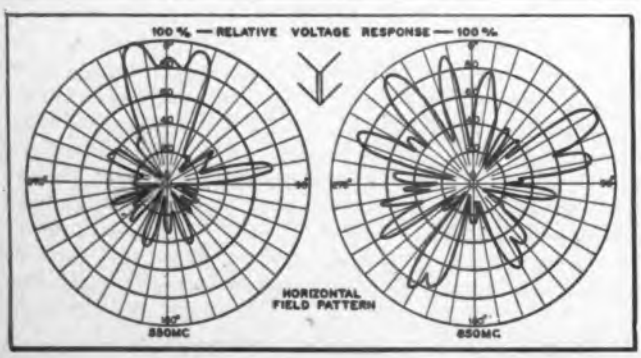
While the factors of performance, size, ease of installation, appearance, strength, cost, and availability of materials must all be considered in UHF antenna design, this discussion will be limited to performance, as determined by the electrical characteristics.

Antenna characteristics are classified here according to gain, directivity, and bandwidth, as follows:

Gain—Antennas may be roughly classed as "low gain" or "high gain," depending on their design for use in strong signal areas or weak signal areas. It should be noted that in all







Figs. 1-3: (Left) Diagrams showing (above) horizontal field patterns for Channel 2 dipole and reflector, (center) VHF fan-type dipole and reflector, (bottom) VHF double V antenna

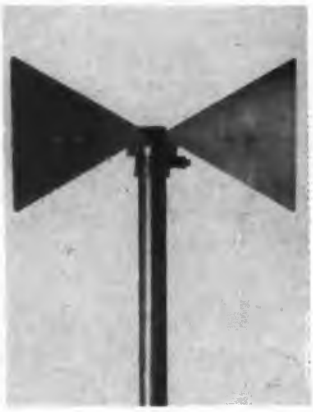


Fig. 4: Fan dipole

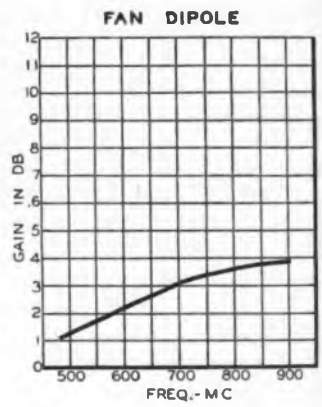
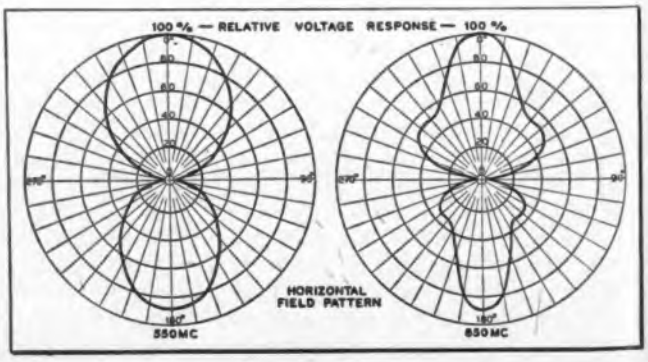


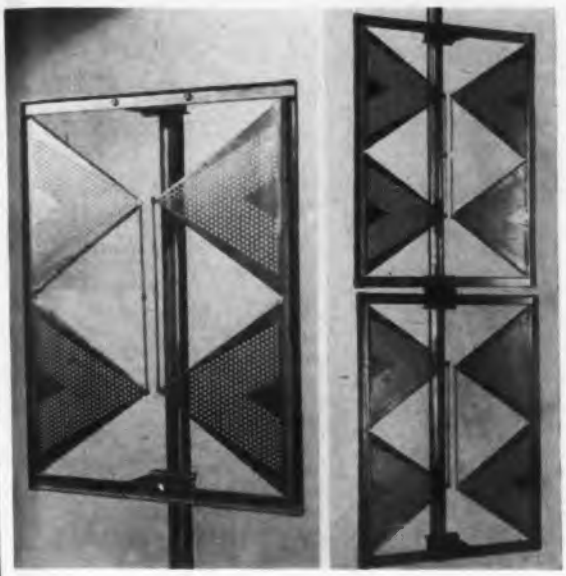
Fig. 5: Fan dipole gain

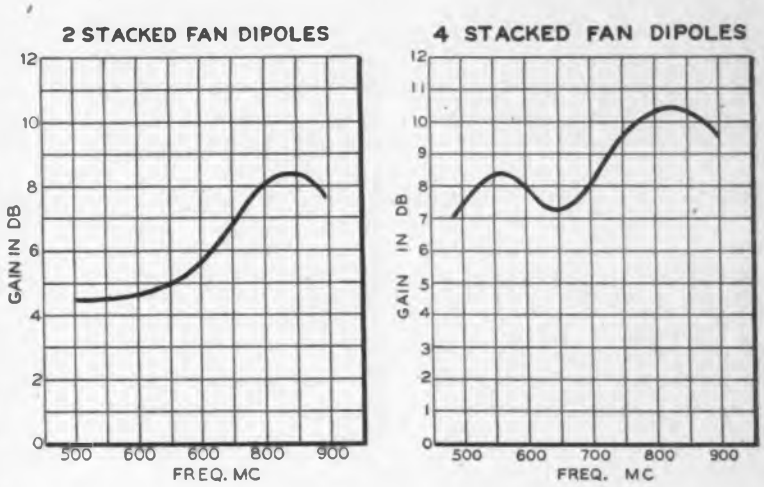
Fig. 6: Horizontal field pattern showing directivity of fan dipole



for UHF Television

and Bridgeport, Conn. reveal antenna types best suited performance, mechanical simplicity, and cost economy





Figs. 7-10: (Left) Physical appearance of two-stacked (left) and four stacked fan dipoles. (Above) Gain vs frequency for the two types

the gain curves shown, the O db reference line is the gain of a thin half-wave dipole adjusted to resonance at each individual frequency. Thus, any given point on the gain curve references the antenna under discussion back to a half-wave-length dipole resonated for that particular frequency. The antennas shown have been designed to work into a balanced 300-ohm line, the gain curves were obtained by using a 300-ohm load at the antenna, and the reference dipole was also matched into 300 ohms.

Directivity—This can vary from the low-gain omni-directional antenna, which receives from all directions, to the highly specialized uni-directional antenna, which has a very narrow angle of reception from one direction only, thus discriminating against unwanted signals. Directivity can be further broken down into horizontal and vertical planes. Horizontal directivity can often be used to great advantage in reducing reflections and multi-path cancellation of signal from objects in directions other than that of the transmitting station. Vertical directivity is often very useful in removing the effects of signal cancellation due to reflection from the earth or other objects either above or below the path between the receiving antenna and the transmitter. This also makes the placement of the antenna less critical. Flutter of signal caused by airplanes is often substantially reduced by an antenna with high vertical directivity. Since high directivity and high gain usually go hand in hand, the so-called "fringe area" type of antenna is very useful in metropolitan areas to eliminate reflections or multi-path conditions.

Bandwidth—Antennas may also be classified as to their bandwidth, i.e., their ability to receive signals efficiently over a wide range of frequencies. Since the UHF spectrum covers 70 television channels, the design of these antennas sometimes seems unconventional when compared to the usual type of antenna designed for single-channel operation.

VHF Antennas at UHF

Most VHF antennas are not very satisfactory at UHF, except in medium and high signal strength areas which are free from reflection problems. Their general UHF characteristics are:

Gain—Low, varying from approximately 10 db below a resonant dipole to 3 db above that of a resonant dipole when they are oriented for maximum response.

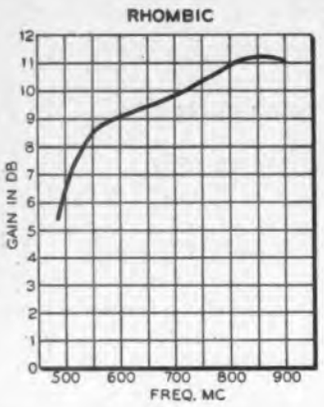
Directivity—Poor in both the horizontal and vertical planes. This is due to the many lobes present and the fact that the major lobe does not usually fall on the axis of the antenna. Figs. 1, 2, and 3 show the horizontal polar patterns of three widely used types of VHF antennas at 550 and 850 MC.

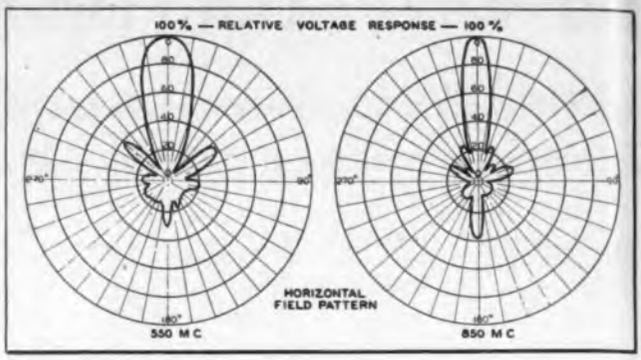
These, as well as other polar patterns in this article, are shown in terms of relative voltage with the maximum lobe being equal to 100%. Because the television receiver is essentially a voltage-sensitive device, signals picked up by any of the minor lobes will appear on the receiver in the same relation as shown on the chart. Polar patterns are sometimes shown in terms of power, which will make the same antenna appear to be more directive. Thus, a minor lobe showing only 10% response in a power plot, will actually be 31.6% in voltage.

Bandwidth—This is generally adequate, with the gain falling off somewhat toward the high end of the band. A major disadvantage is that the main lobes shift direction with frequency, requiring separate orientation for stations operating on widely separated channels.

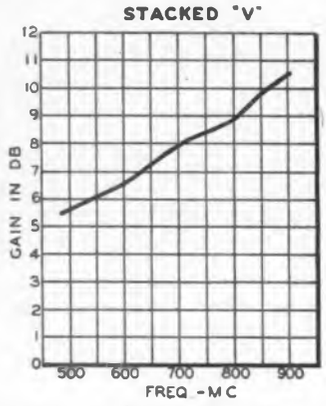
Fan Dipole

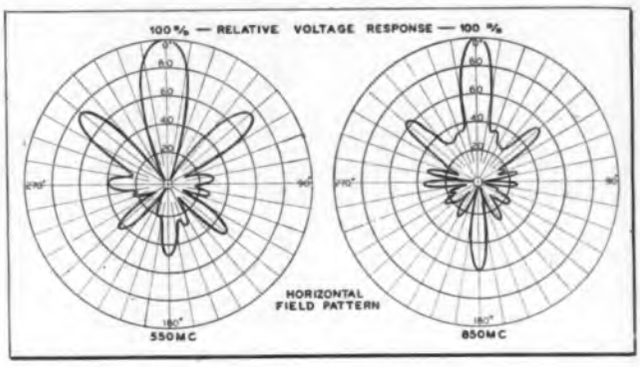
This dipole, shown in Fig. 4, is one of the simplest of all UHF antennas. The antenna is constructed of two triangles of metal, supported





Figs. 11-13: Physical appearance, gain vs frequency curve, and horizontal field pattern directivity for rhombic antenna





Figs. 14-16: Physical appearance, gain vs frequency curve, and horizontal field pattern directivity for stacked "V" antenna

by a suitable insulator. Both triangles lie in the same plane, and the transmission line is attached to each apex. Its characteristics are as follows:

Gain—The gain is shown in Fig. 5. It will be noted that this antenna shows some gain over a half-wave dipole because of its unique construction.

Directivity — Typical directivity patterns are shown in Fig. 6. While a slight front-to-back ratio seems unusual for a dipole antenna, the reduction in response in one direction is caused by the metal mast and mounting support.

Bandwidth—As can be seen from Fig. 5, the bandwidth of the triangular shaped dipoles is excellent.

Stacked Fan Dipoles

The simple fan dipole can be stacked vertically, as shown in Figs. 7 and 8. When properly phased, the gain of the two-stack fan dipole is that shown in Fig. 9, and that of the four-stack fan dipole is that shown in Fig. 10.

This stacking will result in an increase of vetrical directivity, although the horizontal directivity will remain as shown in Fig. 6.

It will be noted that the bandwidth, while still good, is not quite as uniform as that of the single fan dipole. This is mainly due to some frequency selectivity in the individual transmission lines used for phasing the dipoles.

Rhombic Antenna

Rhombic antennas have been built and used very successfully during all the UHF field tests. One of these is illustrated in Fig. 11. These rhombics have been adjusted for unidirectional operation and are usually terminated at the far end with a suitable resistor. The general characteristics are as follows:

Gain—High, as shown in Fig. 12, making this antenna very well suited for fringe area operation.

Directivity—This is also very good, as shown in Fig. 13. It will be noted that the major forward lobe is quite narrow in the horizontal direction, decreasing in width with increasing frequency. While some minor side and back lobes are present, these should give no trouble except in very severe cases of reflections or multipath reception. Although the vertical directivity pattern is not shown, the major lobe in the vertical direction is approximately three times as broad as that shown for the horizontal.

Bandwidth—This is a broad-band type of antenna, showing a rising gain characteristic toward the high-frequency end of the band, which is very desirable.

Stacked Rhombics

Two or more of these rhombics can be stacked vertically, one above the other. When two of these antennas are stacked 12 inches apart, the result is an increase in gain of about 2 db across the entire band.

This stacking also increases the vertical directivity, although the horizontal directivity will remain approximately as shown in Fig. 13.

Stacked "V"

Two "V" type antennas stacked one above the other are illustrated in Fig. 14. This combination uses the same rods as a standard dipole made for Channel 2, and thus contains about the same amount of metal as a simple VHF dipole and reflector. It is a very efficient antenna, considering its simplicity of

Figs. 17-20: Sheet reflector-type antennas (l. to r.) Flat sheet, parabolic reflector, and corner reflector with gain vs. frequency curve

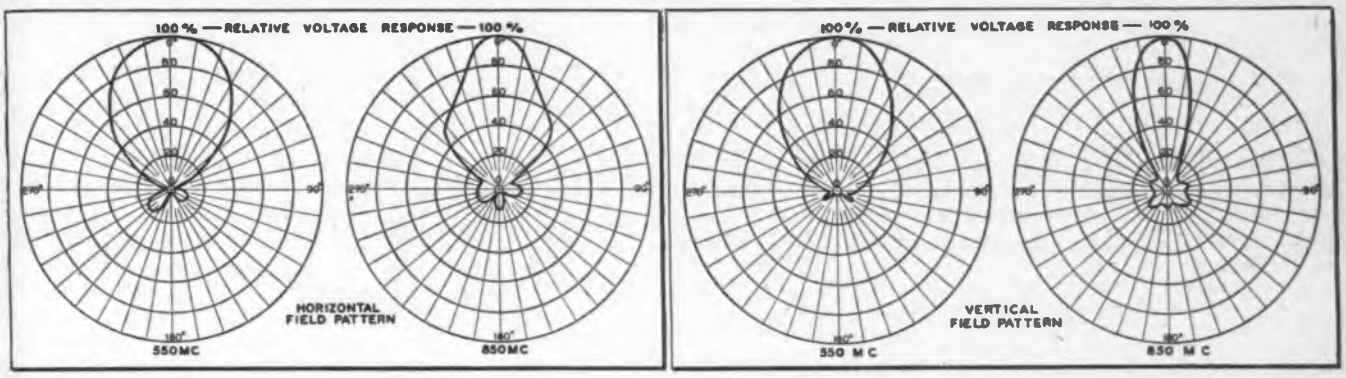


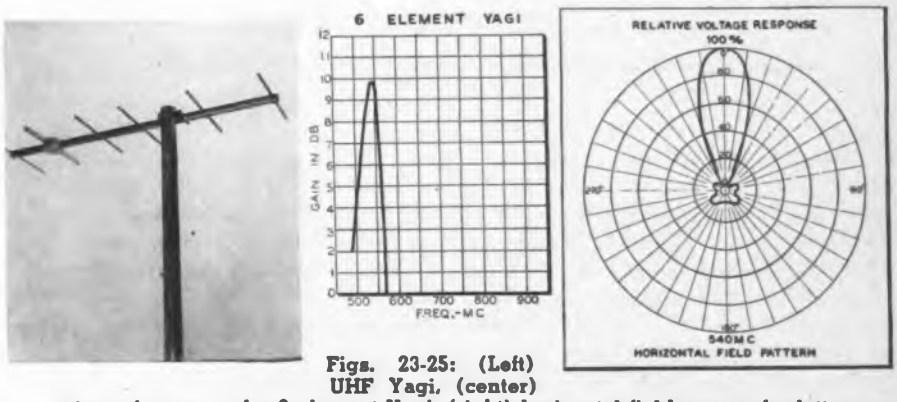
Fig. 21: (Left) Horizontal directivity field pattern for corner reflector. Fig. 22: Vertical directivity field pattern for corner reflector

construction, and is relatively easy to mount on existing masts. It shows the following characteristics:

Gain—This is a relatively high-gain antenna (as shown in Fig. 15) for use in medium and weak signal areas. It also shows an increasing gain characteristic with frequency, which is highly desirable to overcome both propagation and transmission line losses which increase with frequency.

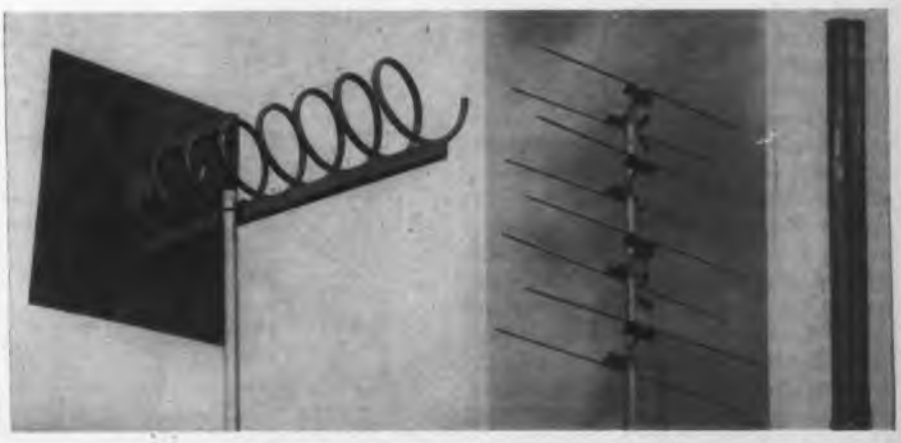
Directivity—The directivity pattern, as shown in Fig. 16, indicates one narrow major lobe, plus multiple secondary lobes. This should be adequate in most areas that are reasonably free of reflections.

Bandwidth—The bandwidth of this antenna is excellent, covering more than the required frequency spectrum.



Figs. 23-25: (Left) UHF Yagi, (center) gain vs frequency for 6 element Yagi, (right) horizontal field pattern for latter

Fig. 26: (Left) Helical antenna. Fig. 27 (Center) Stacked dipoles and reflectors Fig. 28: (Right) Slot type antennas may be used extensively on UHF-TV



Sheet Reflector Types

Sheet reflector-type antennas, wherein one or more dipoles are arranged in front of a large metallic sheet, have been in use for some time in such applications as radar and micro-wave transmission.

Although they can take many forms, three experimental types are shown here, Fig. 17 showing dipoles arranged ahead of a flat sheet; Fig.

(*Continued on page* 78)

Signal-to-Noise

An evaluation of scanner requirements. Peak signal

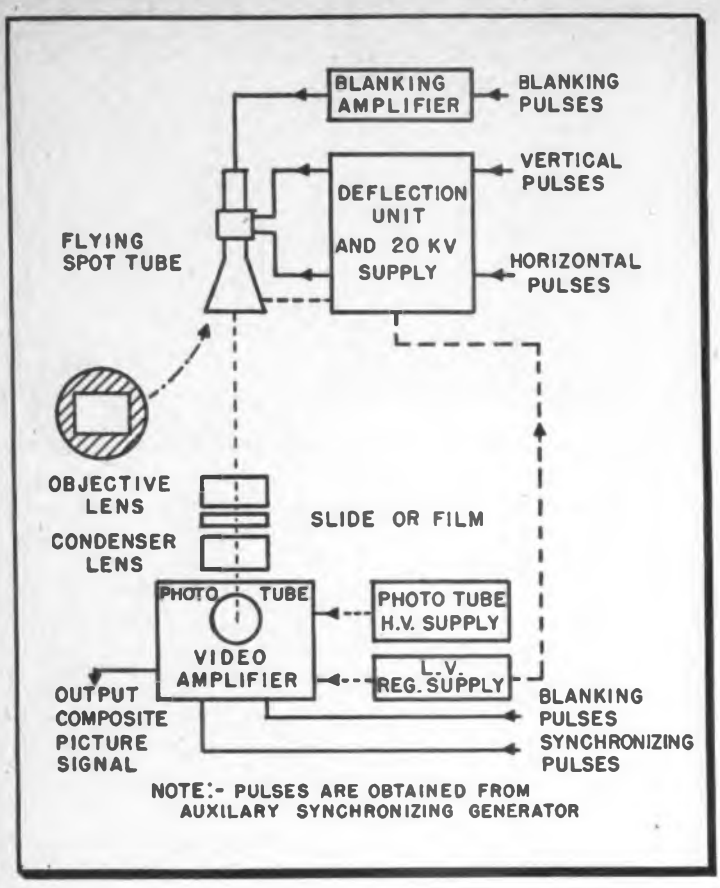


Fig. 1: Block diagram of flying spot scanner

By ALBERT J. BARACKET

Senior Project Engineer, Federal Telecommunication Laboratories, Inc. Nutley 10, N. J.

IN all TV stations, motion pictures and stills form a large percentage of TV daily programming. In most stations, image orthicon or iconoscope camera chains, costing upwards of $12,000.00 are used not only for motion pictures but for slides as well.

A much simpler way of transmitting slides is by means of the flying spot scanner which uses familiar components in a simple arrangement capable of producing pictures of high resolution, excellent gradation and good signal-to-noise ratio. Not only is the scanner much cheaper initially than the image orthicon and iconoscope camera chains but the operating cost is less since only one operating technician is required.

It is the purpose of this paper to evaluate the signal-to-noise capabilities of the scanner and discuss experimental results. We will proceed using a step-by-step analysis which is applicable as well to other pick-up devices such as the image orthicon and the iconoscope. As a matter of fact, with some modification these methods may be used in the analysis of color television systems.

Flying Spot Scanner

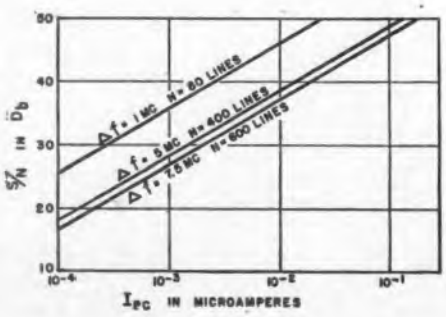
The mechanical scanner had its origin years ago in the form of a perforated disk rotating between a source of light and the televised subject. Because of the spiral nature of the perforations, as the wheel rotated the flying spot of light traversed vertically and horizontally across the scene. The latter was limited to a rather small field which could be adequately covered by photo cell pick-ups.

The advent of cathode ray tubes with phosphors of extremely short persistence makes possible highly efficient all-electronic flying spot scanners. Fig. 1 shows a cathode ray flying spot scanner in block form. The deflection circuits, driven by pulses from an auxiliary synchronizing generator, deflect the cathode ray tube beam horizontally and vertically. A high voltage supply provides 20 kv d-c for the cathode ray tube accelerating anode. These are the elements required for producing the flying spot of light. A projection type lens focuses the raster on the transparency to be televised. A condensing lens gathers the light from all parts of the transparency for collection by the photo-cathode area of the photo multiplier tube. A video preamplifier raises the amplitude of the photo multiplier output signal for feeding into blanking and synchronizing inserter sections of the video amplifier.

Because there is a limit on the light out of the flying spot cathode ray tube there is a limit to the signal to noise capability of the system even with a highly efficient optical section. For any value of signal to noise below the limit there exists a minimum optical efficiency which must be maintained. A practical approach in the design is to set a minimum standard on the signal to noise ratio and then calculate the effective aperture the optical system must have in order to reach this goal.

There are a number of sources of random noise in the system of which the most important are (1) shot noise, due to the discrete particle nature of electron flow, (2) thermal noise developed in the load resistor, and (3) dark current due to thermionic emission.

Fig. 2: S/N vs photocathode current



Shot Noise

Because electrons flow as discrete particles and not with perfectly smooth continuity, a random noise current component exists. This current is a function of the average cur-

Ratio in Flying Spot Scanners

capabilities based on shot and thermal agitation noises and optical efficiency to r.m.s. noise ratio of 35 db considered satisfactory minimum standard

rent in the circuit, and the frequency bandwidth of the following amplifiers. The square of the noise current.

$$i_n^2 = 2eI\Delta f$$

where i_n is the r.m.s. value of the noise current in amperes, e is the electron charge (1.59×10^{-19} coulomb). I is the average current in amperes, and Δf is the bandwidth in cycles.

Thermal Agitation Noise

The random motion of free electrons in the load resistance causes a random e.m.f. to be developed across the resistor. This potential is a function of temperature, the resistance in ohms and the frequency bandwidth of the following amplifiers. The square of the developed noise voltage,

$$e_n^2 = 4KTR\Delta f$$

where e_n is the r.m.s. value of the noise potential in volts, K is Boltzmann's constant (1.374×10^{-23} joules per degree K), T is the absolute temperature in degrees Kelvin, R is the resistance in ohms and Δf is the bandwidth in cycles.

For a representative load resistance of 1000 ohms, e_n is approximately 10/uv. when f = 7.5 MC and T = 300°K. This may be neglected when we consider that in the 10–stage electron multiplier associated with 1P21 and 931A type photo multipliers, both the signal and shot noise currents may be multiplied by as much as 100,000 times before flowing through the load. The shot noise voltage across the same 1000 ohms resistance would be of the order of 2000/uv, 200 times as great as the developed thermal agitation noise voltage.

The random noise due to thermionic emission is limited to 0.1/ua. in the IP21, and 931A photo multiplier collector circuits. It is apparent, that compared to the shot noise, the dark current is a minor factor even in the dark areas of a television picture having a contrast ratio as high as 30 to 1. However, in some non-television applications such as the detection of very low light levels, the dark current may become the limiting factor.

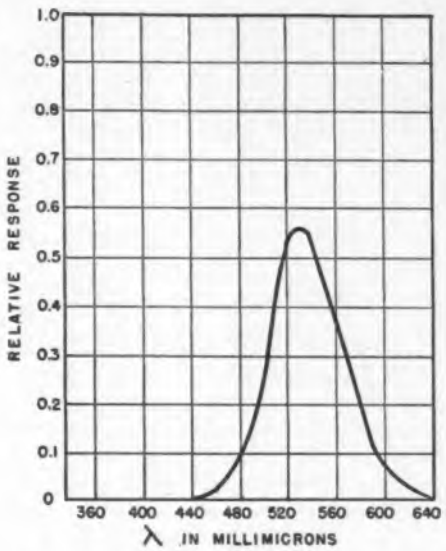


Fig. 5: Eye response to P15 excitation

S/N vs. Photocathode Current

At the signal to noise ratios required for a good television picture, the shot noise due to the photocathode current is the most important noise in the system. Considering the signal to noise current ratio in the picture highlights or peak white areas, this becomes from $i_n^2 = 2eI\Delta f$:

$$\frac{S}{N} = \frac{I}{i_n} = \frac{I}{\sqrt{2eI\Delta f}}$$

$$\frac{S}{N} = \sqrt{\frac{I}{2e\Delta f}}$$

The photocathode current:

$$I_{pc} = 2e\Delta f\,(s/n)^2$$

Where s/n is the minimum signal to noise ratio to be met in terms of peak signal and r.m.s. noise. Fig. 2 shows s/n in db plotted against photocathode current in microamperes. This is given for three different bandwidths: 1 MC corresponding to a resolution of approximately 80 lines, 5 MC for

Fig. 3: ε (λ), the P15 emission function

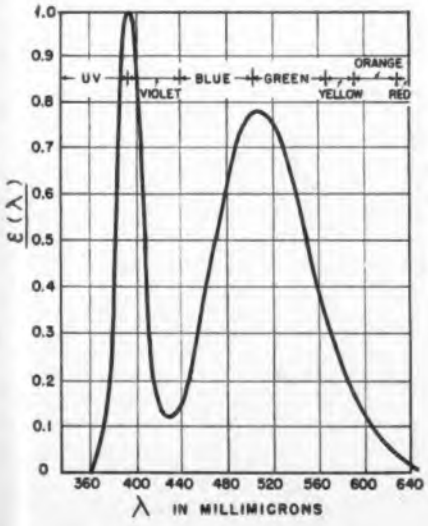


Fig. 4: $\bar{y}$ (λ), the visual response function

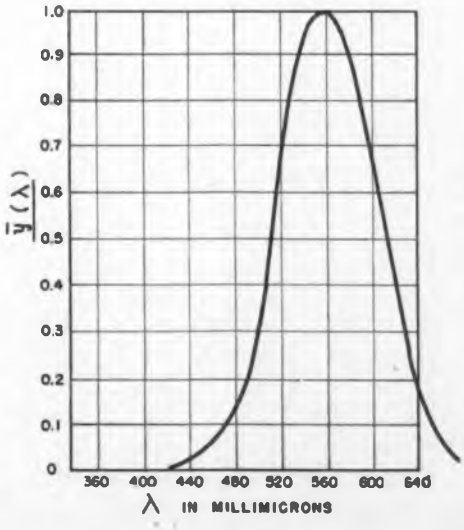


Fig. 6: Spectral response of an S4 surface

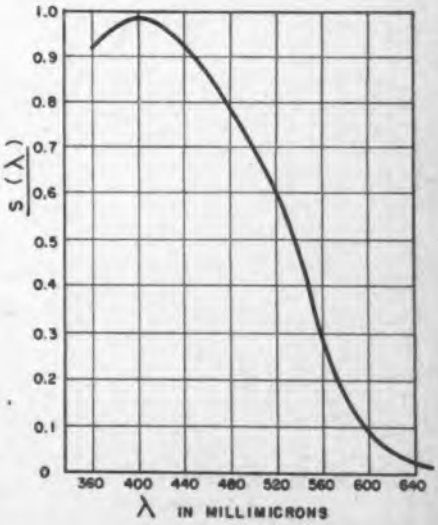


Fig. 11: Front view of FTL-93A Dual Scanner (Right) Operating controls

resolution of 400 lines, and 7.5 MC for 600 line resolution. For any required signal-to-noise ratio, the greater the resolution or system bandwidth the greater is the required photo cathode current to meet the signal-to-noise ratio.

S/N Minimum Standard for TV

What is a reasonable minimum standard for signal to noise? Subjective tests were made on several observers at the laboratories. The signal-to-noise ratio was varied until the picture was judged to be satisfactory. For the average, the satisfactory picture had a peak signal to r.m.s. noise ratio of 35 db. The system bandwidth was 8MC and the resolution was somewhat over 600 lines.

From the signal-to-noise vs. photo-cathode current curve, for 600 line resolution the photo-cathode current needed for a 35 db signal-to-noise ratio is approximately .01 micro-amperes. In a photo-multiplier tube this small current is raised as much as several thousand times to a level of approximately 100 micro amperes.

Optical Efficiency Requirements

In determining the optical system efficiency needed a number of important factors must be taken into consideration. The first is how much radiant energy is obtained from the cathode-ray screen, the second: what is the sensitivity of the photo-cathode, the third is, how closely do the radiated wave lengths match the wave lengths to which the photo tube is sensitive, and fourth, what is the spectral sensitivity curve of the color filter, if one is used.

An ordinary tungsten filament lamp puts out a lot of radiant energy in the infra-red region but in the increasingly shorter wave lengths its output drops off. The cathode ray tube phosphor, which is of the P15 type, has a rather different curve of radiant energy output vs. color or wave length. This is shown in Fig. 3. This is a relative response curve in terms of the watts per millimicron radiated at the peak wave length of 390 millimicrons. The curve has 2 peaks, the second being at approximately 500 millimicrons, in the blue-green region. The latter peak is almost 80% as high as the violet-ultra violet peak.

A convenient means of obtaining quantitative information is to measure the emission of the P15 screen by means of an eye-corrected photometer which would have the response curve shown in Fig. 4. This is the response of the so-called average human observer which was standardized in 1924 by the International Commission on Illumination. It is a measure of efficiency in the conversion of radiant energy to visible flux. The peak efficiency is at 550 millimicrons. At this wave length, 650 lumens are produced for each watt of radiant flux. The eye response drops off on the average approximately 30% at the blue wave length of 500 millimicrons and down to about 15% at the red wave length of 640 millimicrons.

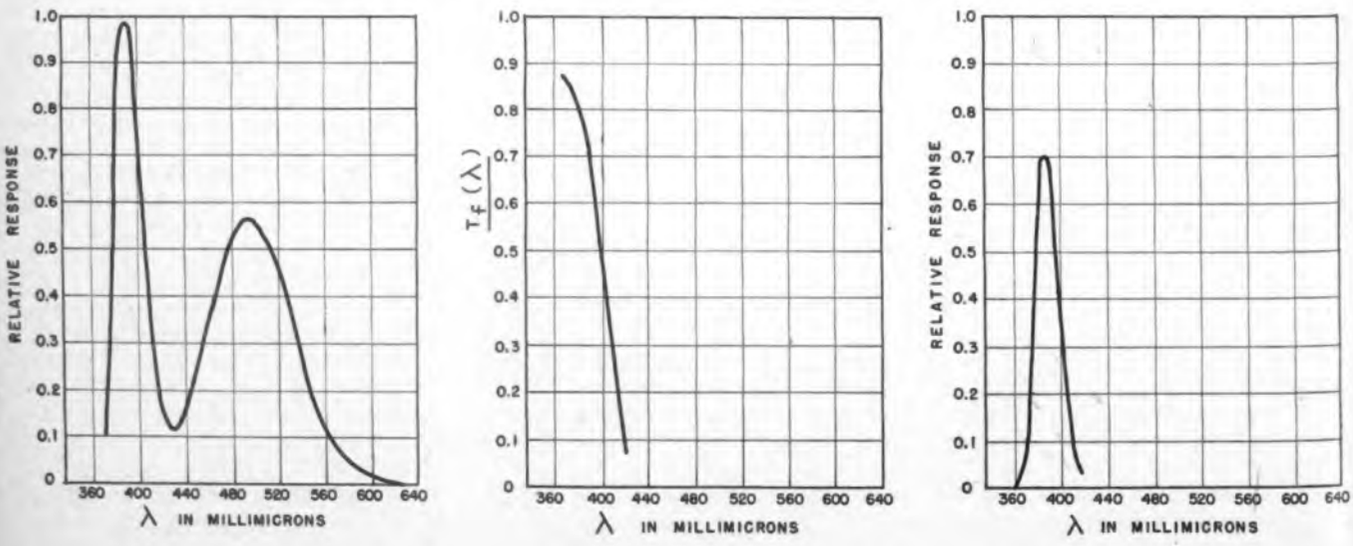
A visual photometer or the human eye looking at the screen of the cathode ray tube then sees the proportions shown in Fig. 5.

As might be expected the ultra-violet component is completely lost. However, based on a measurement of the visible output of the P15 cathode ray screen and a knowledge of the spectral response curves of the phosphor and the photometer response to the phosphor excitation, complete information on the radiant energy output vs. wave length may be obtained.

The tools to help answer the first question of how much radiant energy

(*Continued on page* 95)

Fig. 7: (Left) Photomultiplier response to P15 excitation. Fig. 8: (center) Filter response Corex 5970(½). Fig. 9: (right) 931 and 1P21 photomultiplier response to P15 excitation through filter.



Suppressing Microwaves by Zonal Screens

New system, developed at National Bureau of Standards, alleviates service interruptions resulting from ground reflection effects

A METHOD based on the classical Huygens - Fresnel diffraction theory for the suppression of ground-reflected waves which are present in microwave radio link operations has been developed by H. E. Bussey of the National Bureau of Standards. This system alleviates service interruptions which result from ground reflection effects in line-of-sight microwave communications.

Interruptions in line - of - sight microwave communications may occur when the direct wave from the transmitter and the ground-reflected wave destructively interfere with each other at the receiver. Although it is possible to set the receiver at a point of constructive interference, subsequent atmospheric changes usually shift the spatial interference pattern (the so-called lobe pattern) of the source and its image sufficiently so that an interference minimum frequently occurs at the receiver.

In the NBS method, reflected-wave suppression is achieved by setting a small screen of the proper size on the ground at the "reflection point" in the path. The reflected wave at the receiver is then substantially diminished, to an extent depending on the smoothness of the ground plane. The screen is designed to block only a small part of the reradiation from the ground to the receiver; the remainder of the reflected radiation adds up to zero at the receiver. The direct wave undergoes little or no modification during the suppression of the ground-reflected wave.

Based on Optical Principle

This technique is based on the optical principle that the wave field transmitted from a point source to a point receiver under free-space conditions becomes zero if half of the first Fresnel zone is blocked so that the remaining diffracted contribution of the zone is halved in amplitude and unchanged in phase. The reduced contribution of the first zone is then cancelled by radiation from unblocked zones.

One of the screens developed by NBS takes the form of an opaque quarter-circle. The screen is erected on the ground at a point along the transmission path where the reflected ray from the transmitter strikes the ground. The plane of the screen is perpendicular to the path, and its radius is equal to that of the first Fresnel zone in this plane. Thus, the quarter-circle blocks one-half of the first Fresnel zone for the ground reflected wave; according to optical theory, the remaining contribution from this zone is cancelled and the effect of the image source is effectively eliminated at the receiver. There is also a large area surrounding the receiver position in which

(*Continued on page* 74)

Fig. 1: (below, left) Nullifying effect of ground at receiver by placing opaque screen between transmitter (T) and receiver (P). Ground reflections are considered as originating at (T′) below reflecting plane and are radiating toward receiver along path passing through (S) and its image (S′)

Fig. 2: (right) Zonal screens developed for partial or complete suppression of microwave ground reflections. Screen dimensions are given in fractions of radius of first Fresnal zone: the outside circle of each drawing represents the periphery of the plane. Dashed lines through centers of circles denotes ground plane. In practice only upper half of screen is constructed

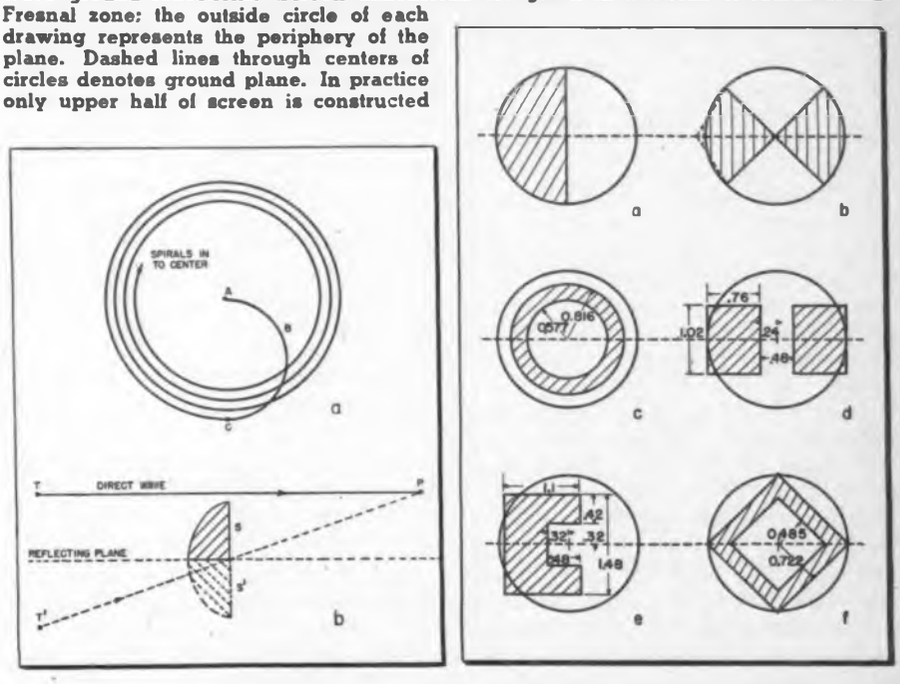
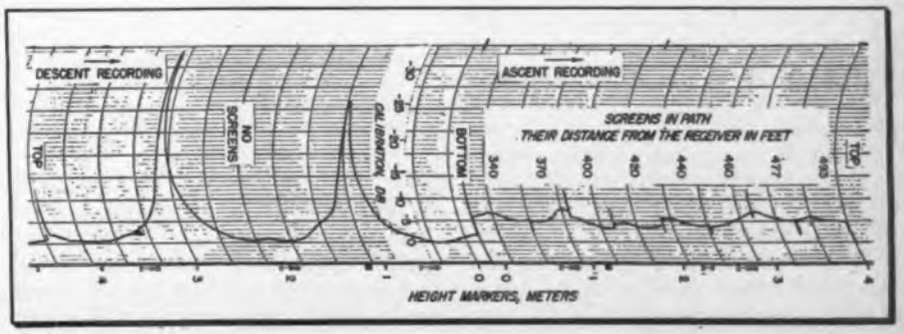


Fig. 3: Receiver-recording of signal strength vs height and time of microwave radio relay with and without zonal screens. With no screen, and receiver descending from four to zero meters, reflected ray interference creates well defined path. With two triangular suppressing screens, and receiver ascending from zero to four meters influence of reflected wave is almost eliminated



CUES for BROADCASTERS

Practical ways of improving station operation and efficiency

Edited by John H. Battison

Simplified Switching of Studio Turntables

SIDNEY FELDMAN, WHOM, New York, N. Y.

AT WHOM, the RCA 76-C console controls two studios; one on each side of the master control room. Each studio has two turntables, and the technician has to select the set of turntables corresponding to the studio in use at the time. Originally, this was done by having the turntables come up to two different sets of buttons on the mixer 5 and 6 inputs on the console. However, it was soon evident that this additional operation involved an increase in the length of time required to make a switch-over when switching from one master control studio to the other. Most important, the chance for human error was increased.

To simplify matters two mechanically-ganged DPDT anti-capacity switches were installed on the console, between the monitor volume control and the channel 1 mixer. At this location the Phone Monitor—Remote—Program switch was located. Having no use for this feature, the switch was removed and the circuits connected for operation in center position.

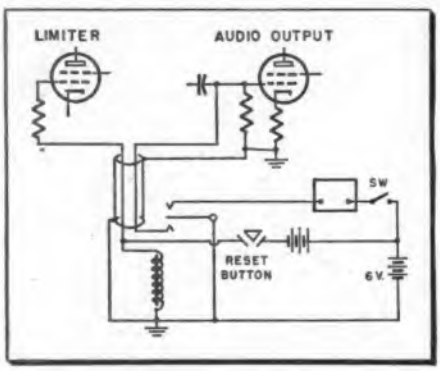
Utilizing spare terminal-board space existing in the console, the two turntables in one studio were wired to one side of the ganged switches and the turntables in the other studio were wired to the other side of the switches. The output of the switches was then connected to the turntable 1-2 console buttons. With this change in the console the proper set of turntables are selected by throwing a single switch.

Defense Alerting Monitor

ALLEN BELL, Chief Engineer, WCLI, WELM, Corning, N. Y.

THE new CONELRAD regulations require broadcast stations to monitor an alerting station. WCLI is using an extremely simple circuit to accomplish this. A "Zenith" Major FM set is used and includes an ac isolation transformer for safety. The circuit consists of a sensitive relay in the limiter grid circuit.

When energized by the signal this relay contacts ground; the last audio grid muting the receiver. If the carrier is interrupted, the relay is released and audio operates. The non-energized contact is moved back far enough so that when once released, the relay contacts will not be energized by the limiter current, and the audio remains on. As an indication of failure of any receiver part and a double check on alerting the engineer on duty, the relay operates a bell in the non-energized position. The bell will ring until turned off.



Defense monitor alerted by carrier

The relay is reset by pressing the reset button which applies about 12 volts to coil. Batteries must be in correct polarity to aid limiter grid current. One advantage of the ac-dc series filament circuit is that filament failure of any tube gives an immediate alarm. The circuit can be easily adapted to AM receivers by inserting the relay in the diode detector load circuit.

Transmitter Quality Monitor

GLEN SOUTHWORTH, Chief Engineer, KBKH, Pullman, Wash.

IN many instances it is considered desirable to make a constant aural "off the air" check of transmitter quality in order to insure that a defective component does not cause excessive audio distortion which might seriously impair the intelligibility or musical qualities of the transmission.

An interesting solution to the problem of continuous monitoring has been the use of a "Tin Listener," designed to give an audible or visual alarm when distortion in the transmitting equipment rises above a certain limit or gain characteristics change. With this type of distortion analyzer, output is compared with a portion of the input signal in such a manner that cancellation of all but the distortion products occurs. The resultant signal is amplified, rectified, passed through a suitable RC time delay network, and used to operate a relay and associated warning device. The main distinction in the case of the tin listener is the fact that it is designed to work with a dynamic signal of varying frequency and amplitude content, rather than a single tone, steady state, signal.

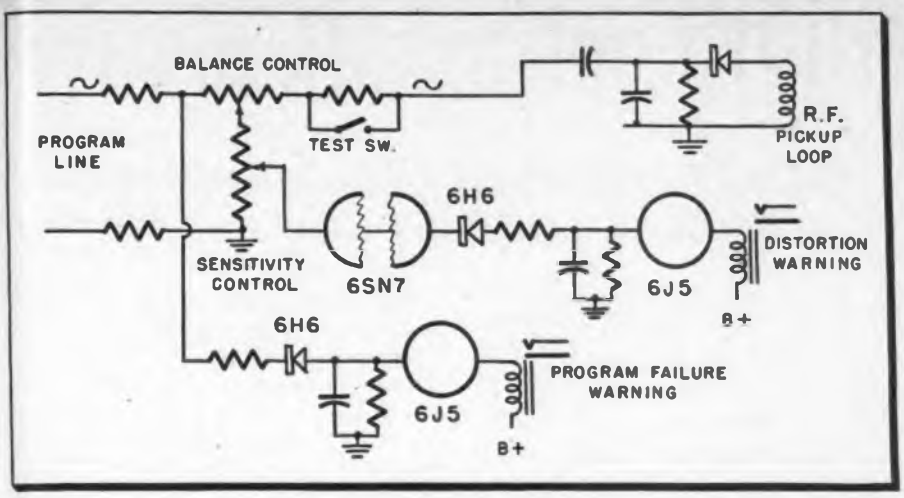
The carrier output is sampled by means of a diode detector, and the detected signal is mixed and balanced with an out-of-phase-signal from the studio line. The resultant distortion products are then amplified by a one or two stage amplifier, depending upon the input voltage available, rectified, passed through a resistance capacitance delay network and applied to the grid of a triode with a relay in the plate circuit. Unbalance in the input circuit causes a negative potential to be applied to the triode grid, thus opening the relay and operating the alarm.

The RC time delay network is of considerable importance in a device of this kind as it tends to prevent instantaneous distortion from operating the warning device. For example, it may not be practical to obtain balanced phase and amplitude characteristics over the entire audio range and if time delay were not incorporated, intermittent sounds with frequency components at the ends of the audio spectrum, such as bass drum or cymbals, would cause operation of the warning device.

The "Tin Listener" may be initially adjusted with an audio oscillator and the sensitivity adjusted that the relay will open at the desired percentage of unbalance. Mid range adjustment from 200 to 3000 cps is most important as the maximum amount of energy in most

$$$ FOR YOUR IDEAS

Readers are invited to contribute their own suggestions which should be short and include photographs or rough sketches. Typewritten, double-spaced text is preferred. Our usual rates will be paid for material used.



Transmitter quality monitor provides distortion indication through audio harmonics

sounds is in this region, and with modern equipment little difficulty should be experienced in holding phase distortion over this range to a low value. Once adjusted with the oscillator, the device may be tested with complex signal material, such as band or orchestral renditions. While in operation, the device may be conveniently tested by introducing a 5 or 10% unbalance at the input and noting if the alarm functions properly after the required interval produced by the time delay.

As well as providing an extra convenience to the engineer on duty, the tin listener may prove useful in detecting equipment defects in the intervals between regular maintenance checks. An extra circuit, which may be considered desirable, will give an alarm in the event of failure of studio equipment or line trouble. This circuit, shown in the diagram, rectifies a small portion of the incoming audio signal, passes the resultant voltage through a RC network with a time constant of 10 to 20 seconds, and applies the potential to the grid of a triode with a plate circuit relay. In the event of program failure the voltage will drain away from the triode grid with consequent operation of a warning device or automatic switching of program lines.

Fool-Proof Remote Cue Feed

R. S. HOUSTON, 18 Oak Lane, Haverstown, Pa.

WITH many makes of broadcast consoles, it is often necessary to use two hands in order to bring in a remote. One hand throws the cue switch from cue to broadcast, and the other opens the fader. In the case of announcer-operator stations, this often means leaving the mike open during the operation with attendant noise, or at best, preventing the announcer from hearing the start of the broadcast. But often fading is necessary. The standard faders with "cue" taps on the last step can be used in a cue feed circuit.

In this usage, the "Q" tap of the fader is connected to a source of cue. As long as the fader is closed, cue is fed back to the line, and testing can also be conducted without fear of unwanted signals on the air. When the line is thrown on the air, the first step cuts the cue, and fading-in is possible from there with one hand. With most consoles this change can be readily incorporated with no circuit changes, other than addition of the cue connection to the fader. Cue is still fed to other lines in the usual manner, but cue to the line in question is fed back through the fader, with the key in the "mix" position. Since these faders are of the unbalanced type, it may be desirable to incorporate repeat coils on the input and output of the mixer and also the cue feed system.

As an adjunct, a key could be put in the cue feed, so that a telephone could be used for talking to the remote operator. Or it could change the "Q" tap from cue to audition, so that the line could be checked without using the audition system in the last position. These are valuable especially with announcers running console. Some variations of faders determine where the off position is.

Tape Recorder Modification

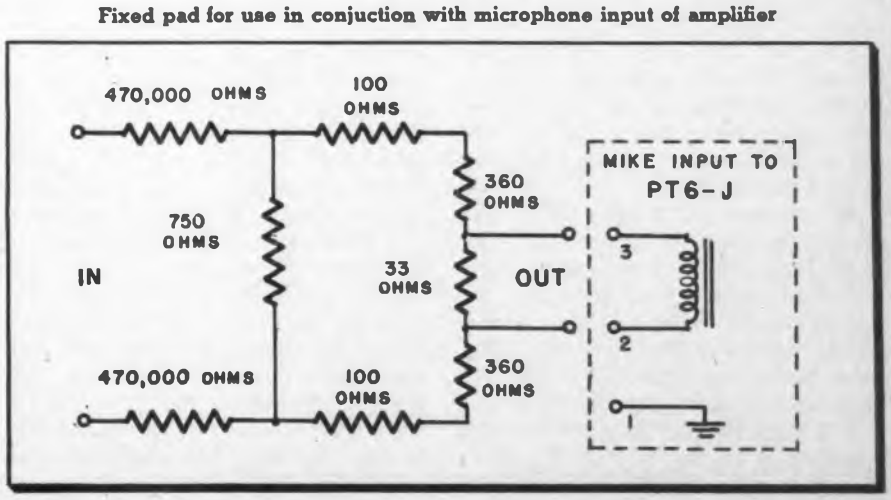
BRUCE GLYCADGIS, WJEF, Grand Rapids, Mich.

OUR company recently purchased a number of Magnecord tape recorders, PT6-J amplifiers and PT6-AH. We planned to set up a number of them for rack use only. Ordinarily this is no great problem. The PT6-J amplifier has only two inputs; a 30 to 60 ohm balanced microphone input and an unbalanced high impedance bridging input. Neither is very suitable for working into the output impedances of telephone lines and program amplifiers.

An additional difficulty is the fact that when a jack is inserted into the bridging input, the recorder cannot be played back until the jack has been removed. The problem was solved by building a fixed pad to use in conjunction with the microphone input of the amplifier. This pad permits recording from any high level program source in the control room without appreciable loss in frequency response.

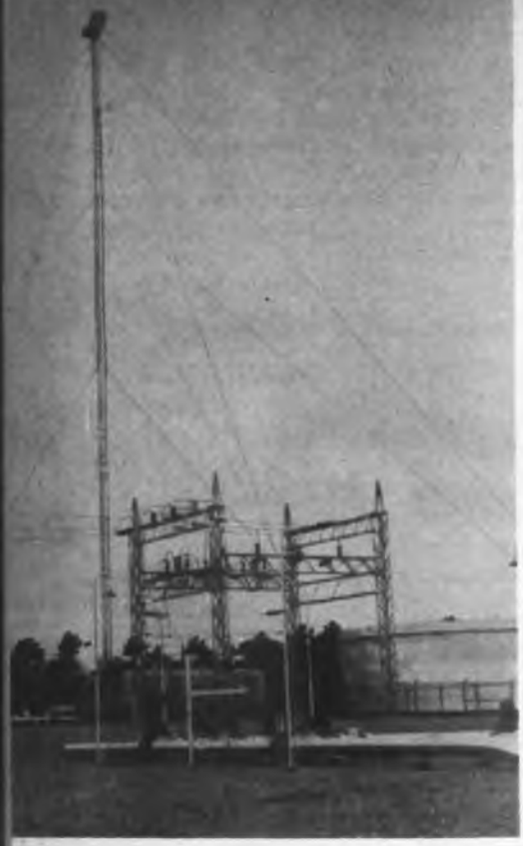
The pad can be mounted on the terminals of the audio patch board (shielded line must be used as signal is low level after pad), or it may be mounted on the amplifier chassis. In both cases the connection to the amplifier is made with the proper Cannon microphone connector which makes it possible to remove the amplifier for portable use or servicing without removing any external wiring.

Fixed pad for use in conjuction with microphone input of amplifier



Microwave

Time and frequency division multiplexing most popular communications; telemetering; supervisory and fixed



Typical utility microwave reflector tower

By CARL M. BACKER,
Microwave Communications Section
Philco Corp., Philadelphia, Pa.

UTILITIES find it extremely important to have reliable and continuous communication available to any point along their lines. The communication system used must provide telemetering, communication, and any other communication facilities required. In the past, wire lines or power-line carrier equipment has been widely used to provide these important services. Now, however, microwave communication equipment is coming to the front as the best means of communication, and is therefore finding increasing application. Microwave towers are becoming a familiar part of the landscape along utilities lines.

All microwave communication equipment up to the present time has been designed to include provision for multichannel operation by the use of multiplexing. The two most widely used systems of multiplexing today are termed time division and frequency division multiplexing.

A typical channel arrangement for a utility is shown in Fig. 1. With this arrangement, the facilities provided include communication for either trunk or party-line service, telemetering, supervisory control, fault alarm, and power relaying. The type of equipment required depends, to a great extent, upon the type of multiplexing.

A block diagram of a communication circuit which utilizes the frequency-division type of multiplexing is shown in Fig. 2. This type of multiplexing, in which each audio channel is associated with a subcarrier is well known. The standard type of carrier uses amplitude modulation with single-sideband transmission and carrier suppression. The arrangement of frequency-division channels in the frequency spectrum is similar to that used in a wire-line system.

Pulse modulation as used in time-division multiplexing (Fig. 4) has the inherent characteristic that only a single increment of a signal is transmitted at any one instant of time; that is, increments of each channel are transmitted in time sequence. Several types of pulse-modulation systems, such as pulse amplitude modulation, pulse time modulation, and pulse code modulation, are available.

Multiplexing Voice Channels

The common denominator of the communications industry is the voice band, which extends from approximately 200 to 3300 cps. In a time-division system, each of the voice channels may be further multiplexed, to provide narrow-band facilities such as telemetering, teletype, supervisory control, and power relaying.

A carrier system makes it possible to obtain a number of independent telephone circuits over the main transmission path. (The single-sideband method of modulation is the one in general use because of its economy in bandwidth.) The usual carrier system accomplishes its operation by shifting the various 200 to 3300-cycle telephone bands to different frequency ranges, so that they are stacked one above the other in the frequency spectrum, as shown in Fig. 3. For example, one telephone band might be shifted to the frequency range of 3800 to 6300 cps. This process of shifting the telephone bands is carried out in the carrier terminal equipment. When a wire line is used with carrier equipment, the operating length of the carrier system is increased by the use of carrier repeaters at intermediate points. In the case of a microwave system, the operating length is increased by the use of repeater stations along the microwave path.

Equivalent to 4-Wire Lines

Utilities use both party-line operation and trunk operation, to obtain maximum service with minimum equipment. Since a microwave relay system is equivalent in function to a four-wire line, a four-wire type of carrier system may be used with it. This permits the use of the same band of carrier frequencies for each direction of transmission.

The usable bandwidth of a microwave equipment may be divided into several narrow bands by a system of frequency division. These narrow bands may be used for telegraph channels, telemetering, supervisory control, control of VHF fixed stations, and power-line relaying. It is also possible to operate a microwave equipment without multiplexing to provide a single voice channel. The frequency-division type of multiplexing provides for the insertion of a basic voice band which may be used without the application of carrier equipment. This band corresponds to a physical circuit in a wire-line carrier system.

A portion of the frequency spectrum between 300 and 3300 cps may be used for a service channel, fault alarm, VHF control, etc. Carriers and other facilities are inserted into the system at frequencies above 3300 cps. The service channel may run the entire length of the microwave system. Carrier equipment may be used for bridging a microwave channel at repeater points in order to provide party-line service for communication or certain other facilities. One or more channels may be dropped out at intermediate points along a microwave route by installing microwave repeaters on a back-to-

System Design for Utilities

methods for obtaining such multichannel operations as voice, telegraph, and teletype VHF station control. Factors determining suitable microwave relay sites are described

back basis, that is, by terminating a microwave system at voice frequencies in both directions at the intermediate point.

Carrier Channels

Carrier channels, when operated on either a frequency-division basis or a pulse-modulation time-division basis, may be used for a variety of purposes, and there is an increasing trend toward the utilization of a single channel for two or more services. For example, in a good many cases it may be desirable to combine telemetering and supervisory control of unattended stations.

Supervisory control is usually accomplished by the use of coded impulses between the control point and the outlying stations. It may also be accomplished by the use of a sequency or combination of audio-frequency tones, the frequencies of which are selected so as not to be a multiple of any power frequencies or other frequencies likely to be encountered on the remote-control line.

The coded-impulse type of supervisory control utilizes a single carrier channel to transmit the operating impulses to the receiver stations. Since the equipment is operated on a four-wire basis, the same channel may be used to send a group of impulses back to the dispatching point, to indicate whether the desired operation has taken place at the receiving station.

The use of supervisory control and telemetering in a microwave communication system is shown in Fig. 5. From the block diagram it may be seen that the various units used for either supervision or telemetering may be operated on a frequency-division basis and applied to a voice band of 300 to 3300 cps. Either one of the two supervisory-control systems mentioned above provides for the control of a specified number of equipments. The supervisory-control system originates and receives the information necessary to select the equipment which is to be controlled, to perform the desired operation, and to indicate whether the operation has been accomplished. The indication provided by supervisory control may be of the lamp type, to indicate whether a circuit breaker is open or closed, or it may be of the type provided by the use of telemetering equipment.

Impulse-Duration Method

The adequate use of telemetering enables a load dispatcher or system operator to have available at all times a complete picture of the conditions over which he is to exercise control. The best known and probably the most popular method of telemetering is the impulse-duration method. This

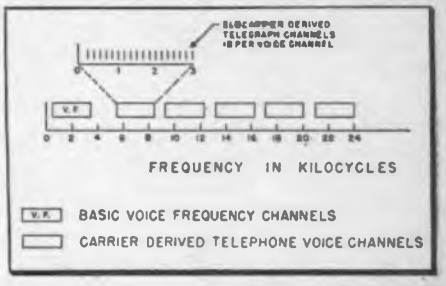


Fig. 3: Frequency allocation chart for a frequency division microwave system

method has been found to be very desirable in cases where nonmetallic circuits, such as power-line carriers or microwave channels, are involved. With this method of telemetering, the microwave system may be used to remotely telemeter such quantities as watts, KVA, voltages, power factors, and frequencies. A new method of telemetering, which uses frequency variation, has been found to be quite suitable for utility application because of its speed.

Teletype equipment is also finding many important uses in the microwave field. Carrier equipment for use with teletype is available in either the relay or electronic type of design. These two designs are available for either frequency-shift or AM type of keying. Frequency-shift keying, which is principally for use in transmission between two terminals where no dropouts are re-

Fig. 1: Channel layout for microwave communication system

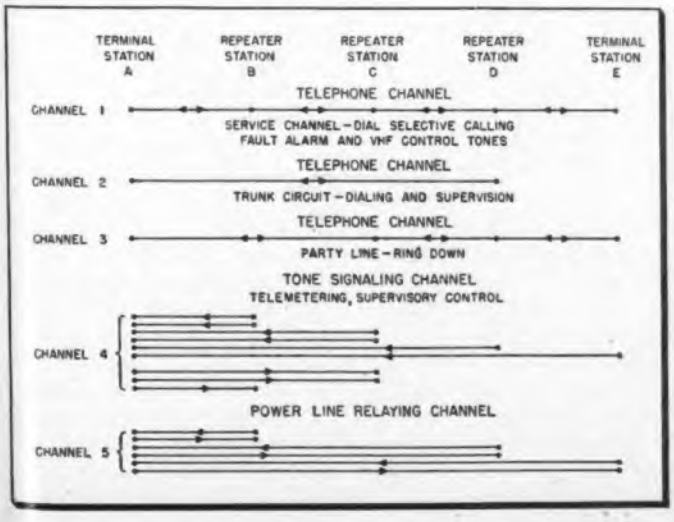
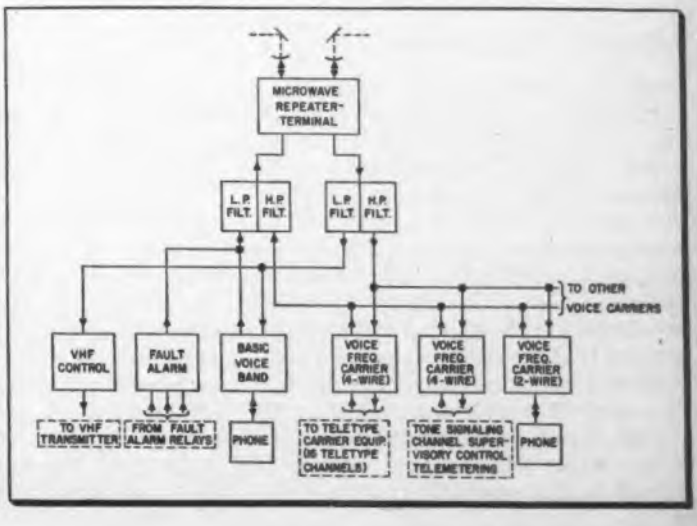


Fig. 2: Frequency division multiplexing at a microwave station



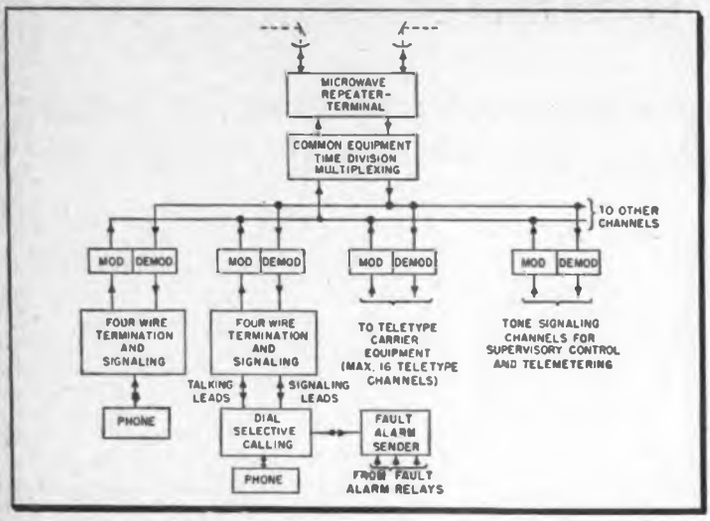


Fig. 4: Time division multiplexing at a microwave station

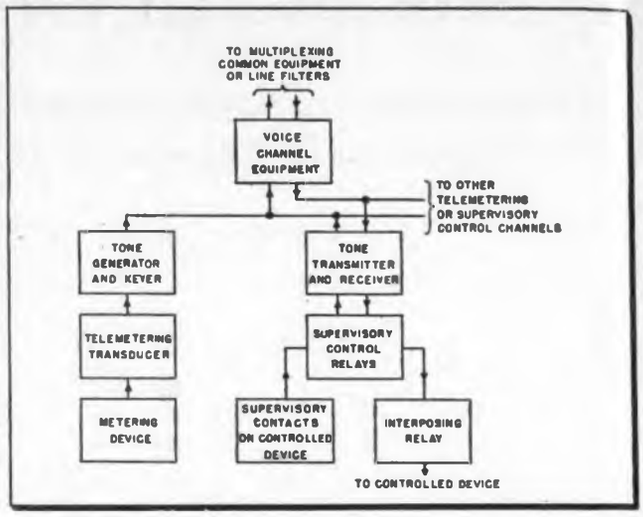


Fig. 5: Telemetering and supervisory control tone channels

quired, operates over wide signal-level inputs and is low in bias distortion. If teletype equipment is to be used on a party-line basis, the amplitude-modulation type of carrier equipment is required.

Either one of the two types of carrier telegraph equipment can be multiplexed on a frequency-division basis, or its output can be fed into a single voice channel of the pulse-modulation time-division type of equipment. Duplex operation is obtained very easily by using a transmitter and a receiver at each one of the dropout or terminal points. Teletype equipment normally used by utilities is designed to operate at keying speeds of 100 wpm, 40 dot-cps. The operation of the equipment is such that teletype transmitters operating at 100 wpm may have a maximum of 16 separate keying tones multiplexed into a single voice channel of 300 to 3300 cps. Such narrow-band equipment (40-dot-cycle speed) operates with 170-cycle spacing.

Fixed VHF Equipment

Another facility which may be incorporated in a microwave system is control of VHF fixed-station equipment. This VHF equipment may be located along a microwave system, for use in conjunction with mobile equipment. The operating signal frequency of the control equipment is between 2000 and 3000 cps. A coded transmission, comprised of two pulse groups of different frequencies transmitted in sequence, is used to operate the control equipment. This coded signal, which is generated automatically when the keying circuit is closed by the operator, results at the receiving end in the operation of a remote-control relay and the energizing of the transmitter control circuit.

Now for a few of the other factors which influence the design of a microwave communication system. For successful operation, a microwave system requires a line-of-sight path between each transmitter and its receiver. A microwave survey should be made to locate suitable microwave sites and to gather information concerning the following:

1. Antenna tower heights necessary to obtain line-of-sight transmission. The tower heights and clearances are calculated from the information obtained in the field survey, taking into consideration such factors as the refraction of light and the refraction of microwave signals.

2. Road and power-line accessibility to microwave sites. Any microwave site which is selected should be close to access roads and power service, so that primary power for the equipment may be brought to the site. There are many different ways of making the microwave survey; but whatever method is used, the results of the survey should indicate the number of microwave repeaters required in the system. The path length between repeaters is, of course, dependent upon terrain and clearance values.

The towers used for obtaining the necessary antenna height represent a considerable portion of the investment for a radio link. Of course, in some cases, the investment for these items can be made somewhat less by using any available buildings or water tanks to provide the necessary antenna height. The height and the rigidity of the towers are probably the most important factors in determining the propagation characteristics of the link. The design and specifications of the tower depend to some extent upon the geographical location where the equipment is to be used. For a range of 25 miles between stations, the average tower height required for most applications is approximately 150 feet, based on $\frac{2}{3}$ earth curvature. Under certain topographical conditions, the height required may be greater or less than indicated. A tower designed for a wind loading of 30 lbs. per square foot with an ice coating of 1 inch all over the structure provides an adequate margin of safety.

Power Requirements

To guarantee continuous and reliable communication service, the primary power source must have adequate voltage regulation and must be free from power failures, and a good source of stand-by power must be provided. These requirements are very important in the case of repeater stations since these stations, in general, are unattended and at times are not accessible. Obtaining suitable primary power for a repeater station may present a few problems in cases where the site is remote from normal sources of power. Stand-by power may be obtained from several different types of alternator equipment; gasoline, natural gas, and diesel equipments have all proved very dependable. Automatic-starting and change-over relays should be included in the emergency setup, in order to provide full power to the equipment within a few seconds after any failure of the com-

(*Continued on page* 84)

Color-TV Development Goes Ahead

Mass production stopped by ODM. But compatible systems research and tests proceed, aimed at asking FCC approval early in 1952.

QUANTITY production of color-TV sets has been abruptly stopped at the request of Defense Mobilizer Charles E. Wilson—probably for a two- or three-year Rearmament period. But research and experimentation in the color-TV field can still proceed without hindrance from Washington, except that no materials will be authorized for color tests or experiments.

At first the intention of the Office of Defense Mobilization was to shut off all research in color-TV, along with manufacturing—the point having been raised that the Navy at the moment badly needed qualified TV engineers. But during the radio-TV manufacturers' session at Washington, assurance was given Director Wilson that any Navy needs in technical manpower would be given priority over color-TV experimentation, and so no official restrictions were put on color-TV research and development.

NTSC, RCA Research Speeded

As a result, research and field tests are now going ahead with renewed vigor and speed-up, in both the NTSC group and the RCA camp. The NTSC standards are now all settled and the form of the NTSC synchronizing pulse is fully determined. As we go to press, color receivers are being completed, and by the time this appears, nearly a dozen compatible color sets employing NTSC standards will be ready for field tests. Meanwhile, various transmitters were to go on the air with the new NTSC color-signal by the middle or last half of November, so that full field tests can be currently conducted on both color sets and standard black-white receivers,—the latter for compatibility observations.

RCA color-TV field tests are also well under way, having advanced to the practical point of demonstrating actual operations, so that it is likely RCA's independent re-application for FCC approval may be entered at Washington by February of the new year. NTSC's similar application, with documents supported by its current tests, should also follow early in the spring of 1952.

In Washington on October 18th RCA invited the members of NTSC to witness a field test of the RCA color-television system in which pictures from New York City were viewed in Washington when transmitted by broad-band microwave relay and also over the coaxial cable. The latter passes frequencies up to only 2.7 MC so the engineering problem successfully solved by the RCA group was: How can acceptable color pictures be reproduced at the end of such a cable, with a 2.7 MC cut-off, when the color sub-carrier is at 3.58 MC?

The RCA signal used oscillating color sequence, balanced modulation and comprised a brightness signal of 0-4.1 MC and a color component modulated on a sub-carrier of 3.58 MC, with sidebands reaching to 2 MC, except that the upper sideband was restricted by the 4.1 MC limit of the equipment. For coaxial use the original sub-carrier by heterodyning is brought to 2.38 MC with sidebands limited to 0.3 MC. The brightness component is limited to 2.0 MC. This must reduce the fine detail in the pictures but to the NTSC members present the picture quality appeared substantially equal to that observed when the wide-band microwave relay was alternately switched in to the circuit. The picture quality at all times impressed TELE-TECH'S reporter as being excellent.

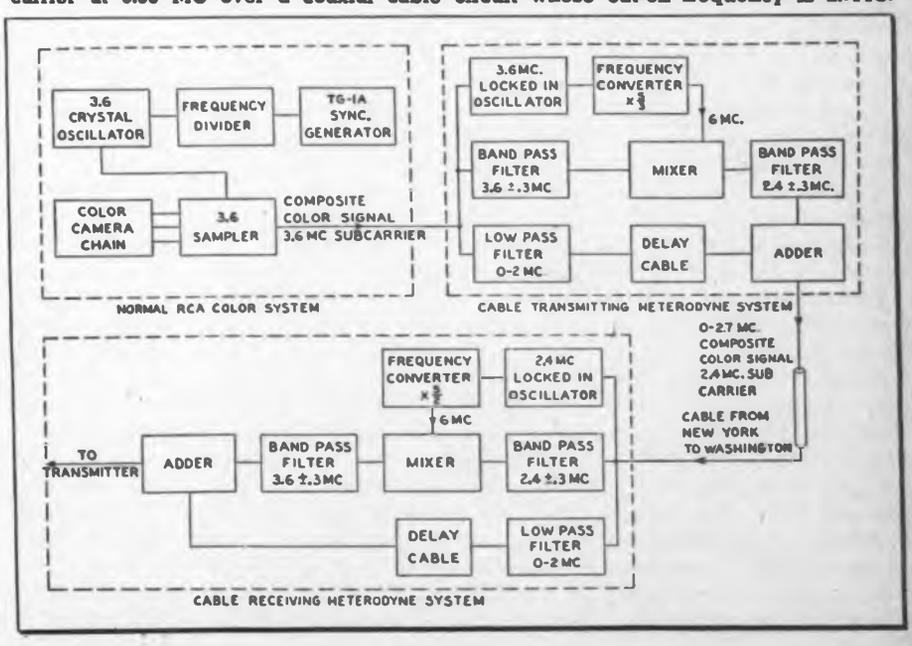
How were these results achieved? The terminal equipment is shown in block diagram form herewith. By means of filters and heterodyning at 5.96 MC, there is fed to the cable the signal having a brightness component of 0-2.0 MC and a color signal extending from 2.08 to 2.68 MC. In this heterodyning certain unwanted signals are produced which would cause trouble by beating with video signals in the band. These are eliminated by filters and high-rejection traps.

Receiving Terminal Equipment

The problem here is to reverse the process carried out at the transmitter. At the receiving end of the cable a low-pass and a band-pass filter yield the brightness and the color components respectively, of the signal. Heterodyning with a 5.96 MC frequency produces the desired difference frequencies. High-rejection traps take care of the unwanted by-products, as at the transmitter. This received color signal of course is fed

(*Continued on page* 68)

Block diagram of equipment used to transmit RCA color-TV signal having a color sub-carrier at 3.58 MC over a coaxial cable circuit whose cut-off frequency is 2.7MC.



Large Flat-Face Cathode-

Photo of 16 in. flat-faced CR tube with an aluminized magnesium fluoride screen

Glass - to - metal sealing larger direct-view, radar

By C. S. SZEGHO,
Director of Research
The Rauland Corp., 4245 North Knox Ave., Chicago 41, Ill.

SPECTACULAR advances in radar presentation were made during and since the last war. One problem, however, the plotting on a PPI display, has not been adequately solved. For certain cases large PPI displays are desirable to permit viewing by a number of observers, and these displays should preferably be on a flat surface to allow plotting and superimposing other information such as markers or maps.

Medium size, flat displays have been produced by the projection of cathode-ray tube images using either the conventional bright trace cathode-ray tube or the dark trace tube. In the former case, the PPI presentation makes use of the information supplied by the afterglow of the phosphor which is very weak and consequently, this solution suffers mainly from the paucity of brightness, besides requiring a more complicated and costly setup, including a high-power optical system. The dark trace presentation suffers from poor contrast and difficulty in controlling the erasure of strong echoes.

On the other hand, the presentation on the face of the direct-view cathode-ray tube has proved to be eminently suitable for PPI but the manufacturing techniques of glass cathode-ray tubes preclude large and flat viewing surfaces. Ingenuity stimulated by the unprecedented flourish of television has solved the problem of extremely large glass-to-metal seals, and it appears that the advent of large metal cathode-ray tubes may contribute a solution to the remaining problems of radar displays. The following is a resume of the work done to date towards this end.

The spherically shaped face plate of conventional, large size cathode-ray tubes introduces two deficiencies from an optical standpoint when such tubes are employed for radar display. The first error arises from the sideward deviation of the light ray as it passes through the face plate. For an observer viewing along the tube axis and seated about a foot from a 16 in. tube, this sideward deviation at the face plate extremities is surprisingly large, being more than ¼ in. for the usual radii of curvature (27 in.). This deviation is 2½ times that which would be observed in the case of a flat face tube.

Moreover, the deviation of the light ray varies as the observer changes his viewing position, reaching zero only for observations made perpendicular to the face plate surface. If the tube is always viewed from a fixed position, the radial scan linearity may be adjusted to compensate for this effect, otherwise it can not be corrected.

The second error is of even more importance when the tube is to be used with an optical arrangement for superimposing the radar picture and a map for plotting purposes. Unless the two images have the same object distance to the operator's eye, the two images shift with respect to one another as the operator moves his eye from side to side, thus making the plot obtained a function of the position of the observer's head.

This source of trouble is known as parallax. The usual method for reducing parallax is to set the object distances to the eye equal for a circle on the face plate having a diameter ½ to ⅔ that of the tube. But, the flat face tube completely eliminates parallax so that radar plotting loses its dependence on the position of the operator's head.

For direct plotting on the tube face plate, a flat face is obviously superior to a spherical face plate since the tracing paper will conform exactly to the shape of a flat surface. Further, if a piece of plate glass is mounted in front of a spherical tube face in order to plot on it, distortion is introduced exactly as in the usual flat Mercator mapping transformation of the spherical Earth. This ap-

Ray Tubes for Radar

techniques developed for TV now being applied to manufacture of tubes providing displays. Flat faces permit plotting or superimposing information such as markers or maps

plies as well to any optical superpositioning device which superimposes the image of a spherical face plate with a flat surface. The time base linearity correction to offset the difference between the radius of curvature of the face plate and the radius of deflection of the electron beam is available in the literature.[1]

A further advantage of flat face tubes when viewed with ordinary ambient lighting is the reduction in specularly reflected images because of the decreased field of view of a plane versus a convex mirror. Roughly this amounts to decreasing the number of objects specularly reflected by a factor of five compared with face plates having a radius of curvature of 27 in.

Metal-to-Glass Sealing Permits Use of Flat Tube Faces

Atmospheric pressure tends to deflect the face plate inward which leaves the outer surface in compression and the inner surface in tensile stress in accordance with the expression:[2] $S = (2/3) \cdot (P_0R^2/t^2)$; where P_o = atmospheric pressure, R = radius of face plate, and t = thickness of face plate.

By proper choice of glass and metal, compression stress can be left in the face plate of a glass-metal tube as it cools down from the high sealing temperature, thereby cancelling most of the tensile stress that arises when the tube is pumped out. Compression stress increases the structural strength of glass (as in tempering) so that face plates of roughly ½ the thickness of an all glass tube can be employed in a metal tube (a glass tube must be completely annealed which removes the compression stress).

To check the effect of such tempering, two flat 16 in. face plates which were held to the cone only with a soft wax rather than being sealed directly to the steel were pressure-tested to destruction. The tempered face plate withstood an external pressure of 34 pounds while the face plate which had its temper removed broke at 13 pounds. Thus by controlling the annealing and tempering of the glassware, the breaking strength of the glass was increased from 5,000 psi to over 13,000 psi to provide the desired safety factor of 2 or 3.

One would expect from first considerations that a spherical face plate would be far superior to the flat face plate in withstanding the external atmospheric force. These forces are not inconsiderable as will be apparent from Table I. Most articles designed to withstand such high pressures utilize curved surfaces; consider for example, the ordinary bell jar which combines cylindrical and sperical shapes. However, the metal cone exerts a squeezing force of approximately a ton on the glass, arising from the fact that the metal of the cone has a higher coefficient of thermal expansion than the glass and so contracts more in cooling from the high sealing temperature and thereby squeezes the glass. This effect may be compared with the results of taking a foot ruler and exerting a compressive force on it with the palms of one's hands. So long as the ruler remains straight, it is able to withstand a very large force; a slight amount of bowing, however, causes it to bow even further and break quite readily, which may be responsible for the surprising strength of the flat face tube.

Table I

Tube Size	Atmospheric Force
5 in.	290 pounds
10 in.	1150 "
16 in.	2590 "
19 in.	3740 "
22 in.	5100 "
24 in.	6100 "
30 in.	9750 "

Table II

Tube Diameter	Thickness of metal at sealing area	Maximum pressure test
12 in.	.092 in.	55 psi
16 in.	.125 in.	50 "
19 in.	.125 in.	30 "
22 in.	.156 in.	20 "

Table III

Tube Size	Face Plate Thickness
22 in.	.39 in.
24 in.	.43 in.
30 in.	.46 in.

Another factor affecting the strength of the tube is the thickness of the metal cone at the sealing area, since it determines the magnitude of the squeezing type compressive force mentioned earlier.

The compressive force F is given by Hooke's Law as $F = YA\ (\Delta l/l)$, where Y = Youngs Modulus, 3×10^7 psi for steel; A = cross-sectional area of metal in region of seal, ≅ 1/10 in²; l = length of seal = 2 π radius ≅ 50 in; Δl = length by which the metal is essentially stretched because the coefficient of thermal expansion differs from that of the face plate.

The change in length Δl may be determined from the coefficients of expansion and the temperature range involved; the latter is the difference between the annealing and room temperatures.

$$\Delta l = (\alpha_1 - \alpha_2)\, l\, \Delta T$$

where α_1 = coefficient of expansion of metal = 11.5×10^{-6}/°C; α_2 = coefficient of expansion of glass = 10.5×10^{-6}/°C; ΔT = temperature interval = 600°C.

Combining the two equations, the expression for the compressive force becomes:

$$F = Y\ A\ (\alpha_1 - \alpha_2)\ \Delta T,$$

which is independent of the periphery of the seal, 1, and so of the size of the tube. The parameters which can be varied for a given metal and glass to increase the compressive force are the cross-sectional area A which is determined essentially by metal thickness, and the temperature differential which depends upon the anneal temperature.

For a 16 in. tube the calculation yields a compressive force of nearly a ton which greatly increases the breaking strength of the glass.

Flat face tubes of 12, 16, and 19 inch diameters have been successfully made to date. The availability of sheet glass (#3720 of P.P.G. Co.) of the proper coefficient of expansion to match the modified 430 stainless steel of which the cones are made has limited the tests to a maximum

(*Continued on page* 94)

Radiosonde Telemetering

AN/AMT-3 equipment, launched from high altitude aircraft, descends pheric pressure, temperature, and humidity in Morse code. Construction

By JOSEPH A. SIDERMAN,
Signal Corps Engineering Laboratories, Fort Monmouth, N. J.

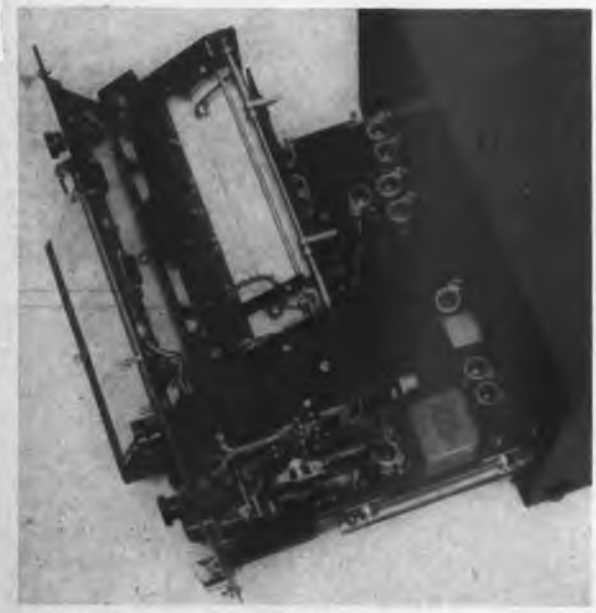
THE recording unit is approximately 18 in. high, 27 in. wide, and 16 in. deep and is completely self-contained. The equipment weighs 86 pounds and operates from 400 cycles 115 V ac power source. Fig. 6 illustrates the mechanical assembly of the recorder which may be considered as consisting of four major sub-assemblies: (1) a gear box, including the differential, (2) a chart-feed drive mechanism. (3) a chart take-up magazine assembly, and (4) a print hammer and helix assembly. Fig. 7 shows the electro-mechanical assembly in block diagram form.

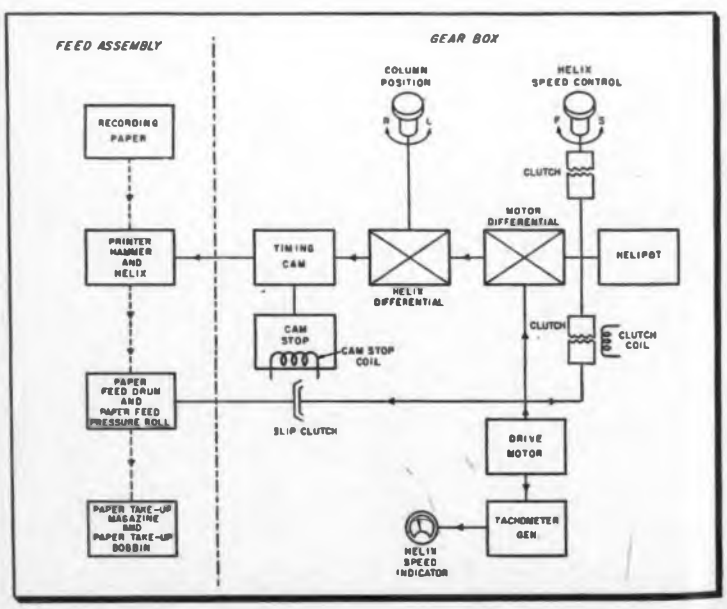
Signal Amplifier

Fig. 8 illustrates the electronic assembly which consists of signal amplifier demodulator shaper circuits, motor helix speed control, automatic synchronization or error corrected circuit, and power supply. The circuit diagram shown in Fig. 9 illustrates the various stages in section form. The function of the voltage, power, and speaker amplifiers is to amplify the radiosonde signals and to furnish the necessary signal voltages required to drive a speaker and the demodulator circuits. Testing by direct mechanical keying and monitoring provisions have been incorporated in this amplifier section. The function of the demodulator section is to detect, filter, shape, and amplify the output of the signal amplifier section. The output supplies the signal controlling voltages for the recording mechanism, automatic synchronization, and motor speed control circuits. The function of the motor speed control circuit is to permit adjustment of the helix drum speed to synchronize with the rate of radiosonde transmission. This produces the vertical columns of the code groups as previously illustrated.

As can be seen from the circuit diagram, Fig. 9, the automatic correction circuit, which is somewhat unique in its application, performs as follows: The "motor control section" and "automatic synchronization section" comprise a servo system. Drive motor B101 is a two-phase motor which provides the driving power for the helix cylinder, chart-drive mechanism, and through the differential, to the Helipot R102 and timing cam O-107. One phase of the motor is connected to the power source in series with the secondary of the motor control transformer T9. The primary of transformer T9 is controlled by tubes V10 type 6J6, V11 and V12 type 6AG7 in a manner so as to vary the voltage applied to this phase of the motor. The speed of the drive motor is proportional to the voltage developed at the primary of the motor control transformer T9. To provide speed-stability of the drive motor with variations in power-line voltage, the 115 volts 400 cycles is fed through transformer T8 to a compensation bias voltage rectifier type 1N48 located in the motor speed control amplifier circuit. The tachometer-generator G101, is connected in series with the output of the 1N48 compensation rectifier. The resulting voltage of this combination is connected in series—opposition with a positive reference voltage whose amplitude is determined by the Helipot setting. The net negative voltage obtained from the algebraic sum of the three e.m.f.'s is applied to the grid of the motor-speed control voltage amplifier stage, V10, tube type 6J6. This amplifier stage applies bias to the motor-speed control tubes which are grid-controlled rectifiers providing a function comparable to a variable resistor in series with the main wind-

Fig. 6: (Left) Mechanical assembly of recorder includes (1) a gear box, (2) chart-feed drive mechanism, (3) chart-take-up magazine assembly, (4) print hammer and helix assembly. Fig. 7: (Right Electro-mechanical assembly in block diagram form





and Recording System

PART TWO
OF TWO PARTS

2000 ft./min. and transmits data describing atmos- of new, automatically synchronized, recorder described

ing of the two-phase drive-motor. Until the helix comes up to speed, there is a positive bias voltage on the grids of the motor control tubes and full power is applied to the drive motor, B101.

When the selector switch is in Manual position and the rate of code characters of the incoming signal changes, the column of the recorded copy will begin to slant because the helix speed is no longer in synchronism with the radiosonde. The helix speed may be adjusted manually by changing the speed control positive bias voltage on the grid of V10 by resetting of the Helipot so as to vertically align the radiosonde message on the chart at the new rate.

If a change in the speed control positive bias voltage is made in the correct direction, the new value will oppose the negative voltage of the dc tachometer-generator and the compensation rectifier, resulting in a new bias voltage applied to the grids of the motor-speed control am-

(Continued on page 77)

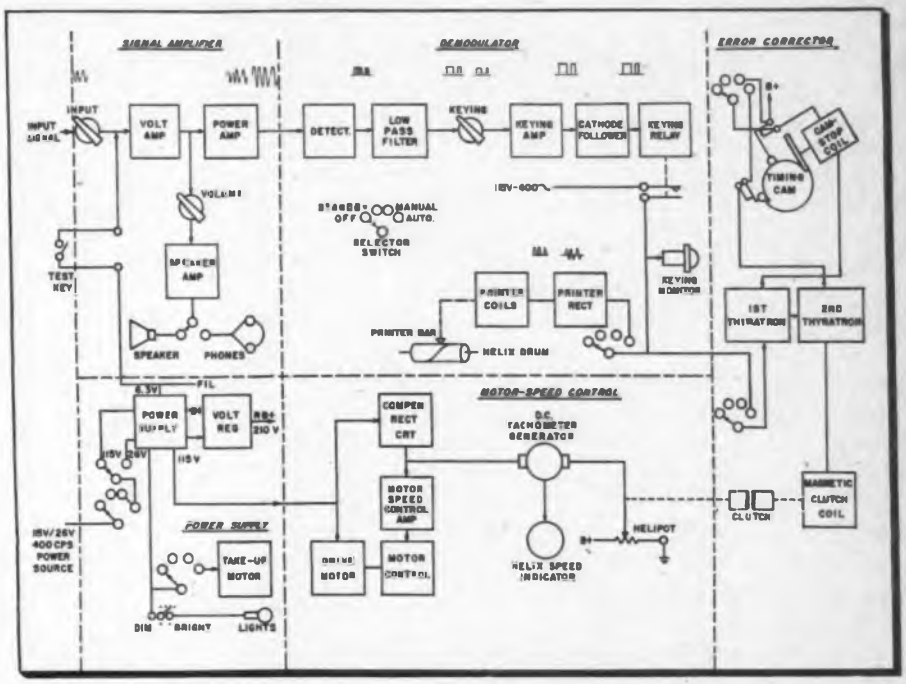
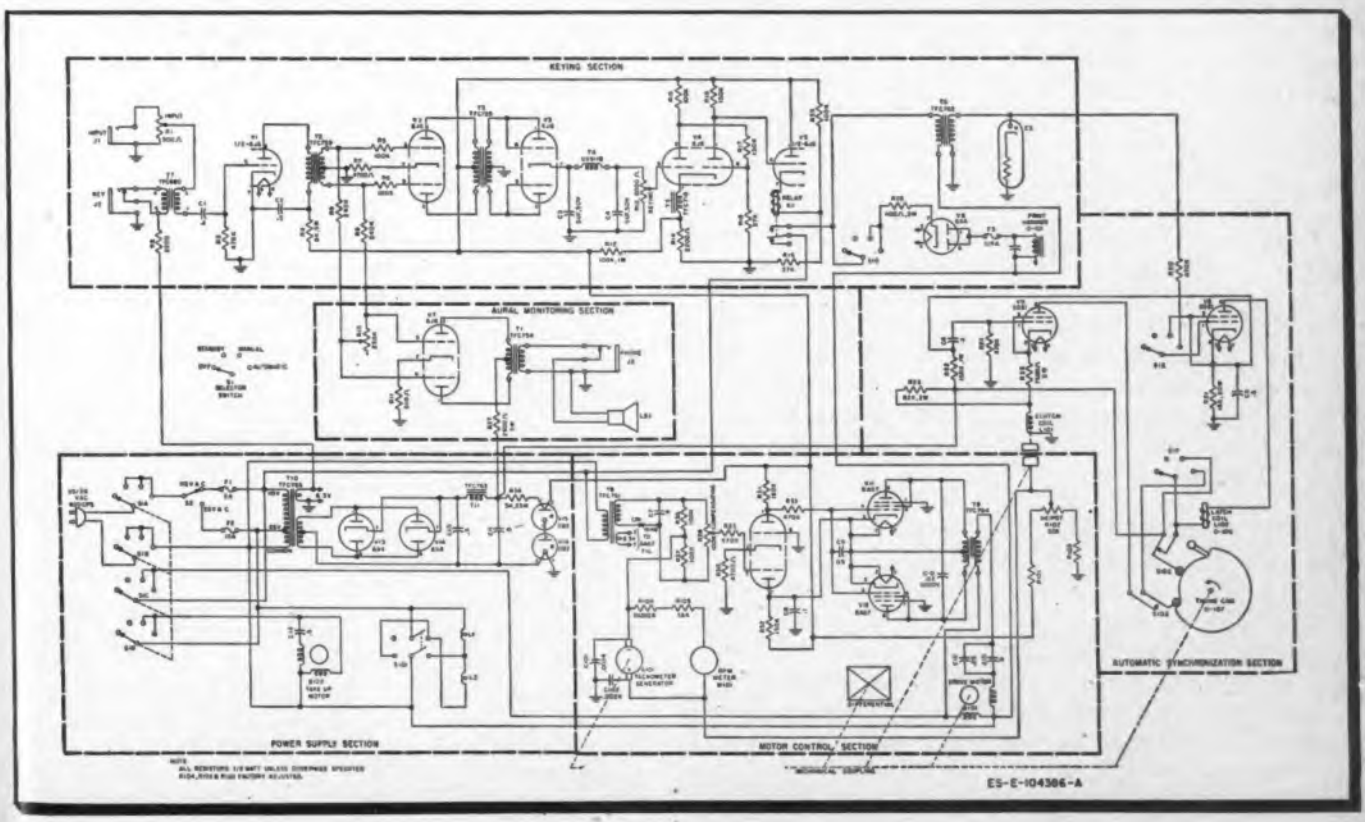


Fig. 8: Block diagram of recorder electronic assembly which consists of signal amplifier and demodulator shaper circuits, motor helix speed control, automatic synchronization or error corrected circuit and a power supply

Fig. 9: Circuit diagram illustrates various stages in section form. Function of voltage, power, and speaker amplifiers is to amplify the radiosonde signals and to furnish the necessary signal voltages required to drive a speaker and demodulator circuits



WASHINGTON
News Letter

Latest Radio and Communications News Developments Summarized by TELE-TECH's Washington Bureau

RECOGNIZE CIVILIAN PRODUCTION—Because of the increasingly strong concept in Washington that a sound civilian economy must be maintained to be the base for growing mobilization production, it has now been indicated that the liberalized quotas of critical metals like copper, aluminum and steel by the National Production Authority for the broadcasting and television manufacturing industry for the first quarter of 1952 will permit manufacturing of adequate civilian output of radios and TV.

CIVILIAN QUOTAS—Production of black-and-white television sets to the number of 750,000 to 1 million and about 1,000,000 broadcasting receivers, as well as TV transmitter and studio equipment, is planned for the first three months of 1952. The imperative necessity for retaining the skilled employee forces at the manufacturing plants of the industry during the transition into substantially increased production for the armed services is recognized by the leading officers of the military services concerned with electronic radio-radar procurement and by Defense Mobilizer Charles E. Wilson, former General Electric president.

COLOR-TV RESEARCH TO CONTINUE—The banning of all color television manufacturing by the Office of Defense Mobilization after the recent conference of Defense Mobilizer Wilson and Defense Production Administrator Manly Fleischmann with the top-ranking executives of the major electronic-radio companies will not erect any obstacles whatsoever in the path of VHF and UHF black-and-white television or the ending of the television "freeze" by the FCC for the expansion of television stations throughout the nation. In fact, the sanction of continued research in color television by the ODM will enable RCA, General Electric, Philco, Hazeltine, Westinghouse, Paramount Pictures and Columbia Broadcasting System to maintain color research and development, and this will enable Dr. E. W. Engstrom and other RCA scientists to progress in the development of their compatible color television system.

FCC FUNDS CUT SLOWS—While the ban on color television manufacturing will not affect in any way development of UHF television, the ending of the FCC "freeze" and the establishment of new VHF and UHF television stations, the practical fact is that the FCC still faces lengthy allocation proceedings in the two video bands and difficult competitive hearings on assignments of channels to applicants. The consensus is that this will mean, even with an early lifting of the freeze and opening of the UHF region for public television service, little progress in the way of new UHF video stations on the air before the latter part of next year or even in early 1953. The FCC staff for the handling of television matters was pared down by the cut in the appropriations for the current fiscal year, which started last July 1, and as a result the processing of video station applications and other TV problems has been slowed up to a greater degree than ever previously.

ELECTRONIC DEFENSE PRODUCTION—A total of $4 billion in the present fiscal year's defense budget has been allocated for electronic-radio-radar and communications equipment and components, a key Munitions Board official has informed TELE-TECH's Washington news bureau. The government's fiscal year, of course, runs from last July 1 to June 30, 1952, and the procurement contracts, preceded by letters of intent, have been placed with manufacturing companies for virtually this entire amount. Defense Mobilization Administrator Charles E. Wilson recently informed the top leadership of the electronic manufacturing industry that electronic production is being successfully accomplished with only a few delays in mass output in certain airborne apparatus. "Production is really pouring out," Mr. Wilson stated.

MOBILE RADIO USE BY ARMY—Mobile radio equipment, which has been successfully used in the police, railroad, petroleum and utilities fields, has been adopted by the Army Signal Corps as valuable in the Korean fighting, Brig. Gen. James D. O'Connell, who is becoming Deputy Chief Signal Officer, brought out in a recent address. General O'Connell cited particularly the work of Motorola in developing a series of non-tactical communication sets, both base and portable, to work in the VHF band, and declared "we feel that, for the first time, completely satisfactory equipments will be supplied for military non-tactical applications."

GROWTH FORECAST—The FCC, according to Commissioner E. M. Webster, who has overall supervision of its safety and special radio services' activities, foresees a total of 148,000 applications for new mobile radio stations during the present fiscal year. From last July 1 to Oct. 1, 36,993 applications were filed with the Commission. During the preceding fiscal year which ended June 30, 1951, the total applications were 107,209, so it can be observed the mobile radio services are still on the upward march.

National Press Building
Washington, D. C.

ROLAND C. DAVIES
Washington, Editor

CINCH

MICRO CONNECTORS

Cinch molded general purpose connectors, from three to fifty contacts or more, are designed and made of materials as desired and necessary to meet application requirements. They are available in low loss mica or melamine for chassis mounting or assembled with cap for cable applications. Terminals gold or silver plated. *Consult Cinch!*

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TRANSISTORS (*Continued from page* 34)

the signal applied to the base electrode. In this case the output signal current change is about 19 times the input original current change. The value .95 is not to be taken as an upper limit. Higher alpha p-n-p transistors have been made. Circuit current gain increases rapidly as alpha approaches unity and, for example, if alpha equals .99 the circuit current gain is 99.

The above remarks are hypothetical and predict certain general characteristics. Next, the actual physical realization of units with these highly desirable characteristics will be described.

Acceptor impurities are diffused into corresponding regions on opposite sides of a thin wafer of n-type germanium, forming a p-n-p sandwich as described above. A number of n-p-n transistors have also been made by diffusing donor impurities into p-type germanium, but all the results given here apply to the p-n-p units with which there is more experience.

At this point, it would be well to outline a summary of the salient features of these new transistors for comparison with the point contact transistors and with vacuum tubes.

1. SIZE: The new transistors can be completely enclosed in a plastic bead less than ¼ inch in diameter. They are much smaller than the tiniest subminiature vacuum tube. How much smaller they can be made depends largely on assembly techniques. There seems to be no fundamental limit in size.

2. POWER ECONOMY: Like the older transistors, the new p-n junction transistors require no filament power at all. They respond instantly when switched on and require no standby power to keep them warmed up.

The efficiency may be compared with the vacuum tubes by reference to Fig. 9, where the shadded areas may be regarded as inaccessible to voltage swings. To obtain the maximum theoretically possible Class A efficiency of 50% in a tube, it would be necessary to be able to operate the tube down to zero plate voltage, and to be able to swing the grid to complete cutoff. For the type 6J7 pentode, with the plate supply voltage and load resistance shown, the maximum efficiency is 29%. The new transistors can operate down below one volt on the collector without serious distortion, and can approach close to the theoretical maximum Class A efficiency of 50%.

3. HIGH GAIN: Power gains on the order of 40 db stage have been measured using matched impedances. Direct coupling of stages is possible with good gain. Maximum utilization of these devices requires a reexamination of circuit theory from a new point of view. The gain depends, in any case, upon the equivalent circuit parameters, and further development of desirable parameters assures even higher gains as development proceeds.

4. STABILITY: Since alpha is always less than unity, p-n junction transistors are entirely free of the short circuit instability which plagued the point contact transistor.

5. LOW NOISE: Quantitative studies of large numbers of units remain to be made, but preliminary data indicate these units are several orders of magnitude quieter than point contact transistors.

6. WIDE POWER RANGE: These units are efficiently usable in the microwatt power dissipation range. Units provided with more area for heat dissipation have been operated continuously above 1 watt. The upper limit of power dissipation on these units has not yet been established.

7. RUGGEDNESS: When properly encased in a plastic bead, these units are mechanically very sturdy.

8. FREQUENCY RESPONSE: P-N Junction transistors have full gain at audio frequencies. They have a usable amount of gain at radio frequencies, depending upon the circuitry used. The upper limit of high frequency response is a complicated function of collector capacitance, transit time, and other effects. Since each upward extension of the frequency range can open new fields of application, high frequency studies will naturally be an important phase of future developments.

9. SIMPLICITY: An outstanding feature of the new transistor is the simplicity of construction. There is no heater to burn out, no cathode to deteriorate, no wire grids to vibrate microphonically. There is nothing to wear out. The heart of the transistor is simply a piece of Germanium with three wires firmly attached.

To what extent it will be possible to replace vacuum tubes by transistors remains to be seen. For one thing, it is not a mere matter of replacement in existing vacuum tube circuits. Circuits must be redesigned to take advantage of the characteristics of p-n junction transistors. But wherever space, power dissipation, and ruggedness are important, transistors will be called upon to serve. Their development is still in its infancy, but the results already obtained are very encouraging. As the making of semiconductor devices becomes less and less of an art, and more and more of a science, continuous improvements may confidently be expected.

Handie-Talkie Set for Troops in Korea

Manufacture of the new Army Signal Corps handie-talkie radio has been started and the equipping of units in Korea with the redesigned set will begin soon.

In production, or expected to be in production soon, are Utility Electronic Corp., East Newark, N. J.; Raytheon Manufacturing Co., Waltham, Mass.; Emerson Radio and Phonograph Corp., New York City, and Sentinel Radio Corp., Evanston, Ill.

While designed primarily to furnish platoon-to-company radio communication, the new set can also contact more powerful radios of the company and the battalion, thus extending integrated radio communications to the front line.

Coming Events

December 10-12—Joint IRE-AIEE Computer Conference, Benjamin Franklin Hotel, Philadelphia, Pa.

January 7-8—AIEE Conference on Electronic Instrumentation in Nucleonics and Medicine, Hotel Statler, New York, N. Y.

January 21-25—AIEE, Winter General Meeting, Hotel Statler, N. Y., N. Y.

March 3-6—1952 IRE Convention, Waldorf Astoria Hotel and Grand Central Palace, New York, N. Y.

March 10-13 — NEMA, Edgewater Beach Hotel, Chicago, Ill.

April 21-25—SMPTE, 71st Convention, Drake Hotel, Chicago, Ill.

April 24-26—Armed Forces Communications Association, National Convention, Philadelphia, Pa.

May 7-9—IRE National Conference on Airborne Electronics, Hotel Biltmore, Dayton, Ohio.

May 16-17—Southwestern IRE Conference and Radio Show, Rice Hotel, Houston, Tex.

May 22-24—American Society for Quality Control, Sixth Annual Convention, Syracuse, N. Y.

June 23-27—AIEE Summer General Meeting, Hotel Nicolet, Minneapolis, Minn.

LEADERSHIP IN TECHNICAL PUBLISHING

Here is the result of a totally unbiased test, conducted by a highly regarded manufacturer who wanted to find out for himself how the chief engineers of broadcasting stations feel about TELE-TECH. He used the basic test of readership known as the three Rs.

DO YOU RECEIVE TELE-TECH REGULARLY?
DO YOU READ TELE-TECH REGULARLY?
HOW DO YOU RATE TELE-TECH?

100% coverage of chief engineers in U. S. A. broadcasting stations is guaranteed by TELE-TECH. As for the 7% difference shown in the test, an analysis disclosed that in some cases the magazine was being directed to Vice Presidents in charge of engineering or to engineering heads with titles other than "chief engineer."

Other magazines in this field reach only 20 to 50% of the top-level engineers in broadcasting stations, as reflected in their audited renewal percentages. (Comparative data on request.)

97% of the engineers receiving TELE-TECH said that they DO READ it regularly — a readership record unprecedented in most engineering fields, and proof of the editorial leadership of Dr. O. H. Caldwell.

98% of the regular readers rated TELE-TECH favorably, using such terms as "good," "very good," "OK," "excellent," "tops," "very helpful," etc.

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MANUFACTURERS
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TELE-TECH

CALDWELL-CLEMENTS, INC.
480 Lexington Avenue, New York 17, N. Y.

NEW EQUIPMENT for Designers and Engineers

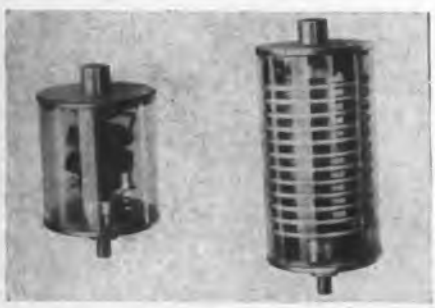
Toroidal Cores

Moulded powdered-iron toroids are now being produced in sizes ranging from 0.800 to 3.375 in. O.D. They are available

in magnetic materials which can be chosen to accentuate high-Q, high inductance, low generation of harmonic distortion products, high magnetic and temperature stability, or small size and low cost. Included is the wedded ring, the smaller size illustrated. The same cores are also suplied wound to individual specifications, cased, uncased, or hermetically sealed.—**Lenkurt Electric Co., 1168 County Road, San Carlos, Calif.**—TELE-TECH.

Hi-Q Loading Coils

Two new base loading coils have been designed for high efficiency performance when used with any type mobile whip



antenna. Available in two models, for 20 and 75 meter operation, the new units called Hi-Q 20 and Hi-Q 75, are designed to fit all standard mounts and whips and, with adaptor supplied, can be used with non-standard types. Both models are housed in sturdy weather-proof ⅛ in. thick plexiglass and feature removable plastic nylon and caps. Each coil is designed for high Q throughout its inductance range. The Hi-Q 20 loading coil is wound with heavily plated ⅛ in. diameter solid copper wire. A heavy flexible copper strap is provided which permits easy adjustment to exact inductance desired. The Hi-Q 75 loading coil features two pie-wound coils of heavy insulated wire adjustable for maximum efficiency over a powdered iron core slug. Coils are treated with Insulax to resist moisture and fungus growth and to maintain high Q.—**Mallard Mfg. Co., 6025 North Keystone Ave., Chicago 30, Ill.**—TELE-TECH.

50 Ohm Coaxial Cable

The HH 5S cable is a simplified and inexpensive version of the RG-5/U and has approximately the same electrical characteristics. It is very flexible and easy to install and can be used as a general-purpose medium-size cable, as well as a substitute in many applications where RG-5/U would normally be used. Construction and engineering data on HH 5S cable are as follows: Inner conductor is #16 AWG solid plain copper and Dielectric is Polyethylene, 0.182" O.D.; Nominal capacitance is 28.2 mmf/ft; impedance is 52.5 ohms; attenuation is 2.6 db per 100 ft at 100 MC, 4.9 db per 100 ft at 300 MC.—**Columbia Technical Corporation, 5 East 57th Street, New York 22, N. Y.**—TELE-TECH.

Phono Cartridge

L-12-U phonograph pickup cartridge employs a capacitor harness which slips on or off the terminals to change output from a high of 4.0 v. to a low of 1.2 v. at 1 KC. It will serve as replacement for more than 125 different standard 78 rpm cartridges now in use. A needle chuck limiting principle restricts motion of the chuck both radially and lengthwise. Purpose is to prevent dislocation of the chuck and to prevent crystal breakage from rough handling. The L-12-U cartridge is furnished with the tiny capacitor harness in position on the terminals.

Slipping off the condenser raises output. Range is 5 KC. Minimum needle pressure is one ounce; weight of the cartridge is 19 grams.—**Astatic Corp., Conneaut, Ohio**—TELE-TECH.

UHF Tuner

When the FCC authorizes telecasting on UHF channels, every Raytheon TV receiver having a continuous tuner can be equipped to receive all of the 83 channels approved. The new Raytheon UHF tuner mounts on the standard Raytheon continuous tuner to provide smooth, all-channel tuning with a single knob. The complete unit fits inside Raytheon cabinets, and operates so that there will be no need to re-set the tuner when new television stations are added. Suggested retail prices are $29.95 for the UHF tuner installed at the factory (optional equip-

ment on new receivers) and $39.95 installed on receivers in the field.—**Belmont Radio Corp., 5921 W. Dickens Avenue, Chicago, Ill.**—TELE-TECH.

Gain Set

Type 12A transmission measuring or gain set is an ac-operated, rack-mounted instrument designed for the measure-

ment of voice transmission systems. Source output and receive input are 600 ohm balanced circuits, provided with dc blocking capacitors so that the equipment will not interfere with the normal operation of modern dial systems. The oscillator consists of a 1000 cps low-distortion feedback type R-C oscillator, buffer and associated power amplifier. The output impedance is 600 ohms resistive. The output level is +10 to —35 db adjustable in 1 db steps. Controls are provided on the front panel for adjusting the 1000 cps frequency over a range of +30 cps, and for adjusting the oscillator level output to the red line of the meter. The receive section consists of a high gain, wide range amplifier, whose range is variable from +20 to —60 db, full scale meter reading, in steps of 10 db. By utilizing the meter scale, the range is increased from +20 to —80 db. Two balanced inputs are provided: 600 ohms terminating and 600 ohms bridging (6000 ohms). Filters, which provide four frequency response curves, are located at the "front end" of the amplifier to eliminate the possibility of errors due to internal distortion in the tube circuits. A full wave biased clipper or limiter is used to limit peak power to meter. —**Daven Co., 191 Central Ave., Newark, N. J.**—TELE-TECH.

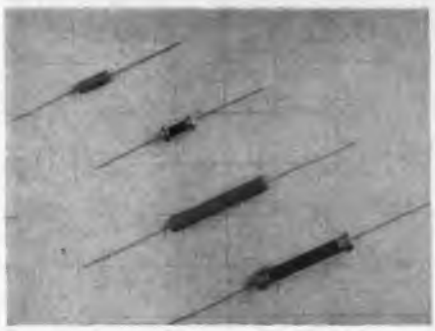
Cavity Resonators

Television interference caused by spurious and harmonic radiations of base station 2-way radio communications equip-

ment can be eliminated by the addition of a new precision selector cavity resonator. This unit minimizes spurious and harmonic radiation for any transmitter antenna system and makes it possible to use two or more transmitters on the same antenna without mutual interference. Designed for the 30-48 MC, 72-76 MC, 122-132 MC, and 132-180 MC communications bands, these cavities are temperature compensated for performance over wide temperature ranges. Mechanical design and element dimensions are proportioned for optimum impedance match and a low voltage standing wave ratio. Each unit has an input and output inpedance of 50-72 ohms with a 250 watt maximum power rating.—**Motorola, Inc., 4545 W. Augusta Blvd., Chicago 51, ILL.**—TELE-TECH.

Resistors

A deposited carbon resistor, known as the Phaostron Carb-ohm, is being manufactured for high frequency applications



where high values of resistance are essential, or power dissipations up to 2 watts are required. Carb-ohm resistors are available hermetically sealed in glass or clad in a specially-developed humidity impervious casing which provides stability over time and freedom from variations due to climatic changes. They are available in a variety of mountings. Wattage ratings range from 1/3 to 2 watts with a resistance range of 20 ohms to 200 megohms. The Carb-ohm is manufactured under license arrangements with Western Electric Co., Inc.—**Phaostron Co., 151 Pasadena Ave., South Pasadena, Calif.**—TELE-TECH

Selenium Rectifiers

All ratings up to 200 ma dc output in the Plastisel line of miniature selenium rectifiers are molded-in similar to small

tubular capacitors. The outer case is spiral-wound phenolic wax which is rock hard at 100° C. The excellent thermal conductivity of this wax and the low loss plates compensate adequately for the loss of cooling due to molding in. These rectifiers are manufactured with bare or insulated tin-copper leads. In ratings from 250 ma dc to 500 ma dc, the standard open plate construction is used. However, the high-efficiency plates lead to cooler operation and resultant longer life.—**Electronic Devices, Inc., Precision Rectifier Div., 429 12th St., Brooklyn, N. Y.**—TELE-TECH.

Crystal Sockets

A new line of crystal sockets has been designed for use where extremely low losses and frequency stability are desired

and mechanical shock and vibration are encountered. Made of Teflon, du Pont's tetrafluoroethylene resin, these "Chemelec" crystal sockets have a loss factor of less than 0.00025 and a dielectric constant of only 2.0 from 60 csp to 30,000 MC. Having zero water absorption rating by ASTM test, they are unaffected by extreme humidity. Chemelec crystal sockets are serviceable at temperatures from 110° F. to 500° F. with negligible change in critical electrical characteristics. Due to the inherent resiliency of the plastic, they are unusually sturdy and aid in absorbing shock and vibration in severe service. Made in three sizes for 0.050 in. pins spaced 0.500 in., 0.095 in. pins spaced 1.500 in., and 0.125 in. pins spaced 0.750 in., they are single hole mounted and facilitate assembly as there is no danger of breakage as with glass or ceramics.—**Fluorocarbon Products Division, United States Gasket Co., Camden 1, N. J.**—TELE-TECH.

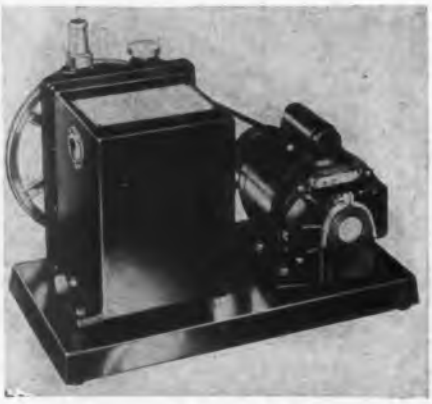
16mm Sound Camera

The new Morton Soundmaster is said to have the simplest system for sound recording ever devised. Ideal for TV

stations operating on a limited budget, it features simple, single-knob tuning, 200-ft. outside magazines for daylight loading (400 ft. magazines available) and is operated completely by battery. Amplifier covers the 60 to 6,000 cps range and a geared footage meter is included. Variable density sound recording system is utilized. An accurate optical viewfinder with parallax adjustment matches 15mm, 25mm, and 75mm lenses.—**Libra Equipment Distributors, 6525 Sunset Blvd., Hollywood 28, Calif.**—TELE-TECH.

Vacuum Pump

A high capacity duo-seal pump has been developed with a free air capacity of 140 liters per minute and an unlimited



vacuum of 1/10 micron. The pump is extremely quiet in operation and is particularly suitable for infusion of cathode ray tubes as well as the illuminizing process. — **W. M. Welch Manufacturing Co., 1515 Sedgwick St., Chicago, Ill.**—TELE-TECH.

Open Wire Transmission Line

The development and production of "Super-Gain," a new open wire transmission line, which is manufactured of copper wire with steel core, will deliver 1/6 the db loss of regular 300 ohm twinex lead-ins. Excellent for long-line set-ups, "Super Gain" has a 400 pound breaking point tensile strength. This is made possible by the steel core.—**JFD Manufacturing Co., 6101 Sixteenth Ave., Brooklyn 4, N. Y.**—TELE-TECH.

Resin Flux

A new and highly active Resin Flux has been developed. In speed of action for fast soldering, "44" Resin is said to surpass and resin now known to the solder industry. In spite of its unusual activity, "44" resin-core solder is non-corrosive and electrically non-conductive. It conforms not only to Army-Navy-Air Force Specifications MIL-S-6872 for a non-corrosive flux which is a 3-day humidity test at 100° F., but it also meets the extremely rigid U.S. Air Force Specification No. 41065-B-Method 31 which is a 14-day humidity test at 160° F.—**Kester Solder Company, 4201 Wrightwood Ave., Chicago 39, Ill.**—TELE-TECH.

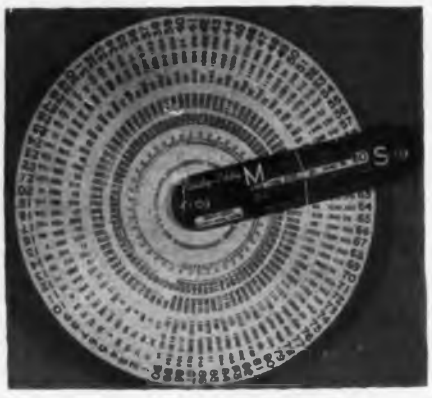
Hermetically Sealed Relay

A new miniature hermetically-sealed relay has been developed which features an 8-terminal hermetically-sealed header

.600 O.D. and a new design balanced armature relay sealed in a ⅞ in. square drawn aluminum can. The entire unit is so constructed that it may be panel mounted from top or bottom. It is supplied with a dry air fill or vacuum pumped and pressure filled with dry nitrogen. — **Hermaseal Co., Inc., Elkhart, Indiana**—TELE-TECH.

Film Computer

The Ready-Eddy has been designed to answer the many questions which frequently arise regarding footage, projection time in minutes and seconds, number of frames per foot and per second, and equivalents of 16mm and 35mm motion picture film. Operation is simple. The indicator is rotated and set on the



respective number (feet, seconds or minutes) and the correct answer read on the same line. There are three scales. Scale "F" around the edge of the disc represents feet. The two inner bands indicate seconds and number of frames of 35mm film. The two next bands indicate the same for 16mm film. Thus, the equivalents of both standards may be obtained, too. The opposite side of the disc has two scales. Scale "S" on the outside represents seconds with the three adjoining bands indicating feet of 16mm film, number of frames of both 16mm and 35mm (same for both standards) and feet of 35mm film. Scale "M" starting from inside indicates minutes, subdivided into half minutes of projection time. The next two bands indicate the equivalent footages of 16mm and 35mm film ranging from 1 to 45½ minutes. It is made of durable plastics and sells for $2.50 with carrying case.—**Ready-Eddy, Sandy Hook, Conn.**—TELE-TECH.

PERFORMANCE...

COMES IN... MANY SIZES

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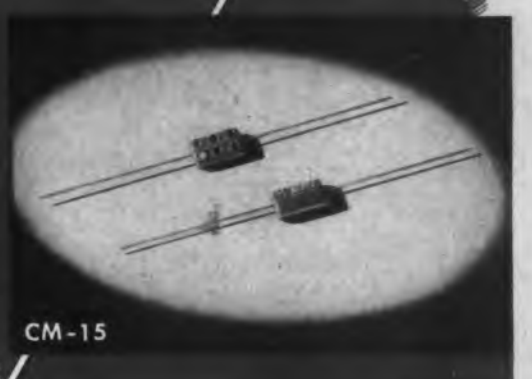
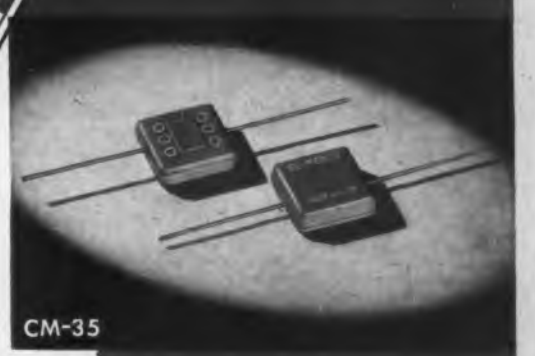

CM-15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Color TV

(*Continued from page* 51)

to a local TV transmitter. To afford good interlacing in the TV receivers, the 5.96 MC heterodyne frequency is locked in with the 3.6 MC sampling signal employed at the color signal source.

A "burst" selector at the transmitter, fed by horizontal synchronizing, selects the burst and uses it to lock in the 3.58 MC oscillator, the signal from which is divided by 3 and multiplied by 5 to obtain the 5.96 MC heterodyne frequency.

A similar "burst" selector is used at the receiver where it operates on the 2.38 MC burst, using it to lock in the 2.38 MC oscillator the ouput from which is divided by 2 and multiplied by 5 to secure the 5.96 heterodyning voltage required.

In front of the audience in Washington were two standard monochrome TV receivers, showing that the signal was compatible; two 16-in. tri-color tube receivers and one 19-in. tri-color tube receiver. Switching means were available so that the radio transmitter could be modulated by either the signal from the coaxial cable or that from the microwave relay.

In an interesting studio program of dancers, both distant and close-up views were shown. The costumes in this and the following "Western" skit were of gorgeous color, well reproduced. The act involving the "Love Birds" demonstrated no color-fringing even with rapid wing motion of the birds. An outdoor camera picked up marching Highlanders, carrying flags of many of the United Nations countries. Regardless of the communication link employed between New York and Washington the picture quality left nothing to be desired. (The FCC report on color-TV, at the close of the FCC hearing on this subject, stated that the RCA system could not be transmitted over networks. This field test proved that this is no longer true.)

RCA's 5 Tri-color Kinescopes

Disclosing the wide scope of their work in developing electronic picture tubes for color-TV, RCA researchers report that they have built at least five types of tri-color tubes, each one capable of operation on all known television systems.

These five types of color tubes illustrate basic designs covering a wide range of principles according to Dr. E. W. Engstrom, who said that RCA research scientists have studied and investigated many ideas and concepts of color picture tubes, in-

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cluding some later shown by persons outside of RCA.

Dr. Engstrom pointed out that these five prototypes of tubes include those employing viewing screens formed of color phosphors arranged in patterns of dots, lines and checkerboard. Although the dot structure has been adopted for the tri-color tube now used experimentally in the compatible color television systems, other designs, he said, can incorporate any one of the several screen textures or a variation of them, without affecting the system.

In commenting, Dr. Engstrom said: "The selection of one particular tube as a production model does not mean that the other tubes are not promising. Practical reasons made it desirable, at this time, to narrow the choice to one tube for pilot-plant production. By initially concentrating the major part of our work on five tubes instead of one, we had a five-fold better chance of coming up with one which would be best suited to our present needs."

The scope of the effort involved in the development of the tri-color tubes is indicated by the fact that several hundred people, recruited from many different RCA divisions, were involved in the project.

Engineering details for the tri-color tube used in current field tests were turned over to the television industry in July, 1951, together with actual working models.

"As an objective for a good color reproducer," Dr. Engstrom continued, "we aimed at a tube which would give us good color, would perform on any known color system, and would also reproduce pictures in black-and-white from present television broadcasts.

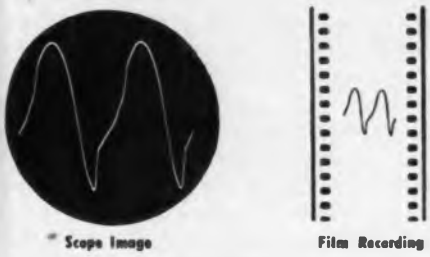
"The tri-color tube now being used meets all these requirements. It is a high performance tube. It provides high-quality color pictures and it operates with all known television systems. It does not impose external limiting factors on picture size."

Dr. Engstrom also said that "wide engineering and manufacturing experience in electron tubes enabled us to take both cost and performance factors into account in choosing the tube."

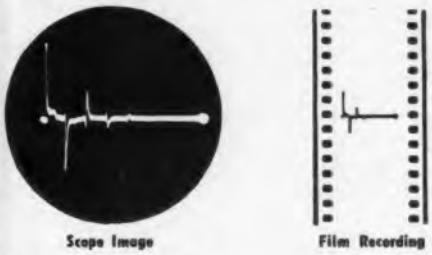
This three-gun tri-color tube now in pilot plant production at Lancaster, Pa., comprises a glass plate and a metal shadow mask. On the plate are 600,000 small, closely-spaced phosphor dots, each .014 in. in diameter, arranged in triangular groups. Each group consists of three dots which glow in the three primary colors—red, green, blue—when hit by the scanning electron beam.

Behind the phosphor dot plate is

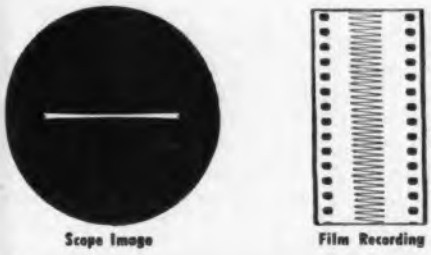
How much can you expect an oscilloscope camera to do?



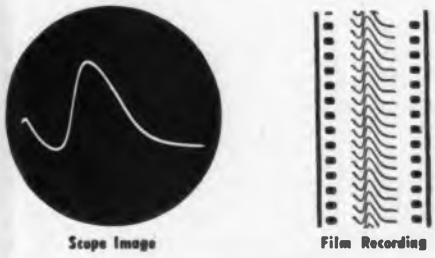
1. Single-frame photography of stationary patterns using a continuously running sweep.



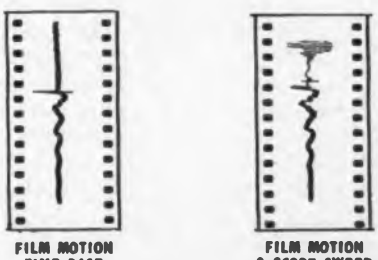
2. Single-frame photography of single transients using a single sweep.



3. Continuous-motion photography employing film motion as a time base.



4. Continuous-motion photography employing oscilloscope sweep as a time base.



5. Continuous-motion photography employing combination of film motion and oscilloscope sweep as a time base.

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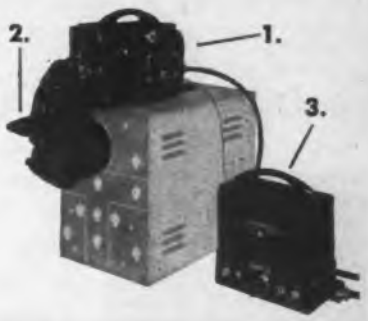

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the shadow mask. This is a thin metal sheet perforated with 200,000 tiny holes, and acts as a mask so that each electron beam, as it scans, can "see" only one dot of each color group. In the neck of the picture tube are three electron guns. These generate the beams of electrons which "paint" the color pictures on the phosphor plate.

The other four tri-color picture tubes reported on are basically similar in that the color is created by the action of electron beams on color phosphors.

One of these four tubes is similar to the three-gun production model, except for the use of one gun instead of three. Three tube (in which the single beam is made to "corkscrew" into its approach in the masking holes) was shown publicly in Washington, D. C., in March 1950, along with the three-gun tube. The other three tubes, however, were disclosed for the first time publicly at a Radio City showing Oct. 23.

In a third tube, called a "line-screen color kinescope," narrow parallel strips of color phosphors are used in place of dots. The single electron gun scans the phosphor strips in an unorthodox manner, the beam being deflected up and down in stairstep fashion in such a way as to scan each color in synchronism with the received color signal during each journey from one side of the screen to the other.

In a fourth entirely different tube, the axis of the electron gun is placed at a 45° angle to the phosphor screen. The scanning electron beam passes through slits in the phosphor screen and is then reflected back onto the phosphor. The emitted color is controlled by the deflection of the electron beam in the immediate vicinity of the phosphor screen. This makes the color control entirely independent of the scanning process.

Grid Control Tube

Still another type of tube, based on principles analogous to the layers of emulsion in Kodachrome film, was developed by S. V. Forgue. In this tube, the layers of red, blue, and green phosphors are placed on three closely-placed screens. By controlling the voltage changes on two intervening grids, the color is controlled. Successful experiments were conducted with one and with three electron guns.

The process used in applying the color phosphors to glass plates, used in four of the tubes, was developed out of silk-screen printing methods, and is used or applying dots and lines, as well as any other pattern.

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The built-in resistance standard is composed of seven Type 510 Decade Resistors, adjustable from 1 ohm to 1,111,111 ohms in 0.1 ohm steps.

The indicating meter shows percentage difference between the unknown and the built-in standard over a range of ±20% on a meter the scale of which is colored gold for 5% limits and silver for 10% limits as an aid to rapid operation.

A sensitive relay can be substituted for the indicating meter to operate various types of rejection or selection mechanisms for automatic sorting or inspecting.

The instrument can be used as a conventional Wheatstone bridge. Its accuracy is adequate for a large majority of resistance measurements. Its ability to measure resistances up to one megohm without added booster voltages increases its utility considerably.

As a limit bridge its accuracy is ±0.5% or better; for matching pairs of resistors it is accurate to ±0.2%; for null measurements, with an external standard, between 1 ohm and 2 megohms the accuracy is ±(0.2% plus accuracy of the standard).

The instrument is a-c operated from 105–125 or 205–250 volts, 60 cycles. It is supplied in either welded aluminum cabinet or relay-rack models.

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Zonal Screens

(*Continued from page* 45)

the effect of the image is nearly eliminated; consequently there will always be at least a partial suppression of the reflected wave at the receiver as meteorological fluctuations vary the position of the image source.

To obtain experimental confirmation of the reflected-wave suppression, the NBS investigators used a 4500-MC transmitter. Horizontally polarized signals were radiated from a 4- by 6-in. horn set about 14 feet above the ground. The receiving antenna was an exact duplicate of the transmitting horn. The receiving antenna was located about 800 ft. from the transmitter and could be raised and lowered on a 50-ft. tower. The received power was recorded as a function of this variable height.

One of the experimental wave suppressors is composed of two triangular screens with edges of 7.3, 6.6, and 5.4 ft. When the path was not obstructed by the suppressor, the receiver recorded a well-defined interference pattern of minimum and maximum signal strengths as the receiving antenna was raised and lowered on the tower. But when the triangular screens were placed in their proper position, the influence of the reflected wave was substantially eliminated at the receiver. The field strength of the remaining direct wave was 6 db less than that of the signal at a point of maximum interference when no suppressing screen was used.

By moving the receiving antenna above and below its normal operating position in search of any nearby reflected-wave interference, it proved to be possible to determine whether the reflected wave was really suppressed or merely shifted in phase.

In practice, microwave radio relay paths are usually about 20 or 30 miles long, and the transmitters generally operate at a frequency of about 4000 MC (wavelength 7.5 cm). Under these conditions, the first Fresnel zone is 80 to 100 feet in radius at the middle of the path, and the radius of the main suppressed area at the receiving point is about 8 to 10 ft. Fortunately, the antennas commonly used for microwave relay transmissions are about 8 ft. in radius. To accomplish nearly complete suppression, the screen is positioned on the path to within a few feet of the center. Because the direct wave is diffracted, perfect suppression cannot be obtained in any instance, and some error in lo-

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cating the screen can be tolerated. For a first zone of 80 ft., a satisfactory screen is a rectangular structure made of hardware cloth and mounted on poles 40 ft. high.

A number of experiments using differently shaped screens have substantially confirmed the application of optical theory to microwave techniques. They have indicated that troublesome ground reflections can be eliminated by small screens erected in the path, or when technically feasible, by utilizing obstacles permanently located near the proper position in the path.

Radiosonde

(*Continued from page* 55)

plifier tubes. The motor-control tubes will then reflect a different resistance value in series with the drive motor and thereby change its speed so as to cause vertical columns to be printed again. Vertical columns will appear on the pressure-sensitive chart as long as the input-signal code characters are being received at a uniform rate. A change in the drive-motor speed caused by a change in the radiosonde transmission rate will cause a corresponding change in the output of the dc tachometer generator. Consequently, the rate indicator will also change correspondingly. In turn, the change in tachometer output will affect the value of the bias voltage to the motor control tubes, resulting in a change in the effective resistance in series with the main winding of the drive-motor such as to restore the drive-motor speed to the original rate. If the power-line voltage should change, the corresponding change reflected in the output of the compensation rectifier will also effect the motor control amplifier in a like manner and thereby prevent a change in the drive-motor speed.

Automatic Synchronization Circuit

The automatic synchronization circuit works in conjunction with the motor control section to maintain vertically aligned columns despite changes in the rate of incoming code cycles over the range of 8 to 16 cycles of code groups per minute, (pressure, temperature, and humidity constitute one cycle of a code group). The timing cam measures the column position error of the recorder due to a difference in speed between the incoming signal cycles and the complete rotation of the recorder helix.

During normal synchronized operation, the recorder helix will make one revolution for each cycle of code signals received from the radiosonde transmitter. If the recorder is faster or slower than the received code signals, the automatic synchronizing mechanism, utilizing two thyratrons (V8 and V9, type 2D21), and timing cam assembly O-107, in conjunction with a system of microswitches S102 and S103, with an electrically activated speed-control circuit located in the motor control section, will adjust the motor-speed control voltage to synchronize the drive-motor speed with that of the incoming signal. This is accomplished by the electro-mechanical operation of the helix stop-start control assembly, which either advances the helix if the recorder is slower than the radiosonde transmission rate or, conversely holds the helix until the signal is again in synchronism.

It is recognized that this system has certain limitations in available accuracy and sensitivity which are contributed primarily by the use of the mechanical type of sensory element. A new system now under development at the Signal Corps Engineering Labs., offers greater accuracy and response sensitivity.

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TT-1251

UHF ANTENNAS

(*Continued from page* 41)

18 showing five co-linear dipoles at the focus of a parabolic sheet; and Fig. 19 showing a modified fan dipole of a corner reflector.

While the ideal reflector is a solid sheet of metal, a multiple number of rods or a wire mesh is generally used to reduce wind resistance, ice loading, and weight. This is perfectly satisfactory from an electrical standpoint, provided that the openings in the metal are only a small fraction of a wave length.

Being one of the most compact and highly efficient of the sheet reflector types, the corner reflector has been selected for discussion here. This particular antenna uses a 90° included angle in the corner and a modified type of fan dipole as the antenna element. It will be noted in Fig. 19 that the fan dipole is also folded at 90° to conform to the shape of the reflector. Following are its characteristics:

Gain—This antenna has the ultimate in gain for its compact size, as shown by Fig. 20. It should be one of the best performers in fringe areas.

Directivity—This antenna is also an outstanding performer in directivity, being truly uni-directional. The directivity in the horizontal plane is shown in Fig. 21, and the directivity in the vertical plane in Fig. 22. The almost complete absence of unwanted lobes should reduce reflection and multi-path troubles to an absolute minimum.

Bandwidth—Although the corner reflector antenna is normally considered to be a relatively narrow-bandwidth antenna, the combination of a proper-size reflector and the unique design of the dipole element has resulted in a compact, high-gain antenna which covers the entire UHF spectrum.

Yagi Antennas

The Yagi is a familiar type of high-gain, narrow-bandwidth array which can be equally as useful at UHF as at other frequencies. It produces more gain for its size and weight than any other types of antenna. The mechanical construction of a yagi to operate at these frequencies is very critical, and close dimensional tolerances must be held if its high gain is to be realized. The one illustrated here (Fig. 23) is a six-element, wide-spaced type. At UHF, advantage can be taken of the increased gain afforded by wide spacing without a structure which is prohibitive in size. The antenna shown here has an over-all length of only 28 inches.

Gain—The gain curve is shown in Fig. 24. While this should be adequate for most weak signal installations, still higher gains may be obtained by stacking two or more of these antennas in the conventional manner.

Directivity — The horizontal directivity pattern of this antenna is shown at its resonant frequency in Fig. 25. This is also a very excellent pattern for the elimination of reflections and unwanted signals. The vertical directivity pattern shows only a slightly greater lobe width than the horizontal pattern.

Bandwidth—This is a very narrow bandwidth antenna, showing its peak gain only on the channel for which it is made. It may be noted, however, that a total of seven UHF channels fall within the range of this antenna if a sacrifice in gain of 3 db at either end of the pass band can be tolerated.

Almost any type of antenna used at other frequencies can be designed for operation on the UHF television

German crowd, part of the 1,250,000 from East and West Berlin, sees a typical RCA television program.

"Freedom's window in the Iron Curtain"

You've read the story of last summer's TV demonstrations in Berlin. It attracted a million and a quarter Germans—including thousands who slipped through the Iron Curtain to see Western progress at work.

Behind this is another story: How RCA engineers and technicians broke all records in setting up these Berlin facilities. The project called for a TV station and studio, a lofty batwing antenna, and the installation of 110 television receivers at strategic points. Such a program would normally take several months to complete. It was installed and put to work by RCA in a record-breaking 85 hours!

Programs witnessed by Berliners included live talent shows, sports events, news commentaries, and dramatizations of the Marshall Plan. Observers pronounced reception fully up to American standards—another impressive demonstration of democracy's technical ingenuity and leadership.

* * *

See the latest wonders of radio, television, and electronics at RCA Exhibition Hall, 36 West 49th St., New York. Admission is free. Radio Corporation of America, RCA Building, Radio City, N. Y. 20, N. Y.

Part of the 401 cases of RCA equipment shipped to Berlin for television demonstrations.

RCA

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band. Simple types, such ordinary dipoles, dipoles and reflectors, and combinations of these can be usec effectively, although they will not show the broad bandwidth characteristics of the previously described special types. One such array of dipoles and reflectors is shown in Fig. 27.

Also worthy of mentioning are several experimental types which are too cumbersome to use at lower frequencies, but adapt themselves very readily in this portion of the spectrum. They are the helical-type antenna, shown in Fig. 26, and the slot-type antenna, shown in Fig. 28.

Transmission lines are an important part of the receiving antenna system, and many types of lines have been evaluated during the field tests. The best antenna performance can be obtained only by the proper choice and installation of the transmission line. Because of the much greater loss in the flat ribbon types of transmission line under adverse weather conditions, those used with the most success in experimental UHF installation have been Types 2, 3, and 4, in the list below. The 300-ohm tubular line, while better than the flat line under conditions of soot, grime, and moisture, still shows an appreciable increase in loss. The coaxial types are not affected, but naturally have greater initial attenuation. The proper choice of transmission line and its proper installation will provide the same trouble-free service as that obtained on present VHF channels.

		Loss — DB/100 Feet					
		100 MC		500 MC		1,000 MC	
	Type	Dry	Wet	Dry	Wet	Dry	Wet
1	Standard 300-Ohm Flat Line	1.2	7.3	3.2	20.0	5.0	30.0
2	Tubular 300-Ohm Line	1.1	2.5	3.0	6.8	4.6	10.0
3	RG 59/U Coax	3.7	—	9.6	—	14.5	—
4	RG 11/U Coax	1.9	—	5.2	—	7.8	—

The antennas discussed above are all of the balanced 300-ohm type. Where it is found desirable to use an unbalanced 75-ohm coaxial transmission line, or where the receiver is designed for 75-ohm unbalanced input, an impedance transformer and balancing network are necessary to couple these two unlike items together. This balancing network is referred to as a balun, and the impedance transformer can be conveniently incorporated in the same structure.

A lightning arrestor is often necessary on UHF as well as on VHF. Lightning arrestors designed for VHF use have proven unsatisfactory at UHF, due to their electrical mismatch and signal loss. The balun incorporates positive lightning protection in its design, without the

They're headed for

new frontiers

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EACH year the Bell System selects hundreds of engineering graduates from technical schools, to find the answers to communications problems through the application of science and technology. A specifically qualified group joins Bell Laboratories to develop *tomorrow's* telephone system — also, in the present emergency, more powerful electronic devices for the armed services.

They come — thanks to the competence of our nation's educators—with an excellent grounding in fundamentals. To equip them still further, the Laboratories operate a school at graduate level for advanced communications.

The new men receive an intensive course in the latest theory and techniques. At the same time they take their places as members of the Technical Staff doing responsible work which, with their classroom instruction, reveals where they can make the most of their aptitudes.

More than ever America's future must depend on men and women who are trained to think far ahead in technology whether for tomorrow's telephones or national defense. By helping them, Bell Telephone Laboratories help make America's telephone system the world's best, help the armed forces keep our country strong.

BELL TELEPHONE LABORATORIES

Exploring and inventing, devising and perfecting, for continued improvements and economies in telephone service.

Fig. 29: Balun for matching balanced 300-ohm line to unbalanced 75-ohm coaxial

losses of standard lightning arrestors, provided its case is adequately grounded.

Typical installation procedure when using 300-ohm line is to install the balun (shown in Fig. 29) on the outside of the building near the entrance point of the transmission line, and to attach a lightning ground to its case. Coaxial line is then run to the 75-ohm input of the receiver.

If coaxial line is used throughout, the balun is installed at the antenna and the shield of the coaxial cable is properly grounded at the entrance to the building.

Naturally, it will be to everyone's advantage to make UHF installations as simple and economical as possible. The approach in adding UHF to present VHF may be to utilize one of the following procedures:

a. Investigate the possibility of using the existing VHF antenna and transmission line—compromising antenna orientation where necessary.
b. Utilize built-in or cabinet-top antennas—principally in strong signal areas.
c. Install a separate UHF antenna on the existing mast, feeding both UHF and VHF antennas into a common transmission line by using a special coupling network.
d. Make an entirely separate UHF installation if the location of the VHF antenna is not satisfactory, or move the existing VHF mast to a position suitable for both services.

Pittsburgh-St. Louis Microwave Link Planned

Application has been filed by the Long Lines department of A. T. & T. with the FCC for permission to install a radio relay system between Pittsburgh, Pa., and St. Louis, Mo. Expected to be completed about mid-1953, the entire system is estimated to involve an investment of about nine million dollars.

News of MANUFACTURERS' REPS

G. S. Marshall Co., Pasadena 1, Cal., electronic engineering representatives, now represents: **Tensolite Insulated Wire Co., Inc.**, Tarrytown, N. Y., makers of miniature and sub-miniature wire and cables; **Sterling Engineering Co., Inc.**, Laconia, N. H., manufacturers of telephone-type relays; and **Electronic Devices, Inc.**, Brooklyn, producers of selenium rectifiers. Area to be covered includes California, Arizona and New Mexico.

The Marvin E. Nulsen manufacturers' representative organization, 5376 East Washington Street, Indianapolis, Ind., has been named sales representative for the cathode-ray tube division, **Allen B. DuMont Laboratories, Inc.** Nulsen representatives will cover jobbers in Indiana and the cities of Cincinnati, Ohio, and Louisville and Lexington, Kentucky.

Electronic Measurements Corp., engineers and producers of precision electrical testing equipment, of 280 Lafayette St., New York 12, N. Y., has just announced the appointment of **Intex Co., Inc.**, of 303 W. 42 St., New York 18, N. Y., as their exclusive export representatives.

Gertsch Products, Inc., Los Angeles, has appointed Ron Merritt, Seattle, as its northwest representative.

Gerald B. Miller Co., Hollywood electronic engineering representative, has opened a branch at Albuquerque, N. M., at 302½ W. Central Ave., with E. P. Brooks as manager, according to G. B. Miller, president. The new office will service Arizona, New Mexico and to El Paso, Texas.

Antenna Lab for Workshop Associates

A new antenna laboratory will be erected by the Workshop Associates, Division of The Gabriel Company. To be located in Natick, Mass., the laboratory is scheduled for completion in mid-1952. The laboratory site consists of a 46 acre tract approximately twenty miles from Boston. The building will be two stories with a modern glass brick front. The roof will be specially designed for outdoor antenna work. Electrical engineering, mechanical engineering, model shop, and a drafting department will all be located in the laboratory, together with all engineering offices for the Workshop Associates.

Microwaves for Utilities

(Continued from page 50)

mercial supply. Other factors to be considered in connection with the stand-by power equipment are starting batteries, battery chargers, and capacity of fuel tanks. It is also advisable to include remote-control starting from the dispatch point. Remote-control starting makes it possible to check the operation of the stand-by equipment periodically, to make sure that it is ready for use at all times.

The paraboloidal type of antenna is used for microwave communication. Since directional transmission is desired, this type of antenna is utilized to concentrate the transmitter's energy into a narrow beam. Because of the inherent power gain of the antenna, the repeater power required is reduced by the factor of the antenna gain at both the receiving and terminating points. For example, at 7000 MC, a paraboloidal antenna 4 ft. in diameter has a gain of approximately 36 db, power gain of approximately 4000. Microwave equipment should be located near the base of the tower, and the antenna located at the top, with the proper type of transmission line connecting the microwave equipment to the antenna. This type of installation is quite satisfactory where reasonably short transmission lines are used. Either coaxial cable or wave guide may be used, depending upon the operating frequency. In general, coaxial cable is satisfactory for frequencies up to 3000 MC. Wave guide, because of its higher efficiency, is used for the higher frequencies.

WABD ON EMPIRE STATE

Rodney D. Chipp, director of engineering for the Du Mont television network, gives the signal for Chris J. Witting, the web's director and general manager, to throw the master switch, which put WABD's new transmitter, atop the Empire State Building, on the air. C. G. Alexander, network operation director, looks on.

MILITARY CONTRACT AWARDS

Manufacturers who have received contract awards for producing of radio-radar-electronic equipment for the Armed Services are listed below by name, city and equipment. Subcontractors interested in bidding on performance of any part of each contract should sell their services to these prime contractors. This list, which is current up to our press time, covers the period from Oct. 3 to Oct. 31.

Batteries

Manufacturers Battery Co., Madison, Wisc.; Ray-O-Vac Co., Madison, Wisc.; Union Carbide & Carbon Corp., New York City, N. Y.

Cable

Crescent Insulated Wire & Cable Co., Trenton, N. J.; James T. Haggerty & Co., Philadelphia, Pa.

Circuit Breakers & Switches

General Electric Supply Corp., Chicago, Ill.; Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.

Crystals & Crystal Units

Rex Bassett Co., Fort Lauderdale, Florida.; Electrical Products Corp., Oakland, Calif.; Sherold Crystal Corp., Kansas City, Kansas.

Electron Tubes

Kuthe Labs., Newark, N. J.; Radio Corp. of America, RCA Victor Div., Harrison, N. J.; Raytheon Mfg. Co., Newton, Mass.; Sylvania Electric Products, New York City, N. Y.

Facsimile Sets

Times Facsimile Corp., N. Y. City.

Generators & Power Supplies

Beech Aircraft Corp., Wichita, Kans.; Buda Co., Harway, Ill.; General Electric Co., Washington, D. C.; P. R. Mallory & Co., Indianapolis, Ind.; Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.; Penn Electric Switch Co., Goshen, Ind.; Vickers, Inc., Vickers Electrical Div., St. Louis, Mo.; Westinghouse Electric Corp., Dayton, Ohio.

Headphones

Mackay Radio & Telegraph Co., Marine Div., New York City, N. Y.

Indicators

Eclipse-Pioneer Div., Bendix Aviation Corp., Teterboro, N. J.; General Electric Co., Schenectady, N. Y.; Kollsman Instrument Corp., Elmhurst, N. Y.; Sperry Gyroscope Co. Div., The Sperry Corp., L. I. City.

Magnetic Tape Recorders

Ampex Elec. Corp., San Carlos, Calif.

Radar Sets

Transducer Corp., Boston, Mass.

Radiosonde Equipment

Friez Instrument Div., Bendix Aviation Corp., Baltimore 25, Md.

Radio Transmitters & Receivers

Barker & Williamson, Upper Darby, Pa.; Lewyt Corp., Brooklyn, N. Y.; Sentinel Radio Corp., Evanston, Ill.; Wickes Engineering & Construction Co., Camden, N. J.; Wilcox Electric Co., Kansas City, Mo.

Test Equipment

Boonton Radio Corp., Boonton, N. J.; Hewlett-Packard Co., Palo Alto, Calif.; Manhattan Lighting Equipment Co., New York City, N. Y.; Stamford Electronics, Stamford, Conn.

Transformers

American Gas Accumulator Co., Elizabeth, N. J.; Burnell & Co., Yonkers, N. Y.; Freed Transformer Co., Brooklyn, N. Y.; Standard Transformer Corp., Chicago, Ill.; Westinghouse Electric Corp., N. Y. City.

PERSONAL

Robert Dressler has been appointed director of research and development for Chromatic Television Laboratories, Inc., Paramount Building, 1501 Broadway, New York 18, N. Y. For the past five years, he has been in charge of various aspects of television research for Paramount Pictures Corp. (which holds a 50% interest in Chromatic Laboratories). He now assumes complete administrative and technical responsibility for Chromatic research and development activities, including projects for the Armed Services, theatre television and color television cathode-ray tubes and system.

Rear-Admiral Stanley F. Patten, U. S. N. (Ret.) has been elected vice president of Allen B. Du Mont Laboratories, Inc., by the Board of Directors. His most recent assignment was Director of Mobilization Planning for the Government Department of Allen B. Du Mont Laboratories, Inc.

Howard Rowland has been appointed chief research engineer of The Workshop Associates, Needham Heights, Mass., Division of The Gabriel Co. In this capacity, he will direct a selected group of engineers in the investigation of new products and advanced research into antenna problems. Currently, his group is investigating new antenna designs in the fields of microwave communications, UHF and VHF receiving and transmitting antennas, and mobile communications.

Don Haines has joined Belmont Radio, Chicago, in an administrative capacity to assist in the development of increased research and engineering facilities. In this capacity, Haines will assist William Garstang, administrative director of engineering and research. Mr. Haines moved to Belmont from the post of chief engineer at Sentinel Radio.

James B. Ferguson has been appointed chief engineer of Link Radio Corp., 125 West 17th St., New York, N. Y. Since Mr. Ferguson came to Link Radio as consulting engineer in June, 1950, he has designed new mobile radio transmitter - receiver units. He is a veteran in the radio business, being one of the first 100 men in this country to receive a commercial radio operators' license in 1912. For 12 years, from 1923 to 1935, he was president and chief engineer of J. B. Ferguson, Inc. and Ferguson Radio Corp. In 1935, he became di-

rector in charge of engineering and production of Ferguson Radio Corp., Ltd., in England. In 1941, he became general manager of the U.S. Television Manufacturing Corp. One year later, he became manager of the Production Division, Press Wireless, Inc. From 1944 until he joined Link Radio, he was chief engineer of the communications division of Belmont-Raytheon.

Dr. Louis N. Ridenour has been appointed director of engineering of International Telemeter Corp., 846 N. Cahuenga St., Los Angeles 38, Cal. Until recently he was chief scientist of the U. S. Air Force, assisting General Vandenberg and the Air Staff in carrying out a reorganization of the Air Force's research and development activities. During the war Dr. Ridenour served as staff member and asst. director of the Radiation Laboratory of MIT, on contract from the OSRD.

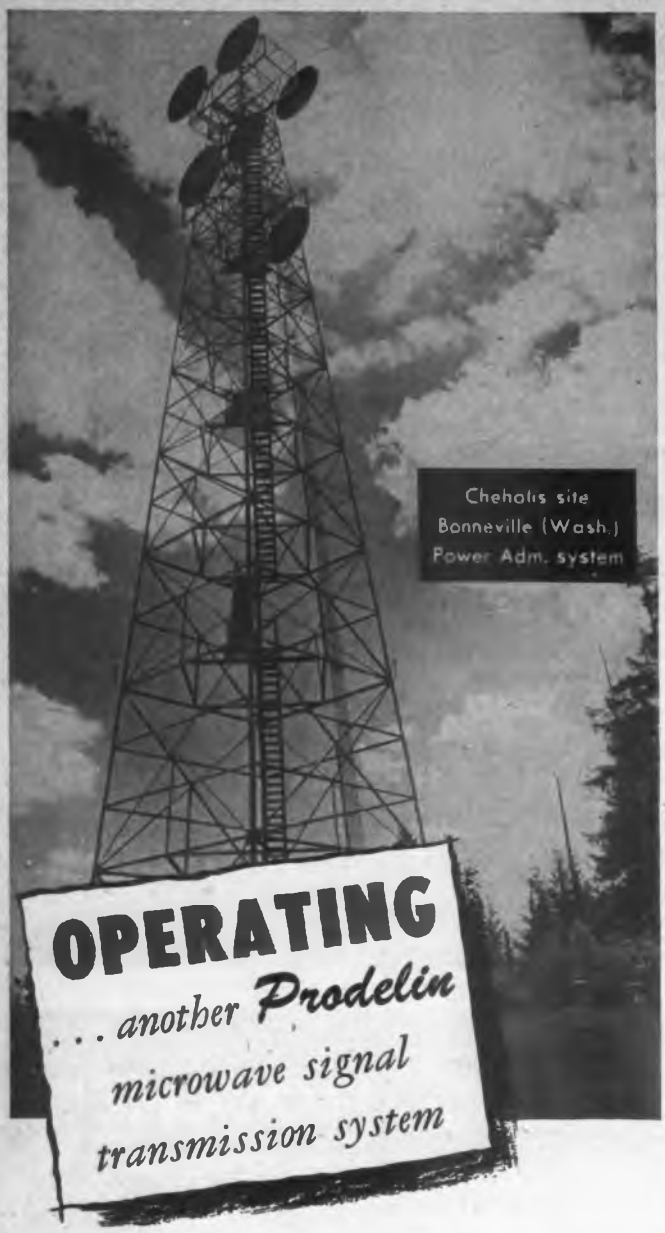
H. A. Williams has been appointed manager of the Electric Components Division of the Stackpole Carbon Company, St. Mary's, Pa. "Hi" Williams, as he is more familiarly known throughout the trade, has been with the Stackpole organization since 1929, having started as a meter repairman. For a number of years past, he has served as sales manager of the Electronic Components Division with its lines of fixed and variable resistors, iron cores, Ceramag non-ferrous cores, switches and various specialties.

Frank B. Rogers, Jr., has been appointed to the executive staff of Reeves Soundcraft Corp., Long Island City 6, N. Y., as vice president in charge of sales.

Edwin R. Liberg has been appointed supervisor of custom engineering for the Audio & Video Products Corp., 730 Fifth Ave., New York 19, New York.

Murray Weinstein, consulting engineer, is now associated with Regal Electronics Corp., New York, N. Y., manufacturers of Regal Television Sets and Radios.

Harrison Johnston has been appointed manager of Ampex Electric's newly created product engineering division, with headquarters at the company's Redwood City, Calif., factory. Among his activities he will supervise the marketing of the Ampex audio and data recorders.



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- *Texas Eastern Gas Transmission Corp.*
- *Bonneville Power Administration*
- *U. S. Coast Guard*

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BULLETINS

Transformers

The Crest Transformer Corp., 1834 West North Ave., Chicago, Ill., makers of Crestran transformer equipment have issued their new Crestran catalog. On the 16 pages of this illustrated catalog will be found complete data on their entire line of radio, television, and electronic transformers.

Parts & Equipment

Milo Radio & Electronics Corp., 200 Greenwich St., New York 7, N. Y., distributors of industrial electronics, radio, television, sound and broadcast equipment have announced the publication of their new 1100 page 1952 general catalog. This large, hard-cover bound book contains a listing of over 75,000 items and 7,000 illustrations of the major standard brand radio-electronics products in the industry, complete with technical specifications, physical dimensions and prices.

Relays

A new four page bulletin (MTR-170), describing and illustrating the Signal Engineering Series 80 line of Midget Telephone Type Relays, has just been issued by Signal Engineering & Mfg. Co., 154 W. 14th St., New York, N. Y. It contains information and drawings regarding types of covers, characteristics, general specifications and pertinent data.

Subminiature and Special Purpose Tubes

Raytheon Manufacturing Co., 55 Chapel St., Newton 58, Mass., has published a new brochure describing its line of subminiature tubes. Application notes, tube descriptions, performance curves, and quality test details are described. The company has also released a booklet covering the Raytheon line of special purpose tubes. These include: magnetrons, klystrons, rectifiers, voltage regulators, radiation counters and transmitting tubes.

TV Antennas

A free booklet entitled "TV Facts" has recently been published by the Fretco Television Co., 1041 Forbes St., Pittsburgh 19, Pa. It presents diagrams, pictures and simple field patterns of antennas in the Fretco line.

Power Selenium Rectifiers

The Sarkes Tarzian Rectifier Division, 415 North College Ave., Bloomington, Ind., has just released a new comprehensive catalog, No. PR1, covering power selenium rectifiers. This catalog shows iso-thermal, frequency, reverse versus temperature curves, and many others which have never been published before. This information is vitally needed by electrical engineers to design power supplies for the military service.

Potentiometers

Laboratory Report #3 published by Technology Instrument Corp., 531 Main St., Acton, Mass., is now available upon request. Features include an article on a new analog computer and Part I of "A production test method for the determination of the linearity of precision potentiometer" by Joseph R. Altiere.

Connectors

"The AN-M Pocket-Size Service Manual" is the title of a booklet published by Cannon Electric Co., P. O. Box 75, Lincoln Heights Station, Los Angeles 31, Cal. It is an up-to-date reference on the proper technique for servicing the new AN-M military specification and other Cannon Electric resilient-insert connectors.

New 3,000-Watt Diesel Electric Plant

A new 3,000-watt Diesel electric plant, powered by an air-cooled full-Diesel Onan engine, is described in a new bulletin published by D. W. Onan & Sons, Inc., Minneapolis 14, Minnesota. The compact and easily installed Model 3DSP-1E generates 115-volt, 60-cycle, single-phase current. Other A.C. models available in single-phase produce 230 volts and 115/230 volts. A 32-volt battery charging model can also be supplied. All models are conservatively rated to provide ample overload protection.

8000 Register at 3rd Audio Fair and Convention

Held in conjunction with the annual convention of the Audio Engineering Society, the third Audio Fair took place in November at the Hotel New Yorker in New York City. The nearly 100 exhibitors showed audio lines and new products in individual rooms on two floors of the hotel. There was a preference shown for tape as the source

F. Sumner Hall (left) and H. H. Scott received awards during the A.E.S. convention, held in New York City with the Audio Fair. Over 8000 visited the 3-day show.

of demonstration program material, with transcription turntables a close second.

During the convention the newly-elected officers and board of Governors took office. In addition, Dr. Harry Olson of RCA Laboratories presented the society's award "for outstanding efforts on the behalf of the Society in 1951" to F. Sumner Hall president of Audio Equipment Sales, Inc., New York, N.Y. Mrs. Dorothy M. Potts presented the John H. Potts Memorial Award to Hermon H. Scott, president of H. H. Scott, Inc., Waltham, Mass. Officers whose terms of office started were: C. G. McProud, president of the Society; F. Sumner Hall, executive vice-president; Lloyd C. Wingard, Central vice-president; Howard Tremaine, Western vice-president; C. J. LeBel, secretary; and Ralph Schlegel, treasurer. The new Governors are John D. Colvin, Victor Liebler, Theodore Lindenberg, J. B. Minter, H. E. Roys, and W. O. Summerlin.

IRE Elects Officers for 1952

Dr. Donald B. Sinclair, chief engineer of the General Radio Company, Cambridge, Mass., has been elected president of the Institute of Radio Engineers for 1952. He succeeds Dr. I. S. Coggeshall, general manager of Western Union's overseas communications.

Harold L. Kirke, assistant chief engineer of the British Broadcasting System, will succeed Jorgen Rybner, Royal Technical University of Denmark, as I.R.E. vice-president. Elected as directors for the 1952-1954 term are John D. Ryder, professor and head of the electrical engineering department of the University of Illinois, and Ernst Weber, professor and head of the electrical engineering department of the Polytechnic Institute of Brooklyn.

New Stereophonic Tape Recorder

In November at the Audio Fair in New York City, Magnecord Inc. announced the availability of a dual channel tape recorder for binaural recording. In making this product commercially available a long-awaited dream of audio engineers has become a reality.

The machine is a standard tape transport mechanism which has two record-playback heads mounted so that they record two tracks simultaneously and also playback together. Two recording amplifiers and two reproduce channels are provided in the new amplifier, type PT6-BN. Initial experiments with the machines have indicated tentative placements for the two microphones which feed the separate recording channels. It has been found that the binaural effect seems best when recording speech and dance music if the microphones are placed about 2 feet apart. For piano and chamber music a spacing of five feet has brought optimum results, and considerably wider spacing was found to sound most natural in the recording of larger music groups.

Microwave Hybrids

(*Continued from page 37*)

the voltages at A and B out-of-phase. The pulse is propagated down the wave guide to the T. R. tubes which are ionized, causing the energy to be reflected back toward the hybrid. One T. R. is located ¼ λ further from the junction than is the other so that reflected wave at B has an overall travel ½ λ more than the reflection at A. Since the energy was originally out-of-phase at A and B, this extra travel shifts the B energy 180° and the reflected waves are in-phase.

Because these hybrids may be considered as linear devices, in-phase inputs to A and B are summed and appear at arm D (the inverse of energy applied at D splitting into in-phase outputs at A and B). Thus the transmitter pulse is coupled to the antenna. Note that the overall length of both wave guide runs between the two duplexers is equal. Thus the spike of transmitter pulse energy which leaks through the T. R. tubes as they are ionized appears at arms A and B of the lower hybrid as out-of-phase signals, by the linearity principle, is summed and appears at Z. This is a dummy load which absorbs this energy so as to remove it from the plumbing system and prevent the formation of standing waves.

Note that the spikes in the two arms are not equal in amplitude (unless the T. R. tubes are perfectly balanced) so that an amount of energy approximately equal to the spike difference remains in the plumbing system. Part of this energy appears at the receiver and is displayed on the radar indicators as the "main bang."

Received energy is coupled into D from the Antenna, appearing at A and B as in-phase voltages. These voltages do not ionize the T. R. tubes but are coupled into arms A and B of the lower hybrid as in-phase voltages and so are coupled through the shunt arm to the mixer.

Hybrid Characteristics

Isolation—The isolation characteristics of the hybrid junction between the shunt and series arms is generally better than the isolation in the hybrid ring. Typical values for the junction over the X-bank average about 35 db with the isolation being better than 30 db everywhere. Isolation between the output arms is much lower, dropping as low as 15 db. The hybrid ring, because of its symmetrical nature, has uniform isolation between inputs and outputs. Typical values run between 20 db and 35 db over the X-band. The hybrid ring is thus generally not as good as the hybrid junction in isolation characteristics.

Matching—The hybrid circle has better impedance matching characteristics than does the hybrid junction, typical voltage standing wave ratios averaging less over the band for hybrid rings. This is particularly true for the series input to the hybrid junction which is frequency sensitive because the reactance elements (iris and post), both of which affect the series junction impedance match, are frequency sensitive.

Usage—In general the hybrid ring is capable of handling more power than an equivalent hybrid junction and does so with a smaller impedance mismatch than does the hybrid junction. It is thus desirable to use the hybrid ring in high-power applications such as in duplexing. The hybrid junction has the advantage of higher isolation and should be used, for example, in mixing where it is desirable that the local oscillator be isolated from the antenna to prevent radiation of local oscillator energy. The hybrid ring has the disadvantage of requiring rather complex plumbing construction because the arms are not at right angles.

ANNUAL INDEX-1951

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

FREQUENCY ALLOCATIONS

GENERAL

GOVERNMENT COMMUNICATION

GOVERNMENT PURCHASING

INSTRUMENTS, MEASUREMENTS, & TEST METHODS

FOR MANUFACTURERS— New Methods, Materials, and Machines

MANUFACTURING: RADIO—TV—ELECTRONIC

MATERIALS, PROPERTIES OF

MICROWAVES AND UHF

ANNUAL INDEX (Continued)

CR TUBES FOR RADAR (*Continued from page* 53)

glass thickness of 5/16 in., and hence to the maximum diameter attempted. Shown in the photograph is a 16 in. tube with an aluminized magnesium fluoride screen; the flatness of the face plate is evident. The aluminum backing, among other things, prevents charging-up of the fluorescent screen and so facilitates plotting directly on the face plate. Actually, the face plate does have a slight curvature resulting from the tempering of the glass prior to sealing which is necessary to reduce breakage from mechanical and thermal shock during the sealing process itself. Sphereometer measurements of the radii of curvature yielded values from 120 inches to 1500 inches, with a value of 200 inches being typical. For all practical purposes such a faceplate can be said to be flat.

The interplay of the factors mentioned in the discussion of the preceding section is apparent from the actual destruction pressure test data obtained and listed in Table II.

Flat face tubes of still larger size, 24 to 30 in. in diameter, would be desirable for radar presentations. In this case, the metal in the sealing area of the cone must be of greater thickness to increase the compressive force arising from the differential temperature contraction, which is seen to be approximately independent of tube size, in order to counteract the tensile stress in the face plate which is proportional to the square of the tube radius. To check the influence of thickness, 12 and 16-inch tubes having cone thicknesses of .020 in. less than those shown in the table were pressure tested. A strong dependence of maximum pressure on the cone thickness was indicated; such tubes failed at pressures about 50% of values for thicker cones.

The glass thickness must also be increased to provide the desired strength. Using the value of breaking strength computed from the equation for tensile stress, already quoted, and the pressure test value for the 16 in. tube, the face plate thickness required by a flat face tube to yield at least a 40 lb. pressure test is shown in Table III.

TV Planning Book

Facilities and function of equipment used in a well-integrated TV station are described in "Station Planning," a booklet published by Allen B. Du Mont Laboratories, Television Transmitter Div., Dept. TH, 1000 Main Ave., Clifton, N. J.

FLYING SPOT SCANNER

(*Continued from page 44*)

is available from the cathode ray screen are now at hand. These are: 1. a knowledge of the radiant output vs. the wave length of the P15 emission; 2. a measurement of the ft. lamberts of luminance or the lumens of flux at the screen and; 3. a knowledge of the combined characteristic of lumens vs. wave length for screen and visual photometer.

The second and third questions which have to be answered deal with the photo-multiplier characteristics. One is the relative response vs. wave length, in other words, its color response. This is shown in Fig. 6 for the S4 surface, representative of such tubes as the 931A and 1P21.

This response is rather broad, being as high as 93% at the ultra-violet wave length of 360 m/u, a maximum of 100% at the peak wavelength of 400 m/u, and still showing some response at the orange wave length of 630 m/u.

The absolute sensitivity at the peak wave length is approximately 37 ma/watt for the 1P21 and approximately 19 ma/watt for the 931A. Again we must stress that this refers to the photo-cathode sensitivity and not the overall. It is quite common to have a photomultiplier tube which has excellent electron multiplier gain but poor photo-cathode sensitivity, and another tube with the reverse characteristics, that is a good photo-cathode and a poor multiplier. However, as long as the following amplifier has the required gain, the tube with the good photo-cathode will give good signal to noise.

It is true that Fig. 6 shows that the S4 surface of 1P21 and P15 tubes has fairly good response at the lower wave lengths but the question is how well does it match the wave lengths generated by the cathode ray tube. This is shown in Fig. 7.

Although the selectivity curve for the 1P21 and P15 response seems similar to that of the P15 above, there are some important differences. The wave lengths higher than the violet have been attenuated. Instead of a blue-green response 80% of the peak, this has now dropped to approximately 55%. Without a color filter or other color attenuation the area under this curve represents the total current obtained from this type of photo-cathode.

A color filter while not absolutely necessary is highly helpful. All cathode ray tube phosphors have the property known as persistence to some degree. If the cathode ray beam should move from one small area of the phosphor to another small area in its normal travel, the light from the first region does not abruptly shut off but decays in some quasi-exponential manner. For flying spot work the shorter the persistence the better will be the system resolution. That is, all other things being equal, the better will be the ability to produce sharp transitions from black to white and from white to black. The finite build-up time and the finite decay time behave very much like a low pass filter. In other words, the effect is as though the higher frequency components of the signal were attenuated. Such an effect may be compensated by the use of high pass networks. For the P15 phosphor the persistence characteristic is more pronounced at the longer wave lengths, that is, in the direction of orange and red. The violet and ultra-violet components have extremely short persistence. If the full output of the P15 screen were to be utilized, several stages of filtering would have to be used, preferably separated by buffer tubes. However, if a color filter, passing only the violet and ultra-violet wave lengths

Opportunities for Engineers

ELECTRONIC ENGINEERS

THE WALL STREET JOURNAL
Friday, September 28, 1951

Westinghouse Air Brake Acquires Melpar Stock

Westinghouse Air Brake Co. has acquired all the stock of **Melpar, Inc.,** of ALEXANDRIA, VA., and CAMBRIDGE, MASS.

Melpar has prime contracts with the armed services covering the fields of sonar, radar, communications, guided missiles, computers and miniaturization. The new owners plan a "large expansion program" geared to meet increasing demands by the armed services, according to Edward O. Boshell, chairman and president of Westinghouse. He described the purchase as "an important step in our expansion program."

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is placed in the path of the light rays, then the compensation becomes much more simple and may be accomplished by one RC network. Fig. 8 shows the transmission vs. wave length of a color filter found adequate for this work.

This filter, a Corex 5970, has a transmission of 87% at 370 m/u and drops off sharply to less than 10% at 420 m/u. The effect of this filter is to pass only the violet and the ultra-violet. As might be expected, this cuts off much of the visible light from reaching the photo-multiplier cathode. This naturally cuts down the photo-cathode current that can be expected.

Fig. 9 shows the 1P21 and 931A relative response to the P15 excitation after it has passed through the color filter. This curve still represents an absolute photo-cathode sensitivity of 37 ma/watt of radiant flux at 400 m/u for the 1P21 and 10 ma/watt for the 931A. Again the total photo-cathode current is a function of the area under this curve. This is another way of saying, in order to calculate the photo-cathode current, the product of the P15 emission and the photo-cathode sensitivity for the wave lengths enclosed in this curve must be summed up or integrated.

The amount of radiant flux which arrives at the photo-cathode is dependent upon the efficiency of the optical system including the projection and the condensing lenses. This is, of course, through the high light areas of the transparencies, assuming 100% transmission in these areas. The required optical efficiency in order to give us our .01/ua. of peak photo-cathode current may be evaluated from the following relationship:

Optical Efficiency:

$$\eta_o = \frac{I_{pc} 650 \int_o^\infty \epsilon(\lambda)\bar{y}(\lambda)\, d\lambda}{F_{LST}\, S_{pc_{max}} \int_o^\infty \epsilon(\lambda)\, S(\lambda)\, T_r(\lambda)\, d\lambda}$$

Aperture:

$$f = \frac{M}{2(M+1)} \sqrt{\frac{T_x}{\eta_o}}$$

The optical efficiency is proportional to the required photo-cathode current and inversely proportional to the photo-cathode sensitivity and to the visible flux measured at the cathode ray tube. The integral in the numerator is the area under the curve shown previously giving the eye response to the P15 excitation. The integral in the denominator is the area under the curve for the response of the 1P21 or 931A photo-cathodes to the P15 excitation after it has passed through the color filter. One way these integrals may be ap-

proximated is by graphical determinations of the areas.

The required optical system aperture or f-number squared is shown in this equation to be proportional to the lens transmission factor and inversely proportional to the required optical efficiency. M is the magnification. In general the larger the f-number can be, the slower the optical system, and vice versa. This equation is shown plotted for 35 mm. transparencies in Fig. 10.

For the effective photosensitivity of the 1P21 a figure of 110 /ua. per lumen is obtained provided the light source is the P15 phosphor operating under normal conditions. For the 931A, this figure is 57/ua per lumen. Again stressing that the light source is the P15 phosphor with no color filter. When the color filter is interposed these figures drop to 30/ua. for the 1P21 and 15/ua/lumen for 931A.

Operating under normal conditions, that is, at a second anode beam voltage of 20 kv. and a beam current of 150/ua the average luminance of the cathode ray screen was measured, by means of an eye corrected instrument at 76 ft. lamberts. Based on the blanking duty cycle used and the raster dimensions, this corresponds

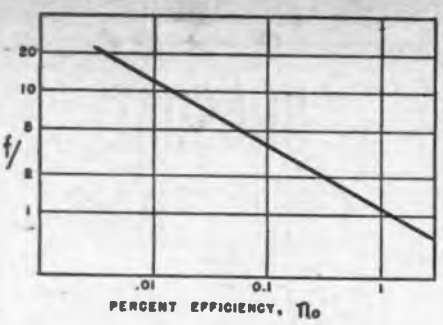

Fig. 10: Aperture vs optical efficiency

to a visible flux at the cathode ray tube of 7 lumens. In order to obtain the required photo-cathode current of .01/ua. the optical efficiency required for a 1P21 tube is .005%. This calls for an optical speed of f13. The measured photo-cathode current in the system using an f 1.9 objective was 0.6/ua or 60 times the required value. For an f 1.9 projection lens the calculated photo-cathode current is 0.51 microamperes. This is fairly close correlation between analytical and experimental results.

Description of Scanners

The single FTL-35A has a phototube mounted inside the slide projector housing together with the 3-tube preamplifier. The cathode ray tube is mounted vertically in the console and mirrors are used to transfer the light to the projection lens. The high voltage supply is a pulse type independent unit with protective circuits shutting off the high voltage when the sweep drops to half size. A video amplifier and sync and blanking inserter brings a composite signal out at a level of 1.4 volts peak to peak. A separate identical signal is available for monitoring purposes.

Fig. 11 shows the FTL 93A dual scanner which uses only a single cathode ray tube. In other words, this consists of a single scanner with an auxiliary unit containing only a projection unit, a mirror system, and a montage amplifier for special effects. This permits the two slide units to be used independently with switching means from one to the other or permits the second unit to act as a source of keying signals which can gate on and off two channels in the montage amplifier. By use of special slides different parts of the picture may be shared by two live pick-ups or a live pick-up and the picture from the first slide unit. Electronic and manual switching and lap dissolve are provided.

This paper was presented at the NARTB Convention, April, 1951.


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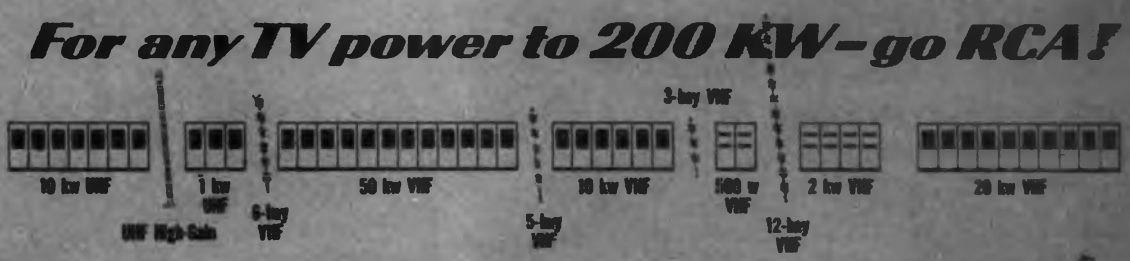

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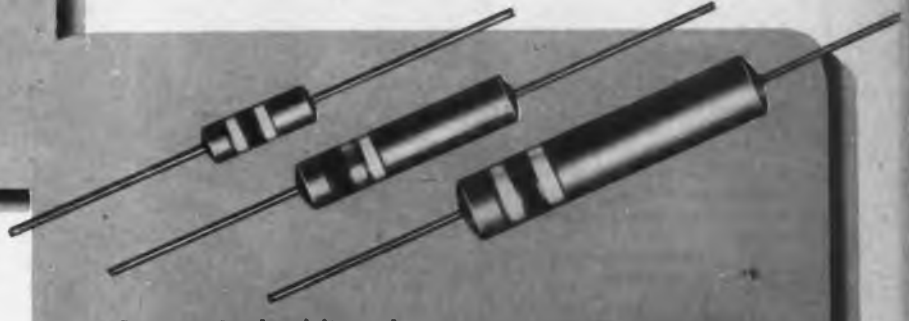

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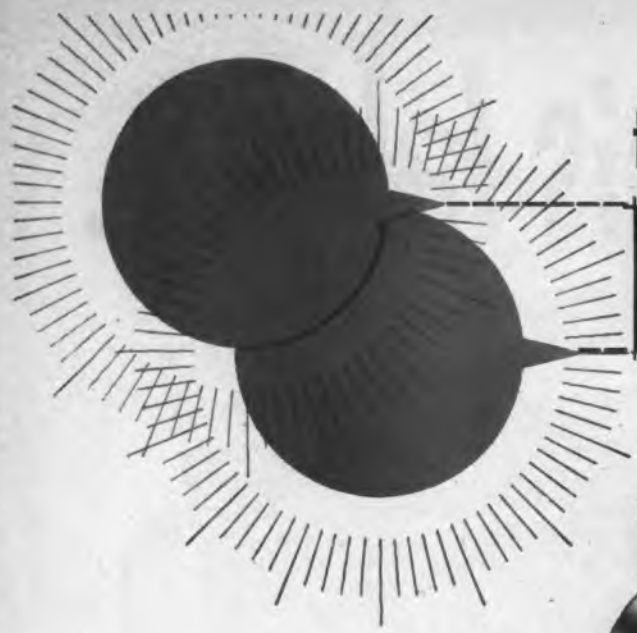

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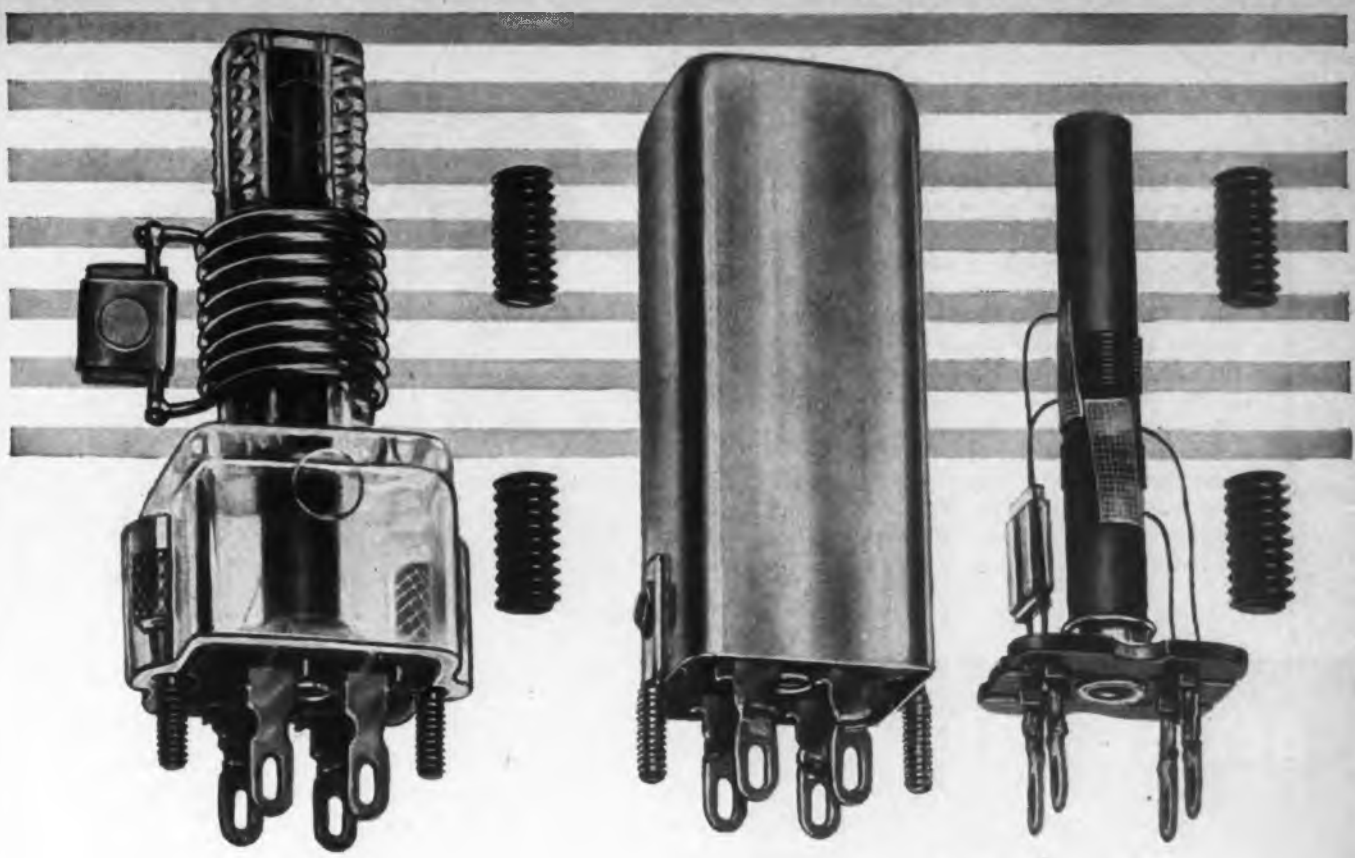

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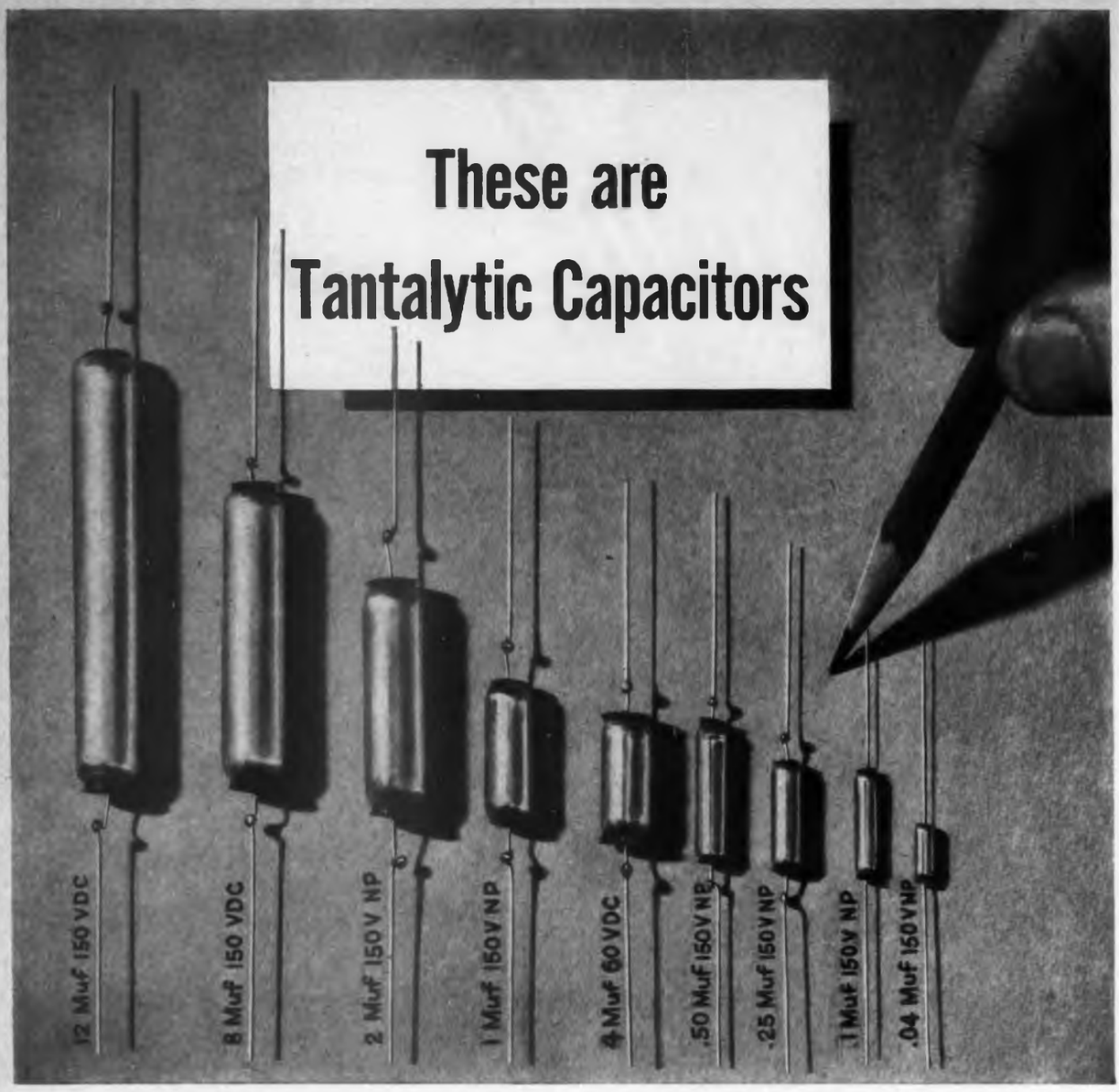

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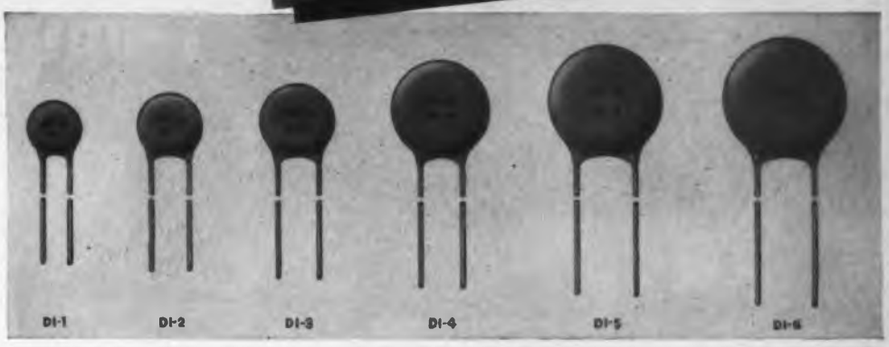


Illustrations approximately actual size.

Temperature Compensating DISK Capacitors

Capacity range from 475 mmf on the DI-6 N1400 material down to .3 mmf on the DI-1 size with tolerances of ± 5% or greater. Conservatively rated for working voltage at 500 volts DC and flash tested at 1500 volts DC. Insulation resistance at 100 volts is well over 10,000 megohms. Electrodes are fired directly to the low loss dielectric and are coated with a non-hydroscopic phenolic for protection against moisture and high humidities. Conform to RTMA Class 1 ceramic capacitors.

Extended Temperature Compensating DISK Capacitors

Produced from a recently developed group of extended coefficient ceramics, this type of **HI-Q** Disk permits a much wider temperature compensating range than was possible on the formerly available normal linear temperature coefficient ceramics. Specifically developed for applications requiring a very large gradient of capacity versus temperature. These new **HI-Q** Disks exhibit relatively higher dielectric constants permitting capacities in the range intermediate between the high K and linear or normal group of ceramics. The Q (a minimum of 250 at 1 megacycle) is somewhat lower than the Class 1 ceramics. It has, therefore, not been classified by RTMA as Class 1. However, characteristics are superior to by-pass Class 2 ceramics.

ALL HI-Q DISK CAPACITORS COME IN THESE SIX SIZES

Type	Diameter	Lead Width	Thickness
DI-1	5/16" Max.	3/16" ± 1/16"	5/32" Max.
DI-2	3/8" Max.	1/4" ± 1/16"	5/32" Max.
DI-3	7/16" Max.	1/4" $+\frac{1/8"}{0"}$	5/32" Max.
DI-4	19/32" Max.	1/4" $+\frac{1/8"}{0"}$	5/32" Max.
DI-5	11/16" Max.	3/8" ± 1/8"	5/32" Max.
DI-6	3/4" Max.	3/8" ± 1/8"	5/32" Max.

Companion Lines to the Popular HI-Q By-pass DISK Capacitors

The widely used **HI-Q** By-pass Disks are fixed ceramic dielectric capacitors which meet RTMA Class 2 specifications. They are available in the complete capacity range of from .3 mmf to 30,000 mmf. Standard tolerances of 5% thru 20% where applicable can be furnished.

Write for Engineering Bulletin Giving Details of all HI-Q DISK Capacitors

HI-Q*

**Trade Mark Registered, U. S. Patent Office*

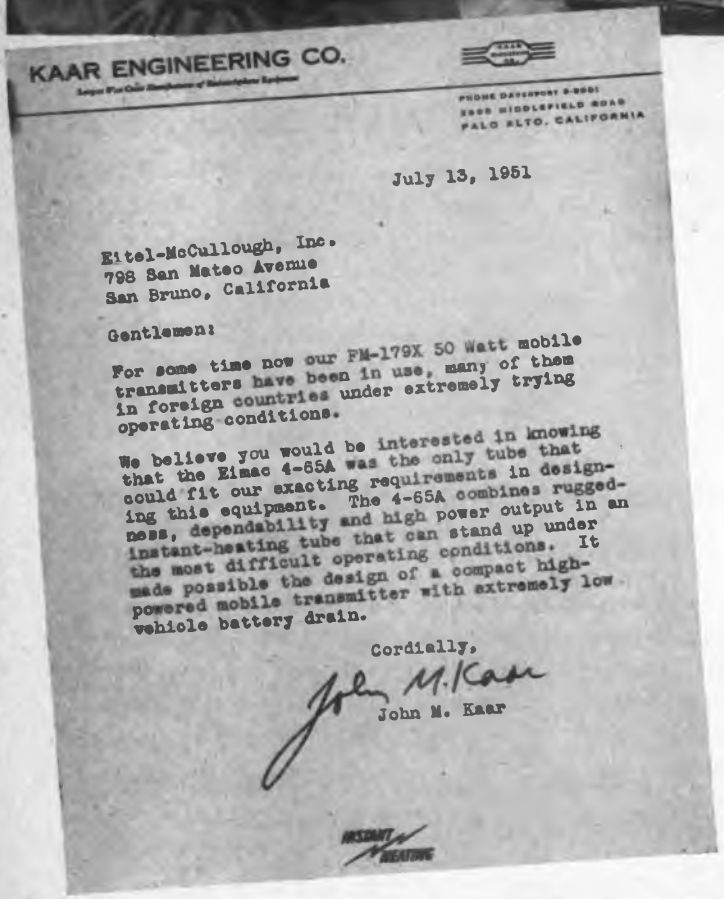
Electrical Reactance Corp.
OLEAN, N. Y.

SALES OFFICES: New York, Philadelphia, Detroit, Chicago, Los Angeles

PLANTS: Olean, N. Y., Franklinville, N. Y. Jessup, Pa., Myrtle Beach, S. C.

You don't have to look, because THERE ARE NO SPLICES in audiotape*

John M. Kaar, President of Kaar Engineering Co., prominent manufacturers of high quality radio-telephone equipment.



KAAR ENGINEERING CO.

PHONE DAVENPORT 6-8001
2905 MIDDLEFIELD ROAD
PALO ALTO, CALIFORNIA

July 13, 1951

Eitel-McCullough, Inc.
798 San Mateo Avenue
San Bruno, California

Gentlemen:

For some time now our FM-179X 50 Watt mobile transmitters have been in use, many of them in foreign countries under extremely trying operating conditions.

We believe you would be interested in knowing that the Eimac 4-65A was the only tube that could fit our exacting requirements in designing this equipment. The 4-65A combines ruggedness, dependability and high power output in an instant-heating tube that can stand up under the most difficult operating conditions. It made possible the design of a compact high-powered mobile transmitter with extremely low vehicle battery drain.

Cordially,

John M. Kaar

John M. Kaar

INSTANT HEATING

Eimac 4-65A tetrodes are the heart of the Kaar FM-179X mobile transmitter. As Mr. Kaar indicates, his engineers chose these tetrodes because they were known to be outstandingly dependable and because they exhibit highly desirable operating characteristics.

The 4-65A is excellent for power amplifier and modulator service in both fixed and mobile stations. They operate over a plate voltage range from 600 to 3000 volts with output powers ranging from 50 to 280 watts per tube. Upper operating frequency of the 4-65A under normal conditions is 220 Mc.

Put Eimac 4-65A tetrodes to work for you . . . take advantage of their proved performance and low cost. Complete data available upon request.

Follow the Leaders to Eimac TUBES The Power for R-F

301

EITEL-McCULLOUGH, INC.
San Bruno, California

Export Agents: Frazar & Hansen, 301 Clay St., San Francisco, California

. . . but this "transparency test" shows some other important things about Audiotape quality

■ When you hold a reel of plastic base Audiotape up to the light, notice its extremely uniform translucency—free from dark rings or fuzzy areas. You can see your fingers right through it, sharply outlined against the light. This is proof of the clean, straight line slitting that makes Audiotape track and wind absolutely flat. There are no rough or turned-over edges which would lift the tape away from the heads, causing loss of high-frequency response. Of course this test also proves that the tape is entirely free from splices. But with Audiotape you can be sure of that without looking. For all 1250 foot and 2500 foot reels of plastic base Audiotape are *guaranteed splice-free!*

You can *see* the output uniformity of Audiotape, too. For every 5-reel package includes an Esterline-Angus output chart, showing the measured output of the entire length of one of the reels in the package. And since all 5 reels are slit from the same roll after coating, the chart actually measures the uniformity of all the tape in the package. This gives positive visual proof of Audiotape's unequalled output uniformity.

NO OTHER TAPE OFFERS YOU ALL OF THESE EXTRA-VALUE FEATURES:

- **Splice-Free Reels.** All 1250 and 2500 foot reels of plastic base Audiotape are *guaranteed* to be free from splices.
- **Unequalled Uniformity.** Plastic base Audiotape is guaranteed not to exceed ±¼db within the reel and ±½db from reel to reel.
- **Output Curves** in every 5-reel package of plastic base Audiotape show actual measured output of the tape contained in the package.
- **Maximum Output with Minimum Distortion.** Oxide formulated to give high output at bias which results in low harmonic distortion.
- **Safe-Handling Package** for 2500 and 5000 foot reels permits loading onto turntable without danger of spilling tape from hub, simplifies attachment of reel flanges, and provides safe storage without flattening bottom of roll.

*Trade Mark

AUDIO DEVICES, Inc.

444 Madison Avenue, New York 22, N. Y.

Export Dept.: 13 East 40th St., New York 16, N. Y. Cables "ARLAB"

BIGGER PLANES?
. . . or smaller capacitors?

In the black of night a plane steals in miles overhead. Suddenly, capacitors discharge into an electronic flashtube and a flash of light stabs through the darkness for the briefest instant as a synchronized camera shutter clicks . . . The enemy position below is recorded on film . . . The photo reconnaissance plane streaks homeward . . .

A normal military mission, of course . . . but one made possible by the development of Vitamin Q☆ energy storage capacitors to meet the severe requirements of this photo-flash application.

These space-saving Sprague capacitors literally made this type of aerial night photography practical, since they are only one-fifth the size and weight of capacitor energy-storage banks composed of "standard" general duty units made to joint Army-Navy specification JAN-C-25.

Like many other Sprague components, these special capacitors were designed to meet size, weight, and electrical requirements that were impossible with "standard" units. Naturally, the Sprague Electric Company produces standard JAN components by the thousands, but it realizes that standards are not meant to limit progress.

Wars are not won by standing still . . .

If your military production faces special problems that cannot be solved by use of standard capacitors, resistors, pulse networks, interference filters, or magnet wire, Sprague probably has the answer at its finger-tips.

Write today to the Application Engineering Section, Sprague Electric Company, North Adams, Massachusetts.

☆ Vitamin Q is a registered trade-mark of the Sprague Electric Company for an exclusive organic-polymer capacitor impregnant with unusually excellent electrical and temperature characteristics

SPRAGUE

PIONEERS IN ELECTRIC AND ELECTRONIC DEVELOPMENT

INSTANT ACTION!

NEW KESTER "44"
RESIN CORE SOLDER

ESPECIALLY FOR TV . . . RADIO WORK . . . EVERYTHING ELECTRONIC

In speed of action for fast soldering, this product far surpasses anything in the Industry today. Unbelievably more active and mobile . . . absolutely non-corrosive and non-conductive.

For an actual demonstration in your plant, contact Kester's Technical Department.

KESTER SOLDER

Conforms with following specifications:
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Army-Navy-Air Force Mil-S-6872 (AN-S-62)
U. S. Air Force No. 41065-B-Method 31

KESTER SOLDER COMPANY
4210 Wrightwood Ave., Chicago 39
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TELE-TECH NOW HAS NEW PROOF OF ITS

CABLE AUDIVICES, NEWYORK
PLAZA 3-0973

AUDIO DEVICES, Inc.
Manufacturers of Precision Equipment
for Reproduction and Recording . . . Audiodiscs
444 MADISON AVENUE, NEW YORK 22, N. Y.

October 26, 1951

Mr. M. Clements, Publisher
TELE-TECH
480 Lexington Avenue
New York, 17, New York

Dear Mr. Clements:

Some of the claims you made several weeks ago concerning TELE-TECH seemed so extraordinary that I decided to check your publication's readership by means of a survey to broadcast station engineers. We wrote to every second chief engineer listed in the 1951 Broadcasting Yearbook. There was more than a 43% return to this questionnaire -- which seemed to us to be exceptionally good. The questions and answers were as follows:

1. Question: Do you receive TELE-TECH regularly?
   Answer : 93% said yes.

2. Question: Do you read TELE-TECH regularly?
   Answer : 97% of those who receive it said yes.

3. Question: How do you rate TELE-TECH?
   Answer : 60% said "excellent, very good, tops, superior, etc."
   27% said "good" or its equivalent in comments.
   11% said "o.k., fair, average".
   2% said they were not interested.

Such a good return from so large a mailing seems to me to give added significance to the figures. 97% readership among the 93% receiving the magazine is most impressive. Also, the 87% rating the publication as good to excellent calls for hearty congratulations. There were so many voluntary statements regarding TELE-TECH's editorial section that I am sending you copies of several hundred of these comments on a separate sheet, without any names being mentioned.

I was so impressed over the high standing of TELE-TECH in the communications field that I want to discuss with your sales manager, Mr. Reed, the possibility of buying a preferred position in connection with one of the editorial features which was most frequently mentioned by the engineers.

Very truly yours,

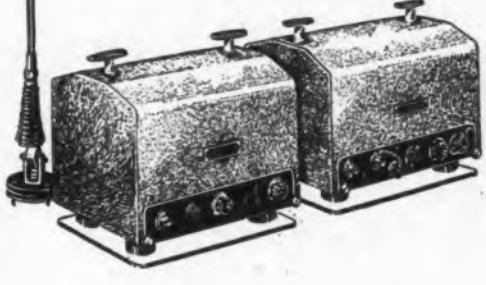
Bryce Haynes

Bryce Haynes
Vice President

BH:cba

Photostatic copies of Mr. Haynes' letter to chief engineers or copies of the questionnaire used, available on request.

Watch for other independent tests of **TELE-TECH's** readership



Radio Set AN/VRC-2

Power Output	*30 watts*
Freq. Range	*30-40mc crystal controlled*
Receiver Sensitivity	*.35 uv. double superhet.*
Temp. Range	*−40°F to +160°F*

THE TEST OF QUALITY

IS . . . *Performance!*

Yes, the test of quality is performance—faithful and dependable, made possible only by design and construction adequate to the intended purpose. For the past three years, Utility Electronics has been producing two-way mobile communication equipment for the U.S. Army Signal Corps. Thousands of these AN/VRC-2 Radio Sets have been utilized by Army and Air Force personnel in a wide assortment of vehicles from jeeps to tanks. This equipment, as manufactured by Utility Electronics Corporation, has successfully demonstrated under the most rugged conditions its ability to withstand THE TEST OF QUALITY. This is only one of the many ways in which Utility's design and production know-how are serving the U.S. Government.

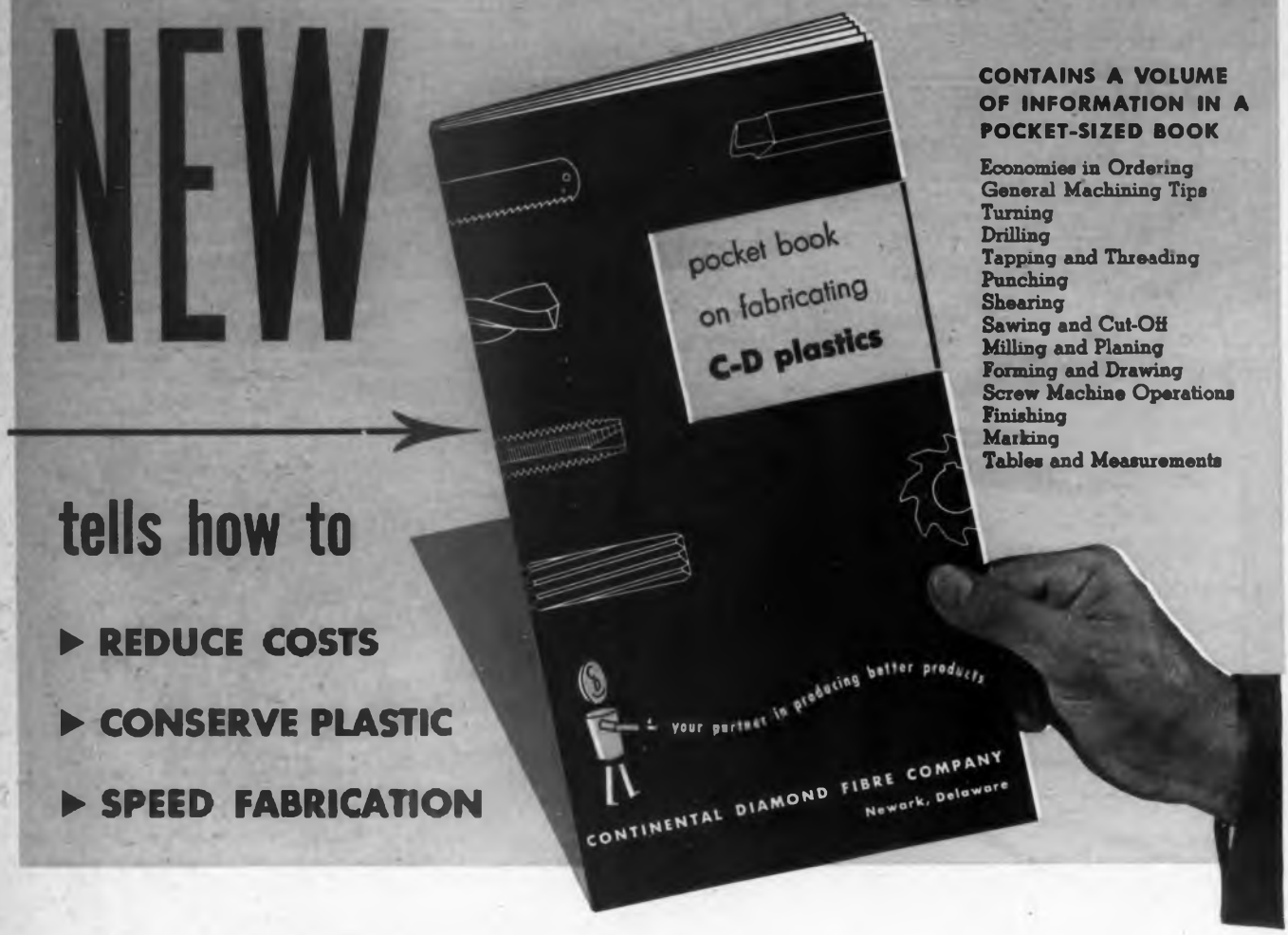
For the future—Utility Electronics Corporation is investigating possible commercial application of military communication equipment like Radio Set AN/VRC-2.

Utility Electronics Corporation

231 Grant Avenue East Newark, N. J.

Manufacturers of **ELECTRONIC AND ELECTRO-MECHANICAL EQUIPMENT**

NEW



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Tele-Tech

Advertisers - December 1951

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RELAYS FOR EVERY PURPOSE

Over a Million in Stock!

Each relay is brand new, standard make, inspected, individually boxed and fully guaranteed.

The following list represents only a portion of our relay stock. Write or wire us for information on types not shown.

STANDARD DC TELEPHONE RELAYS

Stock No.	D.C. Voltage	Ohmage	Contacts	Unit Price
R-806	115*	900	1A	$2.05
R-161	6	10	2B & 1A	1.10
R-518	85/125	6500	1C	3.60
R-632	180/350	10,000	1C & 5 Amps. Oct. Rht.	2.90
R-667	6	.75	1B/10 Amps. 1A/3 Amps.	2.45
R-632	6	12	5A & 1C	1.45
R-154	6/12	200	1A	1.25
R-517	12	250	2A	1.50
R-116	85	3000	1B	1.50
R-631	100/125	3300	2A	3.05
R-545	110/250	7000	1C	1.90
R-124	300	12,000	1A	2.45
R-160	6	12	3C & 3A	1.55
R-155	12	100	4A & 4B	1.30
R-520	200/300	14,000	2C	1.45
R-159	6	50	2A	3.45
R-153	12	200	1C 1A	1.35

SHORT TELEPHONE RELAYS

R-635	12	100	1C & 1A	$1.35
R-826	12	150	2C, 1B	1.55
R-770	24	150	1A/10 Amps.	1.45
R-771	24	200	1A/10 Amps.	1.45
R-603	18/24	400	2A	1.55
R-575	24	500	2C	2.40
R-764	48	1000	2C & 2A	2.00
R-563	60/120	7500	1A	1.70
R-801	115*	——	None	1.45
R-213	5/8*	——	2A	3.10
R-589	12	125	2A	1.30
R-113	12	150	4A	1.55
R-639	12/24	255	1C	1.55
R-799	24	500	None	1.00
R-115	24	500	1C	1.70
R-110	24/32	3500	1C	1.70
R-121	150	5000	2A & 1C	2.05
R-634	150/250	6000	1A & 1B	2.45
R-800	12	150	2C 1A	1.55
R-537	12/24	150	2C 1B	2.00
R-750	24	400	1A	1.60

CONTACTORS

R-650	24	100	1A/50 Amps.	$3.70
R-312	24	7	1A/200 Amps.	5.50
R-333	98/120	975	4A/Size 2	5.50
R-334	115	1200	3A/Size 2	5.50
R-338	6	7.5	1A/50 Amps.	3.45
R-353	65*	——	2A	2.95
R-358	18/29	200	1A/Dble. Brk.	2.00
R-445	14	12.5	1A/200 Amps.	4.05
R-446	12	18	1A/50 Amps.	3.90
R-447	12	18	1A/50 Amps.	3.90
R-448	24	67	1A/50 Amps.	3.90
R-449	28	160	1A/50 Amps.	3.90
R-450	24	75	1A/50 Amps.	3.90
R-188	24	200	1A/75 Amps.	3.70
R-183	24	60	1A/50 Amps.	3.45
R-187	24	100	1A/50 Amps.	3.70
R-554	24	85	2A/100 Amps.	5.90
R-788	100*	——	3B & 2A	5.45
R-682	115*	35	5A/10 Amps.	6.10
R-767	24*	20	2A/10 Amps.	4.95
R-180	12	25	1A/50 Amps.	4.05
R-365	24	60	1A/100 Amps.	3.45
R-585	24	70	1A/100 Amps.	4.80
R-566	24	70	1A/100 Amps.	4.80
R-557	24	100	1A/50 Amps.	3.85
R-178	24	100	1A/100 Amps.	4.80
R-608	24	125	1A/200 Amps.	2.80
R-184	28	50	1A/100 Amps.	4.90
R-719	24	10	1A/200 Amps.	4.95
R-182	28	80	1A/25 Amps.	2.40
R-344	75*	265	1A/20 Amps.	2.20
R-859	12	7.2	2A/20 Amps.	1.70
R-562	24	70	4A/50 Amps.	5.35
R-185	24	100	1A/50 Amps.	3.45
R-186	24	132	1A/50 Amps.	4.35
R-817	24	150	1A/50 Amps.	3.45
R-534	14	45	1A/30 Amps.	2.05
R-223	28	150	1A/40 Amps./48 VDC.	1.70
R-680	6	3	1A/50 Amps.	3.90
R-677	6	3.5	1A/50 Amps.	3.90
R-532	6	15	1A/50 Amps.	3.90
R-676	12	16	1A/50 Amps. 1AUX/25A	3.90

ROTARY RELAYS

R-712	24	200	2B	$2.05
R-711	24	200	2C & 1B	2.05
R-573	28	200	1C & 1B	2.05
R-766	24	230	12 Pos. 3 Dec.	4.90
R-809	28	7	1B & 12 Pos. W/ 7" Shaft for Wafers.	2.45

DIFFERENTIAL RELAYS

R-208	120	2000	2C/3 Amps.	$2.45
R-209	220/250	8000	1C/3 Amps.	3.10

SEALED RELAYS

R-261	12/24	1900	1C/ Pin Plug	$3.75
R-673	48/150	7500	1C/5 Amps.	2.80

VOLTAGE REGULATORS

R-745	6	2	1A/10 Amps.	$1.05
R-780	24	350	1C/6 Amps.	1.05
R-509	6/12	35	1B/2 Amps.	1.05

SPECIAL RELAYS

R-503	12/32	100	3A, 2C	$13.50
R-749	600	——	Max. 28 Amps.	7.45
R-804	550*	——	1B/38 Amps.	4.35
R-579	220*	——	1B	8.70
R-294	27.5	200	1B	5.35
R-686	115*	——	2C	6.10
R-246	115*	——	1B	11.20
R-246A	115*	——	1A	11.20
R-611	24*	——	1A/30 Amps.	5.35
R-283	12	125	1C/10 Amps.	4.35
R-614	18/24	60	1A/15 Amps.	4.35
R-245	12	25	4" Micalex Lever	3.20
R-527	6/12	50/50	In Series	1.20
R-544	12/24	60/60	1C	2.05
R-255	——	——	1A	3.50
R-669	75*	400 Cy.	1B, 1A	1.20
R-660	6	——	3/8" Stroke	1.20
R-651	24	100	Solenoid Valve	3.10
R-295	12	275	Annunciator Drop	2.70
R-230	5/8	2	2A, 1C	2.70
R-813	12	12	Wafer	5.35
R-275	12	750	1A, 1B, 1C	3.45
R-716	24	70	2A/5 Amps.	1.80
R-620	6/12	35	2C, 1A	1.30
R-629	9/14	40	1C/10 Amps.	1.55
R-720	24	50	3C Ceramic	1.70
R-500	12	10/10	2C/6 Amps.	3.55
R-816	12	10/15	2C/6 Amps.	3.55
R-524	24**	——	——	1.20
R-566	115*	Coil Only		1.00
R-710	——	150 Coil Only		.75

KEYING RELAYS

R-714	9/14	65	2C/5 Amps.	$1.55
R-850	12	450	1A/1.5 Amps.	1.50
R-721	18/21	290	2C/5 Amps.	1.55
R-694	24	300	1A/5 Amps.	1.50
R-935	28	1000	1C/1.5 Amps.	1.65
R-949	2.4*	60 Cy.	1A/5 Amps.	1.95
R-704	2/6	25	2B/5 Amps.	1.35
R-173	2/6	2	1A	3.00
R-280	6/8	77	1A Dble. Brk.	2.45
R-647	6/12	15	1B/20 Amps.	1.45
R-273	20	160	2A/15A Dble. Brk.	3.55
R-169	24	200	1A	2.45
R-570	24	230	1B Dble. Brk.	2.70
R-960	24	230	3C/15 Amps.	2.95
R-529	24/48	1020	3C	3.10
R-715	24	——	2C Ceramic	3.70
R-584	6	20	1A Dble. Brk.	1.30
R-192	12	44	3C/10 Amps.	1.70
R-204	12	66	2A	1.45
R-224	12	85	1A	1.45
R-221	18/24	5000	1A	2.00
R-205	24	260	2C	1.55
R-891	24	475	1C/5 Amps.	1.45
R-536	27	230	2C	1.55
R-858	27.5	250	1A Dble. Brk.	1.45
R-833	6.5	1300	2C	3.05
R-220	75	5000	1C	1.50
R-828	6/8	42	1A	1.50
R-627	115*	——	1B Dble. Brk.	3.10
R-734	24	150	3C/10 Amps.	1.30
R-598	28	185	2C	1.30
R-622	20/30	200	3A & 2C/10 Amps.	1.45
R-274	24*	——	2A	1.55
R-855	110*	60 Cy 160	1A Dble. Brk./15 A	3.25
R-277	12	30	2C-D Break Cera	2.20

MIDGET RELAYS

R-572	24	256	1C	$1.25
R-857	24	260	1 Make Before Make	1.75
R-912	4/5	20	3A-1C Ceramic	2.50
R-291	6	5	1A	1.25
R-921	6.7	18	1A Dbl. Brk. @10 Amp.	1.45
R-738	12	60	3A	1.20
R-922	12	75	1A Dbl. Brk. @10 Amp.	1.45
R-144	12	228	1A	1.45
R-145	18/24	250	2A Ceramic	1.45
R-298	21	300	1A	1.25
R-296	21	300	1A	1.25
R-586	21	300	1A & 1C	1.25
R-137	24	300	1C	1.45
R-142	24	400	2C	1.50
R-785	24	200	2C/10 Amps.	2.00
R-607	24*	——	1A	1.20
R-606	24*	——	1A & 1B	1.20
R-605	24*	——	3A	1.20
R-728	6	30	1A	1.25
R-149	6/8	45	1B	1.50
R-732	12	120	1A	1.45
R-281	12	126	2A	1.25
R-818	18/24	300	1B	1.30
R-135	24	250	1B	1.45
R-133	24	300	None	.75
R-138	24	300	4A	1.45
R-132	24	300	2C	1.50
R-731	24	300	2C	1.55
R-292	24	350	1C	1.25
R-626	24	400	1A/5 Amps.	1.55
R-786	60	1300	2C	2.00
R-588	90/125	6500	4C	2.70
R-755	24	300	1A	1.45
R-150	6	30	1A	1.50
R-893	14	150	1A, 1C	2.50
R-895	14	150	2A, 1B, 1C	2.50

*A.C. **AC/DC.

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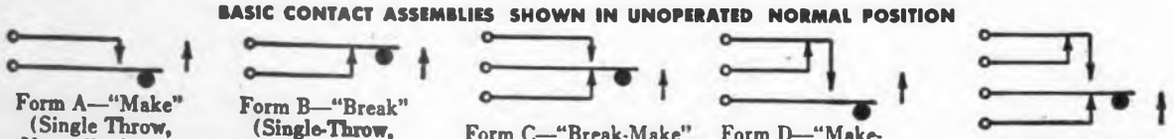
D153766 SPDT, 6 VDC. 19 Ohm coil. Designed to accommodate 75 watts maximum. Perfect for all types of antenna switching. Designed for using standard 83-1SP coaxial fittings. Part of RAX-1 equipment. No. R-846—**$6.95** Ea.

BASIC CONTACT ASSEMBLIES SHOWN IN UNOPERATED NORMAL POSITION



Form A—"Make" (Single Throw, Normally Open)

Form B—"Break" (Single-Throw, Normally Closed)

Form C—"Break-Make" (Double-Throw)

Form D—"Make-Before-Break"

Form E—"Break-Make-Before-Break"

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RCA-5893 "Pencil-Type" UHF Triode

RCA-5893 is a new, medium-mu, "pencil-type" triode employing a double-ended, coaxial-electrode structure. As a plate-pulsed oscillator in grounded-grid service, the 5893 will deliver a useful power output at peak of pulse of 1200 watts at frequencies up to 3300 Mc.

Maximum Ratings as Plate-Pulsed Oscillator

For max. total "on" time, in any 5000-μsec interval, of 5 μsec

Peak Positive-Pulse Plate Supply Voltage	1750 max. volts
Peak Negative-Pulse Grid-Bias Voltage	150 max. volts
Peak Plate Current from Pulse Supply	3 max. amp
Peak Rectified Grid Current	1.3 max. amp
Plate Dissipation	6 max. watts
Pulse Duration	1.5 max. μsec

RCA-5946 UHF Power Triode

RCA-5946 is a new forced-air-cooled power triode for use in circuits of the coaxial-cylinder type. In plate-pulsed service, the 5946 will deliver a useful power output at peak of pulse of 14 kw at a frequency of 1250 Mc.

Maximum Ratings as Plate-Pulsed Oscillator & Amplifier

For max. total "on" time, in any 1000-μsec interval, of	10 μsec	100 μsec
Peak Positive-Pulse Plate Supply Voltage	7500 max.	7500 max. volts
Peak Negative-Pulse Grid-Bias Voltage	600 max.	600 max. volts
Peak Plate Current from Pulse Supply	4.5 max.	3.5 max. amp
Peak Rectified Grid Current	1.0 max.	0.75 max. amp
Plate Dissipation	250 max.	250 max. watts

RCA-4C33 UHF Power Triode

RCA-4C33 is a forced-air-cooled power triode for coaxial-type circuits. For plate-pulsed service, it will provide a power output at peak of pulse of 130 kw at a frequency of 600 Mc.

Maximum Ratings as Plate-Pulsed Oscillator

Peak Positive-Pulse Plate Supply Voltage	13000 max. volts
Peak Negative-Pulse Grid-Bias Voltage	2000 max. volts
Peak Plate Current from Pulse Supply	30 max. amp
Peak Rectified Grid Current	4 max. amp
Plate Dissipation	250 max. watts
Pulse Duration	5 max. μsec

RCA-3E29 Twin-Beam Power Amplifier

RCA-3E29 is a twin-unit, beam power amplifier designed to handle a peak plate current of 10 amp. in pulse modulation service.

Maximum Ratings as Pulse Modulator (both units in parallel)

For pulse length of	1 max.	1.2 max. μsec
DC Plate Supply Voltage	5000 max.	5000 max. volts
DC Grid-No. 2 Supply Voltage	850 max.	850 max. volts
DC Grid-No. 1 Supply Voltage	−200 max.	−200 max. volts
Plate Input	85 max.	60 max. watts
Peak Grid-No. 2 Current	0.5 max.	0.5 max. amp
Plate Dissipation	15 max.	15 max. watts

For further technical data or design assistance on any RCA pulse tube, write RCA, Commercial Engineering, Section 57LR, Harrison, N. J., or contact the RCA Field Office nearest you.

FIELD OFFICES: (EAST) Humboldt 5-3900, 415 S. 5th St., Harrison, N.J. (MIDWEST) Whitehall 4-2900, 589 E. Illinois St., Chicago, Ill. (WEST) Madison 9-3671, 420 S. San Pedro St., Los Angeles, Calif.

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