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- * RADIO ENGINEERING
- * THE RADIO PROXIMITY FUSE
- * TUNED P-A NEUTRALIZING CAPACITOR DESIGN
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1945

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The C.T.C. Terminal Lugs pictured in the inserts are shown actual size.





Left: C.T.C. Double End Terminal Lugs provide two terminal posts in one swaging operation. May be wired from top or bottom. Electrical connection perfect because both posts are part of same lug. Stocked in $\frac{3}{32}$ " terminal board thickness. hole through

Center: C.T.C. Split Terminal Lugs have a .050" them permitting wiring from top or bottom side out drilling. Stocked to fit 3/2" terminal board. Ideal for

other potted units. Right: C.T.C. Turret Terquickly, making wiring $\frac{3}{16}$ and $\frac{1}{4}$ terminal soldering space.



minal Lugs have two soldering spaces. Lugs heat firm and neat. Made to fit 1/32", 1/16", 3/32", 1/8", board thicknesses. Also available with single

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Electro Voice

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Poly-Directional with Adjustable Polar Pattern The versatile high fidelity Cardak

is readily adjustable to reduce any combination of reflected sound. Cuts reverberation or random noise pick-up . . . minimizes acoustic feedback. For broadcasting, recording, public address, communications. Model 725—Cardak I. List.....\$55

Model 725—Cardak I. List....\$55 Model 730—Cardak II. List....\$75



Maximum Intelligibility Under Extreme Noise

Hand-Held, close-talking single button carbon *DIFFEREN-TIAL microphone for all speech transmission in any noisy, windy, wet or extremely hot or cold locations. Cancels out background noise. Articulation is at least 97% under quiet conditions, and 88% under a 115 db noise field. Model 205-S. List Price.......\$25 *Patent No. 2,350,010



General-Purpose Dynamic for Voice and Music

Widely used because of its dependable all-arcund performance. Excellent frequency response for both indoor and outdoor speech and music pick-up. Rugged, small size, light weight. High output. Suitable for public address, dispatching, paging, recording and remote broadcast. Model 630-C. List Price......\$30



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Bi-Directional Sound Pick-Up Wide, flat frequency response, bi-directional polar pattern, high fidelity characteristics, wideangle front pick-up, and pick-up range make it ideal for solo, orchestra, or chorus, for single speaker or groups. For indoor P.A., broadcasting, recording. Model V-1-C. List Price.....\$30 Model V-2. List Price.....\$37.50 Model V-3. List Price.....\$50



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Gives valuable data on Electro-Voice Microphones for communications, public address, broadcasting and recording. Includes helpful Reference Level Conversion Chart.

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ELECTRO-VOICE, INC., 1239 South Bend Ave., South Bend 24, Indiana * Export Division: 13 East 40th St., New York 16, N. Y., U. S. A.— Cables: Arlab COMMUNICATIONS FOR OCTOBER 1945 • 1

We See.

RESEARCH APPEARS TO HAVE BECOME AN influential factor in many reconversion programs in a variety of industries, particularly communications. Formerly relegated to a minor activity of a few. research today finds itself not only the prime project of substantial staffs, but as a favored asset by management. While the war accented the progressive advantages of research, prewar research had also demonstrated its long-term value. Many of the fundamental concepts established during peacetime served as the bases of innumerable successful wartime projects.

In the halls of Congress, research has also become a featured topic of discussion. A number of bills before the House provide for specialized governmental research programs to increase our world scientific leadership.

Aware that the usual commercial requisites interfere with pure research progress. many industries have removed these barriers and initiated extremely flexible longterm programs . . . programs that will afford unusually wide-scope research activity.

During a recent debate in Washington on the value of research to government and industry a leading government communications specialist said: "Research is a sound investment in the future."

Sound comment!

THE PAST MONTHS HAVE FOUND EVERYONE IN RAILROAD RADIO communications extremely active. Dozens of plans have now become actual installations throughout the country.

According to R. A. Clark, Jr., railroad radio specialist of Chicago, it appears as if around 40,000 fixed, mobile and portable stations may be installed by the roads during the next few years. This estimate covers equipment for engines, cabooses. passenger cars and fixed stations. These data are predicated on the present rolling stock, which is expected to increase, and which should, therefore, increase the number of required communications units.

Frequencies tested recently have ranged from 30 to 2,000 mc. Tests on 2,000 mc using f-m have been very encouraging. According to Mr. Clark, operation at this high frequency was found to be very satisfactory regardless of the territory, and that included operation through an extremely long tunnel. It's a general consensus that railroad-

radio communications development will now proceed at an accelerated pace and many railroads will install equipment as fast as it can be made available and as quickly as FCC assigns the necessary frequencies .--- L. W.



OCTOBER, 1945

VOLUME 25 NUMBER 10

COVER ILLUSTRATION

Control room of the Great Lakes radiotelephone system at Lorain, Ohio. (Courtesy R. C. Hakanson)

MILITARY SUB-MINIATURE RECEIVER-TRANSMITTER DESIGN

The Radio Proximity Fuze......Ralph G. Peters 48

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SYLVANIA NEWS Electronic Equipment Edition

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72

Published by SYLVANIA ELECTRIC PRODUCTS INC., Emporium, Pa.

SYLVANIA CATHODE RAY TUBES NOW AVAILABLE

Ready for New Television Sets To Be Produced

Sylvania Electric announces the welcome news that cathode ray tubes are once more available for the manufacturers of television sets.

Constant research in this field, combined with wide experience in large-



Sylvania Electric precision-built cathode ray tube now available to television set manufacturers.

scale production to meet war requirements, has placed Sylvania in a position to manufacture these tubes to a much higher standard than ever before.

This is an important factor to manufacturers of television receivers whose "plans" are rapidly becoming realities.

Check today with Sylvania Electric Products Inc., Emporium, Pa.

MANY MANUFACTURERS TO USE ELECTRICALLY SUPERIOR TUBE

Sylvania Lock-In Radio Tube Ideal For FM, Television, Radar

With the increasing trend toward higher frequencies—as shown by recent FCC decision assigning FM the band between 88 and 106 megacycles —set manufacturers will tend, more than ever, to use a tube ideally suited to the adoption of these very high frequencies.

The Sylvania Lock-In is *known* to be electrically and mechanically superior to any tube made.

Electrically, it is more efficient because the element leads are brought directly down through the low-loss glass header to become sturdy socket pins-reducing lead inductance-and interelement capacity.

1945

Mechanically, it is more rugged because support rods are stronger and thicker—there are fewer welded joints and no soldered joints—the lock-in lug is metal, not molded plastic—the elements are prevented from warping and weaving.

Today, set manufacturers considering the many developments in the field of communications, are looking to the Sylvania Lock-In Tube as a perfect electronic unit—the tube built to handle ultra-high frequencies.



The Sylvania Lock-In Tube showing construction-electrical and mechanical-that makes it superior to any tube made.

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better way to hermetically seal transformers ... relays ... condensers ... rectifiers ... switches. The HermetiCan* is a FUSITE original. Wide range of can sizes. Any number of terminals . . . from one to nine or combinations, thereof. FUSITE terminals are now available in two different styles: (1) Hollow Tube; (2) Flattened and Pierced.

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No more "special orders" to obtain suitable resistors to withstand the extreme thermal and humidity conditions to which your product may be subjected in many parts of the world! STANDARD Sprague Koolohm Wire-Wound Resistors now incorporate these extra protection features - and this means that you can count on STANDARD Sprague Koolohms for maximum dependability in ANY climate, ANYwhere on

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SPRAGUE



ELECTRIC COMPANY, Resistor Division, North Adams, Mass. COMMUNICATIONS FOR OCTOBER 1945

SPRAGUE

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IN TUBE MANUFACTURE IN TUBE MANUFACTURE ALL SMALL DETAILS ARE LARGE TO Federal

From slender filament to anode block ... all tube construction details, however small, are important to Federal. That is why this experienced and longtime manufacturer uses the illustrated high-magnification metallograph as part of its test equipment for checking raw material quality.

An example is the micro-photo inset. Here is shown oxide-free, high conductivity copper used for copper-to-glass seals . . . after the material has been reduced to a fine grain, nonporous structure through Federal's special metal-processing methods.

But whether copper, molybdenum or tungsten... they all are subjected to the same exclusive treatment and put through the same searching scrutiny... assurance that only the finest materials go to make up Federal tubes.

This exacting test is another good reason why Federal tubes are better tubes. Transmitting, rectifier, industrial power... they have a reputation that is deserved because they are *built to stay*.

Federal always has made better tubes.



COMMUNICATIONS FOR OCTOBER 1945 • 7

Federal Telephone and Radio Corporation

T WAS 50 YEARS AGO, on November 8, 1895, that scientific investigation led Roentgen to the discovery of X-rays. In this semi-centennial year we honor his work, and the work of the pioneers who, sometimes at the sacrifice of their own lives, developed the theory and practice of a science that today means so much to all mankind.

Very soon after Roentgen publicly announced his discovery in 1896, Robert H. Machlett made the first practical American X-ray tube. Quickly he improved his techniques, creating a whole series of "firsts" such as the first ray-proof tube, the first cooled by water, the first for contact therapy. The organization he founded carries on his principle of constant research, improvement and initiative, and has many other firsts to its credit, culminating in the amazing and unique 2,000,000-volt, direct current, sealed-off, precision X-ray tube. To a large extent, X-ray history is Machlett history, a history of service to mankind. Today, Machlett tubes are in use by doctors, hospitals, laboratories and factories in mary parts of the world, saving lives inspecting products, performing delicate analyses, expanding man's knowledge, serving with unmatched exactitude and economy, for the future, Machlett's talents will create other and still more valuable applications, for Machlett never stands still, is always creative, improving its tubes, developing new ones for old and new services.

In addition to X-ray tubes for all purposes, we also make oscillators, amplifiers and rectifiers for radio and industrial uses, all to the same high (and unmatched) standards to which our X-ray tubes are held. It will pay you to buy Machlett tubes. For information as to the available types, write Machlett Laboratories, Inc., Springdale, Connecticut.

50 YEARS OF X-RAYS

YEARS OF

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ELECTRON TUBES

X-RAY HISTO



Transformer tube

Pyrex heavy anode builb tube, type MR



Small shockproof tube, type CYS

Sec. Sec.



Silver bearing long-life rotating target tube, type DX



Tube with beryllium window and hooded anode, 250 k. v., type IR



2,000,000 volt direct current precision radiographic tube, type VM



COMMUNICATIONS FOR OCTOBER 1945 • 9

From the Beginning

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"When in 1895 Professor Roentgen announced his discovery, Machlett was immediately interested and began experiments to reproduce the results of Roentgen. He was ideally equipped for such work, for just at that time he had perfected a mercury pump capable of producing a very high vacuum. He attacked the difficult task and before many days had passed, succeeded in producing the first X-ray tube in this country."—I. S. Hirsch, Radiology 8:254, 1927.

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OLD Man Centralab knows what he is talking about . . . for today it is as true as it was twenty years ago . . . that Centralab Radiohms represent QUALITY in Volume Controls. Today the service man cannot afford to take chances so he must be doubly sure. That is why, if he is wise, he will always specify CENTRA-LAB for all his replacement jobs.

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Post VJ Day production of Bliley acid etched* crystals for FM receivers. Aircraft and Marine radios, Railroad communications equipment and many other applications is proceeding with the same skill and efficiency that marked our wartime operations. Substantial quantities of these crystals are in the hands of foresighted manufacturers who planned in advance with Bliley engineers for frequency stabilization in their postwar models.

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need the versatile experience of Bliley engineers and craftsmen gained through more than 15 years of quartz crystal engineering exclusively. Whether your requirements are one crystal or a million, you can be sure of top qualitytop design-and top performancein Bliley crystals.

*Acid etching quartz crystals to frequency is a patented Bliley process.

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Radio Engineerswrite for temporary **Bulletin CM-26**

BLILEY ELECTRIC COMPANY . UNION STATION BUILDING ERIE, PENNSYLVANIA

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Thousands of testimonials are in the files at Hallicrafters. They are from members of the armed services all over the world. They tell how Hallicrafters-built communications equipment has performed dependably and brilliantly on all the battle fronts of the world. Many of these letters are signed by licensed amateurs who include their call letters with their signatures. A high percentage of the letters conclude with sentiments like these — we quote: "If a rig can take it like the HT-9 took it in the Australian jungles, it's the rig for my shack after the war''... "When I buy my communications equipment it will be Hallicrafters". . . "After we have won this war and I can get a ham ticket there will not be the slightest doubt as to the equipment I will use . . . it will be Hallicrafters''. . . ''Meeting Hallicrafters gear in the service was like seeing someone from home . . . I used to have one of your receivers at W7FNJ . . . hope to have more after the war''''being an old ham myself I know what went into the 299'' Thus does the voice of the amateur come pouring into Hallicrafters headquarters, providing information, guidance and further inspiration to Hallicrafters engineers. Amateurs will find in Hallicrafters peacetime output just the equipment they need refined and developed in the fire of war and continuing to live up to the well earned reputation as "the radio man's radio."

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The bulletin includes such useful information as electronic applications, performance features, principles of operation, operating characteristics, graphs, specifications of the three immediately available designs, cased, uncased, and endbell, and a price list.

We urge you to send for your copy promptly. Ask for Bulletin DL48-537, and address your request to Raytheon Manufacturing Company, Electrical Equipment Division, Waltham 54, Mass.



STABILIZED TO 2 ONE HALF PERCENT



Here is the difference in pickup patterns between the Cardioid and the Shure Super-Cardioid Microphone. Maximum sensitivity (100%) is achieved by sound approaching the Microphone, directly at the front. At 60° off the front axis sensitivity of the Super-Cardioid is only slightly less than the sensitivity of the Cardioid (69% against 75%). The Super-Cardioid insures, therefore, a wide range pickup at the front. Beyond the 60° angle, the sensitivity of the Super-Cardioid decreases rapidly. At 90°, the sensitivity of the Cardioid is 30%; the super-Cardioid $37\frac{1}{2}\%$; $12\frac{1}{2}\%$ less. For sounds approaching at a wide angle at the back (110° to 250°) the sensitivity of the Cardioid is 33%; the Super-Cardioid $15\frac{1}{2}\%$ or $17\frac{1}{2}\%$ less. It has been proved mathematically that the ratio of front to rear pickup of random sound energy is; *Cardioid* 7:1; Super-Cardioid 14:1.

This additional directional quality is important in critical acoustic work. The Shure Super-Cardioid, employing the exclusive "uniphase" principle, gives such performance in a single, compact rugged unit.

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At Ansonia, electrical cable is engineered to meet all necessary requirements as far as that is possible. And,

thanks to ANKOSEAL, a remarkable thermoplastic insulation, our engineers are usually able to combine in one cable all the qualities you need.

Simply tell us what you want in a cable -we'll design and produce it. It won't be the cheapest cable-but it will be right! The difference will result in longer life and better performance.

We'll be glad to describe in detail what Ansonia can offer you in the form of job-engineered cable. Write now for fuller information.



facturers of fixed mica dielectric capacitors and other radio, radar and electronic equipment.

Why ANKOSEAL solves cable problems

Ankoseal, a thermoplastic insulation, can help solve many electrical engineering problems, now and in the future. *Polyvinyl* Ankoseal possesses notable flame-retarding and oil resisting characteristics; is highly resistant to acids, alkalies, sunlight, moisture, and most solvents. Polyethylene Ankoseal is outstanding for its low dielectric loss in high-frequency transmission. Both have many uses, particularly in the radio and audio? fields. Ankoseal cables are the result of extensive laboratory research at Ansonia-the same laboratories apply engineering technique in the solution of cable problems of all types.

Highway Police of

STATES NOW USE-

AND 3-WARTSTEAS PADOTELEPHONE SYSTEMS ADDOTELEPHONE SYSTEMS From čoäšt to čoäst the swing is overwhelmingly to Motorola. Police of 36 states and over 1000 communities now depend on Motorola F-M Radiotelephone for emergency communication. There *must* be a reason . . .

WRBU

11

1. SIMPLICITY—It doesn't take an electronic technician to operate a Motorola Radiotelephone. Any man on your force can use it *without special training*.

2. EFFICIENCY—Motorola Radiotelephone has range and power, enabling patrols to maintain contact with the control station at distances up to 50 miles.

3. RELIABILITY—The Motorola Radiotelephone is made by the makers of the battle-tough "Handie Talkie" and "Walkie Talkie". You couldn't ask for a better guarantee that your radiotelephone will always deliver!

The terrain of the area you service may present a particular problem, but Motorola engineers can solve it. Write today—we will be glad to submit specific recommendations—without obligation, of course.

*Including Washington, D. C., Hawaii and Panama.

FREE! Write for detailed Motorola Radiotelephone Directory covering more than 1000 Motorola two and three way F-M systems now operating in United States, Canal Zone and Hawaii.



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STANDARD CRYSTALS

Announcing

STANDARD'S MIDGET crystal unit, now on a production basis.

STANDARD brings you, as an answer to your frequency control problem, the MIDGET. A precision crystal to your specifications in a holder that's radically different* — designed to fit *minimum* space requirements. Furthermore, the cost is attractive.

The MIDGET is a real triumph of that skill and knowledge gained through our years of research, development and production experience. We have furnished the armed forces millions of crystal units—NOW we welcome the opportunity to supply your requirements.

STANDARD'S engineering staff is at your command. Write, wire or phone us your frequency control problems.

For general AIRLINE, POLICE, BROADCAST, AIRCRAFT, AMATEUR and COMMERCIAL uses we make a complete line of crystals in standard or special holders. *Send for new catalog just coming off the press*. We take this opportunity to greet our old customers in these fields and to solicit their continued business.

* Refers to designs of holders.

In the inset (opposite page) the new STANDARD MIDGET is reproduced in actual size. The background pictures popular types in the STANDARD line.



Standard Piezo Company

Established 1936

Quartz Crystals and Frequency Control Equipment Office and Development Laboratory CARLISLE, PA., P. O. Box 164

SCRANTON, PA.

CARLISLE, PA. COMMUNICATIONS FOR OCTOBER 1945 • 19

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Aerovox "Know-How" in action: Chief Engineer Stanley Green (center) with Joseph L. Collins (Electrolytics), Louis Kahn (Assistant Chief Engineer) and Samuel Heyman (Production Manager) working out the capacitance problem of a customer from the application blueprints.

... can save you untold time, expense, trouble

AEROVOX HOU

• Ingenuity, imagination, versatility, adaptability, coupled with sound engineering practice, add up to Aerovox "Know-How."

Of course Aerovox has an outstanding line of standard capacitors—paper, oil, electrolytic, mica and low-loss ultrahigh-frequency types. A wide range of requirements are met with such a variety of listings. But Aerovox can also meet most extraordinary needs with special types that do not have to be billed at usual special prices. Here's why:

A tremendous variety of cans, terminals, insulators, mountings and production processes at the disposal of Aerovox engineers enables Aerovox to make up special types quickly, readily, inexpensively. So:

Bear in mind Aerovox "Know-How"—and save untold time, expense, trouble.

Try us on that capacitance problem.



BACHOLS

Typical "special" capacitors assembled from standard Aerovox parts, indicating the wide variety of cans, terminals, insulators and mountings.



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New Pilotless Plane?

BACK IN 1939 PACIFIC DIVISION HAD ALREADY FLOWN THIS RADIO CONTROLLED AIRPLANE

ix years ago we did it the hard way. Month after month at an isolated camp n the Mojave Desert Pacific Division radio engineers collaborated with ockheed engineers to perfect electronic controls and the aerodynamic haracteristics of one of the first airplanes to fly by radio direction alone. The operations were part of a special Army project and, in all, six airplanes of Lockheed design were successfully flown. In light of the tremendous trides Pacific Division radio engineers have made since those early days, it interesting to know that this first radio control receiver had to provide imultaneous operations of *thirteen* controls—for the elevator, rudder, -position throttle, altitude, airspeed, counter, camera and parachute release.

The success of these early, complicated experiments have given Pacific Division a six-year lead in the development of numerous types of VHF ontrol and communication equipment. We would like the opportunity o demonstrate how these modern controls may solve your problems, too.



SIX

RATING



This portable 100 watt transmitter was used to control the plane. "Ground Pilot"sat in the truck body.



Taken from movie film, this shows an actual take off. Note perfect flight altitude for this critical operation.



Trailing smoke made observation easier. The 80 h.p. plane, comparable to a single-seater, had speed of 105 m.p.h.



COMMUNICATIONS FOR OCTOBER 1945 • 21

STATIONS

ERIMENTAL

Unit 540

UNIT 540 is the latest model Fairchild Amplifier-Equalizer. Its design permits the unusual operational advantage of *unlimited frequency selection* over two critical ranges: 20 to 100 cycles; 4,000 to 10,000 cycles with an available boost of 0 to 20 db.

Unlimited frequency selection compensates for brilliance-loss at the slower 33.3 speed and for response-deficiencies of cutterhead, disc material, pickup or speaker by electronically boosting the higher frequencies from 4,000 on up to 10,000 cycles — with a negligible effect on volume and without loss in the bass.

a limited number of Fairchild MPLIFIER-EQUALIZERS.

Unit 540 can be used with two recorders to record or play back continuously by switching from table to table; to make two identical records at the same time; or to 'dub' from one table to the other as in copying a recording played on one table and recorded on the other.

Unit 540 is compactly designed to fit into a light-gauge metal trunk measuring

 $17'' \ge 18'' \ge 11''$. It can also be rack mounted. And provision has been made in the inputs and outputs to permit operation under many varying conditions — to meet the exacting professional requirements of the radio and communications fields.

Descriptive and priority data are available. Address *New York Office*: 475 – 10th Avenue, New York 18; *Plant*: 88-06 Van Wyck Blvd., Jamaica 1, New York.



www.americanradiohistory.com

Developed for Signal Corps portable, nobile, or emergency communications quipment, the 2E25 r.f. beam tetrode is asy on the battery. The thoriated tungten filament permits simultaneous appliation of filament and plate potentials. Precious battery power is conserved during tandby periods.

NEW INSTANT-HEATING BEAM TETRO

Completely shielded for r.f., the 2E25 reuires no neutralization even at its maxinum frequency of 100 megacycles. Other eatures are: low-loss octal base, plate conection to top cap, filament potential cenered at 6.0 volts, and extremely rugged onstruction.

Lonsider the advantages of the 2E25 as an instant-heating replacement for the 6V6GT r 6L6G in older equipment, or for use in nodern equipment such as the new Kaar nobile FM set illustrated. Remember, the ersatility of the 2E25 beam tetrode simlifies the spares problem; this one type an power a whole transmitter—R.F. and I.F. Order your engineering samples today.

HYTRON 2E25

Instant-Heating 15-Watt R.F. Beam Tetrode TENTATIVE ELECTRICAL DATA

| Filament Potential \dots $6.0 \pm 5\%$ ac or dc vo | olts |
|--|--------------------|
| Filament Current 0.80 an | np. |
| Plate Potential | olts |
| Screen Potential | olts |
| Grid Potential | olts |
| Plate Current | na. |
| Plate Dissipation 15 max. wa | tts |
| Screen Dissipation 4 max. wa | tts |
| Grid Driving Power (Class C) 0.5 watt appro | ox. |
| Power Output (Class C) 20 was | tts _{, s} |

AVERAGE DIRECT INTERELECTRODE CAPACITANCES

| Grid to Plate | e (with | externa | shielding) | 0.18 max. | mmfd |
|---------------|---------|---------|------------|-----------|--------|
| Input | | | | 8.5 | mmfd · |
| Output | | | | 6.0 | mmfd |

MECHANICAL DATA

| Maximum | 0 | ve | га | 11 | I | _e | n | g | tŀ | 1. | | | | | | • • • | | | | • | | | | | | | Ż | | 43 | í6 i | nche | es |
|---------|---|----|-----|-----|----|----|-----|---|----|----|---|-----|----|----|---|-------|---|----|---|----|-----|----|---|---|---|-----|---|----|------|------------|-------------|----------|
| Maximum | D | ia | m | e | te | r. | 6 | • | • | • | • | • • | • | • | • | 4. | | 1. | | • | -41 | • | • | • | • | • • | • | • | 17/ | 1 6 | inch T-1 | es 11 |
| Cap | | | ••• | | | | | | | ., | * | • | | • | | • | | | | | | | | | | •.• | | S | Sma | all | met | al |
| Base | | | • | • • | | | • • | • | • | • | 1 | 7-: | pi | in | 1 | m | e | d | • | sl | h |)T | t | s | h | e11 | 1 | 01 | v-lo | oss | oct | al |

The New 2E25 Supersedes and Replaces the HY65

New instant-heating mobile FM transmitter developed by Kaar Engineering Co. uses 7 Hytron 2E25 and 2 Hytron HY69 or HY1269.

WRITE TODAY to Dept. 10 for these: New Hytron transmitting and special purpose tube catalog; 21 x 17 inch sheet illustrating Step-by-Step Assembly of Typical Hytron Tube.

OLDEST MANUFACTURER SPECIALIZING IN RADIO RECEIVING TUBES



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EXCELLENCE

THE MARK OF



N ORTH AMERICAN PHILIPS is one of the few manufacturers of electronic tubes endowed with the skill and experience required for the mass production of the 5JPl and similar cathode ray tubes.

The deflection-plate terminals of these tubes are brought out at the neck of the glass envelope to provide higher insulation and lower lead capacitance at very high frequencies.

In the manufacturing procedure the tubes are cracked at the neck, the deflection-plate leads bent out, and the envelope sections rejoined on a glasssealing lathe, as illustrated. During this operation the tubes are maintained at a high temperature to prevent the formation of water vapor on the fluorescent screens.

The ability to produce, in volume, NORELCO cathode

ray tubes that meet exacting specifications is the result of experience gained by an organization with a background of over half a century of research and development in the electrical field.

The facilities which North American Philips has applied to the manufacture of electronic tubes during the war are now available for the postwar production of cathode ray tubes for direct viewing and projection television.

XXX

Write today for interesting booklet on "How and Why Cathode-Ray Tubes Work."

When in New York, be sure to visit our Industrial Electronics Showroom.



OTHER PRODUCTS: Quartz Oscillator Plates; Searchray (Industrial X-ray) Apparatus, X-ray Diffraction Apparatus; Medical X-ray Equipment, Tubes and Accessories; Tungsten and Molybdenum Products; Fine Wire; Diamond Dies.

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WARD LEONARD ELECTRIC CO.

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3 OUTSTANDING FEATURES OF THE NEW EIMAC 4-125A TETRODE

LOW DRIVING POWER

With but 2.5 watts driving power, the 4-125A will deliver 375 watts output at frequencies as high as 120 Mc. The low driving power requirement has been achieved without the use of excessive secondary emission. The control grid is specially processed to reduce both primary and secondary emission.



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DRIVING POWER-WATTS

3

HIGH FREQUENCY PERFORMANCE

The Eimac 4-125A will deliver 200 watts output at 250 Mc. The performance curves below show the relationship between driving power and power output at frequencies up to 250 Mc.

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EIMAC 4-1254 PERFORMANCE DATA

3

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10



The grid-plate capacitance of the 4-125A is only 0.03 uufd. This low value allows operation up to 100 Mc. without neutralization. Stability is further assured by the special grid processing which reduces secondary emission.

A technical bulletin on Eimac 4-125A Power Tetrode contains full specifications and detailed discussion of the tube's characteristics, circuit diagrams and constant current curves. Write for your copy today.

POWER OUTPUT - CLASS-C

The Eimac 4-125A is the first of many new Eimac tubes that are on the way. Watch for future announcements.

ELECTRICAL CHARACTERISTICS

Filament : Thoriated Tungsten Voltage 5.0 volts Current . . . 6.2 amperes Plate Dissipation (Maximum) 125 watts

Transconductance (is = 50 ma., Es = 2500 v., Ec2 = 400 v.). 2450 *u*mhos

1085

TELEGRAPHY

40

30

60

80 100

200 300

THE COUNTERSIGN OF DEPENDABILITY IN ANY ELECTRONIC EQUIPMENT

20

FREQUENCY - MEGACYCLES

DRIVING POWER-CLASS-C. TELEGRAPHY



THIS CIRCUIT PROVIDES AN ACCURATE FIXED STANDARD FREQUENCY...

A modulator divider tube with a resonant circuit tuned to 1f/10 and a modulator multiplier tube with a resonant circuit of 9f/10 are the fundamentals of a frequency divider unit which is the basic element of this -bp- Secondary Frequency Standard.

A small transient voltage in the resonant circuit of the modulator divider tube is applied to the grid of the modulator multiplier tube, and the input voltage f is also applied to this tube. The two voltages mix to supply an output frequency of 9f/10. This frequency (9f/10) is fed to the grid of the modulator divider tube where it is mixed with the input frequency (f), and results in a frequency of 1f/10 in the modulator divider tuned circuit. The action is repeated and the voltage is built up until a stabilized condition is reached or until the frequency (f) is removed. Thus the output of the divider unit is controlled by the input frequency.

Three such frequency divider circuit units in conjunction with a temperature controlled oscillating quartz crystal, which generates 100 kc, make up the *-hp*- 100B Secondary Frequency Standard. By cascading the 100 kc down through the three dividers, accurate fixed frequencies of 10 kc, 1 kc and 100 cps are made available in addi-



tion to the 100 kc supplied by the oscillator.

As can be noted by the block diagram, these frequencies are available through a selector switch (on front of panel) or individually from binding posts (rear of chassis). All four fixed frequencies can be utilized at separate test stations simultaneously, which is an economical feature. This instrument is extremely valuable for use in audio and the low radio frequency fields. More complete information will be gladly sent in response to your inquiry. 1072

These -hp- Representatives are at your Service Eastern Representatives Burlingame Associates, Ltd. 11 Park Place New York 7, N. Y.-Worth 2-5563-4 Midwestern Representative

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O^{UR} spirited steed is not only fast but well-gaited. We curled our lasso around the neck of "Electronics" a long time ago and with our strong personality, and kind treatment, turned it into our pet horse. It took a lot of skull work, a lot of smart engineering, but it worked out. Now our stable has 28 red hot electronic devices that should interest you. How about hitching your chariot to our fast-stepping organization, giving Aireon its head in helping solve your electronic problems?



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TUBE SOCKET GUIDE

The latest addition to the famous line of Johnson tube sockets is the 275, Giant Five Pin socket with all the oustanding features which have made other Johnson sockets superior. A special feature of the 275 is the provision that has been made to allow forced ventilation from below the chassis, as required for the recently announced Eimac 4-125A and 4-250A. This socket may also be used for other Giant Five Base tubes when a wafer type socket is desired.

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If you have a special tube socket problem, write Johnson, today.

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Johnson sockets are stocked by leading radio-electronic parts jobbers.

F. JOHNSON COMPANY COMMUNICATIONS FOR OCTOBER 1945



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Inter-Electrode Capacities:

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Frequency Limits as Power Amplifier: Half Power Input LICENSED UNDER R.C.A. PATENTS List Price \$10.

Catalog sheets and tubes ready for distribution!

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A manufacturing organization ... the pride of an entire community . . . with an electronic engineering background of 20 years experience! Plus a war-born performance record of meeting huge production demands and exacting technical requirements - on time and economically!

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offer you these advantages:

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For a given power output the space required by metallic rectifiers very small.

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B-L Rectifiers are silent in operation and have no moving parts.

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Dependability is assured by their simple and rugged construction, which no glass bulbs, filaments, or other fragile parts are employe

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B-L Rectifiers are rugged and will withstand heavy overloads for short periods of time.

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B-L Rectifiers are adaptable for power outputs from Milliwatts Kilowatts.

Many rectifier applications, heretofore considered impractical, have been devised by B-L Engineers. It is more than likely that they can be of assistance in solving your problems of converting AC current to DC... Write for Copper-Sulphide Bulletin R38-e — or for Selenium Bulletin R41-e.

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All radio frequency circuits are included in the 2-20 Mc. R. F. head shown above. All connections to the transmitter cabinet are by means of plugs and receptacles.



A medium power transmitter, designed particularly for aeronautical service. Equally adaptable to other fixed services. Check these features for their application to your communication problems:

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- * Four transmitting channels, in the following frequency ranges:
 - 125-525 Kc. Low Frequency.
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- * Simultaneous channel operation, in following maximum combinations:
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 - 2 Channels telephone.1 Channel telephone, 2 Channels telegraph.
- * Complete remote control by a single telephone pair per operator.
- * 400 Watt plus carrier power.
- * Low first cost. Removable radio frequency heads are your protection against frequency obsolesence.
- ★ Reliability backed by two years of engineering research, one year of actual field operation.
- ★ Available with all-steel, or wood pre-fabricated transmitter house complete with primary power, antenna, and ventilation fittings.
- * Not a "post-war plan," but a field-tested transmitter now in production.

An inquiry on your letterhead outlining your requirements will bring you complete data.

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To make this readily possible, Struthers-Dunn offers 5,312 standard types, each available in countless design adaptations to fit your needs exactly. These include thousands of styles, shapes, sizes and ratings in a-c types, as well as hundreds more of the most modern d-c types including those capable of withstanding the rigors of war equipment usage.

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IN TELEVISION DIMONT SETS THE PACE!

DUMONT'S JOHN WANAMAKER Television Studio, Station Wabd

Regular Television broadcasts will begin about December 1, 1945

DuMONT TELEVISION engineers, who have designed and built more elevision stations than any other company, will soon complete the world's largest television installation. They are now transforming more than 500,000 cu. ft, of the great John Wanamaker store in New York into the first "Television City."

The largest studio (50' x 60' with 1 50' ceiling) boasts 4 cameras—the first studio to be so well equipped. A balcony accommodates 700 spectators and a rear glass wall of the control room permits sightseers to watch rehearsals and broadcasts. Two other "live talent" studios are equipped with 3 and 2 cameras each. Several cameras are mounted on a new type dolly providing extreme ranges of elevation and camera angle. A telecine studio has projectors for both 16 mm. and 35 mm. film.

DuMont Television broadcasting equipment embodies all the flexibility and refinements accruing from more than 4 years of continuous and increasing y etaborate programming experimentation. Simplified precision control—the keynote of Du-Mont design—assures high efficiency and rugged dependability at low operating cost. DuMont leadership means adequate training of your technical personnel, and the finest craftsmanship for the least outlay.

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DANN Precision Electronics and Television

ALLEN B. DUMONT LABORATORIES, INC., GENERAL OFFICES AND PLANT, 2 MAIN AVENUE, PASSAIC, N. J. TELEVISION STUDIOS AND STATION WABD, 515 MADISON AVENUE, NEW YORK 22, NEW YORK

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JENSEN RADIO MANUFACTURING COMPANY • 6603 SOUTH LARAMIE AVENUE, CHICAGO 38, ILLINOIS IN CANADA—COPPER WIRE PRODUCTS, LTD., 137 RONCESVALLES AVENUE, TORONTO • COMMUNICATIONS FOR OCTOBER 1945

For Foxhole Conditions A HERMETICALLY SEALED PANEL INSTRUMENT

Important

Features

OW, damp, wet holes protect lives, but cause equipment o rust, corrode, and fall apart. Where there is no cover, rain, lew, and fog soak into equipment—until, even in direct sunight, it doesn't dry out for weeks.

To protect the sensitive element from fungus growth and he rapid deterioration caused by these conditions, our engineers developed a unique, hermetically sealed enclosure for his 2½-inch G-E panel instrument. Complete sealing, easy ield servicing, accurate combat-proved element, and sturdy construction make this a superior instrument. It is designed to neet tentative Signal Corps Specification 71-3159, and is availble for direct-current (DW-61) or radio-frequency (DW-62) ervice.

This new hermetic enclosure is another example of the way 3-E measurement engineers have been, for nearly fifty years, vercoming difficulties in the design and application of preision instruments. There are many other recent G-E accomlishments, typical of which are the new 1½-inch instruments, he internal-pivot element, and new magnetic alloys.

For more complete information on this hermetically sealed nstrument, ask the nearest G-E office for Booklet GEA-4429, w write to General Electric Company, Schenectady 5, N.Y.





- Glass-to-metal Seals. Vacuum-tight joints are assured by fusing the thick, special window into a matched metal ring, and by fusing an insulating glass bead to a matched metal stud and metal eyelet.
- Steel Case. Thorough shielding against stray magnetic fields, and complete protection from all adverse atmospheres are assured by a strong, vacuum-tight steel case.
- *Dehydrated.* Moisture, the major cause of corrosion, is reduced to a minute quantity by a special dehydration process.
- Ease of Servicing. This hermetically sealed device can be easily serviced by removing the crimpedover metal ring and withdrawing the base, with the element attached, from the steel case. To reseal the instrument, only a new metal ring and a simple crimping tool are required.
 - Internal-pivot Element. High resistance to shock, fast response, and compactness are inherent in the internal-pivot-element construction—a design which has had a fine record of performance throughout the war.

Complete Line of Ratings

D-c microammeters to kilovolt meters, as well as r-f thermocouple-type and rectifier-type (a-c) instruments, are available.

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COMMUNICATIONS

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Every product bearing the Eastern trade mark will conform to the most exacting requirements. The Eastern Amplifier line will include standard items and many exceptional innovations. For complete details, write our Sales Manager, Department 10-G.

Buy War Bonds



EASTERN AMPLIFIER CORPORATION 794 EAST 140th STREET • NEW YORK 54, N.Y.

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THESE Gammatron TUBE TYPES ARE NOW AVAILABLE!

STANDARDIZED Gammatron TYPES

Electrical and physical characteristics guaranteed to meet currently high standards. These tube types will always be readily available.

14 TRIODES

| TUBE TYPES | PLATE DISSIPATION | TUBE TYPES | PLATE DISSIPATION |
|---------------|------------------------------|---------------|----------------------|
| HK-24 | 25 watts | HK-454L | 250 watts (Low My) |
| | (Grid lead to base) | HK-454H | 250 watts (High Mu) |
| HK-24G | 25 watts | HK-654 | 300 watts |
| | (Grid lead through envelope) | HK-854L | 450 watts (Low Mu) |
| HK-54 | 50 watts | HK-854H | 450 watts (High Mu) |
| HK-254 | 100 watts | HK-1054L | 750 watts |
| HK-354C | 150 watts (Low Mu) | HK-1554 | 1000 watts |
| HK-354E | 150 watts (High Mu) | HK-3054 | 1500 watts |

1 PENTODE

HK-257B Plate Dissipation, 75 watts (Beam pentode)

4 RECTIFIERS

 HK-253
 Inverse Peak Volts, 15,000
 HK-953D
 Inverse Peak Volts, 75,000

 HK-953B
 Inverse Peak Volts, 30,000
 HK-953E
 Inverse Peak Volts, 150,000

3 IONIZATION GAUGES

VG-2

VG-24G VG-54

Gammatron tubes, famed for the past 18 years for their ability to stand up under heavy overloads, and for their efficiency even at very high frequencies, are again available for civilian use! Look for the "HK" before the type number - your assurance of the best in tantalum-element tubes.

REPLACEMENT Gammatron TYPES

The following Gammatrons are being made available primarily for replacement use. Designers of new equipment are asked to consider recommended standardized types.

| REPLACEMENT TUBE TYPE | DESCRIPTION | RECOMMENDED STANDARDIZED TUBE TYPE |
|--------------------------|--|--|
| HK-354 | Triode, grid lead to base pin, ratings same as HK-354C | HK-354C HK-454L HK-454H |
| HK-354D | Triode, Medium Mu | HK-354C or E HK-454L or H |
| HK-354F | Triode, High Mu | HK-354E |
| HK-257A | Beam Pentode | HK-257B |
| HK-153 | High Vacuum Rectifier, inverse peak volts, 5000 | HK-253 |
| HK-54S | Triode. Same as HK-54 except fil. current is 3.35 instead of 5 amps. | HK-54 |
| HK-2054A | Triode | |
| HK-2054B | Triode | |
| | | |



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THE RADIO PROXIMITY FUZE

1945

iny Receiver-Transmitter Units n Noses of Bombs, Rockets and Shells Activate Explosive Charges Bursting Projectiles When in the Proximity of a Target

by RALPH G. PETERS

ECENTLY the Army and Navy revealed that a radio-proximity or VT fuze had been developed and used in the noses of bombs, rockets and shells. The fuze has been cited as one of the most important weapons of war ever conceived, its role in bringing the war to an end being compared to that of the atom bomb.

These radio units were identified as proximity fuzes because they burst when in the proximity of a target. The official name, VT, which means variable time, was applied because the device is a form of a time fuze which automatically adjusts its time of function to provide a burst at just the right time to give maximum damage to the target.

The fuze operates as a miniature send-ing and receiving station. When the projectile is released, this station begins to send out a continuous r-f signal, not a short pulse as in radar. As the projectile approaches its target, the signal is reflected back and operates to detonate the explo-

sive charge. The basic components of the fuze are: (1)—miniature *rugged* vacuum tubes, (in the shell application the tubes must be strong enough to stand the tremendous stresses of being shot from a gun . . 20,000 G), as essential elements of simple electrical circuits; (2)-a miniature rugged battery or generator to provide elec-

Figure 1

The first successful The first successful radio proximity fuze in the world, tested at the Navy Dahlgren Proving Grounds by National Bureau of Standards scientists on February 12, 1941, less than two months after initiation of the day initiation of the de-velopment. It was attached to the tail of a b o m b and trailed a whip-like antenna. Be-side it is shown the later-developed miniature mortar radio proxture mortar radio prox-imity fuze and, for size comparison, a conven-tional r a d i o receiver tube. (Courtesy National Burcau of Stand-arde)

ards)

trical power, and (3)-safety devices to prevent operation of the fuze until it had travelled a safe distance.

An oscillator generates the r-f signal. When a target is approached, part of the radiated signal is reflected back to the fuze and an impulse is set up in the fuze by the interaction of the radiated and returned signals.

This impulse is amplified by an a-f amplifier in the fuze and is fed to a thyratron tube which serves as a switch to initiate the detonation of the projectile.

The detonation of the projectile is accomplished by an electrical detonator When the much like a dynamite cap. thyratron is triggered by the impulse generated by approach to a target, it causes



enough electric current to pass through the electrical detonator to make it explode. This explosion sets off an auxiliary explosive charge, or booster, carried in the fuze, which in turn detonates the explosive filling in the projectile.

In addition to the primary elements of the fuze, there are also included safety devices which prevent operation of the fuze until it has travelled a minimum safe distance. Some models of the fuze also contain a self-destruction switch which acts to detonate the projectile beyond the target if it has passed the target without coming close enough to function.

Fuze Operation Analysis

In Figure 3 we have a block diagram COMMUNICATIONS FOR OCTOBER 1945 • 45

MILITARY SUB-MINIATURE RECEIVER-TRANSMITTER DEVELOPMENT



which illustrates the basic pattern of fuze operation.

In use safety devices complete the electrical circuits and line up a powder train shortly after the projectile is set in mo-tion. Within a fraction of a second the tubes warm up and the transmitter excites the antenna which may be the bomb or shell itself or a small auxiliary conductor. The outward radiation moves away from the projectile until it encounters some reflector obstacle, perhaps an airplane, buzz bomb, or the ground below. The radiation is reradiated or reflected by the obstacle and part of it returns to the projectile. But if the projectile is moving with respect to its target (as generally happens) the returning radiation has a slightly different frequency because of the Doppler effect, Figure 4.

If f is the frequency of the radiation from the fuze which moves toward the target with velocity v, the frequency of the wave

striking the reflector is $f + \frac{v}{\lambda}$. The tar-

get reradiates at this frequency and the



Figure 2

Cut-away view of ring-

Cut-away view of ring-type bomb fuze devel-oped. by National Bu-reau of Standards. View shows transmitter-re-ceiver located in com-partmert directly be-low propeller. Genera-tor is visible at center. Part immediately below denerator is a dear

generator is a gear train and below that

is the firing unit; white section just be-low center of fuze. Below firing unit is detonator compartment

and below that, the booster charge. This fuze was used in bombing of Iwo Jima, Italy, Japan,

(Courtesy National Bureau of Standards.)

that,

Japan,

and below

Germany, etc.

 $f + \frac{2}{2}$. A suitable detector then separates

out the beat or difference frequency ---.

Moreover, as the fuze gets closer to the target the reflected wave gets stronger and the difference frequency component gets larger. When it gets large enough and changes in the proper manner, the fuze circuit functions and explodes the charge.

An equivalent concept can be applied, if we think of the reflector as changing the input impedance to the antenna. Let us suppose the antenna carries a current I; it will set up an electric field at the reflector which is proportional to I. A certain fraction of this field will be reflected back to the fuze giving a reflected field proportional also to I. This reflected field will induce a voltage v in the antenna proportional to its strength, finally resulting in voltage induced in the antenna

which is proportional to I and theref appearing like an impedance.

The presence of the reflector is t equivalent to an added impedance in antenna circuit. Each time the path tween the fuze and target is shortened $\lambda/2$, the over-all path is changed by λ : the phase angle of the impedance vec changes by one cycle.

Thus we may express the addition impedance due to the reflector in the fo

$$Z = a e^{J} \left(\frac{4 \pi r}{\lambda} + \Phi \right)$$

where Φ is an arbitrary phase factor ta ing account of changes of phase at refle tion. Now if r changes so that

$$\mathbf{r} = \mathbf{vt}$$

where v is the component of project velocity toward the target then

$$Z = a e^{i} \left(\frac{4 \pi vt}{\lambda} + \Phi \right)$$

which is of the form

$$\mathcal{L} = a e' (wt + \Phi)$$

if we say $w = 2 v/\lambda$ thus getting the same Doppler frequency as before. In the terms the fuze problem becomes a simp one. If we call Zo the input impedance of the antenna in free space, then in the preence of a reflector

$$Z = Z_{\circ} + a e^{j} \left(\frac{4 \pi v t}{\lambda} + \Phi \right) + \cdots$$

and the problem is simply to design a cir cuit to respond to this change in antenn impedance.

The VT fuze uses the same antenna fo transmission and reception. Thus the radition pattern f (Θ) is used twice an radition pattern t (Θ) is used twice an we have a directivity pattern f² (Θ), giv ing the sensitivity of the device in vari ous directions, Θ . This means that th ampliture *a* contains f² (Θ) as a factor In Figure 5 appears an extremely sim

plified drawing of the variation of th amplitude a and the resistance componen of Z, Zr, as a VT-fuzed projectile passe an airplane.

In the figure P is the closest distance o approach and r the distance to the target Now

$$r^{2} = x^{2} + P^{2}$$

$$\frac{dr}{dt} = v = \frac{x dx}{r dt} = \sin \Theta V$$

and the antenna impedance is of the form

$$Z = Z_{\circ} + a e^{j} \left(\frac{4 \pi V \sin \Theta}{\lambda} + \Phi \right)$$

showing that the frequency is 2 V/ λ at large distances dropping to zero momentarily when x = o and rising again when the projectile passes beyond the plane. The amplitude *a* is small at large distances, gets large at the center, and falls again when the projectile passes.

The dotted curves in this figure, indicating the impedance changes, show at every instant the antenna impedance. If the projectile moves rapidly through the interacting region, the changes in impedance are rapid; if it moves slowly the changes are slow.





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The problem is to get the burst (* in ure) to occur shortly before the protile reaches point x = o to take account the forward motion of the fragments ported by the projectile motion.

When the projectile is used for function on approach to ground as in a bomb, distance to the target, in this case a it plane of large extent, is the vertical light h, Figure 6.

In this figure $h = s \sin \theta$ and

$$v = \frac{ds}{dt} \sin \Theta = V \sin \Theta$$

d the appropriate antenna impedance is

$$Z = Z_{\circ} + a e^{j} \left(\frac{4 \pi V \sin \Theta}{\lambda} + \Phi \right)$$

in the previous case. In Figure 6, the npedance amplitude a and resistance mponent Z_r have been plotted as dotted rves along the trajectory. In this case, e angle θ and V are almost constant rer the last few hundred feet of travel here the reflection becomes appreciable b that the ripple frequency w is constant

nd a grows as the height decreases. In designing the circuit, the optimum umage height had to be considered careily. The circuit had to be designed so hat a burst was obtained about 50' to i' above the ground.

It will be immediately evident from the gure that when the projectile approaches steep angles, the radiation toward the round is small, whereas at small angles, he radiation directed toward the ground large. Thus, the burst will be higher or small approach angles and lower for urge approach angles. Later designs vercame this difficulty. In the bomb aplication, for example, a radiation patern with maximum sensitivity directly off

(Continued on page 92)



Figures 4 (below left). 5 (above right) and 6 (above left)

Figure 4 illustrates reflection of radio waves from target. Figure 5 shows the variation in antenna impedance as a radio-fuzed rocket passes by plane. In Figure 6, we see the variation in antenna impedance as a radiofuzed bomb or artillery projectile approaches ground.

lery projectile approaches ground. (Patterns shown in Figures 5 and 6 are sensitivity patterns. In Figure 5, the vertical line or closest distance of approach to target is P.)

Figures 7, 8, 9 (right. top to bottom)

Figure 7. Artist's conception of region of sensitivity of radiofuzed rocket approaching airplane. (Official War Department photo.)

Figure 8. Bar type VT-fuze developed by National Bureau of Standards inserted in nose of 500-pound bomb

(Courtesy National Bureau of Standards.)

Figure 9. Army fighter plane carrying steel tubes used to launch rockets. (Official War Department photo.)









WITARY SUB-MINIATURE RECEIVER-TRANSMITTER DEVELOPMENT

A 9-SPEAKER BATTLE-



by H. W. DUFFIELD

Engineer, Radio Division Western Electric Co.

HEN the Navy's amphibious forces recently stormed the beaches at 1wo Jima and Okinawa, a 9-speaker high-level, highgain announcing system was used to carry instructions for beach activities and landings of men and equipment.

System's Power

The system's frequency response rises from about 250 to 500 cycles and then is reasonably flat at 6,000 cycles at which point it decreases. It is capable of creating a sound level of about 116 db above the reference level of 0.000204 dyne per square cm, at a distance of 30' from the loudspeaker. The major part of the energy is radiated through a cone of 50°.

The amplifier unit consists of two sections, a preliminary amplifier and a power amplifier.

The preliminary amplifier is a fourstage unit employing two resistances coupled stages, two resistance-coupled push-pull stages with transformer coupling between the second and third stage. The push-pull operation with inverse feedback employed in the last two stages stabilizes its operation and insures low distortion. When transformer-coupled to the power amplifier, this unit is capable of delivering approximately 10 watts (200 volts) to a resistance load of 4,000 ohms (simulating the maximum load presented to the amplifier by the power amplifier during normal operation) connected across the output terminals. An input voltage of approximately 0.0015 volt connected across the appropriate input terminals will produce full output.

An electric eye, visible to the operator through a gasketed window in the carrying case, indicates the degree of full power from the power amplifier during operation.

The preliminary amplifier is supplied with two input circuits designed to match either a magnetic-type or a carbon-type microphone. A gain con-

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and Okinawa



Figure 3 Circuit diagrams of the preliminary and power amplifiers.

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trol, which is easily accessible, provides a continuous gain adjustment common to both input circuits.

Power Amplifier

The power amplifier consists of a two-tube, single push-pull stage transformer coupled to the output. The unit includes a self-contained power pack which, also provides filament, plate and screen currents to the preliminary amplifier. To protect the rectifier tubes from possible damage, a thermostatically-operated time delay relay is provided. A separate rectifier tube is furnished for the preliminaryamplifier branch and is connected in the normal manner directly to the main a-c power supply. When the amplifier is in operation, the thermostatically-operated relay closes the winding of the electromagnetic relay. Thus, the operation of this relay closes both the filament and plate circuits of the power amplifier. Therefore whenever the unit is subjected to the vibrations and shock of modern battle, the lockup relay will insure the unit against the opening of the power supply to the filament and plates of the power amplifier.

The amplifier unit will deliver 250

watts to an impedance load of 9 ohms, with normal voice input.

nine-

The loudspeaker unit consists of a group assembly of nine dynamic-type receivers and horns mounted on a common metal panel. In the receiver the moving coil, which moves in a p-m field, is rigidly attached to a phenolic diaphragm. Added features consist of blast valves to protect the receivers from powerful gun blasts and as a precaution against heavy tropical rains the receivers are equipped with special drainage slots.

Speaker Setup

The nine receivers and horns are wired as three parallel groups of three receivers in series. Each receiver has a d-c resistance of approximately 5.5 ohms. Thus each group of receivers in series has a resistance of about 17 ohms, and the resistance of the three parallel groups connected to the receptacle will range between 5 and 6 ohms. Due to the motion of the diaphragms the reproducer presents an impedance load of 9 ohms to the output of the amplifier.

During operation the loudspeaker unit is attached to a metal yoke, all of which is then mounted on a tripod assembly.



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By swinging the speaker unit on its voke supports, it is possible to point it up or down through an angle of 110°. A lever-operated pin located on one side of the yoke serves to hold the speaker unit in any desired vertical position. It is also possible to point the speakers in any horizontal direction by swiveling the voke on the tripod. A thumbscrew in the tripod collar serves to key the yoke to the tripod and clamps the speaker in any selected horizontal position. The legs of the tripod are adjustable in length from 40" to 57". The speaker unit, less the mount, when placed in its metal carrying case weighs approximately 145 pounds, including the case.

The microphone ordinarily used is of the magnetic-type (sound powered) equipped with a push-to-talk button switch, a feedback reduction attachment, and a chest plate and neck strap.

Because of the high output characteristic of the loudspeakers, the feedback reduction attachment is introduced to permit relatively close operation of the microphone with respect to the loudspeakers without causing the system to sing. The microphone is watertight and its cartridge is constructed to offer protection from gun blasts. It is equipped with a 50' cable attached to a weatherproof plug which connects to the input of the amplifier.

Power for the operation of the system is supplied by an engine alternator set. The set is a portable, integral gasoline-engine-driven electric power plant designed to supply a-c continuously and is rated at 1.67 kva and 0.9 power factor. The engine is a singlecylinder, air-cooled, 2-cycle vertical type, governed for 3600 rpm. It is equipped with a flywheel-type magneto which is mounted as a complete assembly on the end of the intake valve shaft. The fuel tank, which holds one gallon, sufficient for 11/2 hours operation, is mounted under the engine. Fuel is forced to an adjustable-jet type carburetor by crankcase pressure. The engine and alternator are completely shielded against radio interference. In addition filters are wired to the output of the alternator to suppress extraneous r-f noise. Starting of the engine may be done either manually by means of a rope or electrically by a 24-volt storage battery.

The power set, which is shock mounted in a metal watertight carrying case, weighs approximately 210 pounds including the case.

All operating units are tropicalized. The system has functioned satisfactorily in rain, mud and snow in temperatures ranging from -40° to $+ 130^{\circ}$ F.



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ROLE OF THE NEUTRALIZING CAPACITOR

THE purpose of neutralization is to prevent oscillations at the natural frequency of the tuned circuits in r-f power amplifiers employing triodes with cathode at ground potential. In the absence of neutralization these oscillations are produced by power supplied to the tuned-grid circuit from the plate-tuned circuit through the grid-plate capacitance of the tubes and all incidental wiring and other capacitance in parallel with it.

There are several well known neutralization methods.¹ Two, Rice neutralization and Hazeltine neutralization² or their combination known as

by WILSON PRITCHETT Radio Engineer E. F. Johnson Company

cross-neutralization in push - pullamplifiers, have a distinct advantage of being useful over a wide frequency range. This paper analyzes the function of the neutralizing capacitor in

Figures 1 (above) and 2 (below) Figure 1a (left). Schematic circuit of a tuned r-f power amplifier with Rice neutralization. The neutralizing circuit of 1a appears in 1b (right). Figure 2a (left) shows the schematic circuit of a tuned r-f power amplifier with Hazeltine neutralization. In b (right) we have the neutralizing circuit of a. these circuits with the emphasis on the principles of wide-band neutralization."

Wide-Band Neutralization Circuits

Radio-frequency amplifiers having a single tube or group of parallel tubes make use of either a balanced tuned-

¹The Radio Amateur's Handbook, ARRL, West Hartford, Conn.

^aTerman, F. E., *Radio Engineer-ing*, Sec. Ed., pp 321-2, McGraw-Hill Book Company, Inc.; 1937.

^aTerman, F. E., *Radio Engineers' Handbook*, pp 501-2, McGraw-Hill Book Company, Inc.; 1943.



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grid circuit or a balanced tuned-plate circuit to supply the neutralizing voltage. Schematic circuits of these are shown in Figures 1a and 2a.

Pull-pull amplifiers having both grid and plate circuits balanced supply the neutralizing voltages automatically as shown in the simplified circuit sketch of Figure 3a.

Neutralizing Capacitor Voltages

Since the neutralizing capacitor voltages are the same for both the push-pull and the single-ended types of amplifiers for a given supply and tuned circuit voltage, we shall limit our voltage considerations to circuits of the latter type.

The circuits of Figures 1a and 2a referred to supply the direct currents to the tube through the inductors. Neither chokes nor blocking capacitors are used. This condition subjects the neutralizing capacitor to the greatest possible voltage.

We are familiar with the 180° relationship between the sinusoidal voltages on the grid and on the plate.⁴ Since the supply voltages are in series with them, we see from the directions of the voltages in the diagrams that the crest value of the neutralizing capacitor voltage,

$$\mathbf{E}_{\mathrm{N}} = \mathbf{E}_{\mathrm{B}} + \mathbf{E}_{\mathrm{C}} + \mathbf{E}_{\mathrm{L}} - \mathbf{E}_{\mathrm{S}} \tag{1}$$

Where: E_L and E_s are the crest values of the sinusoidal voltages e_L and e_s respectively. Therefore the neutralizing capacitor in this instance must withstand almost twice the plate supply voltage.

The use of grid or plate blocking 54 • COMMUNICATIONS FOR OCTOBER 1945

Figure 3 In a (left) appears a simplified schematic circuit of a push-pull tuned r-f power amplifier with cross neutralization. In b (right) appears the neutralizing circuit.

capacitors or both may reduce the needed voltage rating. In the case of a blocking capacitor between one side of the neutralizing capacitor and the grid,⁵ the rating is less by the amount of the bias voltage

$$\mathbf{E}'_{\mathrm{N}} = \mathbf{E}_{\mathrm{B}} + \mathbf{E}_{\mathrm{L}} - \mathbf{E}_{\mathrm{S}} \tag{2}$$

In the case of a plate blocking capacitor,^{δ} the direct plate voltage, E_B, is removed, and

$$\mathbf{E}''_{\mathrm{N}} = \mathbf{E}_{\mathrm{C}} + \mathbf{E}_{\mathrm{L}} - \mathbf{E}_{\mathrm{s}} \tag{3}$$

Circuits taking advantage of both blocking capacitors' have

$$E^{\prime\prime\prime}{}_{\rm N} = E_{\rm L} - E_{\rm S} \tag{4}$$

In plate-modulated amplifiers for 100% amplitude modulation conditions, the voltage, E_B , changes with modulation between a very low value and one that is nearly twice the directsupply voltage. During the time that E_B is largest, E_L assumes a magnitude twice its unmodulated value. Although plate-modulated amplifiers nearly always use a considerable portion of grid leak bias, the change of E_c with modulation is insignificant as far as

*See reference 2, page 314.

⁶Everitt, W. L., Communication Engineer, Fig. 32^oa, p 552, McGraw-Hill Book Company, Inc.; 1937.

⁶Brainerd, Koehler, Reich, and Woodruff, Ultra - High - Frequency Techniques, Fig. 3-58, p. 165, D. Van Nostrand Company, Inc.; 1942.

⁷Everitt, W. L., *loc. cit*, Fig. 329b.

the rating of the neutralizing capacitor is concerned.

Applying these facts to equation we find that without blocking capacitors the voltage rating of the neutral izing capacitor must be approximatel four times the plate supply voltage for high level modulation. The respective ratings needed for the other three cases are also almost doubled.

Further consideration of Figures 1a and 2a is needed to determine the voltage ratings of the insulators supporting the two electrodes comprising the neutralizing capacitor. Assuming that the electrodes of the capacitor are supported from a grounded part of the amplifier, we notice that the insulator supporting the grid electrode must withstand a crest voltage of

$$E_{\rm GN} = E_{\rm c} + E_{\rm s} \tag{5}$$

and that the insulator supporting the plate electrode must withstand a cress voltage of

$$E_{\mathbf{P}N} = E_{\mathrm{B}} + E_{\mathrm{L}} \tag{6}$$

This shows us that the insulator supporting the plate electrode must provide the same order of insulation that is found at the plate of the tube The requirements of the grid electrode insulator, on the other hand, are moderate.

Use of blocking capacitors, again, eases the crest voltage burden. These remove the direct voltage from the corresponding supporting insulator.

Neutralizing Circuits of Single-Ended Amplifiers

The circuits of Figures 1a and 2a COMPONENT DESIGN



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were drawn to simplify the transition from the schematic to the respective neutralizing circuit of Figures 1b and 2b. These neutralizing circuits were drawn in the familiar form of the bridge circuit showing conditions for zero coupling between grid- and plate-tuned circuits through tube and stray capacitances of the system. Coupling due to mutual inductance of the grid and plate inductors varies with frequency and in practical construction of amplifiers is intentionally made small.

In Figure 1*b* the stray capacitance to ground of the plate, C_P , has been separated from that of the plate side of the neutralizing condenser, C_B , and in Figure 2*b* the capacitance of the grid to ground has been lumped with that of the grid side of the neutralizing capacitor and of the wiring. This difference in procedure was due to the fact that the wiring inductance in the plate side of the neutralizing circuit is frequently made appreciably greater than the wiring inductance in the grid side of the neutralizing circuit to prevent the oc-



Figure 4

Neutralizing capacitors mounted for measurement. Dimensions and mounting data: Diameter of lower electrode, $6\frac{1}{8}$ ''; overall height of capacitor, $15\frac{1}{4}$ ''; spacing upper and lower lips, $1\frac{1}{4}$ ''; insulator length, 6''; separation vertical centerlines of capacitors, 10'' lower cup above table, $3\frac{1}{4}$ ''. Measurement data appear in Figure 5.

currence of certain types of high-frequency parasitic oscillations.³

For ideal conditions of balance in the neutralizing circuits just considered we may make several observations. The grid tuned circuit, Z₆, together with the stray capacitances of the wiring, the grid of the tube, and the grid side of the neutralizing capacitor to ground of Figure 1b shall remain balanced to ground over the frequency range necessary. A similar situation shall hold with regard to the plate tuned circuit, Z_P, and the capacitances C_P and C_B of Figure 2b. The inductance of the plate wiring to the neutralizing capacitor shall be centertapped at point 3 and C_P shall equal C_B in Figure 1b. A similar situation

Figure 5

Direct capacitance variation of neutralizing capacitors of Figure 4. Data on incidental capacitances in mmfd: Upper electrode to ground, 7.7; lower electrode to ground, 13.7; between upper electrodes. 1.8; between lower electrodes, 2.5; between one upper and opposite lower electrode. 0.4. Spark-over at 2 megacycles, 40 kilovolts peak.

0



shall hold for the grid wiring to the neutralizing condenser in Figure 2b. And finally, the capacitances, C_N and C_{GF} , shall be equal.

Neutralizing Circuit of Push-Pull Amplifier

We are now ready to carry over to the neutralizing circuit of the pushpull amplifier the same principles observed in the case of the neutralizing circuits of the single-ended amplifier.

Figures 3a and 3b show a simplified schematic diagram of the push-pull t-r-f amplifier employing identical tubes and the corresponding neutralizing circuit. The plate lead inductances have been made larger than the gridlead inductances and the stray capacitances to ground separated on the plate sides of the circuit, as before, for the single-ended amplifier.

The ideal conditions for balance and consequent zero coupling between Z_P and Z_G through the grid-plate and stray capacitances of the circuit may be observed at once. The grid- and plate-tuned circuits together with the attached wiring and electrodes shall remain balanced to ground over the frequency range necessary. The plate lead inductances shall be center-tapped and the capacitances, C_{P_1} , C_{P_2} , C_{B_1} and C_{B_2} shall be equal. And finally, the capacitances, C_{GP_1} , C_{GP_2} , C_{N_1} , and C_{N_2} shall be equal. This shows us that the basic requirements for balance are in general the same as those for the single-ended amplifier.

Since the neutralizing circuit is a balanced bridge and the capacitances of the circuit themselves small, it would seem that the circuit as a whole is sensitive to a small change in any capacitance. This is found to be the case in the actual neutralizing process of an amplifier.

Neutralizing Capacitors

The influence of the various direct and stray capacitances of the neutralizing capacitors upon the amplifier and its neutralizing circuit will now be examined, as we refer again to Figure 3b. Only the direct capacitance, C_N , between the electrodes of the neutralizing capacitor contributes to the neutralizing process. The stray capacitance to ground of the electrode of the neutralizing capacitor connected to the plate circuit of the amplifier shunts the half of the plate circuit to which it is connected. The stray capacitance to ground of the electrode of the neutralizing capacitor connected to the grid circuit of the amplifier

(Continued on page 82)

⁸The theory and technique of this method of capacitance measurement will appear in an early issue of COMMUNICATIONS.

Now, as before, expect quality leadership n Collins broadcast equipment

THE NEW COLLINS AM transmitters and remote amplifiers, now ready, reflect characteristically advanced Collins engineering.

Notable transmitter refinements include extremely high fidelity, and increased safety factors through the use of oversize components throughout.

The Collins 21A is a superb 5,000 watt transmitter, with reduced power operation at 1,000 watts also available. Its response curve is flat, within $\pm \frac{1}{2}$ db, from 30 to 10,000 cycles.

The Collins 20T is a 1,000 watt transmitter, of similar characteristics, equipped for reduced power operation at 500 watts if desired.

The Collins 300G is a 250 watter of equal fidelity, with reduced power operation at 100 watts available.

The Collins 12Y one channel remote amplifier is light, handy, simple and efficient. It is for unattended operation from a 115 volt a.c. power source.

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FOR BROADCAST QUALITY, IT'S



An Analysis of a Method of Calculating the Response of RC Amplifier Coupling Circuits to Pulse Voltages

Figures 1 (insert) and 2

Figure 1. Resistance-capacity network for low-frequency response. Figure 2. Response of RC network to square pulse; T represents width of pulse.

PULSE AMPLIFIER COUPLING

by

N pulse-amplifier design it is important to correctly proportion interstage-coupling components to maintain flat tops on amplified pulses. In a method recently evolved, it has been found possible to select values of grid resistance and coupling capacity to support pulses of any given width and repetition rate. This method may be applied to amplifiers that do not require low-frequency compensation because of sufficiently high pulse rate resulting in small physically realizable coupling components. Where compensation is required, the amount can be determined from a knowledge of the pulse response of the coupling network used.

This method is based on the fact that if a step voltage, E, is applied to a capacitor and resistance in series, as in Figure 1, the voltage across the resistance, e_r , is given as

$$e_r = E \epsilon^{-t/RO}$$

where t is the time measured from the beginning of the step.

For small values of t compared to RC, this equation may be written as $e_r = (1 - t/RC) E$



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SIDNEY MOSKOWITZ Engineer Federal Telecommunications Laboratories Engineer Engine

Values of e_r versus t have been plotted in Figure 2 for several values of RC. On this graph, T represents the width of a pulse.

By inspection of the curves, a time constant can be selected to give the required minimum rate of decrease in pulse amplitude over its duration.

The foregoing may be related to bandwidth by applying the fact that the frequency at which the sinusoidal response of an RC-coupled amplifier drops 3 db is given by

$$f_{o} = \frac{1}{2 \pi RC}$$

1

To be exact, the resistance comprising the RC coupling should be taken as the grid resistance in series with the parallel combination of plate-load and plate resistance. However, in most video designs, the latter are negligible.

Figure 2 shows that the fractional falling off of the pulse top (d/A) is

Figure 3

The time constant of coupling required to pass pulses shown can be secured by the method offered in this paper; see discussion under Example.

.

equal to the reciprocal of the factor X by which the pulse width is multiplied to give the RC time constant. This is true when RC is 10T or greater. For example: When RC is equal to 20T, the pulse top will decay to 1/20 of the pulse amplitude.

Example

Let us find the time constant of the coupling required to pass pulses as shown in Figure 3. We may write

ĥ

$$C = XT_{a}$$

From the foregoing discussion and since the coupling cannot pass a d-c component,

$$d = (1/X) KA$$

where

$$K \equiv T_1/T_2$$

then X = KA/d.

Let us assume that $T_1/T_3 = .1$ and d/A is to be made 5%. Then X = .1/.05 = 2. Hence, $RC = 2T_3$.

If $RC = 2T_a$ is then used for the positive pulse top, RC will equal $20T_a$. The positive top will therefore fall to 1/20A or 5%. It can be seen that the top and bottom parts of the pulse decay by the same percentage.

The above calculation is made for a single RC coupling. If couplings for a multistage linear amplifier are being designed, the effect of each coupling must be taken into account. For such a case, it may prove simpler to consider sinusoidal frequency response. The amplifier should then be designed

(Continued on page 88)



From inner conductor to outer covering ... Federal really knows high-frequency transmission lines.

And this knowledge was not easily won. As the pioneer in the field Federal not only developed over 80% of all h-f cable types in use today . . . but developed most of the equipment needed to test them.

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That's why it's logical to turn to the acknowledged leader in the field for the finest in h-f cables, specialty-engineered harnesses and cable assemblies.

Where requirements are critical ... for transmission lines with special characteristics... for custom-built and engineered harnesses and

cable assemblies . . . take your high-frequency transmission problems to Federal.



Federal Telephone and Radio Corporation Newark 1, N. J.

THE CBC H-F GLOBAL



D ECEMBER 19th, 1944 will always be an eventful day for us, for on that day our two 50kw 6- to 22-mc global transmitters went on the air. While long-distance broadcasting on h-f is not new, we had planned a system capable of broadcasting to nearly any spot on the globe, and that was quite an order.

We had to consider ionization and its effects. The variable nature of the ionosphere prompted the use of different frequencies at different times Figure 1 View of power-supply system for 50-kw transmitters.

of the day. The type of antennas selected required a separate curtain array for each frequency in the International band, in each direction chosen; five antenna systems in each of three major directions. Incidentally two-hop transmission is required for transmission to Europe for most of the frequencies used.

Another very important factor affecting the ionosphere that we had to consider was the earth's magnetism. Since the earth is a magnet of

| Frequency (mc) | Time of Day E.D.T | Average µv/m Ottawa | Average µv/m Halifax | Gain (db) |
|--|--|---|--|---|
| 15.14 17.81 15.14 11.75 9.58 6.11 | 1130 1130 1400 1900 2115 2215 | 56.3 64.3 18.5 221.0 447.0 227 | 118.1 131.1 78.2 649. 1112.0 446. | 6.28 6.2 12.5 9.37 7.36 4.12 |
| | | Avera | ge | 7.64 |

Figure 2 Results of tests on BBC signal strength and fading at Halifax and Ottawa.

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by R. D. CAHOON

Senior Engineer International Service Canadian Broadcasting Corp.

a variable nature, its effect on the ionosphere is also variable. Unfortunately for Canada the centre of the earth's magnet, the north magnetic pole, is within Canada's territorial boundaries, in fact, located on Boothia Peninsula, north and west of the Hudson's Bay. When the earth's magnetism comes to an unstable varying condition, we have those annoying magnetic storms. During these periods, the ionosphere becomes very disturbed, particularly at the magnetic poles, with decreasing disturbance further from these poles, and unpredictable results. Signals may fade badly or disappear entirely depending on the severity of the storm and on the proximity to the magnetic poles of the ionosphere areas where the electromagnetic waves are refracted.

For Canada, h-f service to Great Britain and Europe was originally the most important circuit. It was therefore necessary to examine Canada very carefully for the most suitable location for the transmitters to avoid, as far as possible, transmission through ionosphere disturbed by magnetic storms. From published literature of various communications circuits, we found an interesting analysis that was made in 1934 by K. A. MacKinnon, then with the CBC. From this study it was concluded that best transmissions to England could be made from the extreme South East coast of Nova Scotia. An actual improvement of from 6 to 8 db was predicted over transmission from Montreal. But even this was not considered conclusive enough, and it was decided that experimental tests should be carried out to prove the point.

The BBC h-f service was then in operation and since transmission and reception are reciprocal, it was decided to make some extended quantitative measurements on reception of BBC at Ottawa and at or near Halifax, Nova Scotia. These experiments were carried out by the writer in April and May, 1941. The tests ran for a month on frequencies in five of the international h-f bands. It was thought advisable to check transmis-

H.F BROADCAST SYSTEM DESIGN

FRANSMITTING SYSTEM

ons at all useful times of day on the ptimum frequencies used at these articular times. Quantitative measrements were made of the field rengths at each location on duplite sets of measuring equipment Graphic nder identical conditions. narts were kept of these results.

Furthermore, qualitative tests were ade possible on the various types programmes, by having the prorammes transcribed at both points by lentical equipments, right from the ntenna to the discs used. This exedient was extremely effective in nowing up the effects of fading, parcularly during periods of extreme agnetic storms.

The results (Figure 2) of these tests greed remarkably close to the preicted results on signal strength and lso definitely proved that fading conitions were better at Halifax, furher from the zone of maximum disirbance

Comparison of the transcriptions arther verified our contentions. Of 26 sets of recordings, we found that ie results were:

| etter | in | Ha | lifaz | ς. | ۰. | • | | | | • | | | ł | | | • | | | | | 103 |
|-------|----|------|-------|-----|----|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|-----|
| qual | | | | • • | • | • | • | • | • | × | | • | • | • | • | • | ٠ | • | * | , | 17 |
| etter | in | Otta | awa | | ÷ | | | | | | • | • | | • | | | , | | | | 6 |

The results were conclusively in vor of transmission to the most eastn part of Canada, to avoid a path rough the more disturbed ionophere. We then had to select a site uitable from practical considerations, roximity to power, proximity to telehone lines, suitable land and ground onductivity, etc. The site of our BA transmitter was the obvious anwer. All the necessary requirements vere there and in addition there would e the economy of joint operation of -f transmitters with the CBA broadasting transmitter.

Intennas

One of the major decisions to be hade was on the type of antenna sysem to be used. We attempted to proide the best possible antenna system egardless of cost and structural difculties. This policy proved to be a vise one in the results obtained. In general study of the problem of rorld coverage, it was decided that ontinuous service to all countries and

inguages was decidedly out of the uestion, and we therefore attempted provide listening service during the naximum listening hours in general.

I.F BROADCAST SYSTEM DESIGN

Figure 3 Aerial view of one of the 380' beam antenna towers. The antennas are multi-element cur-tains of the resonant type composed of sixteen half-wave elements properly phased driven by two t two trans-



From an azimuthal map centered on Sackville, New Brunswick, we found that it was possible to cover nearly all

major continents of the globe with three antenna systems which were reversible and which could have the direction slightly altered in a system known as slewing.

Figure 4 Horizontal polar diagrams of radiating systems of one, two and four-element half-wave antennas: a represents one half-wave element; b, two half-wave elements; c, four half-wave elements; and d, four half-wave elements plus reflector (rear lobe eliminated by reflector).

The antennas chosen were actually multi-element curtains of the resonant type composed of sixteen half-wave elements properly phased and driven by two transmission lines. Behind each element was an identical element





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- standardization required at any time. • STABILITY ... po temperature
- drift after initial 30 second warm-up.
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CBC TRANSMITTERS

(Continued from page 61)

spaced a quarter wavelength, acting as a reflector properly phased and connected by two more transmission lines properly stubbed.

Figure 4 a, b and c shows the hori zontal polar diagram of radiating systems of 1, 2 and 4-element half-wave antennas. These illustrate the important concentration of energy by the use of a multi-element system. Similarly stacking the elements in a vertical plane concentrates the energy in the vertical plane. The effect of the reflectors in eliminating the back lobe and strengthening the forward lobe is illustrated in d. Because of the time differences, it is very unlikely that transmission in opposite directions from the same antenna will ever be required. Thus the inclusion of the reflectors with provision for reversing shows an increased signal strength in either direction at the time of day required.

The slewing of the beam is accomplished quite simply by delaying the phase in one-half of the curtain. This is done by adding in an additional length of transmission line and is controlled from the antenna switching room by remote control.

The so-called medium gain arrays are mostly two frequency antennas with only two elements in height but four elements long. This results in less gain because of less vertical concentration.

In Figure 8 (see page 86) appears a tabulation of the fundamental characteristics of all the antennas. This shows increased signal strengths afforded by using antennas four elements high by four wide, giving us a gain of 21.5 db. Reducing to four horizontal elements and two vertical elements reduces the gain to 15.3 db when the lower element is one wavlength above ground and 12.6 db when the lower element is only a half wave above ground. The problem of this point is, of course, an economic one as it becomes expensive to erect antenna

Figure 5 Tube racks designed to move 100-kw tubes from storage vault to panel.



structures high enough to accomnodate four elements at 6 megacycles where the wavelength is approximatey 150'.-

Transmitters

Specifications for the transmitter alled for an output power, at least 50 kw, capable of full modulation. The six international bands between 6- and 2-mc had to be covered. Frequency response was \pm 1.5 db from 50 to 3,000 cycles and \pm 2 db between 30 and 10,000 cps. Other required feaures were: Frequency stability, 005%; audio distortion, less than 5% ms total harmonic content; and carier noise, 60 db below 100% modutation.

The transmitters were installed by RCA. (A simplified schematic of the ircuit is shown in Figure 7.) This is straight-forward class C plate-modilated transmitter, high-level moduated in the final stage by class Bnodulators. The tubes are air cooled with the exception of the final stage ind the modulator tubes which are water cooled 880's. The oscillator vorks at half frequency and is a conentional plate-tuned crystal oscillaor. This is followed by an 802 buffer loubler feeding into push-pull 828's perating class C. In the second stage ve have two 810's in push-pull crossneutralized inductively coupled to the hird power-amplifier stage (827R raliation-cooled beam pentode). For implicity and stability these tubes vere neutralized and drove directly he final stage 880's in push-pull crossneutralized inductively coupled to the output circuit. This stage operates lass C with an efficiency of approximately 75% over the entire freuency range.

The audio amplifier is quite conrentional and is push-pull throughout. To reduce audio phase shift over a eed-back loop, the third audio stage (Continued on page 65)

Figure 6 Two of the four antenna towers used at the Sackville N. B. station of CBC.





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Unvarying accuracy is all-important. Variaten Gain Set, Type 1901-B (shown above) has a flat frequency characteristic of 0 to 20 kilocycles, and leakage is guaranteed to be less than $1/10th \ db$. (Measurements have been made at frequencies as high as 100 kilocycles with practically no error.)

Variaten Gain Set 1901-B is equipped with both send and receive impedance matching controls for *both* Straight T and Balanced H circuits. This dependably accurate instrument can be supplied with either one or two meters.

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Figure 7 Functional schematic of transmitters.

SOLVING TRANSMISSION LINE

With Charts of Complex Hyperboli Tanh and Coth

I N calculations of long transmission lines having appreciable attenuation the complex hyperbolic functions tanh and coth $(\alpha + j\beta)$ are frequently used. Although these values can be computed directly from tables of real hyperbolic and circular trigometric functions, such computations are rather tedious. Values can be found more readily from charts. Accordingly the charts shown in Figures 1 and 2 were developed and found to be quite handy for transmission line work.

The values of the tanh of the complex angle $(\alpha + j\beta)$ are also complex and are shown on the charts as the rectangular coordinates $u \pm jv$. Values of α are shown by the arcs centering on the horizontal axis. Values of β are shown in degrees by the arcs centering on the vertical axis (in plain figures for tanh). In the range $0^{\circ}-90^{\circ}$ the corresponding values of v are positive. To permit a larger scale the same arcs are used for the values in the range $90^{\circ}-180^{\circ}$ where the corresponding values of v are negative. Since the values in the lower corner of Figure 1 were too crowded for accurate reading, an enlargement of this section was prepared, Figure 2.

The same charts are used to evalu-

Figure 1

Chart of tanh $(a + j\beta) = u \pm jv$, or coth $(a + j\beta^{\circ}) = u \pm jv$. For tanh values in the $0^{\circ}-90^{\circ}$ range, v is positive; in the range of $0^{\circ}-180^{\circ}$, v is negative. For coth values in $0^{\circ}-90^{\circ}$ range, v is negative; in the range of $90^{\circ}-180^{\circ}$, v is positive. [B₁° = (B° + 90°)].

ate the functions of coth $(\alpha + j\beta)$ since

 $\coth (a + j\beta) = \tanh [a + j (\beta + \pi/2)]$ For coth the β arcs are changed from the values for tanh functions, and an shown by the italicized values, thu 85° in the text and circled values i Figures. The β arc values correspond ing to the coth functions are obtaine by adding 90° to the tanh β arc value between 0° and 90° and subtractin 90° between 90° and 180°. The value of v corresponding to coth $(\alpha + j\beta)$ i the range 0°-90° are negative, and i the range 90°-180° positive. Fo either tanh or coth functions all value recur at intervals of 180°. Therefor to obtain functions of values over 180 it is necessary to subtract n (180°), a required, to obtain values between 0 and 180°.



by ROBERT C. PAINE-

BLEMS

amples

(1) Required: Input impedance of line short circuited or open circuited the terminal; line is 4.167 waveigths long and has a characteristic ipedance, Z_{o} , of 600 ohms and a tal attenuation of 4.34 db (when operly terminated).

These values are equivalent to a t propagation characteristic of $+j\beta = .5 + j1500^{\circ}$ which will be und on the chart at .5 + j [1500° 8(180°)] or $.5 + j60^{\circ}$. In Figure 2 nh of this value is found as u + jv 1.12 + j.83. The short-circuited put impedance

$$Z_{se} = Z_{e} \tanh (a + j\beta).$$

this case

 $L_{sc} = 600 (1.12 + j.83) = 672 + j.498;$

open-circuit impedance of a line, $Z_{os} = Z_{o} \operatorname{coth} (a + j\beta).$

or the given line this value correonds to

h
$$(.5 \pm j \ 60^{\circ})$$
 or $u - jv = .57 - j \ .43$



and the input impedance

 $Z_{oc} = 600 (.57 - j.43) = 342 - j.258.$

(2) Required: Propagation characteristic of a given line by input impedance measurements made at one end. These are made as

ese are made as
$$Z_{cs} = 1200\omega | + 15$$

$$_{se} \equiv 1200\omega [+15^{\circ}]$$

with the distance end short circuited, and

$$Z_{op} \equiv 300\omega \mid -15^{\circ}$$

with the distant end open. Since

Figure 2
Enlargement of a section of chart, shown in Figure 1, for the higher values of
$$\alpha$$
.

$$Z_{se} = Z_{o} \tanh (\alpha + j\beta)$$

and
$$Z_{oe} = Z_{o} \coth (\alpha + j\beta), \qquad Z_{o} = \sqrt{Z_{se}Z_{oe}}$$

$$Z_{oe} = Z_{o} \coth (\alpha + j\beta), \qquad Z_{o} = \sqrt{Z_{se}Z_{oe}},$$

or
$$(\alpha + j\beta) = \tanh^{-1} \sqrt{Z_{se}/Z_{oe}}.$$

Then

$$Z_{\circ} = \sqrt{(1200\omega \mid + 15^{\circ}) (300\omega \mid - 15^{\circ})}$$
$$= 600\omega \mid 0^{\circ}$$

$$tanh(\alpha + j\beta)$$

and

$$= \sqrt{(1200\omega | +15^{\circ})/300\omega | -15^{\circ}} = 2|+15^{\circ}$$

(Continued on page 89)



MANSMISSION LINE CALCULATIONS

N. Y. NAVY YARD'S QUIET ROOM



THE New York Navy Yard in Brooklyn, features one of the quietest spaces in the world, a specially designed *silent* $16' \times 26' \times$ 12' high room in which ship microphones, telephones, loudspeakers and other communications devices can be calibrated for level and fidelity.

Designed for as low as 4 cps and for a noise level of 24 db, the usual range of frequencies for which the room is used is between 200 and 20,-000 cps. The noise level is less than 20 db, and at most freqguencies is in the order of 15 db; 4 cps is approximately 16 cycles below the lower limit of audible sound, while a noise level of 15 db is just above the threshold of audibility.

The quiet room is all but completely isolated from the rest of the Material Laboratory building and is enclosed in a second room, $30' \times 40'$, and 25'high, with brick walls 12'' thick which rest on a 6''-thick concrete floor. The walls and concrete ceiling of the outer room are lined with fiberglas 6'' thick, held in place with wire

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Figure 1

Cross-sectional view of construction of the quiet room in the N. Y. Navy Yard in Brooklyn.

mesh. To break the symmetry of any standing sound waves, the walls are built so that no two of them are parallel. Between the outer room and the quiet room there is a free space of 18".

The function of the outer room is to exclude outside noise, whereas the quiet room itself is designed so that sound waves generated within it will be absorbed instead of being reflected back from the walls, floor and ceiling to distort the pattern when calibrating equipment.

To exclude all vibration created by outside noise or due to other causes, the steel skeleton of the quiet room is supported on 14 rubber columns, 8" square and 14" high when compressed

by WILLIS M. REES

Acoustical Specialist Owens-Corning Fiberglas Corporation

 $1\frac{1}{8}$ " by the weight of the room which is approximately 20 tons. The rubber columns, which provide the only contact between the quiet room and the rest of the building, rest on a 6"-thick monolithic concrete panel poured on 2"-thick corkboard laid on the concrete floor of the building. Fiberglas, 6" thick, is laid on the concrete panel.

Walls, Ceiling and Floor

The walls, ceiling and floor of the quiet room consist of four layers. On the outside is a 1" thick perforated fiberboard, 4" of fiberglas, 1"-thick perforated fiberboard, and a 4"-thick lining of fiberglas held in place by wire mesh. Panels of fiberglas, covered with cheesecloth, are hung, with the longer axis running vertically, all around the walls, reaching from top to bottom. The panels are 4" thick and 24" from front to back. There are approximately 2" of space between each panel.

Suspended Panels

Similar panels, with the longer axis running horizontally, are suspended from the ceiling and are projected vertically from the quiet room floor. Above these latter panels is a steel framework which, when covered with sections of metal grill, provides a means of walking about the quiet room. All of the metal grill sections, except those which may be needed to support instruments, are removed during testing periods. It is unnecessary for anyone to be in the room during the testing periods, since all tests are conducted by remote control.

Fiberglas Construction

The fiberglas material employed consists of fine, interlaced glass fibers treated with a thermosetting resin to provide permanence of form. Its average density is $2\frac{1}{2}$ pounds per cubic foot. Tests made in accordance with methods prescribed by the Acoustical Materials Association show that a 1" thickness of the material has a noise reduction factor of 0.60 at 550 cycles.

New Production Technique

ecently developed methods of post-forming fully cured Formica iminated plastic sheets have adapted the material for very much rider use in a great many applications that were formerly thought mpractical.

a this process the sheets are heated, and formed quickly with inexensive wooden or Pregwood dies into many curved shapes.

reviously to secure such shapes it was thought necessary to mold ae material in curing with the use of very elaborate and expensive teel molds—which were impractical for any but a few large volume pplications.

his shaping method provides a very light (specific gravity 1.35) naterial, that is strong, stable in dimensions, inert chemically and nerefore possessing a finish that is free from corrosion and long of life.

ormica engineers will be glad to tell you the story.



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PLASTIC PARTS ...

Figures 1 (below) and 2 (right)

Figure 1. A Pierce-type crystal oscillator oircuit used in an a-m broadcast and short-wave receiver. Figure 2. Chart showing frequency relationships for each of the first six television channels.

| Channel | Channel Frequency (MC) | Sound Channel Resting Frequency | Video Carrier Frequency | Local Oscillator Frequency | One-half Oscillator Frequency | Fundamentai Crystal Frequency | Harmonie Order of Crystal |
|---------|------------------------------|--|-------------------------------|----------------------------------|-------------------------------------|-------------------------------------|---------------------------------|
| 1 | . 44-50 | 49.75 | 45.25 | 27.50 | 13.75 | 4.583 | 3rd |
| 2 | . 54-60 | 59. 75 | 55.25 | 37.50 | 18.75 | 6.25 | 3rd |
| 3 | . 60-66 | 65.75 | 61.25 | 43.50 | 21.75 | 4.35 | 5th |
| 4 | . 66-72 | 71.75 | 67.25 | 49.50 | 24.75 | 4.95 | 5th |
| 5 | . 76-82 | 81.75 | 77.25 | 59.50 | 29.75 | 5.95 | 5th |
| 6 | 82-88 | 87.75 | 83.25 | 65.50 | 32.75 | 6.55 | 5th |



A Discussion of Crystal Oscillator-Mixer Circuits For the Standard Broadcast Bands and the New F-M/ Television V-H-F Channels

CRYSTAL-CONTROLLED RECEIVERS FOR A-M, F-M AND TELEVISION

W ITH the recent announcement by RMA of the approved f-m i-f of 10.7 mc and the unanimous proposal of 22.25 mc for the i-f sound channel of television receivers, it is now possible to analyze the quantitative design features of the oscillator sections of these receivers.

In a-m design, we have 455 kc as the i-f for broadcast and s-w receivers, a standard i-f for years. In Figure 1 we have a push-button crystal-oscil-



Consulting Engineer

[Part Three of a Series]

lator circuit used as the local oscillator of an a-m b-c/s-w receiver. The circuit is the *Pierce* type discussed in previous papers and also described as a Colpitts or ultraudion. Several crystals and one end of the manual-tuning LC



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Figure 3 lat of mixer and qu scillator to tune is

Circuit of mixer and local oscillator to tune to television channel *I*, using an oscillator generating ¹/₂ desired frequency and a diodefrequency doubler.

circuit could be connected together at point x. The switching could then be effected at point y by a push button, rotary, or dial type of selector switch.

The crystals required are high-frequency thickness-shear type oscillators covering a 995 to 2,055-kc range and having a low temperature-frequency coefficient. It is simple to utilize higher-frequency crystals in the oscillator to select stations in the shortwave bands. The station selector switch must of course control all tuned r-f circuits. The Pierce-type circuit makes it unnecessary to tune the oscillator to resonance at the crystal frequency. For different communities it is only necessary to slip the proper crystals into place to tune to the desired channels.

If manual tuning is desired, an LC circuit may be switched in to replace the crystal, and tuned as usual.

Crystal oscillator circuits for television receivers are somewhat more complicated. These systems will usually require at least one tuned *LC* circuit. Limiting the requirement to only (Continued on page 106)

CRYSTAL OSCILLATOR-MIXER CIRCUITS


hfon

'4G

ACTUAL SIZE

IONICALLY HEATED LOW VOLTAGE GAS RECTIFIERS

Readily Available + Smaller Space Requirement + Lower Operating Temperature + Commercial in Cost + Long Life + Quicker Starting

RAYTHEON

0Y4

A major deterrent to the further size reduction of radio receivers and other equipment designed for universal operation from a standard 117 volt AC or DC line or internal batteries, has been the size and power dissipation associated with the rectifier tube. The advantages of an ionically heated tube for low voltage applications were recognized early by the Raytheon engineers, who have long pioneered in the field of gas tube development. However, considerable research has produced the OY4 and OY4G which start cold from no more than 95 volts DC. High rectification efficiency is realized from the low internal drop and high peak current ratings. Physically these types have the same dimensions as the familiar OZ4G and OZ4.

Where size is an important factor, use of the OY4G in place of the 117Z6GT, as extensively employed in the three way receivers, will result in a substantial reduction of the space requirements.

OY4G AND OY4 RATINGS

Half Wave Rectifier-Condenser Input to Filter*

| Maximum Inverse Peak Voltage | | • | x | | | R (| 4 | • | | | 300 | volt |
|-------------------------------|-----|-----|----|-----|-----|-----|------|-----|----|----|-----|------|
| Maximum Peak Current | 7 | | ų. | | R. | | | 2 | y. | 2 | 500 | mo |
| Maximum DC Output Current | | | | | | | e i | | r. | • | 75 | mo |
| Minimum DC Output Current . | | | ÷ | | | ļ. | e. | | | | 40 | mo |
| Minimum Series Anode Resistar | nce | (11 | 7V | lin | e o | per | atio | on) | | | 50 | ohm |
| Approximate Tube Drop | | | | | | | ki l | | | | 12 | volt |
| Maximum DC starting Voltage* | ۰. | | | | | ł | | | • | ×. | 95 | volt |
| | | | | | | | | | | | | |

*Pins 7 and 8 must be connected together. Rapid intermittent operation is undesirable.

**With starter anode network as shown in circuit.

Radio Receiving Tube Division

NEWTON, MASSACHUSETTS + LOS ANGELES NEW YORK + CHICAGO + ATLANTA

Even more important is the differential of approximately eight watts in favor of the OY4 and OY4G because of the ionic heating feature. This saving cuts the input power down by more than 50% for a normal receiver. Consequently, cabinet size can be decreased without danger of excessive heating. Furthermore, the time required for the set to become operative is the same whether on DC, AC or battery — that is, almost instantaneous.

ACTUAL SIZE

These tubes have been engineered to produce a minimum of the radio frequency disturbances associated with a gaseous discharge. The simple filter circuit indicated below will generally reduce such interference to a negligible value.

If your product does not call for the ionically heated low voltage gas rectifier, there is a Raytheon type designed for your need. And all Raytheon tubes follow the same rigid pattern of advanced engineering with precision manufacture. To get continuing best results, specify Raytheon High-Fidelity Tubes,



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Figures 1 (left above) and 2 (right above)

1. A normalized T-to- π network transformation, where: $s^2 = 1.333$, u = 1.044, v = 0.696, w = 0.348, a = 1.915, b = 3.830, and c = 1.276 ohms. Figure 2. A normalized π -to-T network transformation, where: $s^2 = s^2$, a = 3.39, b = 2.71, c = 1.35, u = 1.23, v = 0.49 and w = 0.62 ohms. Figure 1.

RESISTIVE ATTENUATORS, PADS NETWO RK A Their Applications An Analysis of in Fader Mixer and Systems

The preceding papers in this series on purely resistive types of networks gave the general philosophy involved in their design. Charts and tables were prepared to expedite computations of the elements of the network. The form of presentation of the charts and tables also was arranged to permit the complete and rapid determination of the performance of the networks in terms of their image impedances, insertion and transmission losses. Use was made of a symbolical method whereby most mathematical expressions were compressed into quite simple forms. These forms were then shown to be directly convertible Into hyperbolical, algebraical and exponential expressions and were compactly arranged in a key chart which served to define all of the relationships between the various forms.

In this installment, the last of the series on networks of the purely resistive type, a few examples have been chosen from an infinity of those possible. These examples may be considered representative of those which would be most probable in practical design work. The examples are given directly in terms of the nomenclature used throughout the text, the key chart and the figures of the various charts.

(3)

T HE T to π transformation results in the equivalence shown in Figure 1. The equations of the transformation are

| $a \equiv \phi/v$ | (1) |
|-------------------|-----|
| $b = \phi/w$ | (2) |

and

 $c \equiv \phi/u$

where

$$\phi = uv + uw + vw.$$

For unit values of n=1.044, r=0.696and w = 0.348 ohms for the T network, application of equations 1, 2 and 3, respectively, give a = 1.915, b = 3.830 and c = 1.276 ohms respectively. The terminations are $s^2 = 1.333$

ohms and unity, but need not be unless it is desired to match the network image impedances. The terminations given are on a unit image-impedance basis.

π to T Transformations

The π to T transformation results in the equivalence shown, on a unit

Figures 3 (below left) and 4 (below right) Figure 3. An equivalent T network of one hav-Figure 3. An equivalent 1 network of one hav-ing N elements providing open-circuited measure-ments, $Z_{01} = Z_{02} = 1,000$ ohms and short-cir-cuited-measurement of $Z_{s1} = 360$ ohms; u = v =200, w = 800 ohms. Figure 4. An application of Bartlett's bisection theorem applied to the equiv-ulent T of Figure 3. The image impedance = 600 ohms.



PAUL B. WRIGHT b v Communications Research Engineer

matched image-impedance basis, in Figure 2. The equations of the transformation are

$$u = ab/\Delta$$
 (4)

 $v = bc/\Delta$ (5)

$$w = ac/\Delta$$
 (6)

where $\Delta = a + b + c$. For a = 3.39, b = 2.71 and c = 1.35 ohms, 4, 5 and 6 give the resultant T as u = 1.23, v = 0.49 and w = 0.62 ohms.

Equivalent T of N Elements

and

The equivalent T network of any complicated arrangement of purely resistive elements may be found by calculation from three independent measurements upon the network. These measurements may be either two open-circuit measurements from the two ends plus one short-circuited measurement, or alternatively, two short and one open-circuited measurement. Assuming that the first of these two







COMMUNICATIONS FOR OCTOBER 1945

RESISTIVE NETWORKS

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GEORGE H. CLARK, Secretary

Personals

EROY BREMER, for many years an energetic VWOA representative, as secretary of the Los Angeles-Hollywood chapter, is back at his civilian activities after 5 years of service with the U. S. Maritime Service.

LB was a Lieutenant (Senior Grade) in the U. S. M. S. He traveled some 700,000 miles covering all theatres of operations, participating in thirty-three invasions. He was wounded three times, on Saipan, Palau and in Manila.

LB has received the Combat Bar; Defense Bar; Philippine Defense Ribbon; Philippine Liberation Ribbon; Middle East War-Zone Bar; Atlantic War-Zone Bar; Pacific War-Zone Bar; the Presidential Unit Citation and a Personal Citation from General of the Army Douglas MacArthur.

A note from LB states that he'd like to act as L.A. secretary again. With LB doing the spadework, Doc de Forest as a most active participant and Hal Styles as chairman, we are certain that the L.A. chapter will again become preeminent in VWOA affairs.

Congratulations, LB on your outstanding war record and all good wishes for continued success in your civilian work, and in VWOA affairs.

E understand Commander Fred Muller is now stationed at Norfolk. . . . Our twenty-first birthday party at the Hotel Astor on Saturday evening, February 16, 1946, will be a victory celebration. . . . J. F. Rigby, life member and personnel director of RCA Communications, recently completed 25 years of RCAC service. An interesting biographical sketch of JFR appears in RCAC Relay, authored by his older daughter. . . We're glad to hear that director C. D. Guthrie is up and around again. We look forward to seeing him at our meetings. . . . Congratulations to E. H. Price, an enthusiastic VWOA member, upon his recent election as vice president of the Mackay Radio and Telegraph Company. . . . It's now Major General H. M. McClelland, the



George Clark, VWOA secretary, who prepared a historical chapter on radio pioneers for the souvenir brochure distributed at the recent radio pioneers' dinner in New York City.

Air Communications Officer of the Army Air Forces. Congratulations. ... Old-timer R. K. Davis, long with Tropical Radio, has resigned to enter business at Fort Plain, N. Y. Good luck. . . . Lloyd C. Nunn, one of our most faithful members, has completed 33 years of service with RCAC. He is a senior operator at RCAC. . . . The Fall meeting of VWOA at the 77th Division Club on October 25, 1945, was attended by many old-timers. . . . We are anxious to obtain wartime heroic act details of radiomen in all branches of the services as well as in civilian pursuits. Please send them in to headquarters with photos if possible. ... George Street, chairman of our Honolulu chapter continues to be quite active in wireless affairs out Wakiki way. . . . R. H. Pheysey, who received a VWOA testimonial scroll recently is now with United Fruit Company. For years he was with Tropical Radio. . . . Col. Thompson H, Litchell, vice president and general manager of RCAC, was at the recent communications conference in Rio. . . . Congratulations to Captain George F. Shecklen, U. S. N. R., upon his recent election as vice president and general manager and a director of the Radiomarine Corporation of America. Captain Shecklen, a 33-year veteran of radio, graduated from the Philadelphia School of Wireless Telegraphy in 1912, subsequently serving as wireless officer aboard mer-

chant vessels for three years. Progressing through various assignments in radio-shore station operation, sales commercial representative - Captair Shecklen was instrumental in setting up communications facilities of RCAC throughout the Far East. Commercial manager of RCAC at the time of his call to active duty, he served as Communications Officer in the Third Naval District, New York. He then went on a special mission to South America for the State Department. In 1944 he was transferred to the staff of the Commander-in-Chief of the U.S. Pacific Fleet. He served for fifteen months at Pearl Harbor and in the Western Carolines. . . . W. F. Aufenanger, life member, is an outstanding member of the executives bowling team at RMCA. Washington chapter chairman F. P Guthrie, a pioneer wirelessman, was recently elected an assistant vice president of RCAC. Many thanks FPG for the splendid work you've done for VWOA in the Nation's capital. In the Navy in 1923 for four years, then the Coast Guard from 1929 to 1934 and back to the Navy from 1937 until the present, now serving as an Aviation Chief Radioman, is the record of William Shaw Nagata. . . Frank D. Pizzuti, formerly radio officer on the S.S. Caddo, now senior engineer at Airadio, Stamford, Conn.

Pioneers Honored

PionEERS of the wireless art were honored at a recent dinner held in the grand ballroom of the Hotel Commodore, under the auspices of the IRE, VWOA, ARRL and the RC of A.

One of the features of the evening was a souvenir brochure containing the intriguing history of the pioneering personalities and their developments, prepared by our own George Clark. George, who is now secretary and director of the VWOA and one of the original VWOA incorporators, was a charter member of the Wireless Institute, predecessor to the IRE. He is also a charter member of the IRE and was the first Chief Radio Aid to the U. S. Navy. Congratulations to a grand old wireless pioneer.

A NEW SOCKET for very high frequencies

TYPE XLA

Born of war-time necessity, this new socket, Type XLA, for the 6F4 and the 950 series acorn tubes, has been designed for working frequencies as high as 600 MC. The acorn tube is inserted in position, and rotated to engage the contacts. The tube terminals are held in a vise-like grip which insures permanently low contact resistance. Inductance is low and constant, and leads are short and direct. An internal shield, Type XLA-S, is available for tubes such as the 956. By-pass condensers may be conveniently mounted between the contact terminals and the chassis, but for minimum radiation a special ceramic condenser, Type XLA-C, may be mounted inside the socket in place of the contact screw. The socket is 1 17/32" diameter. Insulation is low loss R-39. Prompt delivery can be made without priority.



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RESISTIVE NETWORKS

(Continued from page 72)

(8)

sets of measurements is chosen, the equations for the elements are

$$u = Z_{o1} - w \tag{7}$$

$$v \equiv Z_{o2} - w$$

$$w = (Z_{02}(Z_{01} - Z_{s_1}))^{\frac{1}{2}}$$
(9)

If the open-circuited measurements each equal 1,000 ohms and the shortcircuited measurement from one end is found to be 360 ohms, use of equations 7, 8 and 9 give the equivalent T shown in Figure 3, with u = v = 200and w = 800 ohms. If Z_{01} and Z_{02} were unequal, the equivalent T would be an asymmetrical network with uand v unequal also.

Bartlett's Theorem

An application of *Bartlett's theorem* is shown in Figure 4. To determine the image impedance of the network of Figure 3, and find if the terminations shown in figure are correct for proper match of impedances, the network is bisected as shown. The square root of the open and short-circuited impedances of the bisected network will give the image impedances of any symmetrical network. The equations for the open circuited and short circuited conditions are, respectively,

$$Z_{\rm oc} = Z \coth \frac{\Theta}{2} \tag{10}$$

and

$$Z_{\rm sc} = Z \tanh \frac{\Theta}{2} \tag{11}$$

Since the hyperbolic coth and tanh of the half angle subtended by the network half are reciprocal functions, from 10 and 11, the above statement follows. For Figure 4, the open-circuited bisected network gives 200 +1600 = 1800 ohms and the short-circuited condition gives, simply, 200 ohms. The square root of their product equals 600 ohms. Hence, the termination as shown is the correct one for image operation or matching.

Series-Insertion Network

(a)

Let us assume that we should like

to know the effect of inserting a given resistance between any two impedances having a ratio of four to one, hence, $s^{a} = 4$. Referring to Figure 5*a*, with *u* equal to 2 ohms, the insertion loss as found from the equation

$$db = 20 \operatorname{Log}_{10} \left(1 + \frac{u}{s^2 + 1} \right)$$
 (12)

is found to be 2.92 db. This is the loss that would be obtained with the series resistance connected into the circuit over that which would result if it were missing or short circuited.

Conversely, if the loss is caused by an inserted facility between these same impedance terminations, the unknown network element is given by the equation

$$u = N (s^2 + 1)$$
 (12)

From the first table given in the series, N is given by interpolation as 0.40, hence u = 0.4(4 + 1) = 2.0 ohms as the value of the inserted resistance.

Shunt-Insertion Network

Figure 5b shows a shunt of 2 ohms placed across the terminations of 5ainstead of in series. The equations for loss and element value are

db = 20 Log₁₀
$$\left(1 + \frac{1}{w} \frac{s^2}{s^2 + 1}\right)$$
 (13)

and

$$w = n \frac{s^2}{s^2 + 1} \tag{14}$$

with w = 2 ohms; the loss in this case happens to be identical to that

Figures 5 (below left) and 6 (below right) Figure 5a, b and c. Insertion losses of these networks on a normalized or unit basis give for: (a) 2.92 db with $s^2 = 4$, w = 2 ohms; (b) 2.92 db with $s^2 = 4$, w = 2 ohms; (c) 13.3 db with u = 1, v = 4, w = 2, $s^2 = 4$ ohms. Note that these networks are not matched by image impedances. Figure 6a, b and c. Transmission losses of these L-taper networks on a normalized basis give for: (a) 12.04 db with $s^2 = 4$, v = 3.5, w = 1 ohm, matched at series end only; (b) 6.52 db with $s^2 = 2$, v = 1, w = 1.5 ohms, matched at shunt end only; (c) 11.5 db with $s^2 = 4.05$, v = 3.5, w = 1.15 ohms, matched at both ends of the network. of the series case, or 2.92 db. Were loss given as 2.92 db instead, with a same terminations, the element val $w = 0.8 \times 2.5 = 2.0$ ohms. The interpolated value of n = 2.5 as found from the first chart, or may be secured taking the reciprocal of N from a series case.

Series and Shunt Insertion Network

In Figure 5c appears a series a shunt insertion network; Figures and 5b are merely special cases of the more general network. The equati for the loss of this network when a seried between any given facilities

$$db = 20 \operatorname{Log}_{10} \left(1 + \frac{u+v}{s^2+1} + \frac{(u+s^2)(v+1)}{w(s^2+1)} \right)$$
(1)

If the unit values of the elements a u = 1, v = 4 and w = 2 ohms respetively, the insertion loss for an inpedance-termination ratio of $s^2 = 4$ 13.3 db. The elements cannot found uniquely in terms of the lo function since an infinite variety elements can give the same insertie loss in this case.

L Taper, Series Matched

This type of network, Figure 6 is matched on its series-end only. The power transmission loss for this network is given by the expression

$$db = 20 \text{ Log}_{10} (s(1 + 1/w))$$
 (10)

and the network element values by

$$V \equiv S(S-1) \tag{1}$$

and

1.

$$w = sr/(1 - rs)$$
 (1)

For $s^2 = 4$, v = 3.5 and w = 1 ohm, the transmission loss is 12.04. Conversel if the loss were given as 12.04 are the terminations as shown, the element values from 17 and 18 by use of the first table, v = 2(2 - .25) = 3.5 are $w = (2 \times 0.25)/(1 - (2 \times 40.25)) =$

L Taper, Shunt Matched

Figure 6 illustrates an L-taper pa or attenuator matched on its shunt en only. With $s^2 = 2$, v = 1 and w =1.5 ohms, the loss and element equations are given by

$$db = 20 \text{ Log}_{10} (s(1 + v/s^2))$$
 (19)



RESISTIVE NETWORK

(c)

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(b)

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$$v = s(k-s)$$
 (20)
and

w = s/(s-r)

The transmission loss is 6.52 db. Conversely, were the loss given and the element values desired, equations 20 and 21 with the interpolated value of k and r from the first table of this series would result in $v = (2)^{\frac{1}{2}}$ (2.121 - 1.414 = 1 ohm, and w = 1.414 /(1.414-0.471) = 1.5 ohms.

(21)

L Taper, Series and Shunt Matched

This is a minimum-loss network, Figure δc . It is matched by its image impedances at both ends. Their ratio must be equal to or greater than unity with the larger impedance connected to the series end of the network.

The ratio which it is possible to match and build the network with positive elements is given by column E in the second table of the series. If the minimum loss pad desired is 11.5 db, the ratio of terminating image impedances must be 4.049. The unit elements required to give this loss are given by the equations

| $\mathbf{v} = \mathbf{A}\mathbf{s}$ | (22) |
|-------------------------------------|------|
| and | |

w = as (23)

From table *two* of the series, the element values are therefore,

 $v = 1.746 \times 2.01 = 3.51$ ohms and $w = 0.573 \times 2.01 = 1.154$ ohms (24)

T-Network Design

Usually, the loss desired for the network and the impedances between which is is to operate are given as data from which the element values can be obtained. When the terminations are equal and the network is connected at its terminal ends by equal image impedances, particularly simple forms of the equations result. If a pad or attenuator having a transmission loss of 10 db is to be designed for given ratios of the image impedances, it is necessary to first determine the maximum ratio which can be used and still result in physically realizable elements. This ratio is given by the hyperbolic cosine-squared function which is designated symbolically as E. It will be noted that any ratio up to a maximum of 3.025 can be satisfactorily used and will give positive elements. Let us assume that the ratio of terminating impedances is $2.0 = s^{a}$, and that the loss is 10.0 db. The equations for the element values on a unit basis are

 $u = cs^{2} - w$ (25) (Continued on page 78)



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RESISTIVE NETWORKS

(Continued from page 77)



(26)

$$v \equiv c - v$$

and

$$w = as$$
 (27)

From the above data and the second table of the series, the element values required are $u = [(2 \times 1.222) - (1.414 \times 0.703)] = 1.448$ ohms, v = (1.222 - 0.996) = 0.226 ohm and $w = 1.414 \times 0.703 = 0.996$ ohm. These values are shown in Figure 7b.

When, however, the image impedances are equal, $s^2 = 1$ and the equations 25 to 27 simplify to

$$\mathbf{u} = \mathbf{v} = \mathbf{D} \tag{28}$$

and

$$w \equiv a$$
 (29)

For a 10-db pad, the unit values are then read directly, without any calculation, whatever, from table *two* of the series, and give respectively, u =0.519 ohm = v and w = 0.703 ohm. To place the unit values on any desired impedance level basis other than unit ohm at the small terminating impedance end of the network, it is only necessary to multiply all element values and both terminations by the smaller of the two terminations if different, or by the common value if terminations are equal.

Since the loss of the unit network is given by the equation

db = 20 Log₁₀
$$\left(s\left(1 + \frac{v+1}{w}\right) \right)$$
 (30)

for the general T and the same without the s factor when the network is symmetrical with equal-terminating impedances, a means is readily available to determine the transmission loss of any such network when operated between its image impedances. If we assume that the network whose loss is desired is that of Figure 1, then equation 30 applied gives 16.62 db.

π -Network Design

The π -network design may be obtained by first designing a *T*-network and then using the *T*-to- π transformation. However, the more direct method using the equations shown in the charts together, with the hyperbolic functions from the second table of this series is preferable when available. The equations for the element values on a unit basis are

$$u = s^2/(c-as)$$
 (31)

$$r = As$$
 (32)

and

$$\mathbf{v} \equiv \mathbf{s}/(\mathbf{cs} - \mathbf{a}) \tag{33}$$

(Note that the formula for the unit value of u was inadvertently omitted in the chart, but may be obtained as in 31 by dividing both sides of the equation for u on a full-impedance basis by z, the smaller of the terminating image impedances.) Let us assume that the network is to operate between unequal-terminating impe-

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Figure 7

Transmission losses of these networks (T, π) and bridged-T respectively operating between image impedances on a unit basis give for: (a) 10.0 db with $s^2 = 2.0$, u = 1.448, v = 0.226, w = 0.996 ohms; (b) 15 db with $s^2 = 4$, u =12.1, v = 5.446, w = 1.132 ohms; (c) 5 db with v = 0.778 and w = 1.285 ohms.

dances having a ratio of $s^2 = 4$, and a transmission loss of 15 db is desired. The element values are therefore, $u = 4/[(1.065 - (0.367 \times 2)] = 12.1,$ $v = 2.723 \times 2 = 5.446$ and $w = 2/[(1.065 \times 2) - 0.367)] = 1.132$ ohms respectively, Figure 7b.

The loss for this network in terms of the image impedances and the element values is given by the expression

$$lb = 20 \operatorname{Log}_{10} \left(1 + v + \frac{v}{w} \right) / s \quad (34)$$

on a unit basis.

Were the element values obtained above substituted into equation 34, the loss obtained would be found to be 15 db.

In the special case of equal-terminating impedances, this network also may be designed by direct inspection of the second table in the series and the simplified equations of

$$\mathbf{u} = \mathbf{w} = \mathbf{d} \tag{35}$$

and

$$v = A \tag{36}$$

For a 10-db pad, on a unit basis, u = 1.925 = w and v = 1.423 ohms. It may be noted that these values are simply the reciprocal function of equations 28 and 29 for the T network; hence the general rule that for symmetrical networks of the T and π configurations, the reciprocal of the series-T. arms give the shunt- π arms and the reciprocal of the shunt-T arm gives the series- π arm. When the π -element values are given for a symmetrical network, the converse relationship is used to find the equivalent T configuration.

Bridged-T Network Design

This type network is one of the most

Figure 8

An application of a multiple-bridging normalized network of five branch outlets. Transmission loss is 20 db; R = 1.838, r = 0.308 and $s^3 = 4.0$ ohms.

•

ul of all of the standard configuras of symmetrical form. It is shown Figure 7c on the unit or so-called nalized basis. The design equas for the series and shunt arms simple forms and the network be designed by inspection of the table of the series and the equa-

(37)N (38) n

, for example, a 5-db pad is ded, the values of the elements from table are found to be 0.778 = v, series arm and w = 1.285 ohms the shunt arm. All other values he unit elements are given directly er the columns N and its reocal, n. The product of the series shunt element values by 37 and equals unity and the functions are inverse to each other with ret to the unit termination.

he loss function may be expressed several ways as shown by the rts. The most convenient of these be used to obtain the transmission of

 $= 20 \operatorname{Log}_{10} (1 + v)$ (39)

us assume that v = 4.623 ohms. In from 39 and the first table givvalues of k, the loss is found as db.

tiple-Bridge-Network Design

his type of bridging network is ely a building-out network which series resistances so adjusted that any given number of outlets lged onto the circuit and for any o of input and load-impedances e will be no reflections of energy urring at the network junction The configuration is nections. wn in Figure 8. If all load imances are not equal they may be le so by means of either transners or minimum-loss type pads. unequal input and load imances, the building-out series reances R and r will be unequal, le for equal input and output terations of the network R = r. ce the number of branches which be connected in multiple to this work is always integral and never a tional or decimal number, the function progresses in discrete ounts depending upon the number ridging outlets and the ratio of the at and output terminations. The on a power transmission basis n the input to the network to any of the equal outlets is

= 20 Log₁₀ n_m s (Continued on page 80) (40)



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MAIN OFFICE AND FACTORY MALDEN **MASSACHUSETTS**



RESISTIVE NETWORKS

(Continued from page 79) while the element values are respectively equal to

(41)

•

$$R = \frac{1}{2} (cs^2 - as)$$

and

$$=\frac{1}{2}(c-as) \tag{42}$$

For a 4:1 ratio of input and output impedances with five branches connected, the transmission loss by equation 40 and the k column of the first table of the series 20 db. From 41 and 42 with table two of the series, $R = [(4 \times 1.02) - (2 \times 0.202)]/2 =$ 1.838 ohms and $r = (1.02 - 2 \times 10^{-1})$ (0.202) = 0.308 ohm for the unit building out values. For equal terminations, s = 1 and the equations 41 • and 42 become identities. Equations . 40, 41 and 42 become, respectively

$$db = 20 \operatorname{Log}_{10} n_{m} \tag{43}$$

and

а

(44) $R \equiv r \equiv D/2$

For five outlets, the loss becomes equal to 13.98 db and the element values equal to 0.333 ohm each.

Lattice-Network Design

This type of network is a more general one than any of the previously discussed standard configurations of networks. Since, however, in this generalized form, it is essentially an unbalanced structure with respect to the ground plane, and further, since it is uneconomical of elements, it is not expected to have but little practical application in this form. The equations which determine its performance were given in the second set of charts in this series. The symmetrical form of the lattice has, however, great usage both in the direct-lattice arrangement of elements and in the transformed applications of it; hence it will be the only one used for an example of the use of the charts and tables.

The design equations become simple



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Attention! **RADIO STATION ENGINEERS!** RV can now make immediate delivery on hallicrafters Model S-36-A V.H.F. RECEIVERS

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The Model S-36-A is probably the most versatile V.H.F. receiver ever designed. Covering a frequency range of 27.8 to 143 Mc., it performs equally well on AM, FM, or as a communications receiver for CW telegraphy. Equipment of this type was introduced by Hallicrafters more than five years ago and clearly anticipated the present trend toward improved service on the higher frequencies.

Fifteen tubes are employed in the S-36-A including voltage regulator and rectifier. The RF section uses three acorn tubes. The type 956 RF amplifier in conjunction with an intermediate frequency of 5.25 Mc. assures adequate image rejection over the entire range of the receiver. The average over-all sensitivity is better than 5 micro-volts and the performance of the S-36-A on the very high frequencies is in every way comparable to that of the best com-munications receivers on the normal short wave and broadcast bands. wave and broadcast bands,

The audio response curve is essentially flat within wide limits and an output of over 3 watts with less than 5% distortion is ovailable. Output terminals for 500 and 5000 ohms and for balanced 600 ohm line are provided.

NOTE: For those requiring higher frequency receivers. Harvey can now supply from stock the Hallicrafters Model S-37, with a frequency range of 130 Mc. to 210 Mc.



for the case assuming that u = v and t = w. The element values are

(43)

(44)

$$u = v = d$$

and

$$t = w = D$$

For a given loss, these are respectively the same values obtained for the shunt arms of the symmetrical π and the series arms of the symmetrical Tnetwork. In this case, the terminations of the network equal unity, and the unit elements may be obtained directly by inspection of the second table of this series. For an 8-db transmission loss, the element values are u = v = 2.323 ohms and t = w =0.4305 ohm. The network is shown in Figure 9.

The transmission loss of this symmetrical network is found in terms of the elements by the equation

 $db=20 \log_{10} ((v+w+2)/(v-w)) \quad (45)$

The correctness of this may be checked by substituting the values of v and w just obtained into the equation. This gives an accurate check and shows that the loss is 8 db for w = 0.4305 and v = 2.323 ohms.

Bridged-T to Lattice-Network Transformation

Application of Bartlett's-bisection *theorem* to the symmetrical bridged-Tnetwork of Figure 10a results in the symmetrical lattice network of Figure 10b. The open-circuited bisected half of 10a gives $[(1 + (2 \times 1.285)] =$ 3.570 ohms for the shunt arms of Figure 10b, while the shortcircuited bisected half of 10a gives 1 ohm in parallel with 0.778/2 ohm, resulting in 0.280 for the series arm of the lattice network shown in Figure 10*b*. The values of the bridged-Twere chosen from Figure 7c which was designed to have a loss of 5db. Hence, if the transformation given in Figures 10a and b is correct, the values obtained for the lattice should agree with those which would be obtained by the lattice design equations 43 and 44 for a loss of 5 db. Using the second table of the series as a check, it is found that columns d and D for 5 db give identically the results obtained by Bartlett's theorem.

Ladder-Network Design

An example, carried out in detail, was presented in the discussion relating to these networks. It is believed that no further information would be

(Continued on page 106)



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NEUTRALIZING CAPACITORS

(Continued from page 56)

shunts the half of the grid circuit to which it is connected. The direct capacitance between corresponding electrodes of the neutralizing capacitors in the push-pull circuit shunts the entire plate- or grid-tuned circuit to which the corresponding electrodes is connected. The direct capacitance between the plate electrode of one neutralizing capacitor and the grid electrode of the other neutralizing capacitor is effectively added to the gridplate capacitance of the tube between them.

Although the theory of the measurement of the direct and stray capacitances in a multi-electrode system, such as we see in the four electrodes of the two neutralizing capacitors and ground just considered, is beyond the scope of this paper,⁸ data on the results of such measurements are included.

In Figure 4 appear a pair of neutralizing capacitors designed for use in high-power amplifiers.[®] They are mounted on a grounded panel and placed near a capacitance bridge for measurement. The object of the mounting used was to simulate conditions of direct and stray capacitance that may be found in practice and to afford an opportunity to secure capacitance data for a specific set of conditions which can be used for making estimates under different mounting conditions.

The table top was covered with a heavy copper sheet grounded to the bridge. Rugged probe supports were erected on the high terminal of the capacitance bridge and upon the table top for connecting the electrodes of the neutralizing capacitors either to the high terminal of the bridge or to ground. A precision capacitor is shown to the right of the bridge in the well in the table. The parallel substitution method was used at a frequency sufficiently low to insure that the inductance and resistance of the probes produced negligible error in the measurements.

The graph of Figure 5 gives the variation of the direct capacitance, C_N of one of the neutralizing capacitors in Figure 4. The drive shaft for producing the capacitance variation is shown projecting out the front of the upper electrode and may be located readily in any of eight positions. Only the inner electrode moves, and the capacitance range may be changed by resetting the lower cup. The dimensions of the capacitors and their

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Incidentally the crest spark-over oltage for the capacitor and supportg insulators was the same and is inuded in Figure 5.¹⁰ Since the exrnal parts of neither electrode moves ith shaft rotation, all capacitances her than C_8 remain unchanged roughout the variation shown in igure 5.

bsign of Neutralizing Capacitors

The general principles covered so r point to several factors influencg the design of neutralizing capacirs. We may divide these factors to two groups; first those concerned ith general circuit problems, and cond, those concerned with voltage tings of the neutralizing capacitors d their supporting and drive coupng insulators.

Those factors concerned with the reuit of the amplifier are affected tost by the capacitances of the neualizing capacitor.

-)—To secure complete neutralization the capacitance C_N must be capable of being made equal to the effective grid-plate capacitance of the tubes with which it is to be used.
-)—To prevent detuning or unbalancing, or both, of the grid- or plate-tuned circuit and to prevent changing the effective gridplate capacitance to be neutralized, neither the direct capacitances between like and unlike electrodes of opposite condensers nor their capacitances to ground should change perceptibly with adjustment of C_N .
- ()—To insure constancy of adjustment the supporting members should be rugged and the drive mechanism free from backlash.
-)—To prevent overshooting the proper adjustment of C_N during adjustment the variation of capacitance should be capable of fine control.
- ()—To provide symmetry enhancing the capacitive balance of the circuit the capacitance to ground of the electrodes should approximate those of the corresponding electrodes of the tubes with (Continued on page 84)

^aThese capacitors were designed by W. Olander, chief engineer, E. F. hnson Company, in 1944. ^aThe voltage measurements were de by B. W. Griffith, radio engier, E. F. Johnson Co. ^aSee reference 2, page 395.

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MOBILE TELEVISION CONTROL



Mobile television control system, *Telemobile*, designed by Klaus Landsberg, director of television at W6XYZ, the Paramount station in Hollywood. The unit combines all the control equipment necessary for operation of two television cameras, including the synchronizing pulse generator, sweep signal generator, power supplies and monitoring units.





NEUTRALIZING CAPACITOR

(Continued from page 83)

which they are to be used.

- (b)—To maintain equality between the two neutralizing capacitors used with identical tubes and balanced circuits in a push-pull amplifier provision should be made for positive ganging of the drive controls when desired.
- (7)—To provide flexibility in choice of circuit layout to secure balance and symmetry in push-pull amplifiers provision should be made for convenient electrical and mechanical connections.

Those factors concerned with the voltage ratings of the neutralizing capacitor and its associated parts are problems in high-voltage insulation at r-f in which a constant component of voltage may be present.

The spacing and radii of curvature of the parts exposed to air are largely determined by the total peak voltage involved. These voltages have been given in equations 1, 2, 3, and 4 and their modifications mentioned for high-level modulation.

The rating of the solid insulation on the other hand may be influence greatly at the higher frequencie where uneven or excessive heatin due to the alternating component may cause failure well below the spark over voltage. Equations 5 and 6 give first the constant component and sec ond the crest value of the alternating component of the voltages. The effect tive value of the tuned-plate circuin voltage in high-level modulated ampli fiers depends upon the character of the modulation and has a maximum value of one and one-half times the unmodulated value."

The importance of any one or comp bination of the factors mentioned depends upon the amplifier in which the neutralizing capacitors are to be used. For example the direct and stray capacitances will be greater in amplifiers built where space is at premium. Any capacitance unbalance or dissymetry becomes more significacant in high-frequency amplifiers.

BC TRANSMITTERS

(Continued from page 65)

vas a cathode follower circuit. This as the advantage of a low impedance riving the final class B stage as well s providing low audio-phase shift. Inder certain operating conditions the rid characteristic of the 880 has a egative impedance resulting in a dyatron action taking place. This lynatron oscillation is damped out in his circuit by means of small rectier tubes connected from grid to round with a series resistor. The ction of this circuit is to allow curent to flow when the grid potentials re positive, the condition under which lynatroning occurs. This effectively provides a positive resistance in paralel with the negative resistance when equired.

Three separate rectifiers are providd to supply plate power. The first provides 1500 volts from two 872A ectifiers. The second provides 5000 olts for the driver stage from a fullvave bridge rectifier using four 72A's. A final and modulator power upply provides 10,000 volts supplied y a three-phase full rectifier using ix 857B's with a spare tube continuusly heated up, capable of insertion when required to replace any of the ix in use. A special overall humrequency feed-back amplifier is used o reduce noise at power line frejuency.

The design and installation was urther complicated by two extremey important problems, namely, groundng and shielding. Without paying articular attention to these two items, xtreme difficulty can be expected rom low-level audio stages picking up nd rectifying power from the antenas, in extremely concentrated fields. in The main principle involved rounding was to be sure that all netallic parts of building and internal ittings were carefully grounded at one point only and that ground loops paricularly were avoided. All low-level udio equipment in studio booths was protected from high radio fields by complete double shielding. This policy proved its worth in reduction of inerference problems.

In the mechanical design and layout of equipment special precautions were aken to facilitate maintenance and to nsure safety to equipment and personnel during operation. This is an extremely desirable feature as coninuity of service is important and is only possible by easy access to all combonent parts. Safety to personnel and equipment is a fundamental prerequisite and requires careful design

(Continued on page 86)



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Each day supplies of famous CORWICO Wire, so important in the war and so important now, will be made available for civilian use.

Patience! We've moved mountains before





(Continued from page 85)

of control circuits and relays and grounding.

The transmitters may be started manually with individual switches or can be started automatically from a master switch through proper delay relays and contactors.

Studio and Program Methods

To insure maximum flexibility at transmitter point, all program circuits from studios, recording room and transmitters are terminated in a master control position. This position is equipped with a six-channel pre-set type control console. Monitoring and testing facilities and an automatic telephone system were also provided. This permitted centralizing of supervision and co-ordination of all incoming programs. However, it was not practical to consider programing this station from Sackville where special linguists were required for various languages and countries to be covered. We therefore established a studio point at Montreal, 600 miles away, requiring 600-mile program circuits between studios and transmitters. This studio point consists of mainly three studios, and control rooms, recording room, master control and the necessary offices and facilities for the production staffs. Montreal was chosen as the





placed between Terminals increase the leakage path and prevent direct, shorts from frayed wires at Terminals. Terminals and screws are of nickel plated brass. Insulation is of BM 120 molded Bakelite.

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screws, No. 141—6-32 screws, No. 142— 8-32 screws, No. 150—10-32 screws, 151— 12-32 screws and No. 152—1/4-28 screws. These sturdy Terminal Strips will not only improve your electrical connections but will add considerably to the appearance of your equipment. A truly modern Terminal. Write today for catalog No. 14 listing our complete line of Barrier Strips in addition to other Electrical Connecting Devices.

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|---------------------------|--|---|-------------------------------------|---------------------------------|--|--|--|---|--|
| European | 17 15 11 9 6 | N60°E N60°E N60°E N60°E N60°E | 4 4 4 4 | 4 4 4 4 3 | 1 1 1 1 | 35 35 35 35 35 35 | 21.5 21.5 21.5 21.5 19.5 | $ \begin{array}{rrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrr$ | 7.5 7.5 7.5 7.5 9 |
| South American African | 15–17 9–11 6 15–17 9–11 6 | N97°E N97°E N97°E N171°E N171°E N171°E | 4 4 4 4 4 | 2 2 2 2 2 2 2 | 1 1 1/2 1 1 1/2 | 35 35 35 35 35 35 35 | 15.3 15.3 12.6 15.3 15.3 12.6 | $13 \pm 13 \pm$ | 11 11 17.5 11 11 17.5 |

Figures 8 (above) and 9 (right)

Figure 8. A tabulation of the fundamental characteristics of all the antennas used at the CBC plant. Figure 9. At one of the control consoles.



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tre for this studio point because of comopolitan nature and because of program talent available.

udio Construction

The three studios were constructed accordance with our standards for pustic performance. They are small, ended mainly for talk and announce dios. The control consoles are proed with two microphone positions, ee turntable positions and four line itions with the necessary monitorand cueing facilities. Several spe-I features are incorporated in this nipment for our specific needs such First, automatic starting of turnles when turntable position keyitch is thrown on; second, remote ntrol of microphones by news anincers and station announcers.

Reording Room

In the recording room are installed lee double channels with provision expansion. These recorders are inposite units made to provide the rh performance needed. Installed in its room as well are two reference orders. These are low quality maines using an embossing process on n. Their purpose is to keep an acrate record of everything transited outside the country and are rticularly required to meet censorp requirements.

Prformance

Fo provide good rebroadcast covere to any spot on the globe is cernly an ambitious aspiration. Hower, from our Sackville station we e to provide good service to sevl continents, namely, Europe, South merica and Africa, with somewhat ferior service to the Antipodes.

Measurements made by the BBC on 15-mc transmission gave us aversignal strengths of 400 μ v/m peak-500. This is an improvement of m 6 to 8 db over most other stans, which is very worthwhile parularly in times of magnetic disbances.

antitative Tests

Continuous quantitative tests have en made since our opening broadcast the more than satisfying results. spaal strengths have held up, posly increased; conditions of fading we improved and interference from our stations and from atmospheric tic have been almost nil. On the low band we have experienced a le interference from other stations. I 235 hours of transmissions, 196 urs have been satisfactory for rebadcast quality in England.



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PULSE AMPLIFIER COUPLING

(Continued from page 58)

to have an overall low frequency response such that the frequency **at** which the response falls to 3 db below the mid-frequency response is

$$f_o = \frac{1}{2 \pi X T}$$

In the preceding example and with a repetition rate of 5,000-pulses per second, the low frequency half power point (f_o) is 400 cps.

Sinusoidal Frequency Response

The foregoing procedure may be reversed and used to find the sinusoidal frequency response of a given amplifier. We note, however, that the method must assume that the low-frequency response is affected only by resistance capacity networks as of Figure 1. The effect of cathodeand screed-grid circuits may be neglected if sufficient bypassing has been used.

Applying Method

The method consists of applying a symmetrical square wave $(T_1 = T_2)$ of variable frequency to the input of the amplifier. The output is observed on an oscillograph which is known to have good low frequency pulse response. The square-wave frequency is then varied until the tops of the output pulses decay by a measurable amount, such as 10%. The factor X is then equal to 0.1. Furthermore, the width of the pulse T is equal to 1/2F, where F is the square wave frequency. Hence,

$$_{o}=\frac{1}{0.4 \pi \mathrm{F}}$$

f

The response of the amplifier at any other frequency, f, within the low frequency region may be obtained from the relation

relative gain = cos tan⁻¹
$$\frac{f_o}{f}$$

The phase shift at the frequency, f, may also be obtained from the relation

$$\tan \Theta \equiv \frac{f_o}{f}$$

The advantage of this method is that only one measurement is necessary, whereas a determination of amplifier frequency response by means of applying sinusoidal input requires measurements at several frequencies.

position with a long established, progressive Radio school. To qualify, you should be a college graduate with engineering and operating experience in Radio communications. Experience teaching Radio subjects will be an advantage-experience in writing instruction manuals clearly, interestingly is essential. Get in touch with us now. Let's see if we can come to a mutual understanding so you can start with us the day you are available. Tell us all about yourselfyour education and experience-your ambitions-your salary requirements. We will hold your letter in strict confidence. Write Box 1045-S, COMMUNICATIONS, 52 Vanderbilt Ave., New York 17, N. Y.

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RANSMISSION LINES

(Continued from page 67) in rectangular coordinates

u + jv = 1.93 + j.518.

Figure 2 this value corresponds to

 $\alpha + j\beta = .515 + j 80.5 n (180^{\circ})$

tally the length of the line in wavesths is known approximately; for given line it is between one-half one full wavelength. Thus the uired value of β is

 $180^{\circ} + 80.5^{\circ} = 260.5^{\circ}$

he curves for the charts were ded from the formula for $tanh(\alpha+j\beta)$ $(\sinh \alpha \cosh \alpha + j \sin \beta \cos \beta)/$ $sh^2 \propto cos^2 \beta + sinh^2 \propto sin^2 \beta$ = jv. From this equation it can be wn by an involved process that the ation for a curve of constant value x, Figure 3, is $(u - 1/\tanh 2\alpha)^2 + v^2$ $1/\sinh q$ ². This is the equation of ircle in rectangular coordinates in ich the abscissa for the center, $= \operatorname{coth} 2 \alpha$, and the radius, = $1/\sinh 2\alpha$. Similarly, the equan for the curve of constant value of $u^{2} + (v + \cot 2\beta)^{2} = (1/\sin 2\beta)^{2}$ ich is also the equation of a circle which the ordinate for the center, $= -\cot 2\beta$ and the radius R_b $1/\sin 2\beta$. Since $\coth (\alpha + j\beta)$ is al to $tanh [\alpha + j (\beta + 90^{\circ})]$, the th function can also be represented the same curves.

Itting Similar Curves

imilar curves can be readily plotted in the equations given, by using es of values of real hyperbolic and ular trigonometric functions availin many handbooks. Problems ch do not fall within the ranges wn by these charts can be solved by crts drawn for special ranges as rered.

The curves of Figures 1 and 2 are te similar to those of line impedance sus the standing wave ratio, Q, wavelength.¹ The curves of anguvalues β are similar to the curves b and for low values of α , the connt α curves nearly coincide with the curves when these are given in tes of 1/Q.

erences

Robert C. Paine, Graphical Soluof Voltage and Current Distribuin and Impedance of Tranmission aes, IRE Proc., pp. 686-695; Nov. 4.

V. L. Everitt, Communication Enneering; McGraw-Hill Book Co. . C. Slater, Microwave Transmisin; McGraw Hill Book Co.

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COMMUNICATIONS FOR OCTOBER 1945

NEWS BRIEFS

PROGRAM FOR THE 1945 ROCHESTER FALL MEETING

[RMA Eng. Dept. and the IRE] The Sheraton Hotel Rochester, New York November 12 and 13, 1945

MONDAY, NOVEMBER 12

9:30 A.M. Technical Session (W. L. Everitt presiding) A Coaxial Modification of the Butterfly Circuit; E. E. Gross, General

Radio Company The Radio Proximity Fuze; H. Trotter, Jr., Eastman Kodak Co. Proximity Fuze Tubes; R. M. Wise, Sylvania Electric Products, Inc.

2:00 P.M. Technical Session (J. E. Brown presiding)

Microwave Radar; Donald G. Fink, McGraw-Hill High Quality Sound Recording on Magnetic Wire; L. C. Holmes, Stromberg-Carlson Company

8:15 P.M. General Session (George Town presiding) The Aurora and Geomagnetism; C. W. Gartlein, Department of Physics,

Cornell University

- TUESDAY, NOVEMBER 13
- 9:30 A.M. Technical Session (R. A. Hackbush presiding) Recent Developments in Converter Tubes; W. A. Harris and R. F. Dunn, RCA.

Industry Standardization Work in Television; D. B. Smith, Philco Corporation War Influence on Acoustic Trends;

Hugh S. Knowles, Jensen Radio Manufacturing Company Germanium Crystals; Edward Cor-nelius, Sylvania Electric Products,

- Inc. 2:00 P.M. Technical Session (L. M. Clement |
 - Television—A Review of Technical Status; E. W. Engstrom, RCA Laboratories

Laboratories Comments on Existing Television Systems from a Measurement View-point; Jerry Minter, Measurements Corp.

6:30 P.M. Stag Banquet (R. M. Brophy, toast-The Future of Radar; L. A. Du-Badiation Laboratory, Mas-

Bridge, Radiation Laboratory, Ma sachusetts Institute of Technology

RCA TO CONDUCT WIDE-BAND TESTS RCA has received FCC construction permits and licenses for four new experimental class 2 portable stations to develop and test a sys-tem of wide-band, multi-channel radiocom-munication, and to conduct other related ex-perimental operations. In addition to observa-tion on equipment performance, propagation on s-h-f will be studied under actual operating conditions. Analyses will cover horizon and beyond horizon transmission path capabilities, diurnal, atmospheric and, other influences on the communication ranges; characteristics dur-ing magnetic disturbances and lightning



Veterans of pre-war and wartime electronics, we serve aviation, marine and related companies to C. A. A. and F. C. C. standards. Ask us . . .

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Radio Receivers and Transmitters Industrial Electronic Equipment Airport Radio Control Equipment Marine Radio Telephone Equipment

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storms; seasonal variations in propagation wi

storms; seasonal variations in propagation we particular reference to refraction effects. The terminal stations will be located initial on the Market Street National Bank Buildin in Philadelphia, Pa., or on top of the RC building in Camden, N. J.; and on the Coa tinental Bank Building, 30 Broad Street, Ne York City. The intermediate relay statiol will be located in Bordentown, N. J., and Te mile Run, N. J. * * *

UNIVERSITY OF CHICAGO TO RUN STRATOSPHERE F-M TESTS

The University of Chicago Cosmic Ray Labor, tory has received a license for an experiment i-m portable mobile station aboard a free balloor within a 350-mile radius of Chicago. The con posite type transmitter will be installed on free balloon to obtain scientific information ra-garding the nature of penetrating radiation in the stratosphere.

UNITED AIR LINES TO SPEND MILLIONS FOR AERO **COMMUNICATIONS AIDS** United Air Lines will spend approximate \$10,000.000 for the purchase, development at

RADAR IN NEW HEBRIDES AND ITALY



Radar near an anti-aircraft emplacement at Magnano, Italy.



A radar installation in a sandbagged revetment on Espiritu Santos, New Hebrides. Unit show at left and above was known as the *Micket Mouse* because of the shape of its antennas. (Photos courtesy U. S. Signal Corps.)

inications aids.

bevelopments proposed include airway trafmonitors, operating on the radar principle; tomatic position recorders; radio-impulse dees; automatic landing devices; facsimile, etc.

CKSTEIN JOINS ECHOPHONE

ul H. Eckstein has been appointed sales nager of the Echophone division of Halliafters.

r. Eckstein was formerly with Westinguse Electric as assistant sales manager of radio receiver division.



J. LARKIN NOW NATIONAL D. ENG. MANAGER Iliam J. Larkin has been named engineering nager of the National Radio Company, Mal-. Mass. Ir. Larkin was formerly chief mechanical ineer.



DMMUNICATION PARTS EXPANDS nmunication Parts has moved (o a new at at 1101 North Paulina Street, Chicago.

WINTER MEETING IN JAN. 1946 Institute of Radio Engineers will hold its ual winter technical meeting at the As-Hotel in New York, January 23 to 26, 1946. vard J. Content is chairman of the meeting mittee.

mittee. ustin Bailey, Howard Frazier, William B. ge, Stuart L. Bailey, George W. Bailey and abeth Lehmann have been appointed gencommitteemen.

committeemen. ib-committee chairmen in charge of various vities are: Frank Marx, arrangements; C. Lewis, banquet; H. F. Scarr, exhibits; mond F. Guy, finance; Will Whitmore, dicity; A. E. Harrison, papers: Dorman D. sel, printed program; Harold P. Westman, estration; Don H. Miller, special features; rge B. Hoadley, sections committee activiand William H. Crew, technical commitactivities.

RMAN ELECTED EM CHAIRMAN

. Berman, general sales manager of Shure thers, Chicago, was elected chairman of Association of Electronic Parts and Equipt Manufacturers recently.

Manufacturers recently. y S. Laird, vice president of Ohmite Mfg. was elected vice chairman, and H. A. (Continued on page 95)

ANTI-FUNGUS TREATMENT



rting a chassis with a lacquer containing a ted fungicide at the RCA plant in Camden.





A complete Laboratory Overhaul for your Q Meters and Q-X Checkers after strenuous wartime use.

"Q SERVICE" includes

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In answer to many requests and in recognition of the unusual demands made on your instruments during the Wartime years, this "Q SERVICE" has been developed.

For complete information write to Department C



(Continued from page 47)

the nose was achieved. In the anti-aircraft shell and rocket applications it was necessary to study the sensitivity problem carefully so that the fuzes could function reliably against aircraft for values up to 70'; thus the aircraft's area of activity could be magnified and the chance of hitting enemy aircraft increased several fold.

FUZE

VT fuzes were produced for use on bombs, shells, rockets, and were in production for mortar shells as the war ended.

The developments were started by the O. S. R. D. on its own account and at the independent request of the Army and Navy. The work was divided, because of different technical problems, into fuzes of two classifications; those which would be applied to bombs and rockets (non-rotating projectiles) and those for shells (ro-tating projectiles). The nerve centers of these two development programs were located, respectively, at the Applied Physics Laboratory, Johns Hopkins University and the National Bureau of Standards. On the part of the services, the Bureau of Ordnance, Navy Department, was the responsible organization for the Navy project, charged with monitoring the developmental program and producing the fuzes for distribution to all services; the Office, Chief of Ordnance, and the Office, Chief Signal Officer, operated similarly for the Army

While the basic principle of the fuze was quite simple as already shown, the technical problems were enormous. Special sub-miniature tubes were developed which were capable of withstanding the terrific acceleration of being fired from a gun or mortar and microphonically stable enough to function properly in the presence of strong vibration set up by the rotating generator and the projectile screaming through the air at supersonic velocity. Miniature components were developed and the whole assembly continually reduced in size. The mortar fuze, smallest of the family, could be placed inside an ordinary half-pint cream bottle with almost an inch to spare in length.

The problem of power supply was a



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na

remax

serious one. In the shell fuze a specia storage battery had to be developed. The electrolyte was provided by a capsuld which broke when the projectile was fired The electrolyte was distributed by the rotation of the shell in flight.

To meet the wider temperature require ments for air-borne rockets and bombuneeded by the Army and Navy arms



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Vertical

DEGREE

The new amazing Altec Lansing multi-cellular Duplex Speaker provides up to 800% increased area of quality sound distribution. In the vertical plane, the Duplex delivers a forty degree angle of distribution, or eight times the area distribution at high frequencies as compared to single unit speakers of comparable size. Another reason why the DUPLEX is the SPEAKER that REVO-LUTIONIZES the methods of sound REPRODUCTION.

SEND FOR BULLETINS



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92 • COMMUNICATIONS FOR OCTOBER 1945

wind-driven generator was developed. s was powered by the air stream and the projectile and ran at the tredous speed of 30,000 to 40,000 rpm. generator turned out to be more comt than a battery and was used to power fuze for the tiny 81-mm mortar shell. well as for rocket and bomb fuzes.

he enemy was by no means unaware the utility of such a device and the y of his efforts to produce similar us is interesting and enlightening.

ince the end of hostilities we have ned that the Germans were trying to ce fuzes working on identical princi-. In fact the start was made nearly years before our own and yet a sucful model was never achieved for comuse.

he enemy made the serious mistake of great diversification of effort. At one e the Nazis were working on forty ierent methods of getting proximity es. Each project was given to a small up and knowledge of the other similar vities or results was rigidly restricted. the progress was made on any of these helopments.

he initial military successes of the hrmacht led to a second great mistake; y thought the war was won and all deopment was curtailed. Our growing power convinced them of this error and we development was resumed on some olve methods involving radio, sound, t, light and electrostatic fields. The orgram was still diversified and comattentalized.

as if this were not enough another inder was made. The Nazi engineers re convinced that it was impossible build a vacuum tube that would withind 20,000 G and still operate normally. Insequently, their projects for shell res did not stress the radio method, at they never tackled a fuze for the tiny prtar.

n contrast the engineers and physicists this country spent a short time of carepreliminary experimentation on the ious possible methods including many those tried by the enemy. They disded all but two, the photoelectric and io types, and concentrated on those. ter a short period of intense competin, the radio device proved superior and activity was devoted to it.

When the enemy finally felt the impact these new fuzes, he was working on so ny types, not including the one that hit h, that there was great confusion as to h the American unit was made. There as yet no clear evidence that he sucded in completely unravelling the mysty.

On our own side, after about two years intensive effort, backed by the trendous technical experience of our own ustry with its vacuum-tube production acity, fuzes were in production and ulable. The fear of giving the infortion to the enemy for use against our craft kept the use of the fuzes confined Naval activities on the high seas, until later stages of the war when it became ar that even if the enemy had the inmation, he would not have time to the it.

Large stock piles were built up in the rious over-seas theatres of combat atinst the day when a general release of a fuze secret would be made. The first of VT fuzes over land resulted when a i-aircraft types were employed in the (Continued on page 94)



ONCE AGAIN you can get sturdy, dependable STANCOR Transformers in a wide variety of sizes and types—or get them built to your exact specifications in any reasonable quantity, within reasonable time.

STANCOR Transformers, Reactors and Electronic Equipment made outstanding performance records all over the world—often under most adverse operating and climatic conditions. They are the best that science, skill and modern precision equipment are producing today. So get "quotes" from STANCOR first and specify STANCOR where performance counts.



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• COMMUNICATIONS FOR OCTOBER 1945

RADIO PROXIMITY FUZE

(Continued from page 93)

defense of London against the buzz-bombs. This operation, however, was carried out in secret to protect our allied air offensive. The general release for all types of VT fuzes was finally set for Christmas Day, 1944. By this time sufficient quantities of fuzes were available just behind the front lines to allow their employment to continue after it had once started. The Germans, however, began their Ardennes offensive on the 15th of December and the fuzes were immediately released for the Battle of the Bulge.

Increased Use of Fuzes

Employment of VT fuzes then spread rapidly to all theatres of combat throughout the world. Reports have flooded into Washington of the uniformly successful results. Right up to VJ-Day, VT fuzes were used in enormous quantities by tactical and strategic bombers, by assault fighters firing rockets, by anti-aircraft and artillery gunners and by the fighter-bombers of the carrier fleets.

VT-Fuze Production

The quantities of VT fuzes employed in combat continually increased throughout this period, and since no definite end of the war could be predicted, production of all types of VT fuzes kept pace with the mounting usage. At the conclusion of the war almost one-third of the radio industry was engaged in the production of VT fuzes.

Credits

COMMUNICATIONS acknowledges the assistance of the following members of the VT Fuze Team in preparing this paper:

Army: Captain J. F. Teas



Johns Hopkins University—Applied Physics Laboratory: Dr. Allen Hynel

Figure 11 Display of tiny radio tubes used in production of VT fuze.

(Official Navy photo)

www.americanradiohistory.com

NEWS BRIEFS (Continued from page 91)

staniland, treasurer of Quam-Nichols Co., was amed treasurer.



J. A. Berman

MAJOR F. D. LANGSTROTH NOW CHIEF OF ELECTRON TUBE STAFF

lajor Frank D. Langstroth has been named hief of the Electron Tube Staff of the Army lectronics Standards Agency. He was formerly a commercial engineer for ne radio division of Sylvania.



VEELY ENTERPRISES EXPANDS

lorman B. Neely Enterprises have moved to a ew building at 7442 Melrose Avenue, Holly-ood, California. The company represents lewlett-Packard Company, Kaar Engineering ompany, Presto Recording Corporation, Radio ngineering Laboratories, Inc., Sensitive Re-earch Instrument Company and the Webster lectric Company. lectric Company.



ORHAN TO EXPORT

orhan Exporting Company, 458 Broadway, w York City, have been appointed exclu-re export agents to all countries in the orld, except Canada, for Marion Electrical strument Company, Manchester, New Hamp-ire re.

R. McELROY TO DISTRIBUTE ALLICRAFTERS SETS IN BOSTON R. McElroy, president of the McElroy anufacturing Company, 82 Brookline Avenue, (Continued on page 96)

G.E. ELECTRONICS PARK



del of \$10,000,000 electronics park planned by G.E. for the Syracuse, N. Y., area.





Range: 1-16 megacycles on one dial.



Sucher

Development of special hearing aid analyzer for Western Electric Company.

Production Test Set to test varisters. A sensiwheatstone bridge arranged with tive

switching means for quickly checking a number of varisters in rapid sequence.

Manufacturers have continually called upon the modern facilities of Tech Lab Subcontracting Department to assist them in the production of unusual and vital electronic equipment. Our Engineering Department is ready to assist you with your production problems.

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... Designed to withstand severe shock and vibration. A crystal so precisely finished that it has less than 15 cycles drift from -50C to +85C*. (If oscillator or circuit is furnished, an accuracy of 3-5 cycles can be obtained)

A special solder bead supports a tensile load of 9,000 lbs. per square inch. Crystalab engineered to meet the most rigid operating requirements.

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0

NEWS BRIEFS (Continued from page 95)

Boston, has opened a distributor unit in Boston to sell Hallicrafters equipment.

BUSES INSTALL G.E. F-M UNITS

The Washington, Virginia and Maryland Coach. Company recently installed a G.E. two-way f.m. system on one of their buses to test its effec-tiveness in improving bus service and in public emergencies. Tests will be conducted between the bus operator and the company's headquarters in Arlington, Va.



BROOKLYN POLY E.E. PROGRAM TO FEATURE S-H-F STUDY

The Polytechnic Institute of Brooklyn, N. Y., has revised its electrical engineering curricu-lum to include a series of courses on micro-wave techniques, based on wartime develop-ments.

ments. The revised curriculum will include recent developments in ultrahigh frequencies in their application to f-m and television, theory and design of antennas, and electron optics cover-ing the design of electron focusing systems.

FARNSWORTH OFFICERS REELECTED **FARNSWORTH OFFICERS REELECTED** E. A. Nicholas was reelected president of the Farnsworth Television & Radio Corporation, Fort Wayne, Ind., at a meeting held recently. Other officers reelected include: E. H. Vogel, vice president in charge of sales; Edwin M. Martin, vice president and secretary; B. Ray Cummings, vice president in charge of engi-neering; J. P. Rogers, vice president and treasurer; Paul H. Hartmann, assistant treas-urer, and Fred A. Barr, assistant secretary. Philo T. Farnsworth has resigned as a vice president but will continue as a director. He will also continue his research work for Farns-worth at his laboratory in Fryeburg, Me.

CRYSTAL RESEARCH LAB CATALOG

An 8-page catalog covering crystal devel-opment activities and products has been re-leased by the Crystal Research Laboratories, Inc., 29 Allyn Street, Hartford 3, Connecticut. Illustrations and descriptions of different types of crystals manufactured are presented types of crystals manufactured are presented. Shown, too, are the various steps involved in production of the raw quartz to the finished

crystal. J. M. LANG NOW G.E.

KEN-RAD DIVISION MANAGER

J. M. Lang has been appointed manager of the Ken-Rad division of the G. E. electronics de-

MINIATURE PENTODE



W. E. 6AK5 pentode, 11/2" high and 3/4 in diameter developed for h-f application.

ent, with headquarters at Owensboro, Ky., Lang will be in charge of the operations E. Ken-Rad plants in Owensboro, Ky., untingburg, Ind. He will also be responor the management of government-owned tube plants at Bowling Green, Ky., and ity, Ind. Lang succeeds C. J. Hollatz, who has be-

Lang succeeds C. J. Hollatz, who has be consultant.

COLEMAN BECOMES ASST. CTOR OF RCA VICTOR INEERING DIV.

Coleman has been appointed assistant diof engineering for the RCA Victor divi-

C. Batsel has succeeded Mr. Coleman as ngineer of engineering products. Coleman will make his headquarters at

n, N. J. Batsel was formerly chief engineer at Victor, Indianapolis, Ind.

BALCOM APPOINTED JUDGE

F. Balcom, vice president and treasurer lvania Electric Products, Inc., has been ted Associate Judge of Cameron County lso president of the Emporium Trust of B. G. Erskine, chairman of the board ne of the founders of Sylvania.



D MOVES TO TELEVISION FREQUENCY

nt television station WABD has begun vamp their transmitter and shift from r channel 4 (78 to 84 mc) to new channel to 82 mc). Permission for the move was d recently by the FCC.

RELAY EXHIBIT AT

and timers produced by Struthers-Inc., Philadelphia, were presented in flustrial exhibit staged under the auspices Franklin Institute.

Franklin Institute. exhibit portrayed the development of for both wartime and peace uses.

IL KUCH OPENS AD OFFICE

L. Kuch, former advertising and sales tion manager of Aerovox Corporation, pened an advertising and sales office at lympia Building, New Bedford, Mass.

EL AUTO-ANTENNA DATA

age folder describing cowl-and-fender-type intennas has been released by Radel Manaring Company, 6300 Euclid Avenue, and 3, Ohio. * * *

SHOCK HAZARD BOOKLET

page booklet entitled Measurement of ic Shock Hazard in Radio Equipment t. Karl S. Geiges, U.S.N.R., has been hed by the Underwriters Laboratories, 161 Sixth Avenue, N. Y. 13, N. Y. pared while the author was an associate er at the laboratories, the discussion (Continued on page 98)

RANSMITTER STUDY BY NAVY STUDENTS



students of Iowa State College studying s transmitters during a recent tour of the plant.



One of hundreds of basically different filter types produced by Audio Development, this unit has been designed principally for the use of broadcasting stations and recording studios. The filter consists of a single prototype low pass and a similar high pass filter section, each with eight different cut off frequencies. This permits the selection of a proper cut off frequency for any application. Attenuation of at least 18 DB per octave is obtained for both high and low pass sections with the insertion loss in the pass band less than 1 DB. Coils are individually shielded to permit normal operating levels between -40 and +14 VU. Standard impedance is 600 ohms. Mounting facilities are provided within the unit for transformers, thereby permitting operation in systems of any impedance.



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(Continued from page 97)

Electric shock hazard (threshole covers: perception, let-go currents, fatal currents, perception, *let-go* currents, tatal currents, 1 of measurement); body resistance; shock ards (chassis, external circuit connect vacuum tubes); methods of measuring hazard (electrodynamometer instrument, mocouple instrument, rectifier instrument, uun-tube voltmeter); development of 1 development of uuni-tube voltmeter); development of j uring equipment (diode-peak meter, ac-c d-c measurements, open circuit voltage i urement); specifications (voltage of circuit, circuit potentials, leakage current).

CAPT. NEISLAR RETURNS TO MAGNAVOX

Captain Jerre Neislar has returned to Magnavox Company as sales representativ the southwestern district. the

During his Army Air Force service, Ca, Neislar was Commanding Officer of an base squadron in the South Pacific, an the procurement section of the Army Te cal Service Command at Wright Field.



C. J. HOLLATZ JOINS RAYTHEON Carl J. Hollatz, former manager of the R Rad division of G.E., has joined Rayth Manufacturing Co. in an executive capacity



BOUCHERON RETURNS TO FARNSWORTH Captain Pierre H. Boucheron, USNR, has Captain Pierre H. Boucneron, USINK, has a appointed director of public relations for Farnsworth Television & Radio Corporat Fort Wayne, Indiana. Before being called to active duty in 19 Captain Boucheron was sales manager.



HYTRON CATALOG An 8-page catalog with data on transmitti and special-purpose-tubes has been publish by Hytron Radio and Electronics Corp., Lafayette Street, Salem, Mass. Discussed u-h-f triodes, pentodes, r-f beam tetrod





William J. Halligan, president of Hallicraft steam shovel controls on the new site llicrafters at Kostner and 5th Avenue, Chic at ster Hallier J. J. Frendreis, secretary and treasurer, at



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with heater wound

directly on blade

with

porcelain heater

acorns, rectifiers and voltage rectifiers. A rating and operations chart and a group of base diagrams are also offered.

BENDIX ANTENNA AND COMPASS BULLETINS

An 8-page bulletin describing the MN-31 automatic radio compass and a 4-page bulletin covering the MS-105A v-b-f broad band antenna, have been released by Bendix Radio, Baltimore 4, Maryland. Both bulletins offer construction and performance data.

AUTOMATIC ANTENNA ANALYZER



Above, electronic antenna-tower position computing device, the Antennalyzer, developed at RCA Laboratories. Below, radiation pattern equation expressed in terms of polar coordinates. The Antennalyzer changes the resultant graph from rectangular to polar coordinates by the flip of a switch.



SOUND-PROOFED POLICE RADIO ROOM



Interior of the sound-proofed 14' x 14' x 91/2' high radio operations room, using Fiberglas acoustical board on the walls and ceiling, at police headquarters, Newark, Ohio.



Permoflux Speakers and Transformers Set New Standards of Comparison!

New Permoflux speakers in a complete range of true-dimensioned sizes trom 2" to 15", with power handling capacities from 1 to 20 watts, provide the finest sound reproduction for every application.

Permoflux midget transformers, with their many practical circuit applications, have literally revolutionized efficiency concepts where size and weight are determining factors.

Advanced engineering designs, improved manufacturing methods and new materials have all contributed their share in the development of Permoflux speakers, transformers, microphones and headphones. You can count on Permoflux to provide an acoustical unit to suit your exacting requirements.



PIONEER MANUFACTURERS OF PERMANENT MAGNET DYNAMIC TRANSDUCERS



STANDARD SIGNAL GENERATOR Model 80

SPECIFICATIONS:

CARRIER FREQUENCY RANGE: 2 to 400 megacycles.

OUTPUT: 0.1 to 100,000 microvolts. 50 ohms output impedance. MODULATION: A M 0 to 30% at 400 or 1000 cycles internal. Jack for external audio modulation,

Video modulation jack for connection of external pulse generator.

POWER SUPPLY: 117 volts, 50-60 cycles.

DIMENSIONS: Width 19", Height 1034", Depth 91/2".

WEIGHT: Approximately 35 lbs. PRICE-\$465.00 f.o.b. Boonton. Suitable connection cables and matching pads can be supplied on order.

MEASUREMENTS CORPORATION BOONTON NEW JERSEY



THE INDUSTRY **OFFERS**

COLLINS AIRCRAFT COMMUNICATIONS RECEIVER

A crystal-controlled, light-weight aircraft communications receiver, 51K-1, using the autotune for selecting channels has been developed by the Collins Radio Company, Cedar Rapids, Iowa. Receiver offers ten preselected frequencies for

receiver others ten presenced requencies for reception anywhere within the range of 2.4 to 18 megacycles. The maximum time required for the autotune to change channels is said to be 2 seconds. Fits into ½ ATR unit, and weighs less than 20 pounds. Operates from a 24-volt d-c source; 12-volt model optional.



TRIPLETT TUBE TESTER

tube tester offering tube-value tests, short and open element tests and a transconductance comparison check for matching tubes, has been announced by The Triplett Electrical Instru-ment Co., Bluffton, Ohio.

Features three-position lever switching, and multi-color scale. Size, 10" x 10" x 534".



FTR SEALED-IN-GLASS SELENIUM RECTIFIERS AND IRON-CORE MAGNETIC COMPONENTS

High-voltage selenium rectifier stacks, hermeti-cally sealed in cartridge-fuse type glass, have been developed by Federal Tclephone and Radio Corporation, 200 Mount Pleasant Avenue, New-ark 2, New Jersey. Contact is made through small heavy silver-plated ferrules at each end of the glass tube; ferrules permit mounting in 30-ampere fuse clips, unpolarized or polarized. Especially designed for operation in high am-bient temperatures. Rectifiers are available in several tube lengths and in various voltages up to 4,000. High-voltage selenium rectifier stacks, hermeti-

Iron core magnetic components, custom built to meet specific requirements, have also been announced by Federal Telephone and Radio Corporation.

Available with power ratings ranging from milliwatts to kilowatts. Components can be provided in any of the basic types of construction-open, frame, semi-enclosed, enclosed and hermetically sealed. Various terminal types can be supplied, including standard nut-fasteners and solder-type binding posts with porcelain bases.

Hermetically-sealed units utilize either compression bushings on porcelain bases, or glass-to-metal fusion seals in one piece covers.



FTR Selenium Rectifiers

EIMAC TETRODES

Tetrodes with a maximum plate dissipation rat-ing of 250 watts, type 4-250A, have been an-nounced by Eitel-McCullough, Inc., San Bruno, California.

California. Preliminary class-C amplifier data indicates that at 3,000 plate volts a single 4-250A pro-vides a power output of 650 watts with a driv-ing power of less than 3 watts. Eimac engi-neers state that low grid-plate capacitance (.11 mmfd) eliminates neutralization below 40 mc. Filament (thoriated tungsten) voltage, 5.0; current, 14.5 amperes. Direct interelectrode capacitances (average):

Grid-plate, .11 mmfd; input, 12.7 mmfd; output,

Gru-plate, 11 mmil; input, 12.7 mmfd; output, 4.6 mmfd.
Maximum plate current, 350 ma.
Base, 5-pin metal shell; length, 6.38"; diameter, 3.56".



DIAL LOCKS

Dial locks especially applicable for use on mobile equipment to accurately maintain tuning adjustments, are now available from The Radio Craftsmen, 1341-3 South Michigan Avenue, Chicago 5, Illinois.

Accommodates a wide range of dial thick-esses. Made of 21-gage spring brass, nickel nesses. plated.



ALDEN TELEVISION-TUBE CONNECTOR

A television tube connector, 208FTSC, permit-ting leads to be brought off the side of the (Continued on page 102)

NERVISE ANTENNA FOLDED UNIPOLE Another Example of ANDREW

Concentrating on electrical performance, Andrew engineers have designed a unique Folded Unipole Antenna which—according to comparative tests-easily outperforms other antennas at several times the price.

Used for transmitting and receiving at frequencies from 30 to 40 MC and for powers up to 5,000 watts, this antenna has proved so successful that similar models for higher frequencies are now being designed.



FEATURES:

- Light weight only 15 pounds simplifies installation.
- Lightning hazard minimized by grounded vertical element.
- "Slide trombone" calibration permits exact adjustment for any frequency between 30 and 40 MC, using only a wrench. Optimum performance for that frequency is guaranteed without "cut and try" methods.
- Proper termination of coaxial transmission line. Unlike other "70-ohm" antennas, the Folded Unipole actually provides a non-reactive impedance with a resistive component varying between 62 and 75 ohms (see lower curve).
- Excellent band width, ideal for FM (see upper curve).

Andrew Co. specializes in the solution of antenna problems. For designing, engineering and building of antenna equipment, consult Andrew Co.







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W M C Rules Observed

THE INDUSTRY OFFERS -

(Continued from page 101)

connector at any point has been developed by Alden Products Company, 117 North Main Street, Brockton 64, Massachusetts. Provision has been made for a long leakage path between contacts, strain relief on the leads and a skirt to prevent possibility of touching the pronts of the tube while they are *hot*.



ANDREW FOLDED UNIPOLE ANTENNAS

Folded unipole antennas for transmitting and receiving from 30 to 40 mc and for powers up to 5,000 watts, have been designed by Andrew Company, 363 E. 75th Street, Chicago 19, Illinois. *Slide-trombone* calibration is said to permit adjustment for any frequency between 30 and 40 mc, using only a wrench. Provides a non-reactive impedance with a resistive component varying between 62 and 75 ohms. Andrew engineers say that there is no stand-ing wave on the line with this antenna. Bandwidth is said to be never less than 400-kc wide for a standing wave ratio of 1.2:1. May be used with 70-ohm coaxial cable, solid dielectric or beaded, up to 7% diameter. Lightning hazard said to be minimized by grounded vertical element. Weight, 15 pounds. Folded unipole antennas for transmitting and



RADIO RECEPTOR COMPANY SELENIUM RECTIFIERS

Selenium rectifiers featuring aluminum plates and hermetical sealing have been announced by



Receptor Company, Inc., 251 West 19th New York City. s offered have capacities of from 25 mils hundreds of amperes.

NER PLASTIC MICROPHONES

lpse acetate plastic housings, in a variety pres, for crystal and dynamic microphones, been announced by the Turner Company, Rapids, Iowa. tes will be known as *Colortone*; first allot-will be made in orange, green, yellow and



TON DIRECT-READING ULATION TESTER

-reading insulation-measuring instruments, t-reading insulation-measuring instruments, 799, affording a single range for .1 to 10,000 nms, with the 10,000 mark at 8% of the length, have been produced by Weston rical Instrument Corporation, 617 Freling-n Avenue, Newark 5, New Jersey. circuit has a test potential of less than its d-c. An electrical guard circuit is pro-for elimination of surface leakages when g cables.

g cables. 5%" x $3\frac{1}{4}$ " x $4\frac{7}{8}$ ".



EN STABILIZED RECTIFIERS

lized rectifier units, TRX, have been de-ed by the W. Green Electric Co., Inc., 130 Street, New York City. en engineers say that the load current be varied between zero and maximum at lemand frequency, with negligible variation rminal voltage rminal voltage.

ler features include non-resonant filter, op-l output ranges-110-120, 150-160 volts, modor 1-, 2-, 4- and 7-ampere capacity.



ULINE JACKS eries of midget-sized jacks have been de-(Continued on page 104)

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In addition to its complete, well-known lines of Air Inductor Coils and Heavy Duty Variable Condensers, B & W offers a wealth of specialized facilities for the engineering, design and production of custom-built electronic equipment. Among units recently produced are special transmitters, test equipment, tuning units, high—and ultra-high frequency assemblies, high-voltage equipment and many more. What do you need—designed and constructed throughout to match your application exactly?

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DX RADIO PRODUCTS CO.

GENERAL OFFICES 1200 N. CLAREMONT AVE., CHICAGO 22, ILL., U.S.A.



THE INDUSTRY OFFERS

(Continued from page 103)

signed by the Insuline Corporation of America. There are three models: Single closed-circuit, single open-circuit, and a three-way microphone Features incorporated include arched spring

members and interlocked component parts *

REINER VACUUM-TUBE VOLTMETER AND AMPLIFIER

A vacuum-tube voltmeter, 451, and amplifier, 101, offering 25 millivolts a-c on the lowest range, 1.000 volts on the highest range, 10 cps to 700 mc frequency range, and a 7-mmfd input capacity has been announced by Reiner Elec-tronics Co., Inc., 152 West 25th Street, New York 1, N. Y. Ranges, A complex 2 complex Ranges: A-c volts, 0-.025-.1-.25, (with ampli-

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her) ... 2.5-10-25-100-250-1,000; d-c volts, 0-2.5-10-25-100-250-1,000; d-c current, 0-2.5-10-25-100-250-1,000 ma; ohms, 1 ohm to 1,000 megohms; a-c frequency range. 10 to 5,000 cps, (with amplifier) 50 cps to 700 megacycles. D-c volt, ohm and current accuracy said to be 2% on full scale. A-c volt accuracy said to be 2% for 50 cps to 50 mc; a-c frequency, entire range accuracy, said to be 5%. Weight, 20 pounds. Size, $10\frac{1}{3}$ " x 9" x 8".

COILS

"the heart of a good receiver"

B-L BATTERY CHARGERS

Battery chargers, Fast Battery Superchargers, providing charging in about 20 minutes, have been announced by the Benwood-Linze Company, St. Louis.

Overload circuit breakers on d-c lines protect Overload circuit preakers on d-c lines protect the charger from excessive power loads as a result of shortages or defects in the batteries being charged. Conversion from the a-c source to d-c for charging is obtained by a B-L selen-

Weight, 130 pounds. Two chargers are avail-

able able ... one to operate from 100-valt, 60-c a-c; the other from 220-volt, 60-cycle a-c



CARTER FREQUENCY CONTROLLED CONVERTERS

Frequency-controlled d-c to a-c rotary verters have been developed by Carter M. Company, 1608 Milwaukee Avenue, Chic M Illinois.

Designed with the frequency control in

Designed with the frequency control in base and a vibration reed-type meter to v ally indicate the frequency of the output. In 110-120-volt d-c to 117-volt a-c models, c put can be controlled within ± 10 volts at cycles, over ± 10 -volt d-c fluctuation. Models can be supplied with input volta ranging from 6 through 64 for battery com sion and also 110-120 volts d-c for line c version. Wattage ranges are from 40 thro 250, continuous duty. 250, continuous duty



NATIONAL UNION IONIZATION GAGE

high-vacuum ionization gage has been a mgn-vacuum ionization gage has been veloped by the research laboratories of Natio Union Radio Corporation, 15 Washington Str Newark 2, New Jersey. The gage, NU-R1038, is said to be capable recording pressures below one billionth of atmosphere.

The sensitivity is said to be 1 microamp per 1.0×10^{-5} mms of mercury; conversion i tor is 10

The tubes are equipped with flexible leads

tor is 10. The tubes are equipped with flexible leads connection to the ionization gage circuit wh may be any one of a number of standard for Filament voltage, 3; filament current, 2 a peres; ion collector voltage, --13; shield pote-tial, --13; electron collector voltage, 200; el-tron collector current, 20 ma. Overall length (not including leads), appro-mately 5"; length of bulb (not including exhaust tu approximately 2"; bulb style, T-11; maximi-diameter, approximately 1"; length of less (flexible), approximately 2". The gage may be cleaned up for the measu-ment of high vacuua either by electron bot-bardment from the filament or by inducti-heating of the plates. The first of these mei-ods is useful initially since it serves not only degas the gage parts but also to activate 4 filament. It is recommended that the bombar-ing voltage be in the region between 300 ar-400 which will rive approximately 3". ing voltage be in the region between 300 at 400 which will give approximately 30 watts p plate, heating them red hot.

GENERAL TRANSFORMER PORTABLE POWER UNITS

Portable power supplies for 4-, 5-, or 6-tube 1½-volt battery farm or portables, operating of 105-125-volt, 50-60-cycle lines, have been an

nounced by General Transformer Corporation, 1250 West Van Buren Street, Chicago 7, Illinois. Provides A . . . 1.5 at 200 ma, 1.35 v at 250 ma, 1.55 v at 300 ma, and 1.35 at 350 ma; B . . 90 v at 13 ma, and 101 v at 8.5 ma. Two-section A filter, composed of three high-capacity capacitors, and two oversized iron core chokes; B filter has two high-capacity capaci-tors and an oversized choka

tors and an oversized choke. Universal sockets for battery plugs. Size, $2\frac{3}{8}$ " x $4\frac{3}{2}$ " x $6\frac{3}{4}$ "; shipping weight, 5 pounds.



RADIART AUTO ANTENNAS

An auto antenna, model De Luxe CF, with two An auto antenna, model *De Luxe CF*, with two short, one long and one wedge, adapter insula-tors to fit curved or straight cowls and fenders have been announced by The Radiart Corp., Cleveland, Ohio.

Rod assembly has a top rod of stainless steel. Tubular sections are of antimonial admiralty brass. Leads are *plastic-loom*, said to be im-pervious to moisture. Inner conductor is cov-ered by polyethelene tubing.



SORENSON VOLTAGE CONTROLS

Adjustable a-c voltage controls, Increvolt, for adjustment to any desired voltage between 0 and 130 to within .1 volt have been developed by Sorenson and Co., Inc., 375 Fairfield Avenue, Stamford, Conn. Control has burnout protection; uses auto-

matic Klixon,

Available in two models: Model 5, 5 amperes, 0-130 volts; model 15, 15 amperes, 0-130 volts. One control provides output voltages from 0 to 100 in 25 volt steps; another controls 0-30

volts, and .1-volt increments.



PRECISION BOBBIN COIL FORMS

Die-formed bobbin coil forms for speaker field coils have been produced by Precision Paper Tube Company, 2023 W. Charleston St., Chicago 47. The form comes in one-piece assembly, ready

to go on mandrel of coil winding machine. Coil base shaped by die in one-piece from spirally wound, heat-treated dielectric materials.

Typical of the larger port-able Shallcross Kilovolt-meters, No. 722 is rated 2-20 KV, d-c, 1000 ohms per volt.

Interior view of Kilo-voltmeter Multiplier No. 712-5-3. 12 kv., 5 ma., 2.4 megohms.



special Shallcross Corong Protected Kilovoltmeter with front shielding wire screen removed to show interior. Meters illustrated are optional.

Shallcross **HIGH VOLTAGE** TEST AND MEASUREMENT EQUIPMENT

If your requirements call for standard kilovoltmeters or kilovoltmeter multipliers in any one of many sizes and voltage ranges or for specially designed high voltage equipment, Shallcross offers the services of its High Voltage Engineering Section. Backed with many years of experience in this field, Shallcross engineers welcome the opportunity to help in the solution of practically any high voltage test or measurement problem.

WRITE FOR BULLETIN

Bulletin "F", recently released, includes detailed descriptions of standard Kilovoltmeters, Kilovoltmeter Multipliers, and Corona Protected Resistors and serves as a guide to the many special types that can be produced to match particular requirements in a range of potentials from 1 to 200 kilovolts.





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Hi-Q Ceramic Capacitors are of titanium dioxide (for temperature compensating «ypes) and are tested for physical dimensions, temperature co-efficient, power factor and dielectric strength. CI type with axial leads; CN type with parallel leads.



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Figure 10

An application of Bartlett's theorem to transform a bridged-T to an equivalent lattice network: (a, left) 5 db loss with v = 0.778, w = 1.285ohms; (b, right) 5 db with t = w = 0.280, u = v = 3.570 ohms on a unit basis.

added by citing a second example of the use of design equations.

The compensating resistance required for building out the faders to give a proper match of impedance as viewed from the load end of the mixer system is given on a unit basis by the compact expression

$$\mathbf{R} = \mathbf{c} \tag{46}$$

and the insertion loss of each channel from input to common load exclusive of fader insertion losses is

$$db = 10 \text{ Log}_{10} (2 \text{ n} - 1)$$
 (47)

In this system as well as in all other mixer systems, n is the number of channels and hence cannot be other than an integral number. This means that the loss of mixing systems in general varies in discrete steps or intervals. For a two-channels system, the loss by 47 is 4.77 db. From 46

Figures 11 (below left) and 12 (below right) Figure 11. A series mixer and fader system of two channels. On a unit basis, the loss of each channel = 4.77 db, $s^2 = 1.333$, R = 2.0 ohms. Figure 12. A 4-channel parallel mixer and fader system on a unit basis. Each channel loss = 8.45 db, $s^2 = 2.285$, R = 1.714 ohms. and the second table of the series, R = 2.00, as shown by Figure 11.

Parallel-Mixer Systems Design

This system for four channels is shown in Figure 12. The insertion loss is identical with that of an equal number of series-connected channels, and is given by equations 47. The element value required to compensate or build out the impedances of the faders so that the load is properly matched is

$$R = G/2 \tag{48}$$

From the *third* table of the series, the value of G may be obtained, or from the table which appeared with the mixer section of this series, G/2 may be found directly without interpolation. The loss caused by insertion of the compensating resistances for four channels is 8.45 db. The value of the unit-compensating resistance is 1.714 ohms. The ratio of the source to load impedance is given by column E of the second table of the series for the parallel mixer and also for the series mixer when the ratio is taken of loadto-source for the number of db-insertion loss as given by equation 47.

[Notes on Series-Parallel and Parallel-Series Mixer System Design will appear in November.]



CRYSTAL-CONTROLLED (Continued from page 70) RECEIVERS

one tuned circuit, would be a desirable feature.

In Figure 2 are the six low-frequency television channels with their related sound and video frequencies, plus the local oscillator, one-half local oscillator and fundamental crystal frequencies and crystal harmonics required for a proposed system. Harmonic oscillator operation is projected where the crystal is excited to oscillate at a mechanical harmonic by the LCcircuit in the plate of a conventional t-p-t-g type of oscillator. The fifth

^{*}Resting frequency of an F-M transmitter refers to the unmodulated transmitted carrier frequency.
pric is the highest order of harrequired,

example of the recommended cirsed is illustrated in Figure 3. It be noted that the local oscillator 4.583 mc crystal vibrating at its harmonic because L_2 and C_2 are to 13.75 mc. To inject a signal 50 mc into the mixer to beat with esting* sound channel frequency 75 mc for the i-f of 22.25 mc, a -ave rectifier duo-diode has been dis a frequency doubler. Resonant at L_1 C_1 has been tuned to the frequency of the channel, 4/ mc.

this circuit it is necessary to use witch sections to switch the oscilfrom channel to channel. Both als and $L_2 C_2$ must be switched for ent frequencies. However, there tuned frequency multipliers with honal tuned circuits.

diode frequency doubler has found to be a fairly efficient cirnd simplifies the controls a great

circuit application which is also ble and fairly simple eliminates iode-frequency doubler and oscilthe crystal at its proper mechaniarmonic to equal the required oscillator frequency directly. This e crystal bridge circuit. J⁺ me⁻⁻ e harmonic crystals mounted in e-type holders. These holders usunave four terminals for the diagof the bridge. Figure 4 shows a ct of this type applied to a telen receiver tuned to channel 1.

illator switching in this applicalso requires two switch sections itch crystal holders and also the rcuit, which is tuned to resonate desired harmonic of the crystal.

Itse crystal holders are precisionindevices and therefore are someacostly. To reduce this cost the st shown in Figure 5 could be id.

this circuit the group of oscillator is crystals is connected in parallel, the entire group is connected to none arm of the bridge. The cates, C_n , in the other arms of the the are chosen to effectively cancel tal shunt capacity across the cryssonnected in parallel.

W, if L and C are tuned to resotat a frequency which is an odd onic of the fundamental of any et the shunted crystals, that crystal be excited to oscillate at that chnical harmonic frequency. This the d of local-oscillator frequency nol would eliminate one switch section the selector switch. Thus the



ADAPTERS Any of your microphones can be attached easily to this Boom without purchasing additional fittings. No tools are necessary because all the adapters are threaded in order that they can be screwed together. The fitting attached to the clevis on the end of the boom fits a $\frac{4}{5}$ x 24 thread which is the thread for all W. E. Microphones. An adapter for microphones using $\frac{1}{2}$ inch thread; one for $\frac{3}{5}$ x 27; and a hook complete the adapters normally supplied.

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MELETRON CORPORATION

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Figure 4 Television receiver mixer and local oscillator stages using a bridge-circuit oscillator generating a mechanical harmonic frequency of a low-frequency fundamental crystal plate.

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VSTAL-CONTROLLED RECEIVERS

(Continued from page 107)

Is would not require switching. the LC circuit would be switched e required local-oscillator frey so that the switch mechanism be quite simple. Cheaper cryslders would be usable and only t of bridge balancing condensers, cted externally to the shunted 1 holders, would be required.

oratory experiments to determine timate practicability of this syse now being completed. Results presented in a subsequent paper. different i-f sound channel, 21.75 ere used, we would find quite an sting result. The local-oscillator ney relationships are such that a fundamental crystal when operon its seventh, eleventh, and fifharmonics would oscillate at the frequency to tune the first, third ifth television channels respec-

The total number of crystals ed to tune the six channels would uced to four *instead of six*. Thus be seen that with another choice and possibly an allocation of telechannels adjacent to each other rystal might be suitable to tune annels.

h the proposed RMA television ind channel of 22.25 mc the first burth television channels may be with a 5.5-mc crystal tuned to te at its fifth and ninth harmonics tively. Therefore the six channay be tuned with five crystals. ure 6 shows the harmonic order

rious fundamental crystal freles which equal the six oscillator uncies required to tune the telechannels. For parallel crystal uton it is desirable to choose crysaving fundamental frequencies that odd harmonics of a particular I, other than the one required for

Figure 5 sental bridge circuit with a number of in parallel, used similarly to the oscillator shown in Figure 4.





METALLIC ARTS

that crystal operation, will not fall too

close to the frequency of operation of

Television receivers covering these

six channels and utilizing the RMA

standard will not derive any particular

benefit from a double-superheterodyne

in f-m receivers, the circuits described

would simply be extended to cover the

88- to 108-mc frequency spectrum.

With the RMA adopted i-f of 10.7 mc

the problems may be altered a bit. The

same circuits, however, may still be applied with appropriate local-oscil-

If the television i-f were to be used

the others.

circuit application.

COMPANY

243 Broadway CAMBRIDGE <u>39</u>, MASSACHUSETTS

> lator frequency modifications. With higher oscillator frequencies the double superheterodyne system could utilize two separately-controlled local oscillators, the first variable in frequency and the second fixed in frequency and both crystal controlled. The second oscillator and second mixer may be combined in one tube such as the 6K8. The r-f stages and first local oscillator could utilize the miniature type tubes effectively, since they are more suitable for v-h-f operation.

return in either le-

ver position.

The second local oscillator operates at 22 mc and uses a simple third or

(Continued on page 110)

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CRYSTAL - CONTROLLED RECEIVERS

(Continued from page 109)

fifth harmonic crystal operating in a fixed tuned t-p-t-g type circuit.

The first local oscillator would have to deliver a signal with a frequency

range of 55.3 to 75.3 mc to the first mixer to provide a first i-f of 32.7 mc. This frequency range could be covered with bridge-circuit harmonic crystals

| Order | 27.50 me | 37.50 me | 43.50 me | 49.50 me | 59.50 me | 65.50 me |
|-------|----------|----------|----------|----------|----------|----------|
| 3 | 9.1666 | 12.5 | 14.5 | 16.5 | 19.8333 | 21.8333 |
| 5 | 5.5 | 7.5 | 8.7 | 9.9 | 11.9 | 13.1 |
| 7 | 3.9286 | 5.3571 | 6.2143 | 7.0714 | 8.5 | 9.3571 |
| 9 | 3.0555 | 4.1666 | 4.8333 | 5.5 | 6.6111 | 7.2777 |
| 11 | 2.5 | 3.4091 | 3.9545 | 4.5 | 5.4091 | 5.9555 |
| 13 | 2.1154 | 2.8845 | 3.3462 | 3.8077 | 4.5777 | 5.0385 |
| 13 | 1.8333 | 2.5 | 2.9 | 3.3 | 3.9666 | 4.3666 |
| 17 | 1.6176 | 2.2059 | 2.5618 | 2.9118 | 3.5 | 3.8529 |
| 19 | 1.4474 | 1.9737 | 2.2942 | 2.6053 | 3.1316 | 3.4474 |

Figure 6 (above)

Listing of the local-oscillator frequency for each of the six television channels and odd sub-harmonics of each channel used to determine fundamental frequency of a mechanical-harmonic crystal-oscillator plate.



Figures 7 (above) and 8 (below)

Figure 7. Mixers and local oscillators of a crystal-controlled double-superhet f-m receiver cover-ing 88-108 mc. Figure 8. A double superheterodyne f-m receiver using a common local oscillator to beat with the r-f signal and also the first i-f signal to deliver a 10.7 mc second i-f signal to the i-f system.



• COMMUNICATIONS FOR OCTOBER 1945 110

operating at the proper harmonic deliver the required oscillator quency directly. Figure 7 shows circuit application.

The use of one crystal to de local-oscillator frequencies for diffe f-m station channels is quite feas and will certainly bear investiga from both lowered cost and gre simplicity possibilities.

A double superheterodyne cir which uses a single local oscillator beat for both i-f's is shown in Fig 8. We note that referring to Figur one tube has been eliminated. An crease of one tuning control of a n nant circuit, is also shown. The type of tube may be used as a combi tion second mixer and common le oscillator because the frequent passed through the tube are comp tively low. This type of tube will as efficient as it was in the old t 42-50-mc band f-m receivers.

The common local-oscillator quency range is 49.35 to 59.35 mc. actual frequency injected to mix w the r-f signal and first i-f is one-l of the oscillator frequencies mention and maximum conversion transcond tance will not be realized. The os lator circuit is of the t-p-t-g type us fifth harmonic crystals having fun mental frequencies ranging from 4. mc to 5.935 mc. The second i-f variable in frequency from 38.65 to 48.65 mc. The local-oscillator quencies and the first i-f frequence may be interchanged if desired.

Harmonic crystals are precisi ground devices and require care control in manufacture. It is reas able to expect, therefore, that the of these crystals will be higher t that for those designed for a-m sets

Generally, a-m tuning crystals have a fairly low figure of merit still operate satisfactorily to deve enough oscillator voltage for pro conversion transconductance. Crys used in experimental a-m receiv have been tested and found to hav frequency drift of 70 to 200 cycles a an 80° C temperature range when t ing the broadcast band.

The evaluation and the adoption one of the many circuit possibilities crystal-controlled tuning of receiv must be governed by the following a siderations: (1)—Simplicity and bility of circuits; (2)-ease of adju ment; (3)—cost of manufacture; -cost of component parts; and (5) cost of replacements and repairs.

It is believed that the crystal-co trolled local oscillator would simple spot tuning stability problems, and f applications such as television, adoption becomes almost mandatory.



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