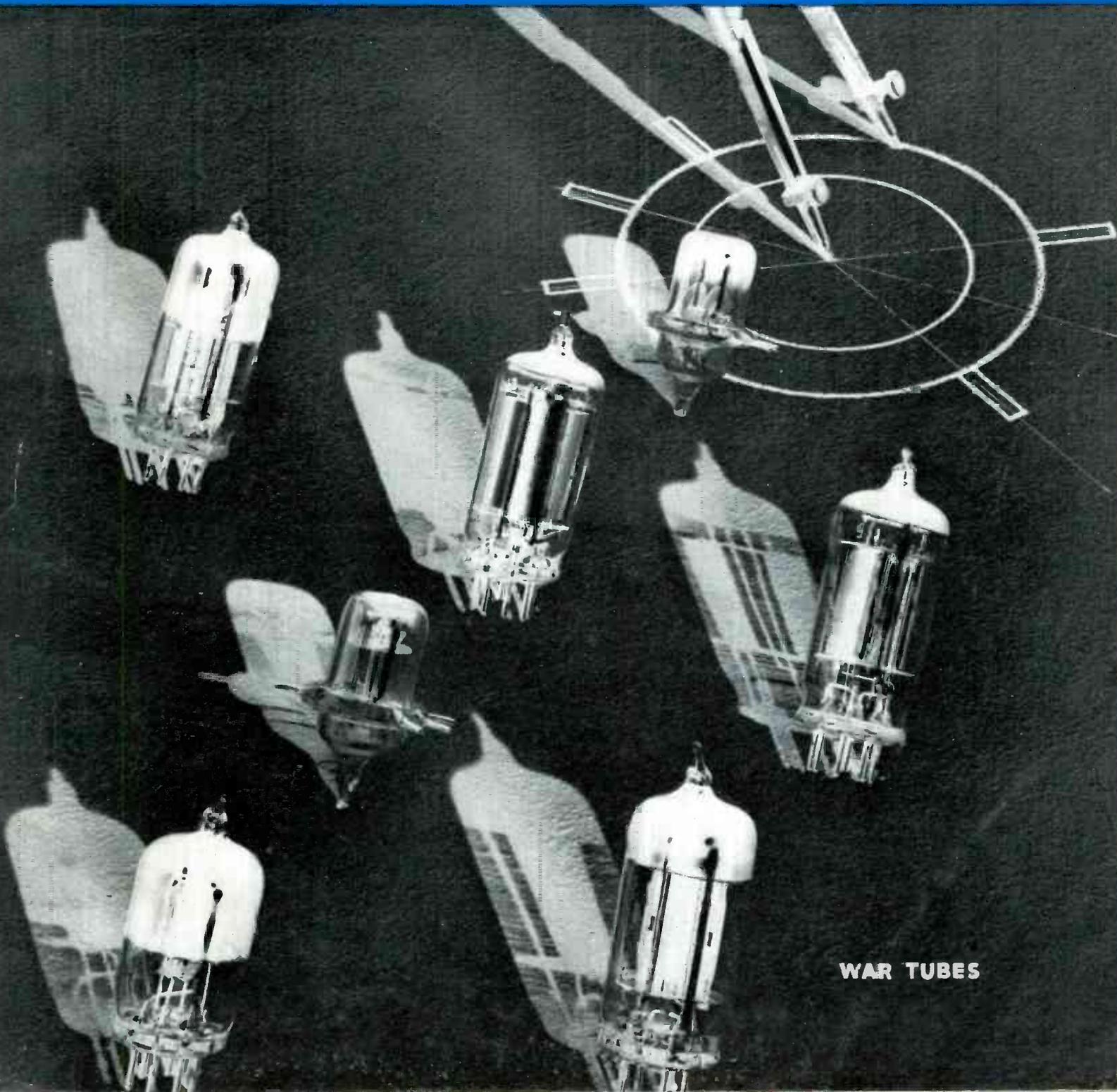


AUGUST • 1942

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electronics

radio, communication, industrial applications of electron tubes . . . engineering and manufacture



WAR TUBES



Our Perseverance Pays Dividends to the National War Effort ...

The merits of graphite and its desirability as an anode material were recognized by Amperex more than a decade ago.

Through the years . . . despite the insistence and claims of other tube manufacturers in regard to the superiority of various rare and semi-precious metals . . . Amperex has consistently held to its conviction that graphite was the preferred material for anodes in high vacuum tubes.

We have demonstrated, during that period, the superiority of our anodes by developing almost 100 types of transmitting tubes that have found favor in commercial broadcasting, aviation and electro-medical fields, as well as tubes for applications in the high and hyper-high frequency range for the armed services of the United States and the United Nations.

With our country in dire need of the rare and semi-precious metals employed as anodes by other manufacturers . . . and with the demand for "military purpose" tubes climbing to staggering quantities . . . Amperex is proud of the fact that its perseverance in developing graphite as an anode substance releases strategically necessary metals for other and equally important War efforts.



AMPEREX ELECTRONIC PRODUCTS
79 WASHINGTON STREET • BROOKLYN, NEW YORK



electronics

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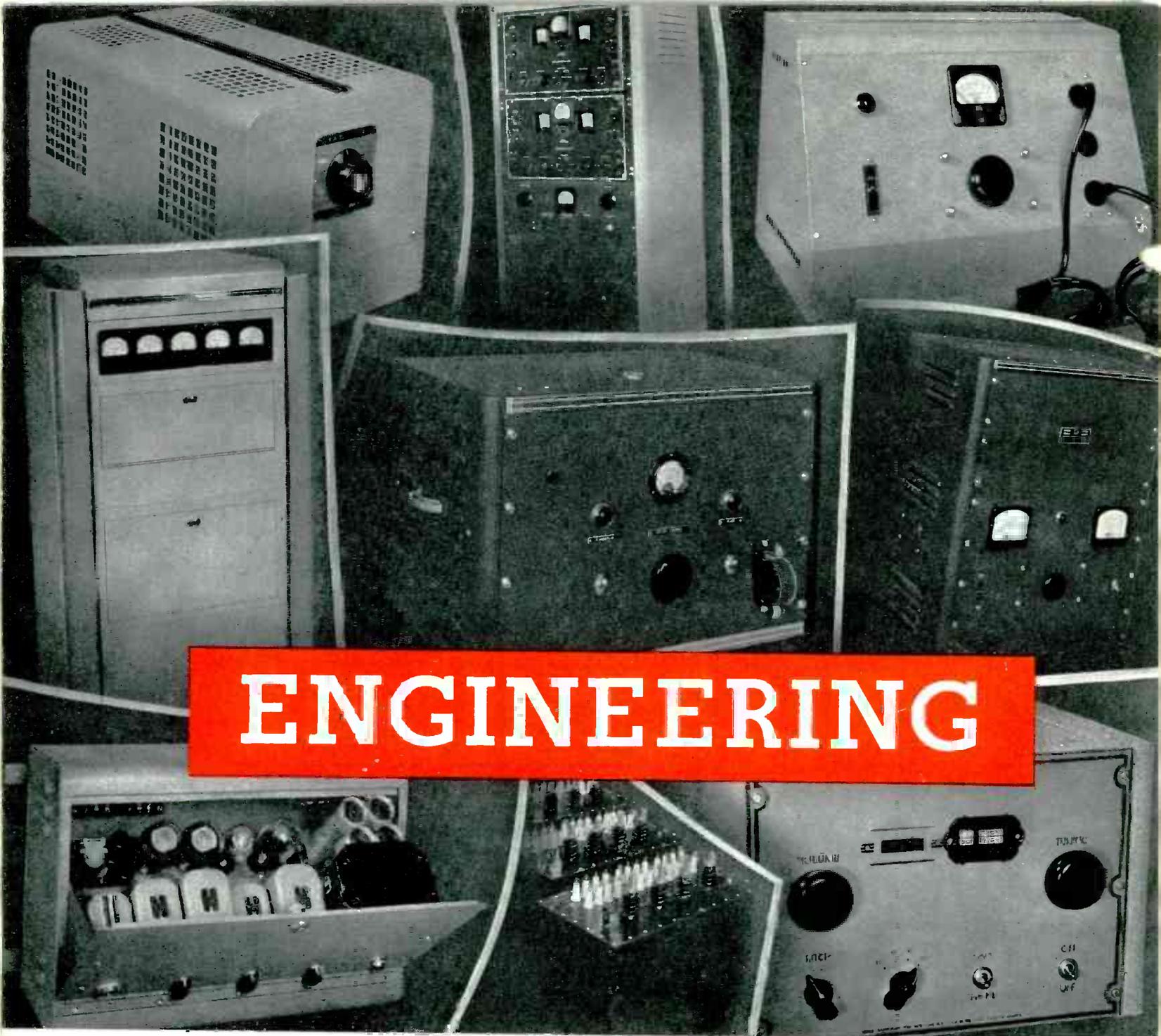
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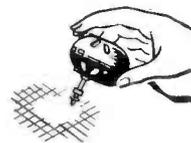
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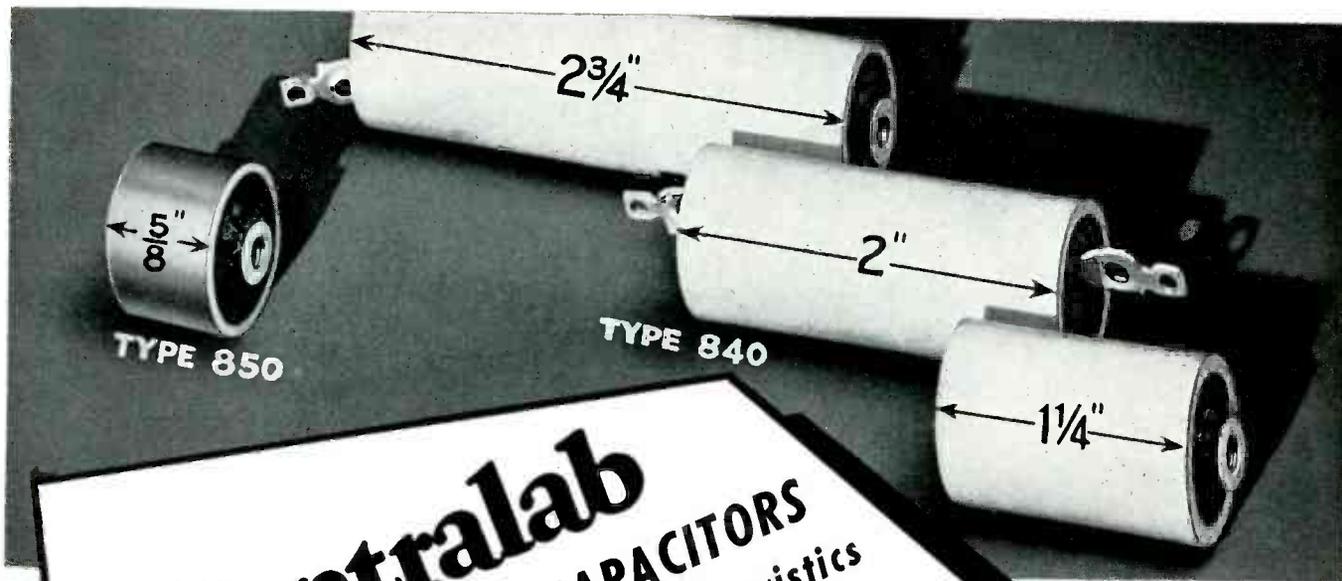
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- 1000 MMF NTC approximately 1" long.
- 500 MMF ZTC approximately $\frac{3}{4}$ " long.
- 1000 MMF ZTC approximately $1\frac{1}{2}$ " long.

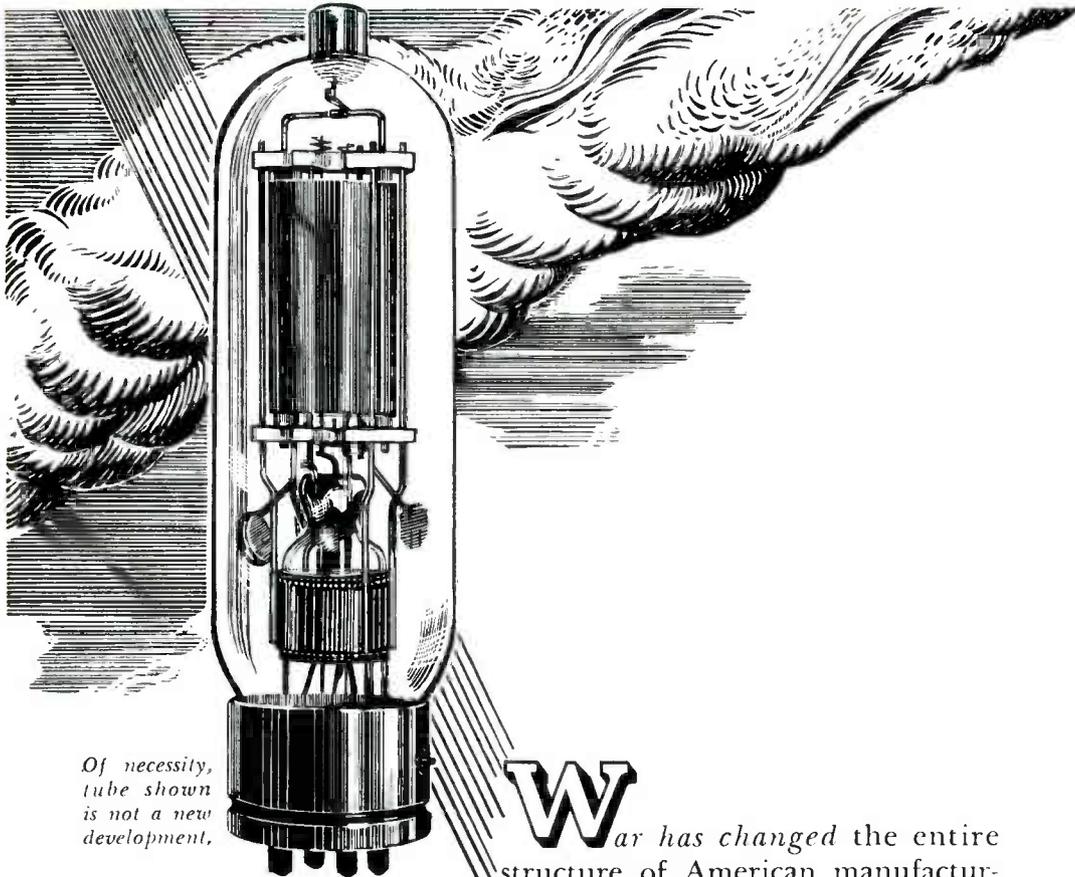
Power factor of .05% — does not increase with ageing.

Voltage rating — 1000 volts D.C. Leakage more than 10,000 megohms.

Terminals — two types available:

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- (2) Axial mounting post with 6-32 machine screw thread.

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*Of necessity,
tube shown
is not a new
development.*

W

*ar has changed the entire
structure of American manufactur-*

ing with resultant shifting in engineering point of view. Electronic designers are conquering problems never before presented.

Many defense developments will—when presented to the post-war commercial market—make unheard of changes in electronic scope.

“Secret weapon” is a hackneyed phrase, but would be justified when applied to any number of new applications of electronics. “RADAR,” the u. h. f. aviation locator, may, for instance, be standard equipment on commercial aircraft after the war. Yet it is only one phase of the new developments.

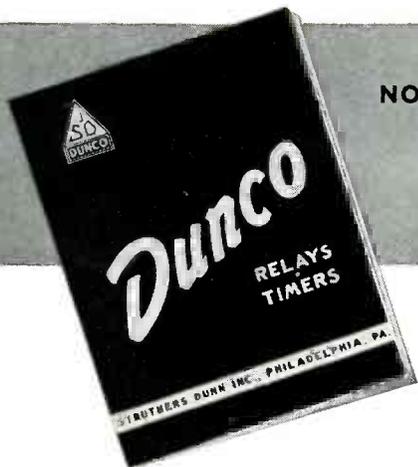
The Raytheon laboratories are well in the vanguard of those developing new devices and usages. When the war is brought to a successful conclusion the RAYTHEON name will mean more than ever before to the engineering world.

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NO! We don't mean to intrude by bothering you with that old biological puzzler, "Which came first—the chicken or the egg?". It's a "natural," however, to illustrate Dunco's ability to solve an electrical problem of far greater importance during these busy times: "Which comes first—relays to fit the specifications, or specifications to fit the relays?".

Frankly, it doesn't make any difference when you buy from Dunco. We have dozens of standard types that cover a wide variety of specifications—and we

are equipped to produce special units to meet literally hundreds of the most exacting applications. In fact, the more exacting the application, the better we like it.

Dunco relay specialists will gladly cooperate in solving your relay problems.

DUNCO RELAYS TIMERS

A Complete, Quality Line—Individually Adapted to Your Specific Needs

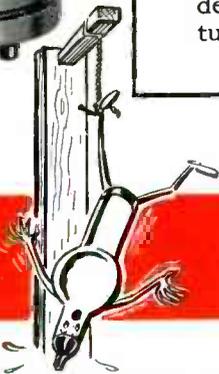
STRUTHERS DUNN, INC., 1326 CHERRY ST., PHILADELPHIA, PA.

How to Get Longer Life from Your MERCURY-VAPOR TUBES



Here's a four-word formula to make your mercury-vapor tubes last longer—"Handle carefully; operate conservatively." Below are a few suggestions to help you put this formula into effect. They will help prevent many of the causes of tube failure, such as: loss of emission, high arc-drop, cathode bombardment, arc-backs, the liberation of gas, and cathode failure. These safeguards are applicable to such tubes as the following General Electric mercury-vapor rectifiers: GL-266B, GL-857B, GL-866A/866, GL-869B, GL-872, GL-872A. For more complete instructions on operation and handling, write for Bulletin GEH-977B. Also list the types of G-E mercury-vapor rectifiers you are now using. We shall be glad to send you complete service information designed to help you get the most out of your mercury-vapor tubes. *General Electric, Schenectady, N. Y.*

1 Keep tubes upright and avoid splashing mercury around. When tubes are first placed in operation, be sure to apply cathode voltage *alone* until mercury is properly distributed.



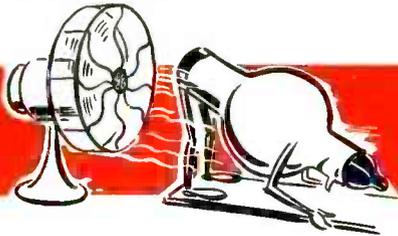
2 Keep condensed mercury temperature within limits recommended by tube manufacturer.



3 Be sure cathode base, not the anode end, is coolest part of tube. Don't let drafts blow on tubes. Never allow the mercury to condense at the anode end.



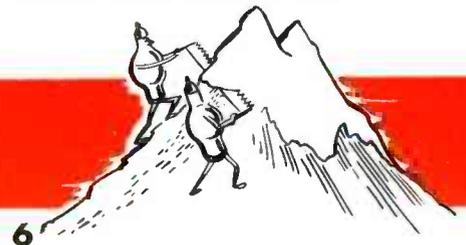
4 If you use forced air against the bottom of the tube, keep the blower on for a few minutes after shutting filaments down.



5 Allow plenty of filament warm-up time before applying anode voltage.



6 Keep peak inverse anode voltage and peak current as low as possible for satisfactory operation. Use adequate protective devices for overload and arc-back protection.



7 Do not allow the cathode voltage (measured at the pins) to deviate more than five per cent from the rated value.



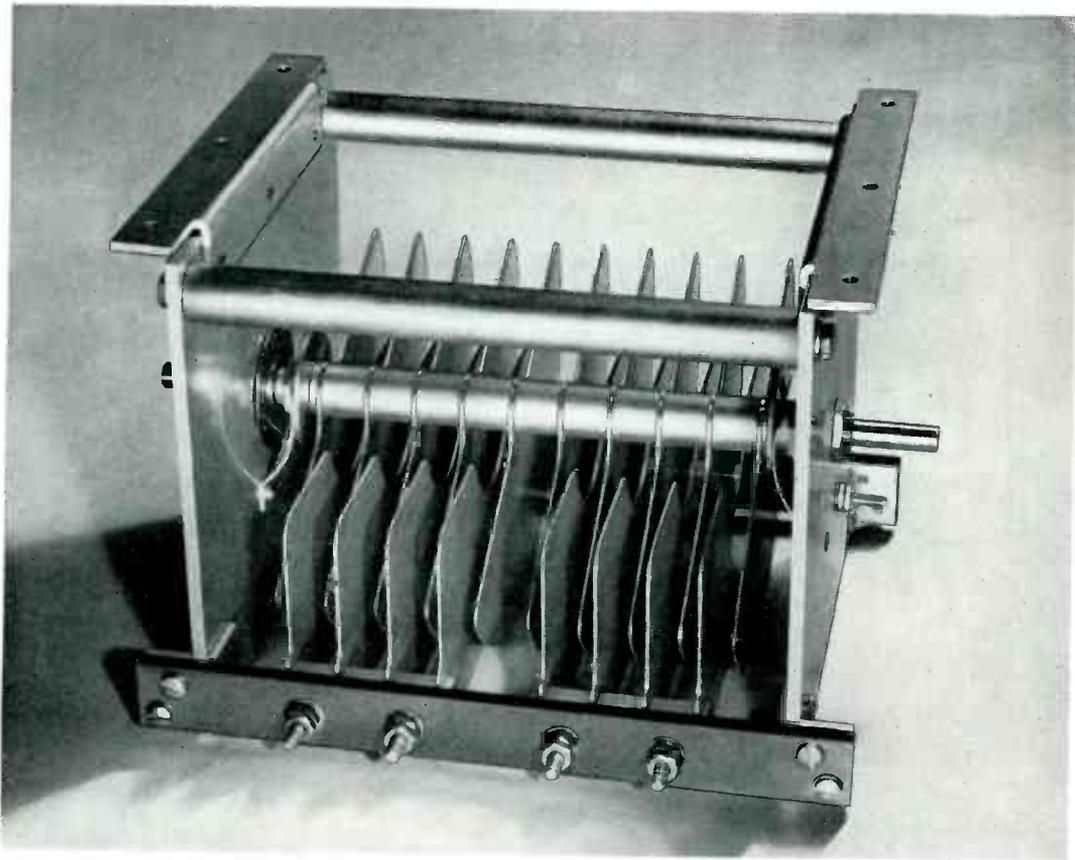
8 Don't overload tubes, even for short periods. Maintain full cathode voltage during standby operation when tube is operated without load.



9 Protect the tubes adequately against the effects of r-f.



READY AND ABLE



Type "GTCD" transmitting condenser, size $7\frac{1}{4} \times 11\frac{1}{2} \times 9\frac{1}{2}$ inches

VARIABLE condensers, like ammunition, are used in vast quantities in every branch of warfare. Hammarlund engineering and production facilities are always ready and able to meet the severest demands of this total war.

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Exclusive features of this compact power rheostat assure you 25% more capacity for handling possible overloads,—and consequently more heat dissipation—less temperature rise without taking up more space. The deeper winding form gives more wire, more surface area.

Our patented contact system, completely enclosed in the body of the rheostat, makes possible a maximum depth of winding space for any given back of panel space. The metal-graphite contact shoe, molded on a coiled pigtail, is the sole sliding electrical contact. It travels smoothly on the inside circumference where the turns of wire are most closely spaced. Each turn is a separate resistance step.

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**TO MANUFACTURERS
WORKING ON WAR ORDERS**

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16

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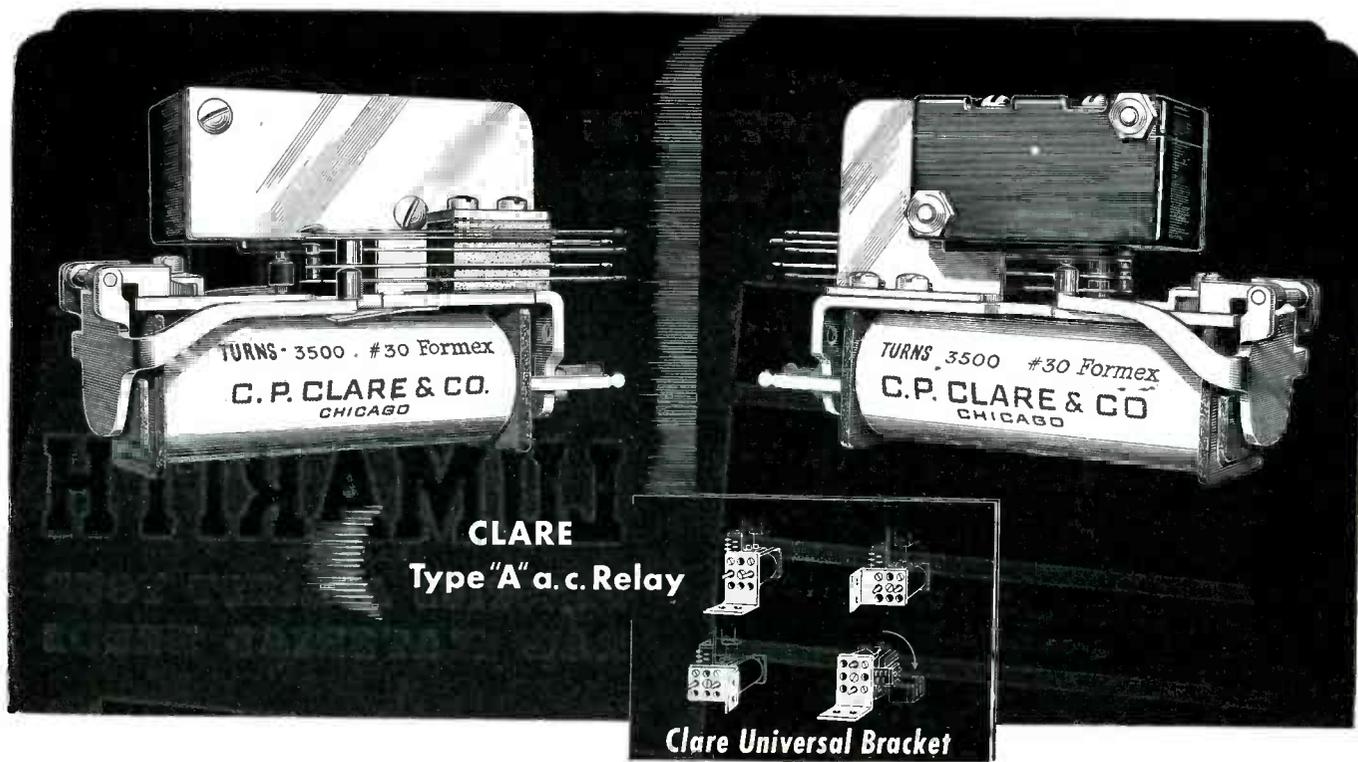


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Notch (Charpy)



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Type "A" a. c. Relay

Clare Universal Bracket

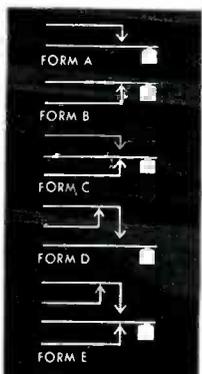
Here's what we mean when we say "Custom-Built"

■ We have been saying a lot lately about "custom-built" relays. The relay illustrated is an excellent example. Note the range of contact forms illustrated below which are available. Note the wide variety of ratings in which this relay can be supplied. It can be furnished with the universal mounting bracket shown above which permits mounting the relay in four different ways. The design and construction features described below are only a few of the features which make it possible for you to secure Clare Relays specifically designed to meet your specific performance requirements.



contacts are within the housing of a precision snap-action switch which has a capacity of 15 amperes, 110 volts a. c. It is available in normally open and normally closed, and double throw as illustrated.

This relay is fitted with both open and enclosed contacts. The enclosed



Open spring contacts em-

ploying any of the forms shown can be furnished.



thereby reducing contact resistance to a minimum and providing for rapid heat dissipation.

Flat or hemispherical contacts, .062" to .1875" in diameter, of either rare metals or special alloys are "over-all" welded to metal springs by a special process which makes them an integral part of the springs.

CONTACT RATINGS: 110 VOLT, 60 CYCLE, A. C. NON-INDUCTIVE

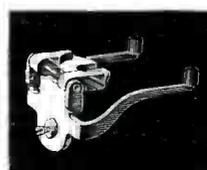
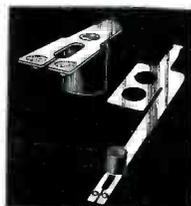
Code No. 1	1 Amp. 50 Watts
Code No. 2	2 Amp. 125 Watts
Code No. 3	4 Amp. 450 Watts
Code No. 4	3 Amp. 150 Watts
Code No. 5	4 Amp. 175 Watts
Code No. 6	3 Amp. 150 Watts
Code No. 7	4 Amp. 175 Watts
Code No. 8	4 Amp. 200 Watts
Code No. 9	4 Amp. 200 Watts
Code No. 10	4 Amp. 450 Watts
Code No. 11	3 Amp. 450 Watts
Code No. 12	4 Amp. 500 Watts

High voltage pile-up insulators assembled in the manner shown with flat or filister headed screws of high-tension steel, specially treated and



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Spring bushing insulators made of Bakelite rod under patented process are used instead of hard rubber generally employed. While similar in appearance, this type of insulator is much superior in wearing qualities. Clare type bushings are essential where heavy contact pressures are required.



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operation. Special magnetic iron can be furnished where necessary.

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CLARE RELAYS

"Custom-Built" Multiple Contact Relays for Electrical, Electronic and Industrial Use

Data on Relaxation Resistance of Nickel Alloy Springs

*Report presented at 1941 Annual Meeting
of the American Society of Mechanical Engineers
now available in printed form*

The oxidation and corrosion resistance of INCO Nickel Alloys, combined with ability to retain strength at elevated temperatures, have made them useful in many elevated-temperature spring applications. When load loss at temperatures from 300° F. to 700° F. is a criterion, "K" Monel, "Z" Nickel and Inconel are comparable to high-alloy spring steels, while Monel is more nearly comparable to low-alloy steels.

Members of the INCO Laboratories and Development and Research Division, in cooperation with the A.S.M.E. Special Research Committee on Mechanical Springs, have now furnished accurate laboratory data for Monel*, "K" Monel*, "Z" Nickel*, and Inconel*, which point to the following conclusions:

1. Inconel resists relaxation up to high temperatures and may be used at high stresses up to 650° F. Above this temperature the

stress must be lowered considerably and a slight degree of relaxation must be tolerated.

2. "Z" Nickel and "K" Monel will withstand higher stresses than Inconel at the lower temperatures, consistent with their generally higher level of mechanical properties.

3. "Z" Nickel may be used with high stress at temperatures up to 550° F. and with reduced stress up to 600° F.

4. "K" Monel may be used with high stress up to 450° F. and reduced stress up to 500° F.

5. Where other factors such as corrosion resistance are involved, Monel offers possibilities as a spring material for temperatures up to about 400° F. and at moderate stress levels.

6. Monel springs should be stress-equalized for 1 hr. at 650° F. where relaxation resistance is desired.

7. Inconel springs should be stress-equalized for 1 hr. at 900° F. for service at elevated temperatures.

Complete technical information on this subject has been published in bulletin form. You are invited to send for this paper by using the coupon below.

THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL STREET, NEW YORK, N. Y.



"Monel" and other trade-marks which have an asterisk associated with them are trade-marks of The International Nickel Company, Inc.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York, N. Y.

Gentlemen: Please mail me a copy of the paper "Relaxation Resistance of Nickel Alloy Springs" (B. B. Betty, E. C. MacQueen, and Carl Rolle)

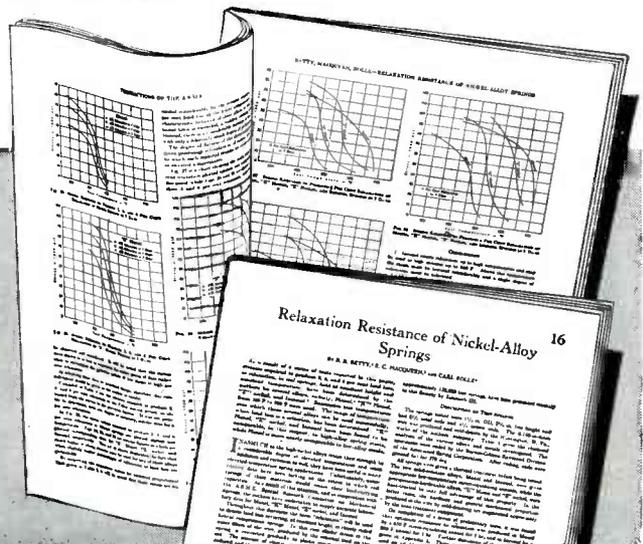
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“IMPEDANCE BRIDGES

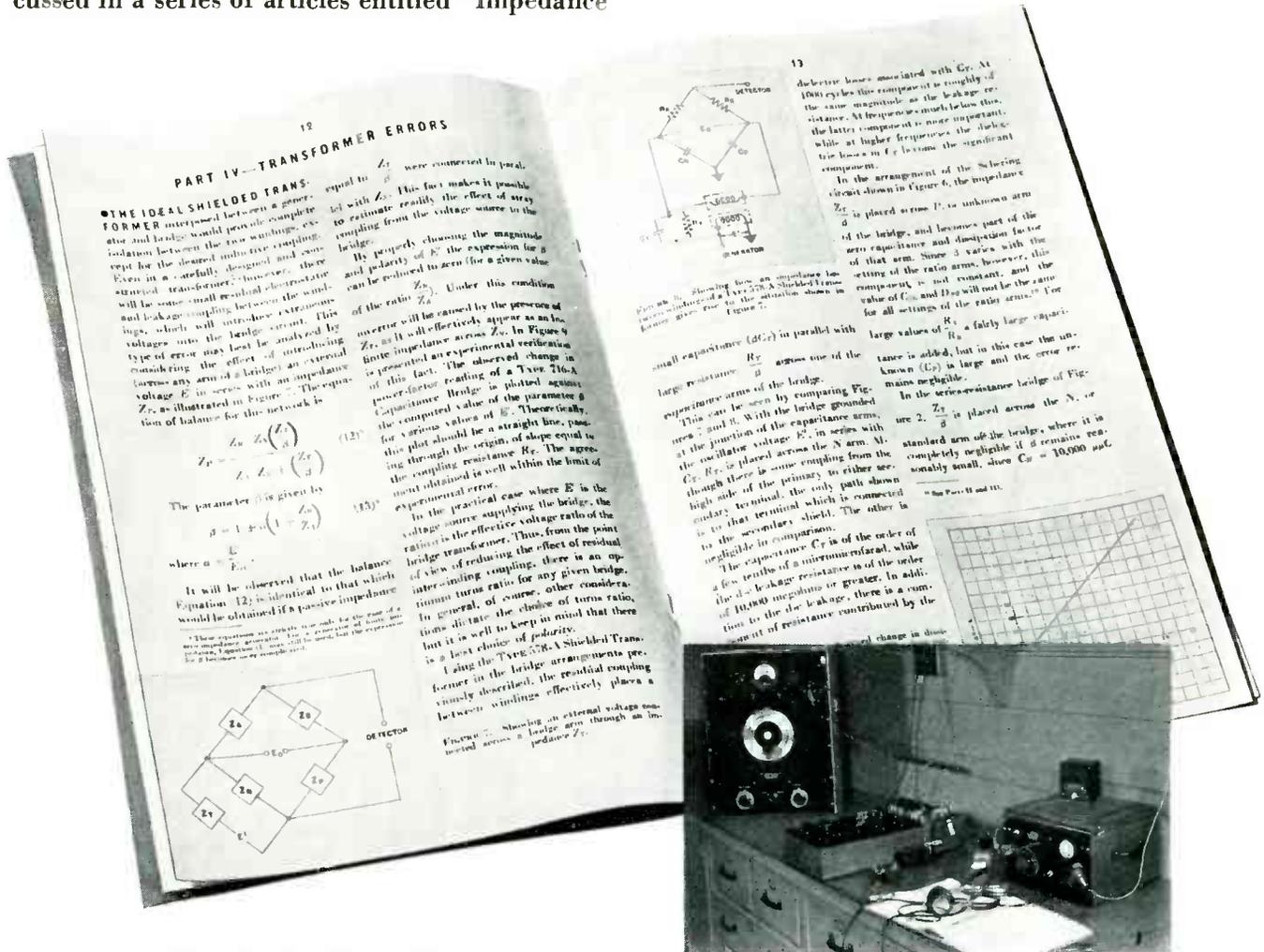
ASSEMBLED FROM LABORATORY PARTS”

In electrical testing, particularly under war contracts, there are many occasions when accurate measurements of impedance—resistance, inductance, capacitance and power factor—are urgently needed. Commercial impedance bridges may not be readily available. Or the need may be for one particular type of measurement where a “tailor-made” bridge would be desirable. In either case, many electrical laboratories already have sufficient General Radio standard parts available from which the desired impedance bridge could be easily assembled.

How to set up and use impedance bridges was discussed in a series of articles entitled “Impedance

Bridges Assembled From Laboratory Parts,” which appeared in the General Radio *Experimenter*. These articles have been reprinted in the 24-page booklet illustrated below. Much information not usually found in text books is included, as for instance, how to choose the best bridge circuit for a given type of measurement, and how to determine the magnitude of residual impedance errors.

A copy is yours for the asking. This booklet should be especially useful to students. Copies are available for educational institutions.



WRITE FOR BULLETIN No. 784

Series-resistance capacitance bridge assembled on a laboratory bench.

GENERAL RADIO COMPANY · Cambridge, Massachusetts

ALSiMAG CAST STEATITE

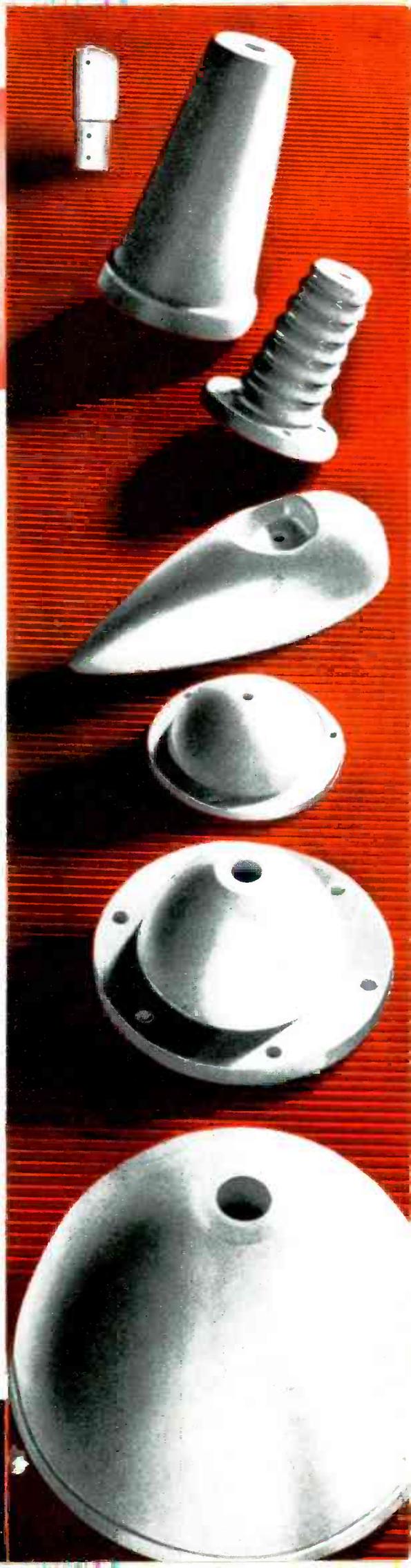
is still available

FOR PROMPT DELIVERY

OUR presses and lathes are busy making close tolerance ALSiMag steatite ceramics of intricate shapes.

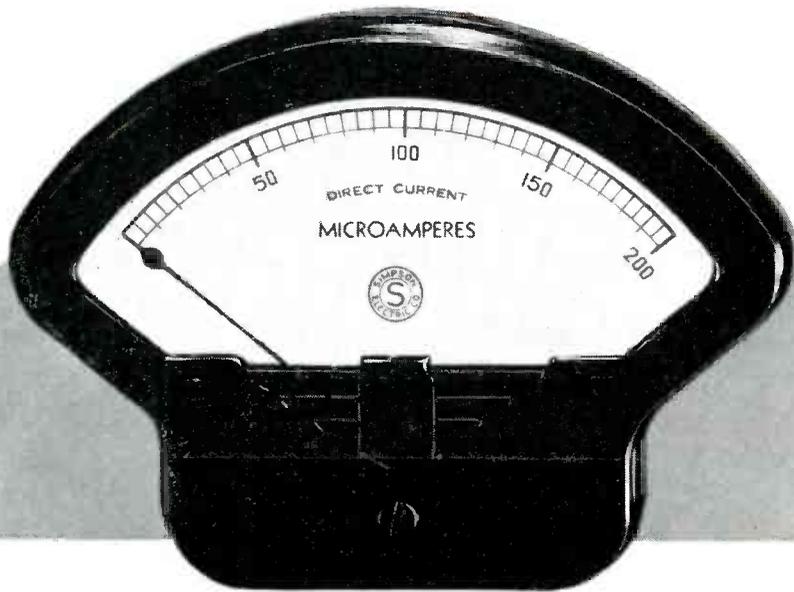
However, where broader tolerances are permissible and when comparatively simple shapes are required (like those illustrated) we can supply cast ALSiMag steatite promptly. With the exception of tolerances, cast ALSiMag steatite maintains the same high quality for which our products are so well known.

Frequently it is possible to redesign a part to meet the requirements of casting. If your production is threatened by a bottleneck due to longer deliveries required for steatite insulators, lay your problem before our engineers. They will be glad to cooperate with you to find ways and means to supply you with ALSiMag cast steatite ceramic parts in time.



ALSiMAG
Trade-Mark Reg. U.S. Pat. Off.

AMERICAN LAVA CORPORATION
CHATTANOOGA, TENNESSEE



Time is an important dimension of Accuracy

IN the strict meaning of the word, accuracy is not a measurable thing. An electrical instrument is either accurate, or it isn't accurate. There can be no more or less, no "almost".

But there *is* one important way instrument accuracy can be qualified—if not in terms of "how much", then in terms of "how long".

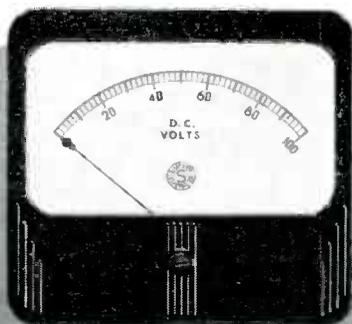
How long will Simpson Instruments stay accurate? Examine the Simpson movement and you'll find your answer. First of all you'll find heat-treated, aged magnets—carefully selected springs, tested and tempered for permanent re-

siliency—specially processed pivots, completely Simpson-made.

But most important of all you'll find a fundamentally-better, stronger construction, with soft iron pole pieces for absolute accuracy, and full bridges at top and bottom that hold the moving assembly always in perfect alignment.

If your requirements are vital enough to give you the right to buy instruments, they are vital enough to rate the best. To those who have learned to measure accuracy in terms of "how long", best can only mean . . . Simpson.

SIMPSON ELECTRIC COMPANY, 5212 Kinzie St., Chicago, Illinois



**ALL POPULAR STYLES,
SIZES, RANGES**

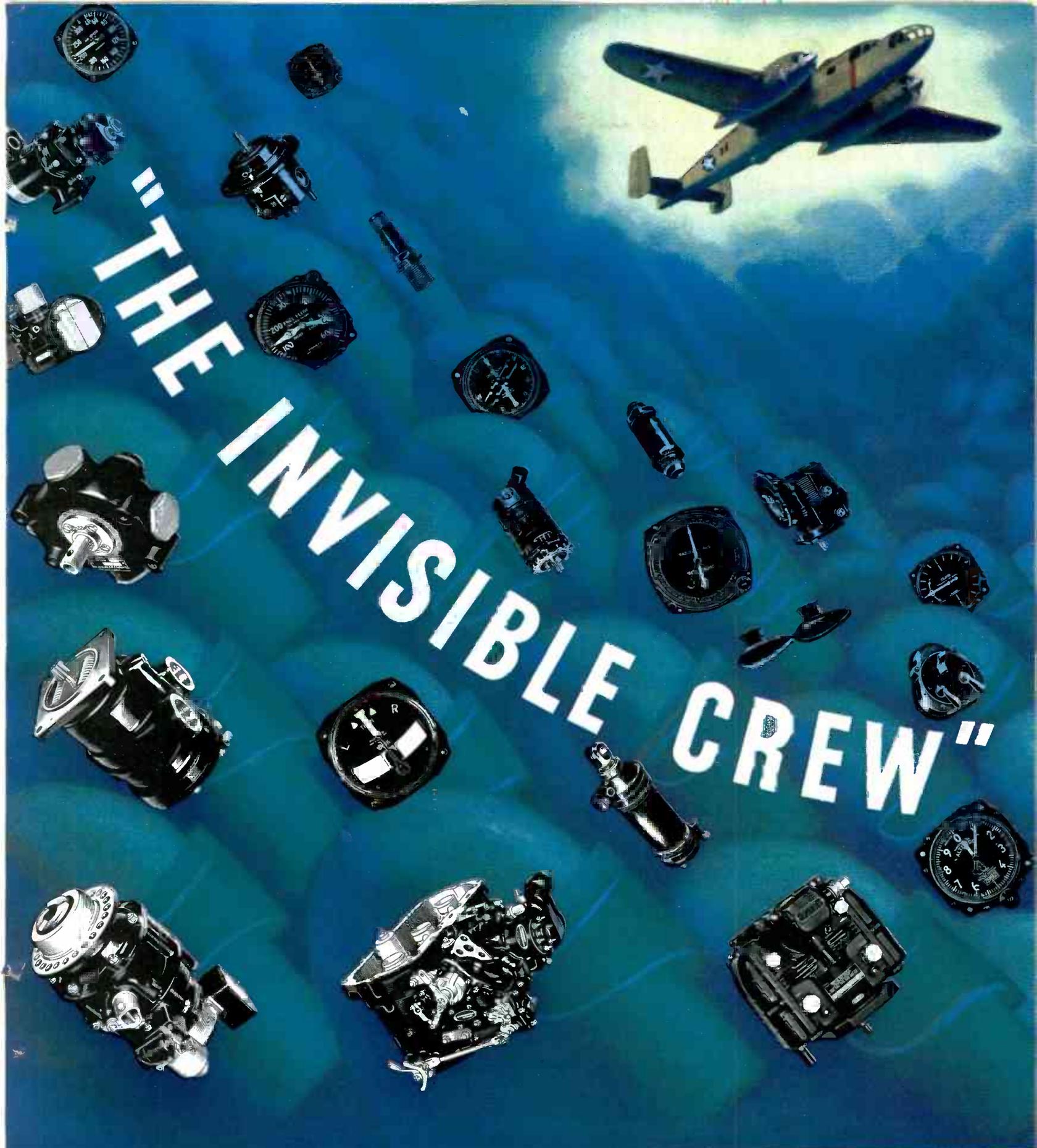
Simpson

INSTRUMENTS THAT STAY ACCURATE

MODEL 260 High Sensitivity Tester

Here is a typical example of Simpson leadership. Ranges to 5000 Volts, both AC and DC, at 20,000 ohms per volt DC and 1000 ohms per volt AC. Current readings from 1 microampere to 500 milliamperes. Resistance readings from 1/2 ohm to 10 megohms. Five decibel ranges, -10 to +52 DB.





... FIGHTING PARTNERS OF THE ARMED FORCES

The exciting story of Bendix precision-built equipment sharing in every action of American fighting machines.

"THE INVISIBLE CREW"

A War Report from the



Today, America reads and hears hourly how industry has turned the tide of its production battle. In that battle, it has been a major task of Bendix to develop high precision instruments and apparatus vital to warfare on land, sea, and in the air—and to produce them in quantity. Today, more than 1,000 types of such technical equipment are built by Bendix — built with accuracy and speed.

Our victory and the lives of our fighting men depend on the precision and performance of these devices of war, devices which we of Bendix call "The Invisible Crew."

To match technical brains with the enemy, to put precision into production, to make engineering skill and widespread manufacturing facilities function as an integral whole; this is the objective of the Bendix divisions behind "The Invisible Crew."

Today, Bendix has mobilized its manpower, brain power and production power. We stand fifteen divisions and subsidiaries strong. Many thousands of trained men and women, at work in more than twenty new and enlarged Bendix plants, are helping technical science fight on every battlefield. With typical American pride, we present this Bendix report to the Nation.

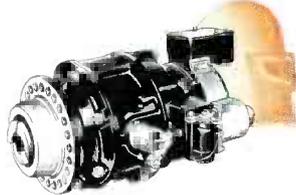
BENDIX AVIATION CORPORATION • Includes these 15 Divisions and Subsidiaries.
DIVISIONS: ★ **BENDIX PRODUCTS DIVISION**, Bendix automotive brakes; airplane wheels, brakes, pneudraulic shock struts; Stromberg carburetors. ★ **WAYNE DIVISION**, Aircraft carburetors and landing gear. ★ **ECLIPSE MACHINE DIVISION**, Bendix drive, Morrow coaster brakes, Startix; ordnance. ★ **MARSHALL-ECLIPSE DIVISION**, Automotive brake lining. ★ **ZENITH CARBURETOR DIVISION**, Zenith carburetors. ★ **MARINE DIVISION**,

MARCHES ON AND ON !

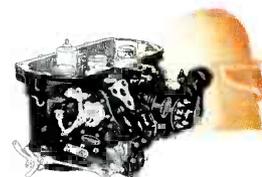
Bendix Plants from Coast to Coast



BENDIX RADIO DIVISION has been building a complete line of aircraft communication and direction-finding equipment for 6 years. Defense activities brought a 10-fold increase in production, and Pearl Harbor stepped it up still further. These Radio members of "The Invisible Crew" flashed the location of the "Bismarck" — guided flying fortresses to secret Philippine bases, aided in our attack on Japan. Bendix Radio is working full-out for fast victory, and for post-war safety and speed in aviation.



ECLIPSE AVIATION DIVISION makes engine starters for today's fighters and bombers. The first Eclipse starters were built for Liberties and Hispano Suizas in 1917. Today Eclipse also produces generating equipment to provide current for dozens of aircraft circuits, and Eclipse vacuum pumps operate navigation and de-icer systems. Eclipse anti-icer pumps keep propellers ice-free. Thus Eclipse members of "The Invisible Crew" contribute vitally to safety as well as speed in military and civil flight.



BENDIX PRODUCTS DIVISION... world's largest brake manufacturer began 18 years ago in 1 building. Developing automotive 4-wheel brakes, they added aircraft brakes. 3 divisions build Stromberg Injection Carburetors, aircraft landing gear, and automotive brake equipment.

STROMBERG CARBURETORS. In 1929 the Stromberg organization joined Bendix. Today's Stromberg automatic, precise metering Injection Carburetors for all loads, altitudes and temperatures are standard on the majority of American planes.



PIONEER INSTRUMENT DIVISION. All-out air warfare brought Pioneer new and varied instrumentation problems. Modern high speeds and high service ceilings, larger planes, higher horsepower presented novel obstacles. Pioneer developed new types of compasses, autosyn-operated remote indicators and remote indicating compasses — these and dozens of other Pioneer instruments are being used by Service pilots in ever-increasing quantities as demanded by the war program.



SCINTILLA MAGNETO DIVISION has developed for Army, Navy and commercial aviation a system of aircraft ignition in step with the newest developments in high altitude and high horsepower operation. The organization that began manufacturing in 1925, with 15 people and an abandoned automobile factory now numbers its personnel in thousands and occupies a new and thoroughly modern plant. War-spurred intensity has produced a whole new list of Scintilla refinements.

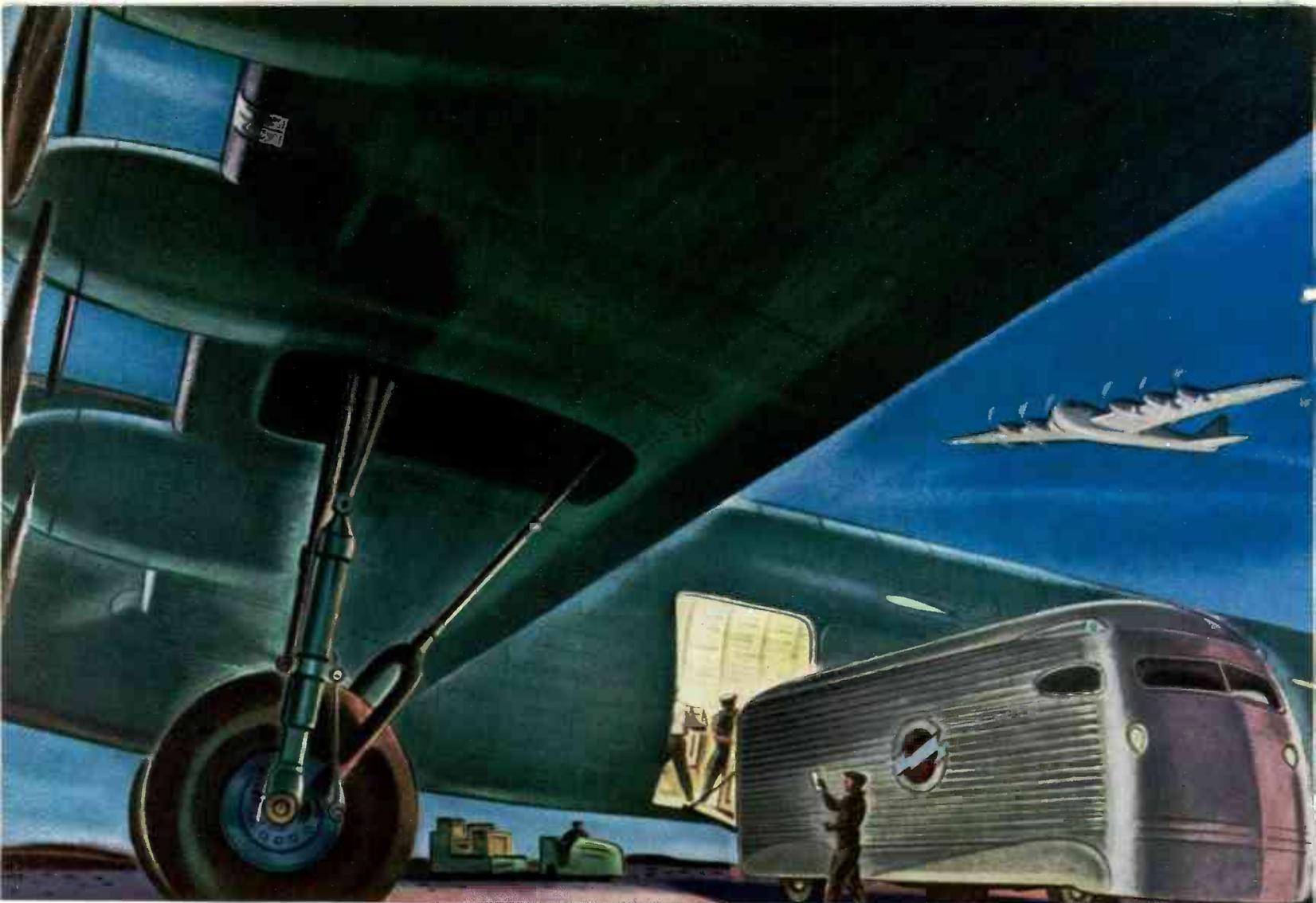


BENDIX LANDING GEAR . . . contributes to "The Invisible Crew" with airplane wheels and brakes, pneudraulic shock struts and steerable tail-knuckles for military ships, from trainer to bomber class.



BENDIX AUTOMOTIVE PRODUCTS. From this department brakes, brake shoes, universal joints and vacuum-operated controls flow out in volume to join the automotive units of our fighting forces all over the world.

Marine signalling, remote controls, indicators. ★ **ECLIPSE AVIATION DIVISION**, Aircraft engine starters, generators, dynamotors. ★ **PIONEER INSTRUMENT DIVISION**, Aircraft flight and navigation instruments. ★ **PHILADELPHIA DIVISION**, Aircraft instruments. ★ **JULIEN P. FRIEZ DIVISION**, Weather and Meteorological instruments. ★ **SCINTILLA MAGNETO DIVISION**, Aircraft magnetos, spark plugs. ★ **EXPORT DIVISION**, Sale of Bendix products in foreign markets. ★ **BENDIX RADIO DIVISION**, Aircraft radio equipment. **CONSOLIDATED SUBSIDIARIES:** ★ **BENDIX AVIATION, LTD.**, Hydraulic valves, radio, cushion clamps. ★ **HYDRAULIC BRAKE COMPANY**, Hydraulic brakes for motor vehicles.



AFTER VICTORY... A Tempo for Tomorrow

*"For I dipt into the future, far as human eye could see,
Saw the Vision of the world, and all the wonder that would be,
Saw the heavens fill with commerce, argosies of magic sails,
Pickets of the purple twilight, dropping down with costly bales...*

—ALFRED LORD TENNYSON, 1842

Our first aim is Victory. Our technicians, engineers and craftsmen form a task force whose mission is to put precision on the production line. We are accomplishing that mission. Wherever American fighting machines fly, roll or sail, Bendix-built instruments and equipment are rendering vital service as members of "The Invisible Crew." All of our efforts, now, are being expended for an early and victorious peace.

Our Second aim will be achieved after the goal of victory has been reached. Then, what we of Bendix are doing in war will turn to its adjusted place in peace. Bendix technical advances and Bendix products will return to normal fields and develop into many new ones barely charted today.

Our post-war world will be a world of flight. In every phase of AIRPORTATION to come, Bendix will have a vital part. When we see "the heavens fill with commerce," as Tennyson predicted a hundred years ago, Bendix-built instruments, equipment and specialized accessories, as we know them in war today, will help set the tempo of tomorrow.

B E N D I X A V I A T I O N C O R P O R A T I O N

THE INVISIBLE CREW

PRECISION

EQUIPMENT BY

Bendix

AVIATION

CORPORATION



**THE JAPS WERE
KNOCKED OUT ON THIS
DRAWING BOARD** *first!*

BEFORE the little brown men of the Setting Sun were shot out of the skies—they were defeated on this drawing board.

Defeated by an army of engineers, designers and draftsmen who make the pencil plans for America's mighty bombers and fighter planes.

Defeated by men whose weapons are brains and pencils—A. W. Faber's WINNER Techno-TONE, America's standard of drawing pencil excellence.

We are proud to contribute this smooth, sleek weapon to the Nation's War Effort—proud to offer a pencil that almost two centuries' experience devised. If you haven't yet used WINNER Techno-TONE we'd like to send you a sample. We want you to discover for yourself how deep-rich, how uniformly unvarying it is in all 17 degrees. Also how toughly resistant to point breakage. Just tell us your favorite degree—that's all. Write Dept. E-8.



WINNER Techno-TONE is available in 17 scientifically graded tones—6B to 9H. Polished rich green. Packed in metal box. Made in U. S. A.

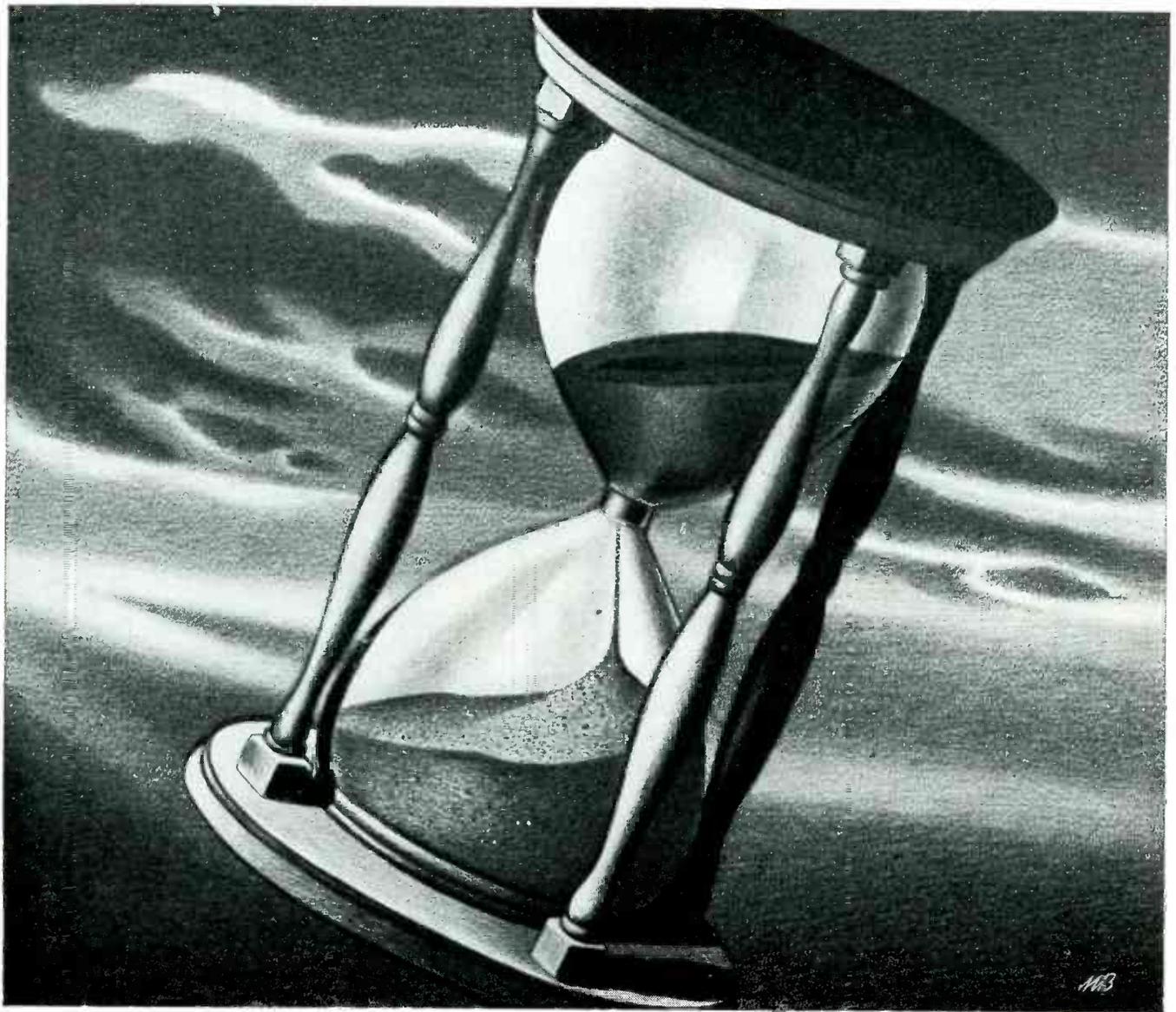
WINNER *Techno-TONE* DRAWING PENCILS

13c each 2 for 25c \$1.25 dozen

At all Drawing and Artists Material dealers and leading Stationers.

Companion Pencil — WINNER Thin Colored Checking — Superb colors and strength. Choicest for all prints: 2381 Red; 2382 Blue; 2383 Green; 2385D Yellow; 2437D Orange. 10¢ each. \$1.00 dozen. Would you like a sample?





RADIO'S ELECTRONIC HOUR-GLASS

Electrons—infinitesimal bits of electricity—are grains of sand in the hour-glass of science.

Today, radio's hour-glass—the electron tube—is turned so that the electron stream flows day and night to help win the war. Unlimited, it will run on and on until Victory is measured out on land, at sea, and in the air.

Only Time and Peace can tip this glass and reverse the flow of magic into new products and services for civilian use. Then, in the hour-glass of progress, will flow television and other new miracles of radio as the electronic sands of science flow again in new directions.



BUY
U.S. WAR
BONDS

RADIO CORPORATION OF AMERICA

PIONEER IN RADIO, ELECTRONICS, TELEVISION

RCA BUILDING, NEW YORK, N. Y.

The Services of RCA: RCA Manufacturing Company, Inc. • RCA Laboratories
R. C. A. Communications, Inc. • National Broadcasting Company, Inc. • Blue Network Company, Inc.
Radiomarine Corporation of America • RCA Institutes, Inc.

C-Ds FIGHT WITH THE CONVOYS



TODAY'S C-D Capacitors Speed Victory . . .

TOMORROW'S C-D Capacitors assure more hours of use per dollar for American industry

A flying boat, bounced from a warship's catapult, does its tour of patrol ahead of a convoy. Suddenly a sub is sighted! The radio flashes warning to the convoy leader. Destroyers, eager for the kill, plunge forward, Y guns ready . . .

Victory demands split-second teamwork of planes and ships, men and equipment. The "impossible" of the last war has become routine. We are proud that the *finer* performance of

C-D Capacitors is successfully meeting the Axis challenge wherever radio and a hundred other electrical and electronic devices serve on critical war duty.

Today's C-Ds speed Victory. Tomorrow's C-Ds assure *more hours of capacitor use per dollar* for American industry. Cornell Dubilier Electric Corporation, South Plainfield, New Jersey; New England Division: New Bedford, Mass.



Low Capacity Bypass Capacitors

*copied • imitated
but never duplicated*

Type DY Capacitors are filled and impregnated with non-inflammable Dykanol and hermetically sealed. They will operate under all climatic conditions and at temperatures up to 80°C. Particularly designed for marine applications. Ideally suited for r.f. and a.f. bypass and a.f. coupling.

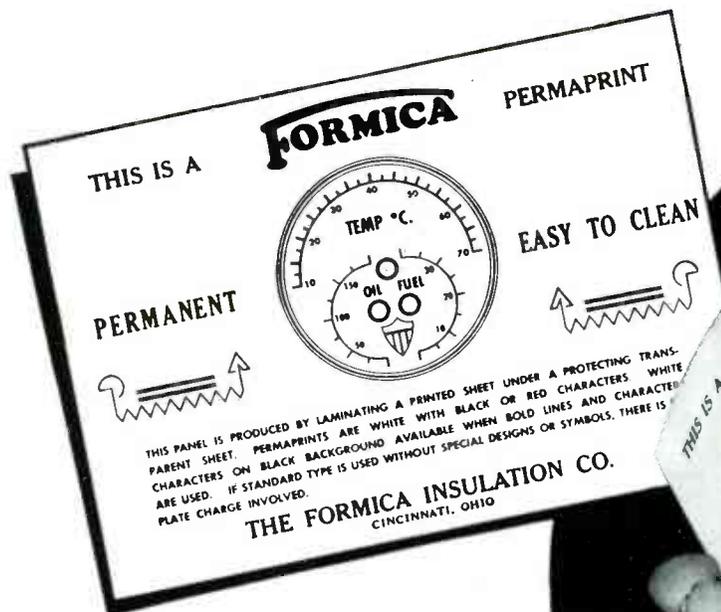
Described in Catalog No. 160T free on request.



Cornell Dubilier Capacitors

MICA • PAPER • DYKANOL • WET & DRY ELECTROLYTIC CAPACITORS

MORE IN USE TODAY THAN ANY OTHER MAKE



You can
BEND

and RIVET these
Flexible Plastic Name Plates!

IN "PERMAPRINT" name and direction plates Formica has something to offer the manufacturer who has been requested by the War Production Board to discontinue use of metals for this purpose. "Permaprint" name plates may be of a flexible type that can be bent to the contour of a curved surface, and can be riveted in place without danger of the material shattering. It is also available in flat, rigid types for flat surfaces.

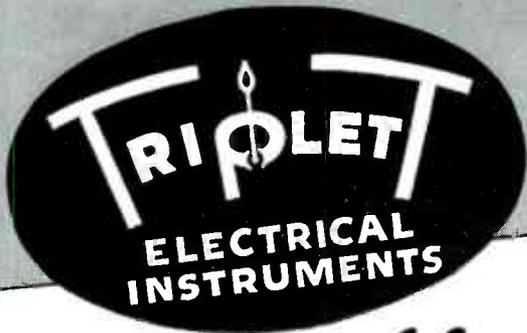
All lettering is protected by a transparent plastic surface against wear or injury by grease or solvents.

The plates may have a white background and black lettering, or a black background and white lettering. Where it is essential that serial numbers form a part of the plate a strip of aluminum may be inlaid, and into this the serial numbers can be stamped easily by the usual methods.

Formica equipment for this product is large and it is available in full to those manufacturers of airplanes and other war equipment who must use non-metallic name plates.



The Formica Insulation Company • 4661 Spring Grove Avenue • Cincinnati, Ohio



"Portables" Speed-Up War Production Testing

Triplet Portables speed up electrical testing with the dependable accuracy that is a vital part of war production.

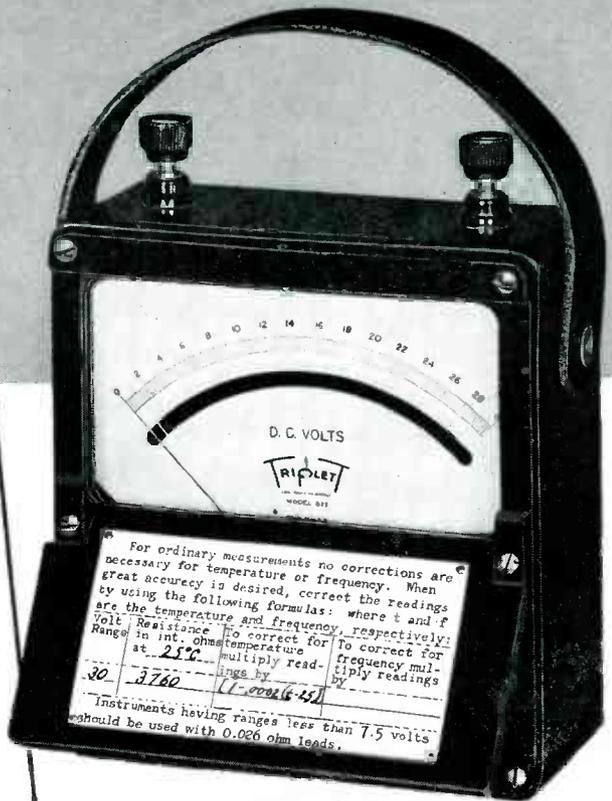
And whether your particular interest lies in laboratory service, production line testing, experimental work, field service, or plant maintenance, you will find your need provided for, with exacting and lasting accuracy in the expanded line of Triplet Portables.

In the drive of production-line testing, Triplet Portables supply the full-scale accuracy, the consistent performance, the hair-trigger answers that result from the Triplet method of safe-guarding quality, by making every essential part in the Triplet plant.

If you, like the writer of the letter quoted below, want to back up our armed forces with time-saving production practices, write for complete details on other Triplet Portables, panel electrical measuring and test equipment.

"With the Ohm Meter we have on order we can do in . . . seconds, what now takes a couple of hours."

Excerpt from letter of a prominent manufacturer (original in our files):



Model 625

Models 625 D.C. and 635 A.C. Portables are unequalled for today's rush in production testing or the rigid requirements of laboratory checking. These highly attractive molded case instruments have long 4.58" hand calibrated mirror scales. The hinged cover closes when instrument is not in use, for added protection. Black molded case for D.C. instruments; A.C. is red. Size is 6" x 5 1/2" x 2 1/2". Has detachable leather strap handle.



Model 425

Another new Portable combining attractive symmetrical case proportions, a long readable scale, and requiring a minimum of bench space when in use. A real beauty in design for those preferring something different. Case and base are molded; base size 5" x 4 3/8". Model 425 D.C. (3.12" hand calibrated mirror scale); Model 435 A.C. (2.88" hand calibrated mirror scale.)

THE TRIPLET ELECTRICAL INSTRUMENT CO.
BLUFFTON, OHIO



**ONLY THE ROLL OF THE SHIP
IS NEW TO JIM!**



Producing instruments in the quantities and to the high quality essential for our war-time needs is a gigantic task. But in this task, too, WESTON continues in its accustomed role of leadership. * * * But of even greater significance are the new instruments and devices which have resulted from WESTON's time-honored policy of *continuing research and development*. While the immediate functions of some of these devices must remain unknown for the duration, their importance in our war effort today foreshadows the benefits they assure to all industry tomorrow.

In instruments, industry can continue looking to WESTON for leadership.

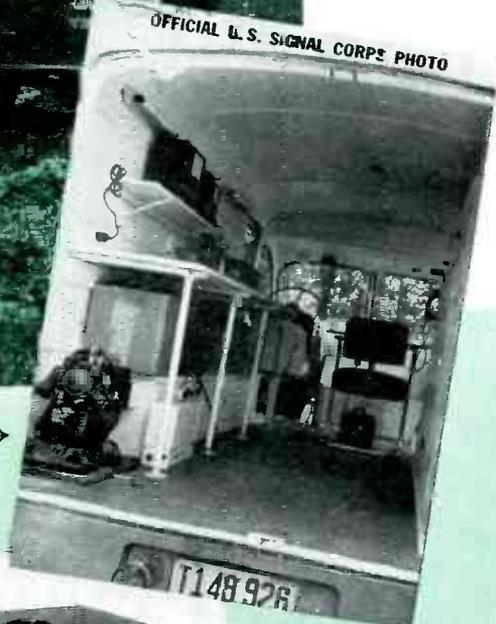
The roll of the ship is the only thing different to Jim about his new job. His last one, and probably his next, was in industrial maintenance. Keeping electrical circuits and equipment fit and efficient is an old story to Jim. Especially so, since he's had nothing but the most dependable tools to work with all throughout his electrical career. And it's no different at sea. Dependable WESTONS on the control panels, for example; also for portable testing and communications needs. And other *special* WESTONS, too. Yes, Jim can be counted on to give his best . . . for like all competent craftsmen, he works best with tools he has learned to trust. Weston Electrical Instrument Corp., 618 Frelinghuysen Ave., Newark, N. J.

WESTON *Instruments*

Laboratory Standards • Precision D-C and A-C Portables • D-C, A-C, and Thermo Switchboard and Panel Instruments • Instrument Transformers • Sensitive Relays • Specialized Test Equipment • Light Measurement and Control Devices • Exposure Meters • Aircraft Instruments • Electric Tachometers • Dial Thermometers

ELECTRONIC'S "MOBILE LAB"

Solves Field Problems on Their Home Grounds



Laboratory research... skilled engineering... exhaustive testing... precision craftsmanship... mean a lot! *But they aren't enough. ELECTRONIC MUST BE ABSOLUTELY SURE!*

That's why we send engineers into the field, fully equipped, to study the performance of Electronic Vibrator Type Power Supplies under *actual combat conditions*.

The U. S. Signal Corps picture above was taken in the field, on one of the many assignments which keep Electronic's Mobile Laboratory rolling. *Tough engineering begets tough products and you won't find "softies" in American tanks!*

You will also find Electronic Power Supplies on planes, P-T boats, walkie-talkies, peeps, jeeps, half-tracks, mobile amplifiers, and other military equipment.

Interior Mobile Laboratory Fully equipped for the testing and design of electrical equipment in the field.



Power Supply using rechargeable non-spill storage battery for operation of "Walkie-talkie" radio equipment. Input Voltage, 4 Volts; Output, Numerous voltages supplying filament and plate requirements of equipment. Width, 3 1/2"; Length, 6 1/2"; Height, 4 3/4".

For Tank Transmitter-Receiver Operation. Dual Input, 12 or 24 Volts; Continuous Output, 500 Volts at 200 Ma.; Intermittent Output, 500 Volts at 450 Ma.; Efficiency, 55% to 60%; Regulator, 13% on 24 Volts; 22% on 12 Volts; Output Ripple, less than 1/2 of 1%; Width, 5 1/2"; Length, 13 1/4"; Height, 4 1/2" (including Shock Mounting Assembly).



Electronic LABORATORIES, INC.





On the white-hot crucible of War

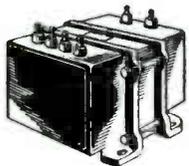
AmerTran is improving its product to meet the exacting needs of today . . . tomorrow you will reap the benefit.



AmerTran modulation transformers and reactors, oil-immersed type, for large broadcast transmitters.



AmerTran RS plate transformers and reactors, oil-immersed type, for all large installations.



AmerTran W plate transformers and reactors for all small and medium installations.

AmerTran transformers are manufactured to meet your exact electrical and mechanical requirements.

Today . . . our entire plant output is being devoted to one purpose . . . to help win the war. Transformers of every type and description are being required in larger quantities than ever before, not only by Government departments but also by defense plants and electric utilities.

AmerTran is doing its share to meet this demand . . . we are developing improved designs and improved manufacturing methods . . . we are increasing our personnel and facilities . . . in short, we are shipping more and better transformers.

Tomorrow . . . when our bombers pull victoriously out of their last dive the resumption of peace time demands will find AmerTran equipment far better than ever before.

During these days when customers without priorities are deprived of transformers, we are supplying the exact same type of product as previously and are developing improvements at a more rapid rate than usual. Customers of the future will benefit from these developments.

As for the past 41 years, AmerTran will continue to hold the place of leadership in the communication field it has gained by the high excellence of transformers supplied for all electronic and radio applications. Manufacturers with sufficient priority rating are invited to discuss their transformer requirements with us now . . . all others must wait for victory.

AMERICAN TRANSFORMER COMPANY, 178 Emmet St., Newark, N. J.

Manufactured Since 1901 at Newark, N. J.

AMERTRAN



**Attention to
Details!**

Near technical perfection is achieved through use of scientific instruments but the trained eyes of skilled workmen inspect completed units before they are passed along to the pumps

An important reason why Eimac tubes set the modern pace in communications

In the fabrication of plates, sealing of stems and leads, winding of grids...every tiny part must pass the rigid inspection of trained individuals, precision testing devices. At the end of each production line sits a group of hardboiled inspectors. All this checking and testing takes place before Eimac tubes reach the vacuum pumps. That's one of many reasons why Eimac tubes possess such uniformity of characteristics...why their performance records have made them first choice among world's leading engineers.

Follow the leaders to

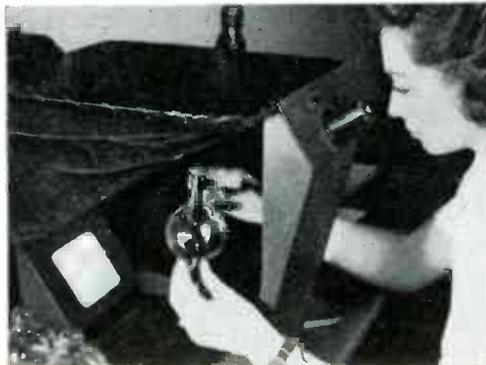
Eimac
TUBES

Manufactured by **EITEL-McCULLOUGH, INC., SAN BRUNO, CALIFORNIA, U. S. A.**
Export Agents: Frazar & Co., 301 Clay St., San Francisco, California, U. S. A.

Bead tester utilizes polarized light in search for stress points in glass beads which seal leads to bulbs



Polariscope is here used to inspect glass bulbs for flaws or strain which may occur during the shaping operations



General inspection bench where completed filament stems and assemblies are thoroughly checked for faulty construction





Serving with the Navy . . .

Night and day Uncle Sam's battlewagons must be ready for action. And in dozens of vital spots, where direct current is required from an A. C. source, I. T. & T. Selenium Rectifiers are helping keep them at top combat efficiency.

Vibration-proof . . . shock-proof . . . electrically and mechanically stable, I. T. & T. Selenium Rectifiers have no moving parts to wear out or cause failure at crucial moments. And of particular importance to marine equipment, Selenium Rectifiers can be supplied to resist moist, salt-laden air.

Consulting engineering service available for specific requirements. Address Rectifier Division for descriptive bulletins.



IT&T Selenium RECTIFIERS

International Telephone & Radio Manufacturing Corporation



General Offices: 1000 Passaic Ave.
East Newark, New Jersey

Which would you pick to keep a fastening TIGHT?

**WEAK-KNEED
WILLY**



OR BULL-NECKED PHIL

WHY YOU CAN EXPECT AN AVERAGE SAVING OF 50%

TIME SAVED. Faster driving methods can often be used.

EFFORT SAVED. No false starts, no wobbling, no crooked screws to withdraw.

ACCIDENTS SAVED. Surfaces and fingers protected because driver slippage is eliminated.

SCREWS SAVED. Fewer screws or smaller sizes can often be used.

And any product with exposed screw heads will have a better appearance with neat, burr-free Phillips Screws



The first thing, of course, is to *get* a fastening tight.

The Weak-Kneed Willies among slotted screws just can't take the pressure that's needed to drive a screw home. Either the head splits or the metal chews out or the operator gives up.

But Phillips Recessed Head Screws go the limit. The close fit between recess and driver makes possible a more efficient use of driving power . . . and the head is carefully designed to utilize that power without loss of strength in the head. Phillips Screws seat tight . . . and stay tight.

Order from any of the firms listed below.

*Get Tighter Assemblies...
Lower Assembly Cost with*

Phillips RECESSED HEAD Screws

WOOD SCREWS • MACHINE SCREWS • SHEET METAL SCREWS • STOVE BOLTS
SPECIAL THREAD-CUTTING SCREWS • SCREWS WITH LOCK WASHERS

Order stronger, cost-cutting Phillips from any of these sources



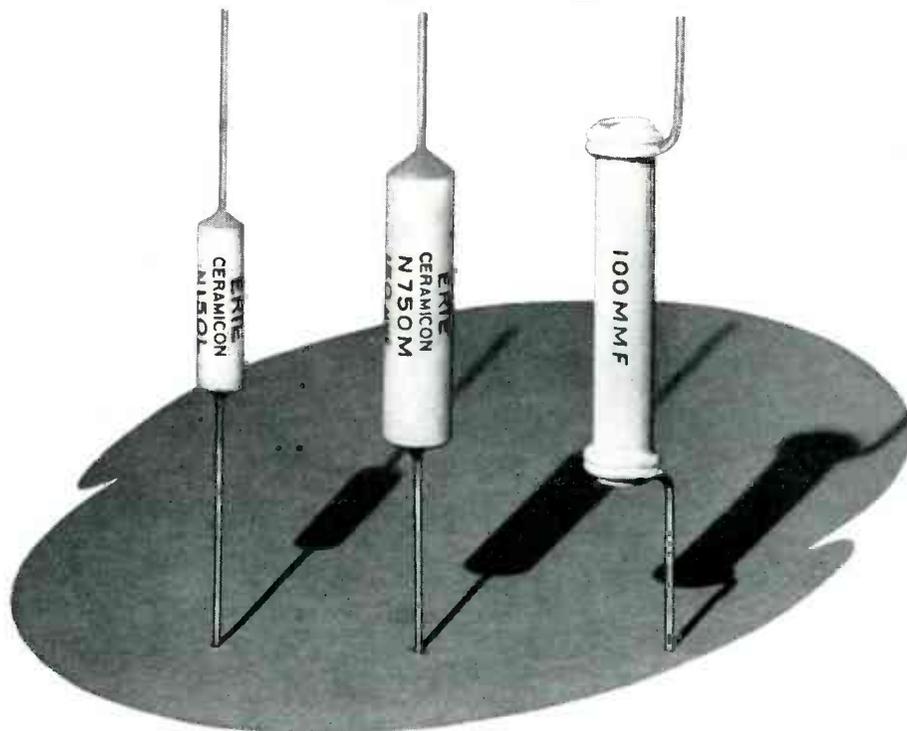
**19 SOURCES
of SUPPLY**

American Screw Co., Providence, R. I.
The Bristol Co., Waterbury, Conn.
Central Screw Co., Chicago, Ill.
Chandler Products Corp., Cleveland, Ohio
Continental Screw Co., New Bedford, Mass.
The Corbin Screw Corp., New Britain, Conn.
International Screw Co., Detroit, Mich.
The Lamson & Sessions Co., Cleveland, Ohio
The National Screw & Mfg. Co., Cleveland, Ohio
Whitney Screw Corp., Nashua, N.H.

New England Screw Co., Keene, N.H.
The Charles Parker Co., Meriden, Conn.
Parker-Kalon Corp., New York, N.Y.
Pawtucket Screw Co., Pawtucket, R.I.
Pheoil Manufacturing Co., Chicago, Ill.
Russell, Burdall & Ward Bolt & Nut Co., Port Chester, N.Y.
Scovill Manufacturing Co., Waterbury, Conn.
Shakeproof Inc., Chicago, Ill.
The Southington Hardware Mfg. Co., Southington, Conn.

DEPENDABLE COMPENSATION

for frequency drift



IN WAR-TIME COMMUNICATIONS

ERIE Ceramicons are small ceramic dielectric condensers that have inherently stable retrace characteristics with respect to temperature. These units, originally developed for peace-time application, are essential for compensating temperature changes in wartime communications equipment. Erie Ceramicon stability is due to the unique method of applying silver plates directly to the surface of the dielectric eliminating the possibility of air space or wax filled pockets. A change of less than $\frac{1}{4}$ of 1% will be found

after subjecting Ceramicons to repeated heating and cooling cycles of 200 hours at 212°F and 200 hours at -40°F. When properly used, these units will provide dependable compensation for drift in other components caused by temperature. Erie Ceramicons are made in nine different temperature coefficients, from +12 parts per million per °C to -75 parts per million per °C. Insulated Ceramicons are available up to 375 MMF and non-insulated units up to 1100MMF. A data sheet giving complete characteristics will be sent upon request.

ERIE RESISTOR CORP., ERIE, PA.

**TORONTO, CANADA
LONDON, ENGLAND**

ERIE

Ceramicons

REG. U.S. PAT. OFF.



we are *Proud* of this **FLAG!**

... Jensen men and women are giving their full time to war work and a portion of their pay as well

Jensen
RADIO MANUFACTURING CO.
6601 SO. LARAMIE • CHICAGO

MAILING LISTS THAT WORK . . .

McGraw-Hill Industrial Mailing Lists are a direct route to today's purchase-controlling executives and technicians in practically every major industry.

These names are of particular value now when most manufacturers are experiencing constantly increasing difficulty in maintaining their own lists.

Probably no other organization is as well equipped as McGraw-Hill to solve the complicated problem of list maintenance during this period of unparalleled changes in industrial personnel. These lists are compiled from exclusive sources, based on hundreds of thousands of mail questionnaires and the reports of a nationwide field staff, and are maintained on a twenty-four hour basis.

Investigate their tremendous possibilities in relation to your own product or service. Your specifications are our guide in recommending the particular McGraw-Hill lists that best cover your market. When planning your industrial advertising and sales promotional activities, ask for more facts or, better still, write today. No obligation, of course.

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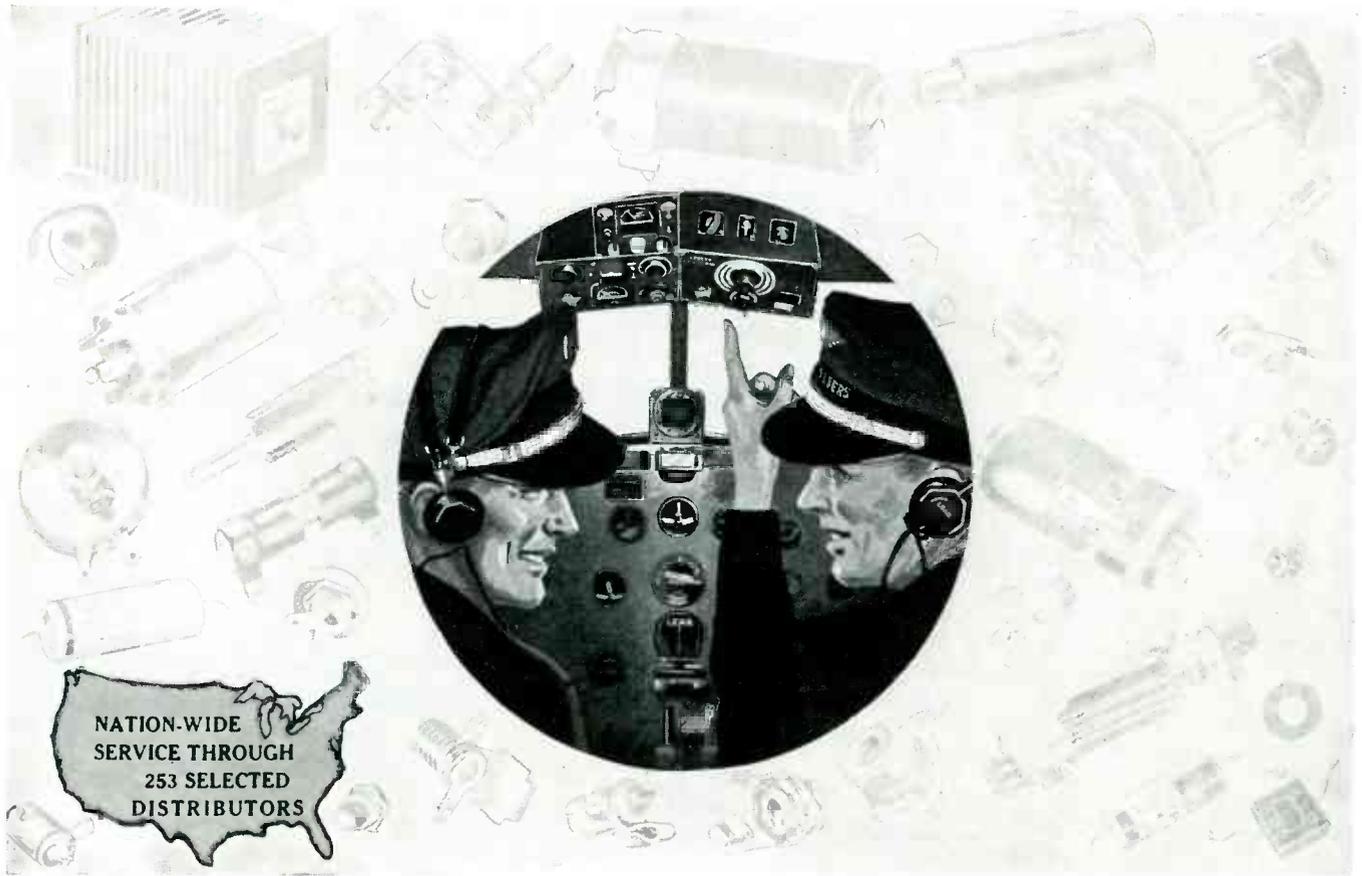
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INDIANAPOLIS, INDIANA • Cable Address—PELMALLO

Machine Tool Builders . . .

the men behind our war production achievement

IT TOOK GERMANY six years to get ready for this war, and Japan even longer. But in less than twenty-four months American industry, starting from scratch, has caught up with and surpassed the war production of the Axis.

When France fell in June, 1940, we unfortunately had no gigantic munitions makers, like the Krupp or Skoda works, to turn to. We had been devoting our attention to making refrigerators and vacuum cleaners and motor cars and lawn mowers. Ordnance output for our Army was a mere million dollars a month. A sad commentary on our National state of mind and our lack of responsible political leadership.

Yet during June of this year, our industries, transformed from peacetime pursuits, produced close to a thousand times that amount. A thousand-fold increase in two years!

The same spectacular gains hold throughout our war program — for ships, planes, guns, tanks, a thousand items. We are well on our way toward the 60,000 planes, 20,000 anti-aircraft guns, 45,000 tanks and 8,000,000 tons of shipping that the President asked us to produce in 1942, and toward the much larger production projected for the year 1943.

We are well on our way thanks to a number of factors, one of the most vital being the extraordinary job done by the machine tool industry. For it has equipped America's metal-working shops with the tools they need to turn out the vast quantities of war weapons.

The machine tool industry's importance springs from the fact that almost every metal product, from mechanical pencils to giant guns, is made with machine tools. They transform pieces of steel into parts for automobiles, farm implements and radios—and for airplanes, guns and tanks.

The Garand rifle, highly praised by General MacArthur at Bataan, has 72 metal parts requir-

ing 1040 separate cutting operations on machine tools. A 40-millimeter gun mount is made up of 1500 separate parts, built to the tolerance of a Swiss watch. Each part must be machined, not once, but several times.

No wonder that when the American defense program was undertaken two summers ago, the American machine tool industry was the first to be called into service. Ninety-five thousand machines were wanted as quickly as possible from 250 builders who in peacetime had produced some 25,000 machines a year.

But the demand did not stop there. The Army, the Navy and the Air Force kept asking for more as the war production program was expanded again and again. Nor was that all. The entire anti-Axis world besieged Washington with urgent requests—from London to Moscow, from Ottawa to Chungking.

To a man the machine tool builders responded. New factories and additions to old plants were built, with deliberate disregard of the prospect that all these sharply expanded facilities could not be used after the war.

To increase output from existing plants practically every company went to two long shifts or three short ones. The industry's work-week was greatly extended. From the beginning of our effort, it has been the longest of any industry.

Working forces were enlarged from 40,000 to 110,000, and this latter figure does not include tens of thousands of employees with sub-contracting firms. Though machine tool building requires a higher degree of individual skill than most products, "learner" courses have been set up to train men quickly. Over 15,000 men and women now are in training.

The machine tool builders were among the first to go in for sub-contracting. They have farmed out parts, subassemblies and complete

machines right and left. To meet their needs, for example, repair shops of carpet mills are making milling machines, a laundry machinery company is producing radial drills, and an automobile body builder is making planers and boring mills.

Machine tool manufacturers quickly shelved peacetime practices to concentrate manufacture on the sizes and types of machines critically needed for the war program. They adopted mass production methods wherever possible, although machine tools are essentially a tailor-made product. They sent their sales engineers, as did machine tool dealers also, to hundreds of munitions makers with invaluable advice as to tooling up most efficiently for their particular jobs.

The swift action taken by the machine tool builders shows what private enterprise can do to meet a national emergency. They were the first to institute a voluntary system of priorities.

All of this involved an almost explosive expansion of the industry. Machine tool builders produced an average of only 7,500 machines a year from 1931 to 1934. In an ordinary year, output totals 25,000 machines. But in 1940, it rose to 112,500, and in 1941 to 187,500.

The 95,000 machine tools wanted for the original defense program were built and delivered within eight months.

Today more than 1,000 machine tools are being shipped to war factories every twenty-four hours, and for seven days a week. Each month's output exceeds that of an entire normal peacetime year and is five times that of the depression year of 1932. And each succeeding month is shattering all previous records.

It is this amazing performance that led Under Secretary of War Robert P. Patterson to declare that "machine tools are the foundation on which our production structure is built. American machine tool men are doing a stupendous job. Machine tools are now being turned out at a rate of \$1,380,000,000 a year. Machine tool designers have worked to improve tools so much that machine tool effectiveness today is one-third to one-half greater than it was in 1930. Our production today is 16 times what it was—in capacity to cut metal—at the peak of the World War."

The results of this performance by this key industry, so satisfying to the Nation, do not spring wholly from the numbers of machine tools produced. They stem also from their improved quality and greater productivity.

Today's warfare differs radically from that of 1917-1918. It calls for mechanized weapons so complicated in design and built to such a fine degree of accuracy that they are beyond comparison with the weapons of a generation ago.

Machine tools, completely redesigned during the depression years, are meeting these new and exacting requirements. In addition, thousands of machine tools of special design, without counterpart in peacetime work, have been built.

The record of the war industries most directly dependent on the machine tool industry speaks for itself. One tank manufacturer alone is producing more than thirty big tanks a day. A midwestern plant is completing 35 anti-aircraft guns a day, round the clock without interruption. A tank engine factory, tooled up to make 650 units a month, is actually building over 1500 a month. Demolition bombs, destined for Berlin and Tokyo, are being made by the tens of thousands every month. Machine guns are being produced at a rate of 50,000 a month.

These manufacturers, all machine tool users, are far in advance of the timetables set for them.

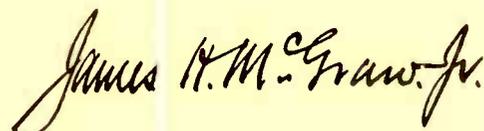
All this is good news for the American people and bad news for the Axis. It is proof that American industry, with each individual and specialized industry doing its part, is living up to the faith put in it by the American people.

But it is more than that, too. It is a guarantee of our confidence in the peacetime future of American industry and of the free enterprise system under which this miracle has been wrought.

Perhaps more than anything else, the foundation of that confidence must be faith in the far-sightedness, the ingenuity, the engineering and designing skill, and the managerial know-how of the machine tool makers.

On them we depend for the most essential tools of the post-war production economy. Without them, our vision of better living standards and full employment through more efficient production and distribution can never be more than a vision.

What they have done as the toolmakers for war is proof of what they can do as the toolmakers of peace. How they have done it as free men is a demonstration of what free men will do.



President, McGraw-Hill Publishing Company, Inc.



CROSS TALK

► **WAR . . .** On May 18 FCC required all possessors of diathermy apparatus, including equipment in stock, to register the apparatus with the commission. Thus an estimated 100,000 units capable of dangerous communication, although performing meritorious service in other capacities, were brought under the regulatory powers of the government communications agency. War had accomplished something that peace had not. Several industry-wide meetings of communications and medical people had been held in past years seeking to find a way by which the troublesome emissions of the medical apparatus could be prevented from creating havoc on communication channels. There is every belief now that some definite policy can be effected regarding these important electronic devices. Actual registry was required to be completed by June 8, later extended to June 22.

In Louisiana a doctor was ordered to cease operating an x-ray machine that interfered with aircraft communication. This may be a precedent which will serve to start a cleanup of many ether busters which have bothered communications people no end. For years your editor has suffered a distinct blank space of many megacycles in his receiver where the interference from static eliminators on nearby printing presses created an uproar. These devices operate at high voltage and produce open sparks which could easily be keyed just as the old spark transmitters could be keyed.

Utilities and industrial concerns have been advised to exercise caution about purchasing or installing blackout masking or warning devices until the several governing bodies have settled the basic requirements. The warning has been issued on the basis that it is futile to install equipment which may not satisfy rules and regulations soon to be issued. This will apply, presumably, to the electronic types of devices offered on the

market, either speculatively (we'll build it if you order it) or from actual stock.

On June 9, the FCC ordered that everyone owning a radio transmitter who does not hold a station license for it to register the machine with the FCC. Our own rig (W2GY, W2EJ et al) of past days long ago fell apart in the garage under the joint action of the weather and ants which, somehow, got into the wooden base and pried the components apart. Rust took care of the metal parts. We hope no license is required.

On May 19, OPA excluded from the General Maximum Price Regulation sales of Brazilian rock quartz crystals. This meant that the Government or its agencies can buy quartz crystal at prices higher than established maximum levels. On the previous day WPB had placed the sale of quartz crystals under such control that they could be used only for products for use as implements of war for the Army, Navy, Government agencies or Lend-lease, as oscillators and filters for use in radio systems operated by Federal agencies or commercial airlines and as telephone resonators.

► **JINX . . .** There is, around every editorial office, a jinx. Sometimes he parks in someone's memory; sometimes he goes to see the printer; there are always plenty of places between writing copy, editing it, setting it in type, proof reading it once or twice, printing it in cold type where the jinx can get in his licks.

As a useful addition to Mr. Sasso's article in July on "Plastics as Dielectrics" the editors prepared a list of manufacturers and suppliers of plastics. On the copy to the printer was the name of Plax Corporation of Hartford, makers of polystyrene high frequency communication components. Either the typesetter did not set this material, or

the jinx threw the type away or something; anyhow it did not appear on page 67 under G where it belonged.

Usually jinx picks on our best friends; this time he worked on a new friend who, we hope, will not think we treat all new friends in this apparently cavalier manner.

► **PERSONNEL . . .** A wartime manpower board, WMC, soon will step into the situation regarding scarcity of skilled manpower. It is not certain, yet, how far this commission will go toward controlling movements of men from place to place, toward killing the raiding that goes on, toward getting good employers and good employees together, but something is urgently needed. Much time is spent by ELECTRONICS staff, willingly but not always efficiently, in trying to find skilled men for various government and government-sponsored privately-controlled jobs. A further expenditure of time and effort goes trying to find places for men who wish to serve their country as civilians or in uniform but who do not know where to turn. Most of these men are highly trained and in great demand, and it is only natural that each man wants to know where his talents will best serve. If he gets into the wrong place he is more or less stuck and someone else, needing him badly, cannot get him. Some agency to coordinate all this sort of thing would help tremendously.

► **A-1-A . . .** ELECTRONICS is the proud possessor of an order of this high rating for reprints of its UHF Technique articles as published in the April issue. With the same solemnity and the same number of signatures of civilians and army officers that would purchase an antitank gun, a batch of reprints was ordered.

Tobruk fell yesterday.

Broadcasting Under War Conditions

Technical operation of broadcast stations adversely affected by wartime shortages of equipment and engineering personnel. Pooling arrangement and strict maintenance urged to conserve existing reserves. Replacement of equipment is critical problem

THE effects of war conditions on the broadcast industry are demanding the most careful consideration of both operating and regulatory bodies at the present time. From the standpoint of technical operations these problems are primarily twofold, although additional factors sometimes enter to affect the operation of broadcast stations adversely. The main problems are: (1) difficulty in obtaining replacement tubes and repair parts due to the high priorities required, and (2) shortage of technical operators and engineers. Unless some way is devised to care for their future needs, broadcast stations may face eventual shutdown in cases of equipment failures.

The equipment and tube shortage is brought on because all manufacturers of transmitting equipment and tubes are extraordinarily affected by the war. All are carrying a heavy defense load, with the result that the A-10 priority rating formerly assigned to broadcasting for maintenance and repair became practically worthless for obtaining tubes and other equipment. Recognizing this condition, WPB issued its order P-129 on April 23, 1942, assigning an A-3 rating for critical materials needed for maintenance and repair. However, because of the increasing scarcity of critical materials, it appears that the A-3 rating is little better than the former A-10 rating when it comes to the purchase of transmitting tubes. This is borne out by the following extract from a form letter received from one tube manufacturer immediately after the P-129 order became effective:

"The critical nature of many essential materials required in the manufacture of transmitting tubes is such as to make it impossible for us to replenish our stock under the A-3 rating. Under these circumstances we shall continue to supply tubes wherever possible against your or-

By **J. B. EPPERSON,**

*Chief Engineer
Scripps-Howard Radio, Inc.*

and **BEVERLY DUDLEY**

*Acting Managing Editor,
Electronics*

ders when covered by the A-3 rating. We feel that you should be advised, however, that for reasons aforementioned, we can fill such orders only provided we have the materials available and we do not have any other unfilled orders bearing higher ratings. It will also be impossible for us to commit ourselves to definite delivery unless the preference rating be sufficiently high to enable us to use it in the purchase of additional materials."

With few exceptions, broadcast stations have managed to keep their equipment in a satisfactory operating condition, but this has been accomplished largely at the expense of reserve stocks of materials. There can be no doubt that the demands on equipment manufacturers have not yet reached their maximum and that it will be necessary to devise some way by which it will be possible to care for future demands of the industry.

Pooling Arrangement as Conservation Aid

To alleviate the shortage of equipment (especially tubes) and to assure that broadcast service will be maintained to the fullest, a "share the spare parts" program has been recommended by the Defense Communication Board (now the Board of War Communications). In brief, this proposal, released on May 24, calls for: (1) inventory of equipment of all stations, together with establishment of requirements of minimum equipment necessary to maintain operations, (2) establishment of conservation districts, each district to con-

tain enough stations so that a representative stock of parts is available in each and to be presided over by a civilian administrator and two assistants, (3) the district administrator and his assistants will be charged with the checking and control of the inventory stock in his district and the redistribution, on a sales basis, of surplus equipment from one station to another.

Such a plan could operate only with the full co-operation of the broadcasters and this co-operation is assured by the fact that it originated with the broadcasters themselves and was prepared and submitted to the BWC by the Domestic Broadcasting Committee of the Board. It is believed that the operation should go a long way to relieve the priorities problem now confronting the 900-odd broadcasting stations in repair and maintenance materials.

It would appear that such a provision for conservation is not only ticklish in its administration, but is, at best, only a temporary stop-gap. There is evidence that not all station operators are fully behind this plan since, it is pointed out, the "share the spare parts" program penalizes the well managed, conservatively operated stations for the benefit of the less efficient stations. Another difficulty with this program as initially outlined is that it makes no provision for the replacement of parts which may be used up in normal operation. Under a system of this sort, it is conceivable that all the broadcasting services of the country could disintegrate simultaneously, like the "One Horse Shay."

The lack of parts is of little concern for many recently modernized stations, or those near metropolitan centers of supply, but it is an increasingly difficult problem for the stations in areas remote from production facilities. A number of stations are unable to obtain such spare parts as condensers, resistors, sock-

ets, transformers or repair parts for their transmitters. Extension of audio line facilities is hampered, and portable and remote amplifying equipment once damaged will probably not be replaced. This situation is being faced as a matter-of-fact problem whose solution must, somehow, be obtained.

Many stations have instituted a complete house cleaning program in which broken and obsolete parts from used equipment have been repaired and reclaimed for future use, even if under restricted conditions. More rigid schedules of repair and maintenance are being enforced, and systematic maintenance is aided by assigning regular duties on a well planned time schedule. Most stations have reduced the filament voltage of tubes to obtain longer life, the amount of reduction being determined by limitations of audio distortion or power output. One station engineer reports that the life of tubes in his station has been increased from 4½ to 7 months through such a procedure.

With regard to tubes, many broadcast operators are caught between the sharp points of a two-horned dilemma. On the one hand they are required by the standards of good engineering practice to maintain an adequate supply of replacement tubes. On the other hand, the heavy demand on tube production for military services makes it difficult or impossible to conform to these regulations. To alleviate the situation somewhat, some stations are reclaiming old tubes previously regarded as unsuitable for operation, but which may be pressed into service under a program of restricted materials. Other stations have experimented with the repair of old tubes. Some engineers feel that too little attention is being given to the rebuilding of transmitting vacuum tubes as a war conservation measure. According to the statement of one company who has rebuilt several tubes, approximately 90 per cent of the defective transmitting tubes above 250 watts in size can be satisfactorily rebuilt. The cost of rebuilding a transmitting tube is ordinarily one-half that of a new tube of the same type. A rebuilt tube might even be better than a new one, providing the tube was originally built before substitute materials were employed.

Even more important than the shortages of tubes and other physical equipment is the shortage of technically qualified personnel for station operation. Through the exercise of additional maintenance and repair work, a station in normally good operating condition can be kept in satisfactory operation for a considerable length of time, with capable technical administration. But the technically trained operating and engineering personnel are vital to its operation and cannot be so easily replaced. Many stations are having difficulty in obtaining experienced technicians since so many have been absorbed by the various government services. The main difficulty arises from the necessity of placing inexperienced men in important positions, and the inability to find individuals with a background sufficiently adequate to become thoroughly trained in a short time.

Personnel Shortages, too!

There is no blanket deferment from military service of men engaged in station operation. Indeed, the broadcast industry has contributed many of its best technical personnel to the Army, or Navy, to various government administrative agencies, or to technical teaching and research jobs, all of which further the country's war effort. Certainly no one makes such a change without the fullest desire to be of maximum assistance, while those left to carry on are performing equally valuable (if less publicized) work in the additional duties imposed upon them. But several stations have lost heavily of their technical personnel, and are unable to replace licensed operators. **The loss of technical personnel does create a serious question as to how the normal services are to be maintained or even extended with an ever-decreasing technical staff.**

There are several partial solutions to the problem of personnel; none are completely satisfactory. Control room operators having operator's licenses but no transmitter experience, have been transferred to the operation of the transmitter, and have, in turn, been replaced by persons less experienced. Qualified individuals who, for one reason or another, are not likely to be called into military service, have been used wherever

possible. The shortage of personnel has, in some instances, led to out-bidding by various stations for the services of those still available. However, a more frequent and self-reliant approach seems to be that of training personnel for broadcast jobs by the NYA or other agencies. In several cases women have been trained as control room operators. It is too early to draw definite conclusions from the few cases in which women have actually been engaged in control room work, although there are indications that qualified women operators are entirely capable of discharging control room duties properly.

Concern has been expressed by some station managers that the necessity for employing less experienced personnel may force a relaxation of standards of operation which could become permanent. Under such conditions, those technically trained men now leaving the broadcast industry might be expected to find other careers for themselves after "the duration." Nevertheless, the opinion is frequently expressed that relaxation of certain standards of good engineering practice, especially with regard to requirements as to distortion tolerances and time off the air, will help materially in easing the present problems.

Several stations, especially the smaller ones, complain of loss of revenue at a time when prices are rising and additional services are required of their operating personnel. The monitoring of key stations for blackout warnings is a problem for some stations who have already lost heavily of their operators and find themselves operating with shoestring personnel. Protection of the station against possible invasion or bombing attacks, fire, lightning, or acts of sabotage requires additional vigilance, especially of stations near the territorial limits of the United States. The need for emergency service equipment, in the event of failure of regular equipment, is recognized by foresighted operators, but again difficulty is encountered in obtaining the necessary priority ratings for engine-driven generators and similar equipment.

Broadcasting forms an integral and important part in the lives of all in the United States. It is a powerful and important factor in knitting

(Continued on page 56)

Electronic WELDING

An introductory discussion of the design problems involved. Basic power circuits. Selection of tubes to fit the work. Phase shift current control. Timing methods. A commercial synchronous spot welding machine control

RESISTANCE WELDING is a broad term which can be subdivided into spot, seam, pulsation spot, projection, butt, and flash welding. As a procedure, it is well known but it did not come into general prominence until after the development of electronic control. Soon after electronic control was made available it became evident that existing jobs could be run faster and that many combinations and materials that previously could only be welded in the laboratory could be welded in production.

Why is electronic welding control so important? To answer this question, a few facts regarding welding machines must be given. To make a resistance weld, the two pieces to be welded must be held in close contact and under pressure. The weld is made by passing a definite amount of current through this joint for a definite period of time, causing the metal at the joint to soften and the

grains to interlock. The result is like a rivet in mechanical properties.

General Considerations

Current through the work will seldom be less than 1000 amperes and may be as high as several hundred thousand amperes. The metal sections in the current path are usually large, therefore the resistance is quite low. The mechanics of getting the pressure where it is needed usually call for a fairly long and large loop of conductor connected to the secondary of the welding transformer. This, together with the low resistance factor, means a highly inductive, low power-factor load. The power-factor range is from as low as 0.1 to as high as 0.9, with the average about 0.5. This brings out one very significant fact—the control must work satisfactorily over a wide range of power factor.

To generate the required heat at the joint, the time of application of the current must be precisely controlled. The increment of time when working with alternating-current is the cycle, therefore the timing is in terms of cycles of the supply frequency. This doesn't mean that the elapsed time is the equivalent of so many cycles. It means that time starts at a predetermined point on the supply voltage wave and ends at the corresponding current zero point so many cycles later.

Weld timers must operate differently for the different types of resistance welding. Spot and projection welding require a single impulse of power, adjustable from 1 cycle to 30 cycles, or $\frac{1}{2}$ second on a 60-cps power supply. Seam welding requires a series of power impulses spaced by a definite "off" time. Both

the "on" and the "off" time may be adjustable over a range of 1 to 30 cycles. Pulsation spot welding timers are similar to seam welding timers except that only a definite number of "on" times are permitted to pass and then the control is locked out and cannot start a new series of impulses until the spot initiating switch is operated. Such "counting control" is usually designed for operation over a range of from 1 to 15 power impulses.

The fact that the power factor is low, that the time is short and that the energy must be the same for each power application, dictates that for best performance welding power must be applied without transient. This feature is called synchronous starting and is a valuable contribution made by electronic control.

Tube Data

Welding controls must be designed to handle from a few hundred volt-amperes, for welding small parts, to 1000 or more kva, for welding heavy parts and structures. Ignitron tubes are commonly used to control large powers. These are mercury pool tubes with immersed starting electrodes. They are artificially cooled, usually by water. For the smaller welding jobs, hot cathode thyratrons are available. Both thyratrons and ignitrons are half-wave rectifiers, therefore two tubes must be used in an inverse parallel fashion to conduct both halves of the a-c wave. Figs. 1A and 1B each show two ignitrons connected in series with the primary of a welding transformer. Two such tubes make the equivalent of a single-pole, single-throw switch.

Ignitrons are rated for two conditions; first, the maximum current

SCHEDULED

Part 2

Electronic Controls for Seam, Pulsation and Special Welding Machines

Part 3

Magnetic and Electrostatic Energy-Storage Welding Machine Controls

Part 4

Checking Resistance Welding Controls With a Cathode-Ray Oscilloscope

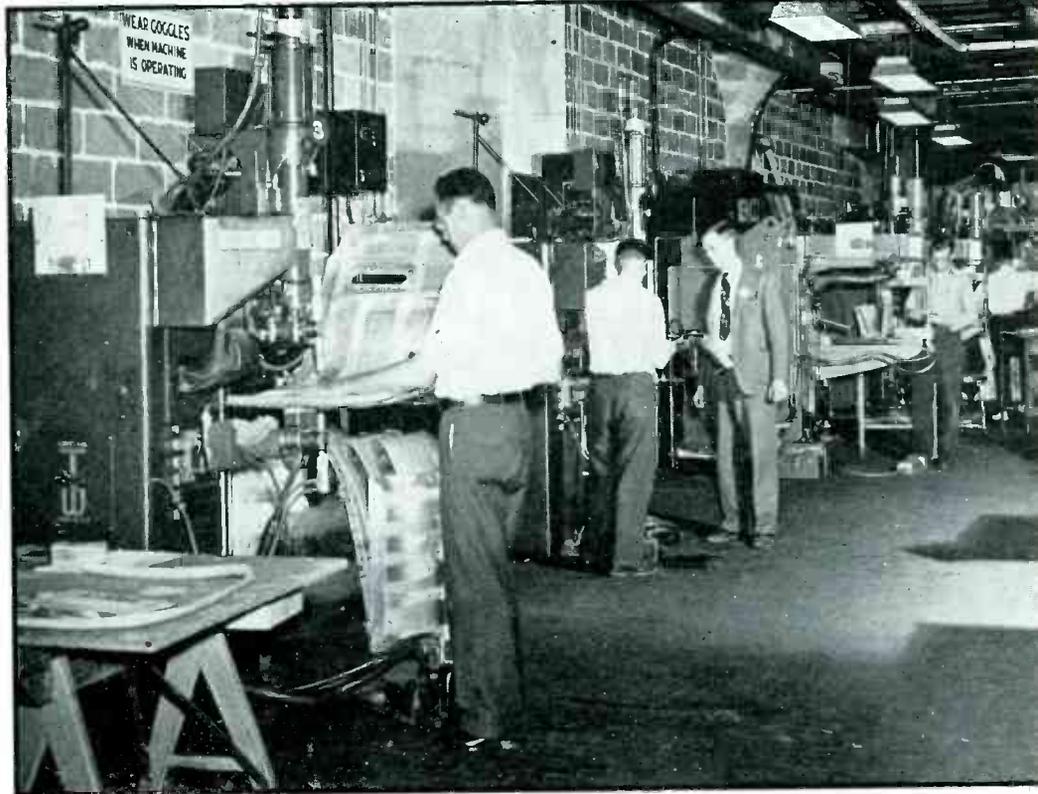
CONTROL... Part 1

By H. L. PALMER

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that can be controlled regardless of the conditions of operation; second, the average current, or the equivalent continuous current, that can be controlled. These two limiting ratings are related to one another and can best be expressed by curves. A third condition, the voltage of the supply, also affects the other two, therefore a series of curves are required for different voltages.

Ratings are usually expressed in terms of rms demand current against duty cycle. By duty cycle is meant the percentage of the total time current is passed by the tubes. The 200-250 volt and the 400-500 volt rating



A-c type spot welding machines with synchronous welding control fabricate aluminum alloy parts in an eastern aircraft plant

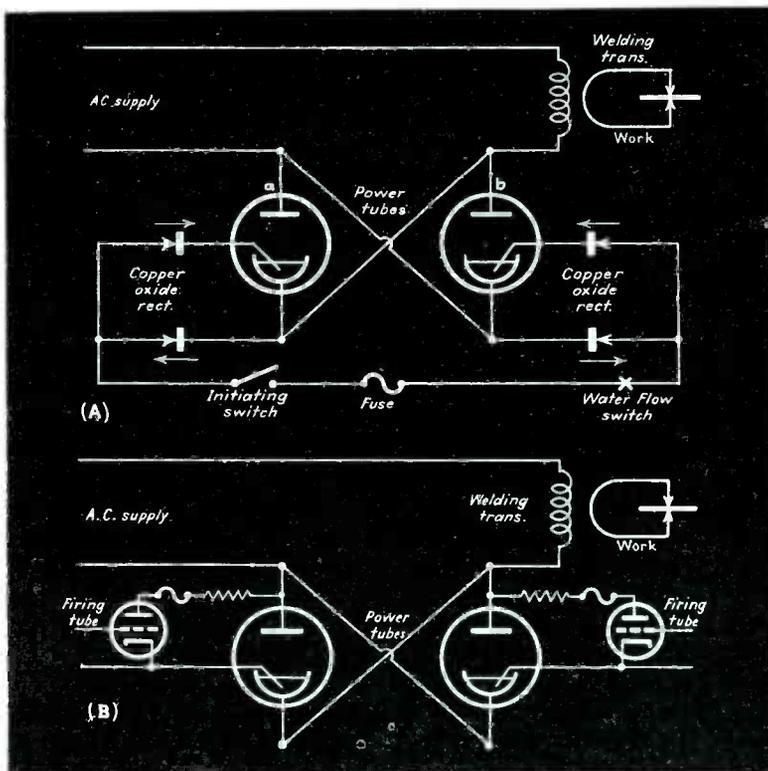


FIG. 1—(A) An electronic welding contactor without phase control or timing. (B) A power circuit used in many synchronously controlled systems, particularly where high voltage supplies are employed

curves for typical ignitrons available for welding control are given in Fig. 2. It should be noticed that on the curve for each size tube is given an averaging time, which is a measure of the thermal capacity of the tube as applied to its rating. This is the maximum time over which the duty cycle can be calculated. The maximum length of spot that can be allowed under the rating for any given value of welding current is the duty cycle for that particular value of current times the averaging time. This is the maximum allowable length of spot, regardless of how long the tube is off between spots. For example, consider the size C tube on 500 volts with a during-weld current of 1500 amps. The tube can operate with a spot length or "on" time of $0.15 \times 7.1 \text{ sec.} = 1.06 \text{ sec.}$, providing the tubes are allowed to remain idle 6.04 sec. It must also be remembered that any one spot must not be over 1.06 sec. even though the tube is off for an hour between spots. The 1.06-sec. "on" period does not have to occur

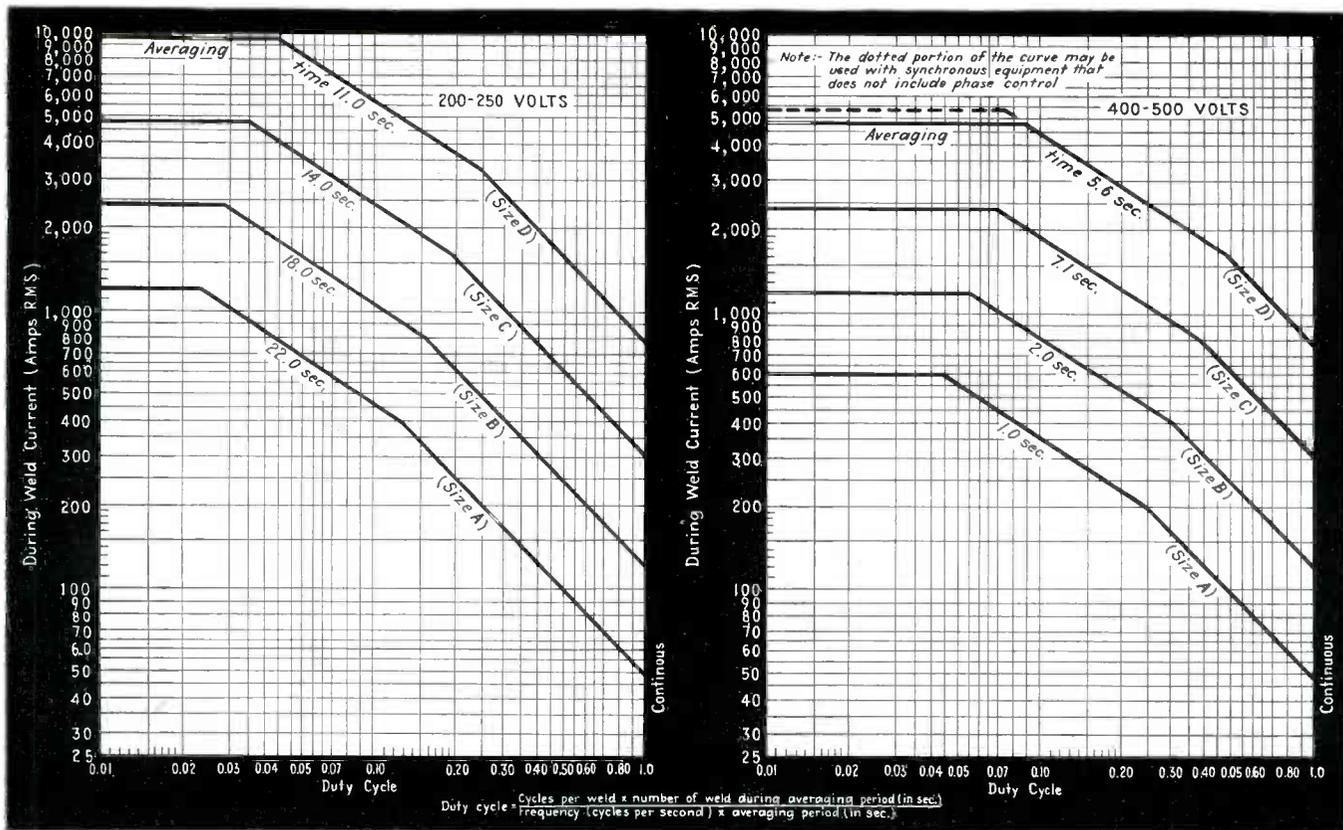


FIG. 2—Rating curves for four typical ignitron tubes used in welding control equipment. Data at the left is for 220 while that at the right is for 440-volt supplies

in one continuous spot. It can be the total conducting time during any 7.1-sec. interval.

Ignitrons tend to have a constant kva rating and therefore the allowable currents for 220 volt operation are somewhat higher for the same duty cycle than for 440 volts. (Hot-cathode thyatron ratings for welding are somewhat simpler in that the ratio of peak to average is lower and the current rating is more nearly independent of line voltage.)

Power Circuits

Certain types of welding do not require full electronic control but speed of operation and maintenance problems make an electronic contactor desirable. The simple circuit shown in Fig. 1A, involving two ignitrons and four copper oxide rectifiers, has been developed to meet this need. With this circuit the power tubes will conduct when the initiating switch is closed and cease to conduct when the switch is opened. No synchronizing feature or timing is included in such a control.

The copper oxide rectifiers are required to prevent damaging reverse current flow from pool to ignitors. When anode *a* is positive and the initiating switch is closed, current

will flow from point *a* through the lower right rectifier, through the flow switch contacts, fuse, initiating switch and the upper left rectifier into the ignitor of the first tube and back to the other side of the line through the welding transformer. When this current flows from the ignitor to the pool a cathode spot is formed and the ignitron carries current for the half cycle.

In tracing this current two alternate paths were available at two places in the circuit. First, at the cathode of the second tube an alternate path is shown, through the ignitor and its copper oxide rectifier. Notice that this copper oxide rectifier is connected to oppose current flow from the pool, while the lower right rectifier allows an easy flow of current. Thus the ignitor rectifier prevents any appreciable amount of reverse current flowing through the ignitor of the second tube. The other choice occurs at the second group of rectifiers, affiliated with the first tube. Here it should be noticed that the ignitor series rectifier is connected to allow current to flow to the ignitor into the pool while the other rectifier blocks the flow directly to the pool. When anode *b* is positive the current path is reversed and the

second ignitron will be fired, causing both half cycles to flow to the welding transformer. This action will continue as long as the initiating switch is closed and will cease when it is opened.

A conventional power circuit when synchronous starting is required is shown in Fig. 1B. In this arrangement, thyatrons are used to fire the ignitrons by connecting the ignitron ignitors to the ignitron anodes through the thyatrons so that load current will flow to the ignitors until the ignitrons are fired. When an ignitron starts to conduct, the voltage across the associated thyatron is reduced to arc drop or about 15 volts, which stops its conduction and, therefore, the current through the ignitor. The grid in the thyatron provides a flexible means of control.

These two basic power circuits will meet the requirements of a complete line of welding controls. The choice of one or the other is determined by the control functions required and the operating conditions encountered. The application of the tube rating curves is the same in either case. The circuit of Fig. 1B has certain technical and economic advantages where the supply exceeds 600 volts.

Two functions of control can be

performed—the amount of welding current or “heat” can be varied by means of phase control, and the application of power can be timed to meet the requirements of the welding operation. Both phase control and timing can be applied independently or together.

Control Circuits

Phase shift control may be added to the Fig. 1A circuit by putting in series with the contacts of the initiating switch a pair of inversely connected thyratrons as shown in Fig. 3A. Control is applied to the grids of these two thyratrons so as to delay their firing during each half cycle. Thus each ignitron is delayed in firing until the associated thyatron starts to conduct. Two methods of controlling the thyatron grids suggest themselves. The simplest is to apply an alternating voltage to the grids of the thyratrons and vary its phase by means of a conventional phase-shift network. When grid vol-

tage is negative it holds the thyratrons nonconducting, allowing the tubes to conduct as the grid goes positive on the next half cycle. By shifting the crossover point the angle of firing can be shifted. Figure 3B shows the phase relation of the anode or line voltage, grid voltage, and line current.

A second method of phase controlling is shown in Fig. 4A. In this case a separate thyatron bias voltage is used and control of the thyratrons is effected by a peak voltage superimposed on the bias voltage. The peak voltage is shifted by the phase shift network to vary the firing point. On and off control of this combination can be obtained by means of a series contact, as in Fig. 3, or it can be controlled by changing the a-c bias with a bucking transformer as shown in Fig. 4A. The phase relations of the on and off conditions are shown in Fig. 4B. The phase shift system using a peaking transformer has the advantage of avoiding completely the transients that can exist on the first half cycle when the Fig. 3 circuit is used because the tubes can only fire when a peak is present. Thus, if the initiating switch is closed just after a peak the tube will not fire but will wait until the peak on the next half cycle. Timing may be off by a half cycle but no transients will be generated.

Phase shift heat control is added to power circuit 1B by putting a phase shift control on the grids of the two thyatron firing tubes. This is done by adding an a-c bias 180 deg. out of phase with the anodes, then superimposing a peak voltage that is not high enough to break through and drive the grids positive. When the power tubes are supposed to conduct, the thyatron bias voltage is reduced by a bucking voltage just great enough to let the peak voltage drive the grids positive. In this way the firing point can be changed by shifting the phase of the peak voltage. Such a circuit is shown in Fig. 5A. Figure 5B gives the phase relations with the power tubes non-conducting and Fig. 5C shows the voltage conditions when the power tubes are conducting.

It will be noticed that whenever an alternating voltage is used to hold a thyatron non-conducting, as in Figs. 4A and 5A, a capacitor is connected around the current-limiting grid resistor. This gives a d-c

component of negative grid voltage due to grid rectification, which avoids difficulty due to false firing by transient voltages that might occur as the alternating bias voltage is building up negative.

Timing Circuits

The timing function can be added to either of the power circuits shown in Figs. 1A and 1B, or it can be added to the power tube phase control combinations shown in Figs. 4A and 5A. To turn any of these circuits on, it is necessary to switch an alternating voltage, which means the two control tubes must be connected in inverse parallel to control both halves of the a-c wave. In such a circuit the cathodes of the two control tubes are not at the same potential, which prevents their connection to the same timing control voltage. This is overcome by the use of a trailing control circuit as shown in Fig. 6. The two control tubes A and B are connected in such a way as to energize the control or grid transformer when they conduct. The grid circuit of tube B is made up of three elements with the polarities as shown. The bias voltage is 180 deg. out of phase with the anode and therefore keeps tube B non-conducting, with the aid of the grid resistor and capacitor combination, as long as the feedback transformer is de-energized.

As long as tube A is held off by the timing circuit, the feedback transformer will not be energized and the control or grid transformer will have zero secondary voltage. Now assume that the timing voltage puts the grid of tube A positive when its anode is positive, causing tube A to conduct for a half cycle. This energizes the feedback transformer and, due to the inductance in the circuit, the current in the primary of the control or grid transformer will continue past the zero of the voltage wave as in any lagging circuit. This means that as the current in tube A goes to zero there will be a positive voltage on the plate of tube B and the feedback transformer will put a positive voltage on the grid that makes tube B conduct for a half cycle.

As long as the grid of tube A conducts, tube B will follow the next half cycle. This is only true when the load has a lagging power factor. If the current through tube A went to zero at the voltage zero there wouldn't be any voltage to fire tube

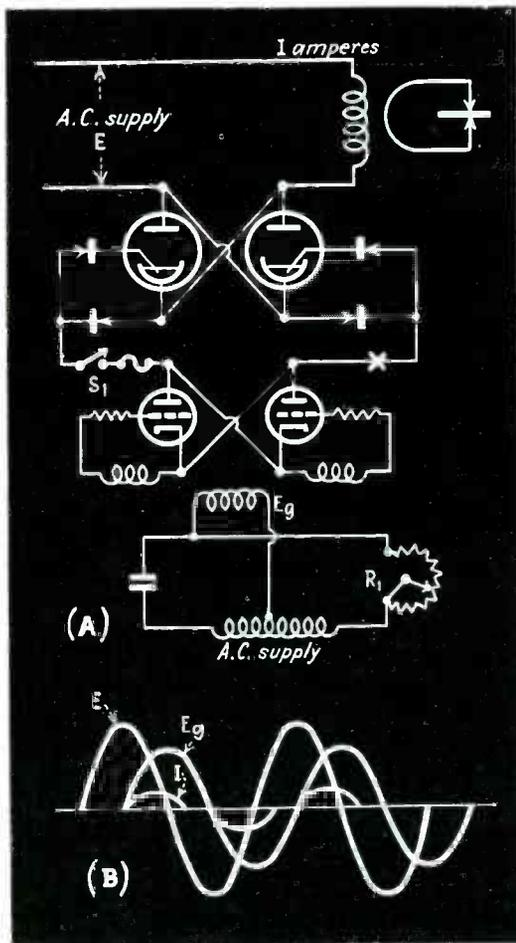


FIG. 3—(A) Contactor with simple phase control added. The amount of current passed to the welding machine depends upon the position of R_1 . (B) Phase relations of line voltage E , grid voltage E_g , and line current I for one position of R_1 .

B. However, practically speaking, there is usually enough leakage reactance in the feedback transformer to cause the current to lag enough to make tube B trail. When the grid of tube A goes negative, the feedback transformer will be de-energized when tube B stops, and when tube A does not fire there is nothing to fire tube B and the control or grid transformer is de-energized.

A trailing tube circuit has a number of important features as applied to resistance welding control. This circuit provides a means of controlling two tubes whose cathodes are at different potentials from one timing source. The suggested solution also uses only one tube in the timing circuit, so that there is no problem of matching tube characteristics. With a trailing tube circuit there is no possibility of getting an odd number of half cycles. This insures against a d-c component and possible saturation of the welding transformer, which is of extreme importance when designing seam weld-

ing controls where the "on" and "off" times are comparatively short and occur with the secondary shorted continuously by the electrodes.

The basic scheme of Fig. 6 is added to Fig. 1A by connecting the two thyratrons A and B in place of the initiating switch and connecting the primary of the feedback transformer across the welding transformer. The application to Fig. 1B is to add the bias and feedback voltage to the grid of one of the thyratrons, with the primary of the feedback transformer across the welder. When adding to Figs. 4A and 5A, Fig. 6 is added complete. The control or grid transformer is used in place of the transformer controlled by switch S_1 .

The timing circuit itself is that part of a welding control which gives the control its name, as the power and control circuits in one or the other of the forms just described are used in all types of welding. It is the timing circuit that makes a control a spot welder control, a seam welder control, a pulsation spot weld-

ing control, or all three.

A commercial spot welding control, without phase control and using the power circuit of Fig. 1B, is shown in elementary form in Fig. 7.

The control is made up of a rectifier furnishing d. c. for timing and control circuits, a keying tube to insure starting at the desired point on the voltage wave after closing the switch, the timing and leading tube and trailing and power tubes.

Complete Circuit

The rectifier is of the conventional type with a filter reactor, X , and a filter capacitor C_1 . A voltage divider made up of two components, R_1 and R_2 , is connected across the filtered rectifier output. The major part of the voltage appears across R_1 and charges the timing capacitor. The small voltage across R_2 is used as d-c bias on the keying tube, T_1 . Connected across a part of R_1 is the filter combination R_3 , and C_3 , which makes the timing practically inde-

(Continued on page 117)

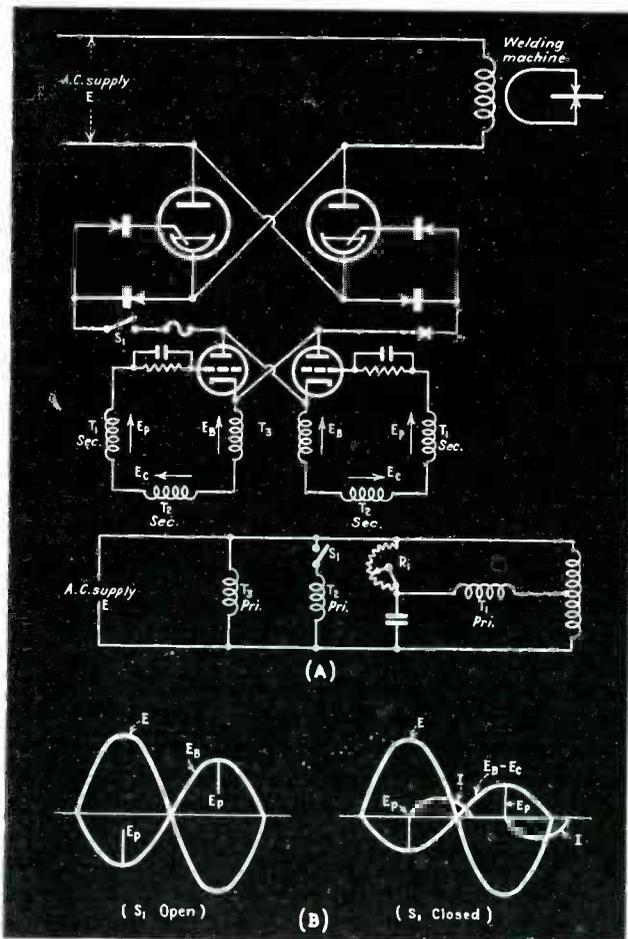


FIG. 4—(A) Another form of phase control, added to an electronic contactor. The amount of current that will flow to the welder is determined by the position of R_1 (B) Voltage and phase relationships, as explained in the text

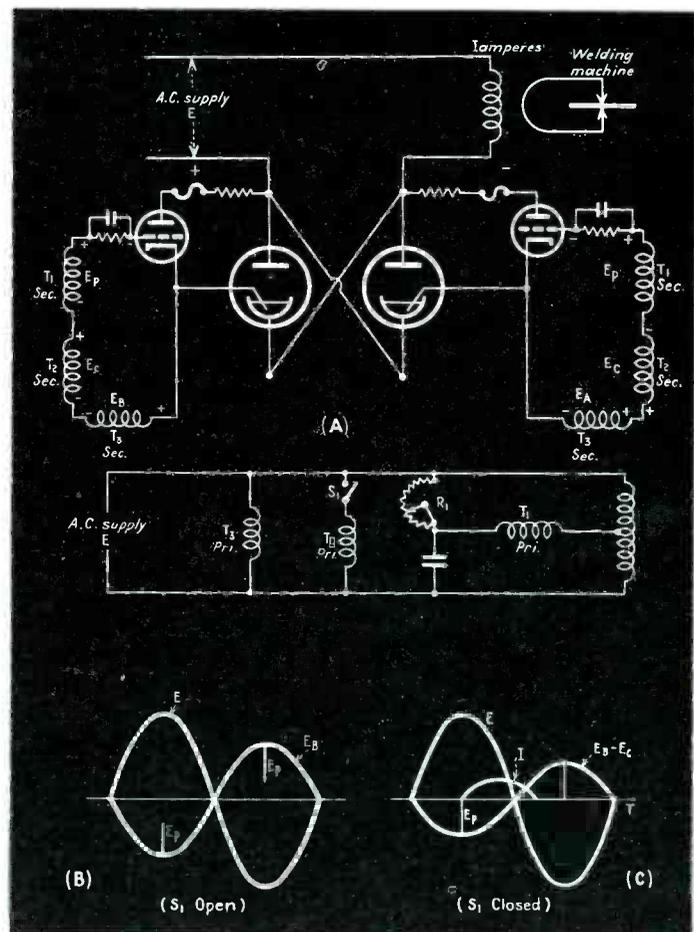


FIG. 5—(A) Phase control added to Fig. 1B. The amount of current that will flow to the welder depends upon the adjustment of R_1 . (B) Voltage and phase relations with S_1 open. (C) Voltage and phase relations with S_1 closed and the tubes passing current

Unsymmetrical Attenuators

This article presents a graphical method of designing T or π resistance attenuators and a simplified means of converting to a dissymmetrical network where impedances of different magnitudes must be matched

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WHEN the need arises for an attenuator with a given loss which will match terminal apparatus or lines of unequal impedances, it will be found necessary to compute the values of the branch resistances of the required pad since such data cannot ordinarily be found in curves or tables. For a T or π network of constant impedance level, however, such information is usually available. Now by utilizing a symmetrical pad which matches one of the two impedances and a transformer of proper ratio to match the other impedance, the required network can always be realized. But it is not usually convenient, and certainly not economic, to utilize this combination, especially as it is possible in most instances to replace both the constant impedance pad and the transformer by a dissymmetrical pad.

The purpose of this note is to summarize the results of the matrix transformation* which may be used

to obtain the branch resistances of the dissymmetrical pad which will fit the required terminal impedances, from design data for the resistance of the branches of a symmetrical T or π pad of the desired attenuation. This follows in Sections I and II. If exact branch resistance values for symmetrical T or π pads (of any impedance level) are not available, they may be obtained from the curves in Section III with fair accuracy.

Section I—T Pad

It should be understood at the outset that the values of branch resistances of a symmetrical T or π pad of given impedance level (say 600 ohms) may be changed to any other impedance level (say 500 ohms) by

multiplying all the branch resistances by the ratio of the required to given impedance levels (namely 500/600 or 5/6 in this example). Thus it is always possible to adjust available data for a pad of the desired loss to fit one of the two impedance levels.

In Fig. 1A, for example, the symmetrical pad giving the desired attenuation, and having branch resistances r_a , $r_b = r_a$, and r_c has been chosen to match the input impedance Z_1 . Since the pad is of constant impedance level, the output impedance Z_2 can be matched only by means of the (ideal) transformer of impedance ratio $1:a^2$.

The branch resistances r'_a , r'_b , and r'_c of the dissymmetrical pad (Fig. 1B) which will replace both the symmetrical pad and the transformer (Fig. 1A), are obtainable from the following equations:

$$\left. \begin{aligned} r'_a &= r_a + (1-a)r_c \\ r'_b &= a^2(r_a + r_c) - ar_a \\ r'_c &= ar_c \end{aligned} \right\} \quad (1)$$

* E. A. Guillemin, "Communication Networks," John Wiley (1935), Vol. II, Chapter VI, Section 5.

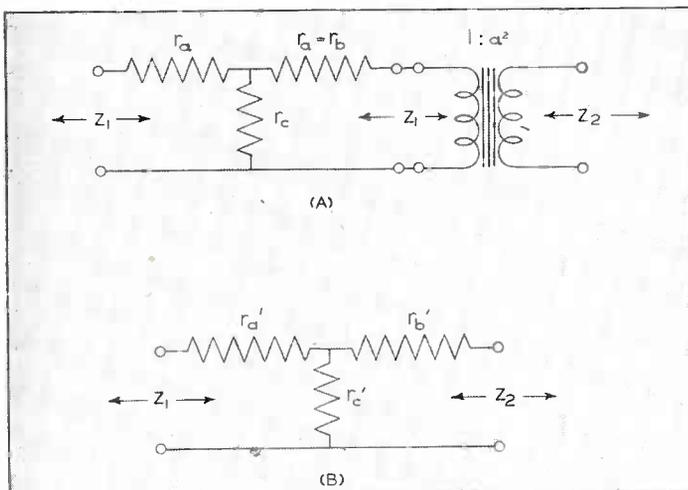


Fig. 1—Symmetrical T pad and ideal transformer (A) and the electrically equivalent dissymmetrical T pad (B), both having the same loss

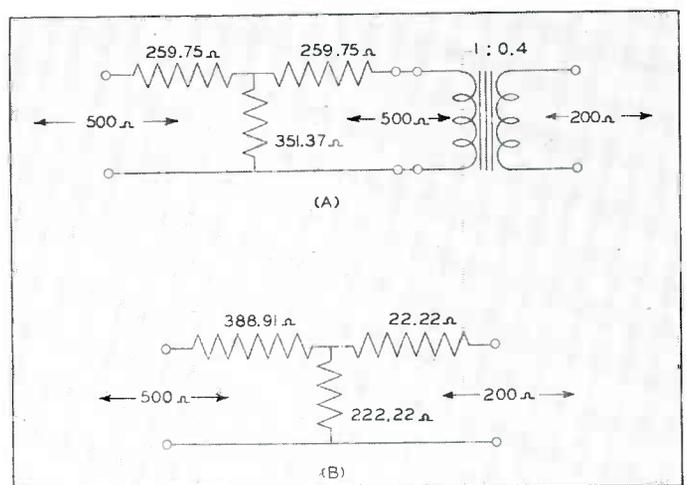


Fig. 2—Examples of dissymmetrical T network (B) equivalent to symmetrical T network and ideal transformer (A), both with 10 db loss

where impedance ratio is given by

$$a^2 = Z_2/Z_1, \quad (2)$$

the ratio of output to input impedance levels. The equations maintain the loss from input to output terminals of the network invariant.

Without going into an exhaustive analysis, it may be evident that for a given ratio of impedance levels, or a^2 , negative elements for r_a' or r_b' may occur. In such an event, the only alternative is to choose a network with more attenuation, which will then result in realizable resistances. Of course, either r_a' or r_b' may actually be zero in the limiting case. This result may answer a question that has undoubtedly arisen in the reader's mind: "Wherein does a symmetrical network and (ideal) transformer differ physically from a dissymmetrical network?" The answer lies in the fact that for a given terminal impedance ratio the former can be approximated physically for any attenuation, whereas the latter network has a definite minimum attenuation below which some of its elements become physically unrealizable.

Numerical Example

As a concrete numerical example of the application of these equations, consider a 10 db pad, required to match impedances $Z_1 = 500$ ohms and $Z_2 = 200$ ohms. From tables (or Section III), the following resistances for the branches of a symmetrical, 10 db, 500-ohm level pad are obtained:

$$\begin{aligned} r_a &= 259.75 \quad \text{ohms} \\ r_b = r_a &= 259.75 \quad \text{ohms} \\ r_c &= 351.37 \quad \text{ohms} \end{aligned}$$

From Eq. (2) we obtain for the ratio of output to input impedances,

$$\begin{aligned} a^2 &= 200/500 = 0.4, \\ a &= 0.63246. \end{aligned}$$

Substituting these values into Eq. (1), we obtain for the branch resistances of the dissymmetrical pad:

$$\begin{aligned} r_a' &= 259.75 + (1 - 0.63246) 351.37 \\ &= 388.91 \quad \text{ohms} \\ r_b' &= 0.4(259.75 + 351.37) \\ &\quad - 0.63246(351.37) = 22.22 \quad \text{ohms} \\ r_c' &= 0.63246(351.37) = 222.22 \quad \text{ohms} \end{aligned}$$

The resulting dissymmetrical network equivalent to the symmetrical pad and (ideal) transformer is shown in Fig. 2B.

Section II—Dissymmetrical π

In order to simplify the mathematical expressions, it is desirable when dealing with π networks to express all quantities as admittances. Since resistors of commercial manufacture, and measuring equipment in general, are calibrated in terms of impedances, computed circuit admittances must be converted into impedances before the final circuit elements are obtained physically. But this is a mere matter of reciprocation of the branch admittance of the network, and should cause no confusion, if the inverted omega is recognized as the conductance symbol in mhos.

Thus, the equations which relate the symmetrical π pad and (ideal) transformer to the equivalent dissymmetrical π , working between unequal terminal admittances, are as follows:

$$\left. \begin{aligned} g_a' &= g_a + (1 - 1/a) g_c \\ g_b' &= (1/a^2)(g_b + g_c) - (1/a) g_c \\ g_c' &= (1/a) g_c \end{aligned} \right\}, \quad (3)$$

where

$$1/a^2 = Y_2/Y_1 \quad (4)$$

is the ratio of output admittance Y_2 to input admittance Y_1 , of the terminal equipment.

As shown in Fig. 3A, $g_a, g_b = g_a$, and g_c are the branch conductances of the symmetrical π , with the dissymmetrical π branch conductances g_a', g_b' , and g_c' given by Eq. (3) shown in Fig. 3B.

Numerical Example

As a numerical example, we consider again a pad with 10 db loss, this time a π , working from 200 ohms into 500 ohms (Fig. 4A). For the ratio of admittances ($1/a^2$) we have, converting the terminal impedances to admittances,

$$1/a^2 = Y_2/Y_1 = \frac{1/500}{1/200} = 0.400,$$

which gives

$$1/a = 0.63246.$$

Reference to tables or the curves of Section III gives the following values for the branch conductances of a symmetrical π pad of 10 db loss, and 1/200 mho admittance level:

$$\begin{aligned} g_a &= 2.5975 \times 10^{-3} \quad \text{mho} \\ g_b &= g_a = 2.5975 \times 10^{-3} \quad \text{mho} \\ g_c &= 3.5136 \times 10^{-3} \quad \text{mho} \end{aligned}$$

The symmetrical 10 db π , therefore, and the required 0.4 admittance ratio (ideal) transformer are shown in Fig. 4A.

To obtain the equivalent dissymmetrical π , substitute these values into the Eq. (3), giving:

$$\begin{aligned} g_a' &= 2.5975 \times 10^{-3} + (1 - 0.63246) \\ &\quad 3.5136 \times 10^{-3} = 3.8902 \times 10^{-3} \quad \text{mho} \\ g_b' &= 0.4(2.5975 + 3.5136) \times 10^{-3} - \\ &\quad 0.63246(3.5136 \times 10^{-3}) = 0.22243 \times 10^{-3} \\ &\quad \text{mho} \\ g_c' &= 0.63246(3.5136 \times 10^{-3}) = 2.2220 \\ &\quad \times 10^{-3} \quad \text{mho} \end{aligned}$$

The desired dissymmetrical π is shown in Fig. 4B, together with the

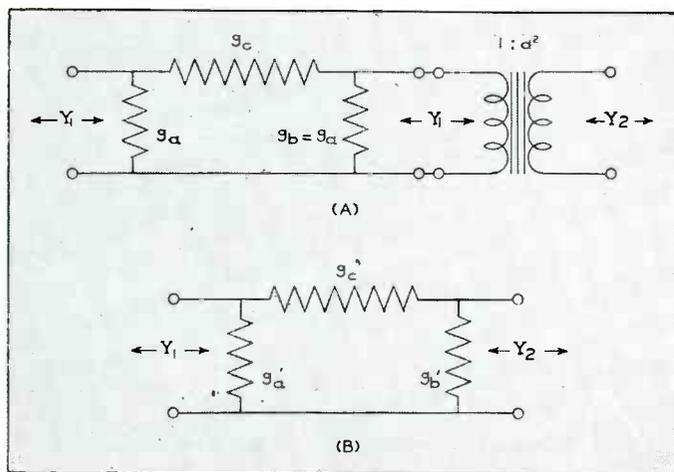


Fig. 3—Symmetrical attenuator and ideal transformer (A) and equivalent dissymmetrical attenuator, (B), with the same loss

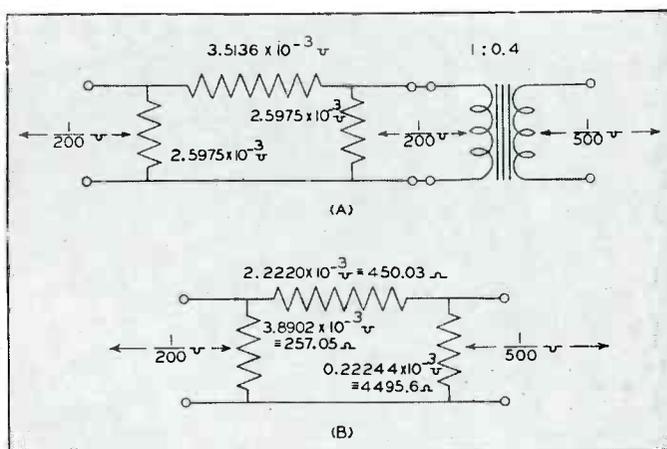


Fig. 4—Dissymmetrical pad of 10 db loss (B) equivalent to symmetrical and ideal transformer (A) both having the same loss

branch element resistances as well as conductances, obtained, of course, by taking the reciprocals of g'_a , g'_b and g'_c .

Section III—Design of Symmetrical T or π Attenuators

There would be no point in repeating here the design equations for symmetrical attenuators, since such information is readily available. However, for those who do not wish to calculate the numerical values of branch resistance or conductance for symmetrical attenuators, the graphs in Fig. 5 are presented for convenience.

The two curves in the figure provide the basic design constants of T or π pads of any constant impedance level, and of 0.1 to 100 db loss. The ordinate of the graph gives the branch impedance of T pads, and the branch admittance of π pads on a normalized basis, that is, on a 1 ohm or 1 mho level. For any desired impedance or admittance level, multiply all the values from the curves for the particular attenuator by the desired impedance or admittance level. The abscissa of the graph is the desired attenuator loss, for which the branch values are to be determined. Although the graph is self-explanatory, it may best be demonstrated by a numerical example.

Numerical Example—T Pad

Required: A 10 db T pad, 500 ohm impedance level. From curve 1, Fig. 5, we find, at 10 db on the abscissa, that

$$r_{a1} = r_{b1} = 0.52,$$

and from curve 2, still at 10 db on the abscissa, we find that

$$r_{c1} = 0.70.$$

These values are on a 1 ohm basis (that is the reason for the subscript 1).

To obtain the branch resistances for the 500-ohm level pad, multiply each factor by 500, giving:

$$r_a = r_b = 0.52 \times 500 = 260 \text{ ohms}$$

$$r_c = 0.70 \times 500 = 350 \text{ ohms.}$$

These values compare with $r_a = 259.75$ and $r_c = 351.37$, obtained from exact equations, as given in the example in Section I.

π Pad

Required: A π pad of 10 db loss, 200 ohm impedance level. We first recall that on an admittance basis, this would be a 10 db pad of 1/200 mho admittance level. From curve 1 of

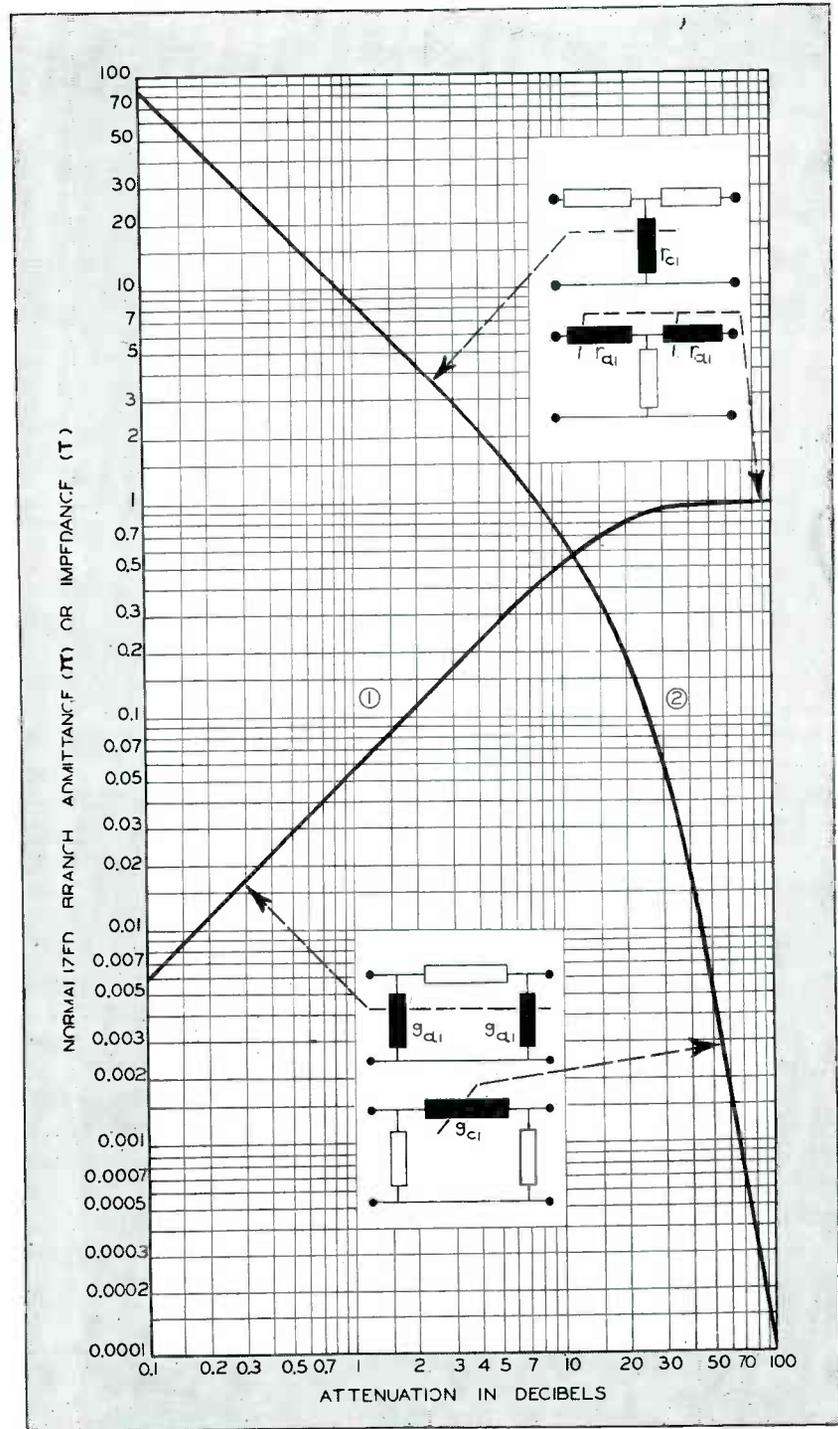


Fig. 5—Graph showing the normalized impedance or admittance for the series and shunt arms of T and π networks. Curve 1 applies to shunt elements of π network or series elements of T network, while curve 2 refers to shunt elements of T network or series elements of π network. The values obtained from this graph must be multiplied by the impedance level for which the symmetrical attenuator is designed

Fig. 5, we obtain at 10 db on the abscissa:

$$g_{a1} = g_{b1} = 0.52,$$

and similarly from curve 2,

$$g_{c1} = 0.70.$$

These values are on a 1 mho basis. To obtain the branch admittances on the required 1/200 mho admittance level, multiply each factor by 1/200,

giving the branch conductances as:

$$g_a = g_b = 0.52 \times (1/200) = 2.6 \times 10^{-3} \text{ mho}$$

$$g_c = 0.70 \times (1/200) = 3.5 \times 10^{-3} \text{ mho}$$

These values compare with $g_a = g_b = 2.5975 \times 10^{-3}$ mho, and $g_c = 3.5136 \times 10^{-3}$ mho, obtained from exact computations, given in the numerical example in Section II.

ELECTRONIC Switching Simplifies

In carrier current communication systems, electron tubes are used to effect voice stimulated sequence operations to provide rapid and automatic conversations without feedback. This article gives the outlines of one highly successful design

TODAY, many high voltage power transmission lines are being used for telephonic communication by radio. In power-line-carrier-communication, the high frequency currents travel along the power line and are not radiated into space. At each power station a complete high frequency transmitter and receiver are used. Because of electronic switching, the system is ready to transmit or receive signals almost instantly when a person speaks into any one of several microphones.

Since it is desirable to utilize only one carrier frequency for each communication channel, all of the transmitters and receivers are tuned to the same frequency. At each station, the transmitter output is connected in parallel with the receiver input and coupled through suitable insulating capacitors to the high voltage transmission line. Because of this parallel connection, when the system is transmitting, the local receiver must be shut off; and when receiving, the local transmitter must be inactive. In many space radio communication systems, the user is required to push a button to accomplish the transfer from receive to transmit. A newly developed voice controlled transfer scheme, working on electronic principles, has now eliminated the necessity of pushing a transfer button.

The transfer is accomplished by means of electron tubes, without any moving parts. The basic operation is indicated in Fig. 1. Two transmitter-receivers (the minimum quantity necessary for a channel) are shown with each divided into four parts:

(A) transmitter input (audio system), (B) transmitter output (carrier system), (C) receiver input (carrier system) and (D) receiver output (audio system).

In the standby condition, i.e. no

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user talking, the input circuits A and C must be active and the output circuits B and D must be inactive. The reason for this is obvious when it is noted that the output terminals of B are directly connected to the input terminals of C and the output terminals of D are directly connected to the input terminals of A. For the "transmit" condition, A₁ and B₁ must operate, and C₁ and D₁ must be blocked. For the receive condition C₂ and D₂ must operate and A₂ and B₂ must be blocked. This requires four transfer functions which must be performed in the following order: (1) block local receiver carrier system (C₁), (2) actuate local transmitter carrier system (B₁), (3) block remote transmitter audio system (A₂), and (4) actuate remote receiver audio system (D₂).

These functions are initiated by speaking into the microphone of an ordinary telephone handset. They are accomplished in a very short time to permit the person at the remote end of the channel to hear and understand the first syllable spoken. When the speaker stops talking, the system must return to the standby condition as quickly as possible. The sequence for releasing the four transfer functions is 2-1-4-3, 2-4-1-3, or 2-4-3-1.

Unfortunately, the difference between speech and noise is sometimes only a matter of opinion. The electronic transfer circuits are unable to select and respond exclusively to the proper sounds. In fact, the only feasible method of accomplishing this choice is for the speaker to talk louder than the noise level at his microphone. In some cases this is very simple. However, the energy content of some syllables is extremely small. Also, the peak sound energy from some common sources of noise, such as typewriters, is quite

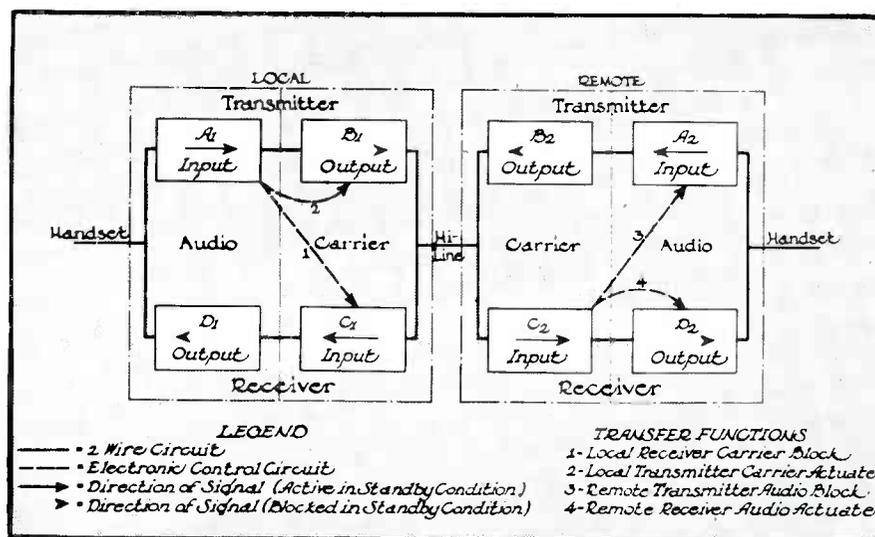


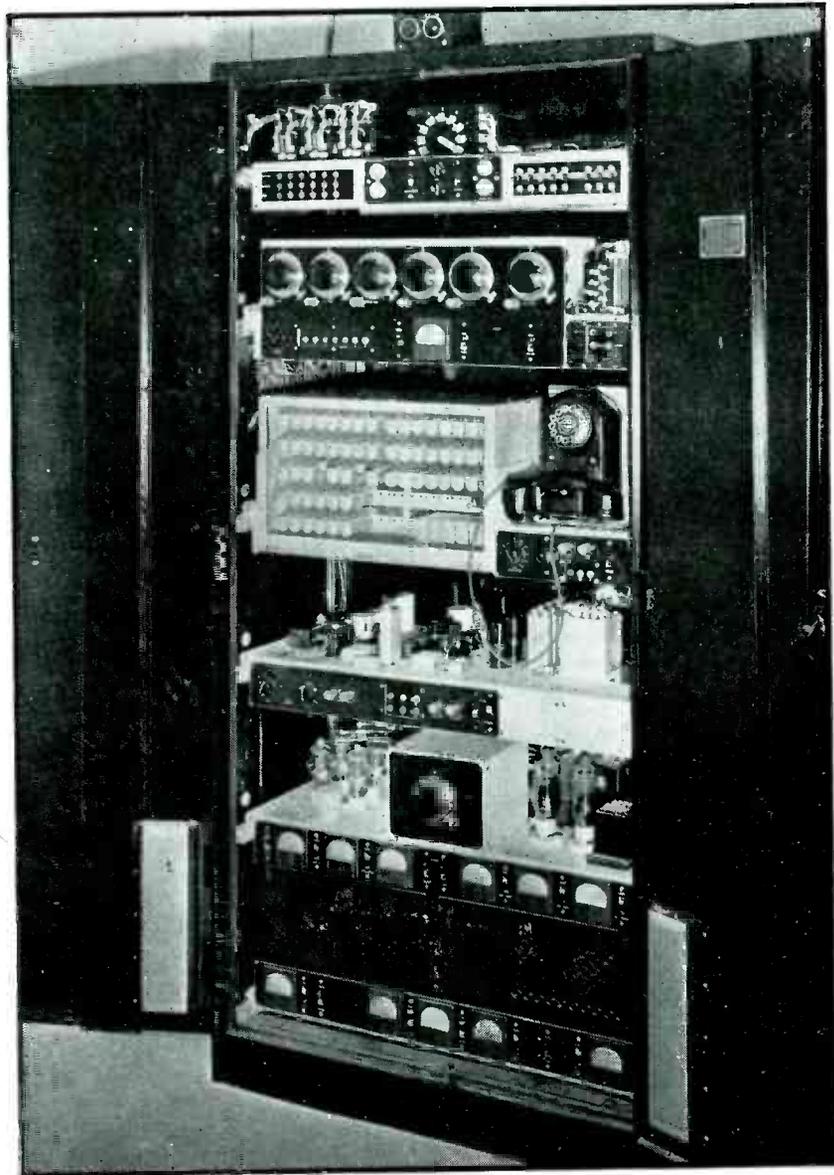
Fig. 1—Functional diagram, in block form, of power line carrier frequency channel with electronic switching control

POWER-LINE COMMUNICATIONS

high. To guard against the undesirable transmission of such noises, the circuits may be so arranged that sounds of short duration even if rather high in amplitude will not cause transmissions.

It is not so easy to take care of the wide variations between syllables and between different speakers. The most practical solution seems to be to provide a slight time delay in releasing function 2. This insures the transmission of weak syllables following relatively louder ones and greatly improves the intelligibility. To take care of weak syllables preceding much louder ones, a quick-acting automatic gain control in the speech amplifier of the transmitter is used. To assure the proper sequence of transfer functions under all conditions, the circuits are so arranged that a gradual increase in the intensity of sound at the microphone makes them operate in the same order as if the initial sound were very loud.

To understand how these various functions are performed, it is necessary to delve more deeply into the circuit details. (See Fig. 2.) For function 1, speech is amplified by the variable gain and isolation amplifiers. It is then rectified and is applied as a positive voltage to the grid of the receiver blocker tube to overcome the high negative bias which holds the tube well beyond cutoff for the



General view of power line carrier frequency communication system in steel protective cabinet

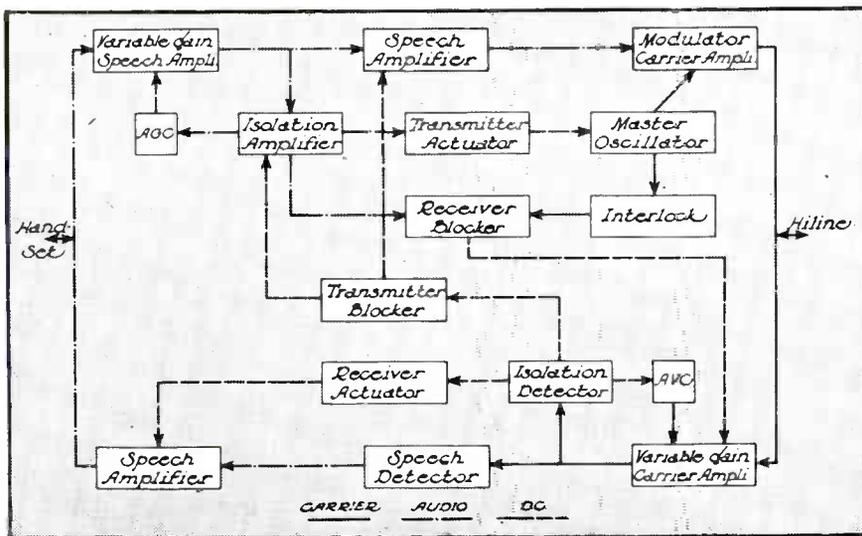


Fig. 2—Functional diagram of transmitter and receiver for the power line carrier frequency system

standby condition. The plate current of the receiver blocker tube passes through a resistor in the receiver carrier amplifier grid circuit. A very high bias is thus applied to cut off the receiver. For function 2, a portion of the output of the isolation amplifier is rectified. Negative voltage is applied to the grid of the transmitter actuator tube. The blocking of this actuator tube starts the transmission of carrier because the plate current of this tube passes through a resistor in the master oscillator screen circuit and holds the screen negative for the standby

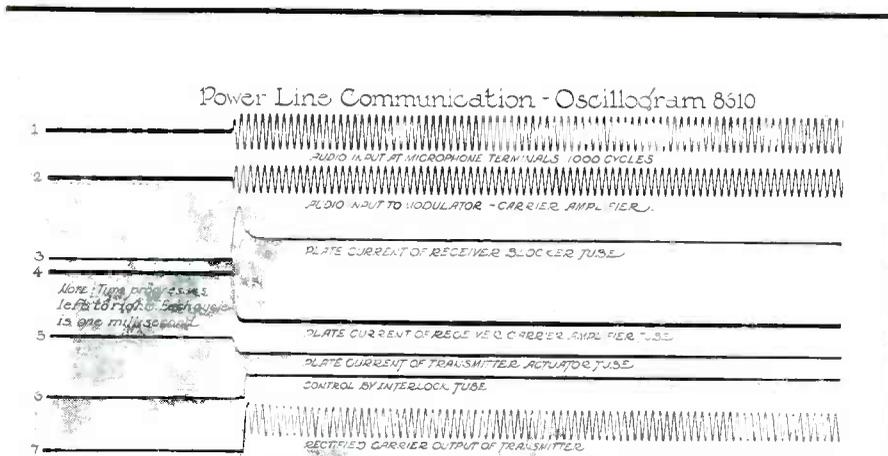


Fig. 3A—Oscillograms illustrating application of input tone

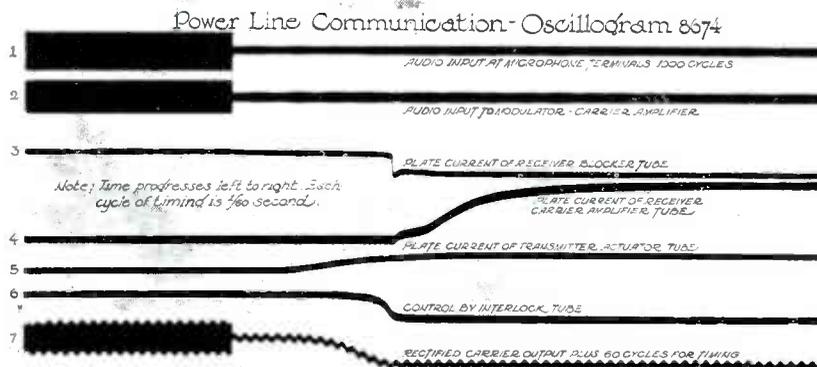


Fig. 3B—Oscillogram showing stopping of input tone

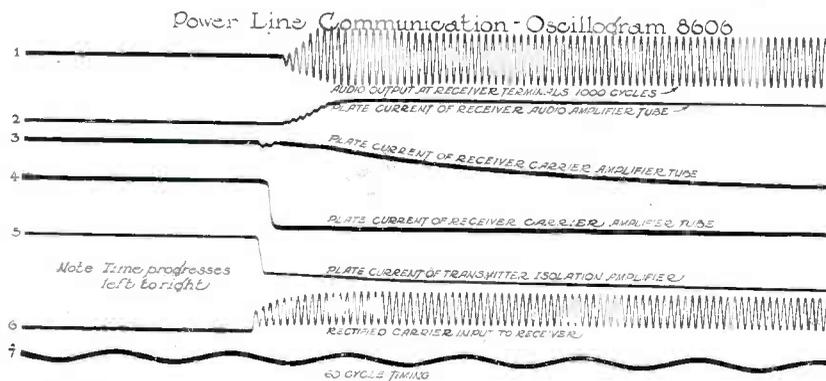


Fig. 3C—Oscillograms illustrating operation of carrier system showing that transmitter speech and isolation amplifier are cut off immediately when audio input is applied

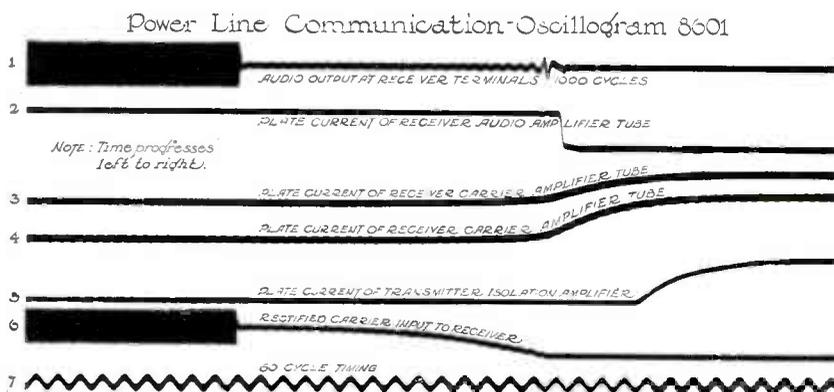


Fig. 3D—Oscillogram illustrating return of carrier system to normal or stand-by operation

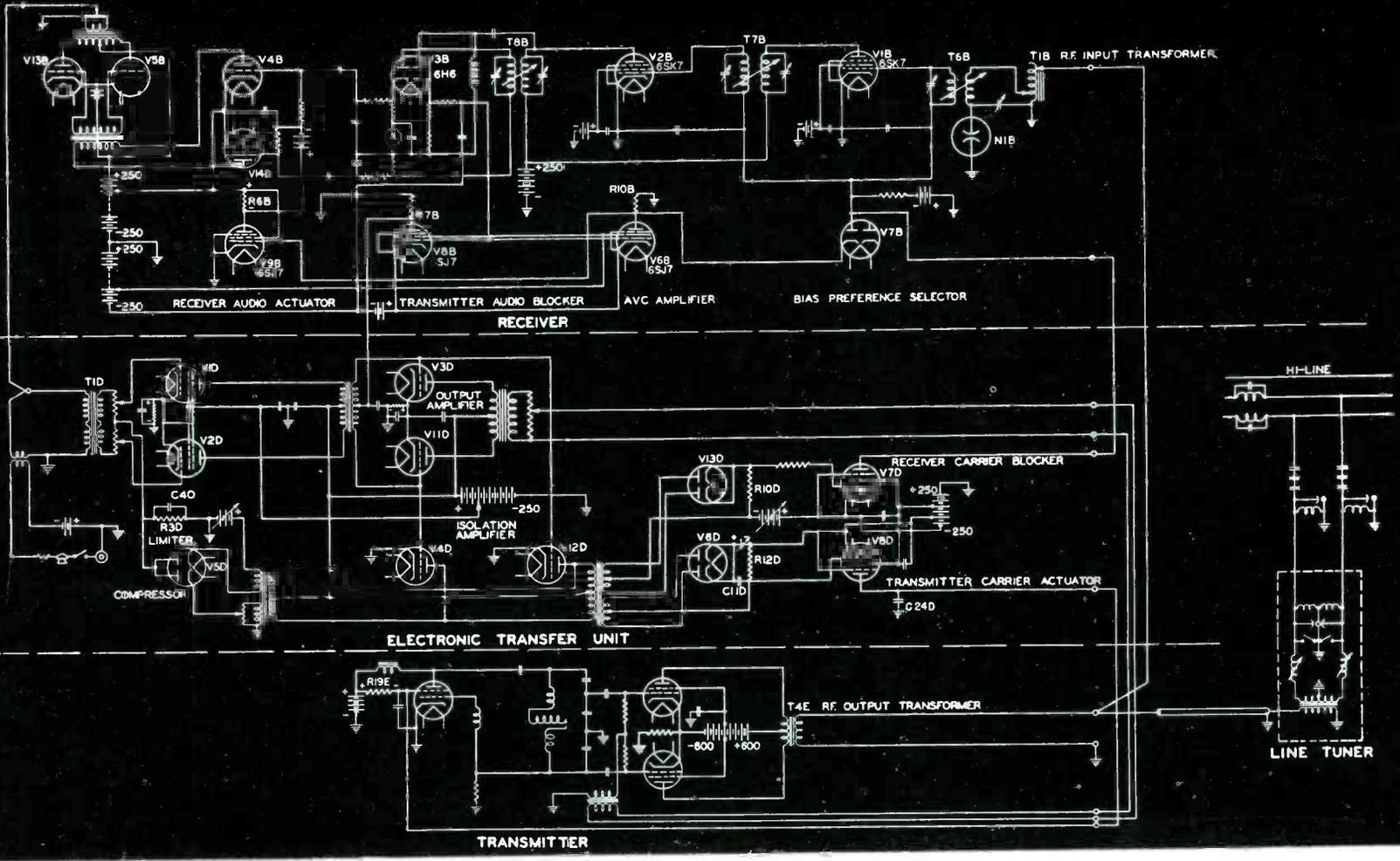
condition required at this time.

For function 3, the received carrier is amplified and rectified. Positive voltage is applied to the grid of the transmitter blocker tube which is held considerably negative for the standby condition. The plate current of this tube passes through a resistor in the grid circuits of the speech and isolation amplifiers in the transmitter circuit. This provides blocking bias for the transmitter audio system. For function 4, a negative voltage is applied to the grid of the receiver actuator tube. The plate current of the receiver actuator tube controls the bias of the speech amplifier tubes in the receiver which are cut off for the standby condition. Thus, the receiver audio system is made active.

To produce the proper release sequence, an interlock circuit as shown in Fig. 2 is provided which holds the receiver blocked after speech stops as long as the transmitter master oscillator is operating. The AGC and AVC circuits shown in Fig. 2 are conventional except that they operate almost instantaneously.

The control tubes (type 6SJ7) are standard high vacuum, high- μ , sharp cut-off pentodes. The trigger action is due to the circuits used and particularly to the use of high control voltages and high biases. The use of high vacuum tubes practically eliminates the effects of ambient temperature which are rather serious in the case of certain types of gas filled tubes. Furthermore, the necessity for interrupting the plate voltage to stop ionization is, of course, eliminated. The use of standard receiver tubes in the preferred series not only minimizes the upkeep cost but facilitates obtaining replacements when necessary. All tubes in the design may be had in the open market.

The tests shown in Fig. 3 were made at the factory using a dummy transmission line in place of the high voltage power line. The top line of oscillogram 8610 shows the application of a 1000 cps tone as a substitute for speech. With this substitute, the functioning of the system is the same as when an operator speaks into the microphone. The second line shows that modulation is instantly applied to the modulator-carrier amplifier. The third line shows the pulse delivered by the receiver blocker to the receiver carrier amplifier grids. The fourth line



Expansion of Fig. 2 into a simple practical diagram. Microphone output goes to V1D, V2D, V4D and V12D. For transfer function 1 (local receiver carrier block) output of V12D is rectified by V13D and amplified by V7D to appear across a resistor in the receiver carrier amplifier grid circuit to block the plate current of V1B and V2B. For transfer function 2 (local transmitter carrier actuate) amplified a-f from V4D and V12D is rectified by V6D to block plate current of V8D. At the receiving station, modulated carrier passes from hiline through coupling capacitors, line coupling tuner, coaxial cable to V1B and is amplified by V1B, T7B, and V2B. V3B acts as a detector for transfer function 3 (remote transmitter audio block)

and its filtered d-c output is amplified by V8D to block V3D. V11D, V4D and V12D preventing transmission from the local station until the distant station speaker ceases talking and releases the channel. Transfer function 4 (remote receiver audio actuate) is accomplished by operating the grids of V6B and V8B in parallel. V6B controls gain of the receiver carrier amplifiers, and blocks V9B when a carrier of usable magnitude is received. Plate current of V9B flows through R6B and normally blocks a-f amplifiers V4B and V14B, by the drop across R6B. Thus there is no audio output from the receiver until a sufficient carrier has been received to block the transmitter audio amplifier

shows that the plate current of the receiver carrier amplifier is cut off completely in less than 2 milliseconds. The fifth line shows that the transmitter actuator plate current also is cut off in less than 2 milliseconds. The seventh line shows modulated carrier slightly delayed by a capacitor discharge circuit to provide the proper starting sequence. The sixth line shows the interlock taking control instantly when carrier becomes available.

Oscillogram 8674 shows the results of stopping the input tone. Note that the transmitter actuator, line 5, does not block the oscillator abruptly since this might cause objectionable transients (clicks). A 60-cycle timing current was added to line 7. This shows that the carrier persisted almost 250 milliseconds after the input tone stopped.

Oscillogram 8606 illustrates func-

tions C and D. The sixth line shows the application of a modulated carrier to the input terminals of the receiver. The fifth line shows that the transmitter speech and isolation amplifiers were cut off almost immediately. Lines 3 and 4 show that the plate currents of the first and second stages of the receiver carrier frequency amplifier are reduced by the automatic volume control. One of these stages is controlled very quickly and overshoots somewhat. The other stage is controlled much more gradually to maintain a more nearly uniform output. Line 2 shows that the receiver speech amplifier becomes gradually active in the proper sequence. Line 1 shows the receiver speech output to the listener. The gradual build-up is coordinated with the automatic sensitivity control characteristics of the human ear so as to provide better intelligibility

than would result from an instantaneous start at or above the final level.

Oscillogram 8601 shows the return of the receiver to standby conditions after the cessation of speech.

These oscillograms clearly indicate that both the transmitter and the receiver are made active from the standby condition very quickly. In fact, the transfer takes place so rapidly that the delay is not noticeable. The users of this communication system seldom realize that they are unable to talk in both directions at the same time until the listener tries to interrupt the speaker. Then, the listener is reminded that he must be polite and wait until the speaker stops to take a breath. Fortunately, most speakers breathe quite frequently and, in so doing, allow the circuits to return to the standby condition.

Wave Form Circuits for CATHODE

Mr. Lewis concludes his summary of circuit arrangements for providing timing axes and waveform control in cathode-ray tube oscillography by dealing with amplitude and impedance methods of changing wave shape

By H. M. LEWIS
Consulting Engineer

THE first part of this article, published in the July 1942 issue of *ELECTRONICS*, dealt with the fundamentals of cathode-ray oscilloscopes and some fundamental forms of *RC* and *R/L* generators used as timing axes. The second and concluding part continues with a discussion of additional means of providing waveform circuits.

The circuit arrangement of Fig. 13 is one which is frequently employed to produce saw-tooth current in an inductance for magnetic scanning in television. This circuit illustrates, in the broadest way, the impedance control of waveform.

As an initial source we have the low voltage impulse wave, e_0 , of the group of waves labelled *A*. The output circuit of V_1 , termed a shaping circuit, is comprised of R, C, L_1 in series and the voltage across this load impedance is of the complex form, e_1 . The output circuit of V_2 is the impedance comprised of the scanning inductance, L_2 , with inherent shunt capacitance C_2 and resistance, R_2 . With a proper choice of circuit constants in the shaping circuit, the output voltage, e_2 is a large

amplitude impulse of the same form as e_0 . The relations required for reproducing the original waveform are:

$$L_1 C_1 = L_2 C_2 \quad (2)$$

$$L_1/R_1 = C_2 R_2 \quad (3)$$

$$C_1 R_1 = L_2/R_2 \quad (4)$$

In other words the series circuit is tuned to the same resonant frequency as the parallel circuit and the *RC* time constants of one circuit equal the *L/R* time constants of the other.

To understand the circuit operation clearly we must refer to the saw-tooth derivative series shown in Fig. 14. This series of related waveforms is such that each waveform is the mathematical derivative of the form immediately below it. Thus the double impulse *A* is the derivative with respect to time of the impulse wave *B*, which is the derivative of the saw-tooth wave *C*, which is the derivative of the parabolic impulse wave *D*. The series may be extended in either direction. Conversely we may say that *B* is the integral of *A*; *C* is the integral of *B* and so forth.

These four forms are commonly encountered in reactive circuits since the current through a condenser is the time derivative of the voltage across the condenser; the voltage across an inductance is the time derivative of the current through the inductance. i.e.,

$$e = L \frac{di}{dt} \quad (5)$$

$$i = C \frac{de}{dt} \quad (6)$$

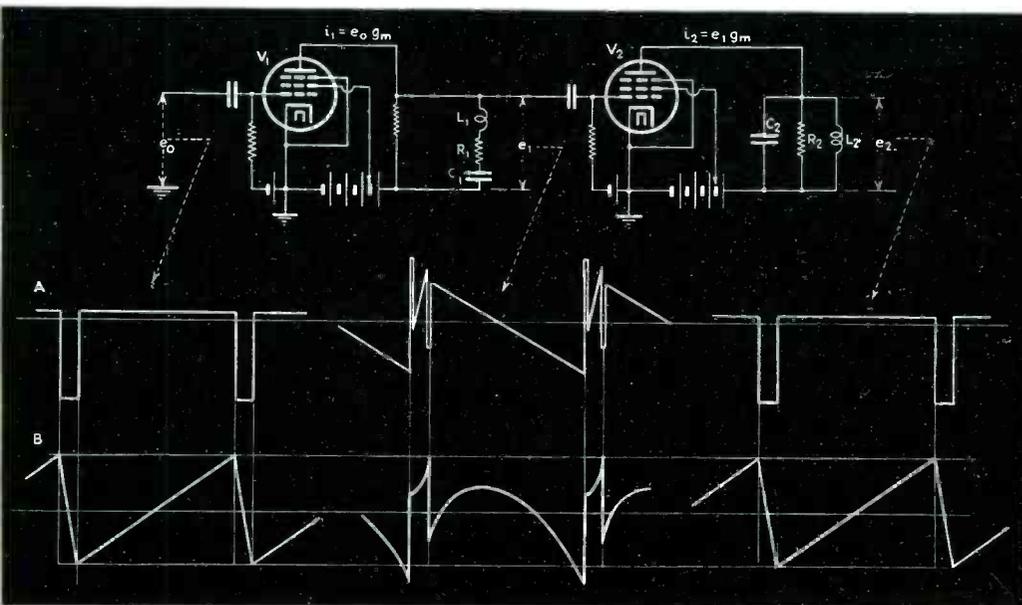


Fig. 13—A two-stage amplifier with series circuit in output of first stage and parallel circuit in output of second stage. If the values of these output circuit constants are properly selected, the output waveform is a replica of the input

RAY TUBES—Part II

Another way of saying it, is that each waveform represents the rate of change of the waveform immediately below it. For example each trace and retrace of the saw-tooth *C* is shown as a straight line of constant slope. Hence the retrace interval of the pulse wave *B* is at a constant height proportional to the steepness of the saw-tooth retrace and in the positive direction since the saw-tooth retrace has a positive slope. The trace interval of *B* is negative and constant at a value corresponding to the lesser negative slope of the saw-tooth trace.

The double impulse *A* would be comprised of points at plus and minus infinity if the sides of the pulse *B* were infinitely steep as drawn. In practice this cannot be true and finite double impulse forms are readily obtained usually with exponential sides due to distributed capacities. The waveform *D* is a parabola during the trace interval joined to an opposite small parabola during the retrace interval.

The waves are all shown with an a-c axis since in coupling through transformers and capacities a d-c component will not be translated. And it is to be observed that, since the average value of an a-c wave over a complete cycle is zero, the areas of the wave above and below the axis are equal.

Recurrent waveforms may be resolved into harmonic series of sine and cosine components by means of a Fourier series analysis. This has been done*, for the saw-tooth waveform *C* and the corresponding series for waves *B* and *D* then obtained by differentiation and integration respectively. In summation-form these series are:—

$$\text{Parabolic wave } \left\{ i = \sum_{m=1}^{m=\infty} \left(\frac{2I}{\pi^2 \omega} \right) \right.$$

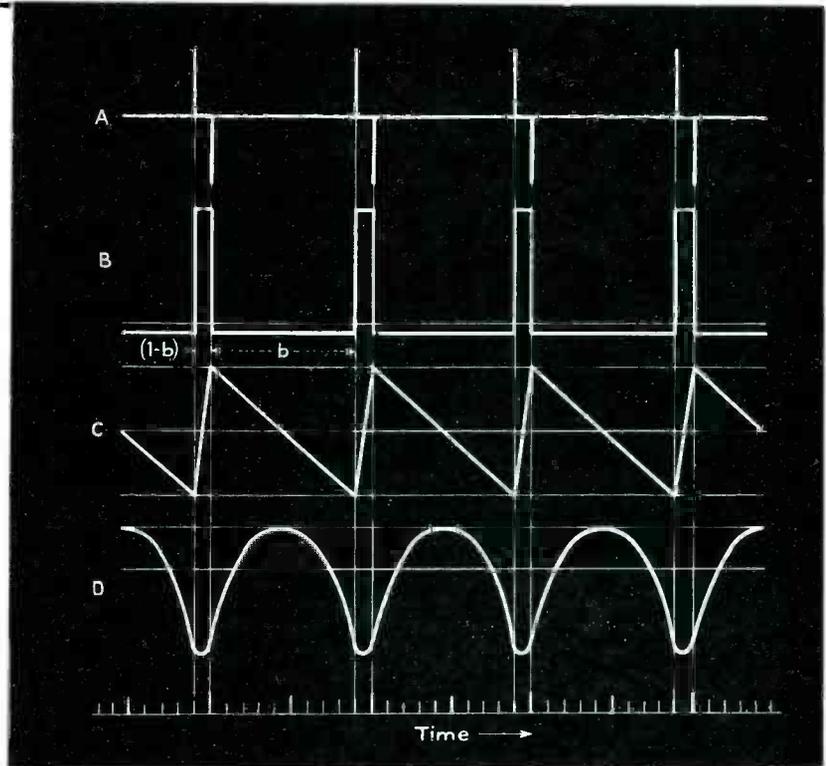


Fig. 14—Derivative and integral waveforms frequently encountered. Any one waveform is the derivative of the waveform immediately below it; conversely it is the integral of the waveform immediately above it

$$\left. \frac{\sin m b \pi}{b(1-b)} \cdot \frac{1}{m^3} \right) \cos m \omega t \quad (7)$$

$$\text{Saw-tooth wave } \left\{ i' = - \sum_{m=1}^{m=\infty} \left(\frac{2I}{\pi^2} \right) \right.$$

$$\left. \frac{\sin m b \pi}{b(1-b)} \cdot \frac{1}{m^2} \right) \sin m \omega t \quad (8)$$

$$\text{Impulse wave } \left\{ i'' = - \sum_{m=1}^{m=\infty} \left(\frac{2I}{\pi^2} \omega \right) \right.$$

$$\left. \frac{\sin m b \pi}{b(1-b)} \cdot \frac{1}{m} \right) \cos m \omega t \quad (9)$$

where $\omega = 2 \pi f$

m is the order of harmonic

b is the fraction of cycle during which trace occurs.

Returning now to Fig. 13 it will be evident that, since pentodes are employed, the current i_1 through the series circuit is of the same wave-

form as the grid voltage e_0 . For the applied pulse *A* we have then a pulse voltage across R_1 , a saw-tooth voltage across C_1 , and a double impulse voltage across L_1 . The addition of these three waveforms is the complex voltage e_1 , as inspection will reveal.

The output current i_2 from tube V_2 will therefore be of this waveform. In order that e_2 shall be of impulse waveform the double impulse current component must flow through C_2 , the impulse component through R_2 , and the saw-tooth component through L_2 since this condition is required by the derivative series. The choice of the impedance elements with the relations previously given will produce this division of the complex current components through the several parallel elements.

*By Madison Cawein, Unpublished Report—April 1933.

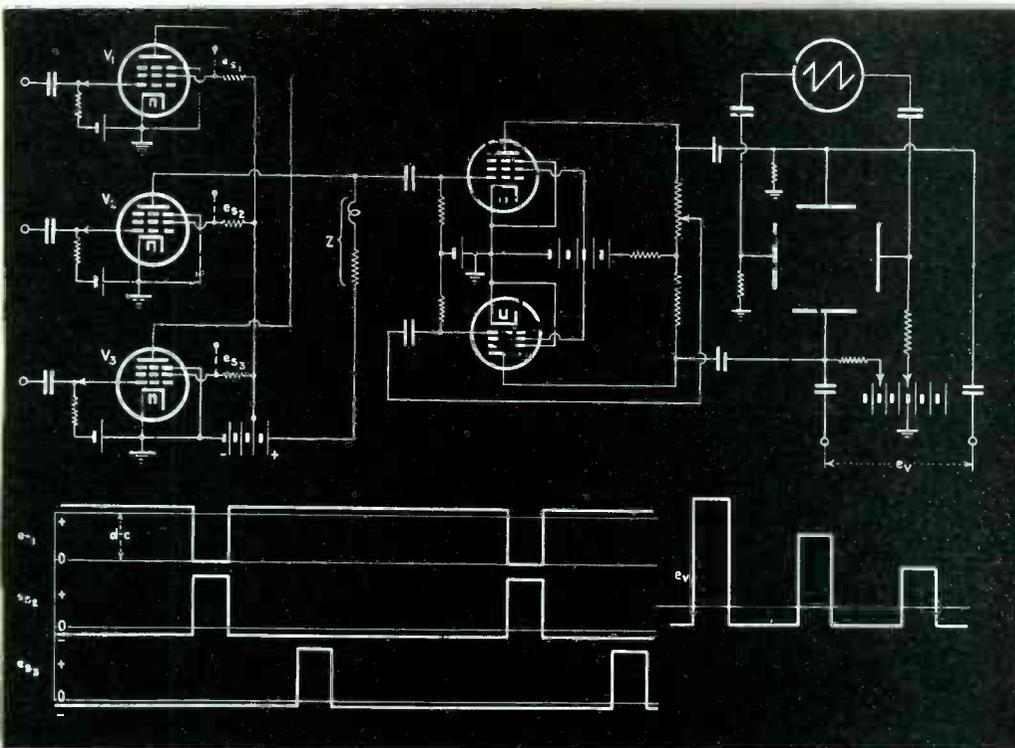


Fig. 15—By applying various input voltages to the grids of the amplifier tubes V_1 , V_2 , and V_3 , these voltages may be combined and the resultant effect viewed on the screen of the cathode-ray tube

For electrostatic deflection, the circuit of Fig. 13 is also employed to develop saw-tooth voltage across the inductance, L_2 , or across a secondary winding coupled to L_2 . This is illustrated in the series of waveforms labelled B, where the initial source of voltage, e_s , is of saw-tooth form. The voltage across the shaping circuit is the complex form, e_1 , and is comprised of a saw-tooth component across R_1 , a parabolic component across C_1 , and an impulse component across L_1 . The output voltage is of the required saw-tooth form. The

current through L_2 is of parabolic form while currents through the shunt elements, R_2 and C_2 are of saw-tooth and impulse form, respectively.

Since all periodic waveforms are comprised of a fundamental plus a large number of harmonic frequencies the waveforms are readily modified by frequency discrimination. Hence care must be taken in translating waveforms to provide circuits of suitable bandwidth and linear phase characteristics. The characteristics of filter and other networks are now commonly studied by observ-

ing the waveform at the filter output as compared with that applied at the input. The square wave, a pulse having equal trace and retrace intervals, is frequently employed for this purpose since the changes due to frequency and phase distortion are easily recognized. A number of articles on this form of testing have recently appeared in the literature.

Amplitude Control of Wave Form

The complex waveform e_1 of curve A Fig. 13 could of course be made up by combining components of pulse, saw-tooth, and double pulse derived from separate sources in chosen amplitude. Many complex forms in television practice are made up by such addition and subtraction.

A general circuit arrangement for combining waveforms and viewing them on an oscilloscope is shown in Fig. 15. The several waveforms will be applied to the grids of the three pentode amplifiers having a common impedance load Z . The combined voltage is thereby developed at the input of the balanced amplifier and so applied to the vertical deflection plates of the oscilloscope. Some complex waveforms, for example those of the standard television synchronizing signal, are made up of sections of one type of pulse which is abruptly changed during intervals to another type. This is accomplished by "keying." Thus a group of keying signals are developed by relaxation oscillators such as the pulse

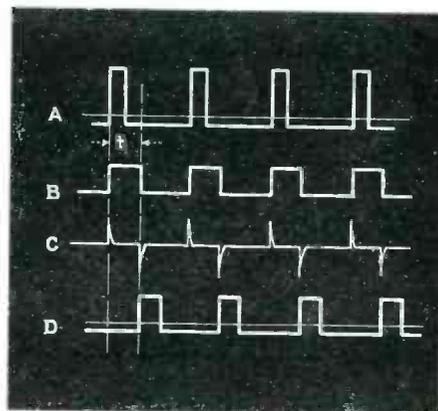
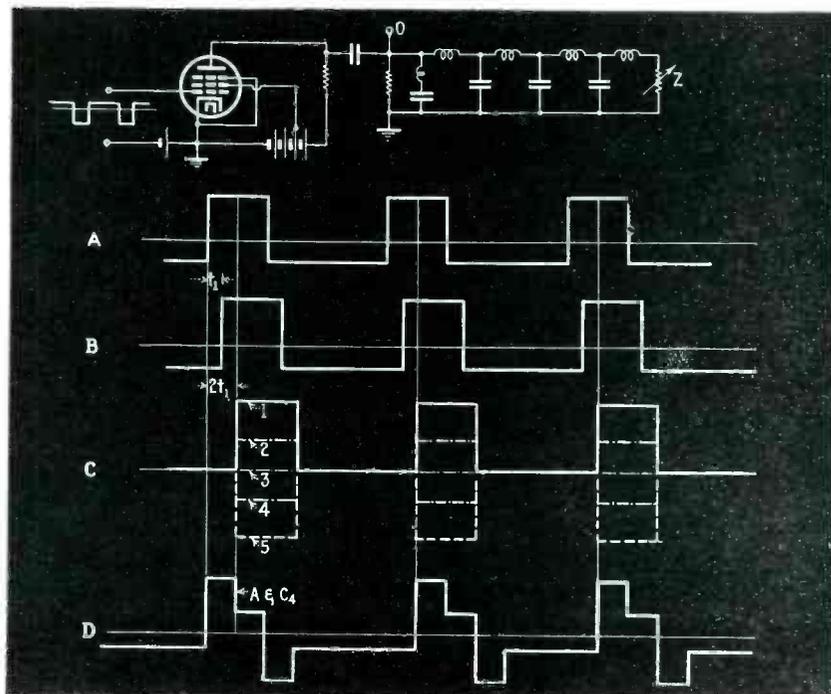


Fig. 17—A square-wave generator rather than the transmission line may be used to provide suitable time delays

Fig. 16—An artificial line provides time delay of input pulses, which may then be combined with other voltages to form new wave shapes

Fig. 19—Circuit for providing successively, amplification and clipping of signal, to produce wave pulses with steep sides

waves e_{s1} , e_{s2} and e_{s3} . Each screen grid d-c voltage connection is suitably chosen and the pulse voltages are applied at the respective screen grid connections as indicated. It is evident that e_{s1} is the same as e_{s2} but oppositely poled and augmented by a d-c potential. Hence the major part of the time the component from V_1 is alone transmitted. When the pulse occurs V_1 is keyed out and V_2 is keyed in to change the waveform during the pulse interval. When the pulse of V_3 occurs the signal from V_3 is added to that of V_1 for the duration of the pulse interval.

It is often desirable to view certain sections of a long cycle of complex waveforms. This may be accomplished by keying the position of the time axis on the oscillograph screen. For example a composite wave of pulses of different height such as e_c may be made up from three pulse sources by means of a combining amplifier. This will be applied as indicated to the vertical plates to change the position of the vertical axis. The frequency of horizontal saw tooth deflection will also be increased so that a single horizontal time axis trace occurs during each pulse interval. Thus we may view three sections of the complex cycle simultaneously and compare the waveforms of these sections. An example of this type of

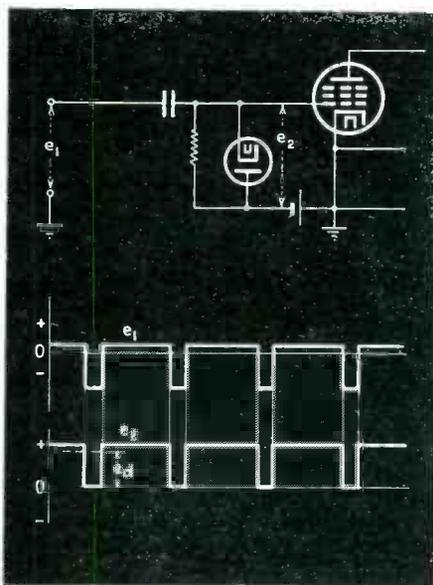
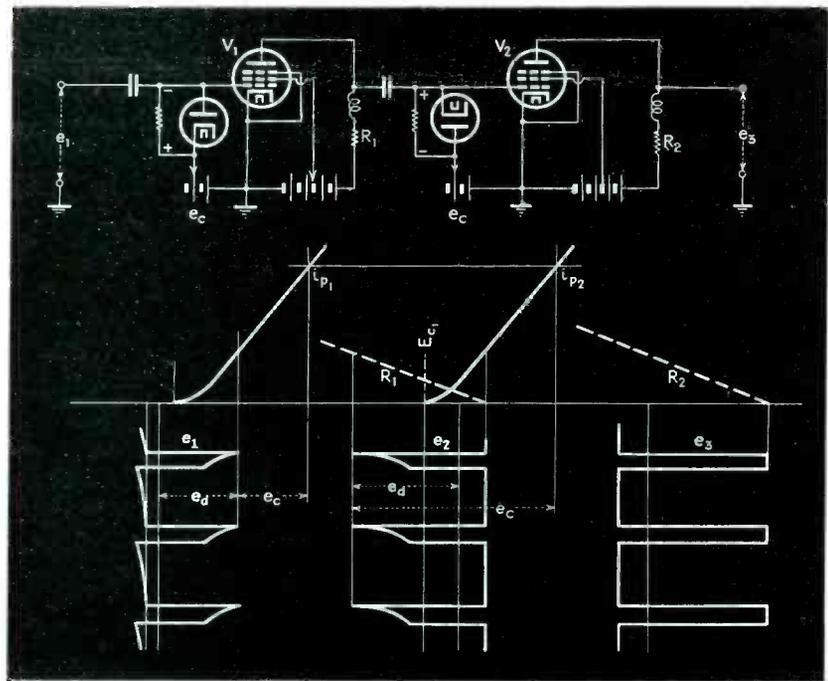


Fig. 18—Circuit for operating pulse waveforms from a fixed level



waveform viewing is shown on the cover of ELECTRONICS for April 1939 where sections of the "odd" and "even" portions of a complete cycle of television synchronizing signal are shown as separate and directly comparable intervals. Keying pulses are often applied to the grid of the oscillograph tube to blank (black-out) the screen except during pre-determined intervals which are to be observed.

Frequently a desired waveform may be built by the addition or subtraction of available forms and by delaying and then combining these forms. A long artificial line is frequently employed to provide short delays. Thus in Fig. 16 if the artificial line is designed to pass the essential frequency band of a pulse voltage such as A applied to the input, then the voltage wave at the far end is of the same form delayed by the time interval t_1 as shown at B . If the far end is terminated by a resistance Z equal to the surge impedance of the line no reflection occurs. If however we vary Z and if the generator end is also terminated to avoid a second reflection then the wave reflected back to the generator end will be delayed by the interval $2t_1$ as shown at curve C . However the amplitude and polarity of the reflected wave will depend on the far end termination, Z .

If Z is infinite (open circuit) the reflected wave is shown by the solid

line waveform (1). If Z is somewhat greater than the surge impedance the reflected wave is decreased in amplitude as at (2). No reflection is indicated at (3) when Z equals the surge impedance. Reflection with reverse polarity indicated at (4) occurs with Z less than the surge impedance and full amplitude with reverse polarity as shown at (5) occurs when the far end is short circuited.

The output waveform viewed at O may therefore be varied in form by varying Z . The waveform shown at (D) is an example of the form due to the original wave (A) and the reflected wave (C) . The waveform viewed at various points along the line will differ due to the difference in delays between the transmitted and reflected waves. If only the delayed wave is wanted it may be obtained with the total delay $2t_1$ by applying the voltage O , and the grid voltage of the tube, to inputs of a combining amplifier whereby the component form A is neutralized and reflected wave C is developed.

Because of the long lines required and the care required in building them, electronic methods are generally more serviceable in obtaining long delays of impulse waveforms. In Fig. 17 we have a pulse waveform A and our problem is to obtain a related form D which is delayed by the interval t_1 and has the pulse intervals as shown. Our procedure

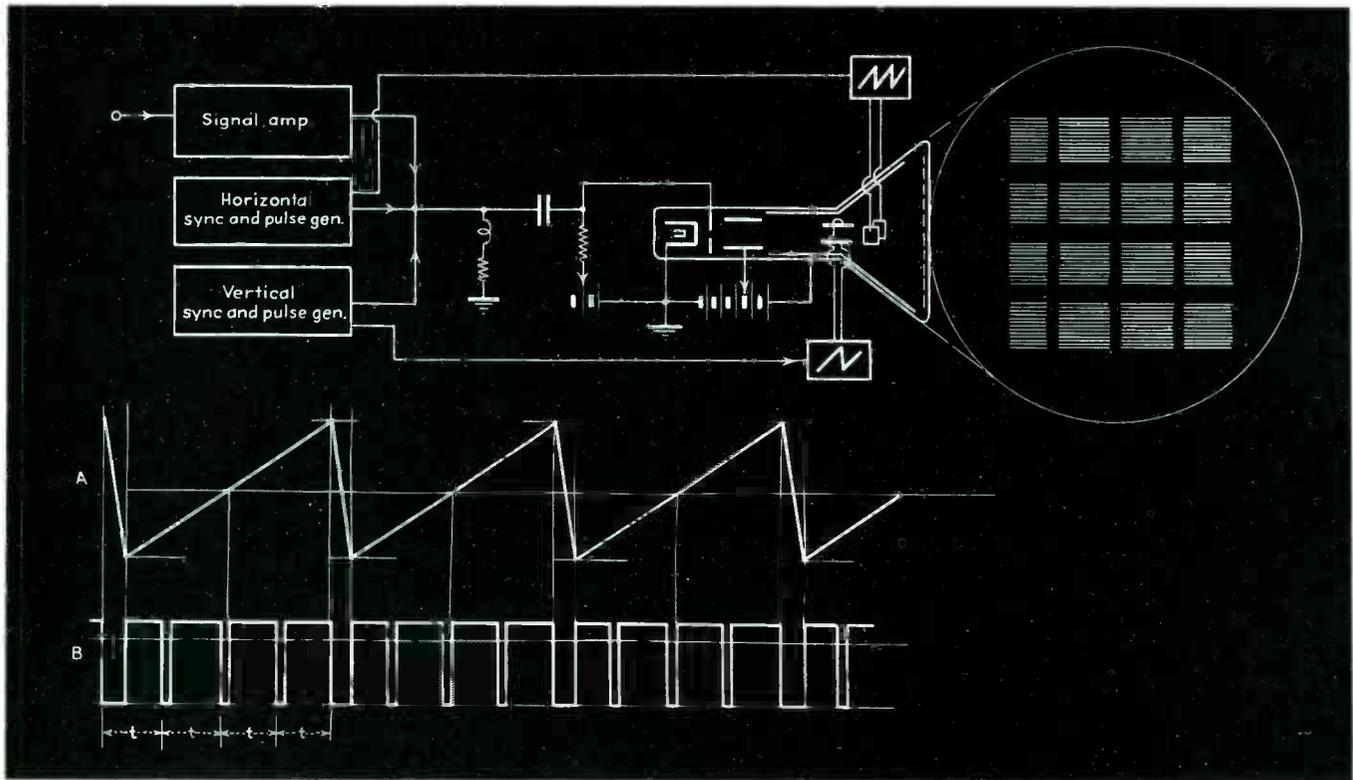


Fig. 20—Functional diagram illustrating method of obtaining two-dimensional sawtooth deflection on screen of cathode-ray tube with vertical and horizontal scanning

is to use wave A to synchronize a relaxation oscillator at the same periodicity and to adjust the circuit constants of the oscillator so that the pulse intervals correspond to the delay interval t . In any circuit path of the oscillator which carries current of the form B we insert a small inductance or transformer so that double pulse voltage of the differentiated waveform C is developed across a winding. This voltage is applied to a second relaxation oscillator in polarity such that synchronization is effected by the second pulse of the pair. This gives us a source of pulses suitably delayed and by adjusting the circuit constants of this second oscillator to give the desired pulse intervals we achieve the required waveform D.

It will be noted that the waveforms have been shown relative to an a-c axis which divides the area equally above and below the axis. The amplitude of a pulse relative to the axis will thus depend automatically upon the ratio of trace to retrace time. Referring back to the waves of the derivative series (Fig. 14) it will be seen that the saw-tooth C has a value of $b = 0.9$. The corresponding pulse wave B therefore has the positive amplitude 9 times that of the negative amplitude.

It is frequently necessary to operate pulse waveforms from a fixed level irrespective of its interval ratios. This is termed stabilization and is generally effected by employing a diode to develop a d-c component equal to the peak value of the wave. Thus in Fig. 18 the a-c impulse wave coupled to the vacuum tube grid is that shown as e_1 . The diode converts this wave to the form shown as e_2 . This is because the diode, poled as shown, draws a small amount of current at each pulse peak to develop and maintain the positive d-c component e_2 . If e_1 is of opposite polarity it is preferable to reverse the diode to develop a negative peak value of d-c stabilizing potential. Frequently the control grid of the vacuum tube may then be used in place of a diode to stabilize the wave by drawing a small amount of grid current as each positive peak occurs.

In the best of the circuits we have been discussing the precise pulse waveforms are not generally available. They generally occur in the exponential form first mentioned and are thereafter shaped by limiting or clipping. This is generally done by applying the pulse wave in large amplitude to a vacuum tube stage or stages as shown in Fig. 19. Stabilization as also illustrated in this

circuit will generally be employed. The diagrams show that the waveform e_1 is set partially beyond cutoff of the characteristic i_{p1} of tube V_1 due to the battery bias e_c and stabilizing diode bias e_d . The output voltage developed across R_1 is the amplified form e_2 having flat trace intervals. The wave e_2 is set with the peaks beyond cut-off of the characteristic i_{p2} of V_2 by battery bias e_c and diode bias e_d so that the output voltage developed across R_2 is the desired pulse e_3 . By this successive process of amplification and limiting we may produce pulses with sides as steep as our circuits permit.

Expanded Time Bases

Two dimensional saw-tooth deflection is common in television wherein the horizontal traces are spread vertically by a second lower frequency vertical saw-tooth deflection voltage to form a grid of lines or picture area. This process is shown in Fig. 20. The pulse generators indicated in block diagram each include sub-multiple pulse generators so that a waveform such as B related to the scanning waveform A is developed in each unit. The waves of form B from each unit are applied to the control grid as shown to blank the retrace and establish

dark lines corresponding to the pulse peaks which divide the screen area into time intervals. A standard source of frequency may be employed to synchronize the horizontal and vertical pulse generators so that precise time intervals of known value are established. Signals whose time relations are to be determined are then added to the grid voltage by the amplifier shown. Their effect of brightening or darkening of the screen marks their position on this two dimensional time scale. Systems for depicting various network characteristics have been developed using this type of expended time scale.

Another two-dimensional time scale is the circular trace of Fig. 21. A phase splitting network serves to provide time quadrature sinusoidal deflection voltages to the deflection plates which are in space quadrature. An elliptical trace results which becomes circular when the two deflection fields are of equal amplitude. This is a case of rotating electrostatic field.

Thus

$$x = K_1 e_s = K_1 E_1 \cos \omega t \quad (10)$$

where e_s is horizontal deflection voltage

$$y = K_2 e_s = K_2 E_2 \sin \omega t \quad (11)$$

where e_v is vertical deflection voltage

$$x^2 + y^2 = \rho^2 \quad (12)$$

From Eq. (10) and (11) above we may write

$$\frac{x^2}{(K_1 E_1)^2} + \frac{y^2}{(K_2 E_2)^2} = \sin^2 \omega t + \cos^2 \omega t = 1 \quad (13)$$

which is the equation of an ellipse,

If $K_1 E_1 = K_2 E_2$ then, with (12) above

$$x^2 + y^2 = (K_1 E_1)^2 = \rho^2 \quad (14)$$

which is the equation of a circle. Also we note that

$$\theta = \tan^{-1} \frac{y}{x} = \omega t$$

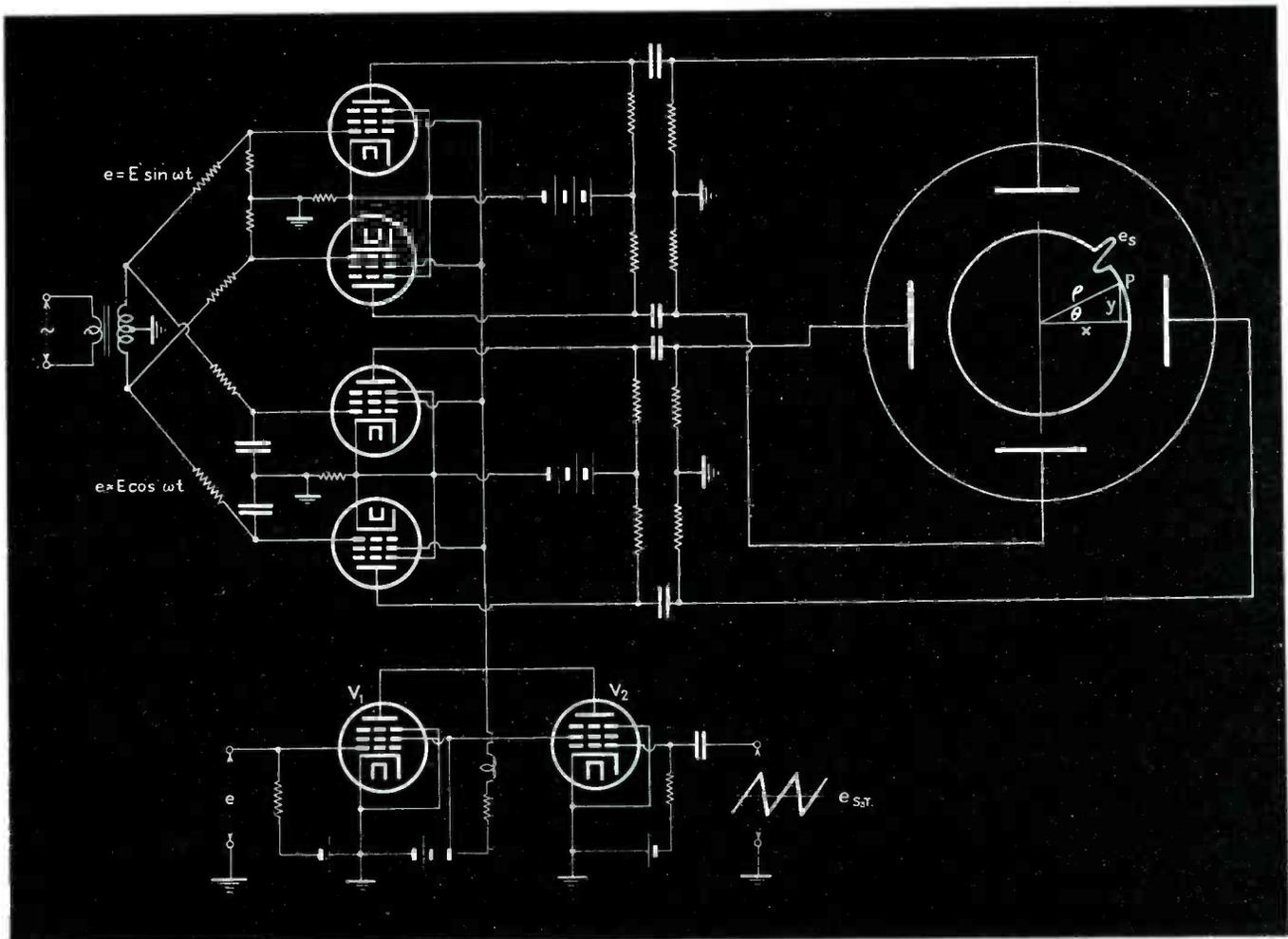
when the trace is a circle.

Ordinarily the deflection sensitivities K_1 and K_2 of the two pairs of plates are sufficiently equal so that we need simply make the deflection voltages equal to obtain a circular trace. The radius of the circle, which the spot traces at angular velocity ωt is then directly propor-

tional to the voltage E' as Eq. (14) shows. A signal e_s applied to V_1 is effective therefore to change the radius of the circle, as indicated on the diagram. If the signal e_s is periodic at the frequency $f = \omega/2\pi$ then the ripple it produces on the circular trace is stationary. If e_s differs in frequency from f it will move around the circle.

If a saw-tooth voltage is applied to the tube V_2 as shown, then it will be evident that the radius of the circular trace will change linearly with time. If the periodicity of this saw-tooth voltage is f_s and lower than f , then the trace becomes a spiral which is stationary if f_s is a submultiple of f . Otherwise the spiral will rotate. If f_s is much higher than f then the diagram becomes radial; like a series of spokes radiating from a central hub. Signals applied to the oscillograph grid or to the tube V_1 will register on these expanded time scales and a variety of useful arrangements are possible.

Fig. 21—Phase splitting circuits are employed to produce two-dimensional deflections in polar coordinates



Notes on Band Pass

By H. HOLUBOW

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THE following notes represent simplifications in methods of calculating the performance of band pass and band elimination filters, especially when it is necessary to allow for the dissipation in the coils. The usual notation holds, i.e., F_1 and F_2 are the critical frequencies (cut-off), F_m is the median frequency in the critical band, R is the terminating resistance.

Band Pass Filters

Although there are a number of networks which may be used as band pass filters, the constant K type, shown in Fig. 1, is most commonly employed. In this structure, the product of the series and shunt element impedances, Z_1 and Z_2 respectively, is a constant equal to K^2 . The expected performance of the band pass filter is usually obtained graphically from the values of $Z_1/4Z_2$. These values are usually given in texts and handbooks in terms of the cut-off frequencies. The calculation of $Z_1/4Z_2$ becomes quite cumbersome when dissipation must be taken into account, but the simplifications that follow are useful in that they do not entail much sacrifice in accuracy.

The impedance of the series arm Z_1 at any frequency F_1 , may be expressed as follows:

$$Z_1 = j 2\pi F_{11} L_1 - j \frac{1}{2\pi F_{11} C} = j \left[\frac{2\pi R F_{11}}{\pi (F_2 - F_1)} - \frac{4\pi F_2 F_1 R}{2\pi F_{11} (F_2 - F_1)} \right]$$

Simplifying,

$$Z_1 = j 2R \frac{F_{11}^2 - F_2 F_1}{F_{11} (F_2 - F_1)}$$

The impedance of the shunt arm

$$Z_2 = \frac{1}{j 2\pi F_{11} L_2 + j 2\pi F_{11} C_2} = \frac{1}{j \frac{2\pi F_{11} L_2}{1 - 4\pi^2 F_{11}^2 L_2 C_2}}$$

Substituting for L_2 and C_2 their values from Fig. 1,

$$Z_2 = j \frac{R F_{11} (F_2 - F_1)}{2 (F_2 F_1 - F_{11}^2)}$$

whence

$$\frac{Z_1}{2 Z_2} = \frac{2 (F_{11}^2 - F_2 F_1) (F_2 F_1 - F_{11}^2)}{F_{11}^2 (F_2 - F_1)^2} \quad (1)$$

The attenuation of the band pass filter at any point may now be calculated from the relation

$$\cosh a = 1 + \frac{Z_1}{2 Z_2}$$

or graphically from

$$\frac{Z_1}{4 Z_2}$$

This equation, however, is cumbersome to use, but the following simplification can be made:

For any point on the filter curve corresponding to F_{11} there is another point F_{22} such that $F_{11} F_{22} = F_1 F_2 = F_m^2$. Substituting F_{11} , F_{22} for F_1 , F_2 in

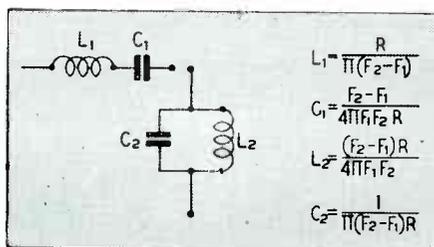


Fig. 1—Constant K band pass filter circuit

Eq. (1), the following is obtained:

$$\frac{Z_1}{2 Z_2} = \frac{2 (F_{11}^2 - F_{11} F_{22}) (F_{22} F_{11} - F_{11}^2)}{F_{11}^2 (F_2 - F_1)^2} = \frac{2 (F_{11} - F_{22}) (F_{22} - F_{11})}{(F_2 - F_1)^2} = -2 \frac{(F_{22} - F_{11})^2}{(F_2 - F_1)^2} \quad (2)$$

This may now be written as

$$\frac{Z_1}{2 Z_2} = -2 \left(\frac{F_{\Delta 1}}{F_{\Delta}} \right)^2 \quad (2a)$$

where $F_{\Delta 1}$ is the band spread at the points of determination (F_{22} , F_{11}), while F_{Δ} is the band spread of the filter between points $F_2 - F_1$. A curve (Fig. 2) may now be made that will give the theoretical determination of the attenuation at any point of any constant K band pass filter.

Attenuation in Filters with Dissipation

The attenuation of a band pass filter obtained by means of curve in

Fig. 2 assumes no dissipation either in the reactors or condensers. The dissipation in condensers is usually small and can be neglected; the dissipation present in the coils, however, is considerable, especially at the audio frequencies. In the ideal filter there is no attenuation within the pass band, while in an actual filter the attenuation within the pass band may be considerable, especially in the narrow band pass filters. However, if the attenuations at the mid-frequency $F_m = F_1 F_2$, and at $F_1 F_2$ are known, the response of the filter may easily be determined.

In the constant K band pass filter at the frequency F_m , $X_{L1} = X_{C1}$ and $Z_1 = 2\pi F_m L_1 d$, or $Z_1 = \frac{2\pi F_m L_1}{Q}$, where

$$d \text{ is } \frac{r}{2\pi FL} \text{ or } Q = \frac{2\pi FL}{r} \quad (r \text{ is the}$$

equivalent series resistance of the reactor) and L_1 is the series arm inductance. In terms of the cut-off frequencies (Fig. 1).

$$Z_1 = \frac{2\pi F_m R}{Q\pi (F_2 - F_1)} = \frac{2 F_m R}{Q (F_2 - F_1)}$$

In the shunt arm, $X_{L2} = X_{C2}$, and assuming dissipation present in the inductances only,

$$Z_2 = \frac{X_{L2} X_{C2} - j^r X_{C2}}{r + j (X_{L2} - X_{C2})} = \frac{X_{L2} X_{C2}}{r} - j X_{C2}$$

or

$$Z_2 = Q X_{L2} - j X_{L2}$$

Inasmuch as the Q of a filter choke is seldom smaller than 20, the reactive component $j X_2$ may be neglected and, from Fig. 1,

$$Z_2 = Q X_{L2} = 2\pi Q \frac{F_m (F_2 - F_1) R}{4\pi F_1 F_2} = \frac{Q (F_2 - F_1) R}{2 F_m}$$

and

$$\frac{Z_1}{Z_2} = \frac{4 F_m^2}{Q^2 (F_2 - F_1)^2}$$

and

$$\frac{Z_1}{2 Z_2} = \frac{2}{Q^2} \left(\frac{F_m}{F_2 - F_1} \right)^2$$

at

$$F_{11} = F_m$$

and Band Rejection Filters

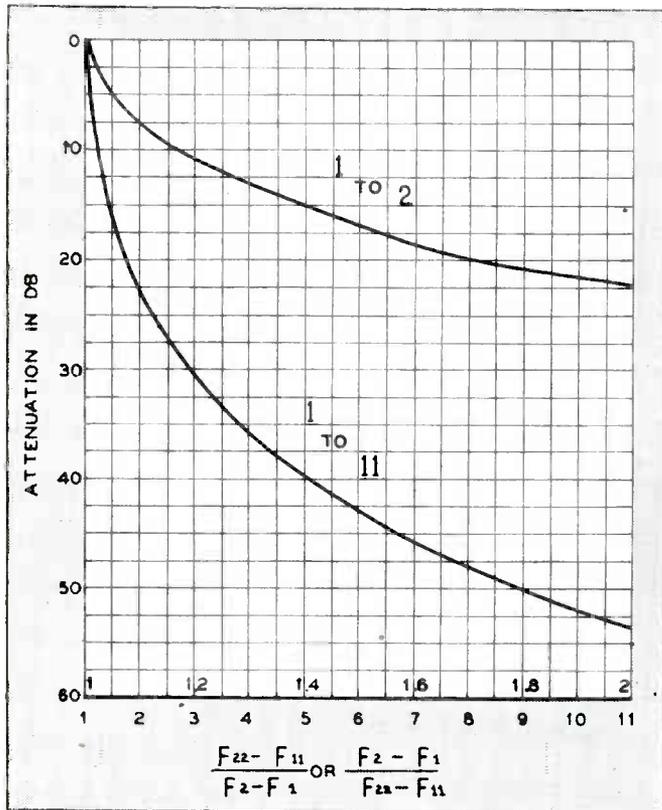


Fig. 2—Curve showing attenuation of band pass filter, without taking into account resistance in coils or condensers

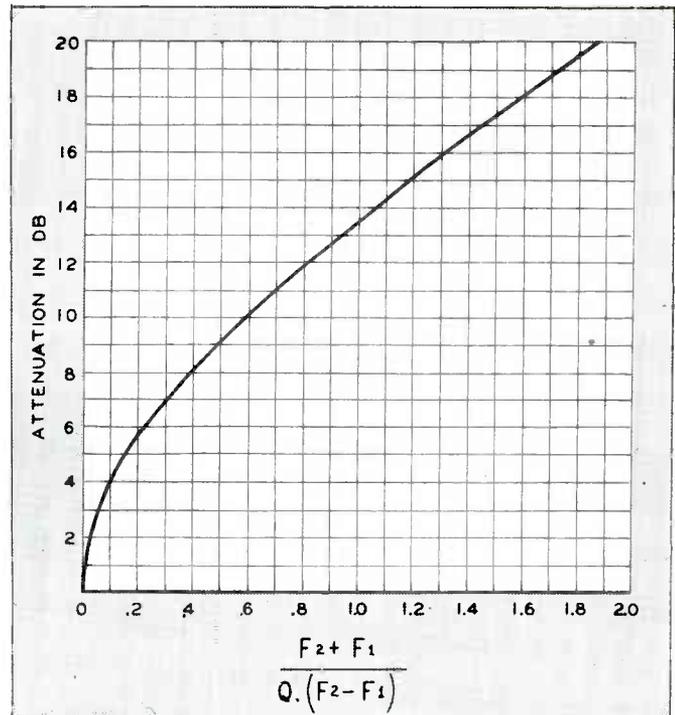


Fig. 3—Attenuation of band pass filter at the critical frequencies F_1 and F_2 when the coils have dissipation

Attenuation at f_m

The attenuation at the midband frequency may be found from tables of hyperbolic functions where

$$\cosh \alpha = 1 + \frac{Z_1}{2Z_2}$$

when α is attenuation in nepers. However, inasmuch as α at the midband frequency is less than one neper, the following approximation may be used:

$$\cosh \alpha = 1 + \frac{\alpha^2}{2!} + \frac{\alpha^4}{4!}$$

Using the first two terms

$$1 + \frac{\alpha^2}{2!} = 1 + \frac{Z_1}{2Z_2}$$

or

$$\alpha = \sqrt{\frac{Z_1}{Z_2}} = \frac{2}{Q} \times \frac{F_m}{F_2 - F_1} \text{ nepers, (3)}$$

$$\alpha = \frac{17.3}{Q} \times \frac{F_m}{F_2 - F_1} \text{ decibels (3a)}$$

The error from using this expression is less than 4 percent for α less than 8 db.

Attenuation at a Cut-off Frequency, F_1

In the same manner it may be shown that at F_1

$$\frac{Z_1}{2Z_2} = 2 \frac{[d \frac{F_1}{F_m} + j \frac{F_2 - F_1}{F_m}]^2}{(1 - jd) [\frac{F_2 - F_1}{F_m}]^2}$$

where d is the dissipation factor of the filter components. Performing the indicated operations

$$\frac{Z_1}{2Z_2} = 2 \times \frac{d^2 \left(\frac{F_1}{F_m}\right)^2 + j2d \frac{F_1}{F_m} \left(\frac{F_2 - F_1}{F_m}\right) - \left(\frac{F_2 - F_1}{F_m}\right)^2}{\left(\frac{F_2 - F_1}{F_m}\right)^2 - jd \left(\frac{F_2 - F_1}{F_m}\right)^2}$$

Inasmuch as d is usually small, all terms containing d^2 or d^3 can be neglected.

$$\begin{aligned} \frac{Z_1}{2Z_2} &= 2 \left[-1 + j2d \frac{F_1}{F_2 - F_1} + jd \right] \\ &= -2 + j2d \frac{F_2 + F_1}{F_2 - F_1} \\ &= -2 + j \frac{2}{Q} \frac{F_2 + F_1}{F_2 - F_1} \end{aligned}$$

The attenuation at F_1 or F_2 may be

obtained from the curve in Fig. 3 where the abscissas are in terms of

$$\frac{F_2 + F_1}{Q(F_2 - F_1)}$$

or

$$d \frac{F_2 + F_1}{F_2 - F_1}$$

To illustrate the procedure in the design, let us assume that it is required to obtain the expected performance curve for a band pass filter when $F_1 = 3000$ cps, $F_2 = 4000$ cps, and the dissipation factor of the coils is 0.04 ($Q = 25$), and in which $F_m = \sqrt{4000 \times 3000} = 3450$. The theoretical performance of the filter may be calculated as shown.

F_{11}	F_{22}	$\frac{F_{\Delta 1}}{F_{\Delta}}$	Attenuation in db
2800	4300	1.5	17
2600	4620	2.02	22.5
2400	5000	2.6	28.0
2000	6000	4.0	36.0
1500	8000	6.5	44.5
1200	10000	8.8	50

In this table either F_{11} or F_{22} is

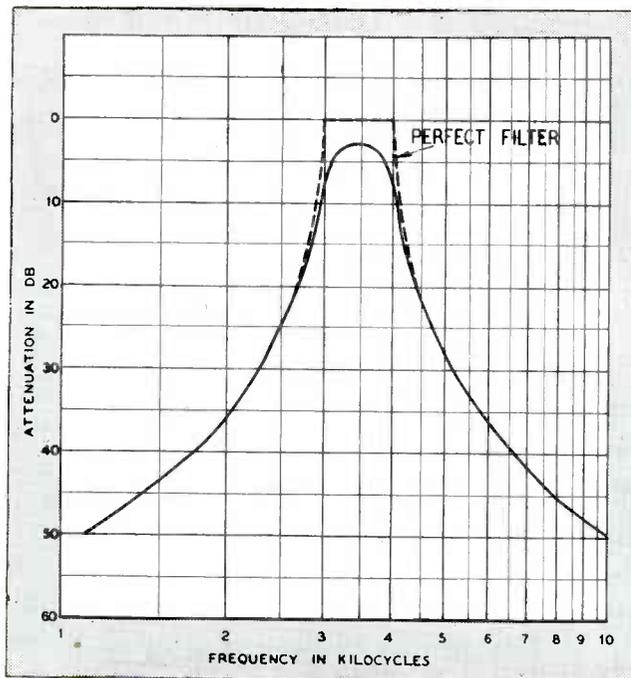


Fig. 4—(Left) Performance curve of band pass filter as calculated by the methods outlined in this article

assumed and the other frequency is calculated from

$$\frac{F_1 F_2}{F_{11}} \text{ or from } \frac{F_1 F_2}{F_{22}}$$

and

$$\frac{F_{\Delta 1}}{F_{\Delta}} = \frac{F_{22} - F_{11}}{F_2 - F_1}$$

The attenuation in decibels is obtained from Fig. 2. The insertion loss at F_m is obtained from Eq. (3a) and is

$$\frac{17.3}{25} \times \frac{3450}{1000} = 2.4 \text{ db}$$

The insertion loss at F_2 and F_1 is 7.6 db, (obtained from Fig. 3). The expected performance curve of the filter is as shown in the heavy line on Fig. 4.

Band Rejection Filters

The band rejection filter does not find as wide an application as the band pass filter. Nevertheless, it is desirable to be able to predetermine

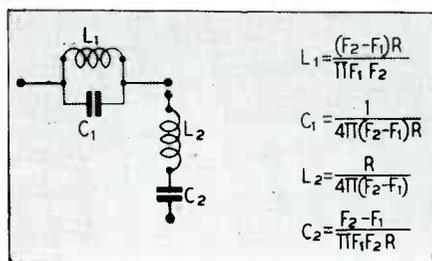


Fig. 5—(Below) Band elimination filter of the constant K type in which the series and shunt reactances are as shown, in terms of the terminal resistance R

the performance of this type of filter. There is only one type constant K structure that is commonly used, as shown in Fig. 5.

Using the same method of analysis as in the case of the band pass filter, it is found that

$$\frac{Z_1}{2Z_2} = -2 \frac{F_2 - F_1}{F_{22} - F_{11}} = -2 \frac{F_{\Delta}}{F_{\Delta 1}}$$

This relation is similar to that obtained for the band pass filter except $F_2 - F_1$ and $F_{22} - F_{11}$ are interchanged. The theoretical performance of a band rejection filter may be then obtained from curve in Fig.

2 using $\frac{F_{\Delta}}{F_{\Delta 1}}$ for the abscissas.

At midband frequency $2 \pi FL = \frac{1}{2 \pi FC}$ for both the series and the shunt arm. At F_m ,

$$Z_1 = 2 \pi F_m L_1 Q = \frac{2 F_m (F_2 - F_1) R Q}{F_1 F_2}$$

$$Z_2 = \frac{2 \pi F_m L_2}{Q} = \frac{F_m R}{2 (F_2 - F_1) Q}$$

$$\frac{Z_1}{2Z_2} = 2 \frac{(F_2 - F_1)^2 Q^2}{F_1 F_2} = 2 \left(\frac{F_2 - F_1}{F_m} \right)^2 Q^2$$

Attenuation α at midband may be obtained from the relationship

$$\cosh \alpha = 1 + \frac{Z_1}{2Z_2}$$

where

$$\cosh \alpha = \frac{e^{\alpha}}{2} + \frac{e^{-\alpha}}{2}$$

Inasmuch as the attenuation is usually large,

$$\frac{e^{\alpha}}{2} = \frac{Z_1}{2Z_2} = 2 \frac{(F_2 - F_1)^2 Q^2}{F_m^2}$$

or

$$e^{\alpha} = \left[2 \frac{F_2 - F_1}{F_m} Q \right]^2$$

The attenuation

$$\alpha = 2 \log_e 2 \frac{F_2 - F_1}{F_m} Q \text{ nepers,}$$

or

$$\alpha = 40 \log_{10} 2 \frac{F_2 - F_1}{F_m} Q \text{ decibels}$$

At the cut-off frequencies F_2 and F_1

$$\frac{Z_1}{2Z_2} = -2 \frac{\frac{F_2 - F_1}{F_m} - jd \left(\frac{F_2 - F_1}{F_m} \right)^2}{\left(\frac{F_2 - F_1}{F_m} \right)^2 - j2d \frac{F_1 (F_2 - F_1)}{F_m}}$$

Simplifying and discarding terms containing d^2 and d^3 , we obtain

$$\frac{Z_1}{2Z_2} = -2 - j2d \frac{F_2 + F_1}{F_2 - F_1} = -2 - j2 \frac{F_2 + F_1}{Q(F_2 - F_1)}$$

The attenuation at points F_2 and F_1 for band rejection filter is obtained in the same manner as for band pass filter from Fig. 3.

Broadcasting Under War Conditions

(Continued from page 35)

together the nation as a unified whole. It is perhaps the most effective single method of disseminating propaganda, in the dictionary sense of "tending to persuade by just discussion and argument." One has only to listen to an hour's radio program to be convinced of the importance broadcasting is playing in the building up of national solidarity, for each and every program makes its appeal for some cause or another which is in-

tended to further our war effort. Only one important speech from Washington or London need be marred, through failure of strategically critical equipment or of inexperienced personnel to bring us forcefully to the realization that broadcasting must be maintained because it is so vital a cog in our vast war effort.

There is no use taking an alarmist's point of view with regard to

the present situation, for those factors which are being recognized as potentially dangerous can be rectified in time to alleviate any serious disruption of service. Nevertheless, the problems confronting the broadcasting industry must be squarely faced immediately, so that steps may be taken to assure the industry that it will receive the personnel and equipment it requires to maintain its services.

PROPAGATION CONSTANT AND CHARACTERISTIC IMPEDANCE

of High Loss Transmission Lines

Graphical and analytical methods for determining the characteristic impedance and propagation constant of transmission lines having high losses resulting from series resistance are presented in this Reference Sheet

MANY transmission lines have a negligible leakage conductance but have a relatively high series resistance. This is particularly true of lines operated at radio frequencies. For such lines the usual formulas for low loss lines are in serious error.

There are many applications of lines especially designed to have a high loss besides those high loss problems normally encountered. Such applications include power dissipating lines in which a short section of a transmission line which has a high resistance is used.¹ Other applications include attenuating sections in which a section of a high resistance line is used to reduce a voltage.

In the accompanying charts are shown universal characteristics of such lines. These curves show simultaneously the components of the line characteristic impedance and of the propagation constant.

Characteristic Impedance

A line with a negligible leakage has a series impedance of

$$Z = R_s + j\omega L \quad (1)$$

and a shunting admittance per unit length of

$$Y = j\omega C \quad (2)$$

where R_s represents the series resistance of the line per unit length,

L represents the series inductance of the line per unit length, and

C represents the shunting capacitance of the line per unit length.

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Such a line has its characteristic impedance given by

$$Z_o = R_o \sqrt{1 - \frac{jR_s \lambda}{2\pi R_o}} \quad (3)$$

where $R_o = \sqrt{L/C}$, is characteristic impedance for R_s equal to zero, i.e. no loss, and

λ represents the free space wavelength.

It is convenient to express components of the characteristic impedance in units of R_o , thus

$$\frac{Z_o}{R_o} = \frac{R}{R_o} - \frac{jX}{R_o} = r - jx \quad (4)$$

where r represents the real part of Eq. (3), or the resistive component of the characteristic impedance, in units of R_o and x represents the imaginary part of Eq. (3), or the reactive component of the characteristic impedance, in units of R_o . It will be seen in the above that the factor $R_s \lambda / R_o$ is the series resistance per free space wavelength in R_o units.

Some approximations for limiting cases are useful. For small R_s , (less than R_o/λ),

$$x = R_s \lambda / 4\pi R_o \quad (5)$$

$$r = 1 + (x^2/2) \quad (6)$$

For R_s , greater than $30R_o/\lambda$,

$$r = \sqrt{R_s \lambda / 4\pi R_o} \left(1 + \frac{\pi R_o}{R_s \lambda}\right) \quad (7)$$

$$x = \sqrt{\lambda R_s / 4\pi R_o} \left(1 - \frac{\pi R_o}{R_s \lambda}\right) \quad (8)$$

Propagation Constant

The propagation constant of the line per unit length is given by

$$\gamma = \frac{2\pi}{\lambda} \sqrt{-1 + \frac{jR_s \lambda}{2\pi R_o}} \quad (9)$$

It is convenient to express the components of the propagation constant in terms of the values per free space wavelength, thus

$$\gamma = \alpha + j\beta \quad (10)$$

where α represents the attenuation constant per free space wavelength

β represents the phase shift constant per free space wavelength

It is seen that the attenuation constant is zero for zero series resistance and increases without limit as the series resistance increases. The phase shift per free space wavelength is 2π radians for zero series resistance and increases without limit as the series resistance increases. For R_s , less than R_o/λ

$$\alpha = R_s \lambda / 2R_o \text{ nepers per free space wavelength} \quad (11)$$

$$\alpha = 4.34 R_s \lambda / R_o \text{ db per free space wavelength} \quad (12)$$

$$\beta = 2\pi \left[1 + \left(\frac{R_s \lambda}{R_o}\right)^2 \frac{1}{8}\right] \text{ radians per free space wavelength} \quad (13)$$

$$\beta = 360 \left[1 + \left(\frac{R_s \lambda}{R_o}\right)^2 \frac{1}{8}\right] \text{ degrees per free space wavelength} \quad (14)$$

For large R_s , (greater than $30R_o/\lambda$)

$$\alpha = \sqrt{\pi R_s \lambda / R_o} \left(1 - \frac{\pi R_o}{R_s \lambda}\right) \text{ nepers per free space wavelength} \quad (15)$$

$$\alpha = 27.35 \sqrt{R_s \lambda / R_o} \left(1 - \frac{\pi R_o}{R_s \lambda}\right) \text{ db per free space wavelength} \quad (16)$$

$$\beta = \sqrt{\pi R_s \lambda / R_o} \left(1 + \frac{\pi R_o}{R_s \lambda}\right) \text{ radians per free space wavelength} \quad (17)$$

$$\beta = 180 \sqrt{R_s \lambda / R_o} \left(1 + \frac{\pi R_o}{R_s \lambda}\right) \text{ degrees per free space wavelength} \quad (18)$$

¹G. H. Brown and J. W. Conklin, Water-Cooled Resistors for Ultrahigh Frequencies, ELECTRONICS, Vol. 14, No. 4, April 1941, pp. 24-28.

The graph is plotted to show the reactive component of the characteristic impedance plotted against the real component, both components of which are measured in terms of units of R_0 . The curves also show the attenuation in 2π nepers, plotted against the phase shift in 2π radians. For convenience in using small values, the graph is divided into two portions, the portion in the insert showing the region near the origin on an enlarged scale.

The use of the graphs is illustrated in the following examples.

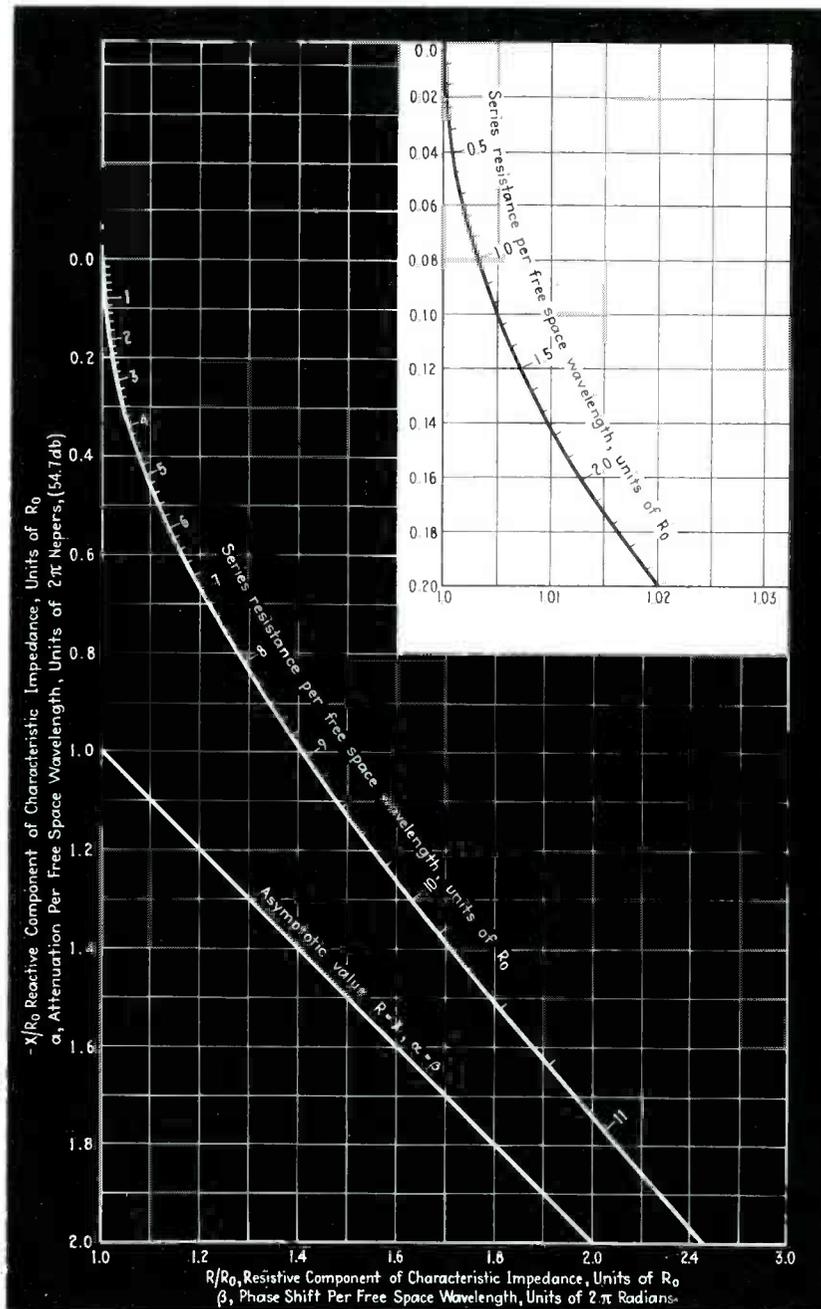
Example 1: A rhombic antenna is fed with 1 kw of power at 10 meters or 30 Mc. The antenna radiates 60 percent of the input power and puts 40 percent or 400 watts into the

terminal impedance. It is desired to dissipate most of this power in a transmission line made of No. 10 iron wire so that only 40 watts reaches a resistor at the end of this line. The terminal impedance should be nearly 600 ohms.

The No. 10 iron wire has a diameter of 0.1019 in. At 30 Mc the skin depth is of the order of 0.0001 in. so that the ordinary skin depth formulas for resistance can be applied. The resistance of the wire is about 1156 ohms per wavelength.

Let $R_0 = 600$ ohms. Then $R\lambda/R_0 = 1156/600 = 1.927$. From the charts, $R/R_0 = 1.0116$. Therefore $R = 606.96$ ohms. Also, $-X/R_0 = 0.0553$, so that $-X = 33.18$ ohms. Hence, $Z_0 = 607 - j33.2$ ohms.

Reactive and resistive components of characteristic impedance, and attenuation and phase shift of transmission lines with high losses. The insert, upper right corner, is an enlarged scale drawing for small values of the graph



The attenuation is $0.0553 \times 54.7 = 3.03$ db per wavelength. For the power to be reduced to 1/10 of its initial value or 10 db, the length of the line must be $10/3.03 = 3.3$ wavelengths = 33 meters. This length of wire will dissipate 360 of the 400 watts fed into it. The other 40 watts must be taken up by a terminal resistor. A 1.5 inch spacing of the wires is needed to give the impedance characteristics indicated above.

Example 2: It is desired to make an attenuator, for use at 51.5 cm, 582 Mc, in the form of a section of a concentric line. The line is to have a section of its center conductor made of a metallized resistor. Use a 1000 ohm resistor, 1 inch in length, and $\frac{1}{8}$ inch in diameter. At this frequency the resistance will be assumed not to be affected by the frequency.

At 51.5 cm, one wavelength is 20 inches long. The high resistance section of the line has a resistance R_0 of 1000 ohms per inch. Let the characteristic resistance of the line be about 75 ohms which is given by using an outer cylinder with an inner diameter of $\frac{1}{8}$ inch. Therefore $R_0\lambda/R_0 = 1000 \times 20 / 75 = 267$. Using the high resistance approximation

$$\text{attenuation} = 27.35 \sqrt{267} \left(1 - \frac{\pi}{267}\right) = 439 \text{ db per wavelength} = 21.95 \text{ db per inch.}$$

The resistive component of the characteristic impedance is

$$\tau = R/R_0 = \sqrt{\frac{267}{4\pi}} \left(1 + \frac{\pi}{267}\right) = 4.69$$

Therefore $R = 4.69 \times 75 = 352$ ohms, and the reactive component of characteristic impedance is

$$-x = -X/R_0 = \sqrt{\frac{267}{4\pi}} \left(1 - \frac{\pi}{267}\right) = 4.52$$

Therefore $-X = 4.52 \times 75 = 339$ ohms, so that $Z_0 = 352 - j339$ ohms

From the phase shift formula for the 1 inch or 1/20 wavelength section the phase shift is calculated to be

$$\text{phase shift} = \frac{180}{20} \sqrt{267} \left(1 + \frac{\pi}{267}\right) = 149.5^\circ.$$

It will be observed that the phase shift and the characteristic impedance differ tremendously from the corresponding low loss values.

The high resistance 1 inch section of line must be matched to the $75 + j0$ ohm non-resistive portion of the line in both directions. When this is done the attenuation of the section is approximately 22 db and the phase shift 149.5° .

OCD Carrier Current Tests

INVESTIGATING the practicability of using existing electric power distribution lines for disseminating preliminary air-raid warning signals and general information to civilian defense personnel, the Office of Civilian Defense has conducted a series of tests in an Eastern city and suburban environs, using existing broadcast receivers without alteration for picking up carrier-current or "wired radio" signals fed into the lines on 720 kc.

Four requirements were laid down in advance. These were:

1. *Radiation from the lines shall be of no directive value to enemy raiders.*

2. *The signal at all desired terminal locations must be dependable, adequate and must not be affected unduly by changing nodes, power loads, or other line characteristics.*

3. *The substation equipment for generating and superimposing the carrier must be of reasonable power rating, and must entail a minimum of critical materials.*

4. *The signal must be capable of central point control and must not be unduly subject to sabotage or jamming or false signals.*

Line Data

Three types of power distribution lines were available in the area selected for the tests:

TYPE "A"—In the heavily loaded downtown area all low voltage secondaries are connected in multiple or parallel ("grid type" network). Service is fed to the system at various points, depending upon load requirements. Feeder lines are interconnected to several power sources. All distribution is essentially underground, with various transformer vaults strategically located throughout the area.

TYPE "B"—In outlying areas underground 4,000-v feeder line distribution is employed. Underground pole and subway type transformers are fed from strategically located substations which are in turn fed from three-phase 13,000-v lines. Low voltage secondaries of underground pole or subway type transformers distribute power to service entrances over an area of approximately two square blocks in residential sections and approximately one square block in neighborhood commercial areas. Feeder distribution from the substation is by three-phase, 4,000-v "Y"-type distribution with the center-tap or neutral grounded at the substation as well as at various points throughout the system.

TYPE "C"—In suburban areas the usual overhead power line distribution system is used. Various substations are interconnected by both 13,000-v and 4,000-v three-phase feeders. The three-phase, 4,000-v feeders emanating from

these various substations distribute power to subscribers in the various residential and commercial areas. The primaries are shunted at convenient points by the usual pole type transformer. Low voltage secondaries which distribute power to subscribers generally run parallel to the primary feeders for a distance of one-quarter wavelength or more.

Equipment Used

Equipment used for the tests consisted of two relatively low power radio transmitters, one consisting of a composite electron-coupled oscillator-buffer stage and a 6L6G power amplifier, high level modulated by means of a three-stage audio amplifier and the other consisting of a 25-watt amateur transmitter modified for broadcast band operation. The latter unit used a type 807 tube in the final r-f amplifier. Both units were equipped with the usual microphones and audio oscillators capable of turning out a 1,000 cps tone. They were capacitively coupled to distribution lines.

Broadcast receivers used for the tests included battery portables, auto-radio and standard line-operated types. Reports were also solicited from listeners located in the areas selected for the tests.

Test Results

Testing results on *Type "A"* lines, a transmitter was coupled into power service lines at a fuse box located on the seventh floor of a downtown office building. Various nearby locations were checked to determine the area covered. The signal was received satisfactorily in other offices on the same floor and, in some instances, on other floors but in no instance was there any indication that the signal followed electric power distribution lines outside the building. By using a portable battery operated receiver a strong signal was detected three-quarters of a block from the building. Tests even at this distance, however, indicated that noise level caused by elevators, motors, diathermy and other electrical equipment precluded satisfactory results in accordance with requirements 2 and 3. The result was not unexpected inasmuch as heavily loaded neutral-grounded grid networks carry several times the power load experienced under average urban conditions. (The problem of civilian defense communications and signalling is not considered serious in central business areas due to the usually ample telephone and alternate wire facilities available.)

Testing on *Type "B"* lines, a transmitter was connected at a substation. Dummy load against earth ground was used for preliminary tuning of the

resonant *L/C* coupler. When connected to the 4,000-v primary very little retuning was required, indicating that the distribution line was being fed under almost short-circuit conditions. The neutral of the three-phase 4,000-v system was well grounded at almost the same point. An estimated five watts of power went into the distribution system. A tour of the area supplied by the particular line bus "disconnects" which were energized indicated good coverage and proved that the signal was following the 4,000-v feeder lines. Although but one phase of the three-phase 4,000 v-primaries were energized directly it was apparent that the other two phases were receiving equal energy as transformers connected to these phases appeared to radiate the same signal strength. Strong signals were detected at manhole locations by means of a portable battery operated receiver for approximately two miles distance from the substation. Where transformers were of the subway type, fully shielded, no signal was received. Tests conducted with various receiver coupling methods to determine to what extent the signal was being induced into low voltage house secondaries were generally unsuccessful. No attempt was made to bridge primaries to secondaries of subway transformers, inasmuch as the equipment needed to do so on the scale which would be required was considered unjustifiable. It was concluded that although requirements 1, 3 and 4 were accomplished satisfactorily terminal locations desired in requirement 2 were limited to the comparatively few points where access to the 4,000-v primary

(Continued on page 130)

How The Wind Blows

THE OFFICE OF CIVILIAN DEFENSE, investigating every possible means of keeping civilian air-raid wardens and other officials in constant touch with headquarters, has already set up a War Emergency Radio Service plan in cooperation with the FCC

NOW THE OCD is hard at work investigating alternate signaling facilities. Here are some pertinent notes concerning one phase of the busy organization's carrier-current investigations.

G-E IGNITRONS—



The ignitron is a mercury-arc rectifier having a special control electrode or ignitor for starting the arc. Of the three G-E ignitrons shown, the two farthest left are welding-control types; the one above, a power-rectifier type.

Cutaway view of a typical welding-control type ignitron. For power-rectifier service, G-E ignitrons, in addition to the features shown below, include a deionization baffle, a splash-hood baffle, and an auxiliary anode.

Anode lead—connects tube in series with line.

Hose connection for cooling water.

Stainless-steel tube wall surrounded by water jacket.

Ignitor—with tip immersed in mercury pool. Connected in series with timer to control tube operation.

Ignitor lead.



Strong glass seal to insulate anode.

Anode—made of treated carbon.

Mercury pool (cathode).

Cathode terminal for support of tube and for connection in series with line.

Today's Electronic Answer

Myriad New Applications Lie Ahead for the Electronic Engineer

THE use of ignitrons in industry has grown steadily in the welding-control and power-conversion fields. The advantages offered by their use over ordinary mechanical devices are many: (1) There are no moving parts, hence little or no attention is required—one reason for the low maintenance expense of electronic equipment. (2) G-E ignitrons are sturdy and do not require extreme care in handling. (3) Because they are replaceable units, tube failure results in only the few minutes' shutdown necessary for making a replacement.

FAST, ACCURATE, RESISTANCE-WELDING CONTROL

In this field, G-E engineers have developed electronic-control equipment using ignitrons which now makes it possible to weld metals and alloys once difficult or impossible to weld. Ignitrons were immediately accepted for this job because of (1) their ability to pass the very high currents needed to develop the necessary heat, and (2) their quick response. The flexible and accurate electronic control of current with ignitrons is evidenced by stronger, neater, and faster welds and a reduction of rejects.

The sale of these tubes conveys no license, either expressed or implied, under patents of the General Electric Company other than those covering the tubes themselves.



RESISTANCE WELDING IS A HIGH-SPEED, PRECISION PROCESS when ignitrons are used to control the high-current surges necessary for this work. There are practically no resistance-welding machines in use today that require currents higher than G-E ignitrons are able to control.

POWER-RECTIFIER SERVICE MADE EASY in E. D. Guthrie mine at Blanche, Ky. A portable d-c substation, 200 kw, 275 volts, including a sealed-off ignitron-type rectifier. View shows General Electric FG-238-B ignitrons and the FG-172 thyatrons used for firing.



The long life of G-E ignitrons and the ease of replacement are also important. Another consideration is their comparatively small size. Since they require only a small amount of auxiliary apparatus, valuable space can be saved in high-production shops.

SIMPLIFIED, QUIET, HIGH-POWER CONVERSION

Power rectifier service is a new field of application for ignitrons in which G-E engineers are also contributing. Electronic rectifiers show how these tubes can replace hard-to-get rotating equipment, and often do a better job, with fewer auxiliaries, lower installation cost, less maintenance, higher efficiency, simpler control, and with no noise or vibration.

One application suggests another. Think of G-E ignitrons when accurately controlled high-current surges are necessary for a job.

Electronic control is fast making yesterday's impossible jobs a regular part of today's production. General Electric has a complete line of electronic tubes—for work that must be done better and faster. General Electric Co., Radio, Television, and Electronics Department, Schenectady, N. Y.

Welding control Types*	Price	Kva Demand	MAXIMUM RATINGS			Cooling	Shipping Weight in Lb	Ask for This Bulletin
			Corresponding Average Anode Current Amperes	Maximum Average Anode Current Amperes	Corresponding Kva Demand			
GL-415	\$33.00	300	12.1	22.4	100	Water	6	GET-968
FG-271	55.00	600	30.2	56.0	200	Water	12	GET-967
FG-235-A	110.00	1200	75.6	140	400	Water	16	GET-967
FG-258-A	250.00	2400	192.0	355	830	Water	45	GET-967

Power-rectifier Types†	Price	D-c Volts	MAXIMUM CURRENT			Cooling	Shipping Weight in Lb	Ask for This Bulletin
			Peak Amp	Average Amp	Average Amp 1 Minute			
GL-427	\$55.00	125	30	5	3
FG-238-B	355.00	300	1800	300	400	Water	35	GEA-3565
		600	1200	225	300			
FG-259-B	200.00	300	900	150	200	Water	22	GEA-3565
		600	600	100	133			

*Ratings are for voltages of 600 volts rms and below. Ignitor requirements for all welding-control types are 200 volts and 40 amperes.

†Typical ignitor requirements for power-rectifier ignitrons are 75-125 volts, 15-20 amperes. Maximum requirements are 150 volts, 40 amperes.

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THE ELECTRON ART

Engineers at I.R.E. convention discuss engineering activities under war conditions, application of f-m to home recording, and award Morris Liebmann prize to Dr. S. A. Schelkunoff for contributions to the theory of electromagnetic wave radiation

Summer Convention of the Institute of Radio Engineers

SMALLER THAN ANY CONVENTION within recent years was the Cleveland Summer Convention of the Institute of Radio Engineers, held at the Statler Hotel, June 29, 30, and July 1. A total registration of approximately 250 persons was indicated with an attendance at each of the meetings of about 180. This low attendance and the lack of papers on new developments reflected war-time activities of the radio engineers.

Highlights of the convention were the luncheon on Tuesday afternoon, at which Frazier Hunt, General Electric News Commentator analyzed world affairs and evaluated them in terms of recent developments in the Mediterranean, the banquet on Tuesday night which included a talk by George C. A. Hantelman on his collection of 14,000 recording discs, and the trip on Wednesday evening to Nela Park, and the Warner-Swasey Observatory to view the large Schmidt telescope.

At the banquet on Tuesday Evening, the Morris Liebmann Memorial Prize for 1942 was awarded to Dr. S. A. Schelkunoff of the Bell Telephone Laboratories "for his contribution to the theory of electromagnetic field in wave transmission and radiation."

In opening the convention on Monday morning, addresses of welcome were given by A. F. Van Dyck, president of the IRE, P. L. Hoover, chairman of the Cleveland Section, and Carl E. Smith, chairman of the Convention Committee. In his address, Mr. Van Dyck emphasized the position of the radio engineer in the country's present war effort, and pointed out that while a certain amount of secrecy may be necessary to prevent the enemy from knowing what is being developed in this country, this policy may become harmful if it prevents our own research workers or engineers from becoming familiar with the developments taking place at the present time. A free interchange of technical ideas is necessary if we are not to limit the present activities of research workers. Ways and means must be found to determine the results of research activities now under way. It was also pointed out that the Institute is engaged in an active program of standardization of

radio components which, it is believed, will prove beneficial after the war. As a result of the recent urging by the War Production Board to minimize travel, it was indicated that the Cleveland Convention may be the last for the duration of the war.

The first technical paper of the Convention was "Recording Standards" by I. P. Rodman, Columbia Recording Corporation, New York, whose paper was largely a recital of the preparation and establishment of standards for recording and associated equipment used for

broadcasting, under the sponsorship of committees organized in June, 1940, by the National Association of Broadcasters. The reports which have already been prepared, have been forwarded to all broadcasting stations. The standards covered such items as the mechanical dimension of records, direction and speed of rotation, the electrical characteristics, recording level, signal-to-noise ratio and wow factor measurements. The most desirable frequency characteristics for transcription records was the point of most concern in the committee meeting establishing the standards. The standard finally adopted for lateral transcriptions was a rising characteristic, almost linear from -14 db at 100 cps, to +16 db at 10,000 cps. For vertical transcriptions the standard rises almost linearly from -14 db at 50 cps to 0 db at 400 cps, is flat at 0 db between 400 and 1500 cps and then rises to +5, +10, and +18 db at 4200, 6900 and 10,000 cps, when the frequency scale is logarithmic, in both standards.

The second paper of the morning, and forming one of four papers on a symposium on sound recording and distortion was delivered by G. L. Beers and C. M. Sinnett, of the RCA Manufacturing Company, under the title "Recent Developments in Record Reproducing

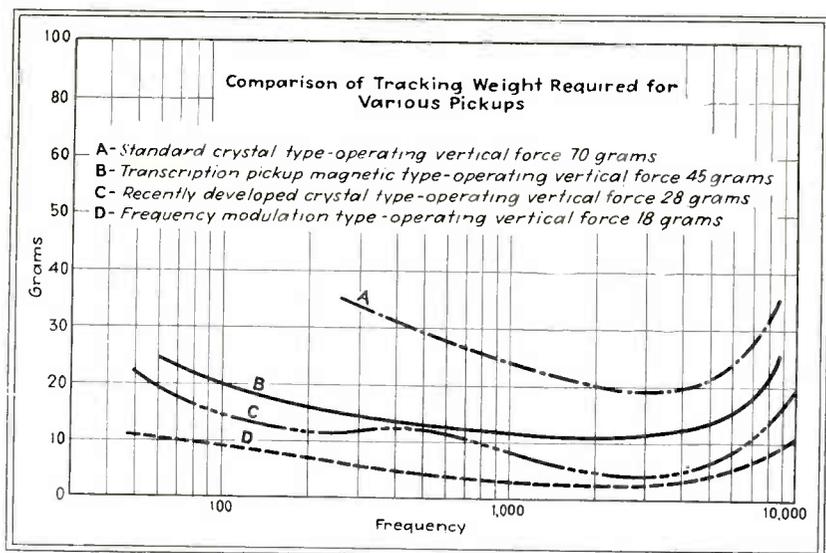


Fig. 1—Graph illustrating the tracking weights required for pick-ups of various construction and illustrating the advantage of the f-m type of pick-up (curve D)

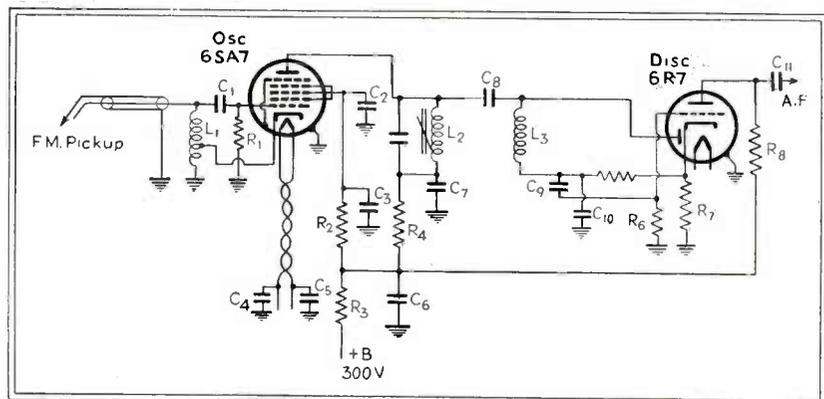


Fig. 2—Schematic wiring diagram of oscillator and discriminator of f-m phonograph pick-up recording system

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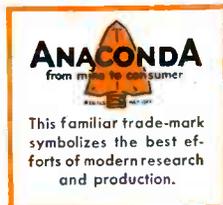
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Systems." The research underlying this paper (as well as that for other papers, for that matter) was concluded before the United States entered the War. Investigations were conducted during the past two years to determine the prospect of materially improving the overall performance of record-reproducing systems. Considerable attention was directed toward the possibility of reproducing frequencies up to 10,000 or 12,000 cps from standard shellacked records without the introduction of objectionable surface noise. The possibility of producing a frequency-modulated signal by means of a special pick-up and associated circuits was studied and such a method was found to lend itself to a realization of many requirements considered essential to a satisfactory reproducing system. A new pick-up, consisting of a metal frame or mounting block serving as a support for an insulated plate which holds a thin ribbon and stylus, was developed as the first essential unit in the frequency-modulated system. The lateral displacement of the stylus in this pick-up results in a change in the position of the ribbon with respect to the fixed mounting block, and thus produces a change in capacitance. In the frequency modulation pick-up it is essential that the change in capacitance with displacement of the stylus be such as to produce a linear relationship between frequency change and motion of the stylus. This condition is fulfilled, to a practical extent, in the type of pick-up already mentioned.

The pick-up producing capacity variations may be connected directly across the tuned circuit of the oscillator. This arrangement is not particularly desirable because the tone arm is made unduly large and the heat from the oscillator tube causes the end of the tone arm, which is handled by the user, to become uncomfortably hot. The same result can be accomplished by mounting the oscillator tube in the main instrument chassis and connecting it to the pick-up through a resonant transmission line which is used as the oscillator tuned circuit.

A simple resonant circuit is utilized as the means for converting the oscillator frequency variations into changes in the amplitude of the signal applied to the diode portion of the 6R7 tube.

The schematic diagram of the circuit used in the f-m recording system is shown in Fig. 2. Considerable attention must be paid to an arrangement of circuit and components which are free from temperature changes, and at the same time enable the pick-up capacity variation to produce the desired frequency changes, as a result of modulation.

A considerable portion of the Beers-Sinnett paper was devoted to a discussion of the experimental and mathematical analyses carried out to determine the characteristics of:

- (a) Lateral mechanical impedance,
- (b) Lateral force acting upon stylus,
- (c) Response characteristic of pick-up and tone.

Fig. 3—Simplified wiring diagram of reactance tube circuit which acts as an adjustable inductance in the distortion meter described by J. E. Hayes. This type of circuit replaced the inductances in a bridged-T frequency discriminating circuit

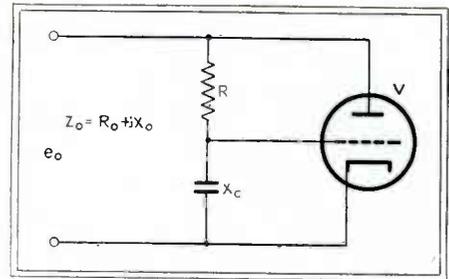
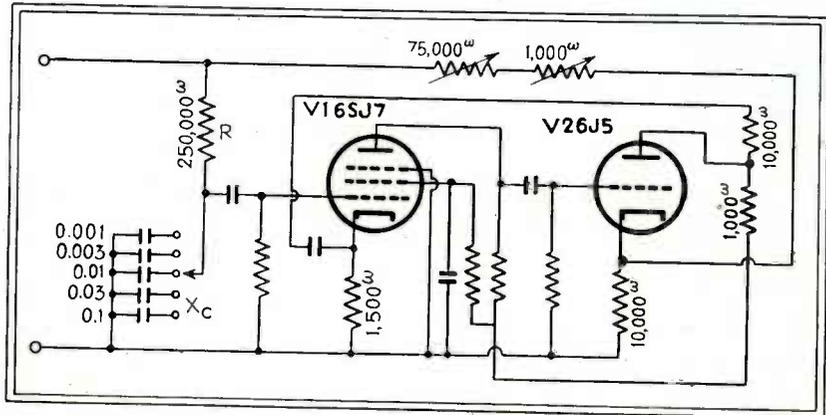


Fig. 4—Simplified schematic wiring diagram of the distortion meter. Gain is provided by the pentode, while proper phase relations are maintained by the triode cathode follower



- (d) Tracking weight required to overcome vertical force due to lateral velocity,
- (c) Tracking weight and relative output to be obtained with different radius of stylus.

An experimental frequency modulation record reproducing system, of the type described has been in use for some time. All of the evidence to date indicates that the system is a practical one and not adversely affected by changes in temperature, humidity and line-voltage.

The experimental frequency modulation pick-up meets the requirements of a satisfactory pick-up to a degree which has not previously been obtained in a relatively inexpensive device. The general performance characteristics in a pick-up of this device can be calculated within reasonable limits.

From the listener's standpoint, the experimental frequency modulation phonograph system which has been de-

scribed, makes it possible when using conventional shellacked records, to extend the frequency range of a record reproducing system to 10,000 or 12,000 cps with a surprising freedom from surface noise, mechanical noise, and distortion. A further reduction in surface noise can be obtained with shellacked records if they are recorded with a high frequency accentuation characteristic which is comparable to that used in transcription. Experimental records of this type have been made. The surface noise obtained from these records with the frequency modulation reproducing system was reduced to a point where it was not objectionable to the most critical listeners.

Although the calculations and measurements which have been given are confined primarily to 78 rpm, records of the same performance advantages are retained in a frequency modulation reproducing system designed for transcription.

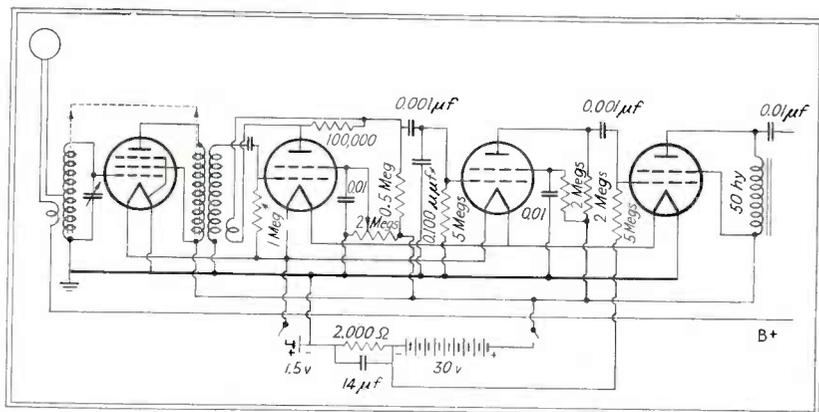
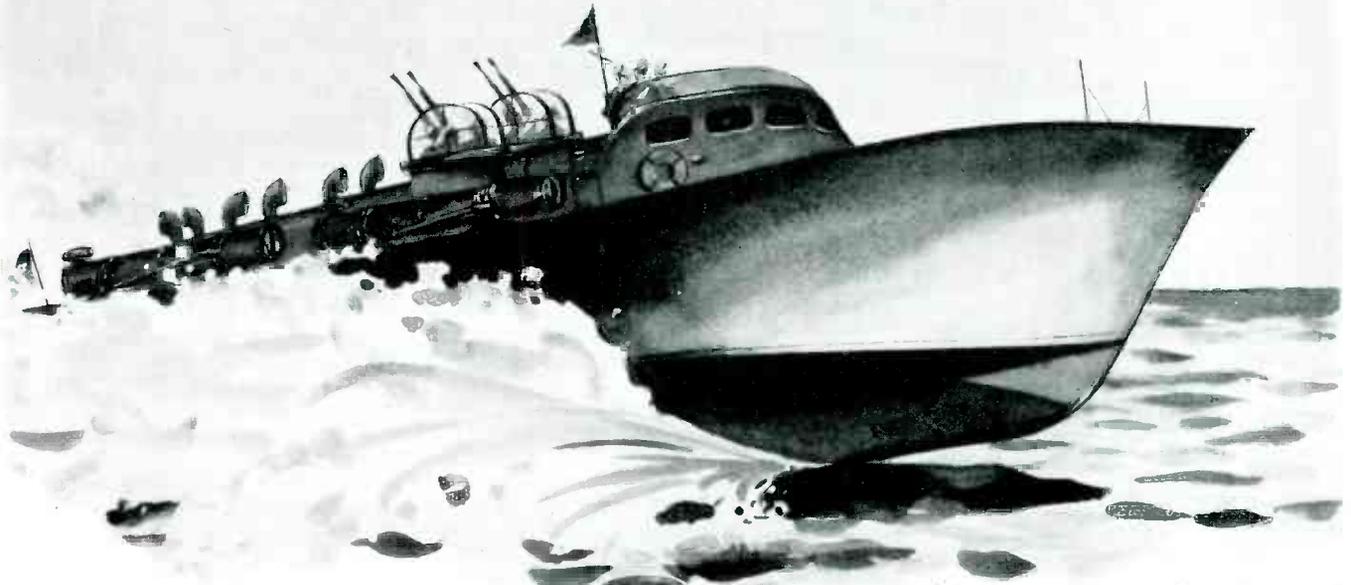
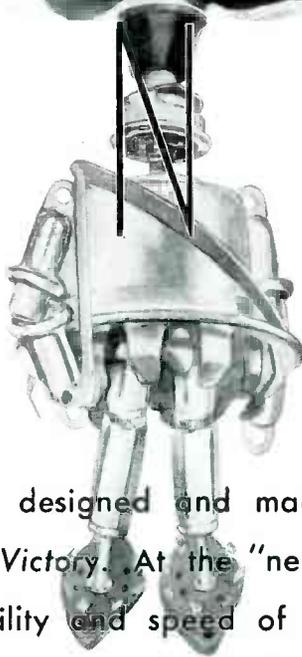


Fig. 5—Circuit of four-tube portable radio receiver which fits into breast pocket of man's suit, as described by W. J. Brown

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A paper by H. E. Roys, RCA Manufacturing Co., Indianapolis, on "Measuring Transcription Turntable Speed Variations" was the third paper on the recording symposium of Monday morning. Because of the extensive use of discs of the transcription and home phonograph type in the radio broadcasting field, it is becoming more important to maintain high standards of record reproduction. One of the essential requirements is that of speed constancy or freedom from wows of the reproducing turntable. The term wow is now generally used to denote such speed variation.

The effect of speed variations as perceived by the ear occur as direct pitch variations at low rates, increasing to flutter at higher rates, and finally indiscernible as pitch changes but recognized as distortion due to the production of side bands because of frequency modulation.

Early wow equipment developed for measuring turntable speeds with the aid of a constant note record and a frequency modulation detector consisted of a tuned circuit where operation was on one side of the resonance curve. The present laboratory equipment which operates on the same principle has been improved and uses two tuned circuits in push-pull to balance out changes of input voltage. A magnetic tone wheel is used instead of records and two balanced pick-ups help to minimize errors due to misalignment and vibration.

Simplified equipment such as used by the RCA Service Department in which a bridge circuit with three resistance branches and one tuned circuit branch was described. With this type of circuit a band-pass filter is used in the input circuit and the tuned circuit of the bridge is tuned to the carrier signal. Any change in speed-frequency unbalances the bridge and is registered on the detector meter. The reading of the meter is then the wow of the turntable.

Due to operating directly at the resonance point of the tuned circuit a speed deviation in either direction gives the same voltage increase across the detector and doubles the frequency applied to the meter. The frequencies applied to the meter are low, however, when wow rates of frequencies corresponding to one revolution at 33½ and 78 rpm are encountered so that the ballistic constants of the meter are important. Tests made with different meters showed the difficulty of reading the meter accurately and to overcome this a special meter with a lower frequency resonance and increased damping was obtained. An improvement in accuracy of reading resulted.

The method of expressing the wow content as a single figure was discussed and preference given to the r-m-s method over the present peak to peak (maximum to minimum speed deviation expressed as a percentage of the average value) method.

A 16 mm film showing the swinging of the meters at low wow rates was shown at the convention.

"A New Type of Practical Distortion

Meter" was described by J. E. Hayes, Canadian Broadcasting Corporation, Montreal. The distortion measuring instrument was developed since commercially available instruments were usually either rather critical in adjustment, or else could be used only on certain predetermined frequencies, and furthermore could be obtained only on orders having high priority rating.

A simple method of making distortion measurements may be based on the frequency selective characteristics of the bridged-T network. The difficulty with such a network made of the usual circuit elements is the lack of flexibility because of the large variable inductances required. This has been overcome in the design developed by Mr. Hayes by replacing actual inductances by their electrical equivalent inductances provided by a reactance tube circuit. The inductance is altered by varying the voltage.

A simplified reactance tube circuit is shown in Fig. 3 in which the voltage applied to the grid of the vacuum tube is retarded almost 90 deg. with respect to e_0 by making R large with respect to X_c . The plate current also lags e_0 by almost 90 deg., producing an effective inductance at the input terminal.

A practical embodiment of this circuit is shown in Fig. 4 where two tubes are required to obtain the desired results. A pentode tube provides the necessary gain, while a triode used as a cathode follower maintains the proper phase relationship and gives the low output impedance necessary for low

values of reactance. Smooth control of the reactance is obtained by a 76,000 ohm resistor, which changes the effect of output impedance R_p of the tube V_2 . This circuit is used as the electronic inductance in the frequency discriminating circuit. The distortion meter consists essentially of a bridge T audio frequency bridge circuit in which the inductance element is replaced by a reactance tube circuit. Because of the flexibility obtainable in vacuum tube circuits, it is a relatively simple matter to vary the effective inductance continuously over a fairly wide range, and thus allow the distortion meter to be used at any frequency in the audio range.

Certain precautions must be taken in a circuit of this type in order to avoid difficulties due to non-linear action of the reactance tube circuit. Application of negative feedback effectively reduces the non-linearity, increases stability, and at the same time keeps tube noise and hum at a minimum level. Certain limitations inherent in a reactance tube circuit of this type are:

1. It can be used only in relatively low-voltage circuits.
2. The Q of the circuits drops off on either side of some optimum frequency, and
3. Care must be taken in the design of the amplifier portion so that phase shifts introduced by it do not cause the circuit to break into oscillation.

The final paper on the Monday morning session was "Frequency Modulation Distortion in Loud Speakers" by

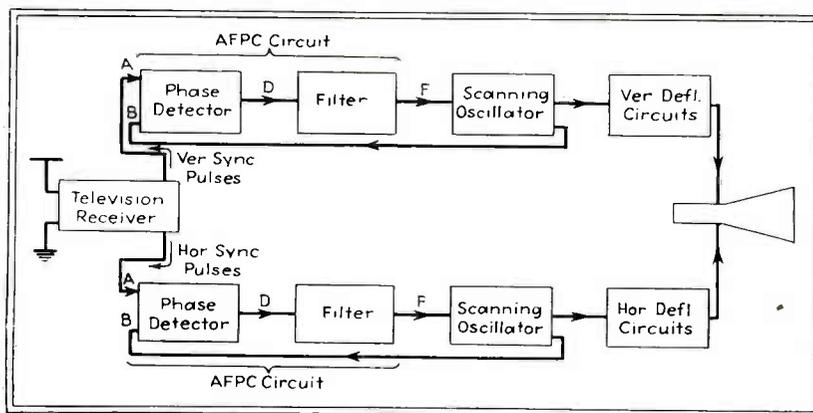


Fig. 6—Block diagram of the elements required in the automatic frequency and phase control synchronizing circuit described by Wendt and Fredenhall

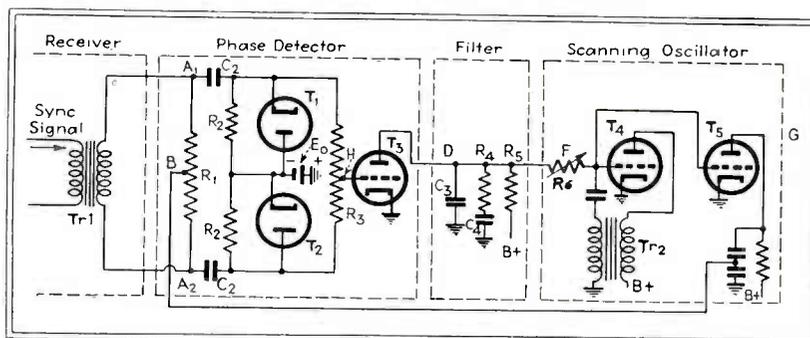
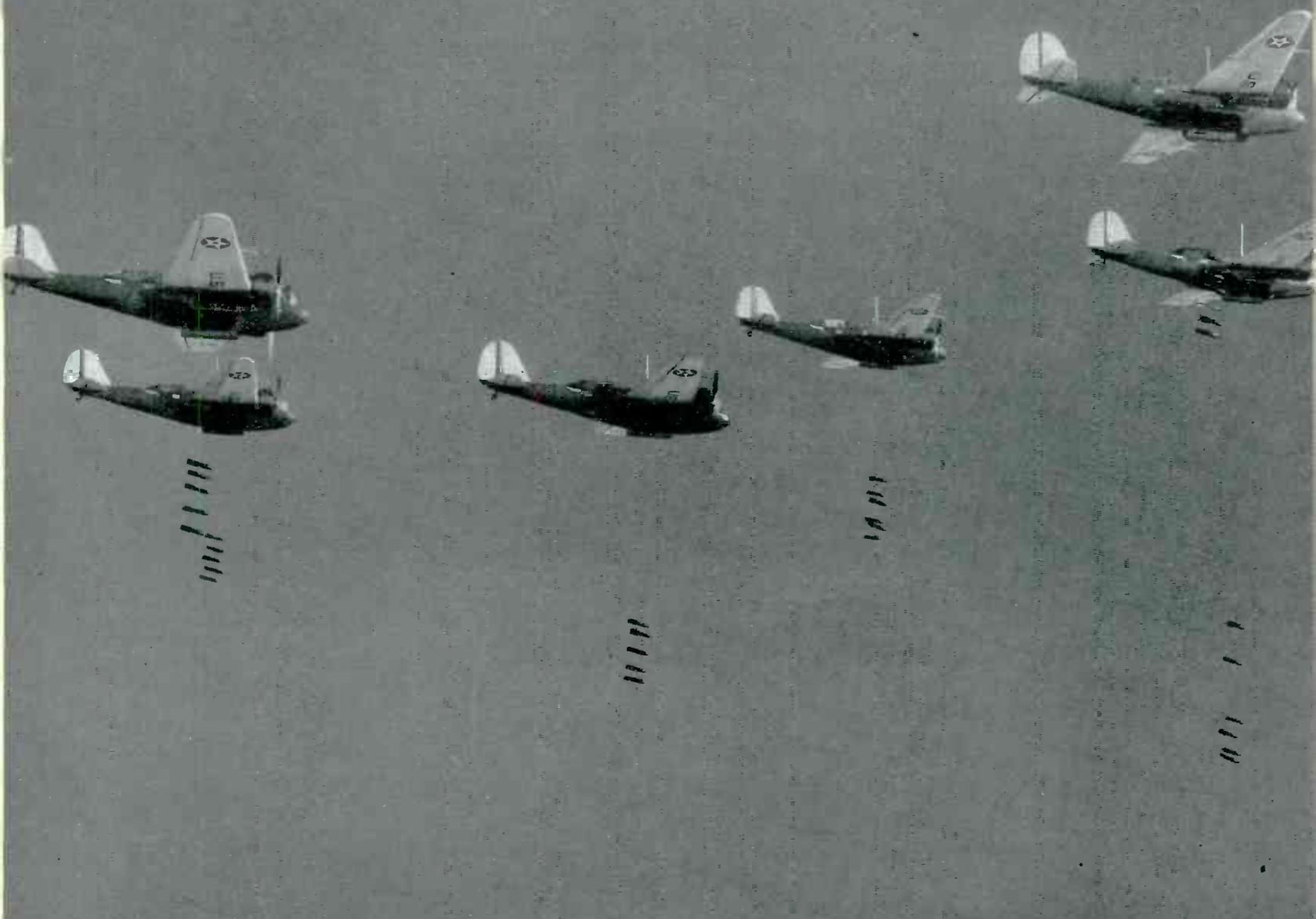
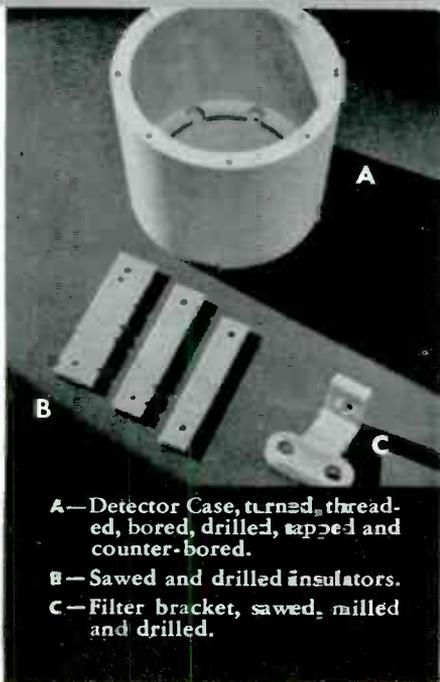


Fig. 7—Schematic diagram of connections of the phase detector and scanning oscillator of the AFPC television circuit



Official Photo U. S. Army Air Corps

Tokio, Nagoya, Osaka, and Points East



A—Detector Case, turned, threaded, bored, drilled, reamed and counter-bored.

B—Sawed and drilled insulators.

C—Filter bracket, sawed, milled and drilled.

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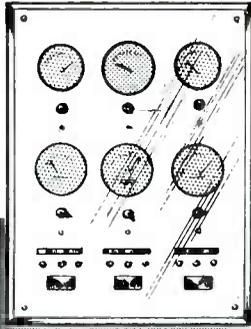
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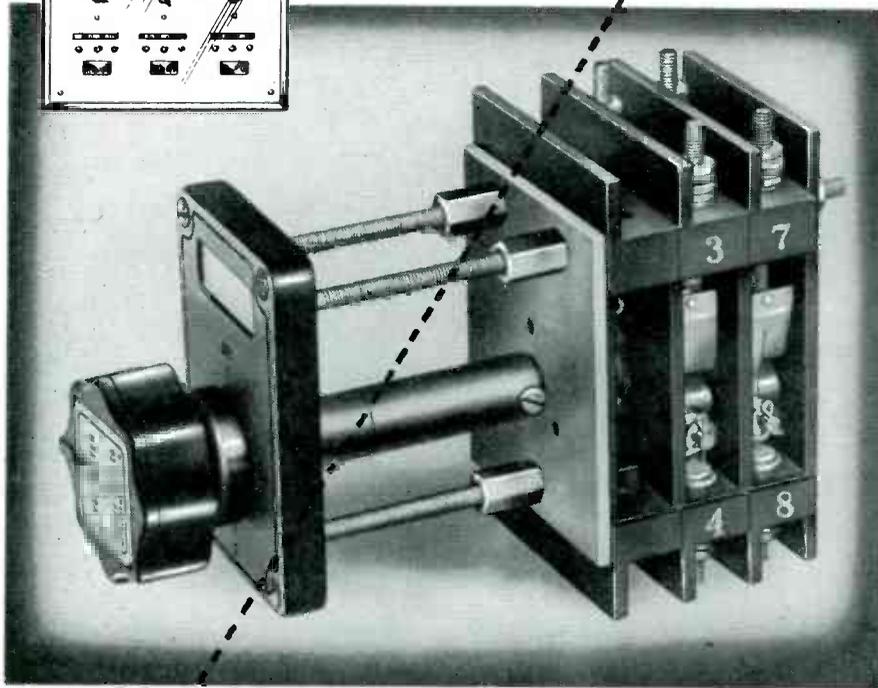
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G. L. Beers, and H. Belar, RCA Manufacturing Company. It was shown that as the frequency response range of a sound reproducing system is extended, the necessity for minimizing all forms of distortion is correspondingly increased. Although distortions contributed by the loud speaker have been frequently analyzed, a type of loud speaker distortion which has not received general consideration was described. This distortion is the result of the Doppler effect, and produces a frequency modulation in loud speakers reproducing complex tone. It was shown by mathematical derivation, supported by laboratory measurements, that this type of distortion may be minimized by reducing the diameter of the cone of the speaker and using separate speakers for both the low and the high-frequency components.

The first paper of the Monday afternoon technical session was "Radio Frequency Oscillator Apparatus and Its Application to Industrial Process Control Equipment" by T. A. Cohen, Wheelco Instruments Co., Chicago. This paper described an electronic relay mechanism which avoids many detrimental features incidental to photoelectric equipment when applied to industrial control. The apparatus described is Fig. 8, a type of tuned grid-tuned plate oscillator which takes advantage of the large steady current changes which may be made to take

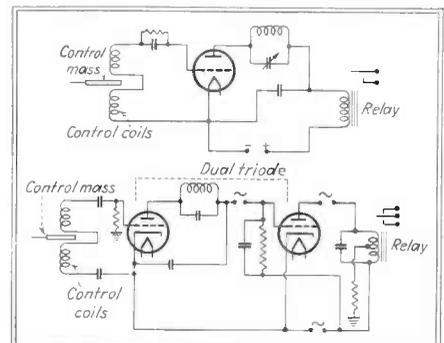


Fig. 8—Fundamentals of tuned-grid tuned-plate oscillator used as a relay. The control mass alters the plate current which in turn actuates a relay

place in some varieties of self-excited radio frequency oscillators, with small changes in coupling or excitation.

In most instances the direct current component present in the plate circuit of such oscillators is allowed to flow through an electromagnetic relay of suitable characteristic which is maintained in a pre-chosen contacting position by suitable adjustment of the oscillator. Upon being tuned or de-tuned by the approach of a mass of metallic, in other cases, non-metallic material, to a suitable portion of the oscillator circuit, the oscillator causes a change in contacting position of the relay through the change in steady plate current value.

One form of the oscillator type relay mechanism has been applied widely to the problem of producing an electrical contact function by the motion of the pointer of a sensitive and delicate measuring mechanism without disturbing

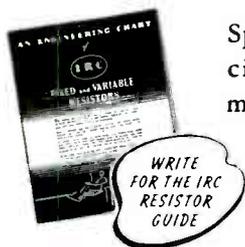
4 Things Resistor Users Can Do

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Wherever possible specify $\pm 20\%$ or $\pm 10\%$ tolerance resistors instead of $\pm 5\%$ tolerance. Stocks of 10% in some ranges, and 20% in almost all ranges, are available whereas 5% resistors must be manufactured. In many types of resistors yield is based on tolerance, therefore the wider the tolerance the greater the yield. Specify wider tolerances to save material, time in delivery, delays in production.

USE STANDARD RESISTORS

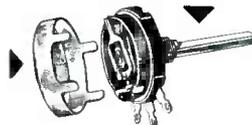


Special resistors require special engineering, tooling, materials, and specially trained operators plus special Army and Navy stocks of spares which greatly complicate the problems of fast production and replacement in the field.

Resistor users are urged to use standard types and sizes wherever possible—standards of the industry, and the standards included in existing specifications for large percentage of Army and Navy equipment.

Whatever your war equipment resistor need, whatever your tolerance specifications or delivery dates, IRC will cooperate to the full limit of its greatly expanded facilities in meeting them. We realize there are many cases

SPECIFY NON-FERROUS METALS FOR NON-CONDUCTING PARTS



In many instances, specifications can safely be revised to eliminate hard-to-get ferrous metals in favor of non-ferrous metals. This is especially true of non-conducting, non-functioning parts such as covers, shafts, etc. for controls and rheostats. Not only does this mean conservation of critical materials, but it serves as an aid in obtaining materials promptly.

SPECIFY DELIVERIES TO MEET ACTUAL PRODUCTION SCHEDULES

The problem of specified delivery dates versus actual production-use dates is a difficult one for both buyer and supplier. With IRC Resistors so generally specified for war work, however, and with IRC production devoted 100% to meeting these demands, our manufacturing problem is simplified when *production-use* dates are specified. On this basis, deliveries can often be staggered over an entire production period, rather than being demanded far in advance of actual use dates, thus taking a long step toward "on time" deliveries for all.

where none of the foregoing suggestions may prove applicable. Wherever they can be applied, however, they will play a part—small, but none the less important—in speeding up the war effort and increasing its efficiency.



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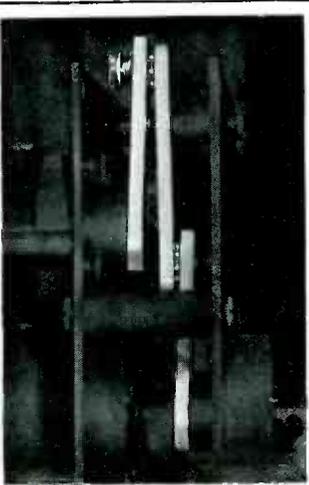
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the measuring accuracy of the mechanism. Other forms of the apparatus where described as applied to forms of industrial control in which no mechanical measuring mechanism is involved, but in which the motion of fluids such as in manometer columns and flowmeters, or moving masses of metallic, non-metallic, solid or liquid material were considered. The control functions described are primarily concerned with contacting action in which the contact determines the presence or absence of the controlled medium such as the electric power flow to a furnace.

The paper dealt finally with more specialized forms of control function, in which the controlled medium must be throttled so that only sufficient controlled medium is made available to supply the demands of the process, consistent with maintaining a steady state of balance in the process.

A comparatively new type of electronic development, "The Scanning Microscope", was described by V. K. Zworykin in a paper of which J. Hillier and R. Snyder were co-authors. The new electron microscope of the scanning type has been developed to examine the surfaces of all material with the high resolving power afforded by the use of the electron beam. The new scanning microscope is suitable for the examination of opaque objects, whereas the usual type of electron microscope thus far in use has been limited to an examination of "transparent" subjects by passing the electron beam through the material under examination. In the scanning microscope the specimen is moved mechanically in such a way that each point of its surface is scanned in a systematic fashion by the electron probe in much the same manner as television scanning. The secondary electrons which are emitted from the point of the specimen bombarded by the electrons of the probe, are accelerated and projected on a fluorescent screen. The intensity of the light emitted by the fluorescent screen varies in accordance with the secondary emission properties of successive points of the specimen. This modulated light signal is converted into an electrical signal by means of a multiplier phototube and is then synthesized in a printed picture by an amplifier and facsimile printer system. The use of the electronic-light-electronic transformation of the image signal improves the signal-to-noise ratio by at least an order of magnitude over that found in conventional method of collection and voltage amplification.

In outlining this paper, Dr. Zworykin traced the difficulties in the development of this scanning microscope and showed how various methods of approach proved most promising at one time or another, depending upon the status of the television development of the time.

An experimental model of the scanning microscope has been constructed and has been successful in producing images of etched metal surfaces at magnifications as high as 10,000 diameters with a resolving power considerably better than 50 millimicrons.

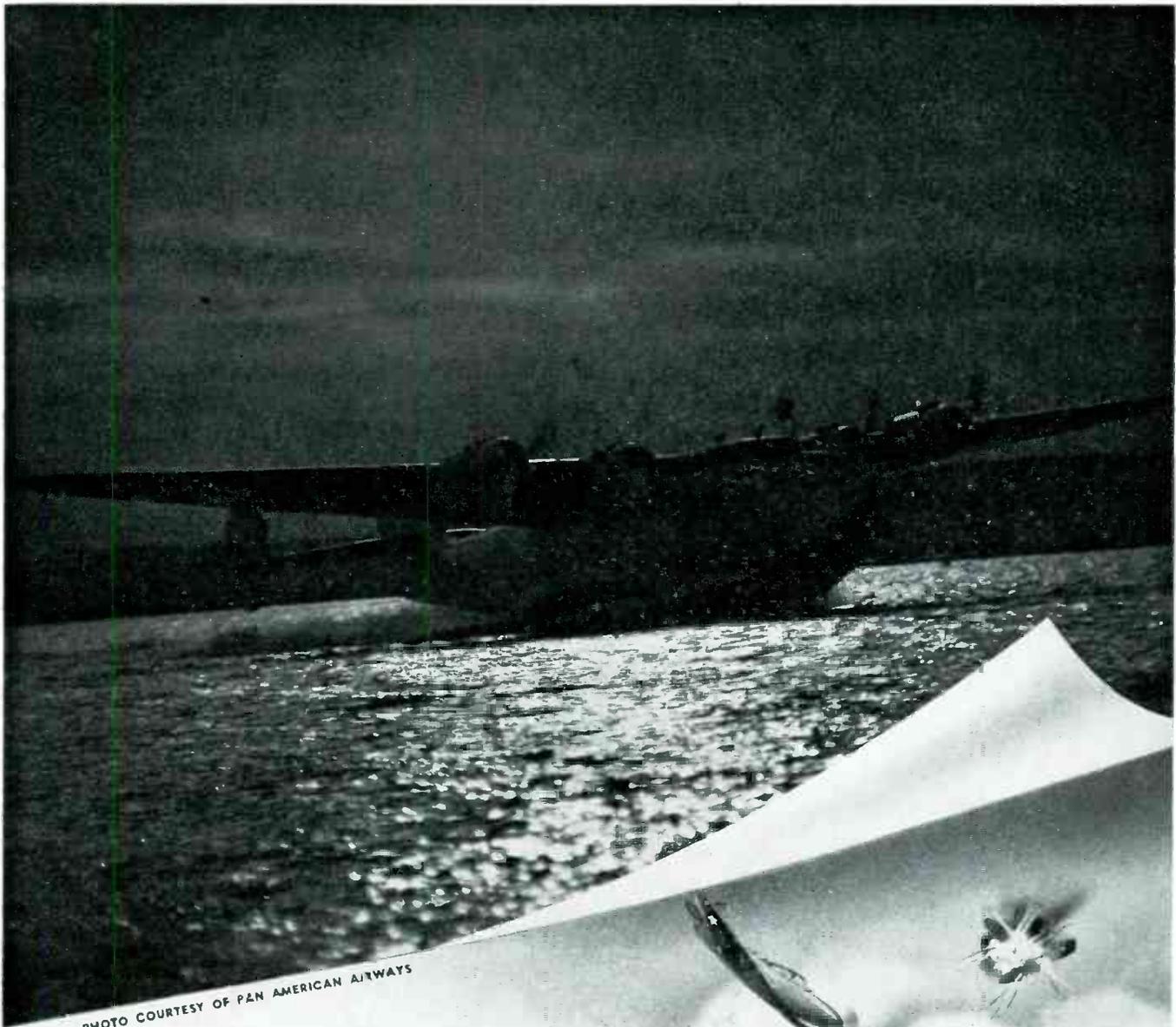


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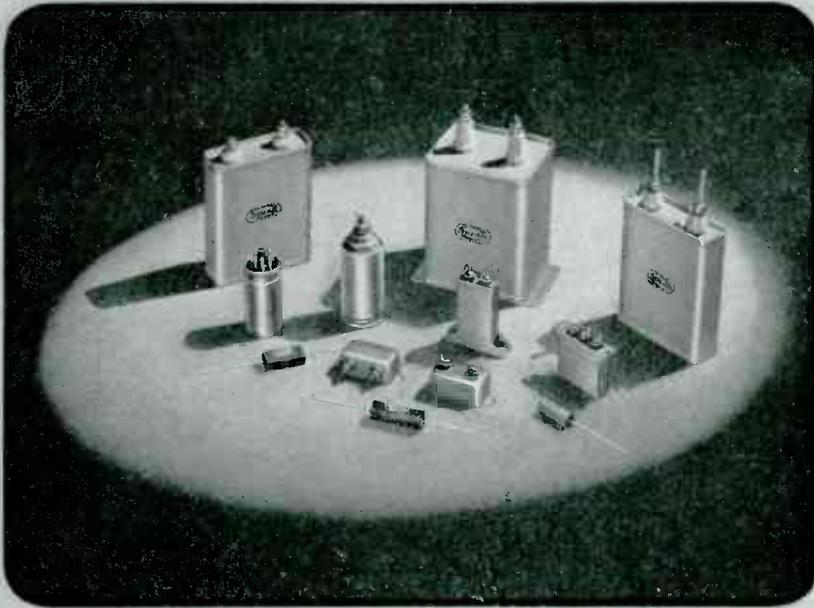
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"QUALITY ABOVE ALL" CAPACITORS



Dr. S. A. Schelkunoff, of the Bell Telephone Laboratories who received the Morris Liebmann memorial award for his theoretical studies of the transmission and radiation of electromagnetic waves

"Spectroscopic Analysis in the Manufacture of Radio Tubes" was the title of a paper delivered by S. L. Parsons, Hygrade Sylvania Corporation. This paper was devoted to a description of the use of spectrographic methods in attacking some of the problems encountered in the manufacture of tubes.

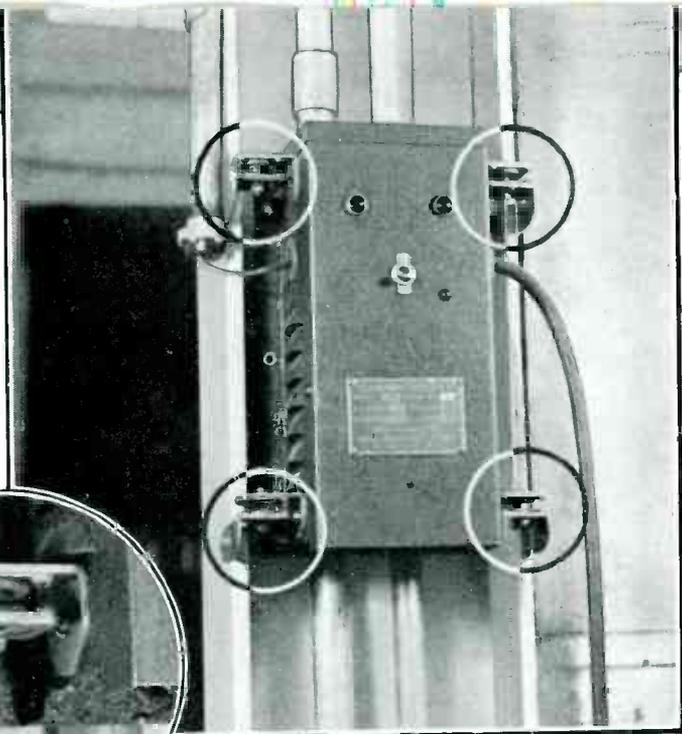
The spectrographic equipment installed at the Hygrade Sylvania plant was intended as a tool in attacking chemical, metallurgical, fluorescent and ceramic problems of tube manufacture. The spectroscope and densitometer used in making and analyzing the measurements, as well as the arc light sources were described in detail. The various applications of this equipment to the quantitative and qualitative analyses of materials going into the manufacture of radio tubes were discussed, and it was shown how the spectroscopic laboratory was able to improve the quality of tubes, minimize difficulties of manufacture through accurate and appropriate analyses.

A rather mathematical paper on "Minimizing Aberrations of Electron Lenses" was given by H. Poritsky of the General Electric Company in Schenectady. The primary object of the paper was the determination of minimum spherical aberration through the investigation of several possible ways of obtaining sharp focusing.

C. H. Gleason presented the paper "Half-Wave Voltage-Doubling Rectifier Circuit" of which W. D. Waidelich is co-author. Both men are with the University of Missouri. It was shown that the half-wave voltage-doubler is useful as a power supply and has several advantages over other circuits employing input transformers. It offers economy in cost, size, and weight and hence is used in transformerless receivers. For use in radio-receiver power supplies, it has the important advantages of having a common input and output terminal.

Although no analysis of this half-

*Isolated
from
Vibration*



When flexibly suspended on **LORD** Mountings,
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electronic equipment requires fewer tube replacements
and retains its designed accuracy in any installation

VIBRATION from overhead cranes and production equipment can easily affect the accuracy and shorten operating life of electronic control equipment. Manufacturers who want to be certain that their electronic equipment will function as well in a steel mill, for example, as in a quiet laboratory, are using Lord Mountings to isolate destructive vibration. Standard Lord Plate Form Mountings are manufactured for supporting loads from ½ lb. up to 300 lbs. each. For heavier loads, Lord Tube Form Mountings are made for loads from 20 lbs. up to 1500 lbs. each.

A typical installation is shown in the above photographs of an electronic rectifier. This instrument is flexibly attached to a steel column at four points by Lord Plate Form Mountings in series. Lord Mountings, when properly installed operate freely in shear, and

the vibrations are dissipated by a slight movement of the equipment on the mountings, rather than being absorbed in the instrument. The use of two Lord Mountings in series, doubles the axial softness, and increases the sensitivity and isolation efficiency of the mounting assembly. Double mountings are also recommended for applications when the vibrations are of a lateral nature in addition to vertical disturbances.

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wave doubler seems to have been made, several references to its operation and applications may be found. The purposes of this paper were to present the results of the analysis by means of curves suitable for use in design, to compare some of the theoretical results with experimental results.

A comparison of the operating characteristics of the half-wave and full-wave voltage doublers shows that throughout the normal operating range (ωCR greater than 10) the full-wave doubler offers a higher input power factor, lower maximum tube currents, slightly less ripple (and of higher frequency) in the input voltage, and slightly better voltage regulation; while the half-wave doubler offers lower peak inverse tube voltages, lower effective input currents, and a common input and output terminal allowing both the load and input source to be grounded if necessary.

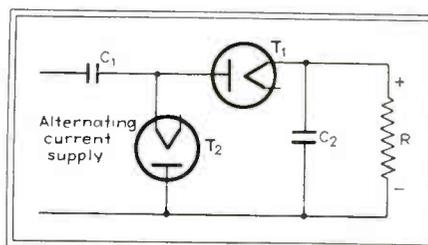
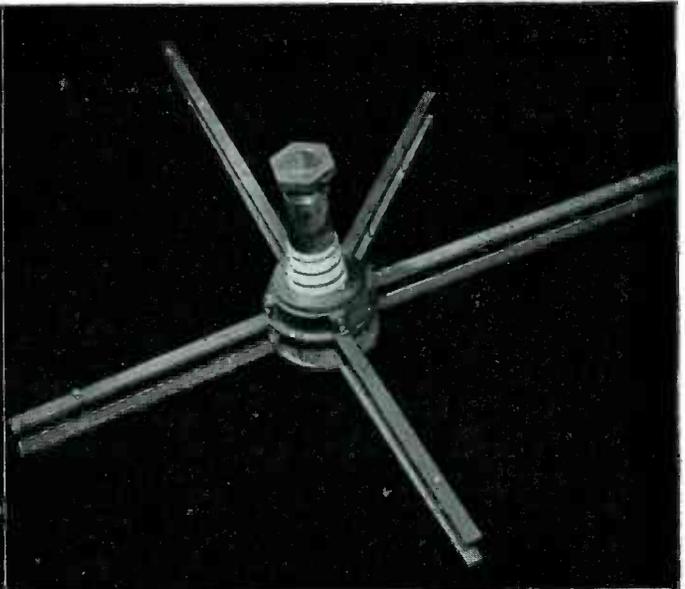
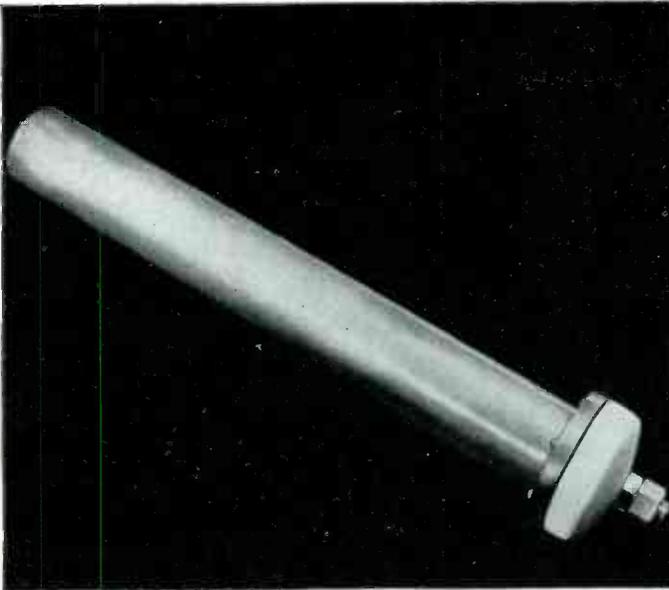


Fig. 9—Diagram of circuit of single wave voltage doubling rectifier

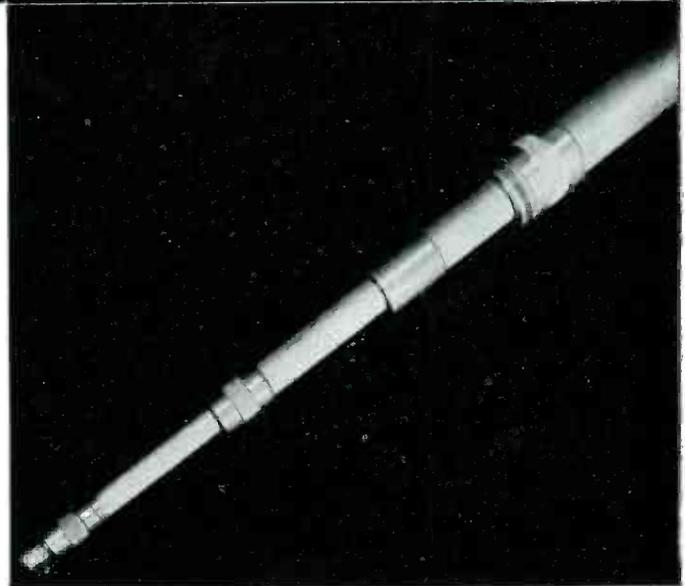
The performance of a half-wave doubler, Fig. 9, may be predicted if the capacitance of the two equal condensers, C_1 and C_2 and the load resistance R are known. Upon evaluation of the parameter (ωCR), the curves of Fig. 10 may be used to determine the operating characteristics of the circuit.

These curves may also be used to design a half-wave doubler to meet certain prescribed operating conditions. Often the input voltage and frequency, the output d-c voltage, and the output d-c current are specified. In addition, the application may restrict the percent ripple allowable in the output voltage. Hence E_m , E_{dc} , and I_{dc} are specified together with a restriction on the percent ripple r . From the curve of Fig. 10 the value of (ωCR) is fixed by the ratio (E_{dc}/E_m). The capacitance of the condensers may be found from ωCR , the load resistance, ($R = E_{dc}/I_{dc}$), and the supply frequency $\omega/2\pi$. The curves of Fig. 10 may be used to determine the peak inverse tube voltage and the maximum tube current, thus enabling the selection of rectifier tubes of proper inverse voltage and maximum current ratings, and percent ripple in the output voltage. If this value is greater than the percent ripple allowable, the output voltage may be filtered, or some compromise in the specified current and voltages may be made so as to increase the value of (ωCR). The percent ripple in the output can be materially reduced by placing a filter circuit between the output condenser and the load resistance. Insertion of a



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release production facilities and
personnel for major assembly jobs



IT IS the countless minor assembly operations that add to the cost and delay the production of war equipment. By turning over to Isolantite Inc., for subassembly, the parts in which steatite is combined with metal in various forms, you release needed production facilities and skilled hands for major assembly tasks. Isolantite's ability to furnish subassemblies that meet the most exacting demands is a matter of record.

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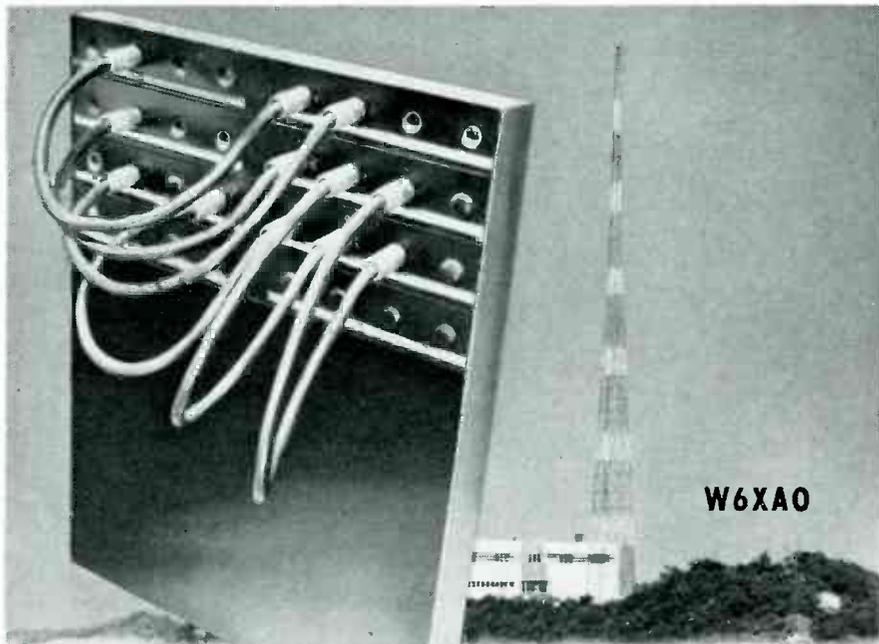
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An important link in the television "picture" switchboard, through which electrical waveforms are patched from one studio to another, is the Cannon Coaxial Connector. The problem of conveying frequencies of 0 to 5 million cycles was solved by coaxial cables and the accompanying plugs and jacks, which are a special Cannon application.



Voices, music and television pictures must pass through plugs without loss or distortion at the Don Lee Television Station atop Mt. Lee, Hollywood, Calif. These coaxial fittings provide continuous shielding with constant impedance. Wiring and shielding are shell protected and Isolantite washers are used for further insulation.

This is just one use of the many highly specialized Cannon Connectors for making electrical connections quickly and with absolute certainty—in tanks, planes, motion picture studios and hundreds of other civilian and military uses.



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filter will cause some alteration in the operation of the doubler circuit as predicted from this analysis; however, the analysis will still afford a rather good approximation of the other operating characteristics of the doubler.

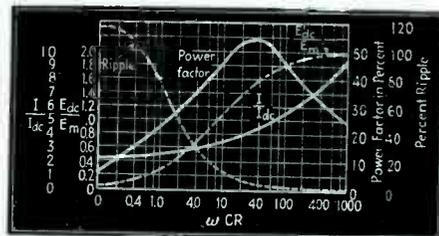


Fig. 10—Performance characteristics of the circuit of Fig. 9

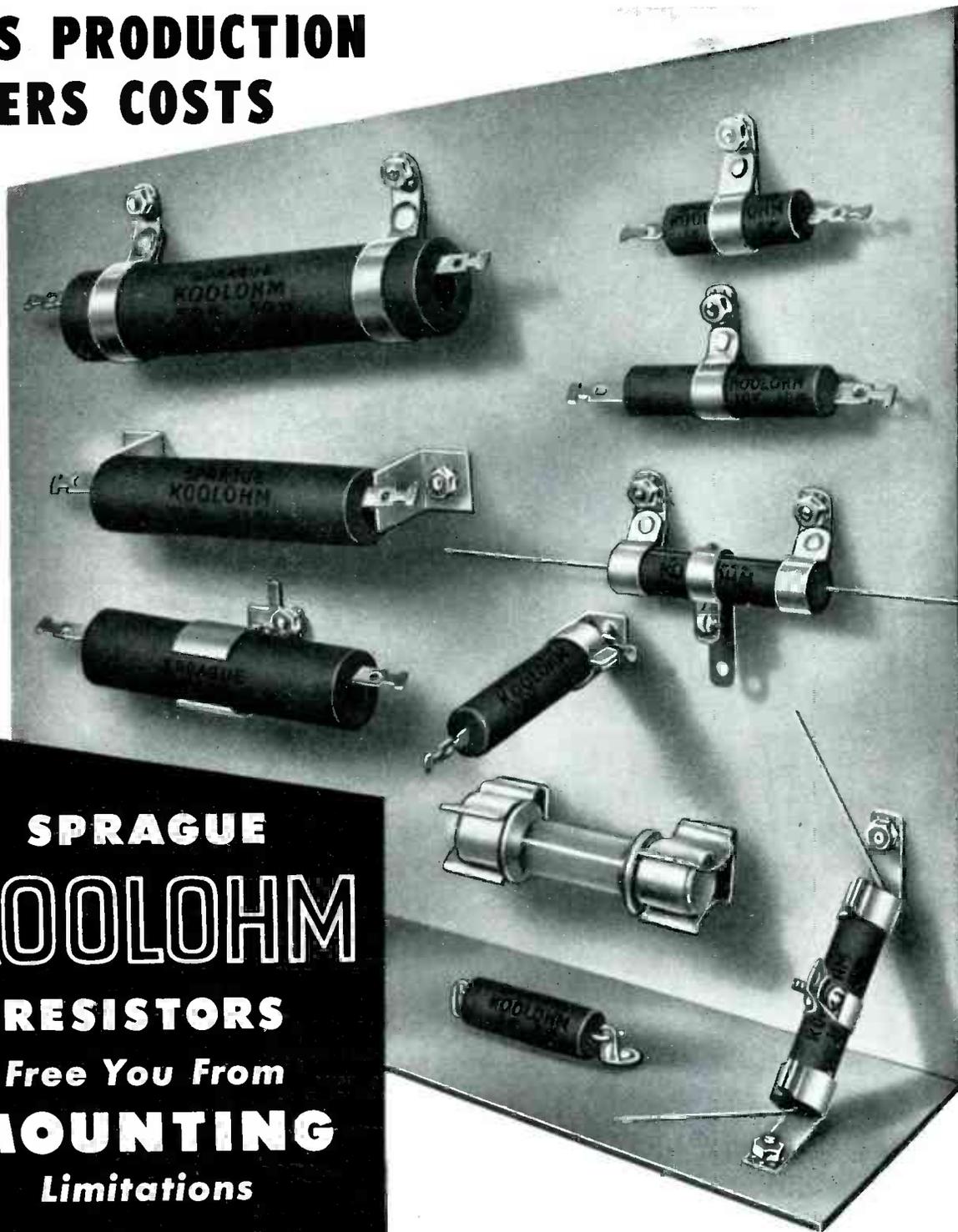
On the basis of the experimental verifications obtained, the mathematical analysis is representative of the actual operation of the doubler circuit, and therefore, prediction of the performance of the doubler by the analysis seems justifiable. The assumption of no tube drop while conducting seems to have introduced little error, but for large tube drops an extension of this analysis would have to be used.

It has been shown that the design of this circuit and the predetermination of its performance is facilitated by the use of the results of this analysis.

In opening the Tuesday morning technical session, J. A. Ouimet of the Canadian Broadcasting Corp., gave a very timely paper on "Maintenance of Broadcasting Operations During Wartime." A rather complete analysis of the current wartime problems facing operators and engineers in broadcasting stations was made. The important factors which must be taken into account include: (1) protection against sabotage, by the erection of fences and barricades, by the provision of floodlighting, and armed guards; (2) protection of plants by fire instruction and precautions; (3) conservation of equipment by efficient utilization, by good maintenance and operation practices, by the rehabilitation of obsolete units, by the elimination of unnecessary operations, and by the reduction of the power of transmitters; (4) protection of transmitter operation by emergency antenna, for operation out of the driver stages, by standby generators, and by standby transmitters of low power; (5) protection of studio operation by dispersion of facilities, by the setting up of emergency control points and by the use of portable equipment and mobile units.

It was pointed out that in all of these measures and others which may be taken, the engineering difficulties are minor ones and yet progress in overcoming them is frequently most difficult. The real problem of the broadcast engineer is first to bring about a full and general realization of the seriousness of the situation and secondly, to take immediate and effective measures to meet that situation irrespective of the effort, inconvenience and constant self-

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Koolohms are doubly protected. The wire itself is insulated before being wound AND—all types are sealed in sturdy, chip-proof, ceramic or tempered shock-proof glass casings.

Therefore, they operate safely and dependably even when mounted directly to grounded parts with the simple attachments illustrated above. All of these methods of mounting are today being used by prime- and sub-contractors who are meeting exacting specifications with Koolohms.

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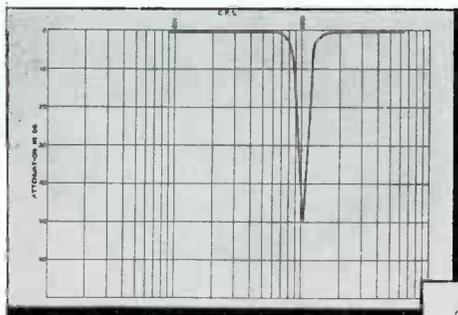
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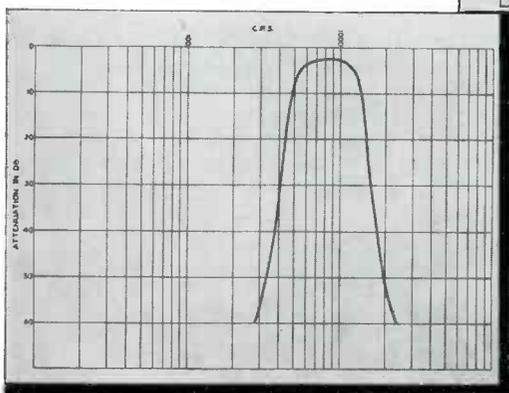


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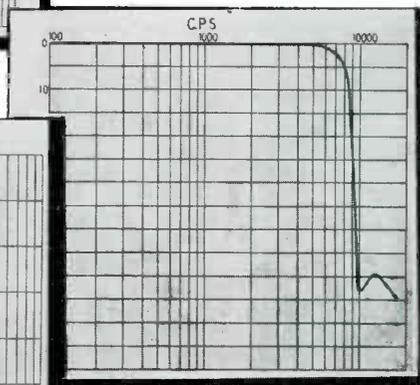


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discipline which these may entail. In the face of an emergency which may strike at any time in any location, preparedness is the first and most important duty.

H. B. Fancher, General Electric Company, described a "High Power Television Transmitter", station WRGB, whose erection was started in 1938. The transmitter is at Helderberg Mountain, 12 miles from Albany, and serves the Albany-Schenectady area. The station includes a 40 kw visual transmitter and a 20 kw aural transmitter. That part of the visual transmitter located at the main station consists of a high frequency receiver, a converter and a chain of linear Class B push pull amplifiers. A standard modulated vestigial side band signal is received from the Schenectady studio or from the New York relay stations, over a high frequency radio link. These signals are then retransmitted from WRGB for television enthusiasts in the Albany-Schenectady area. The principal task at the transmitter was the design of the high-gain, multi-stage, wide-band amplifier stages. The final stages each consists of a pair of water cooled triodes especially designed for television service.

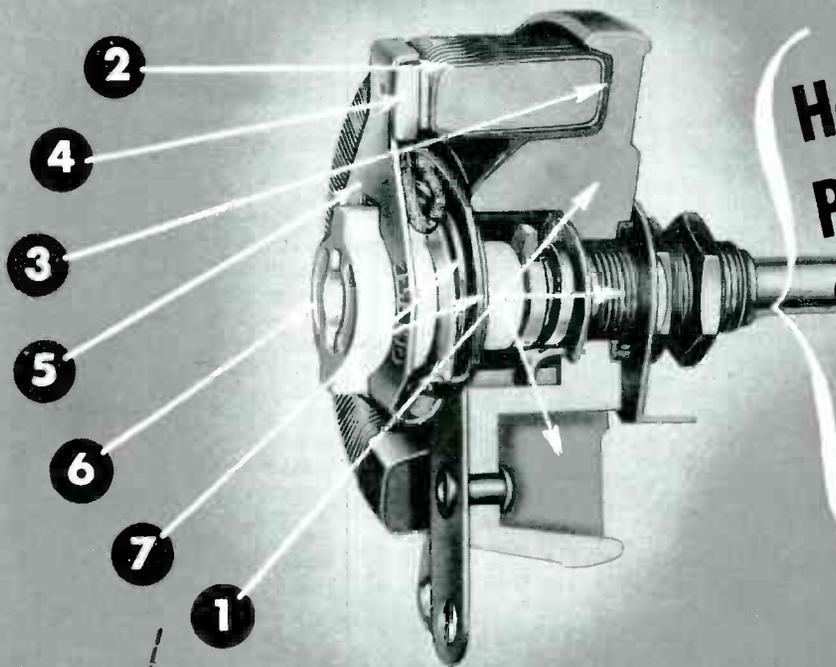
The aural transmitter consists of a 50 watt exciter unit containing the oscillator, modulator, and frequency control unit, a 2 kw amplifier consisting of air cooled triodes, and a 20 kw amplifier using a pair of tubes similar to those in the visual power amplifier.

H. W. Wells, Carnegie Institution of Washington, spoke on "Effect of Solar Activity on Radio Communication." It was shown that the radio disturbances which are most severe are coincident with intense magnetic storms which are usually associated with active sun spot areas. Severe magnetic storms can disrupt normal radio communication for several days and various occasions of interruption to land wire circuits have also been reported. It is felt, however, that the progress which is being made in the observation of ionosphere phenomena will make it possible to predict quite accurately the time and frequency at which radio interference will be a maximum as well as a minimum.

W. J. Brown, of the Brush Development Company, described "The Development of a Pocket Radio Receiver" of such dimensions as to fit conveniently into the breast pocket of an ordinary suit of clothes, and containing a specially developed hearing aid unit which fits into the recess of the normal ear.

Unusual features of this circuit, which is shown in the diagram of Fig. 5 are the use of a four tube receiver employing permeability tuning, the use of the cord connecting the hearing unit with the radio receiver as an antenna, and the very small physical dimensions of the complete receiver. To all external appearances the portable receiver greatly resembles the present-day hearing aid except that the batteries were incorporated as a part of the radio receiver rather than being a separate unit as is usually the case with hearing aid devices.

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The cut-away view shows a number of the important features which make Ohmite Rheostats especially suitable for today's exacting requirements in industry, and in planes, tanks, ships.

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There are many other features which add to the dependability of Ohmite Rheostats—all proved on the Ohmite Life Tester illustrated below, and in actual service as well. They are built to withstand shock, vibration, heat and humidity.

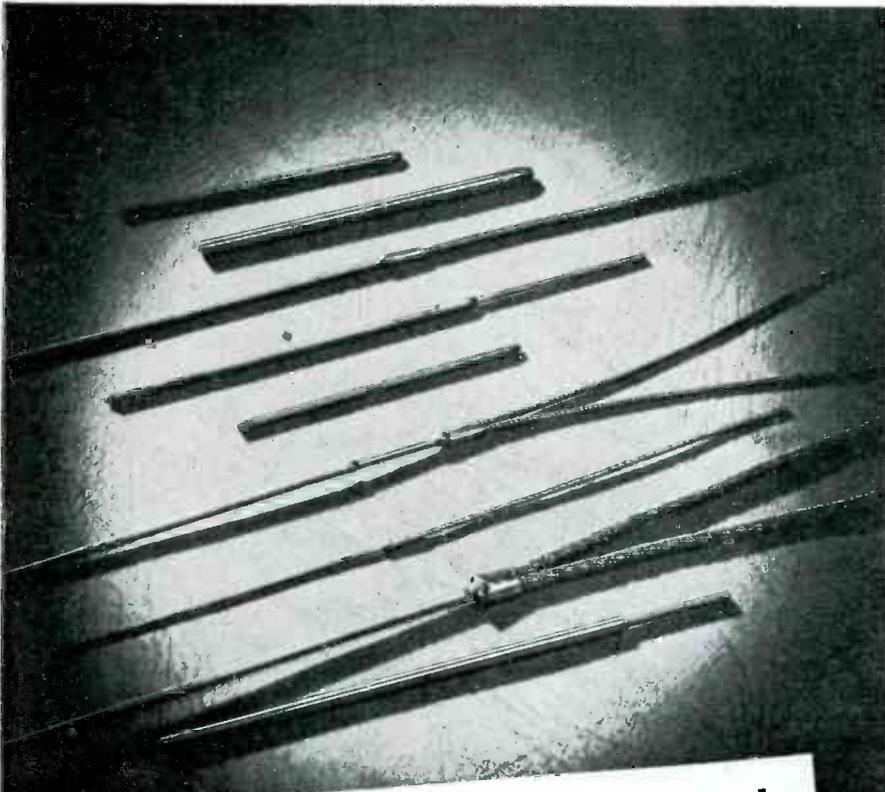
Ten wattage sizes, from 25 to 1000 watts, from 1 9/16" to 12" diameter, in stock or special units to meet each control need. Approved types for all Army and Navy specifications.

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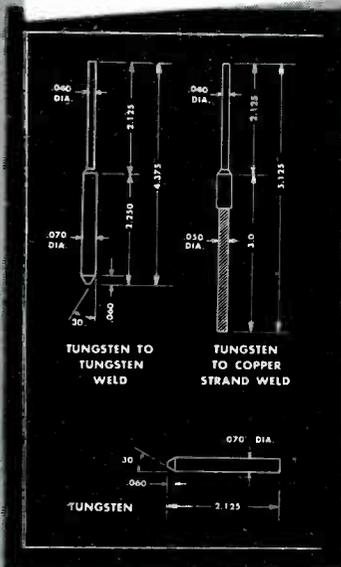
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On Tuesday afternoon a symposium was held on the subject "What Radio Means in the War Effort." Discussion leaders in this symposium were A. F. Van Dyck, Paul Galvin, president of the Radio Manufacturers Association; E. K. Jett, chief engineer, Federal Communications Commission; Neville Miller, president of the National Association of Broadcasters, and Capt. E. M. Webster, of the U. S. Coast Guard.

Mr. Van Dyck pointed out that radio has had to go 100 percent to war and that whereas the vacuum tube and telephony were beginning to be made use of effectively in the last war, the techniques of ultrahigh frequency and television are important contributions in the present war. It was also shown that as a result of present organized research, the rate of change of things at the present time is exceedingly fast. The social and cultural aspects of these developments were also considered when Mr. Van Dyck pointed out that technical developments are proceeding at such a pace and technical achievements are so powerful that administrators must be made aware of their social and economic implications if they are to perform their administrative and executive duties properly. This imposes an additional responsibility on the engineers and technicians who must learn how to "sell" these technical devices to people who will use them and administer their use. As a corollary of this argument it was shown that technical men must find out how to have more influence in places of decision.

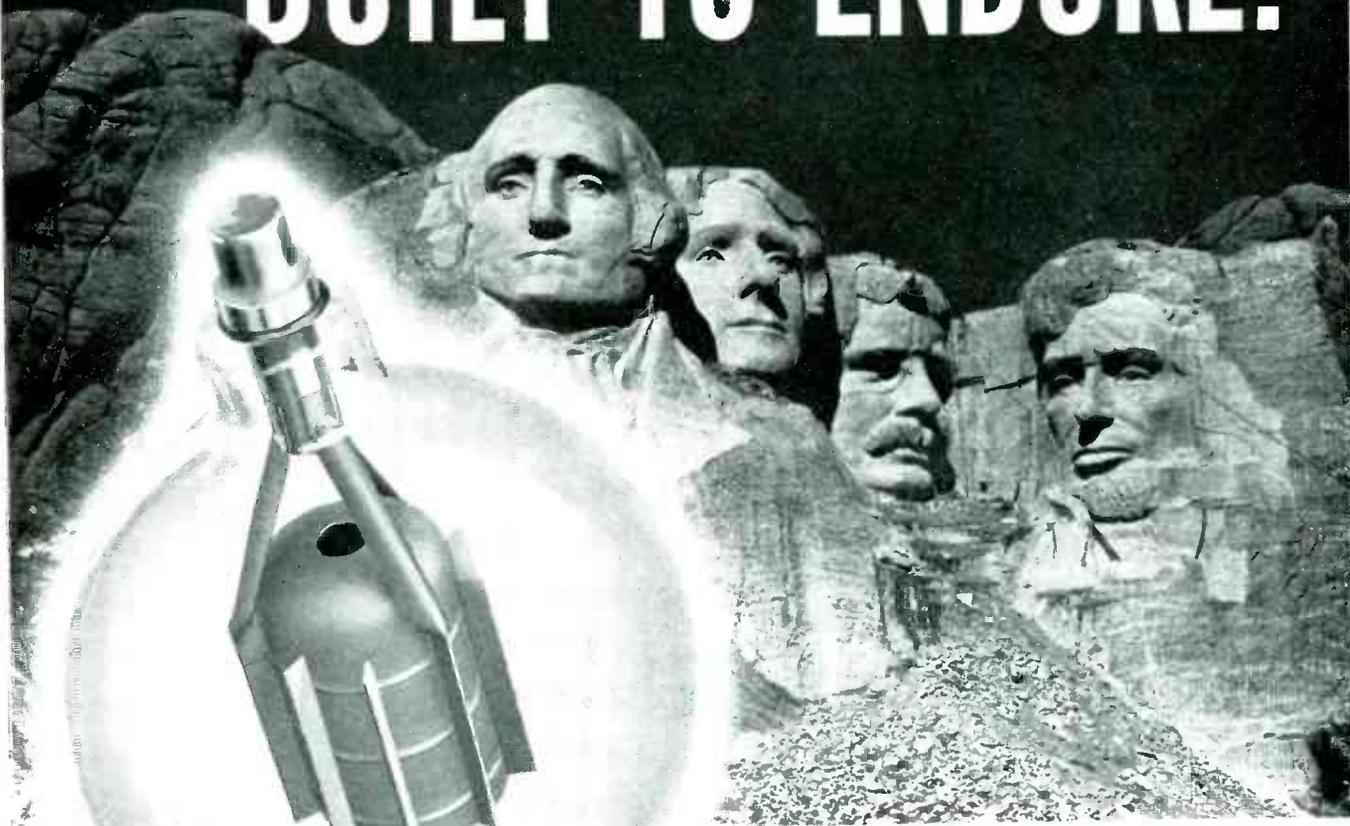
E. K. Jett outlined some of the more recent developments of the Defense Communications Board (now known as the Board of War Communications). His talk was largely a survey of recent governmental activities which are adequately recorded in FCC orders and elsewhere.

The manufacturer's point of view was stressed by Paul V. Galvin who traced the conversion of the broadcast industry from a peacetime to a wartime industry in a remarkable short period of time. In the summer of 1940 some half dozen companies were making a few million dollars worth of radio apparatus for the Army and Navy. During the latter part of 1940, throughout 1941 and up to the present time, these firms have converted their entire production to a war basis without disruption of service. The magnitude of the job is emphasized by the projection of a radio apparatus program in excess of one billion dollars.

The part which the broadcast stations are playing in the present war effort was ably outlined by Neville Miller, president of the National Association of Broadcasters, who again pointed out the need for social development keeping pace with technical developments.

A. O. Austin, president of A. O. Austin, Inc., Barberton, Ohio, opened the Wednesday morning technical session with two papers entitled, respectively, "Radio Strain Insulators for High Voltage and Low Capacitance," and "Improved Insulators for Self-Supporting

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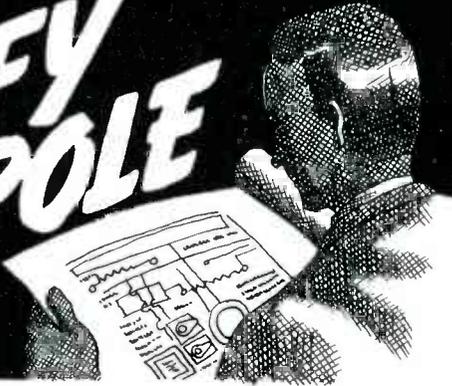
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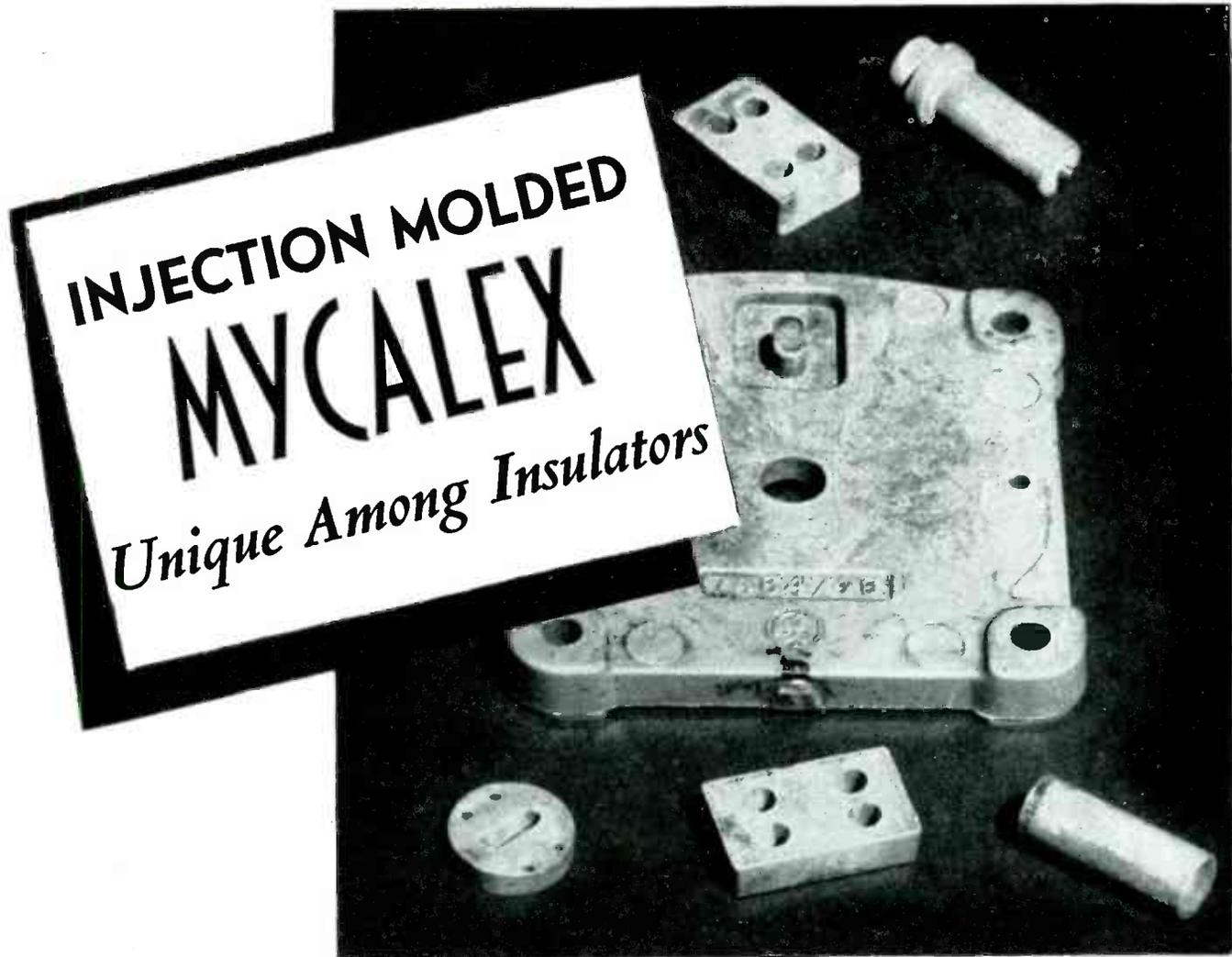
S **STACKPOLE CARBON CO.**
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or Sectionalized Towers." Both papers were on the same general topic and may be reviewed, therefore, together. In the first paper the high voltage requirements of radio insulators for withstanding radio frequency loads were given. The effect of surface conditions in maintaining the quality of the insulator tended to support the motto "Save the surface and you save all," of the paint manufacturers. Some of the defects of past insulator designs were pointed out. In many cases the insulator suffered from high capacitance between its terminals. In other cases, the path of surface leakage was small whereas in still other cases an insulator would be quite serviceable for loads in tension but would be subject to failure from small transverse shocks or impact. A type of insulator designed to overcome these defects was described. Essentially it consisted of an insulating belt impregnated with resin or bakelite materials, contained in an outer protective tube of porcelain or similar material. Appropriate corona sheaths were provided as required. Insulators of this design are affected to a very slight extent by transverse impact loads, and may be used either in tension or compression. Thus, this design is suitable for use as a strain or a compression type of insulator.

A "Brief Discussion of the Design of a 900-ft. Uniform Cross Section Guide Radio Tower" was given by A. E. Wallen of the Truscon Steel Co., Youngstown, Ohio. In contrast to the majority of papers usually presented before the meetings of the I.R.E., this one was primarily a discussion of mechanical design factors with consideration given to such matters as wind resistance, effect of anticipated wind velocity in terms of actual pressures on a complex truss form used in tower construction, correct balance of anticipated external load, a complete analysis of the stress diagram under anticipated operating conditions, effect of ice and other loads, and so on. In the working out of this problem a considerable amount of work was done with various types of sections which were tested after sample models had been constructed.



The circular antenna, described by M. W. Scheldorf, has unusual applications for use on vehicles, because of its ruggedness and small size



G-E MYCALEX is a material possessing a combination of desirable properties and characteristics not found to such a degree in any other insulator. G-E Mycalex has better over-all electrical properties and mechanical strength than porcelain; it has refractory qualities superior to phenolic resins, gums, pitches, shellacs and other organic materials; and it may incorporate metal parts and inserts in molded parts, a feature not readily practicable with ceramic products.

The G-E Plastics Department recently announced the development of a method of injection molding for mycalex which greatly extends the scope of application for this remarkable material.

INJECTION MOLDED G-E MYCALEX PARTS HAVE FOUR DISTINCTIVE FEATURES:

1. More intricate shapes may be obtained.
2. Finishing and machining operations are reduced or eliminated.
3. Holes may be molded in part.
4. Tolerances may be held closer than in other types of molded insulation.

IN ADDITION, G-E MYCALEX HAS THE FOLLOWING PROPERTIES:

1. High dielectric strength.
2. Low power factor.
3. Prolonged resistance to electric arcs.
4. Chemical stability; no deterioration with age.
5. Dimensional stability; freedom from warpage, shrinkage, etc.
6. Imperviousness to water, oil, and gas.
7. Resistance to sudden temperature changes.
8. Low coefficient of thermal expansion.

Two types of G-E mycalex for injection molding are available,— general purpose, and radio grade,—both suited for many uses as insulators in the electrical industry. A booklet describing properties and applications may be obtained by writing Section H-7,
**ONE PLASTICS AVENUE,
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GENERAL GE ELECTRIC
PD-51



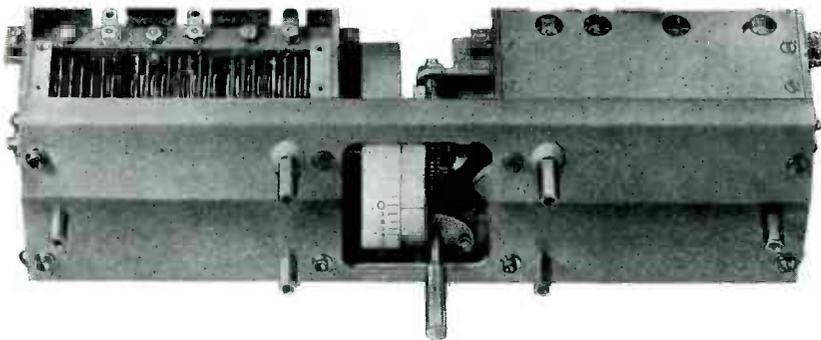
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Seeing Action!

For more than a quarter century our organization has been supplying specialized equipment and components to our military services.

With the same engineering skill that pioneered metal end plate condensers . . . universally adopted as commercial standards . . . we are concentrating our efforts on the design and construction of equipment for our Army and Navy.

In this war, again, better-than-ever CARDWELLS are seeing front-line action.



CARDWELL CONDENSERS

THE ALLEN D. CARDWELL MANUFACTURING CORPORATION

BROOKLYN, NEW YORK

A "Circular Antenna" was described by M. W. Scheldorf of the General Electric Company. This is a new horizontally polarized antenna whose outstanding feature is the radiation of substantially uniform energy in all directions about the antenna without resorting to a complex structure or network to secure this pattern. Essentially it is derived from a half-wave antenna with capacitive loading by bending the elements around a circular shape as shown in Fig. 11. Its low vertical radiation gives a twofold improvement over a single doubler and several units may be used to improve this gain. In multiple unit antennas the coupling between bays in such an arrangement has been reduced to such an extent that adjustments are simplified. The antenna has a pleasing physical appearance and is relatively small in size while it has the further advantage of being mechanically very rugged.

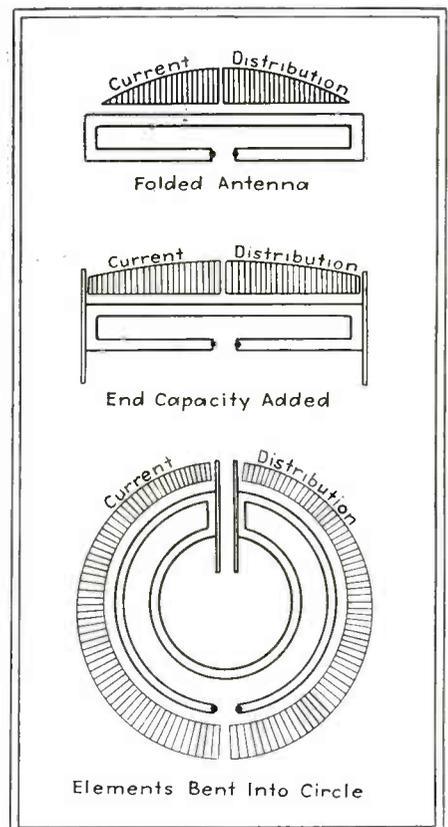
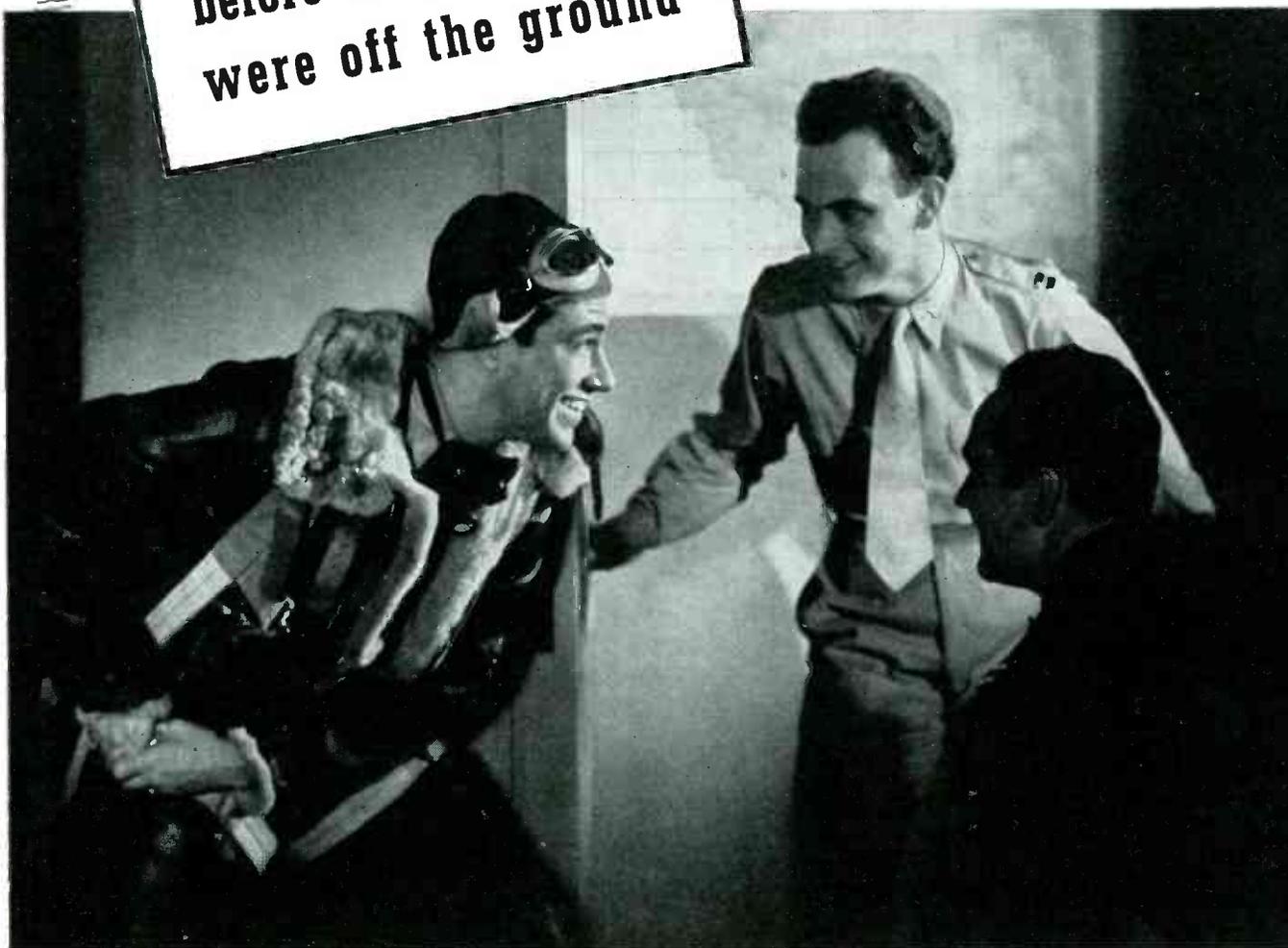


Fig. 11—Diagrams illustrating the development of the circular antenna from the folded doublet, at top

The features of the new antenna are as follows: (1) A simple horizontally polarized antenna with only two terminals, yet essentially uniform in its horizontal radiating properties; (2) low mutual inductance between vertical bays with greatly improved adjustment of multi-bay installations; (3) ability to cover a wide frequency range with one physical structure, through the use of simple means; (4) a system that is easily mounted to a pole of any diameter and grounded to that pole so that there is lightning protection; (5) a system that may be applied to metallic covered vehicles to an advan-

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before they knew we
were off the ground"**



This advertisement has been reviewed and approved for publication by the War Department.

● It takes top notch men, planes and communications to get the jump on the enemy in the air. We Americans have all of these. Helping the Signal Corps to get the jump in communications has long been one of our jobs. Even before our country entered World War I, "Connecticut" was pioneering the

production of two-way military aircraft radio, and throughout the war continued to be a leading supplier of aircraft communications equipment for the Allies.

Today the skill of "Connecticut's" engineers and craftsmen is again fully mobilized in the service of Uncle Sam. And just as radio played

a vital role in making air travel safer and surer after the last war, so today's military developments will blaze new peacetime trails when final victory is won.

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DEPENDABILITY

is awake at the switch

• Here at the switch, where the human element and mechanical perfection must combine to assure top performance—Utah engineering and manufacture can be depended upon. Utah dependability is proving itself in hundreds of industrial electrical applications.

Utah Imp Push-Button Switches combine compact size, highest quality and economical price. Have finest nickel silver or phosphor bronze springs with integral contacts. Springs are fully insulated from the mounting, bushing and shaft—have high grade phenolic insulation. They are made in three circuit arrangements: “single make”—“single break”—one “break—make.”

Utah-Carter Rotary and Push-Button Jack Switches are made in long and short types. Small and compact they are designed to take minimum panel size. All electrical parts are fully insulated from the frame. Write today for full details.

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They are designed to meet your needs—whether it's the application, size or shape.



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CHICAGO, ILLINOIS

tage; (6) improvements in gains per bay over existing units in the field; (7) a design which readily permits sleet melting if desired; (8) a design which is pleasing in appearance.

A paper by H. A. Brown and W. J. Trijitinsky on “Stub Feeder Calculation” was not delivered.

An interesting analysis of the redesign of the antenna system for KDYL was given by G. H. Brown of the RCA Mfg. Company. The paper delivered was entitled “A Solution of the Problem of Adjusting Broadcast Directional Rays with Towers of Unequal Height” by J. M. Baldwin of KDYL and G. H. Brown. The original antenna at KDYL was a half-wave vertical tower radiator whose radiation pattern was to be modified to minimize interference in certain directions and reach the radio audience in other directions more effectively. The method of modifying this radiation pattern consisted in erecting a quarter wave vertical tower as a reflector. Three means of determining the radiation pattern were employed and all were found to work quite well. One of these was based on measurements in the field using the original tower and its reflector. The results obtained by this method were checked by an experimental model built in the laboratory and both of these preliminary checks agreed quite well with the final pattern ultimately obtained.

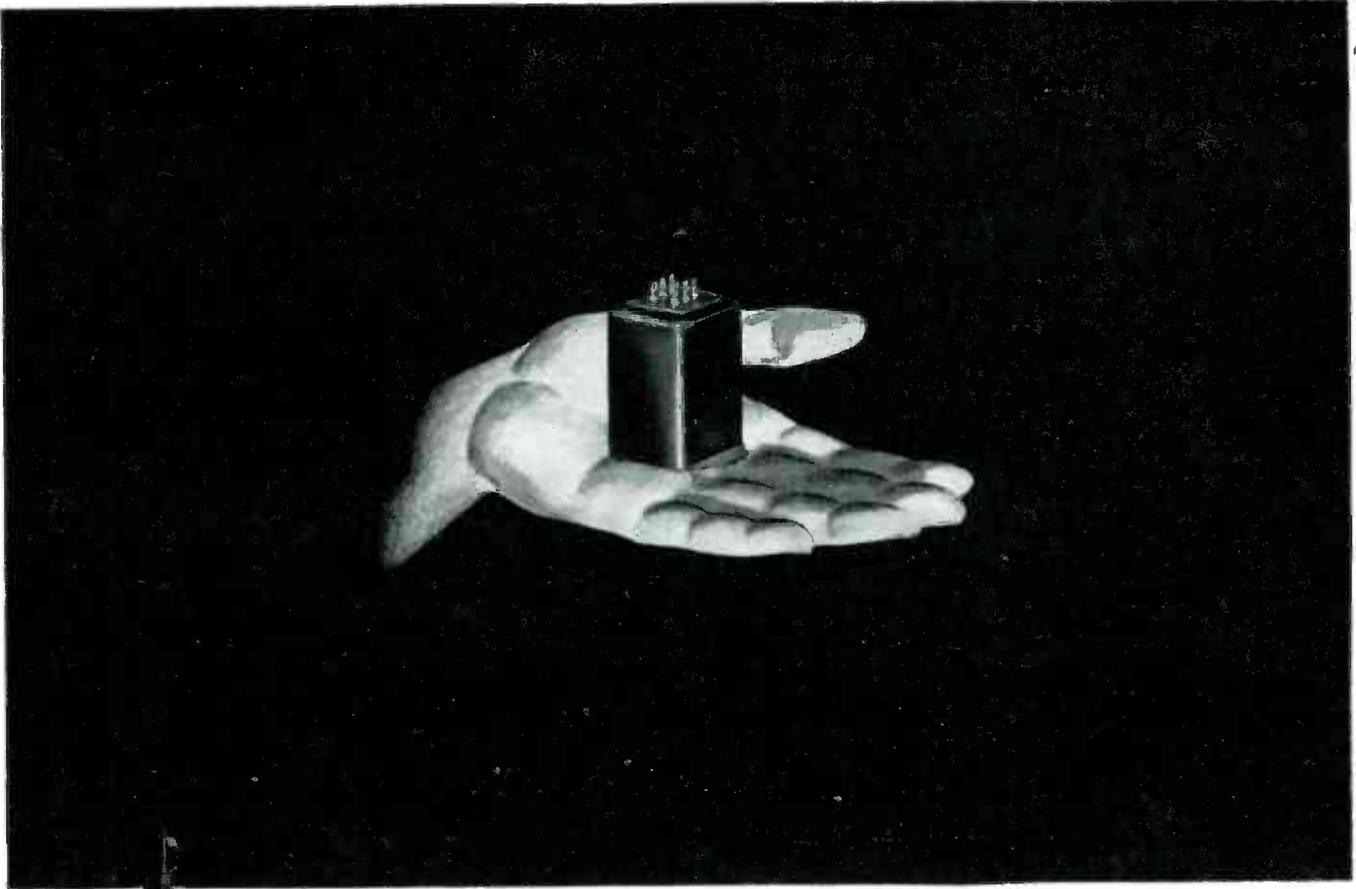
A complete studio-transmitter (S-T) system for high fidelity program relaying studio and main transmitter was described by J. D. Keister of the General Electric Company who presented a paper “Television Video Relay System.”

The entire equipment was designed for simplicity and reliability and of course uses the frequency modulation method of varying the carrier.

The 25 watt transmitter incorporates several novel features which account for the excellent performance obtained. Among these new tube designs especially suited for ultrahigh frequency operation are of most importance. A crystal control, double conversion superheterodyne receiver, employs such features as cascade limiting, carrier-off noise-suppression, and vertical chassis construction. Harmonics from the same crystal oscillator are used in performing both frequency conversions, resulting in an extremely stable unit. Both transmitter and receiver may be remotely controlled when proper compliance is made with the regulations of the Federal Communications Commission.

A high gain studio-transmitter antenna which meets all F.C.C. requirements is totally inclosed against the weather to avoid ice melting problems. An f-m station monitor, for FCC application, indicates center frequency continuously, as well as percent modulation interior level. All monitoring is also obtained from the same unit.

H. A. Breeding of the General Electric Co. presented a paper on “Mercury Lighting for Television Studios.” Experiments with water-cooled mercury vapor



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lamps for television studio lighting were carried out by the General Electric Co. at the New York World's Fair in 1939 and finally culminated in a complete installation in the new modern studios of WRGB at Schenectady in the fall of 1941. Studio lighting in the television studio WRGB is provided by a series of ceiling lights which may be controlled from an appropriate wall panel so that the horizontal and vertical directions of maximum intensity may be varied by operators in the studio. Each of these units contains three water-cooled H-6 lamps in their appropriate container with metallic reflectors. The front surface of each of the ceiling lamps is provided with an irregularly surfaced sheet of glass to prevent excess unequal distribution of light. Each ceiling installation is on rows $9\frac{1}{2}$ ft. apart across the building and $6\frac{1}{4}$ ft. apart along the building. The average space per unit is therefore approximately 120 sq. ft. and these units are mounted approximately 14 ft. above the floor. Ultimately there will be 19 luminaires, of which 12 are installed and in operation at the present time. The average footcandles with all of the floodlights pointed downward and oriented with the long axis of the reflector across the room was found by measurement to be 315 footcandles. It is possible to build up the intensity over a $10 \times 15 \times 10$ -ft. high scene to 650 or more footcandles of general lighting, with the upper portion of the scene reaching 1000 footcandles. By supplementing this lighting with floor lamps, good pictures are produced with little or no discomfort to the performers. This "no discomfort" feature has been found to give excellent results.

Again performing for RCA, G. L. Beers presented a paper "The Focusing View Finder Problem in Television Cameras". It was shown that the technical excellence of the television program frequently depends upon the char-

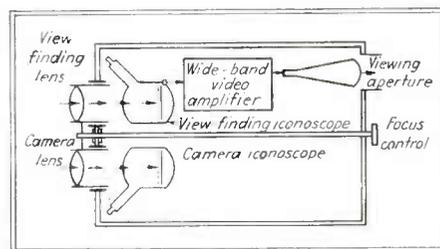


Fig. 12—Electronic view finder using two image forming tubes meets most requirements for view camera for television cameras

acteristics of the view finder used in the television camera. Conditions peculiar to television make it desirable that the television camera view finder be of the focusing type in order that the image as seen by the television enthusiast may be properly focused. The requirements of an ideal view finder of this type are discussed not only from the angle of technical performance required but also from the angle of convenience of operation and speed of manipulation. The characteristics of various types of or-

dinary camera view finders were discussed but it was found that none of these is ideally suited to television cameras. The most suitable type of view finder which has been developed at the present time is illustrated diagrammatically in the illustration of Fig. 12. Essentially it consists of a view finder lens and a camera lens of the same general optical design, a viewing iconoscope and a view finding iconoscope, the latter of which features a wide band video amplifier and ultimately makes the picture available in an iconoscope. The view finding equipment is a miniature reproduction of the complete television monitoring system.

K. R. Wendt and G. L. Fredenall of the RCA Manufacturing Co. presented a paper "Automatic Frequency and Phase Control of Synchronization in Television Receivers" as their solution of one of the problems in the reception of television images in providing satisfactory synchronization in the presence of noise. The system of synchronization which has given satisfactory results up to the present time has depended for its operation on the reception and separation of individual pulses. Satisfactory synchronization can be obtained from those signals which will in all other respects provide an entirely acceptable picture with this method of synchronization. Nevertheless, for limiting conditions of service, particularly where the field strength may be low, an improvement in synchronization will be effective and desirable provided that it does not involve other complications or disadvantages. The new method of synchronization which was described by Mr. Fredenall makes use of automatic frequency and phase control of the sawtooth scanning voltages. In this system, the synchronization depends not on the individual pulses but rather on the average of many regular recurring synchronizing pulses so that the overall effect is an increased synchronization. Noise is relatively ineffective since it occurs at a random distribution rather than at regularly recurring intervals. Noise cannot affect the horizontal resolution or interlacing.

Experimental receivers in which the automatic frequency control of the scanning oscillator has been incorporated have operated well with a high immunity to noise.

Consideration of this new development indicates that its use would result in several improvements in television service. The system is particularly useful when severe noise conditions occur since superior performance is realized within the service area by the new method. Under excess noise conditions the useful service area is extended with the new frequency and phase control system. The maximum resolution permitted by a television channel is attained with the new system whereas it may not be attained in the old system especially where noise is important. It is expected that the cost of television receivers will not be increased by the use of the automatic frequency and phase control circuit, Fig. 6 and Fig. 7.

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True . . . our present activities are mostly high priority War-Time Work . . . yet, we have recently greatly enlarged our Manufacturing facilities . . . and perhaps we could take care of your needs. Why not submit your problems to us NOW . . . and we will do our best to give you an answer. Please address Dept. No. 3.

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PERHAPS you saw the advertisement on the opposite page, in the newspapers.

Did you notice those five examples of the way in which maintenance men are meeting the problem of war operation?

That's what this page is about.

If one public utility maintenance man works out a new way of reconditioning wire, his idea becomes really valuable to the country when all maintenance men with a similar problem find out how he did it.

If one man experiments with silver and bismuth as a substitute for tin solder, that becomes great news for a man who needs tin solder and can't get it.

That's why industry after industry has been able to meet the war production challenge . . . by swapping ideas.

► In industry, this idea swapping is done mostly through the editorial and advertising pages of the industrial press.

McGraw-Hill, for instance, keeps 153 editors and 725 engineer-correspondents busy digging up new methods of doing things.

Industrial advertisers, too, often send men

into the field to discover new ways of making their products do more work, or last longer.

When such practical editorial and advertising information is distributed to the readers of the 23 McGraw-Hill publications, the value of each idea is multiplied by thousands.

So valuable is this interchange of technical information that many companies are surveying their organizations to make sure that the supply of Industrial Magazines is adequate.

► If you would like suggestions as to how to conduct such a survey, just write to Reading Counselor Department, McGraw-Hill Publishing Company, Inc., 330 West 42nd Street, New York.

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Continuous Balance Potentiometer Pyrometer

By ROBERT D. TOWNE and
D. M. CONSIDINE

A COMPACT ELECTRONIC balancing unit has replaced a galvanometer and complex system of cams and levers in the new continuous balance potentiometer pyrometer designed by The Brown Instrument Company.

Galvanometer balancing mechanisms previously used were cyclic in operation, with continuous mechanical motion providing intermittent periods during which the galvanometer was freed to assume its proper deflection unhampered by an engaging mechanism. In the new electronic system, unbalanced d.c. in the pyrometer measuring circuit is converted to a.c., amplified, and used to drive a motor in the proper direction to balance the measuring circuit and maintain correct instrument reading.

Use of the electronic unit eliminates galvanometer inertia, pivot friction, effects of vibration and changes in posi-

tion. When a balanced condition has been established, there is no unbalanced voltage to be amplified and no driving power to be fed into the motor. No further motion takes place until a change in the measured condition requires further rebalancing.

Measuring Circuit

The measuring circuit of the balancing system shown schematically in Fig. 1 consists of a thermocouple and a slide wire through which a known current is passed. Position of the slide wire contactor is adjusted mechanically to balance the voltage from the thermocouple. When the temperature changes, unbalanced d.c. appears across AA. This unbalanced voltage is changed into a.c. by the converter, which is a single-pole, double-throw switch actuated by an a.c. energizing coil so that it vibrates in synchronism with the 60-cycle line voltage. Contacts mounted on the vibrating reed feed the unbalanced voltage into alternate ends of the primary of a specially designed transformer, creating a 60-cycle control voltage which is either in phase or 180 deg. out of phase with the line a.c., depending upon the polarity of the unbalanced voltage of the measuring circuit.

Voltage and Power Amplifier

The a-c control voltage passes into a conventional voltage amplifier employing a three-stage resistance-capacitance coupled circuit. Each stage has an amplification factor of 50, providing total voltage amplification of 125,000. Tubes are high- μ twin triodes. A section of the second twin triode tube is used as a half-wave rectifier to supply plate voltage. The grid of this section is connected to the cathode so that this section functions as a diode.

The power amplifier consists of two identical twin triode tubes having their input circuits connected in parallel and their output circuits in push-pull. Since the twin-triode tubes perform duplicate functions, one of them will be disregarded in the following explanation, and the two sections of the twin triode tube under discussion will be designated tube 1 and tube 2. Referring to the schematic diagram in Fig. 2, in which polarity signs are arbitrarily assumed, tube 1 can conduct plate current only during the odd half-cycles of the control voltage from the voltage amplifiers, and tube 2 can conduct plate current only during the even half-cycles. Thus, a definite phase relation-

ship exists between the control voltage from the thermocouple circuit and the power amplifier output.

Half-wave pulses of current will pass through motor winding A and condenser C_1 during the odd half-cycles of the control voltage. During the even half-cycles, the tubes will pass no current, but condenser C_1 will discharge in the motor winding A. Thus, with an in-

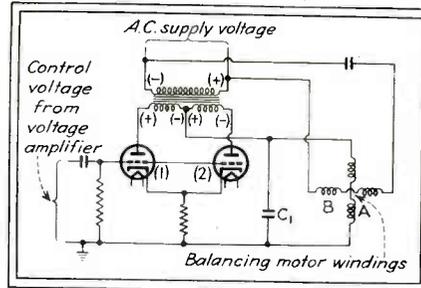


Fig. 2—Simplified schematic of the power amplifier

phase signal on the grid of the power tubes, a sine wave alternating voltage in phase with the supply voltage will be developed across the motor winding A. Conversely, when the control voltage is 180 deg. out of phase with the line voltage, a sine wave a-c voltage 180 deg. out of phase with the supply voltage will be developed across winding A.

Balancing Motor

The balancing motor is a reversible, two-phase induction type. The power winding is energized continuously by the line voltage; the control winding is energized, as explained above, by the power amplifier. Thus, when the thermocouple circuit is unbalanced, the phase relationship between the two windings is determined by the direction of unbalance. Hence the motor, which is connected through gears and levers to the slide wire contactor and to the instrument pointer, always rotates in the proper direction to balance the thermocouple circuit, at the same time correcting the position of the instrument pointer.

When the measuring circuit is balanced and the control voltage to the grids of the power tubes act as full wave rectifiers, applying pulsating d.c. to motor control winding A. This brakes the motor at the position of true balance and prevents overtravel.

Sensitivity of the electronic continuous balance unit is such that maximum driving power of the balancing motor is

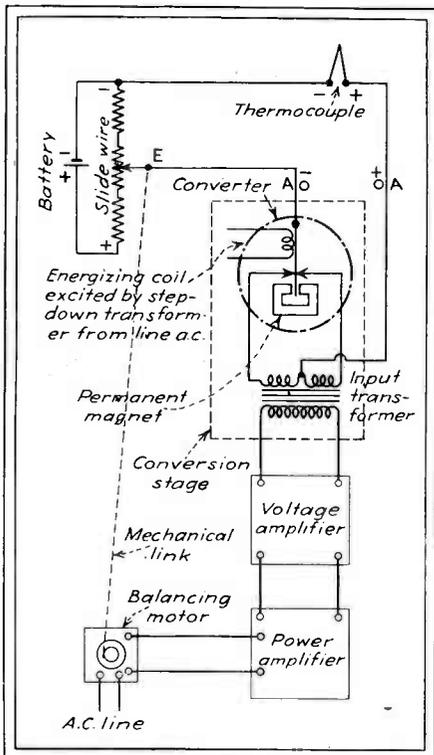


Fig. 1—Diagram of the complete continuous balance potentiometer pyrometer system

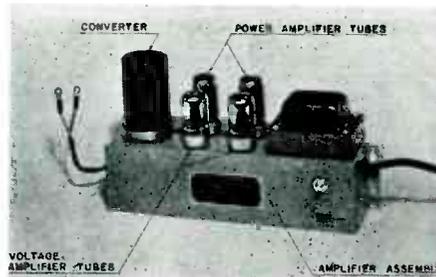


Fig. 3—Photograph of the electronic portion of the equipment

A motion .0000006" sends a Voice around the world



Microphone Diaphragm Design is a Difficult and Fascinating Art

THE Diaphragm is the heart of the Microphone. It responds to sound wave vibrations and actuates the translating element carbon, piezoelectric crystal, moving armature or moving coil. A Diaphragm must be extremely light—present a correct driving impedance to the sound wave and to the translating system—vibrate with uniform displacement or velocity at all frequencies. It must withstand atmospheric changes, extreme temperatures and hard service conditions of vibration, shock, gunblast. Whether designed for the studio or the battlefield, it must function.

The Diaphragm in the "556" Shure SuperCardioid Microphone is .0010" thick and weighs only 1/470th of an ounce. It drives a coil of wire in a magnetic field through .0000006 (six ten-millionths) inch, for average speech at 1 foot from the Microphone. This Diaphragm is designed so that it vibrates equally well at all frequencies from 40 to 10,000 cycles per second, yet is rugged enough to withstand the abuse encountered in daily service.

The Shure Engineering Staff are specialists in Microphone Diaphragm design. At Radio Station WRUL, America's Powerful Short-Wave Station, Diaphragms in Shure SuperCardioid Microphones are moving this .0000006 (six ten-millionths) inch to send the Voice of Freedom around the world!

Send for Booklet 172M

This booklet describes the theory of the SuperCardioid and the Shure SuperCardioid Microphone.

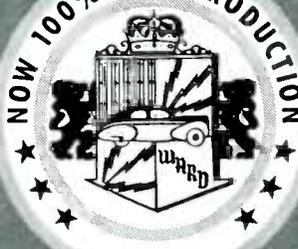
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obtained with an unbalance of less than 0.06 percent of the scale span, which represents one convolution of the slide wire. This is equivalent to a 0.00005 volt unbalance in the thermocouple circuit.

Fig. 3 is a photograph of the electronic portion of the system.

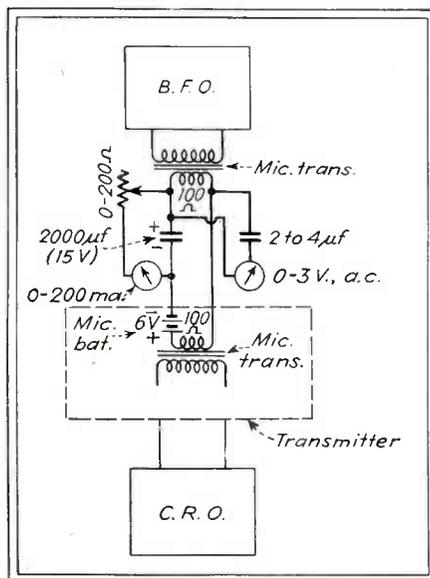
. . .

Transmitter Production Test

SPEECH AMPLIFIER and modulator performance of transmitters coming off the assembly line is rapidly compared with pre-determined standards by means of a simple yet commercially effective test setup devised by the engineering department of the Jefferson-Travis Radio Mfg. Corp.

A 1000 cps signal generated by a beat frequency oscillator delivering between 5 and 10 mw of power is fed to the microphone input terminals of the transmitter under test through a "dummy microphone" circuit consisting of an inverted microphone transformer having a variable resistor and a milliammeter in series with one leg and a 2000-ohms-per-volt a-c voltmeter of the copper-oxide rectifier type across the line. An electrolytic capacitor bridging the resistor and the milliammeter provides a low impedance a-f path while a paper dielectric capacitor connected as shown keeps d.c. out of the voltmeter.

When testing one particular transmitter series the variable resistor is adjusted so that 20 ma flows through the milliammeter, establishing an input impedance condition comparable with that which obtains when a single-button carbon microphone furnished with the transmitter is connected in the circuit. The output of the bfo is then adjusted until the voltmeter reads 1.8 volts. Tests with transmitters known to be up to standard indicate that this input volt-



Simple "dummy microphone" setup for testing transmitter speech amplifier and modulator performance in production

age should be sufficient to modulate the transmitter 100 percent, indicated by a cathode-ray oscilloscope connected to the transmitter output circuit in a conventional manner.

Where transmitters must be tested over a definite audio frequency range, as in the case of a series in current production on which specifications require that modulator output be flat within plus or minus 3 db between 200 and 3000 cps and at least 10 db down at 60 and 5000 cps, production checks are accomplished with the same test device by holding a-f input voltage constant while tuning the bfo over the necessary range and noting the modulation percentage indicated on the calibrated cro screen.

. . .

An Electronic Profilometer

ROUGHNESS ON THE SURFACE of materials finished by abrasives, by milling, turning, plating, grinding and other similar operations, may be measured by means of an electronic profilometer designed by the Physicists Research Company of Ann Arbor, Michigan. Surface irregularities from 0.5

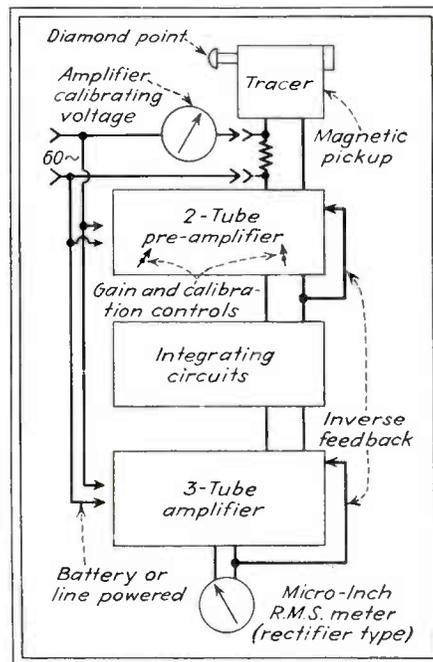


Fig. 1—Block diagram of the electronic profilometer, showing diamond-point p.m. pickup tracer head, amplifier with inverse feedback, velocity compensating integrating circuit, rms microinch meter and provision for calibration check

to 1000 microinch above or below an average centerline or reference point are easily read on the scale of a calibrated rms meter. An instrument with a special scale permits readings between 0.1 and 1 microinch.

Fig. 1 shows the circuit of the instrument in elemental form. Basically, the principle of operation involves generation of voltage in the coil of a p.m.



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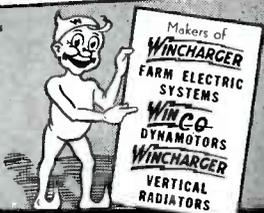
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pickup as a diamond-point stylus is moved over the surface to be examined, an amplifier and a rectifier-type output meter calibrated in rms micro-inches. Provision is made for calibrating the amplifier by means of voltage obtained from the power lines.

The Tracer

One tracer head available for use with the instrument, shown in Fig. 2, is about the size of a pack of cigarettes and so shaped that it may be conveniently held in the hand and moved over the surface to be examined. (It may also be bolted to any mechanical device, such as a motor supplied by the designers, suitable for effecting its motion.)

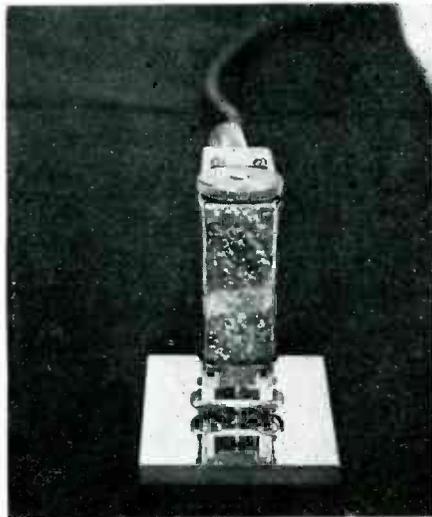


Fig. 2—Typical tracer unit. Note yoke supporting weight and establishing a reference level for the diamond point at the bottom, surface pressure adjustment knob at the top

A diamond is mounted on the end of a duralumin rod which is, in turn, screwed into a tube mounted on parallel springs. The parallel springs serve to restrict the motion so that it is essentially perpendicular to the surface. The upper end of the tube terminates in a coil form upon which is wound about 40 turns of wire two-thousandths of an inch in diameter. The coil is located in the field of a permanent magnet. When the tracer unit is drawn over the surface of the finish to be investigated the diamond transmits vertical motion to the coil. The output of the coil is proportional to the motion and is about 2 μ v per microinch at a 60 cps reference frequency.

The diamond point is positioned midway between two cemented carbide "skids," mounted upon an inverted U-shaped "yoke." Skids may be moved up and down by adjusting a knurled control knob on the top of the tracer unit, so that the tension of the diamond point against the surface to be examined may be delicately controlled to suit the material whose surface is being measured.

The instrument's amplifier consists of a five-tube resistance-coupled circuit using transformer input and trans-

former output. Two inverse feedback circuits contribute to stability and improve frequency response, permitting circuit constants to be altered by a factor of two-to-one without appreciably affecting the gain of the amplifier. The input transformer is provided with a "six-ply" shield to avoid sensitivity to extraneous a-c fields.

The Amplifier

Because the profilometer tracer unit produces voltage through the motion of a coil in a magnetic field, voltage is proportional to the velocity at which the turns of the coil cut the magnetic lines of force. Consequently, the voltage produced by the tracer is proportional to the speed at which the tracer is moved over the surface. This velocity effect is compensated for by special integrating circuits, designed to operate over a frequency range of from 20 to 10,000 cps, within plus or minus one db-

Calibration

The tracer head calibration is effected during manufacture by placing the point of the tracer in contact with a brass block vibrating vertically on the end of a brass reed. The up and down excursions of the reed are thus transmitted to the diamond point, which produces a reading on the profilometer's rectifier-type meter. A microscope with a calibrated eyepiece measures the up and down excursions of the point. The meter of the profilometer is then adjusted to read the value determined by the microscope measurement. Also during manufacture, amplifier gain is measured by introducing a known input voltage. The gain of the amplifier is thus expressed in terms of micro-inches and becomes the calibration number of the tracer. This calibration number is stamped on the back of the tracer and enables any tracer head to be used with any profilometer by performing an amplifier adjustment in the field.

To adjust the instrument so that it reads true microinch units in the field the thermocouple meter shown in the upper left corner of Fig. 3 is employed. Alternating current from any 60 cps power line is fed through this meter and through standardized resistances to produce a known standard voltage drop. This drop, produced at power line frequency, is 100 μ v. It is

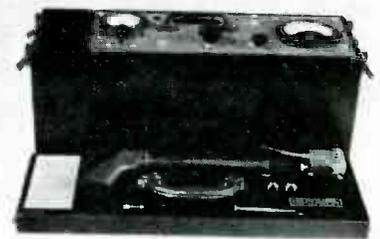


Fig. 3—The complete instrument, with cover removed. Tracer head, extra "yokes" and accessories may be seen in the foreground

inserted in series with the tracer unit and thus effects an open circuit calibration. With such a test voltage exciting the instrument amplifier, the output meter is adjusted to read the number of microinches stamped on the back of the tracer unit by means of a T-pad controlled by a knob on the panel.

• • •

Iron-To-Glass Seals

TIGHT SEALS BETWEEN iron and glass, eliminating the need for the critical metals nickel and cobalt, are now being effected in the construction of vacuum tubes by means suggested by General Electric's Dr. Albert W. Hull and Dr. Louis Navias. Such seals involve the use of special glass compositions. One consists of 45 percent silicon dioxide, 14 percent potassium oxide, six percent sodium oxide, 30 percent lead oxide and five percent calcium fluoride. The rate of expansion is very close to that of iron.

When a glass containing lead is sealed in contact with iron some of the lead atoms migrate from the glass into the iron. Weakening of the resulting joint is avoided by placing a thin layer of lead-free glass directly over the iron, then sealing the lead-containing glass to the lead-free glass. The thin lead-free glass layer prevents lead from reaching the iron yet is not thick enough to crack and let air into the tube.

• • •

POWDER PARTICLES



Dr. A. A. Bates of Westinghouse demonstrates P. R. Kalischer's device that quickly determines grain size of metallic powders having particles as small as 1/25,000 inch. Mixed with a liquid in a long glass tube, the particles intercept a light beam directed into a phototube as they settle. The rate at which the solution clears up, indicated by anode current change through a milliammeter, gives comparative data

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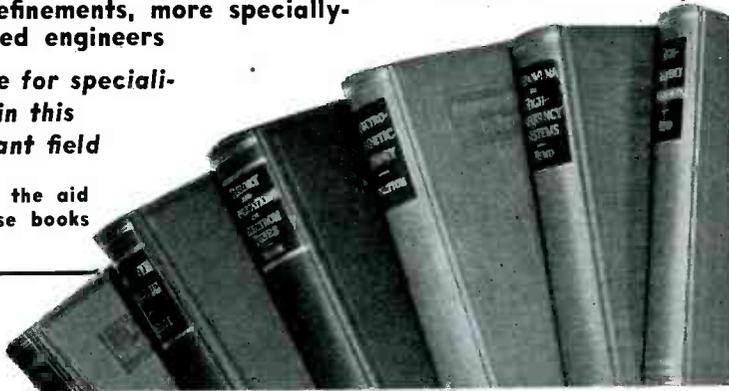
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Moisture Determination in Non-Polar Compounds

BY H. LOUGHNANE

IN NON-POLAR COMPOUNDS such as naphtha, recovered by a system using steam, moisture remains in the solvent in both the condensed and vaporous state. The following method isolates the moisture and permits measurement of very small quantities:

A chamber of known volume is purged with dry air and then a measured quantity of solvent or solution is added. The dry air above the solution is circulated through the solution until it no longer takes up moisture. The dew point of the air is taken to determine the number of grains of water present in the air and this is compared with the number of grains of solution responsible for the rise in humidity. (In practice, absolutely dry air is not required. Humidity may be read before and after the air has been in contact with the solvent. The air is never allowed to go to 100 percent saturation. If samples are so laden with moisture they are diluted with dry solvent and the necessary correction made for volume change. In a converse manner, small amounts of moisture may be more readily measured by using a comparatively large amount of solvent with respect to the volume of air in the chamber.)

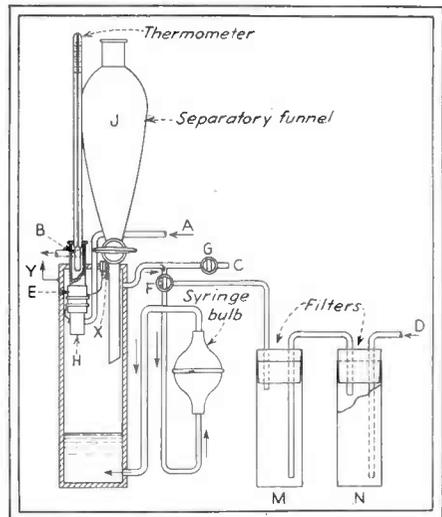


Fig. 1—Setup for moisture determination in non-polar compounds such as naphtha

Fig. 1 shows the chamber, the valve arrangements, a small copper tank *H* and the drying filters *M* and *N*. The volume of this chamber and of the syringe bulb and the tubing is determined by filling up every air space with a dry solvent and measuring the volume of the solvent. With the aid of the bulb, dry air may be drawn through the drying filters to purge the chamber and, by changing the valves, this dry air may be re-circulated in the chamber to bubble through the solution. The tank *H* is fitted with small copper tubes in such a manner as to allow a brine solution to enter the tank

at A, flow about the thermometer bulb and leave through B. The flow of the brine is controlled in order to permit a slow drop of temperature at the glass jacket E.

Electronic Measurement

The Pyrex jacket E contains two number 18 tinned copper wires 1/64-inch apart. One wire is grounded to tank H and the other is brought out through the polystyrene bushing terminating at X.

Fig. 2 shows the amplifier. This amplifier has an input resistance of 15×10^8 ohms and is capable of reading the resistance of the microscopic film of moisture that forms on the glass jacket E without causing decomposition of the film through electrolysis. A 1E7 tube has one control grid tied to ground and in its plate circuit, bridge fashion, is a 0.5-0-0.5 milliammeter. R_1 is used to balance the meter to zero when the remaining control grid is open-circuited. In series with the open grid and the conductors on the jacket E there is a potential of 67.5 volts, positive side to ground. The connection from the polystyrene bushing X is well shielded.

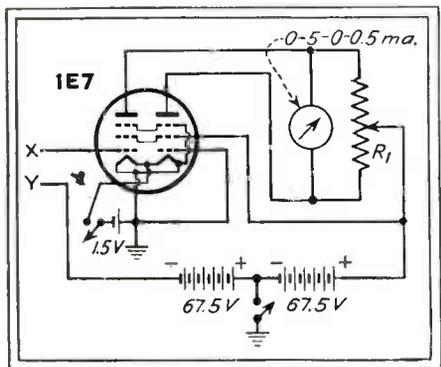


Fig. 2—Circuit for measuring resistance of moisture film condensed on inside of glass jacket

Operation of the instrument is as follows: A measured quantity of solvent or solution is placed in the separatory funnel J. Valves are set to bring dry air into the chamber from D through M and N and to exhaust through C. With the brine at a temperature of about 26 deg. F., the jacket is cooled until a meter indication shows that there is condensation on the glass jacket. The temperature of the jacket is taken at the start of the meter movement. This is the dew point of the air from the dryers. The brine flow is then stopped and the chamber allowed to warm up above the wet bulb temperature. Further purging with dry air will evaporate moisture from the jacket and the meter will return to zero.

The solution is now introduced into the chamber. Air is allowed to escape at C. This release of air should be used to control the flow of solution into the chamber. A low mark on the funnel used to keep a liquid seal over the chamber is suggested. With the solution in the chamber, valve G is closed and F is turned to permit the

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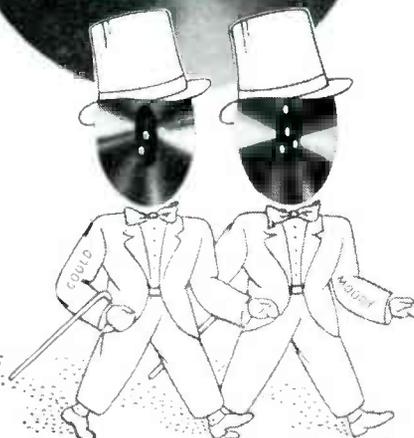
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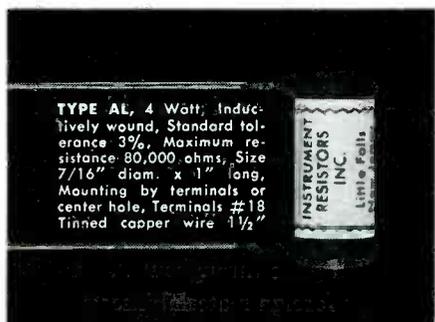
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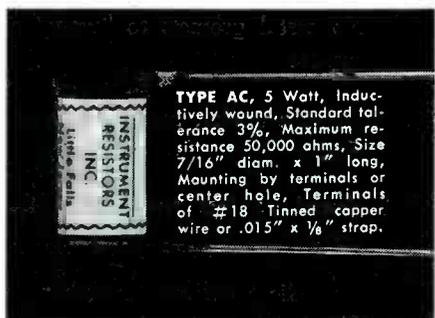
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circulation of air above the solution in such a manner that it bubbles through the solution. The temperature of the jacket is then slowly lowered while operating the syringe bulb. As we now have a closed system, the circulation will depend upon unequal pressures on either side of the syringe bulb, hence high pressures will be built up in the chamber on the compression cycles. This pressure will cause a premature reading of dew point but, on release of the pressure, the meter will start to fall, indicating that the temperature is in the wet bulb range.

When this point is reached the brine flow is adjusted to give a constant reading and the syringe bulb operated until the meter swings, occurring on compression, have reached the maximum. This will indicate that the volume of moisture on the jacket has also reached a maximum and that there is no more moisture available from the solvent. The chamber is then allowed to warm up past the wet bulb reading, or until the meter reads zero. Without any further operation of the syringe, the temperature is again allowed to fall in the jacket *E* until condensation takes place at normal pressures. This will be the actual dew point of the known volume of air.

The water content is then calculated from a psychrometric chart. Subtracting the water content that was first found, before the introduction of the solvent, the grains of moisture that actually came from the solvent may be readily compared with the weight of the solvent.

Hydrogen Moisture Check By Direct Electronic Method

THE QUALITY OF CERTAIN steels treated in atmosphere furnaces is largely dependent upon the purity of hydrogen gas flowing over the metal during manufacture. In bright annealing, for example, the hydrogen must be virtually free of moisture containing oxygen. Ordinarily, to measure the moisture content of hydrogen where dew points are less than 0 deg. C. a cooled and polished metal plate is inserted in the gas stream and the temperature at which condensation first occurs on this plate is noted. Below -40 deg. C. this method depends largely upon niceties of judgment on the part of the operator and is, therefore, subject to human error.

A direct electronic method of continuously monitoring the moisture content of hydrogen is illustrated in Fig. 1. Hydrogen of known moisture content is pumped through a special Westinghouse half-wave rectifier tube with intake and exhaust ports at a constant rate until the interior of the glass envelope is thoroughly purged. Regulated filament and anode potentials are then applied to the tube and adjusted to give a full-scale reading on the anode circuit milliammeter. Hydrogen to be used in the steel-making process is then substituted for the calibrating hydrogen

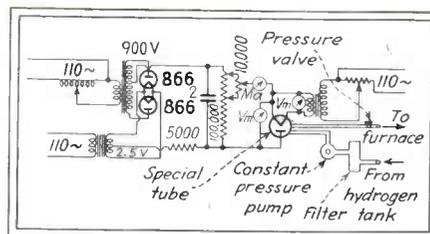


Fig. 1—Circuit of electronic device for continuous monitoring of hydrogen gas moisture content

and, with gas pressure and tube voltages maintained at the pre-determined values, any milliammeter reading change indicates a change in the moisture content of the gas. Presence of moisture, or oxygen, in the hydrogen flowing through the tube in amounts greater than that in the gas used for calibration collects more negative ions in the tube's electron stream, increasing internal impedance and reducing anode current.

The special tube pictured in Fig. 2 employs a tungsten filament and a tungsten anode, this metal being satisfactorily impervious to hydrogen. Moisture determination by this process in connection with certain other gasses would, undoubtedly, require the use of other tube metals impervious to such gases.



Fig. 2—The heart of the system, a special half-wave rectifier tube with gas intake and exhaust ports

Variations in tube anode current with changes in gas moisture content could, obviously, be used to control the operation of dehydrating equipment, thus rendering the entire process fully automatic.

Vacuum Tube Voltmeters The Meter at Work

THESE TWO VOLUMES were reviewed in June *ELECTRONICS* and it has just come to our attention that the prices given are not correct. The book "Vacuum Tube Voltmeters" actually sells for \$2.00, and "The Meter at Work" volume can be had for \$1.50. Both are published by John F. Rider, New York.

NEWS OF THE INDUSTRY

First-quarter receiver production figures. Defense communication equipment and personnel survey. Wartime tube packaging. Notes about men and materials

People

DR. C. B. JOLLIFFE, chief engineer RCA Laboratories and communications chairman of NDRC, was awarded honorary LL.D. degree by the University of Virginia, his alma mater at the school's 75th annual commencement.

Ralph S. Merkle, commercial engineer, Hygrade, Pennsylvania, has been commissioned First Lieutenant in the Coordination Branch, U. S. Signal Corps.

David Grimes has been made vice president in charge of engineering, Joseph H. Gillies, vice president in charge of radio production, and Robert F. Herr, vice president in charge of service, all of Philco Corporation.

News

AEROVOX CORPORATION celebrated its 20th anniversary recently with presentation of tokens of esteem to S. I. Cole, president and other officials and old-timers in the company.

Catalin Corporation of America, manufacturers of cast and liquid resins and plastics, has completely reorganized its manufacturing facilities at its plant at Fords, N. J., has embarked on the erection of a new building for the production of polystyrene molding compounds, and the purchase of land, buildings, and equipment of the former U. S. Tar Products Co., Inc., at Matawan, N. J.

Keystone Carbon Co., St. Mary's, Penna., manufacturers of precision molded products is completing a large program of expansion of plant and manufacturing facilities.

President Roosevelt requested Congress on June 8 for an appropriation of \$2,505,730,000 for the Signal Corps.

Seven official television listening posts have been established in Schenectady County, N. Y. where air raid wardens have been getting instructions originating in New York City relayed to them by the G-E television station.

More About Civilian Defense Communications

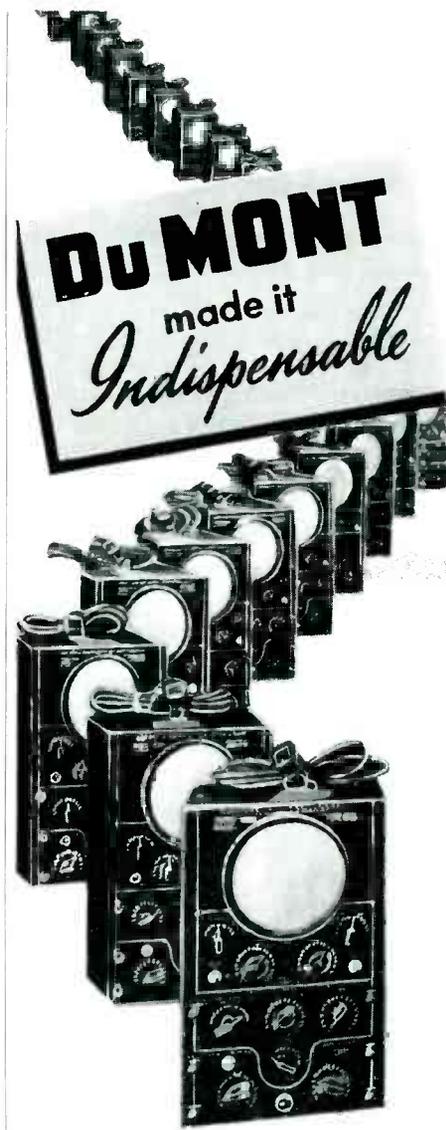
RULES GOVERNING THE operation of civilian defense radio stations (ELECTRONICS, July 1942, p. 103) released in June by the Federal Communications Commission specified that licenses would be issued to amateurs and others having the necessary technical training and equipment only through groups affiliated with the Office of Civilian Defense. The OCD simultaneously announced that it was preparing a manual explaining the procedure to be followed by properly accredited defense groups wishing to set up War Emergency Radio Service networks.

The manual referred to by the OCD is still in process of preparation as this issue goes to press but, in the interim, regional directors of the OCD have received a memoranda from director James M. Landis outlining suggested preliminary organizational steps which should be taken. Among the suggestions are the following: It is recommended that surveys be undertaken to determine to what extent equipment, licensed operator personnel and technical skill are available in each control

Radio Receiver Production-January to March 31*

	1942 Units	1941 Units	1942 Dollars	1941 Dollars
Broadcast Receivers				
Table sets.....	1,120,296	1,261,997	\$14,379,700	\$10,713,000
Console sets.....	141,883	124,976	5,710,900	3,857,600
Portables.....	374,307	196,824	5,810,000	2,228,500
Television (no sound)....	139	4	7,500	200
Auto sets.....	216,910	650,035	3,671,200	10,405,800
Farm battery sets.....	195,854	157,077	2,761,900	1,845,800
F-M adapters.....	4,798	884	120,500	20,100
Elec. phonographs.....	64,563	43,754	932,800	494,600
Combination Apparatus				
Table combinations.....	227,120	112,684	5,761,100	2,034,600
Consoles.....	223,791	106,119	16,345,500	6,498,700
Radio, phono., and recorder	24,488	15,047	2,232,000	742,700
Television.....	92	23	17,300	3,100
Apparatus sans cabinets..	127,608	93,641	2,323,600	1,237,900
Control apparatus.....	780	834	10,600	7,200
Total.....	2,722,629	2,763,899	\$60,084,600	\$40,089,800

* Compiled by the Radio Corporation of America from reports from its licensees.

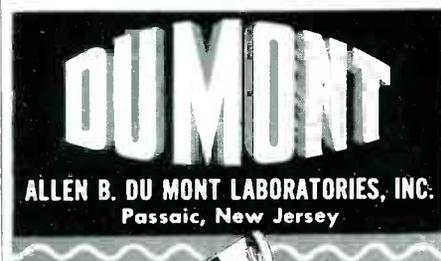


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"Tested and found to comply as an "or equal" to engraving now called for in specifications . . ."

★ Above excerpt from the U. S. Signal Corps Approval offers convincing evidence that Rogan "deep relief" branding on phenolic or other plastic parts achieves results equal to engraved markings. Of greater importance, Branding by Rogan permits the use of simple, fewer cavity, less costly molds.



Heat Control Unit Branded by Rogan

Branding on Plastics Will Speed Your War Production!

Fewer molds are required where parts are interchangeable, save for different markings for specific uses. Eliminates costly new molds and time-consuming mold-making operations. Permits use of blank stock parts.

See accompanying illustrations showing "deep-relief" markings branded on curved surfaces and hard-to-get-at places. Try this faster, big money-saving process now.



Plastic Shut-Off Branded by Rogan



Calculating Device Part Branded by Rogan

Get New Fully Descriptive Circular. No Obligation. Write

ROGAN BROTHERS 2003 S. Michigan Ave., Chicago, Illinois

EASTERN PLANT: 154 Lawrence St., Brooklyn, N. Y.

area. (The OCD does not encourage the manufacture of new equipment, believing that there is a sufficient supply of parts and materials for purposes of construction already in the hands of amateurs or on the shelves of dealers and distributors, and will not endorse requests to the War Production Board for preferential treatment). Regional directors are urged to study the FCC's regulations governing the War Emergency Radio Service and are also urged to inform prospective station operators of the contents of OCD publications "Staff Manual" and "The Control System of the Citizen's Defense Corps" so that such operators will be familiar with the organizational rules with which they will be expected to comply in the event that their equipment and service is enlisted.

Within the OCD memoranda, it is interesting to note, is a statement to the effect that War Emergency Radio Service nets will be required to show proof that all transmitters within such nets can be instantly silenced upon receipt of a single order at the District Warning Center.

Music While You Work

THE ROLL CALL OF FACTORIES using sound system to furnish music to employes while they work is most impressive. Music of the proper kind, level and frequency relieves nervous fatigue and increases morale. Of course these sound systems can be used for announcements, etc.

A new sound system division, created to handle the sound problems of government requirements and of war industries, has been established by the Stromberg-Carlson Tel. Mfg. Company, and has taken over a large share of space in one of the company's new plants. A. C. Schiffino will head up the new divisions, with A. R. Royle as sales manager.

Meissner LITZ
HIGHER Q WITH
Meissner-LITZ
MEISSNER MANUFACTURING CO., M.T. CARMEL, ILLINOIS

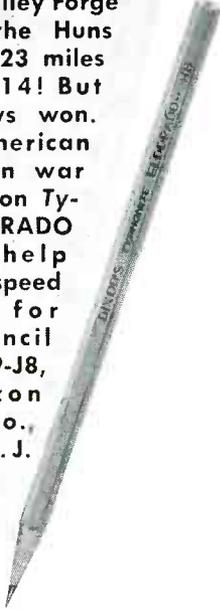


A. C. Schiffino, head (left) and A. G. Royle, sales manager

Coming events cast their shadows...

Victory often hides behind the appearance of defeat! Things looked gloomy at Valley Forge and when the Huns were within 23 miles of Paris 1914! But we've always won.

Today American draftsmen in war work call upon Typhonite ELDORADO pencils to help maintain the speed necessary for Victory! Pencil Sales Dept. 59-J8, Joseph Dixon Crucible Co., Jersey City, N. J.



ELDORADO

**PERFORMANCE
COUNTS MOST
AND COSTS LESS
WITH LINGO**

Into Lingo designing has gone the finest engineering skill and modern antenna engineering. The result—"plus" performance combined with low installation and maintenance costs.

199 ft. (above roof)
Radiator at WIBM,
Jackson, Mich. Another example of
Lingo versatility to
meet every station
need.

LINGO
VERTICAL
TUBULAR STEEL
RADIATORS
JOHN E. LINGO & SON, INC., CAMDEN, N. J.

Included in the new sound division's quarters will be a new development laboratory to handle specific sound system problems, and to conduct a continuous study of sound system equipment and correlate its studies with sound system research.

Within recent months, Stromberg-Carlson sound system engineers have installed sound systems in the ship repair station of Maryland Drydock Company, Camp Lee, Virginia, Bartlett-Hayward Co. of Baltimore, a division of the Koppers Coke Company, and many others.

A testing ground for the new sound division has been established within the Stromberg-Carlson plant in the form of a model sound system.

The new sound system will not only include a straight paging and voice system suitable for general and emergency announcements, but it will be able to carry musical programs to workers to speed production, pick up radio broadcasts, and through central control permit two way communications from guardhouse to guardhouse, or from guardhouse to all of the plant, or any section of the plant. A disaster provision has been built in, enabling each section of the plant to be segregated, in case of demolition, fire, etc., or enabling that section to summon help from either control station, or special department. The system is geared to serve sections with such varying noise levels as machine shops, or offices, serving each with a suitable but not disproportionate level of sound.

War work has been set to music recently in the Westinghouse Lamp Division, Bloomfield, N. J.

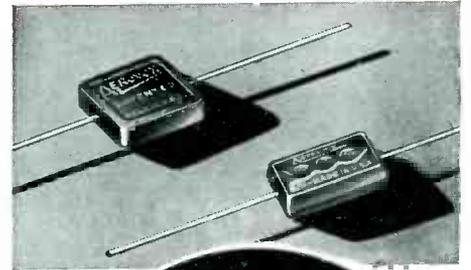
Loudspeakers stationed in main manufacturing areas now play marches, tangos and swing for five and a half hours a day while men and women turn out communications equipment for the nation's armed forces. Recorded music is also played in the Company's recreation rooms and cafeteria.

Band music, greets the first shift workers at 7 a.m. and continues for 15 minutes. Five other half-hour periods of music are scheduled during the eight-hour shift, one at lunch time and the rest timed to coincide with periods of "let-down" or fatigue among the workers. Music during the fatigue periods acts as a stimulant to the employees, reports show. Band selections are played at the end of the first shift and as new workers arrive for the second shift.

Service

TWO WELL KNOWN RADIO engineers have recently been given leaves of absence from their civilian posts to add their abilities to the war effort.

Robert M. Morris has been named a Chief Radio Engineer, U. S. Army Signal Corps, and assumed his duties in the office of the Chief Signal Officer, Washington, June 22. A pioneer in radio, Morris has been given a leave of absence from the National Broadcast-



- For applications requiring precise capacity values, Aerovox offers two precision-type mica capacitors:

SILVER MICAS . . .

Molded in low-loss red (for identification) bakelite. "Postage-stamp" design and dimensions. Thoroughly wax-impregnated internally and externally. Heat-treated for stability. Average temperature coefficient of only .004% per degree C. excellent retrace characteristics. Practically no capacity drift with time. Q as high as 3000 to 5000 in higher capacities. Tolerances to 1%. .000001 to .0025 mfd. 1000 v. D.C.T., and .003, .004 and .005 mfd. 600 v.

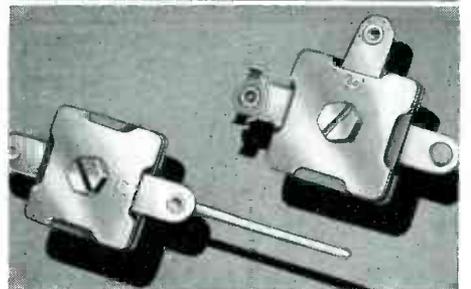
MICA PADDERS . . .

Screwdriver-adjusted mica capacitors set to 1% of given capacity. Can be re-adjusted to compensate for slightest variations in coils and circuit conditions as required. Heat-treated. Wax-impregnated. Four mounting types. .000075 to .01, 600 v. D.C.T.

- Write for DATA . . .

Engineering data on these precision mica capacitors, sent on request. Let us quote on your requirements.

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CORPORATION
NEW BEDFORD, MASS., U. S. A.
In Canada: AEROVOX CANADA LTD., Hamilton, Ont.
EXPORT: 100 Varick St., N. Y. Cable 'ARLAB'





“..information of aid and comfort to the enemy”

THE censor's stamp is, today, a badge of honor. The necessity of withholding information concerning a product implies its importance to the war effort.

How and where this censored new product is going to be used would be of interest to Axis engineers. It and many other parts were created by *Richardson Plastics* to help increase and speed up production of better equipment.

INSUROK Precision Plastics and the suggestions of *Richardson Plastics* have helped many war products producers save time and increase output. If molded or laminated plastics might solve one of your problems, write us.

INSUROK and the experience of *Richardson Plastics* are helping war products producers by:

1. Increasing output per machine-hour.
2. Shortening time from blueprint to production.
3. Facilitating sub-contracting.
4. Saving other critical materials for other important jobs.
5. Providing greater latitude for designers.
6. Doing things that "can't be done."
7. Aiding in improved machine and product performance.

The Richardson Company, Melrose Park, Ill.; Lockland, Ohio; New Brunswick, N. J.; Indianapolis, Ind. Sales Offices: 75 West St., New York City; G. M. Building, Detroit.

INSUROK

ing Company for the duration of the war. Morris started his radio career as engineer for the A.T. & T. when WEAJ was established. When NBC was formed in 1927 Morris was named Chief Development Engineer. In 1935 Morris developed the Orthacoustic method of making lateral electrical transcriptions. He continued as Chief Development Engineer until March, 1941, when he was named Business Manager of the NBC Radio-Recording Division, from which post he has been given leave to assume his new duties.



Robert M. Morris



P. C. Sandretto

P. C. Sandretto, superintendent of United Air Lines' communications laboratory in Chicago and a leading aeronautical radio engineer, has been given leave of absence by United to become a major in the Communications Directorate of the Army Air Forces at Washington.

As head of United's laboratory, Sandretto participated in many aircraft radio developments which have become standard on the nation's air-

lines. A graduate of Purdue University in electrical engineering, he was on the technical staff of the Bell Telephone Laboratories in New York before he joined United Air Lines 10 years ago.

While still in college, Sandretto designed and built one of the first crystal control broadcasting stations in the United States and, after his graduation, worked on television research at Purdue's engineering experiment station. His work with United Air Lines in perfecting plane-ground radio communication and in ground radio direction finding of planes in flight has attracted particular attention.

Sandretto is the author of "Principles of Aeronautical Radio Engineering" to be published early this Fall by the McGraw-Hill Book Co.

New Cartons for Tubes

A NEW PRINCIPLE of packing radio tubes which will result in major contributions to the war effort in shipping space, material, handling and warehousing savings, has been developed by RCA.

By the new method, RCA is saving some 120 tons of packing material a year, and is able to ship approximately twice as many tubes in a boxcar or truck, thus halving the need for critical shipping space. The new method supplants packing, handling, storing and shipping practices which have been common for many years.

To extend the value of the new packing principle more quickly, RCA has granted patent rights to the new type cartons to other tube manufacturers. In addition, other tube manufacturers have been shown factory routines that have been developed to make the most efficient use of the new process.

The new packing ideas were developed by Charles I. Elliott, a 27-year-old packing engineer who was employed by the RCA tube division to study the company's methods of handling tubes during the manufacturing process, and preparing them for warehousing and shipping.

Old Systems Scrapped From Start

Mr. Elliott attacked the problem by consigning all existing packing containers to the scrapheap. Then he set about designing new type containers which would use the least possible amount of cardboard and that would make possible more efficient factory handling. He found that existing packing methods required the use of 210 separate pieces of packing material per 1,000 tubes. Improvised handling methods were used in the factory where tubes travel from one assembly operation to another. A packing box of 22 parts, some of them no longer obtainable, was used to store and ship glass tubes.

When he had finished re-designing

packing cases, Mr. Elliott found that he had reduced the 210 pieces of packing per 1,000 tubes to 24 pieces. He discovered that a single one-piece, tray-like container, planned to hold the tubes safe within shipping cases, could also be used to save time in the manufacturing processes.

Standardization Important in Wartime

Standardization of tube packages is vitally important in wartime for many reasons. Spare radio tubes can be made to fit into spaces designed for them by the builders of planes, tanks, mobile units, ships and other fighting equipment. And the tube packages will fit the spaces, no matter from which factory they originated.

In handling receiving tubes alone, savings of 30 percent in material were achieved. Factory handling efficiency has been stepped up 20 percent, loss by breakage has been materially reduced, as has the need for storage space. It is now possible to pack 647,500 tubes of a given type into a single boxcar, an increase of nearly 100 percent in capacity.

A further improvement in the handling of the smaller types of receiving tubes has been made in the form of a "clip" of cardboard which holds 10 tubes. During testing, warehousing and branding operations, the "clip" of 10 tubes is handled as a unit. However, when the time comes for the tubes to be packed into individual cartons for shipment, the "clip" is torn into 10 pieces along perforated lines, to become the interior support for each tube in its individual carton. Further, the old 31-piece glass tube carton had resolved itself into a smaller, eleven-piece box.

In the case of a certain type power tube, a wooden box used to transfer small quantities about the factory and to the warehouse has given way to a more compact cardboard box in which the tubes are transported with greater protection from breakage.

One universal box has been designed for packing all types of power tubes of the same size, supplanting a large number of various sized special boxes. Ingeniously designed inner supports do away with the layers of wadding once used, while the application of simple laws of physics provides greater safety for the tubes when the box is subjected to unusual stress.

In the case of cathode-ray tubes, the empty glass bulbs are now received at the factory from the glass works in the same packing cases in which they are transported throughout the manufacturing, testing, warehousing and shipping processes. So much has been saved in the cost of the packing cases that the glass company has agreed to furnish them to RCA without cost.

Mr. Elliott's work has been carried on under the direction of L. E. Mitchell, Manager of the Industrial Engineering Department devoted to the development of better methods through work simplification.

"The overall savings under the new method are tremendous, when consid-

KENYON TRANSFORMERS

WHEN SPECIFICATIONS ARE *Tough*



KENYON TRANSFORMER CO., INC.
840 BARRY STREET NEW YORK, N. Y.

"TEST TO DESTRUCTION"



Standard Electro-Voice engineering practise includes orders for "Test to Destruction" during manufacture and assembly. At frequent intervals, microphones are taken from our production lines and abused until they are completely demolished.

Throughout the procedure, Electro-Voice engineers carefully examine and analyze the resulting changes in level and response. This is but one of a series of tests that are perfecting a line of rugged microphones for dependable service under the strains and shocks of military service.

ELECTRO-VOICE MFG. CO., Inc.
1239 SOUTH BEND AVENUE SOUTH BEND, INDIANA
Export Office: 100 VARICK STREET, NEW YORK, N. Y.

SERVING  AMERICA!



DeJUR

**POTENTIOMETERS
RHEOSTATS**

1 to 200,000 ohms in single or dual units. Custom-crafted in the tradition which has earned world-respect. Special attention to individual needs.

Write, wire or phone for new Catalog 1-61, Dept. B


DeJUR-AMSCO CORPORATION
SHELTON, CONNECTICUT

MOLDED
S.S. White **RESISTORS**
The "All-Weather" Resistors



TYPE 65X
Actual Size
Other types available in the lower values

RESISTOR BULLETIN 37 GIVES FULL DETAILS...
It shows illustrations of the different types of S. S. White Molded Resistors and gives details about construction, dimensions, etc. A copy, with Price List, will be mailed on request. Write for it—today.

THESE widely used Resistors are favored because of their noiseless operation and durability and because they retain their values and characteristics under extremes of temperature, humidity and climatic changes.

STANDARD RANGE
1000 ohms to 10 megohms.

NOISE TESTED

At slight additional cost, resistors in the Standard Range are supplied with each resistor noise tested to the following standard: "For the complete audio frequency range, resistors shall have less noise than corresponds to a change of resistance of 1 part in 1,000,000."

HIGH VALUES
15 megohms to 1,000,000 megohms.

S. S. WHITE

The S. S. White Dental Mfg. Co.

INDUSTRIAL DIVISION

Department R, 10 East 48th St., New York, N. Y.

ered in the light of the national emergency," Mr. Mitchell said. "In 1941 we used 400 tons of packing material. In 1942, for the same quantity of tubes, we will need only 280 tons, a saving of 120 tons.

Not only does the new method packaging and handling tubes save on materials but it speeds up the tube testing by 30 percent enabling 30,000 hours of labor at the RCA plant to be devoted to making more tubes. The fire hazard has been reduced since there is no shredded paper in packing cases and no loose partitions, the containers can be laid out flat and so require less storage space.

Radar

CHARLES F. KETTERING, President of the General Motors Research Corporation and Vice President of the General Motors Corporation has been appointed as consultant to the Radio and Radar Branch of WPB.

In announcing the appointment, Donald M. Nelson, WPB chairman, made public a portion of a letter to Mr. Kettering, as follows:

"Our Radio and Radar program has assumed such tremendous proportions that I feel it is now vitally important to have someone of your outstanding capacity and accomplishments in the scientific world, to whom we can turn from time to time in the difficult task of meeting the requirements to that program. Your acceptance of the position of consultant to us in these matters makes me increasingly confident that the job will be well done and I wish to take this opportunity of telling you how pleased I am about the arrangement."

The Radio and Radar Branch is concerned with providing facilities for the production of radio communications, aircraft detector, signalling and fire control equipment. Ray Ellis is chief of the Branch, which reports to Harold Talbott, Deputy Director of the Production Division.

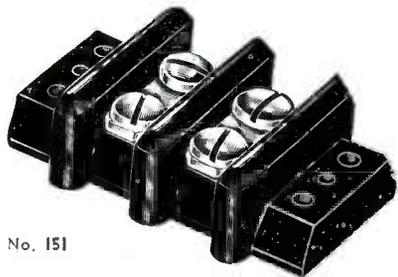
Late News

WPB PROHIBITION on use of copper and brass in radio manufacture has been lifted to permit manufacture of replacement vacuum tubes and various types special types of radio apparatus under certain circumstances.

Because of critical shortage of scientific equipment, university and other private laboratories engaged in research work unrelated to the production of materials or in other research not directly connected with the war effort will be unable to secure new laboratory equipment unless the particular use is approved by the Director of Industry Operations. Repair parts may be obtained, however.

FCC has ordered all amateur transmitters to be registered with the Commission by August 25. Thus the FCC will have a record of what equipment is available, where it is, etc.

JONES BARRIER STRIPS SOLVE MOST TERMINAL PROBLEMS



No. 151

A compact, sturdy terminal strip with Bakelite Barriers that provide maximum metal to metal spacing and prevent direct shorts from frayed wires at terminals.

6 SIZES

cover every requirement. From 3/4" wide and 13/32" high with 5-40 screws to 2 1/2" wide and 1 1/8" high with 1/4"-28 screws.

Jones Barrier Strips will improve as well as simplify your electrical intra-connecting problems. Write today for catalog and prices.

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ALLIED RADIO
833 W. JACKSON • CHICAGO

Colin B. Kennedy

IN ANNOUNCING the death of Colin B. Kennedy, one of the radio industry's pioneering spirits, we can do no better than to quote from a letter from E. F. McDonald, Jr. President of Zenith Radio Corporation.

"When, back in 1921, I became associated with Chicago Radio Laboratory, which two years later became Zenith Radio Corporation, to me the two great names in radio were Grebe and Kennedy, both of whom now have passed on.

"Colin Kennedy, back in those days, headed the radio company bearing his name with St. Louis as its headquarters. He was an engineer radio pioneer, a quiet, modest man, who sought no glory but contributed much to the early days of radio. He was one of the first holders of a license to manufacture home radio under Armstrong patents.

"Colin Kennedy, when he died, was doing his stint for his country as an OPM engineer assigned as civilian advisor to the Army Signal Corps."

Alien Patents

ALIEN PROPERTY CUSTODIAN has taken over approximately 3,000 patents and by end of September 40,000 may be in the same category. In one of the first groups of 600 taken over, 50 were Italian, 10 Hungarian, 100 Japanese and the remainder were German.

Furthermore, the Custodian requires everyone claiming any interest in patents or patent applications now or formerly owned by nationals of certain designated countries to report their interest on Form APC-2 by August 15, 1942.

• • •

REGISTER CONTROL



A G-E photoelectric color register control installed on a press in the plant of New York's Neo Gravure Printing Company is checked for synchronization by means of a cathode-ray oscilloscope



with the new

STABILIZED Element

★ Quietly, modestly, quite unannounced, Clarostat Series 37 controls have, for many months past, been coming through with the new Stabilized Element. We wanted this outstanding development to prove its worth out in the field, by users, corroborating our own critical tests.

Results have spoken for themselves. Users have promptly spotted something radically different in non-wire potentiometers and rheostats. Remarkably accurate resistance values first and last; extreme immunity to humidity, temperature and other climatic conditions; minimized wear; noiseless operation; smooth rotation—these features have marked the introduction of the new Clarostat Stabilized Element—stabilized by heat-treatment, chemical-treatment, lubrication-treatment, for truly outstanding performance.

Try a Clarostat Series 37. Sample on request to responsible parties. Judge it by your own tests. Let us quote.



Clarostat Mfg. Co., Inc.
285-7 N. 6th St. • Brooklyn, N. Y.



Global
REG. U. S. PAT. OFF.

CERAMIC RESISTORS

● Finding the right resistor for a specific application is likely to be no easy problem. Because the solution so often is found in Global Brand Ceramic Resistors we urge you to acquaint yourself with the distinctive qualities of these versatile resistors. The handy chart below shows types available, together with their characteristics.

TYPE	A	B	CX
DIAMETER			
MIN.	1/16"	1/16"	1/16"
MAX.	1"	1"	1"
LENGTH			
MIN.	1/4"	1/4"	1/4"
MAX.	18"	18"	18"
WATT RATING*			
MIN.	1/4w.	1/4w.	1/4w.
MAX.	54w.	54w.	150w.
RESISTANCE per in. of length			
MIN.	25 ohms	5 ohms	1 ohm
MAX.	15 meg.	15 meg.	1000 ohms
NORMAL RATING w./sq. in. of radiating surf.	1	1	2-1/2

*By artificial cooling these ratings may be increased substantially.

Characteristic Coefficient:

Type A: Commercial straight line Voltage and Temperature

Type B: Negative Voltage Negative Temperature

Type CX: Commercial straight line Voltage and Temperature

Terminals: All types: Metalized ends with or without wire leads

In addition to these standard items, special resistors can be made to meet definite specifications both as to shape and characteristics. Ask for Bulletin R and give us details of your requirements.

Global Division
THE CARBORUNDUM CO.
REG. U. S. PAT. OFF.
NIAGARA FALLS, N. Y.

Carborundum and Global are registered trade-marks of and indicate manufacture by The Carborundum Company.

NEW PRODUCTS

Month after month, manufacturers develop new materials, new components, new measuring equipment; issue new technical bulletins, new catalogs. Each month descriptions of these new items will be found here

Explosion-Proof Timers

EXPLOSION-PROOF TIMERS suitable for operations in atmosphere containing gasoline, naphtha, petroleum, benzol, acetone, lacquer solvent, natural gas, etc., can now be had.



The illustration shows a Type TD1C explosion-proof time delay relay which is laid out for panel board mounting with the setting knob and dial projecting. Within this housing it is possible to mount either Type TD1C or TD1 with a small relay. The latter construction would be used where it is desired to control the timer from remote located momentary start button.

The R. W. Cramer Co., Inc., Centerbrook, Conn.

Printing and Coloring Acetate

WIRING DIAGRAMS, CHARTS, indicators and dials can be printed on plastic by a new process called "Print-Cote." Coloring plastics such as cellulose acetate is done by a process called "Print-color." The "Print-Cote" method used for protecting cellulosic sheet plastic is to apply to the printed sheet a liquid film of cellulose acetate, coupled with a suitable solvent and plasticizer. The process is not a lengthy one and the coating will not peel off. The finished product is unaffected by oils, dirt or atmospheric conditions. These printed acetate plates can also be bent to conform to the shape of curved surfaces where necessary.

"Printcolor" plastics may be used for sheet stock, molded items and extruded shapes. In some cases, extruded shapes can be dyed in complete coils. Crystal clear transparent materials become transparent colors by this dyeing process, and translucent or opaque materials in white or light shades may

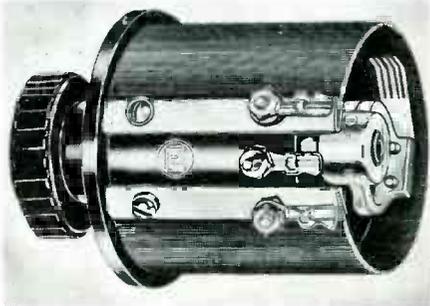
be given a wide variety of colors. The dye penetrates the surface of the plastic, and the color is almost indestructible. The piece can be buffed without removing the color. Since the object to be dyed is not subjected to the action of solvent chemicals, its original finish is not altered, and it needs no subsequent polishing or processing.

Printloid, Inc., 93 Mercer Street, New York, N. Y.

Rheostat, Potentiometer

THESE RHEOSTATS, POTENTIOMETERS, designated as Types 260 and 275 are rugged and durable and were designed to withstand vibration, tropical heat, and moisture. They may also be used in high impedance vacuum-tube circuits where high values of resistance and low noise level are required.

Specially developed machines space wind the fine resistance wire on a strip of fabric base bakelite. These strips are then coated with a binding agent which cements the wire to the strip. A protective bakelite band is then placed externally over the fine wire strip protecting the wire from mechanical damage or derangement. This strip is then bent around and securely fastened to the bakelite supporting form. Constant contact resistance and low noise level is maintained for any position of the knob through the use of five separate wiping fingers which are



self-aligning. The type 260 and 275 have the same mechanical characteristics with the exception of physical depth dimensions and wattage rating. These units are usually furnished for panel mounting and can be converted for top of table mounting by simply reversing the shaft. Either unit can be mounted

directly on metal panels without short circuiting the variable arm.

Specifications of Type 260 are maximum rating, 2 to 100,000 ohms; power rating, 6 watts; net weight, 6 ounces. Type 275 specifications are maximum resistance, 50 to 200,000 ohms; power rating, 11 watts; net weight, 8 ounces. Both of these models have a rotation angle of approximately 327°, a standard 3-hole mounting, and a 3/8 inch diameter Bakelite shaft.

DeJur-Amsco Corp., Shelton, Conn.

Vacuum Tube Voltmeter

ACCURATE MEASUREMENTS throughout the entire audio frequency range are simplified by Model No. 666, a vacuum tube voltmeter specifically designed for that purpose. Essentially a peak type of voltmeter, this instrument has a constant input impedance resistance of 16 megohms. Although designed for 105-130 volt, 60 cps operation, provision has been made for external battery



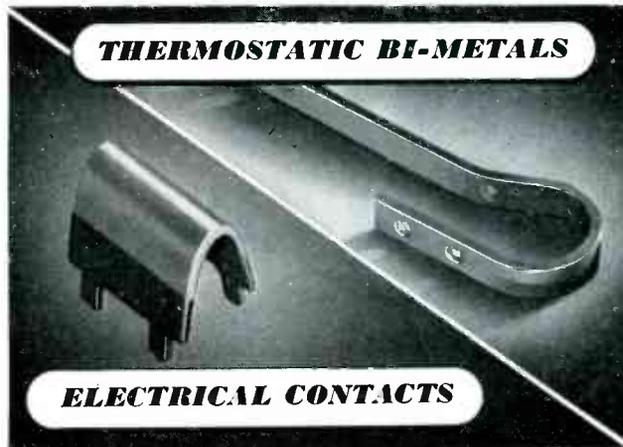
operation through appropriate terminal connections and a throw-over supply switch. Readings are made quickly and easily. The instrument is equipped with a 4 1/2-inch rectangular meter having a movement of 0-200 microamps. Ranges are 0-3-6-30-150 volts. Tubes used are type 6K6GT, 6X5GT, 6H6 and VR105-30. The latter is a voltage regulator, eliminating errors due to line voltage fluctuations.

Radio City Products Co., 127 West 26th Street, New York, N. Y.

Self-Locking Nuts

A NEW ACORN TYPE, self-locking nut is available in three popular bolt sizes, No. 6-32, 10-24, and 1/4 inch-20. They are made of spring steel, heat treated and plated, and have spring-steel jaws that close in and grip the bolt thread when the nut is tightened. They are light in weight, low in cost, and are relatively strong, and can be used to replace regular acorn nuts or nuts with lock washers.

The Palnut Co., 61 Cordier Street, Irvington, N. J.



Percolators or Pursuit Planes

★ Almost overnight, whole industries have changed over from peacetime to war production. ★ Yet, whether it's brooders or bombers, transformers or transports, percolators or pursuit planes, the need for Wilco specialized thermostatic bi-metals and electrical contacts remains unchanged. Resistance bi-metals (from 24 to 440 ohms, per sq. mil, ft.) and high and low temperature thermostatic bi-metals are available in wide variety. ★ Also Wilco electrical contact alloys (in Silver, Platinum, Gold, Tungsten, Metal Powder Groups).



The H. A. WILSON CO.
105 CHESTNUT ST., NEWARK, N. J.
Branches: Chicago and Detroit

Suppliers
to
Foremost Manufacturers
of
**ELECTRONIC
Devices**
demanding
**HIGHEST
QUALITY!**

NEW YORK TRANSFORMER CO.
26 WAVERLY PLACE, NEW YORK, N. Y.



Panoramic RECEPTION!

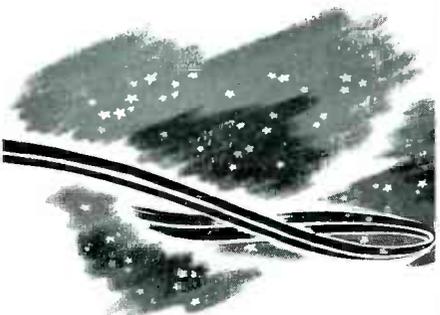
THE VISIBLE SPECTRUM OF RADIO FREQUENCIES

Research and development engineering in the Hallicrafter laboratories goes constantly forward . . . keeping ahead of the fast moving pace of today's defense requirements for communications equipment.

Panoramic reception is only one of the many new developments Hallicrafters will be the first to introduce when short wave equipment is again available for civilian use.

the hallicrafters co.
CHICAGO, U. S. A.

Keep Communications Open!

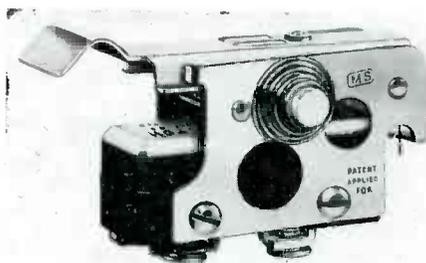


Densitometer

THE BASIS OF THE ANSCO Sweet densitometer (a photographic density measuring device) is its use of a photo-sensitive tube which, when placed in the path of a beam of light, varies the flow of an electric current in proportion to the intensity of the light. This current, after amplification, actuates a meter which is calibrated directly in terms of density. The electronic circuit remains stable over long periods of time and permits uniform calibration of the meter scale in terms of density. The densitometer is easily operated with a minimum of visual fatigue. Agfa Ansco, Binghamton, N. Y.

Switch Actuator

DESIGNED FOR USE in the throttle mechanism of aircraft and other applications, Type "T" Switch Actuator provides a light-weight, compact mechanism for performing a widely useful three-step operation. Steps in the cycle of operation are: closing a circuit by depression of an actuating arm; opening the circuit by mechanical release of the normally open switch while the actuating arm is held in the depressed position; and, return of the actuating arm to normal position. As used in aircraft, the unit employs the



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Micro Switch Corp., Freeport, Ill.

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THE PHOTOMETER is designed to measure very weak light, as well as thin light beams. It comprises a phototube, an electronic d-c amplifier and an indicating instrument. The unit operates from a power line without the use of batteries, and the amplifier circuit is stabilized so as not to be affected by line voltage variations. The instrument is self-contained and built into a port-



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able case. The phototube is mounted in a "search unit" connected to the instrument by a flexible cable. The current output of the amplifier is about 100,000 times higher than the input. Three types of phototube will be supplied, depending upon the spectral characteristics of the light to be measured. The photometer when exposed to incandescent light of approximately 2865°K shows full scale deflection at 0.025 foot candle. The instrument has



many applications in photography, and can be used to measure the density of spectrographs, brightness of paints, measurement of low turbidities and haze, etc.

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Photovolt Corp., 95 Madison Ave., New York, N. Y.

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The Acro Electric Co., 3159 Fulton Road, Cleveland, Ohio.

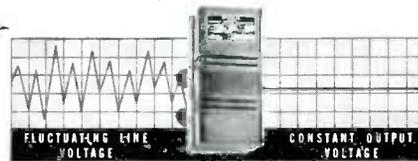
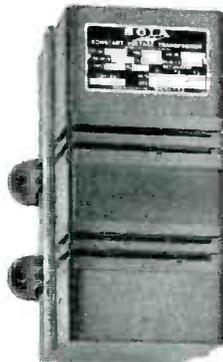
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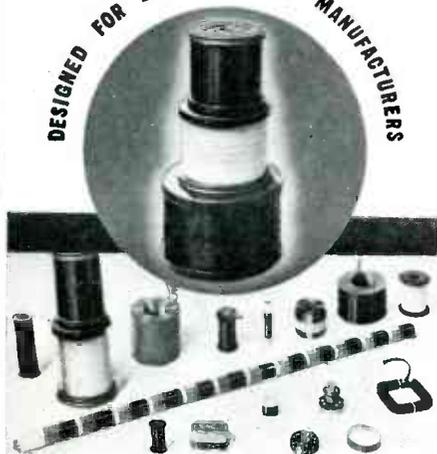


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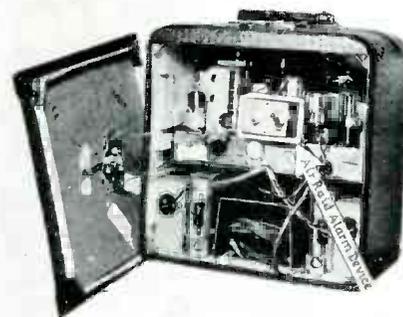
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Literature

Insulating Varnishes and Compounds.
The different characteristics of baking,
air drying, finishing, and miscellaneous
varnishes are described. Also a de-
scription of red oilproof enamels, ma-
chinery enamel, special lacquers, shel-
lac, cable lacquers, synthite varnishes
and insulating compounds. The booklet
includes conversion tables and tank ca-
pacity charts. This may be secured from
the John C. Dolph Co., 168 Emmett St.,
Newark, N. J.

Circuit Control Switches. A pamphlet
describing circuit control switches
for use in signalling equipment, com-
munication apparatus, instrument panel
boards, utility lighting systems, spe-
cialized lighting equipment, aircraft
circuit control systems and many other
industrial applications may be had
from General Electric Co., Accessory
Equipment Sales, Bridgeport, Conn.

Soldering Iron. A circular which de-
scribes and illustrates the uses of "Hex-
acon" screw tip and plug tip soldering
irons. The new "Hatchet" iron described
has the handle offset to give better bal-
ance and reduce fatigue so that better
soldered joints may be perfected. Hex-
acon Electric Co., 161 W. Clay Ave.,
Roselle Park, N. J.

Metal Shielded Wire. This recent book-
let tells about the method of shielding
insulated wire with seamless aluminum
or copper tubing against electrical in-
terference, noise, moisture and me-
chanical damage. Bulletin 201 contains
mechanical and electrical specifications
of approved aircraft wire manufactured
to specifications No. AN-J-C48 and No.
95-27074 by General Motors Corp. Both
booklets obtainable from Precision Tube
Co., 3824-26-28 Terrace St., Philadel-
phia, Pa.



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Knurling of socket screws originated with "Unbrako" years ago.

Condensers. This catalog lists the essential condensers, resistors and test instruments in demand and which are still produced. Also included are motor starting replacement capacitor listings. Aerovox Corp., New Bedford, Mass.

Interchangeability Chart. A transmitting tube interchangeability chart has just been released by the General Electric Co., Radio & Television Dept., Schenectady, N. Y.

TIN Research Report. This report (publication No. 109) summarizes recent researches and developments in the uses of tin in industry. It discusses quite thoroughly tinplate and hot-tinning, electro-deposition of tin and tin alloys, bearing metals, foil, bronzes and chemical compounds of tin. Publication No. 109 available from Battelle Memorial Inst., 505 King Ave., Columbus, Ohio.

Flexible Shafting. An illustrated book showing the many uses for flexible shafting in power drive and remote control. Reproductions show the applications of flexible shafting in airplanes, automobiles and radio. Circle Ess shaftings are graphically illustrated along with illustrations of shaft end and casing end fittings. Manual D from F. W. Stewart Mfg. Corp., 4311 Ravenswood Ave., Chicago, Ill.

Antenna Measurements. In the June 1942 issue of *Experimenter* "Antenna Measurements with the Radio-Frequency Bridge" is discussed. This article outlines the means for measuring antenna systems, gives a convenient procedure and points out the precautions if satisfactory results are to be obtained by present owners of the popular Type 516-C radio-frequency bridge (recently discontinued). Also just released is an up-to-date price list for Catalog K and a list of the new instruments announced since the publication of Catalog K. Both available from General Radio Co., 30 State St., Cambridge A, Mass.

Electronic Devices. This is the third and final discussion on "Industrial Applications of Electronic Devices". This covers inverters and features the following; "direct current" transformer, thyatron temperature control circuits, thyatron ignitron arc light timer, electronic welder control and radio interference. Prepared by the Engineering Dept., Aerovox Corp., New Bedford, Mass.



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Microphones. This booklet "Long Live Your Microphone" gives many helpful hints on the use and care of crystal, dynamic and carbon microphones. Also practical pointers on feedback, cable, plugs, output, response and other information. Bulletin 173G from Shure Bros., 215 W. Huron St., Chicago, Ill.

Iron Powders. The characteristics, and applications of carbonyl iron powders are given in this twenty-three page booklet. The three different grades of G.A.W. carbonyl iron powders, designated as "E", "TH" and "C", are discussed and their special applications are pointed out. Also included are graphs of relative Q-values vs frequency of G.A.W. carbonyl iron powders "TH" and "C". Available from Advance Solvents & Chemical Corp., 245 Fifth Ave., New York City.

Colloidal Graphite. A revised technical bulletin No. 230.8 includes applications for the use of Colloidal graphite dispersions such as "Aquadag" (in water), "Oildag" (in petroleum oil), "Castordag" (in castor oil), "Glydag" (in glycerine) and "dag" dispersions used in the more volatile liquids. Also covered are "Prodag" a concentrated graphite for parting compounds, coarse wire drawing and forging lubricants and a new type 1175 designed for heavy duty such as shell forging work. Available from Acheson Colloids Corp., Port Huron, Michigan or from Denham & Co., 812 Book Bldg., Detroit, Michigan.

Copper Springs. Bulletin No. 4 gives in detail the functions and uses of beryllium copper coil or flat springs. It discusses the Carson Electronic Micrometer which measures wire diameter, coil etc. Available from Instrument Specialties Co., Inc., Little Falls, N. J.

Microphones and Acoustic Devices. A catalog for help in the selection of microphones for various war and civilian applications. Technical data is given on dynamic, crystal, and carbon microphones for use in ordnance plants, Army camps, air terminals, broadcast stations, police mobile and station transmitting equipment, industrial war factories, OCD control centers, etc. Also included is a story telling how microphones are measured. Catalog No. 154, Shure Bros., 225 W. Huron St., Chicago, Ill.

Self-Locking Nuts. The design, advantages, assemblies, types, and application of various types of Palnuts are discussed in this booklet. Suggestions for use on war products are included. Available from The Palnut Co., Inc., 61 Cordier St., Irvington, N. J.

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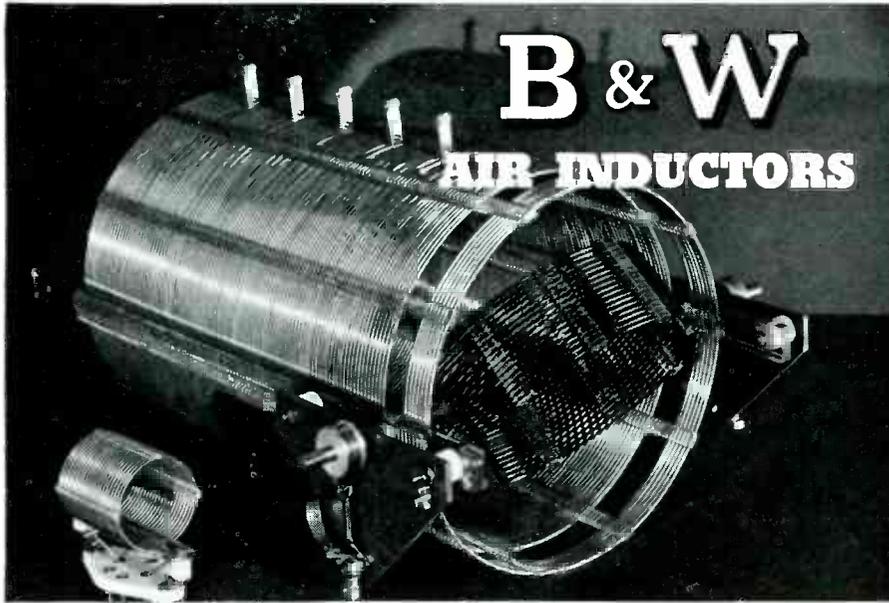
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Sectional Resistors. An 8 page catalog on sectional resistors for a-c and d-c circuits, non-inductive, wire wound and hermetically sealed. The booklet outlines their construction, flexibility and interchangeability. Contains illustrations of various parts and the latter part of the book contains tables giving size, voltage, resistance and price. Catalog 43-820 is available from Dept. 7-N-20, Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Measuring and Control Instruments. This 16-page bulletin describes and illustrates unit construction of temperature controllers. Remote controllers, combustion safeguard equipment and other instruments are covered. Prices and list numbers of catalog sections are also included. Bulletin Z6000 from Wheelco Instruments Co., Harrison & Peoria Sts., Chicago, Ill.

Filters and Coils. This forty-six page catalog gives a complete listing of radio interference filters and coils for mobile equipment. It is very complete in detail and specifications. Catalog No. 42 maybe obtained from the J. W. Miller Co., 5917 S. Main St., Los Angeles, Calif.

Indicating Instruments. D-c and a-c indicating instruments for mounting on switchboards are described in this 12-page catalog. The instruments included are ammeters, voltmeters, wattmeters, frequency and power factor meters, synchrosopes, rectangular triplex ammeters and horizontal edgewise triplex ammeters. The dimensions, weights and list prices on all instruments are included. Catalog 4220, Roller-Smith Co., Bethlehem, Pa.

RCA Questions and Answers. A brochure designed to answer many questions that are asked about the multitudinous activities of RCA. The history of the company, its board of directors and officers, its record of earnings and other financial data, photographs of its laboratories and plants—all this and more is in this book. R.C.A. Bldg., 30 Rockefeller Plaza, New York City.

Guide Book. Two booklets from Mitchell-Rand Insulation Co., Inc., 51 Murray St., New York City, a Guide Book to tape, cloth, sleeving, tubing, papers; and Compounds on waxes, asphalt and similar hydrocarbons, Rubberseal cloth, and copper; both giving considerable useful information on the characteristics of insulating materials of the company. Also a convenient wall map giving dimensions of materials, etc.

Electronic Welding Control

(Continued from page 40)

pendent of line voltage regulation because point A will be held reasonably constant by the energy stored in capacitor C_2 . The slider on R_1 determines the actual potential of point A when C_2 becomes charged through R_2 .

The keying tube T_1 has the voltage across R_2 applied to its grid as negative d-c bias that would normally hold the tube non-conducting. Connected in series with this d-c bias is the secondary of a peaked wave or impulse transformer that makes the grid positive so that the tube can conduct once every cycle, at a time dependent upon the position of the peak. The position of this peak is determined by adjusting the value of R_1 , in series with the primary. It

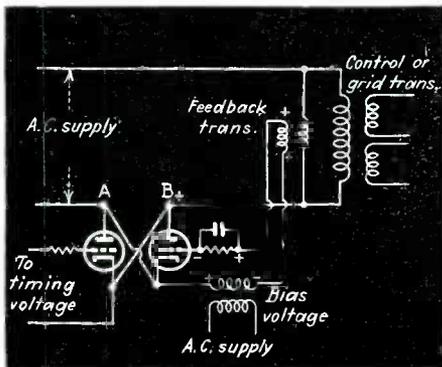


Fig. 6—A "trailing" tube control circuit

will be noticed that the normal position, 1, of the initiating switch S_1 keeps the plate circuit of T_1 open so that it cannot pass current even though the grid goes positive once every cycle.

With initiating switch S_1 in the number 2 position, the plate circuit to T_1 is closed and the next positive peak will cause it to pass current through R_2 . This current will continue to flow as long as S_1 is closed, regardless of voltage applied to the grid of T_1 because of the characteristics of a thyatron on

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direct current. The voltage across R_5 will be the same as that across R_1 minus the arc drop of T_1 . This same voltage is applied to the resistor R_6 and capacitor C_2 network. The time required to charge capacitor C_2 up to a given voltage will depend on the value of R_6 .

Assume that the initiating switch S_1 is in the number 1 position. Point B , which is the cathode of the leading control tube, is at the same potential as point C because no current is flowing in resistor R_5 and the C_2R_6 combination is completely de-energized. The grid of T_2 is connected to point A through current limiting resistor R_7 , which is definitely negative with respect to point C , therefore T_2 is held non-conducting. When switch S_1 is thrown to the number 2 position, R_5 is energized and for the first instant before C_2 starts to charge, R_6 will have the full voltage of R_5 across it and point B will be at the same potential as point D minus the drop in T_1 . Under this condition the grid of T_2 is positive with respect to the cathode point B and the tube conducts. Immediately, C_2 starts to charge and at a certain time later, point B will be at the same potential as point A . At approximately this time T_2 will cease to conduct, as its grid goes negative with respect to its cathode.

The time required for point B to reach the potential of point A depends on the value of R_6 . Therefore, by adjusting R_6 the time can be changed from a short time ($\frac{1}{2}$ cycle)

to a long time ($\frac{1}{2}$ second). By making R_6 a series of fixed resistors controlled by a tap switch, the time can be adjusted in one-cycle steps. The slider on R_1 allows the designer to compensate manufacturing tolerances of resistors and capacitors.

Tube T_2 serves the dual purpose of being the timing tube and the leading firing tube for one ignitron power tube. Tube T_3 is the firing tube for the other power tube and is controlled by a feedback transformer connected across the welding transformer. The details of operation are the same as for Fig. 6. The use of this type of circuit insures full cycles of power applied to the welder, which avoids saturation of the welding transformer even though the calibration should shift. For this same reason, the calibration is much less likely to shift because the timing would have to shift a whole cycle to make any change in the time.

To add phase control to this synchronously timed spot welding control it is necessary to connect the grid of tube A in Fig. 6 in place of the grid of tube T_2 in Fig. 7. This combination produces synchronously timed voltage on the primary of the control or grid transformer of Fig. 6. Now, if this control and grid transformer are put in place of T_2 in Fig. 5A the combination will be a synchronously timed spot welding control with phase control, using the power and firing tubes of Fig. 5A, the control tubes of Fig. 6, and the timing circuit of Fig. 7.

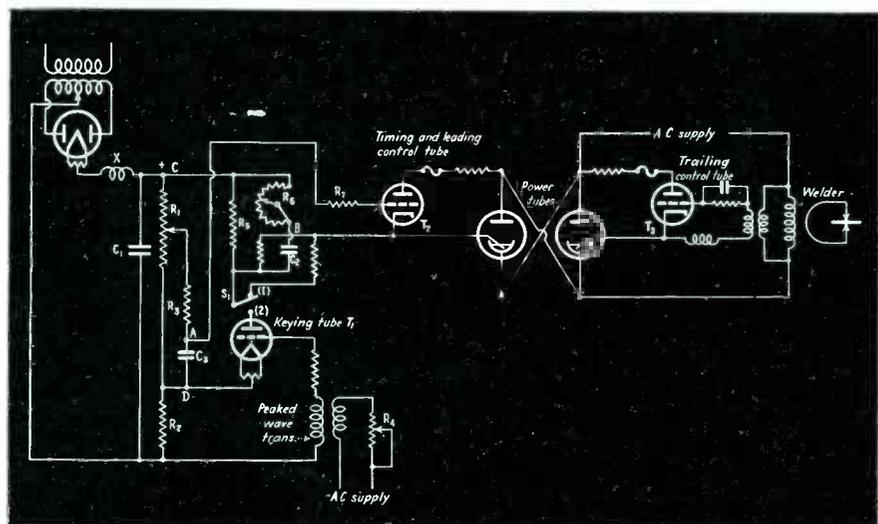


Fig. 7—Elementary circuit of a spot welder control without phase control

RECENT U. S. PATENTS

Each week the United States Patent Office issues grants to many hundreds of inventions that pass the acid test of that office. A few of those relating to electronics are reviewed here

Antennas

Phase Measurement. Voltmeter connected $\frac{1}{4}$ wavelength from each of two antennas by means of a 2-wire transmission line. A. G. Kandoian, IT&T. Dec. 1, 1939. No. 2,283,676. See also No. 2,283,677 to Kandoian on a localizer beacon composed of a central and several side radiators which are fed energy in proper phase and amplitude with respect to central radiator.

Direction and Position Finder. At regular intervals a receiver is tuned to several known marker frequencies, light sources illuminated alternately under control of the receiver, light shutter rotated with a tunable loop in synchronism at a rate within the persistency of vision. Philip Bernstein, Press Wireless, Inc. Dec. 11, 1940. No. 2,282,541.

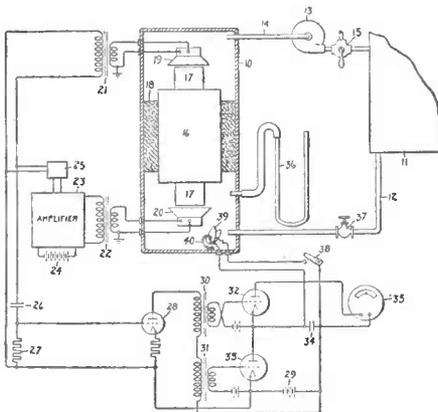
Guiding System. Finding the direction of an electromagnetic wave transmission comprising two sets of three antennas, one made up of loops in mutually perpendicular planes, another of doublets perpendicularly arranged, cathode-ray oscillograph etc. H. G. Busignies, IT&T. Sept. 1, 1938. No. 2,282,030.

Non-communication Applications

Contour Device. Means for outlining contours at various elevations from stereoscopic photographs comprising resonant circuits, phototube apparatus, rectifiers etc. Harry B. Porter, March 19, 1941, No. 2,283,226.

Wave Analysis. In using an oscillograph for wave analysis, a ray is deflected in one direction by a generator of predetermined wave form and deflected in another direction in accordance with an oscillatory wave of a second frequency and of an unknown wave form to be analyzed. Means are provided for varying the intensity of the ray intermittently and periodically at a third frequency differing from the second frequency by a fourth frequency which is normally related to the first frequency in an integral ratio. D. E. Norgaard, G.E. Co., Nov. 1, 1940. No. 2,280,531.

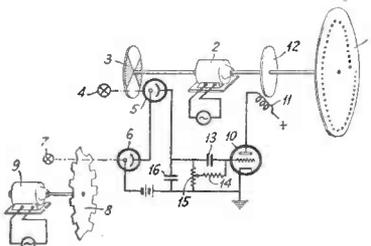
Density Measurement. Resonator with electromagnetic transmitting and receiving apparatus at the free ends of the resonator, amplifier free to oscillate at a frequency determined by the den-



sity of the gas admitted to the resonator and means to compensate frequency for temperature variations in gas. W. Mikelson, GE. Jan. 16, 1940. No. 2,283,750.

Spark Coil Tester. Charging a condenser from a rectifier circuit and alternately connecting a spark gap to the condenser and to the spark coil. S. S. Verney, Auto Electric Supply Co., San Francisco. Oct. 19, 1940. No. 2,283,399.

Synchronizing Apparatus. Method of synchronizing a rotating body with that of a rotating standard comprising pho-

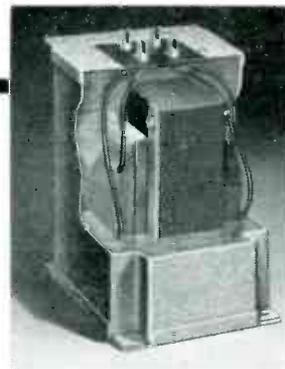


totube apparatus and a braking system. Herre Rinia, RCA. Sept. 26, 1939. No. 2,281,954.

Generator. Circuit to produce triangular waveforms with sides of equal slope using gas and vacuum tubes. B. M. Hadfield, Associated Electrical Labs. May 13, 1940. No. 2,282,130.

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Burner Control. Application of phototube to burner in a furnace. D. W. Fehrenbach, M Kansas City Journal-Post Co. July 31, 1939. No. 2,283,496. See also No. 2,282,551 to R. E. Yates, Drying Systems, Inc., Chicago and No. 2,281,619 to C. R. Roberts, Brighton, Mich.

Hysteresoscope. Application of cathode-ray tube to measuring core materials. S. C. Leonard, GE. March 20, 1940. No. 2,283,742.

Frequency Measurement. Measuring an unknown frequency by arithmetically combining the unknown to an interpolating frequency and adjusting the latter until it differs from the standard frequency by an integral multiple of the same amount as the unknown differs from another integral multiple of the unknown whereby the unknown is calculated from the difference and the known integral multiple frequencies. T. Slonczewski and F. R. Stansel, BTL, Inc. Aug. 3, 1940. No. 2,283,616.

Follow-up System. Light responsive device, source of light, follow-up system for repositioning the light responsive device, and means for anticipating the effect of the follow-up system comprising means for varying the emanation of light prior to the operation of the follow-up device. Mathias Michel, Allis-Chalmers. July 31, 1940. No. 2,283,121.

Telemetry. No. 2,281,710 to Carl Oman, WE&M Co. on a system for transmitting pulses at a rate proportional to a measured quantity; and No. 2,283,072 to Ward Leathers, IBM, on a method of measuring resistances over a wire line.

Waveform Selection. Use of a linear and a square law detector and a polarized relay for distinguishing between currents having a waveform with a high peak factor from currents having a waveform of low peak factor. D. K. Gannett, BTL, Inc. Oct. 25, 1940. No. 2,282,719.

Measurement Apparatus. Determining a magnitude having a related photoelectric effect measurable potentiometrically. A. E. Parker, ETL. June 9, 1938. No. 2,282,741.

Measurement. Two patents, Nos. 21,282,480 and 2,282,726, E. A. Keeler and H. S. Jones, Brown Instrument Co. on measurement and control apparatus.

Time Delay. Circuit using a cold cathode gas tube of the OA4G type. Otto Weitmann, IBM. Nov. 20, 1940. No. 2,282,108.

Differential Analyzer. Phototube-amplifier circuits for comparing optical properties. S. J. Murcek, WE&M Co. July 13, 1939. No. 2,282,198.

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Piezoelectric Apparatus. Patent Nos. 2,281,778 and 2,282,369 to W. P. Mason, BTL Inc. The following description is from Claim 1 of No. 2,281,778. A piezoelectric quartz crystal vibratory body having its opposite rectangular major faces parallel to an X axis and inclined at an angle of $+49^{\circ}30'$ with respect to the Z axis as measured in a plane perpendicular to said major faces, the major axis over-all length dimension and the width dimension of said major faces being inclined 45 degrees with respect to said X axis, said over-all length dimension being in effect divided into a plurality of equal length elementary lengths corresponding to the numerical order of a desired harmonic frequency, said width having a dimensional ratio of less than 0.8 with respect to said over-all length dimension, the thickness dimension between said major faces being one of the values midway between the nearest values given by the relations:

$$\frac{L}{T} = \frac{m^2}{10.88n}$$

and

$$\frac{W^2}{LT} = \frac{m^2}{10.88n}$$

where L, T and W are respectively said over-all length, thickness, and width dimensions expressed in the same units, n is the numerical order of said harmonic frequency, and m is equal to $\pi(i + \frac{1}{2})$ where i is an even order integer that is one of the integers, 2, 4, 6, 8, 10, 12, 14, 16 and 18.

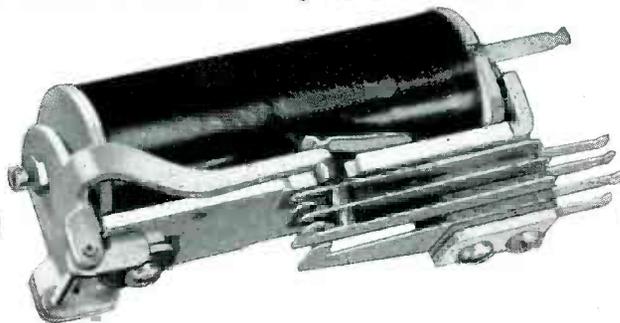
Accelerometer. Apparatus for determining maximum and minimum of attained acceleration comprising inertia-actuated elements, with means so that acceleration may be classified according to the pitch of an audible signal. James A. Buchanan, U. S. Navy. Jan. 2, 1941. No. 2,283,180.

Phase Comparison. Method of comparing phase displacement between two voltages, comprising two amplifiers connected to the voltages, rectifiers connected to the amplifiers and actuated by the vector sum and difference of the supplied voltages, a work circuit responsive to the differential effect of the rectified currents, and means controlling the gain of the amplifiers in accordance with the total amount of the rectified current whereby the operation becomes independent of the amplitude of the supplied voltages. E. S. Purington, RCA. April 27, 1939. No. 2,281,995. Sec. No. 2,282,951 to G. B. Englehardt, BTL, Inc. on a method of measuring phase shift.

Oscillators

Relaxation Oscillators. Gas tube and vacuum tube in series across d-c line; positive line to anode of gas tube; condenser from positive terminal to anode of vacuum tube; cathode of vacuum tube

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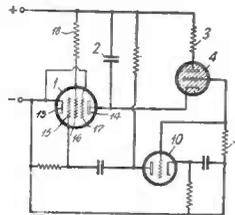
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to negative terminal; grid of gas tube to negative terminal through an impedance; and means for controlling potential of grid of vacuum tube in accordance with potential across the above



mentioned impedance. H. Pieplow, GE. June 10, 1939. No. 2,282,340. See also No. 2,282,895 to F. H. Shepard, Jr., RCA, on a relaxation oscillator producing saw-tooth waves. Two tubes and an electron storage device between anode of each tube and grid of the other tube and rectifiers for maintaining grids positive with respect to cathodes.

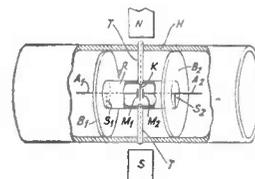
Ultrahigh Frequencies

Waveguides. Nos. 2,281,551 and 2,281,552 to W. L. Barrow, Research Corp., New York. Sept. 10, 1937 and Oct. 31, 1938.

Oscillator. Nos. 2,283,894 and 2,283,895 to I. E. Mouremtseff and G. L. Dinnick, WE&M Co. Resonator type devices.

Bias system. Sources of uhf and dc connected serially in cathode-anode circuit of a tube, the dc being poled and proportioned so that this tube is biased beyond the upper knee of the saturation curve so that current occurs in pulses only during a half cycle of the uhf. R. S. Ohl, BTL, Inc. June 18, 1940. No. 2,283,568.

Magnetron. Tube contained within a coaxial cable with cathode perpendicular to axis of cable, inner conductor of cable being short relative to cable and



having extension which constitutes antenna for exciting the cable. W. Engbert, Telefunken. April 7, 1941, No. 2,282,856.

Modulation. Method of modulating a long-line controlled oscillator by placing modulating input in series with a d-c biasing potential. C. W. Hansell, RCA. Nov. 16, 1938. No. 2,282,295.

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High-frequency Amplifier. At frequencies sufficiently high that the input conductance of a conventional amplifier tube is so positive that it is difficult to develop voltage between cathode and grid, a tube having a cathode, a positive grid-like structure, a control electrode, and an output electrode; potential on electrodes so arranged that a variation in output electrode current is produced which, in relation to input potential, in the vicinity of the applied grid potential is definable by the equation $i = ke^n$ where n is less than $3/2$ and the operating potential of the control grid is negative, i is plate current, e is grid voltage and k is a constant. Horst Rothe, Telefunken. Dec. 21, 1937. No. 2,282,886.

Television Circuits

Discharge Device. An electronic device suitable for use in television comprising an evacuated envelope containing an electron permeable light responsive structure upon which a light image is projected and constructed to develop and retain an electrostatic charge image; a source of electrons for producing a focused electron beam of constant current intensity for scanning one side of the electron permeable structure to project electrons through the structure, the electrons being modulated in intensity in passing through the structure during the scanning by reason of the electrostatic charge image developed on the structure. H. G. Lubszynski, E&MI, Ltd., Jan. 15, 1937. No. 2,280,922.

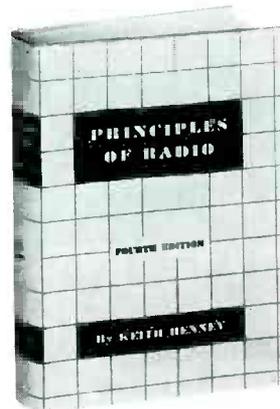
Synchronizing System. Means for transmitting synchronizing signals to a remote scanning system and means for returning the synchronizing signals from the scanner to the original apparatus. By means of a phase comparator a regulating voltage in accordance with the phase difference between the returning synchronizing signal and the master signal is secured for controlling the synchronizing signals. Ulrich Knick, Fernsch Akt. June 14, 1939. No. 2,278,788.

Receiving System. Method for receiving television signals where a common modulated carrier is used for both synchronizing and picture signals comprising band pass circuit to separate the signals. D. L. Plaistowe, RCA. July 16, 1938. No. 2,268,671.

Amplification

Feedback amplifiers. No. 2,282,870 to E. S. Lundie, RCA; No. 2,282, 605 to D. G. Lindsay, Amalgamated Wireless; No. 2,281,618 to J. M. Riddle, Jr. RCA; No. 2,281,644 to Paul Weathers, RCA.

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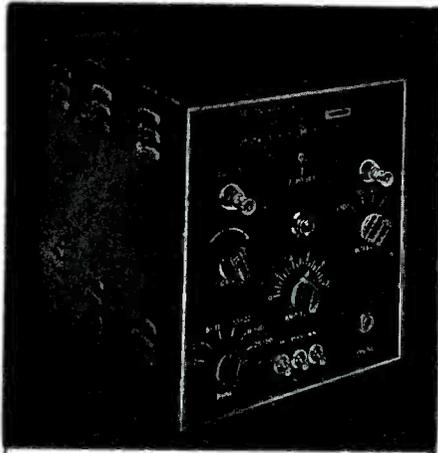
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Backtalk

This department is operated as an open forum where our readers may discuss problems of the electronic industry or comment on articles which **ELECTRONICS** has published

Patents

IN THE CROSSTALK column of **ELECTRONICS**, July 1942, the editor complains about the lack of a description of inventions patented in the U.S. in "full, clear, concise, and exact terms." In particular the editor complains that the single claim of each granted patent published in the *U.S. Patent Office Gazette* is inadequate as a full description of the invention claimed and that, therefore, reading of the *Gazette* is of no value to the engineer. Finally, the editor finds the claims of U.S. patents ambiguous, excessively broad, and lacking a full disclosure of the invention.

As a communications engineer and registered patent agent I would like to

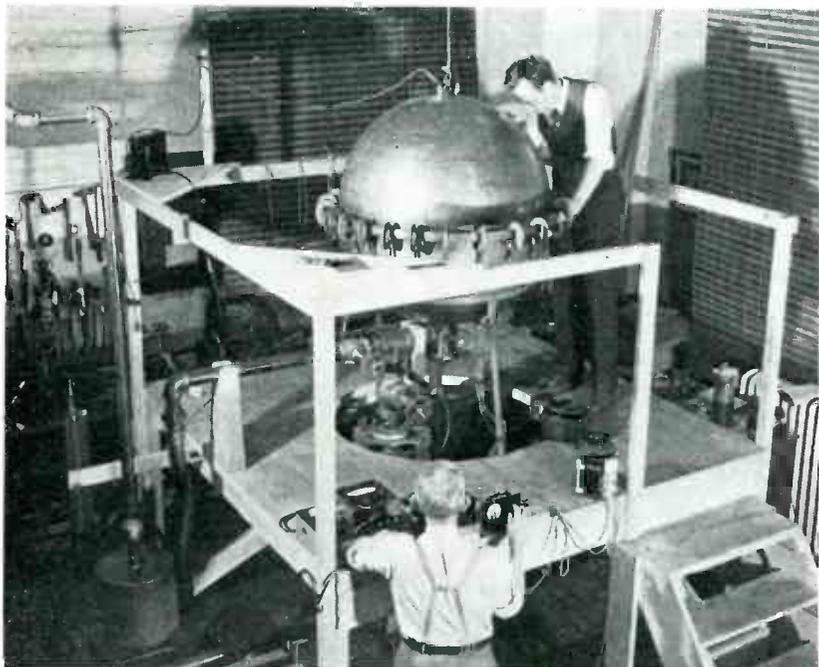
attempt to clarify some of the questions raised in Crosstalk and often raised by engineers.

Crosstalk quotes from a court decision as follows: "... it is a precedent to the obtaining of a patent that the applicant shall, in his written application, describe his claimed invention or discovery in 'such full, clear, concise, and exact terms as to enable a person skilled in the art . . . to make, construct, compound, and use the same.'"

This quotation refers to a requirement contained in the U.S. Patent Laws, which applies to the so called patent specification or the detailed description of the invention and the drawings, which are part of the application and which constitute the disclosure of the invention. It is, however, not to be applied in this general manner to the claims as attempted in Crosstalk, since it is not the purpose of claims to give a detailed description of the invention.

It should be kept in mind that a patent is primarily a legal instrument granting to the patentee a monopoly, the extent and boundaries of which are defined in the claims. The basis for the monopoly granted and defined in the claims is the disclosure of the invention which is found in the patent specification and drawings, which are required fully to describe the invention. Therefore, the engineer who wishes to find a disclosure of the nature and aims of the invention should consult the specifica-

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tion and drawings for this purpose and not the claims. If it were the function of the claims to set forth a detailed description of the invention, the specification would be superfluous.

My own experience has been that the *Gazette*, which usually publishes only a single claim and figure of the drawings of each granted patent, is valuable in selecting patents of interest. However, a full disclosure can be obtained only from the specification, which is part of the patent, copies of which are available at some libraries or from the Patent Office at the price of 10 cents per patent.

Crosstalk complains that "most of the claims of most of the patents published are completely non-understandable without a great deal of study." To spend much time trying to deduct the details of an invention from the single claim published in the *Gazette* seems an inefficient way of operating, since the full disclosure can be had for 10 cents. The determination of the scope of a claim with reasonable accuracy requires study of the complete patent, because claims are always to be interpreted in connection with the disclosure, and this often does require a great deal of study.

Two patent claims are cited in Crosstalk, the first of which relates to a method of manufacturing electrical devices "of the general character indicated." These last words quoted directly from the claim are further evidence of the fact that the specification must be used to interpret claims. The claim enumerates a series of method steps. The editor questions whether the invention resides in the individual steps or in the summation thereof. A claim must always be considered in its entirety and, therefore, the invention obviously resides in the summation or combination of the steps. The recitation in the claim of each additional step represents an added limitation of the monopoly granted and it is not feasible to ignore any one of the steps enumerated in the claim. Therefore, this claim is intended to protect the invention residing in the particular combination of the method steps and does not cover any individual step per se, each of which may be common knowledge in the art.

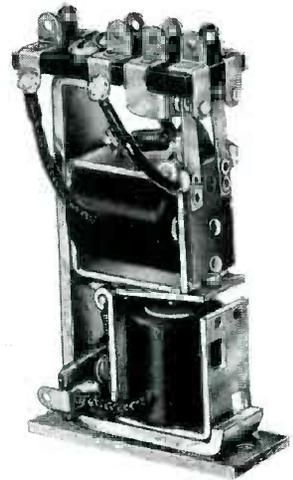
The second claim cited in Crosstalk relates to a welding system comprising a combination of elements. Again it is the particular combination of the enumerated elements which is patented and not any one element per se. The patented invention does not reside in the "control device" listed as an element of the combination, since it is not permissible to use such a broad term without any description of the structure of the element, if the invention resided in that particular element. Several decisions of the Patent Office and the courts deal particularly with this matter, and I am quite certain that the specification of the patent from which the claim is taken, contains a description of the "control device," which in itself probably does not constitute a patentable invention.

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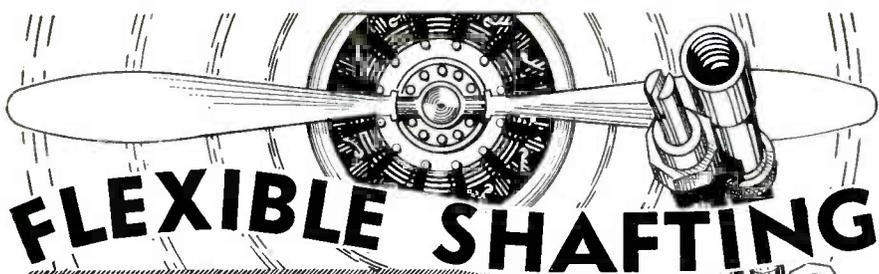
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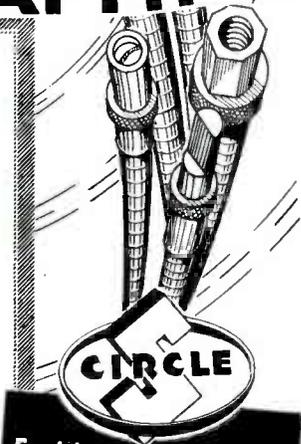


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These two claims, therefore, refer respectively to a complete method comprising a plurality of known steps and to a complete combination of elements and do not cover any of the individual method steps or elements per se. Hence, on their face, these claims are neither ambiguous nor excessively broad.

I believe that the editor's criticism of the U.S. patent system is a bit too severe and have found in the past that the patent specification and the drawings representing the disclosure of the invention are in many cases of great interest to the engineer and are more satisfactory reading matter than the *Gazette*.

Engineers interested in patent matters may find valuable information in various books giving a general outline in understandable terms which do not require any knowledge of law.

RUDOLF F. WILD
Philadelphia, Pa.

IT IS NATURAL for an engineer to admit that he knows nothing of patent matters, but why advertise it and make such a fuss about it in the public press as you have in Crosstalk, July ELECTRONICS.

You doubtless misunderstand the function of the *Official Gazette* of the U. S. Patent Office. It does not pretend to give a complete description of the patents listed therein but merely performs the function of acquainting the reader who is skilled in the art with the general idea of the patent. If, from what can be learned from the drawing and claim in the *Official Gazette*, the reader desires to "make, construct, compound, and use" the invention, he may obtain the full description by forwarding ten cents to the Patent Office.

In the selenium rectifier example you gathered that the invention consists of making a selenium rectifier in a vacuum. The invention is not merely making a selenium rectifier in a vacuum; the invention consists of doing exactly what the claim recites in clear, concise and exact terms and that is much more than merely making a selenium rectifier in a vacuum.

You state that the crux of the welding invention seems to be "a control device." Why do you insist that the invention claimed lies in only one element of the claim when there are so many other cooperating elements recited in the claim?

JOE WEBER,
Irwin, Penna.

I REGRETTED VERY much to read the dissertation on patents published under the heading of Crosstalk on page 25 of the July issue of ELECTRONICS.

This statement is on a par with much material now being published against the patent system, which material is based on complete lack of knowledge as to the subject being discussed. The electronic art perhaps more than any other is dependent for its present high state of development upon the protection afforded to its inventors by the patent system.

It would be impossible from an economic standpoint to carry out the very expensive developmental work which has been carried out in this art unless there had been a patent system to protect the results of such development.

The writer of the article in question obviously knows nothing whatever about patents. The United States Patent Office Gazette does not pretend to give anything but a single characteristic claim and a portion of the drawings of the patents, selected to best indicate the general subject matter.

No patent claim taken independently of the specification can be expected to completely disclose all of the details of construction or use of the invention. The specification of the patent is a technical article which completely discloses the invention and usually discusses briefly the prior art in order to make clear the step forward which is presented by the invention disclosed.

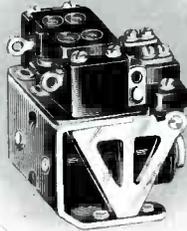
The specification of a patent is entirely adequate to instruct one skilled in the art how to practice the invention. The claims merely concisely limit the exact scope of the invention, these claims being very carefully considered and construed by the Patent Office. The two claims which you cite in the article, upon careful reading, appear to be very clear and concise. Taken in connection with the specification and drawings of the patents, of which they form a part, I have no doubt but that they would be a completely adequate definition of the invention which the Patent Office held had been made by the inventor named in the patent.

Your article appears to boil down to a statement that more of the patents should be published in the *Official Gazette*. This is considered impractical by the Government because of the great expense of publishing a complete patent. The disclosure in the *Official Gazette* is adequate so that one skilled in the art can determine whether the patent is of interest, and if so, a copy of the complete patent can be promptly procured from the Patent Office for the sum of ten cents.

The paragraph near the center of the second column of the article also shows a complete misunderstanding of the basis for a patent. This paragraph repeatedly uses the word "or" where the facts require the use of the word "and"; in other words, the claim would not be infringed unless each and every step set forth in that claim were used by the infringer. The use of any combination of steps less than the whole is not infringement.

I suggest that whoever wrote this dissertation procure copies of these patents, and if he is one skilled in the art of manufacturing selenium-coated electrical devices, or in electric welding, I have no doubt that he will find the disclosure entirely adequate so that he could "make, construct, compound and use" what is described in these claims. It is stated in the third column of the article that if someone doped out a control device to establish flow of current, he would infringe the second claim

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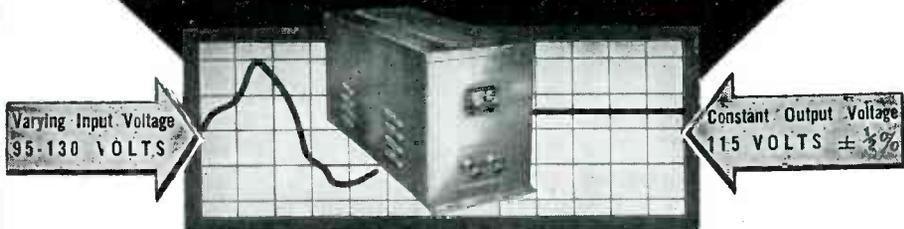
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quoted. He would not infringe the claim unless he carried on every step in the particular combination and for the particular purpose.

It would not be necessary for him to dope out a control device, as no doubt one is fully disclosed in the specification of the patent.

Your statement that the claims are written by lawyers and not by engineers is in error. A large majority of patent lawyers handling technical patent prosecution are engineers first and lawyers second. Most of them received engineering degrees before they studied patents or law.

I may say that I have no knowledge of the inventors or owners of these patents, nor as to their numbers.

At a time when there is so much wholly unjust criticism of the patent system, your magazine, which is the spokesman of an art so greatly dependent on patents for its development, should be extremely careful of any statements made.

You are careful as to the technical content of your magazine and would not publish an article on an electronic subject unless it were carefully checked or its author were a recognized expert. You should deal similarly with a subject such as patents and patent law.

There are many able patent counsels in New York who would no doubt be very glad to give you any information or advice necessary to discuss the matter properly and correctly.

HOWARD W. HODGKINS

Harmonic Filter

I HAVE READ with interest Mr. R. E. Snoddy's article in the May 1942 issue of **ELECTRONICS**. In this article he has shown that the characteristic impedance of the line differed from the manufacturer's value of inductance given as 4.44×10^{-11} henries per 60 ft. which was to determine the capacity for the same 60 ft. section. This is shown to be 954×10^{-12} farads per 60 ft. Then, through a process of working out the equations containing (R, L) and (G, C) in their polar form, the phase shift factor is computed by the equation of the propagation constant, namely:

$$\gamma = \sqrt{Z Y}$$

Granting the characteristic impedance of the manufacturer to be wrong, let us use the computed values of Z_c , the characteristic impedance, 68.2 ohms and C , the capacity per 60 ft., 954×10^{-12} farads and see if there is not a simpler way to arrive at the same result, namely, that the velocity of propagation on the line is 93.6 percent, the velocity of light in free space.

My approach is as follows: $\frac{V}{c} = \frac{\beta}{\theta}$

Where V = velocity of the wave in the line

c = velocity of the wave in free space
= 3×10^{10} cm/sec

θ = angular velocity in free space

β = angular velocity in the line.

$$V = \frac{1}{\sqrt{L_c C_c}}$$

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where L_c and C_c are the unit inductance and capacity per cm length.

We now have upon substitution:

$$\frac{1}{\sqrt{L_c C_c}} \sim \frac{\beta}{\theta}; \quad \frac{\beta}{\theta} \sim \frac{1}{\sqrt{L_c C_c c}}$$

$$\frac{\beta}{\theta} \sim \frac{1}{1.07} = 0.936 \times 100\% = 93.6\% = \frac{V}{C}$$

This would mean λ_0 in free space = 664 ft. at 1480 kc and λ_1 (wave-length in the line) = $664' \times 93.6 = 622'$ or

$$\frac{\lambda_1}{2} = 311'$$

Thus we see we can arrive at the same result by what seems to me a much shorter method.

ROBERT F. LEWIS
New York City

Tropical Radio Receiver Trouble

I WAS NATURALLY very interested in Mr. H. C. Schwalm's comment in the March, 1942 "Backtalk" column on my article of a year earlier concerning tropical radio receiver troubles.

His comment is similar to that of many men who have struggled with this problem, and I quite agree with him when he states that the corrosion of the high potential windings in receivers is due to electrolysis.

He suggests in the case of an audio transformer that a choke in inductance-capacity coupling be used to take the high potential from the transformer winding; and in the case of a speaker field the speaker frame be placed at a higher positive potential than the field winding to prevent electrolysis. The same procedure, he says, might be applied to other parts of the set. He mentions some applications that have been tried, and I have also seen such schemes used with some success.

I can imagine the alarm caused in some engineers' minds by the idea of placing the chassis or speaker frame at high potentials. I can also imagine Mr. Schwalm's retort that you don't dare touch the frame or chassis of most North American receivers after they have been in the tropics a few weeks anyhow. The leakage currents automatically raise their potential to high values while operating, unless they are definitely tied to ground.

However, I do not feel that the solutions offered by Mr. Schwalm are the best answers. In the case of the inductance-capacity coupling the high potential has simply been transferred to the winding of the choke. If it is made of the same materials as the transformer the problem still exists, but in the choke instead of the transformer.

The presence of leakage currents in the various parts of a receiver detunes the r.f. and i.f. transformers, changes the grid bias on tubes, upsets AVC action, and in various ways greatly reduces performance. The electrolysis is only the most annoying feature because it eventually stops operation completely, and requires costly repairs.

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It would seem to be much more desirable to use better insulations and better designed insulators so that the leakage currents do not exist, even under extremely humid conditions.

At the same time that I was observing these faults in commercial equipment in the tropics I was working with U. S. Army Signal Corps equipment that was operating under the same weather conditions. However, the Signal Corps equipment had been built to meet rigid specifications with regard to humidity and temperature. From my observations I am sure that receivers can be built with conventional circuits that perform as well in humid climates as in the more temperate ones.

Nearly every radio design engineer in North America is now working on equipment for our armed forces which must meet those rigid humidity tests. If the lessons they learn there will only be carried over to commercial products they can certainly make friends in tropical America.

W. E. STEWART
Formerly Ass't Radio Eng.,
Panama Air Depot

UHF Nomenclature

SEVERAL LETTERS have been published in this column and in Crosstalk dealing with the terms to be decided upon for the very high frequencies, or very short wavelengths, which are now coming into use. Readers interested in the background for the following letters should see ELECTRONICS.

Mr. William A. Stirrat of Schenectady suggests that since engineers like to reduce matters to logarithmic terms, the higher frequencies could be designated as log cycles. Thus a frequency of 1 megacycle would be represented by 6 lcs. A 10 megacycle frequency would be in the 7 lcs range. He also suggests the ranges from 0 to 1, 1 to 10, 10 to 100 etc., be given spectra letters A, B, C, etc. In his system a frequency of 7500 Mc would be designated as 9.875 lcs or K_{9.875}.

Two other proposals are cited in full since they are simpler and have a better chance of being worked upon by other engineers.

"Since reading that portion of Crosstalk for May, 1942, dealing with proposed names for 10⁹ and 10¹² cycles per second, I have been looking around for established precedence, both of the prefixes which others have recommended and the one which we have been using in connection with 10⁹ cycles per second. To date, however, my quest has been fruitless.

"For a period of over a year now, this laboratory has employed the name bega-cycles for frequencies expressible in units of 10⁹ cycles per second. We believe that our choice has a basis in logic because of its resemblance to megacycles. The Greek prefixes deci, centi, and milli, resemble closely the prefixes billi and trilli, which others mentioned, yet unlike the Greek prefixes, they do not designate units which are sub-multiples of unity.

"We should like to propose, therefore,

that the prefixes bega and trega be adopted for factors of 10⁹ and 10¹² respectively."

R. M. BOWIE

Director of Research
Hygrade Sylvania Corporation

"I have been interested in the Crosstalk items in ELECTRONICS relative to UHFI. I think Mr. Pickard's suggestion of billicycles and trillicycles is a most excellent one. I have only one additional comment and that is that this gives only four divisions for the whole range and also, for many workers in the higher frequencies, the use of wavelengths has certain advantages.

"These two points could be taken care of by speaking of the millimeter band or millimeter waves and dekameter waves. In other words, the following ordinary metric table could be used:

Millimeter	0.001 meter
Centimeter	0.01 meter
Decimeter	0.1 meter
Meter	1 meter
Dekameter (or decameter)	10 meters
Hectometer	100 meters
Kilometer	1000 meters
Myriameter	10,000 meters

We would, therefore, speak of broadcasting using the hectometer band or range.

"So far as I can find out, there is no common expression for a unit of length that corresponds to 1/10 millimeter. However, the term "micrometer" is well known and, of course, is equivalent to 0.001 millimeter. Even at the way progress has been made the past few years in expanding the spectrum on the high-frequency side, it may be a little time before we are using micrometer waves and, even then, the mechanical engineer may claim them as a part of his sphere of thermodynamics."

W. C. WHITE,
Engineer
Electronics Laboratory
General Electric Company

OCD Tests

(Continued from page 59)

might be available and convenient for civilian defense use.

Testing on Type "C" lines, a transmitter was coupled to the overhead lines at a substation whose 4,000-v primary feeders are extended to and interconnected with other substations serving a dozen or more small towns throughout the county. A 75-mile tour was made and it was found that in a majority of these small towns there was a well-distributed pattern or radiation which fulfilled requirements 1, 2, 3 and 4 satisfactorily. It was the general consensus that local distribution in these various areas could usually be accomplished by extremely low powered "phonograph oscillators" operated as remote-controlled carrier-current transmitters and turned on or excited by a carrier radiated along the 4,000-v primary feeders.—W. MACD.

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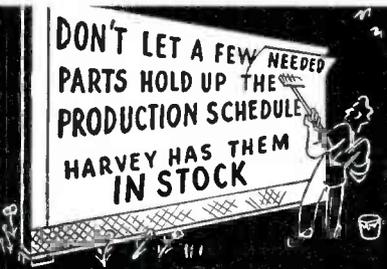
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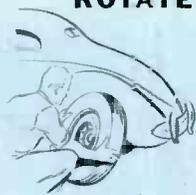
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One way of making an easier schedule for tubes is to keep them cooler. This can be done by reducing plate voltage and dissipation to the lowest permissible limits. Another, and often more feasible, method is to use forced-air cooling—even on tubes where it is not specified or, in other cases, to a greater extent than may be specified for normal use.

Where tubes are already being operated conservatively, additional air cooling may not be of any great benefit, yet is desirable as long as specified operating temperature limits are observed. In other cases, worthwhile savings in tube life may be obtained.

A few cautions should be observed in using air-cooling: Place fans so that their air blast is well distributed over the entire tube, not concentrated on one side. Screen fans with a fine mesh wire to avoid blowing dirt on tubes and clean the tubes regularly to remove any dust that may collect. Be careful not to over-cool mercury-vapor tubes. Hold all tube operation to specified temperature limits.

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