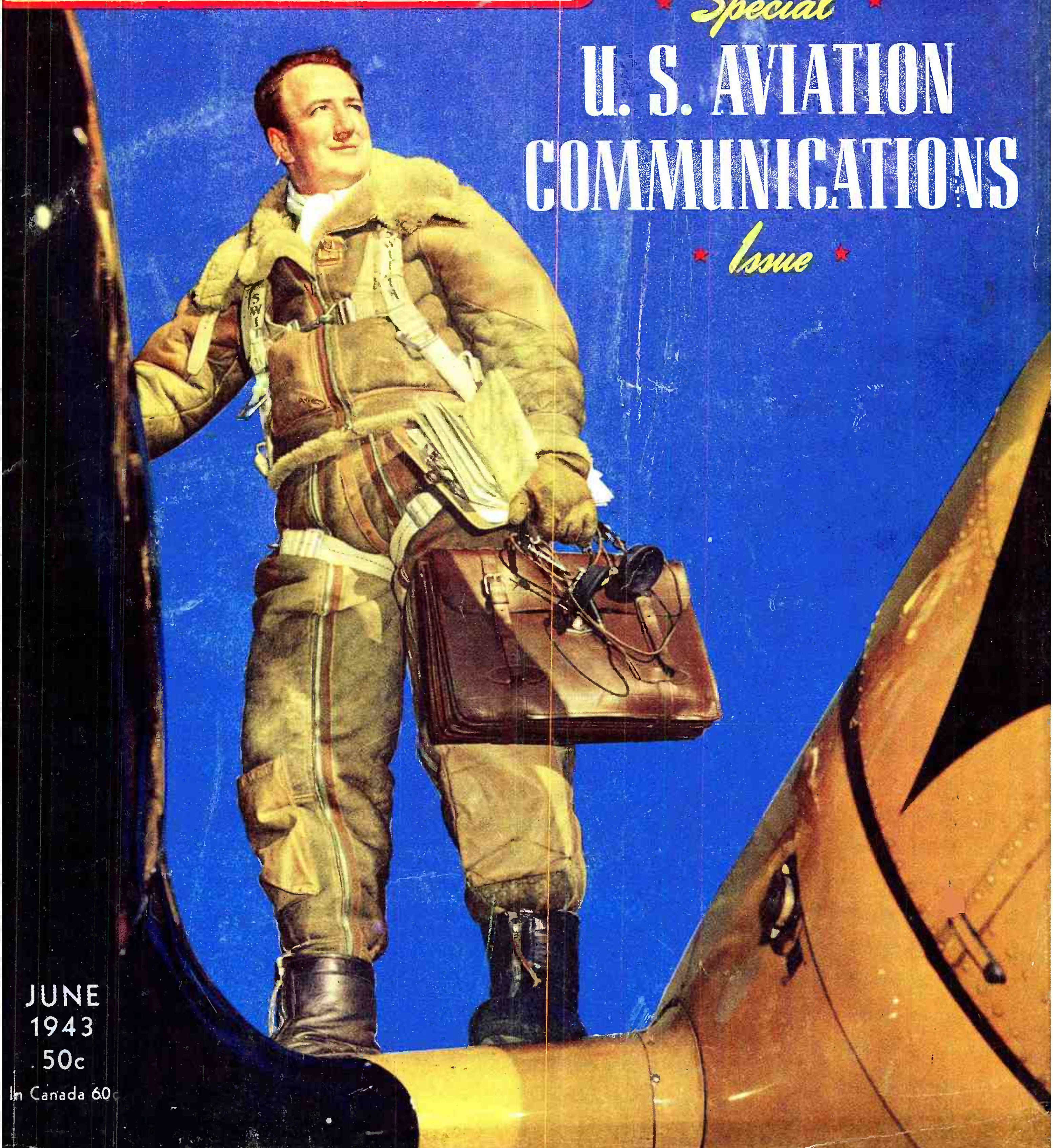
RADIO NEWS

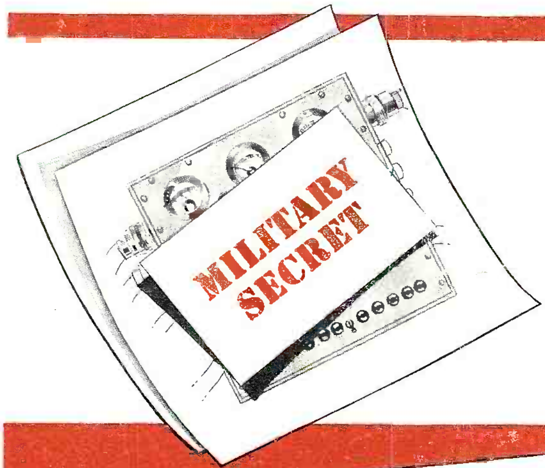
★ *Special* ★
U. S. AVIATION COMMUNICATIONS
★ *Issue* ★



JUNE
1943
50c
In Canada 60c

Freed-Eisemann

...a name famous in peacetime for one of the world's great radio-phonographs



...a name famous in wartime for unsurpassed engineering skill and precision in the production of military communications equipment

Ever since radio became an amazing reality to the world, the Freed-Eisemann name has been identified with outstanding radio achievement. The first crystal sets were made by Freed-Eisemann, as were the first neutrodyne sets, and sets with self-contained speakers. Then, with the invention of Armstrong Frequency Modulation, Freed-Eisemann became the first to produce FM radio-phonographs *exclusively*.

Famous for magnificent musical tone and cabinet design, these superb instruments rank with the world's *great* radio-phonographs. They represent Freed-Eisemann engineering genius at its peacetime best, and help to explain why Freed-Eisemann *wartime* production involves assignments calling for the highest degree of engineering skill and precision—in the manufacture of communications equipment and highly complex electronic devices for America's armed forces.

In war and in peace, the Freed-Eisemann watchword is *quality*.

FREED RADIO CORPORATION · 200 HUDSON STREET · NEW YORK, N. Y.

RADIO NEWS

JUNE, 1943

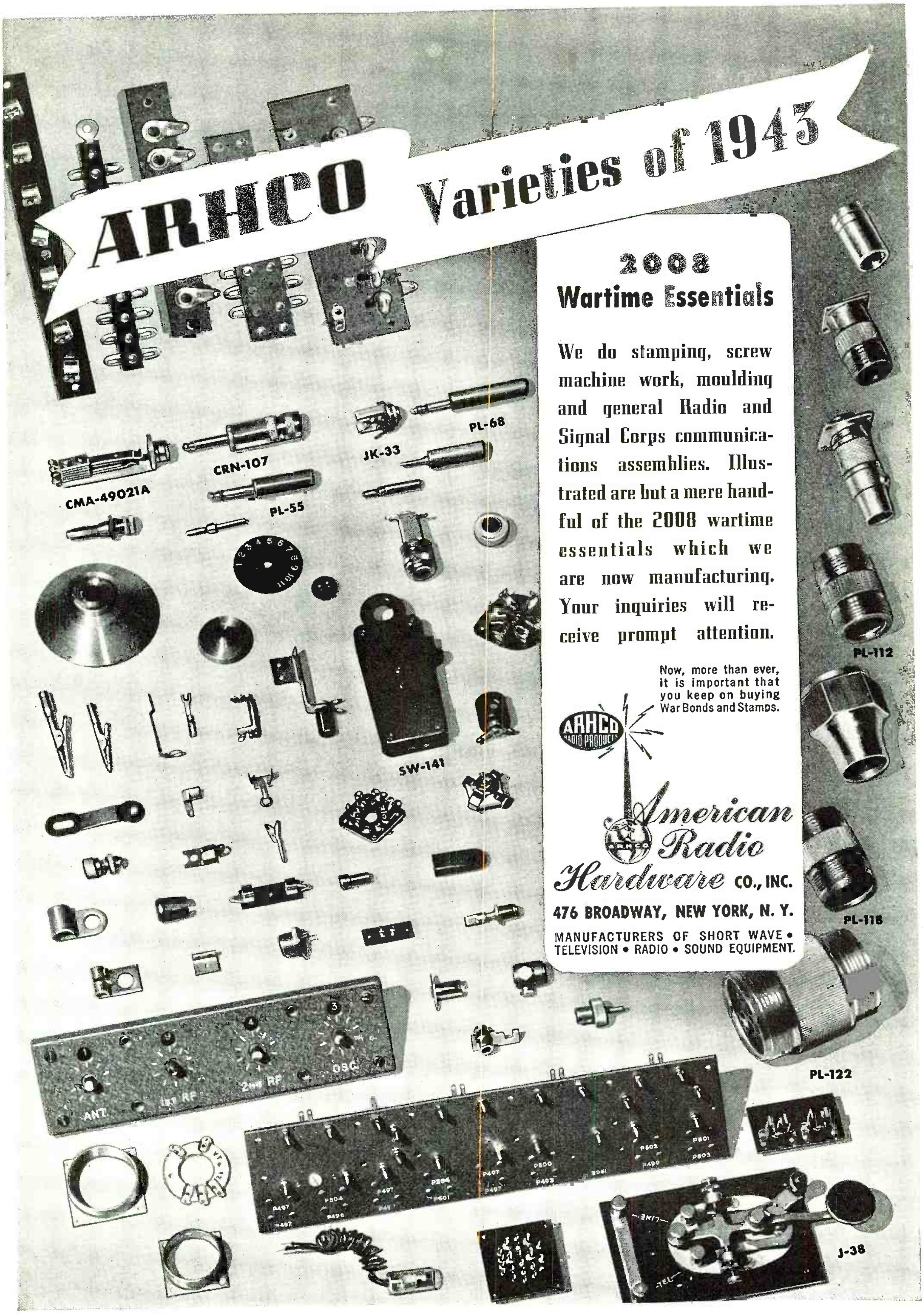
Vol. 29, No. 6

Contents

Cover Photo: A pilot of the Civil Aeronautics Administration

SPECIAL U. S. AVIATION COMMUNICATIONS ISSUE

RADIO NEWS is published monthly by the Ziff-Davis Publishing Company at 540 N. Michigan Ave., Chicago, Ill. New York Office, 270 Madison Ave. Washington, D. C. Office, Earle Bldg. Special Washington Representative, Col. Harold E. Hartney, Occidental Hotel. London Editorial Representative, A. Spenser Allberry. Subscription Rates: In U. S. $3.00 per year, single copies, 25 cents; in South and Central America and U. S. Posessions, $3.00 per year; in Canada $3.50 per year, single copies 30 cents; in British Empire, $3.75 per year; all other foreign countries $6.00 per year. Subscribers should allow at least 2 weeks for change of address. All communications about subscriptions should be addressed to: Director of Circulation, 540 N. Michigan Ave., Chicago, Ill. Entered as second class matter March 9, 1938, at the Post Office, Chicago, Illinois, under the Act of March 3, 1879. Entered as second class matter at the Post Office Department, Ottawa, Canada. Contributors should retain a copy of contributions. All submitted material must contain return postage. Contributions will be handled with reasonable care, but this magazine assumes no responsibility for their safety. Accepted material is subject to whatever adaptations, and revisions, including "by line" changes, necessary to meet requirements. Payment covers all authors, contributors or contestants' rights, title, and interest in and to the material accepted and will be made at our current rates upon acceptance. All photos and drawings will be considered as part of material purchased.


ARHCO Varieties of 1943
2008
Wartime Essentials
We do stamping, screw machine work, moulding and general Radio and Signal Corps communications assemblies. Illustrated are but a mere handful of the 2008 wartime essentials which we are now manufacturing. Your inquiries will receive prompt attention.
Now, more than ever, it is important that you keep on buying War Bonds and Stamps.
ARHCO RADIO PRODUCTS
American Radio Hardware CO., INC.
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MANUFACTURERS OF SHORT WAVE • TELEVISION • RADIO • SOUND EQUIPMENT.
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PL-122
J-38
ANT.
1st RF
2nd RF
OSC
LINE
TEL

with but a

Gertrude Fontaine, mount operator at Hytron's Salem plant, and soldier in the Army of Production.

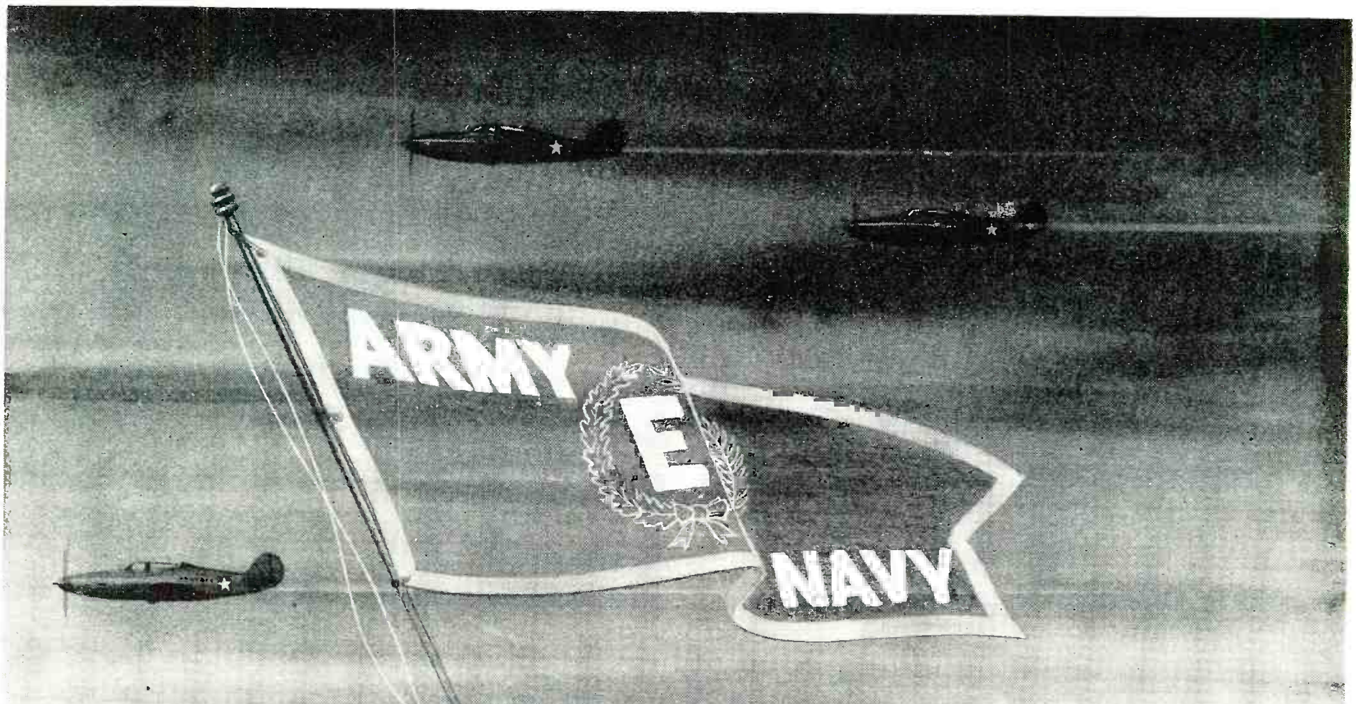
Miss Fontaine concentrates her nimble fingers and keen young eyes upon spot-welding and assembling the minute parts of a 954. On another floor, a Hytron engineer is giving lavishly, night and day, of his long training and experience as he designs and develops a new War tube in record time.

The driving force urging them — and all of us at Hytron — on to superhuman effort, stems from a single thought, a single purpose: to supply our courageous fighting men with tools to win. Hytron employees have but one goal — a mounting flood of top-quality tubes to serve as the "hearts" of electronic and radio equipments helping our boys to blast the way to speedy and permanent Victory.

Since 1921 Manufacturers of Radio Tubes

Hytron ELECTRONIC AND RADIO TUBES


Single thought
1616—HALF-WAVE, HIGH-VACUUM RECTIFIER
1616
HYTRON
MADE IN U.S.A.
954—SHARP CUT-OFF, ACORN PENTODE
954
Consult the May issue of RADIO NEWS for a listing of new and other popular Hytron tubes.
Corporation
SALEM AND NEWBURYPORT • MASSACHUSETTS



FOR AIRCRAFT COMMUNICATIONS ...USE MEISSNER *Precision Built* PRODUCTS!

Engineered to meet the exacting demands of modern usage. The MEISSNER is your guarantee of high quality. Typical uses of MEISSNER products are:

TRANSMITTERS—Universal coils, Variometers, Tank coils, Power and RF chokes.

RECEIVERS—RF coils, IF coils, RF chokes.

TRANSMITTING STATIONS—Signal shifters.

LABORATORY—Signal calibrators.

SERVICE—Analyst.

RADIO TRAINING KITS—For classroom and military radio training.

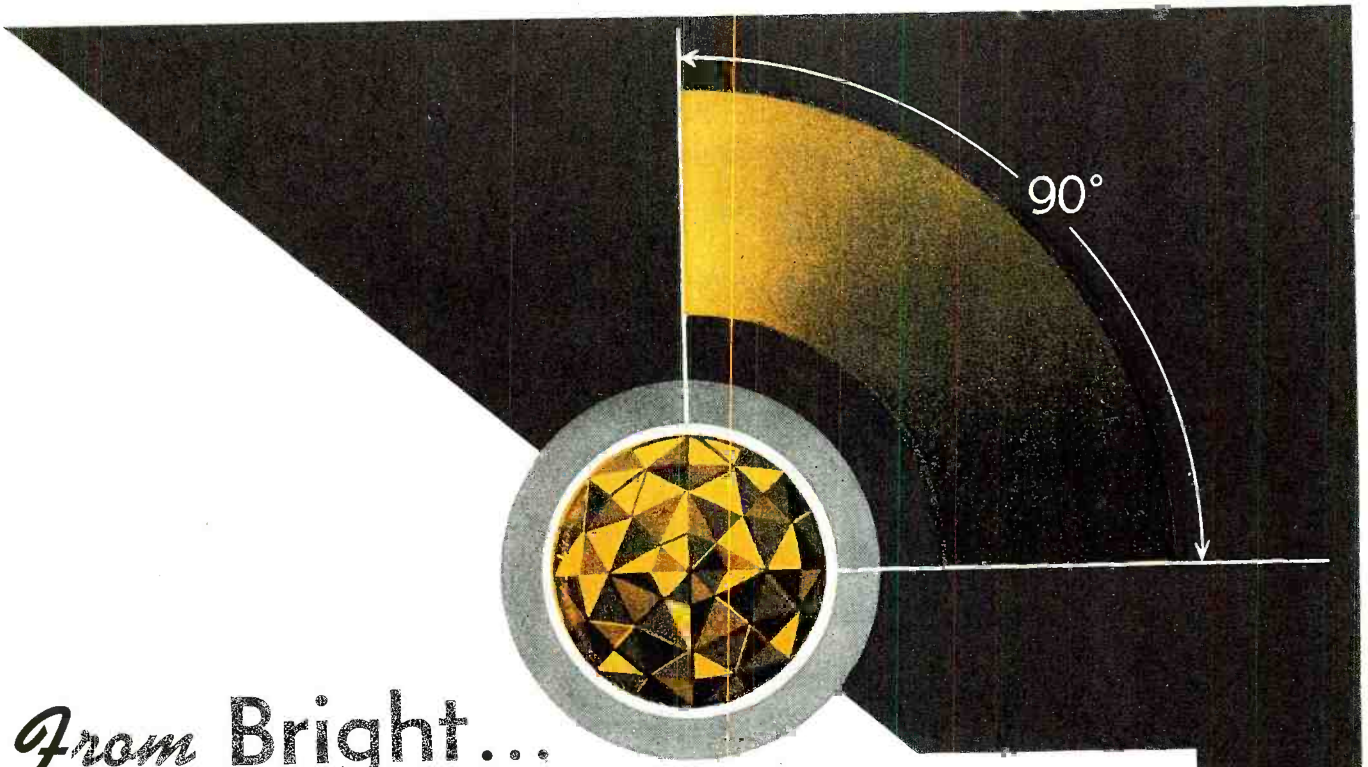
COMMUNICATIONS—14-tube "Traffic Master" receiver.

CIVILIAN REPLACEMENTS—"Victory" coils—soon to be announced.

PRECISION-BUILT PRODUCTS

Meissner

MT. CARMEL, ILLINOIS

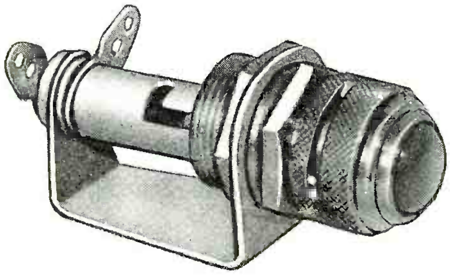


From Bright...

thru intermediate glows to Total Dark

within 90° turn of Shutter

This Gothard Shutter Type Pilot Light is especially suited for such applications as airplane and marine instrument panels where a faint glow is preferred at night and a brighter light is required for visibility during the day—and similar applications where various intensities of light are desired under constantly changing conditions. This assembly mounts securely on panel and will not loosen with use. These lights are also available with polarized lens. Lenses are furnished in red, green, amber, blue and opal. Gothard's relatively unlimited facilities make these and Gothard's many other styles of Pilot Lights available for short schedules. Special Pilot Lights to meet specific requirements are given personalized attention and recommendations are furnished promptly upon request.

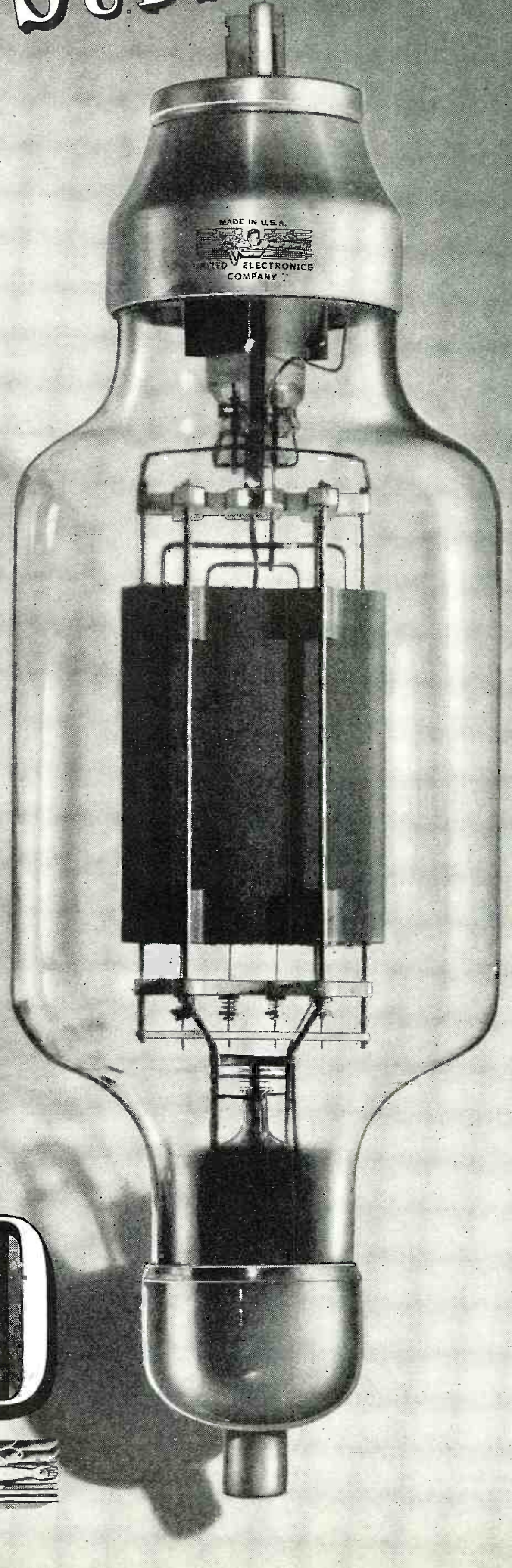


No. 430—Faceted Jewel
No. 431—Plain Jewel

Do you have a copy of Gothard's Pilot Light Assemblies Catalog? Write for it!

Gothard
MANUFACTURING COMPANY
1350 N. Ninth Street • Springfield, Illinois

SHADOW AND SUBSTANCE



In the highly specialized field of electronics, the question "Who made the tubes?" will always be a matter of vital importance. Power tubes bearing the name "United" are products of original pioneers in the miracle known today as electronics. Step by step these seasoned engineers helped evolve the principles and advance the science of fabricating transmitting tubes which hold a superb record of performance. The early pioneers at United are *still actively pioneering!* The wealth of experience which they have been privileged to accumulate under the demands of war will be available to you when "United" electronic tubes are available again on a peace-time scale for radio and industrial applications.

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NEWARK NEW JERSEY

Every RADIO Man should KNOW—
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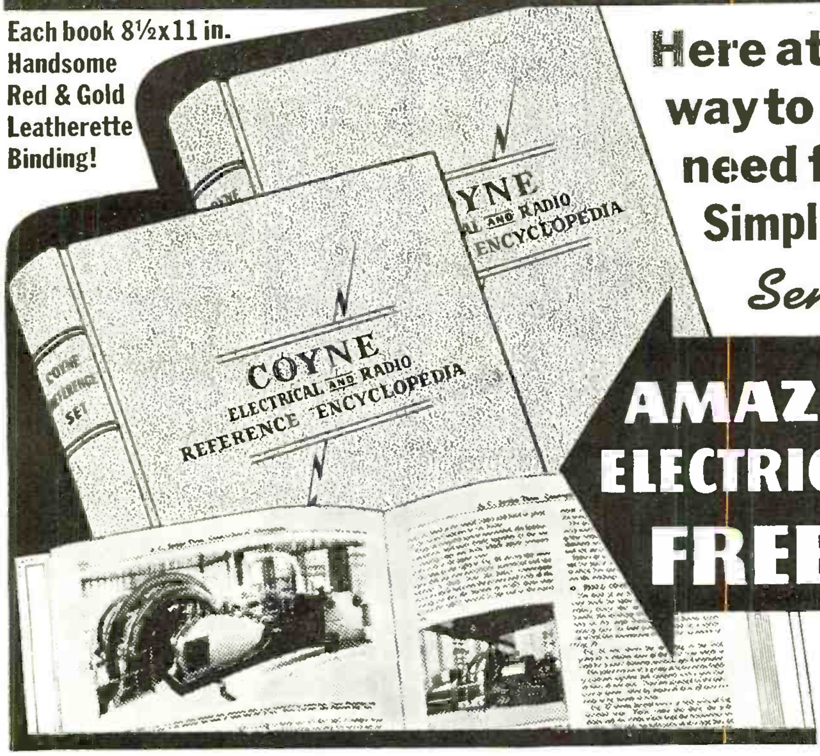
Each book 8½x11 in. Handsome Red & Gold Leatherette Binding!



Here at last is the quick, easy way to get the knowledge you need for a real Radio future!
Simple . . practical . . complete!

Send coupon now for this

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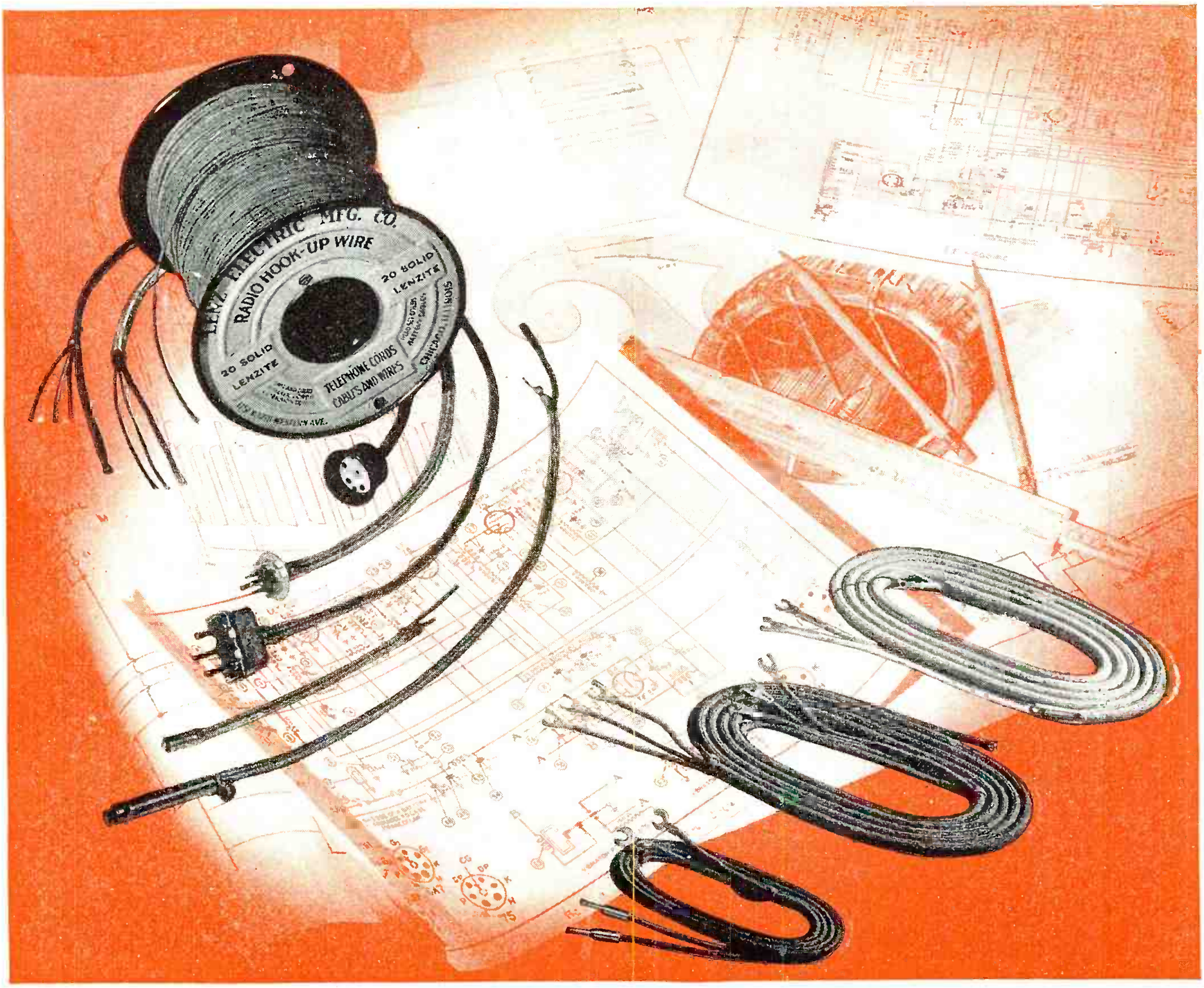


"15 ZEROS HEADED YOUR WAY—"

Messages like these, crackling through the ether enable our flyers to meet and defeat attacking enemy forces. The efficiency of aviation radio communications has played a major role in our air victories, and the engineers who design and produce this equipment deserve their share of the glory.

That millions of feet of Lenz wires and cables were selected for this equipment is a source of considerable pride to this organization.

The Lenz wire engineers are always ready to consult with the designers of communications equipment on their wire and cable specifications. No matter how stringent and exacting the requirements, how severe the conditions under which the equipment must operate, Lenz engineers will help you find just the right wire for the job.

LENZ

ELECTRICAL CORDS, WIRES AND CABLES

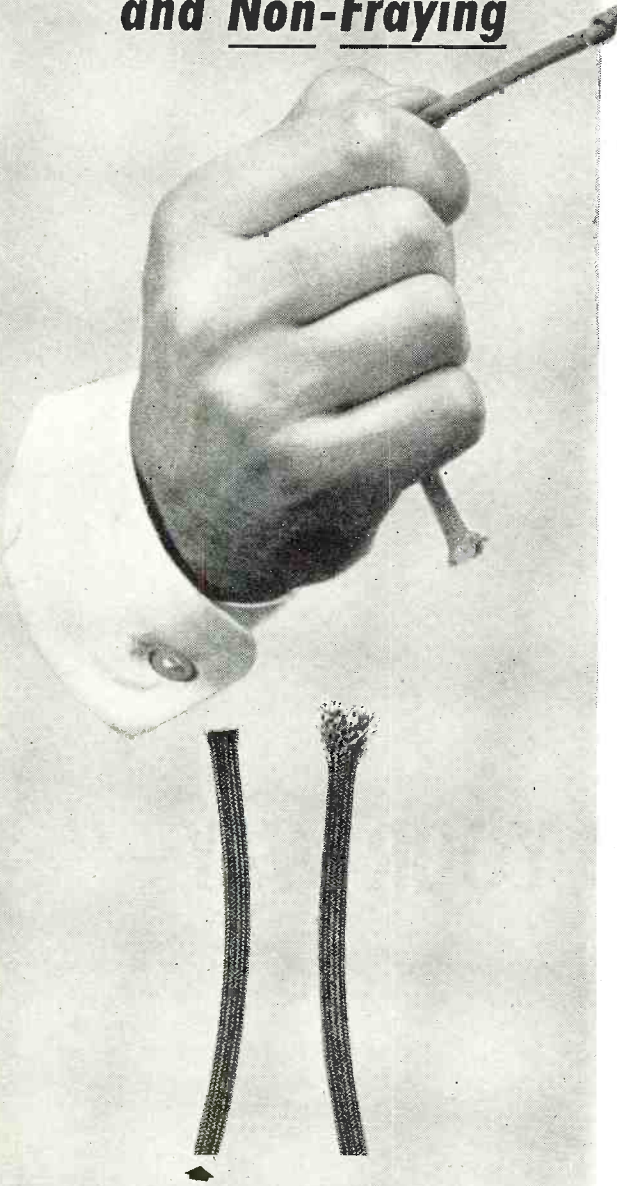
LENZ ELECTRIC MANUFACTURING CO.

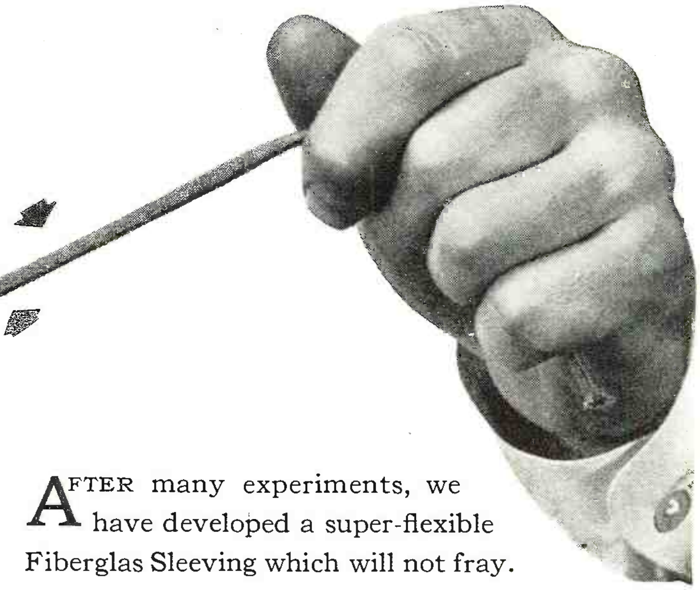
1751 N. Western Ave., CHICAGO, ILLINOIS

"IN BUSINESS SINCE 1904"

AT LAST!

A New Sleeving— Flexible as String and Non-Fraying





THIS — NOT THIS

AFTER many experiments, we have developed a super-flexible Fiberglas Sleeving which will not fray.

This sleeving is made by an entirely new, recently-discovered process. Formerly, to prevent excessive fraying, it was necessary to saturate the sleeving, sometimes to a degree where stiffness became objectionable. The new BH Fiberglas Sleeving is as limp and flexible as string—you could tie any kind of a knot with it—yet the severest handling will produce only the merest fuzz at the end.

NON-FRAYING • FLEXIBLE • HEAT-RESISTANT
NON-INFLAMMABLE • WATER-RESISTANT
NON-CRYSTALLIZING at LOW TEMPERATURES

The new BH Fiberglas Sleeving is woven from the choicest continuous-filament Fiberglas yarns. It possesses extremely high dielectric strength, is water-resistant and, like all BH Sleeving and Tubing—is non-inflammable.

All sizes, from No. 20 to 5/8″, inclusive, are available. Write for samples of this radically new and different sleeving today—in the sizes you desire. Seeing is believing! Bentley, Harris Manufacturing Co., Dept. R, Conshohocken, Pa.

BH PRODUCTS

NON-BURNING IMPREGNATED MAGNETO TUBING • NON-BURNING FLEXIBLE VARNISHED TUBING • SATURATED AND NON-SATURATED SLEEVING

BENTLEY, HARRIS MANUFACTURING CO.
Conshohocken, Penna.


There'll be White Stripes in the Sky
..."painted" by Radio
Today Western Electric radio is helping our air fighters on every front to knock Axis planes out of the sky—to dump destruction on the enemies of freedom.
When Victory is won, aviation and communication will have a happier job. Thousands of American planes—air liners, cargo carriers, private planes—will fly the airways of the future!
Just as white stripes guide motorists on the highways today, so there will be guides in the skyways of tomorrow—and radio will "paint" them there.
In the new world, dependable radio equipment by Western Electric will continue to serve American pilots—as guide, traffic cop and weather reporter.
Western Electric
ARSENAL OF COMMUNICATIONS EQUIPMENT
WALTER COLE

INTELLIGIBILITY

Built to Civil Aeronautics Administration specifications, CAA-515, the Electro-Voice Model 7-A microphone is widely used for airport landing control and is highly suitable for many other sound pick-up applications.

The smooth frequency curve, rising with frequency, gives extremely high intelligibility even under adverse conditions. Desk mounting incorporates easily accessible switch which can be operated by thumb of either right or left hand. Microphone may be moved without danger of pressing this switch.

SPECIFICATIONS

SWITCH: Push-to-talk Acro-switch, SPDT, for relay operation; positive action; slight pressure required for actuation; 1/16" over-travel; connections terminate on terminal strip in base.

OUTPUT IMPEDANCE: 25 ohms.

CABLE: Eight feet, 4 conductor, shielded, overall rubber jacket, equipped with MC4M connector.

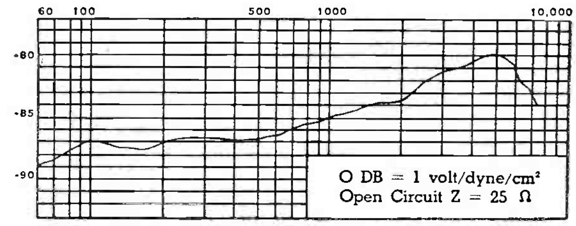
DISTORTION: Not exceeding 5% for sinusoidal sound waves from any direction from 100-4000 cps, up to 50 dynes/cm².

INSULATION: Leads from the moving coil are insulated from the microphone housing and stand, and are capable of withstanding 500 volts RMS, 60 cps.

STAND TUBE: Wear resistant, 1/8" XXM bakelite.

CORROSION RESISTANCE: The entire microphone is completely inhibited against corrosion and will successfully withstand a 20% salt spray atmosphere for 100 hours at 95° F.

NET WEIGHT: 3½ lbs.; Shipping wt.: 5 lbs.



This Model 7-A Desk Mounting Communication Microphone supersedes our previous Model S-7. Our Engineering Department may be able to assist you with your microphone problem. *Electro-Voice Manufacturing Co., Inc., 1239 South Bend Avenue, South Bend, Indiana. Export Division: 100 Varick Street, New York, N. Y., U. S. A.—Cable Address: "Arlab"*

Electro-Voice MICROPHONES


Smallest CAPACITOR
.... Yet
MOISTUREPROOF
BAKELITE RESINOID IMPREGNATED
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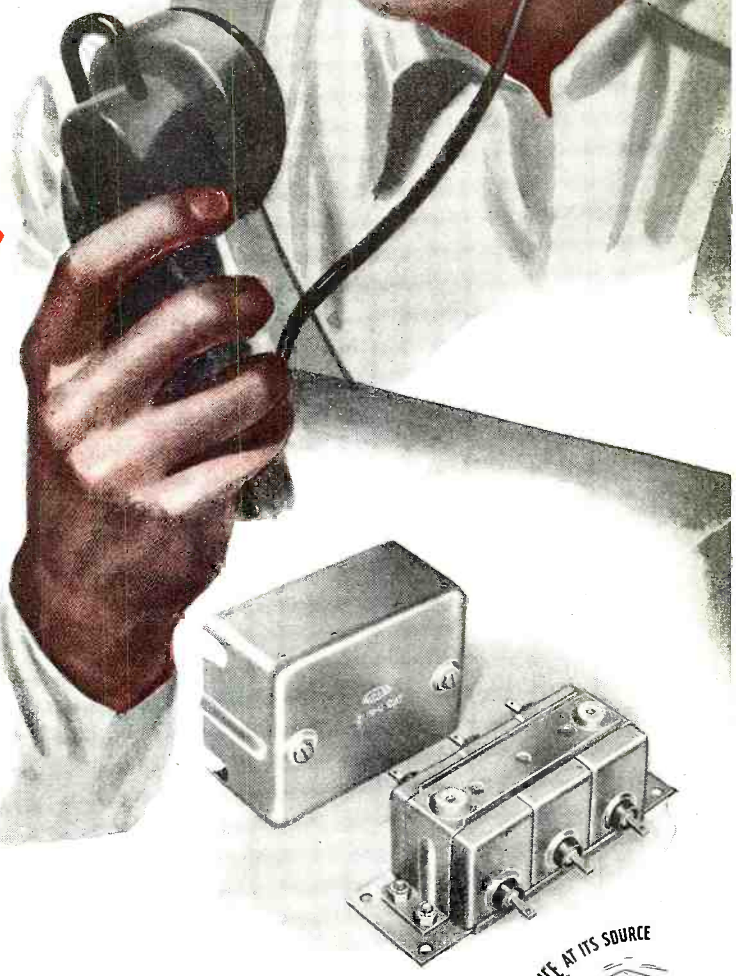
A proud achievement .... after years of research for a small moisture-proof paper capacitor .... Dumont engineers have scored a signal victory by perfecting a water-tight seal that is definitely moisture-proof. Conclusive tests of many samples show LESS THAN 1% CHANGE IN LEAKAGE RESISTANCE after 150 hours in water.
• Dumont moisture-proof capacitors, in all types of radio construction, are being used in radio equipment serving our armed forces and governmental agencies here and over there.
Samples on Request
LESS THAN 1% CHANGE IN AVERAGE LEAKAGE RESISTANCE AFTER 150 HRS. IN WATER
DUMONT
ELECTRIC CO.
MFR'S OF
CAPACITORS FOR EVERY REQUIREMENT
34 HUBERT STREET NEW YORK, N. Y.

Radio Noise SABOTAGES COMMUNICATIONS *unless...*



Like so many demons, the crashes and crackles of unwanted radio noise can play havoc with communications. They blot out words—vital words broadcast from plane to plane, from ship to ship, from command car to jeep or tank. They endanger the lives of fighting men—they sabotage communications—*unless* the proper suppression filter system is installed.

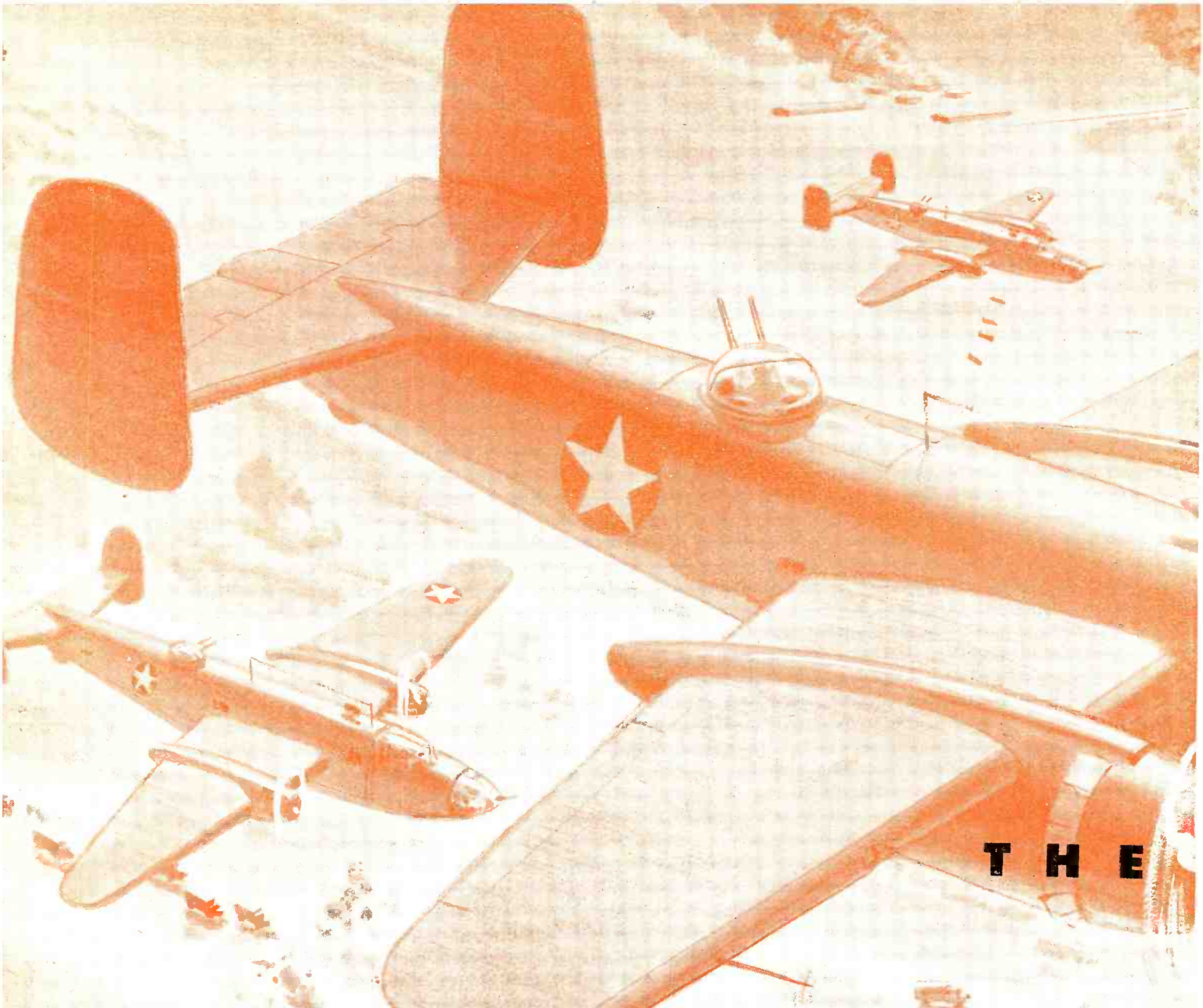
Solar Elim-O-Stats suppress interference *right where it starts.* They absorb interference from generators, motors, contacts and other sources. Thousands of these compact filters protect the lives of our land, sea and air fighters. They prevent the blotting out of vital communications in radio-directed combat.

Pioneers in capacitor manufacture and electronic research, Solar engineers probe the rapidly-expanding future of radio development. In post-victory cars, ships and planes, Solar war-proven Capacitors and Elim-O-Stats will safeguard civilian communications, just as they are safeguarding military operations today. Solar Manufacturing Corporation, Bayonne, New Jersey.

Solar SOLAR — ELIM-O-STAT — STOPS INTERFERENCE AT ITS SOURCE

MAKERS OF RADIO NOISE SUPPRESSION FILTERS AND CAPACITORS

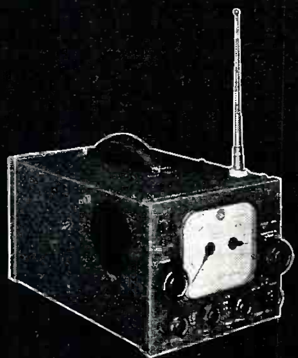
3717



T H E

HT-4B

High powered rig with carrier output of 325 watts on phone and 450 watts on CW. Pre-amplifier supplied with transmitter.



S-29

Completely self-contained portable communications receiver operates on AC or DC or from batteries.

SX-28

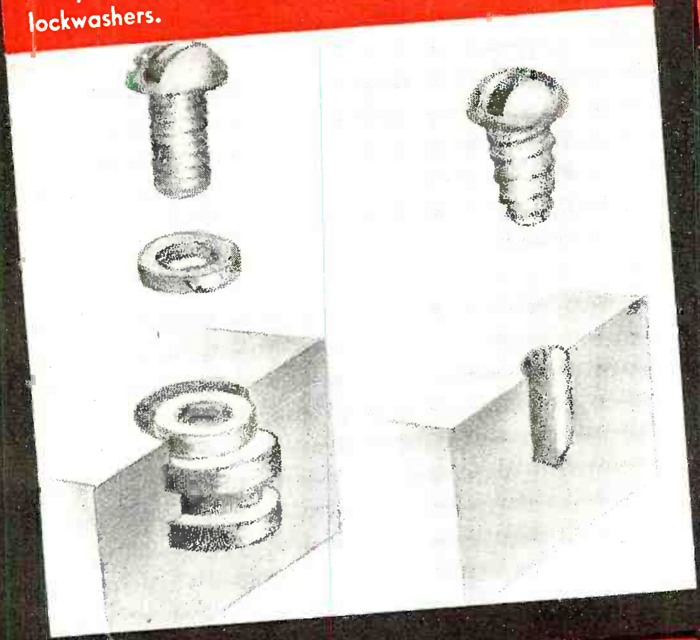
A 15 tube communications receiver incorporating every known engineering advancement. Frequency coverage, 550 kc. to 42 mc.

WORLD'S LARGEST EXCLUSIVE MANUFACTURER OF

In the Battle of Design

A waste of material or machine time in engineering design today is as damnable as sabotage. The battle of design will be won by refinements in existing components as well as by new inventions. Savings in small things add up . . . to big things. Here are some examples:

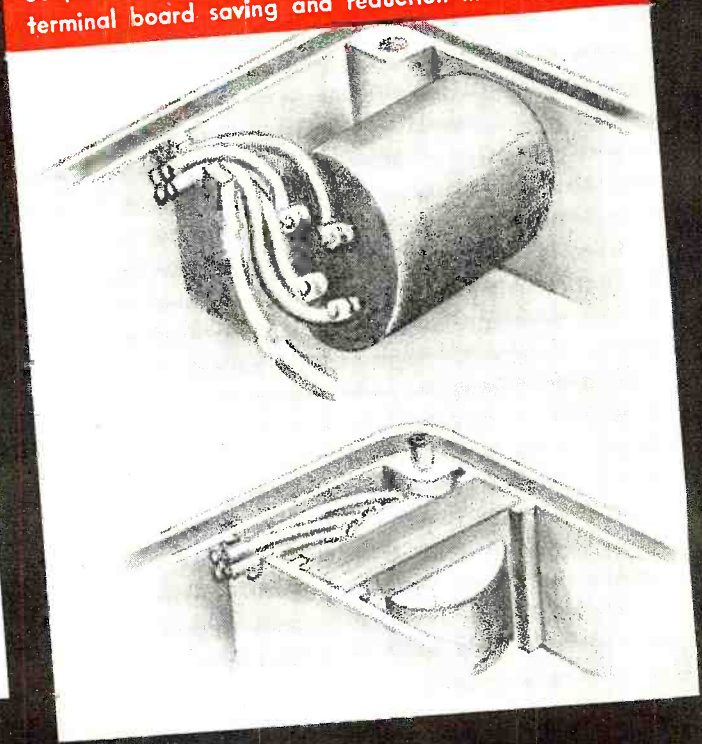
One of our engineers changed the construction of a plastic assembly from brass insert + lockwasher + brass screw to steel PK screw only. Approved by the Army, the savings represented 1,000,000 inserts and lockwashers.



In die cast structures, covers and nameplates were held on by screws. A UTC design modification added a round projection in the casting, which is spun over to hold the plate or cover. Saving: over 3,000,000 screws and lockwashers . . . over 3,000,000 tapping operations.

One UTC design eliminated a threaded shank, lockwasher and nut by changing to a spun-over shoulder on the shank. Saving . . . 250,000 lockwashers and nuts . . . 250,000 threading operations.

This structure employed a cased transformer fastened to a compartment wall with screws. A changed design permitted potting the transformer directly in the compartment. Saving . . . 3,000,000 terminals . . . 500,000 screws . . . 750,000 aluminum cans . . . plus terminal board saving and reduction in overall size.



These savings *added up*. Small in themselves . . . slight for each individual unit . . . their total is impressive. Today we need all possible savings . . . even those which seem impossible at first. Review your designs for Savings for Victory.

UNITED TRANSFORMER CO.

150 VARICK STREET ★ NEW YORK, N. Y.


HE BOUGHT AN ECHOPHONE EC-1!
HE BOUGHT AN ECHOPHONE EC-1!
ECHOPHONE
Dear Mom-Thanks for sending me an Echophone EC-1 it has certainly kept me from getting lonely!
SGT. J. L. KILDAY
CAMP LEE
Creator of
Echophone "Hogarth"
Advertisements
"ON QUIET DAYS LIKE THIS MY ECHOPHONE EC-1 GIVES ME A LOT OF COMFORT!"

IS IN THE SERVICE, TOO!

So that our boys on the fighting fronts may get the news from the home front, Echophone Communications Receivers are doing their duty in the service.

Even the creator of Echophone "Hogarth" advertisements is in the service, doing his share for victory.

ECHOPHONE

ECHOPHONE RADIO CO.

201 EAST 26TH STREET, CHICAGO, U. S. A.

Majestic
MIGHTY MONARCH OF THE AIR

A GREAT NAME IN RADIO

In the nineteen months since Pearl Harbor, the radio industry has answered all-out the call of the Armed Forces.

Majestic has accepted the new tempo of precision production at high speed.

Even more important, the engineering and production staff at Majestic, has assumed a high ranking position in this vital industry.

Under the leadership of Dudley E. Foster, Majestic engineering has successfully undertaken both electronic development and new products responsibilities.

The production department, under Arthur W. Freese, has not only maintained the required high standards of quality but has done so at stepped-up production rate.

ENGINEERING
DUDLEY E. FOSTER
Vice-President
In Charge of Engineering

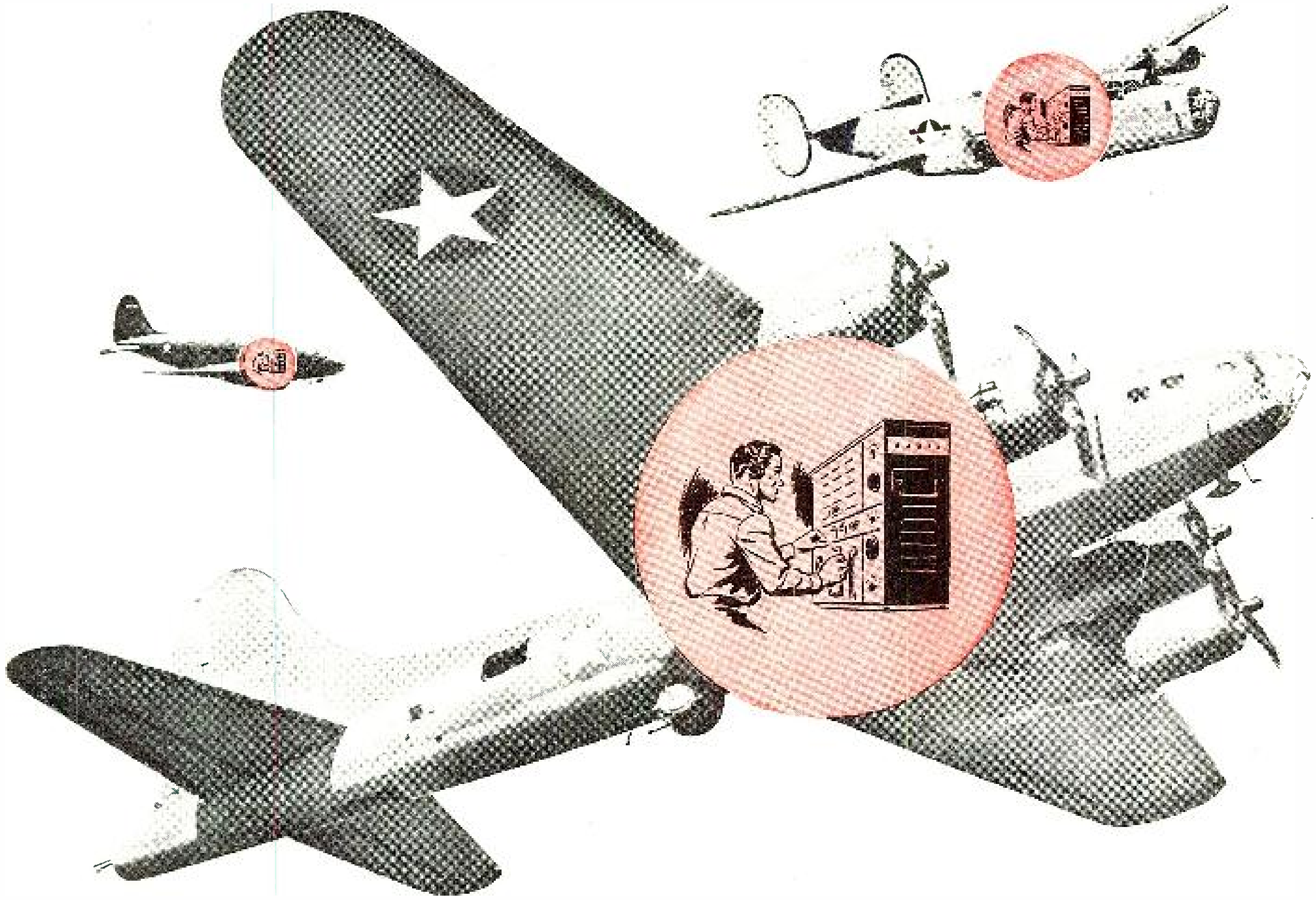
PRODUCTION
ARTHUR W. FREESE
Vice-President
In Charge of Production

PURCHASING — EXPEDITING
JOSEPH J. NERI
Purchasing Agent

PRODUCTION CAPACITY AVAILABLE

OUR EXPANSION of engineering and production, personnel and equipment, has increased the output of the Majestic factory to a point where we can handle additional Army-Navy requirements of electronic equipment.

MAJESTIC RADIO AND TELEVISION CORP.
2600 WEST 50th STREET • CHICAGO, ILLINOIS



EVERY FORTRESS, LIBERATOR AND COMMANDO IS EQUIPPED WITH GENERAL ELECTRIC RADIO!

HOW GENERAL ELECTRIC ELECTRONIC ENGINEERING WILL BUILD THE OUTSTANDING RADIO FOR POST-WAR AVIATION!

• Every American heavy bomber being built for the Armed Forces gets a General Electric transmitter as standard equipment. It is either the long-range "375" or the nearly identical "191."

The Flying Fortresses, the Liberators, the Commando transports, on missions everywhere, depend upon one or the other of these vital instruments. So, too, do our paratroop and cargo planes and many medium and light bombers.

G.E. designed this aviation radio. G-E plants are volume-producing it to meet every condition of rapidly changing altitude, atmosphere, temperature, humidity, and vibration encountered by military aircraft. In tests simulating extreme flight conditions, these G-E sets must function continuously in temperatures as low as minus 40° centigrade and as high as plus 70° centigrade. And they must stand humidity varying from drenching saturation to desert dryness.

Another test calls for successful operation during and after hours of mechanical vibration at 60 times per second through a 1/16-inch vibratory space.

These same G-E transmitters are also used in tanks and other mobile and motorized military apparatus, and in ground operations from point to point and from ground to planes.

G-E electronic engineering, expert assembly under ceaseless inspection, and thorough testing, gear them to faultless operation in all these services. Of outstanding importance is the fact that G.E. has spent years of research perfecting the component parts that make this performance possible.

These same sturdy parts will lend themselves to the particular requirements of aviation transmitters and receivers for safeguarding post-war commercial and private flying. G-E electronic research will rearrange them, and G-E mass-production experience will assemble them, as fine new guardians of peacetime flying worthy of the G-E war-radio record! . . . *Electronics Dept., General Electric, Schenectady, N. Y.*

Tune in on "General Electric News Time" every Tuesday, Thursday, Saturday evening over C.B.S. On Sunday night listen to the "Hour of Charm" over N.B.C. See newspapers for time and station.

GENERAL ELECTRIC FM · TELEVISION · AM

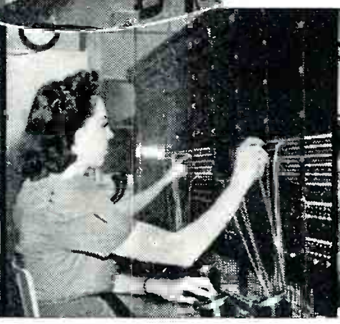
170-B14

STUDIO EQUIPMENT · TRANSMITTERS · ANTENNAS · ELECTRONIC TUBES · RECEIVERS

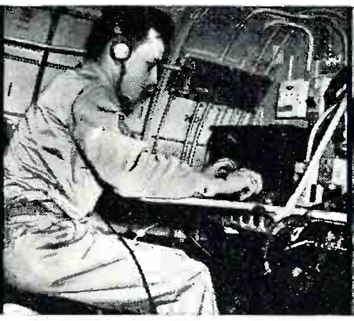
Helping Supply the Vital Needs of THE MAN BEHIND THE "MIKE"

Kellogg microphones and other communication equipment is used in radio-equipped "half tracks." (U S Army Signal Corps Photo).

Radio operator at control panel of large Navy amphibian. (U. S. Navy Photo).



Kellogg switchboard at large Army Air Force Navigation School. (U. S. Army Air Forces Photo).



Operator at control panel of aircraft 2-way high power liason set. (U. S. Army Air Forces Photo).

Kellogg-made microphones, headsets, etc. are widely used with field telephone and wireless sets. (U. S. Army Air Forces Photo).

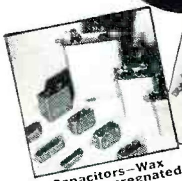
Kellogg Communication Equipment Is in the Fight on Every Front!

Behind the man behind the "mike" stretches a vast, complex network of radio and telephone equipment. To help supply the tremendous quantities of communication equipment needed in modern warfare, the Kellogg plant is busy day and night, turning out a wide variety of products ranging from tiny capacitors to complete telephone switchboards. For here at Kellogg are the required skills for such production. Here is the experience and background, gained in supplying the telephone and many other industrial fields with fine communication equipment for 46 years. Here are the facilities for precision mass production to rigid specifications. Here is a modern research, engineering and manufacturing organization qualified to work with you on any problem involving communication equipment.

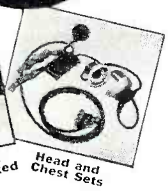
For Everything in Communications—From Complete Systems to Single Parts
CALL ON KELLOGG

● Kellogg has the capacity, resources and manpower to handle more contract and subcontract orders for communication and industrial electrical equipment for the Armed Forces. So whatever your requirements in this respect, write immediately to the Kellogg Industrial Sales Department.

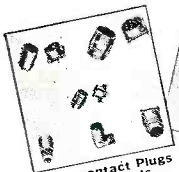
A Few Examples of Kellogg Products in Military Use



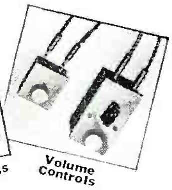
Capacitors—Wax and Oil Impregnated



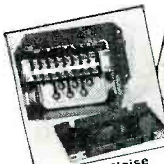
Head and Chest Sets



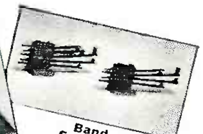
Multi-contact Plugs and Sockets



Volume Controls



Radio Noise Filters



Band Switches

Other communication equipment supplied by Kellogg includes telephone and radio earphones; field telephone and telegraph sets; hand, palm and throat microphones; jacks and plugs; telephone cords; many other related and allied products.

KELLOGG SWITCHBOARD & SUPPLY CO., 6676 So. Cicero Avenue, Chicago, Illinois

KELLOGG

WHERE ENGINEERING AND RESEARCH BUILD *Finer Communication Equipment* FOR WAR AND PEACE

There it flies
The coveted
Army-Navy "E" . . .

We can't tell you
Very much about
The electronics research
That won it . . .

Such matters are
Wartime secrets . . .

But this we *can* say . . .
In the words of
The Army and Navy
This pennant
Represents
"Great accomplishment
In the production
Of war equipment."

Today
Modern radio equipment
Designed and developed
By the Laboratories Division of
Federal Telephone and Radio Corporation
An I.T.&T. Associate
Is helping Uncle Sam's fighting forces
Work together
On land, sea and in the air . . .

Tomorrow
It will help build
A better world
For every man.

THE LABORATORIES DIVISION OF

Federal Telephone and Radio Corporation

67 Broad Street, New York, N. Y.

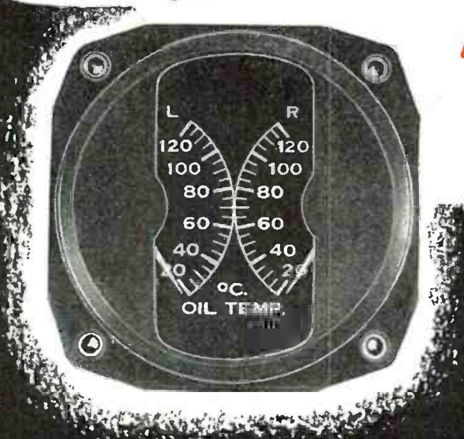
AN **T&T** ASSOCIATE

HICKOK

33 Years of Progress..

1910..
1 small plant
1 employee
2 styles of meters

1943..
2 large plants
Nearly 1000 employees
Hundreds of styles of meters and test instruments



HICKOK METER

HICKOK DYNAMIC MUTUAL CONDUCTANCE TUBE TESTER

From its organization in 1910 until now The Hickok Electrical Instrument Co. has always been in the forefront of those companies who have contributed most to Electrical and Radio Instrument progress.

Quality has always predominated over quantity of production—building a reputation for highest grade instruments that is now reflected in the enormous demand for Hickok Meters for Aviation and other War Time uses. The meter illustrated is typical of these War Time Instruments.

The Hickok Dynamic Mutual Conductance Tube Tester, developed soon after the advent of the 3-element radio tube, is the standard instrument for tube testing today.

New Hickok Meters and Instruments are being designed or are already in production for the use of our Armed Services. They will be available for everyone as soon as the present emergency is over.

So keep your eye on Hickok for the newest and best in indicating meters and radio service equipment.

Hickok ELECTRICAL INSTRUMENT CO.

CLEVELAND, OHIO • U. S. A.


Keep 'Em Running
FOR THE DURATION!
It is difficult to secure new Generating Sets or new Rotary Converters... Pioneer is devoting all of its resources toward winning the war... but we can, and will, help you keep your present equipment running for the duration.
Send your service problems, by letter, to Pioneer's Customer Service Department.
DYNAMOTORS • CONVERTERS • GENERATORS • DC MOTORS • POWER PLANTS • GEN-E-MOTORS
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CHICAGO, ILL. • EXPORT ADDRESS: 25 WARREN ST., NEW YORK CITY • CABLE ADDRESS: SIMONTRICE, NEW YORK

PHILCO

RESEARCH LABORATORIES

ARE ENGAGED IN VITAL AND SECRET DEVELOPMENT PROJECTS FOR WAR

Philco had more than manufacturing skill and experience to offer in producing the radio, communications and electronic equipment they are building for the Army and Navy. They had scientists, laboratories and their years of pioneering research in radio and television ready to serve the nation at war.

So Philco was given assignments worthy of the engineers whose achievements have won leadership in the radio industry. With their background of knowledge, experience and accomplishment in the theory and practical application of radio, television and ultra-short-wave principles, Philco engineers are at work today on urgent and vital projects in the realm of research and engineering development.

★

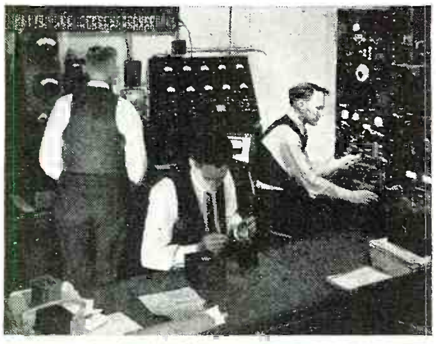
AFTER THE WAR...

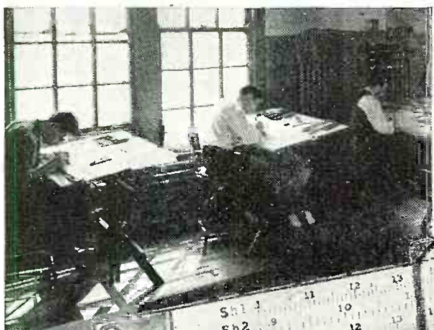
What the scientists of the Philco laboratories contribute to victory must remain a military secret until the dawn of peace and the Age of Electronics. Then the discoveries they have added to the sum of man's knowledge in electronic science will enable Philco *leadership*, once more, to serve the homes and industries of the nation.

☆ ☆ ☆ ☆ ARMY E NAVY ☆ ☆ ☆ ☆

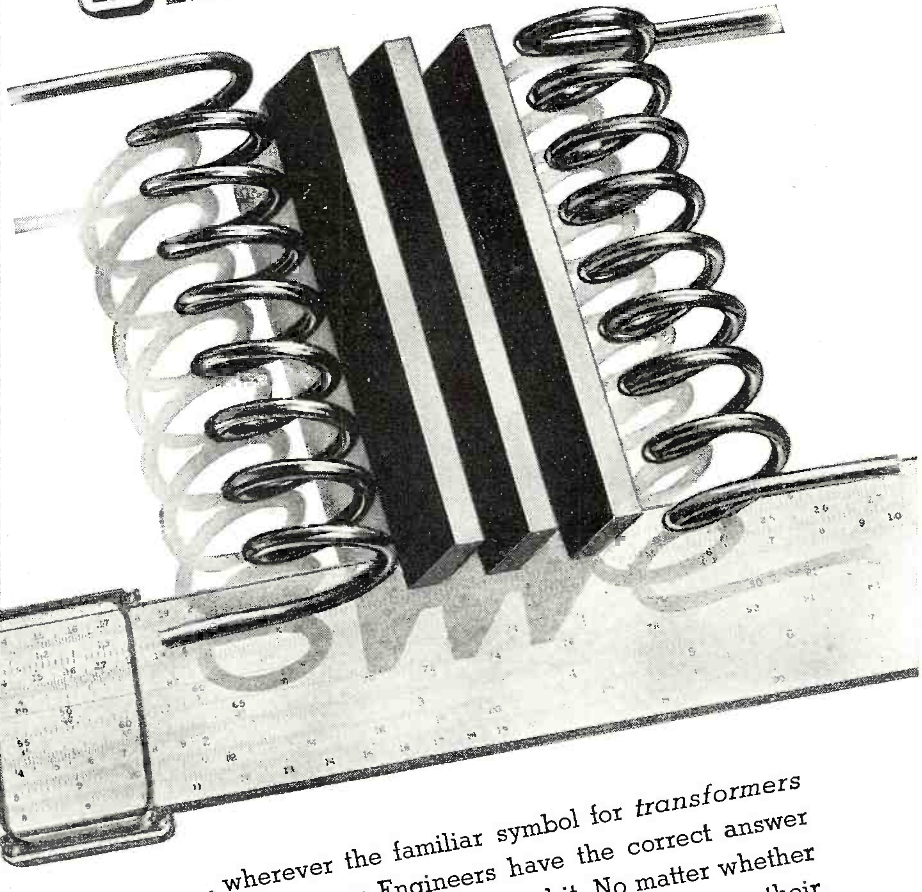
OUR WAR PRODUCTION PLEDGE:

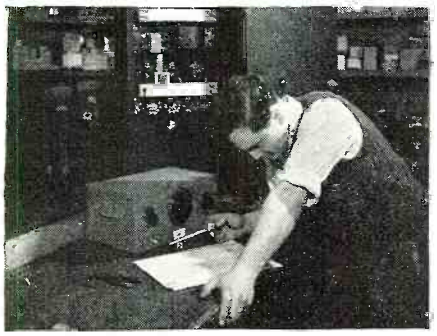
More • Better • Sooner





One basic symbol....





. . . . wherever the familiar symbol for *transformers* appear—Stancor Engineers have the correct answer waiting for you—or they will find it. No matter whether the job is easy or tough — simple or complex — their broad experience and facilities may save you precious days of time and worry on rush work. And, when Tokyo and Berlin are finally blasted off the map these same brains—plus new knowledge gained in vital war developments—will be ready to help you swing back into profitable peacetime production.

STANCOR

STANDARD TRANSFORMER CORPORATION • 1500 N. HALSTED STREET • CHICAGO

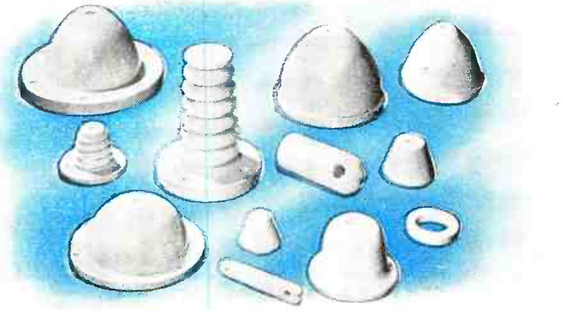
THE TRUTH ABOUT STEATITE INSULATORS

Let's get this straight . . .

General Ceramics Steatite Insulators are available *NOW* . . .

There are adequate raw materials to meet the demand . . .

Our production facilities are greater than ever . . . our backlog of Steatite orders has been melted down . . . there's no basis for the belief that there is a current shortage of General Ceramics Steatite Insulators.



Sure, there *was* a shortage . . . a serious one, but we at General Ceramics met the problem with the "do-it" spirit which typifies American War Production . . . by the location of new sources of supply, rapid plant expansion, procurement of necessary equipment and the training of new employees—*all in record time.*

As a result, delivery time on General Ceramics' Steatite Insulators has been cut in half. Here is our record on that:

June 1942—delivery time—four months.

April 1943—delivery time—two months on standard parts from stock.

General Ceramics Steatite Insulators are available for you NOW

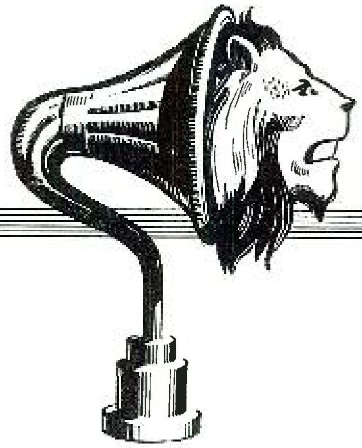
If you have any insulator problem—whether specialized or standard—we'd like a shot at it. Your request will be given prompt, individual action.

General Ceramics

GENERAL CERAMIC AND STEATITE CORPORATION — STEATITE INSULATORS

AND STEATITE CORP.

KEASBEY NEW JERSEY



For 32 years Magnavox has been serving the radio industry. Now our engineering skills and factory facilities, which have made such important contributions to radio, are concentrating on winning the war.

Magnavox

TAKE OUR WORD FOR IT—the new Magnavox factory is an excellent plant . . . six acres under one roof . . . facilities, talent and resources to handle anything in the communication and electronic field.

With engineering skill amplified and production capacity increased we are able to exceed the enviable achievements already made by our organization in war work.

As prime and sub-contractor Magnavox has set many new records. Some facilities are again available for additional contracts. Write, phone or wire. The Magnavox Company, Fort Wayne, Indiana.

MAGNAVOX IS NOW WORKING FOR THESE BRANCHES OF SERVICE:

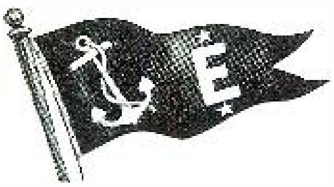
ARMY—Air Corps . . . Signal Corps . . . Ordnance

NAVY—Aeronautics . . . Ordnance . . . Ships

COAST GUARD

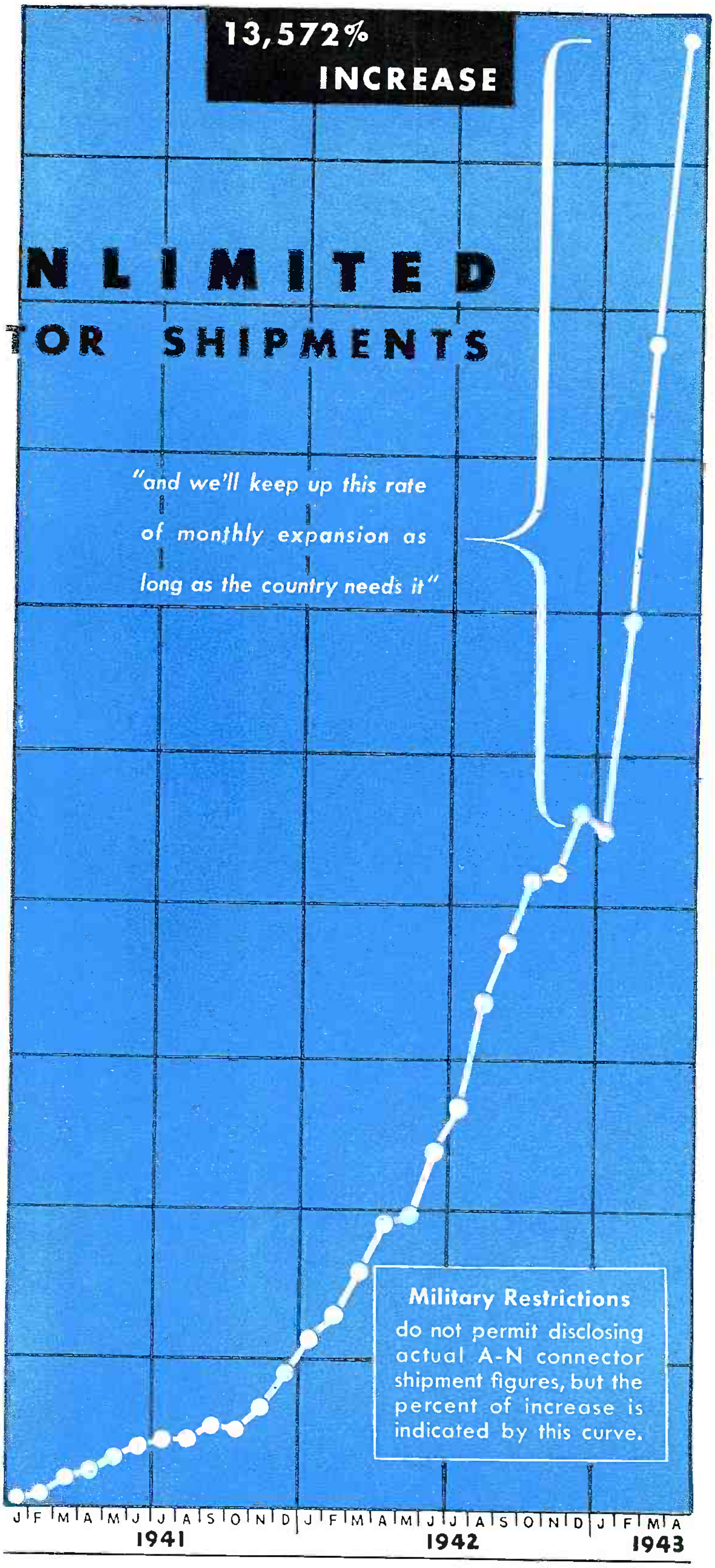
MARINE CORPS

MARITIME COMMISSION



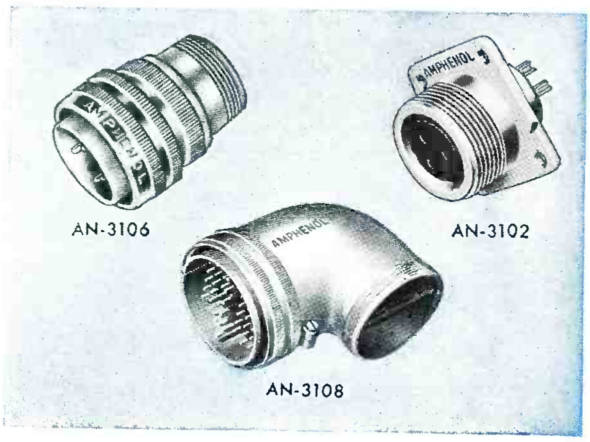
The skill and craftsmanship which won for Magnavox the first Navy "E" award (and White Star Renewals) among radio receiver manufacturers, has served the radio industry capably for 32 years.

CEILING UNLIMITED
ON A-N CONNECTOR SHIPMENTS



In 27 months, there has been an increase of 13,572% in the shipment of Amphenol A-N connectors for electrical, radio, and communications equipment used by the armed forces. Similar increases have been made also in the war production of other Amphenol products: molded plastics, high frequency cables, radio sockets, plugs, and microphone connectors. Actual production figures cannot be released, but these facts—typical of the resourcefulness of American enterprise—can give no comfort to the enemy.

AMERICAN PHENOLIC CORPORATION
CHICAGO



AMPHENOL

A-N ELECTRICAL CONNECTORS — CONDUIT — FITTINGS — LOW-LOSS INSULATION

✔ **AVAILABLE for prompt shipment**

✔ **FULLY PROVED and tested to meet exacting specifications on land, at sea, and in the air**

H NDLE TODAY'S CAPACITOR JOBS with SPRAGUE ELECTROLYTICS

Frankly, we're looking for the people, military or civilian, who "don't like electrolytics". We keep hearing about them, but never quite catch up with them. When we do, we're not going to argue. We simply want to find out what performance they need, then give it to them—in *electrolytic* capacitors that can be delivered almost in the time it takes to arrange priorities on certain other types.

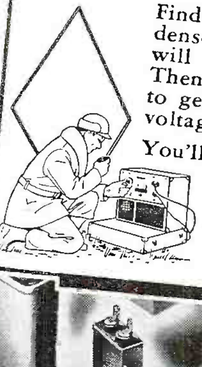
Actually, Electrolytics have far more than small size and light weight to recommend them. They meet all specifications: salt-air, reduced pressure, reduced and elevated temperatures, transients, reversed voltage, r.f. impedance, and many more. They fly. They swim. They even sit unused for months and are still ready to go at the flick of a switch. They can be sealed as well as any condenser type—and they're adaptable to many designs and combinations, from the popular octal base types shown here right along the line to whatever may be required.

SPRAGUE SPECIALTIES COMPANY
North Adams, Mass.

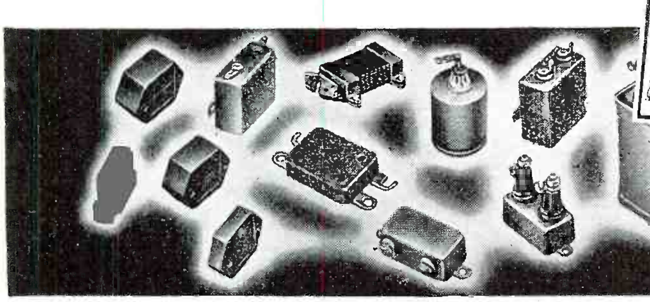
GET THE PROOF!—*Put your capacitor problem up to Sprague engineers. Let them prove that Sprague Electrolytics will do your job—and do it right.*

SPRAGUE ELECTROLYTICS for PORTABLE EQUIPMENT!

To those who question the use of electrolytics in portable equipment, we suggest: Find the smallest capacity of paper condenser (even if it is as big as a house) that will do your low frequency filtering job. Then tell us the low frequency you are trying to get rid of (20 to 120 cycles), and the voltage ranges . . . then . . .



You'll be unable to detect any difference in performance between this paper condenser and the Sprague Electrolytic we'll recommend. *The only difference will be in the greatly reduced size and weight of the electrolytic!*



MANUFACTURERS OF A COMPLETE LINE OF RADIO AND INDUSTRIAL CAPACITORS AND KOOLOHM RESISTORS

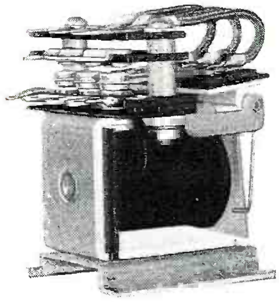
FROM "HAM" TRANSMITTER RIGS

TO INTER-PLANE COMMUNICATION

RELAYS BY GUARDIAN

★ Today they are off the air . . . voices stilled . . . home-built rigs carefully covered. For most of yesterday's "hams" are lending their experience, knowledge, and ingenuity to the war effort . . . creating and perfecting new communication devices . . . the amazing new flight recorder, for instance . . . or Radar. But whether they work in a wartime lab or have their "office" in a Fortress, they are still close to one of their early friends—"Relays by Guardian".

One of the newer developments is a multi-purpose aircraft radio relay pictured at the right. It is built in contact combinations up to three pole, double throw. Coils are available in resistances from .01 ohm to 15,000 ohms. At 24 volts DC it draws 0.12 amperes. This relay is also built for AC with a contact rating of 12½ amperes at 110 volts, 60 cycles. Standard AC voltage is 92-125 volts but coils are available for other voltages.



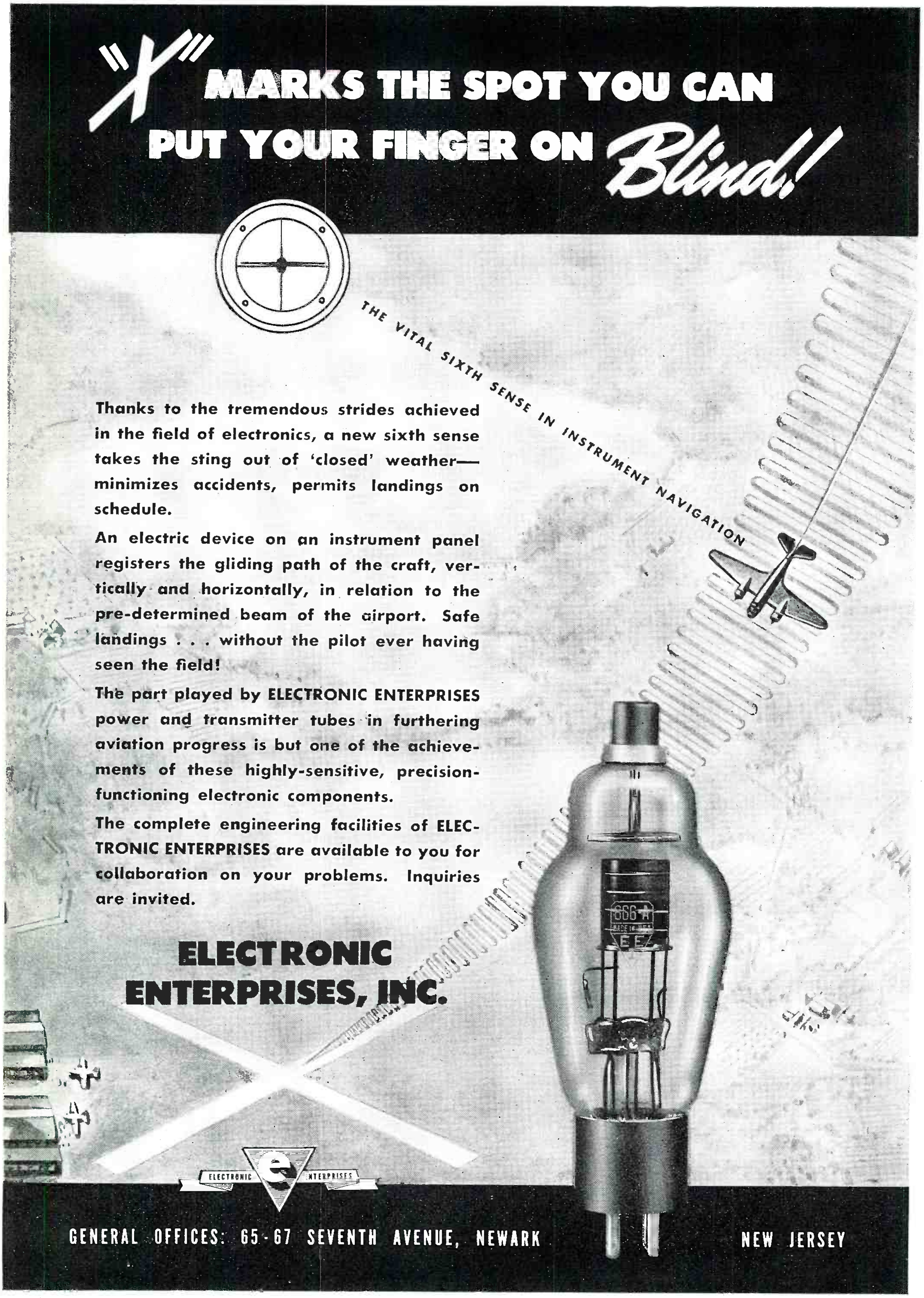
Aircraft Radio Relay
DC Model—Bulletin 345
AC Model—Bulletin 340

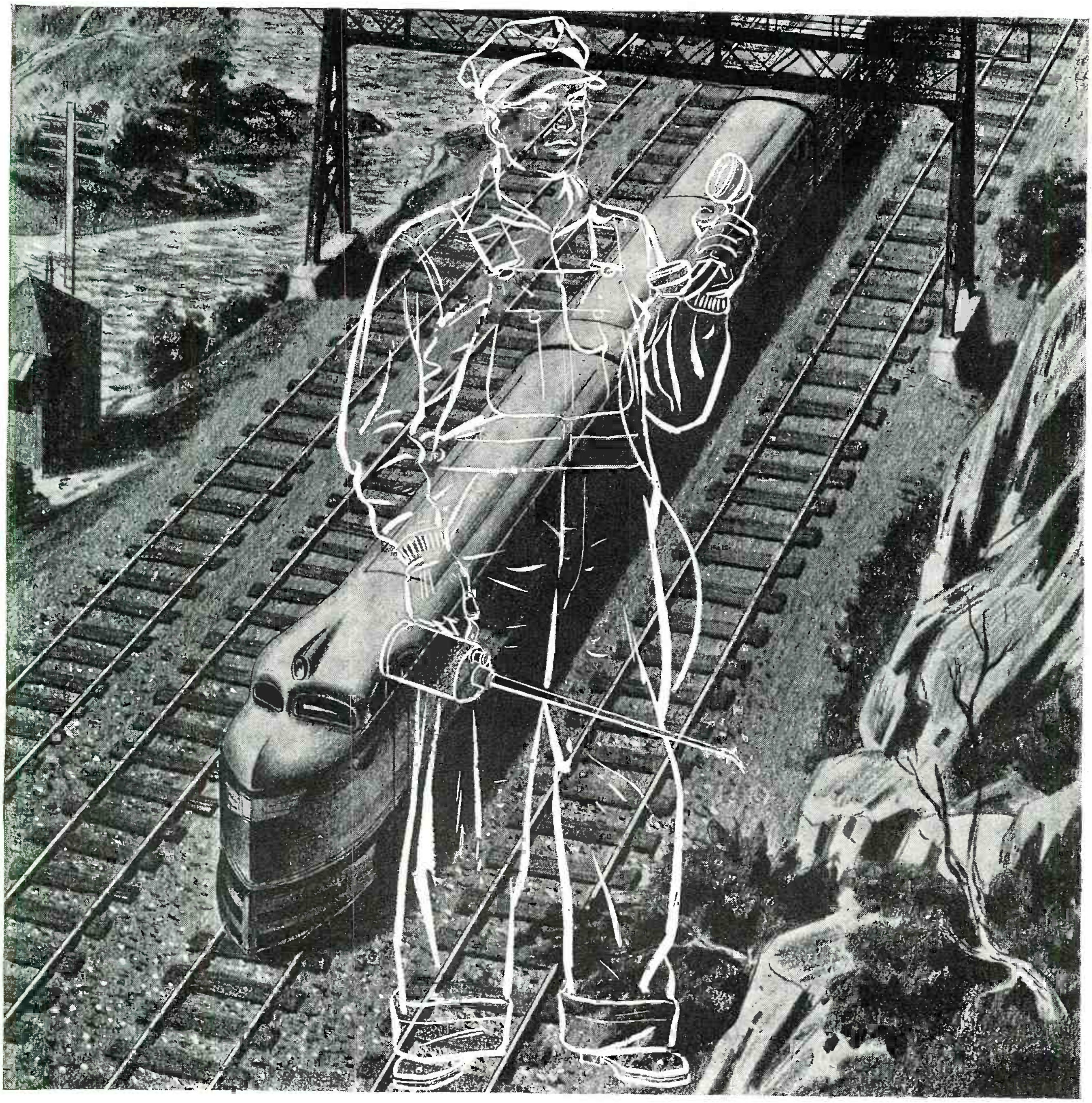
Write on your business letterhead for these new bulletins: B-8, Six pages of Aircraft Contactors—195, Midget and Signal Corps Relays — B2A, Aircraft Relay — SC65, Solenoid Contactor.

GUARDIAN G ELECTRIC

1630 WEST WALNUT STREET — CHICAGO, ILLINOIS

A COMPLETE LINE OF RELAYS SERVING AMERICAN WAR INDUSTRY


"X" MARKS THE SPOT YOU CAN
PUT YOUR FINGER ON Blind!
THE VITAL SIXTH SENSE IN INSTRUMENT NAVIGATION
Thanks to the tremendous strides achieved in the field of electronics, a new sixth sense takes the sting out of 'closed' weather—minimizes accidents, permits landings on schedule.
An electric device on an instrument panel registers the gliding path of the craft, vertically and horizontally, in relation to the pre-determined beam of the airport. Safe landings . . . without the pilot ever having seen the field!
The part played by ELECTRONIC ENTERPRISES power and transmitter tubes in furthering aviation progress is but one of the achievements of these highly-sensitive, precision-functioning electronic components.
The complete engineering facilities of ELECTRONIC ENTERPRISES are available to you for collaboration on your problems. Inquiries are invited.
ELECTRONIC ENTERPRISES, INC.
866-A
ELECTRONIC ENTERPRISES
GENERAL OFFICES: 65-67 SEVENTH AVENUE, NEWARK
NEW JERSEY



Wherever man goes . . . after the war the two-way radiotelephone will find its place in the industrial, business and social life of all nations. At the moment, Jefferson-Travis equipment, with its many exclusive developments, is being used by United Nations throughout the world. With peace, this remarkable electronic device will once again be yours to know, use and enjoy.

JEFFERSON-TRAVIS

RADIOTELEPHONE EQUIPMENT

NEW YORK • WASHINGTON • BOSTON

Foreword

WAR needs have brought on a spectacular development of the aviation industry. It is now the number one industrial establishment of the nation. Almost lost to sight in this brilliant display of industrial might is the role of radio as it has kept pace step by step with the sparkling inventive and production genius which has given us our big bombers, our swift and dangerous fighter planes, and our great new transports.

All great technological developments are interdependent. The growth of one element of technical achievement brings with it a challenge, and opportunities to other and sister craft, which are soon found developing along parallel lines. This has indeed happened as aviation relates to the radio industry.

An integral part of the entire pattern of aviation development has been the need for efficient communications allowing for successful and safe operation. For this purpose radio has proven indispensable.

When the war is over and military security permits the whole picture to be blueprinted for the public to see in detail, it will be discovered that radio has made almost as startling advances as the airplane itself. In this specialized phase it has contributed elements of such power and importance that it has become a primary industrial factor on its own account.

These developments have supplied a communications system which has made it possible for our military forces to successfully carry out far-flung missions in theatres scattered the length and breadth of the globe. If the engine is the heart of the airplane, the radio is its five senses. Above all it supplies the miracle of sight and hearing, brushing aside the obscuring haze of distance and piercing natural obstacles of terrain, fog and weather alike.

Aviation radio in all of its various aspects is not only an achievement. It is rapidly becoming a great industrial art involving newly developed skills and know-how. It is leaving its mark indelibly on this war and, through it, on the course of human history. During the great rebuilding period which will follow the termination of war, it will gain even greater luster and importance. It will give America possession of a unique industrial plant, essential to her prosperity and of great potentiality as a source of military power.

It is with pride and satisfaction that we present to our fellow Americans the picture of eminent achievement which is contained in the pages which follow.

We wish to make grateful acknowledgment to the U. S. Army Air Forces, the Bureau of Aeronautics of the U. S. Navy, the U. S. Army Signal Corps and the Civil Aeronautics Administration, for the generous cooperation which has made this report to the Nation possible.

William B. Ziff

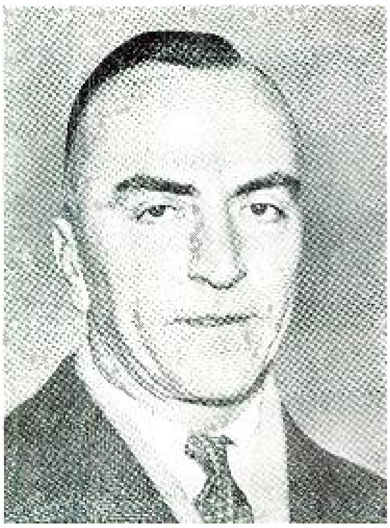
Publisher, RADIO NEWS

NOW HOPE HAS A HELPER

The hopelessness of waiting on a cruel sea for days or weeks—with help just over the horizon—will probably not be experienced by another crew from another disabled bomber. Now emergency life rafts are equipped with radio transmitters with a kite and a length of antenna wire. Now a call for help will travel over the ocean to friendly ears . . . and the shipwrecked have something more reassuring than a bare hope of rescue.

Belden Wire is used in this life saving apparatus . . . as well as in a thousand other types of electro-mechanical war equipment.

Belden WIRE



Introduction

NOTHING, so much as radio, marks the difference between air fighting in this war and in the last. This time it's team work. Without radio in the air teamwork would be impossible. The close grouping of formations, the quick wing-to-wing coordination of the boys who fight, and win, as a group could not be carried through unless there was instant, clear voice communication from plane to plane.

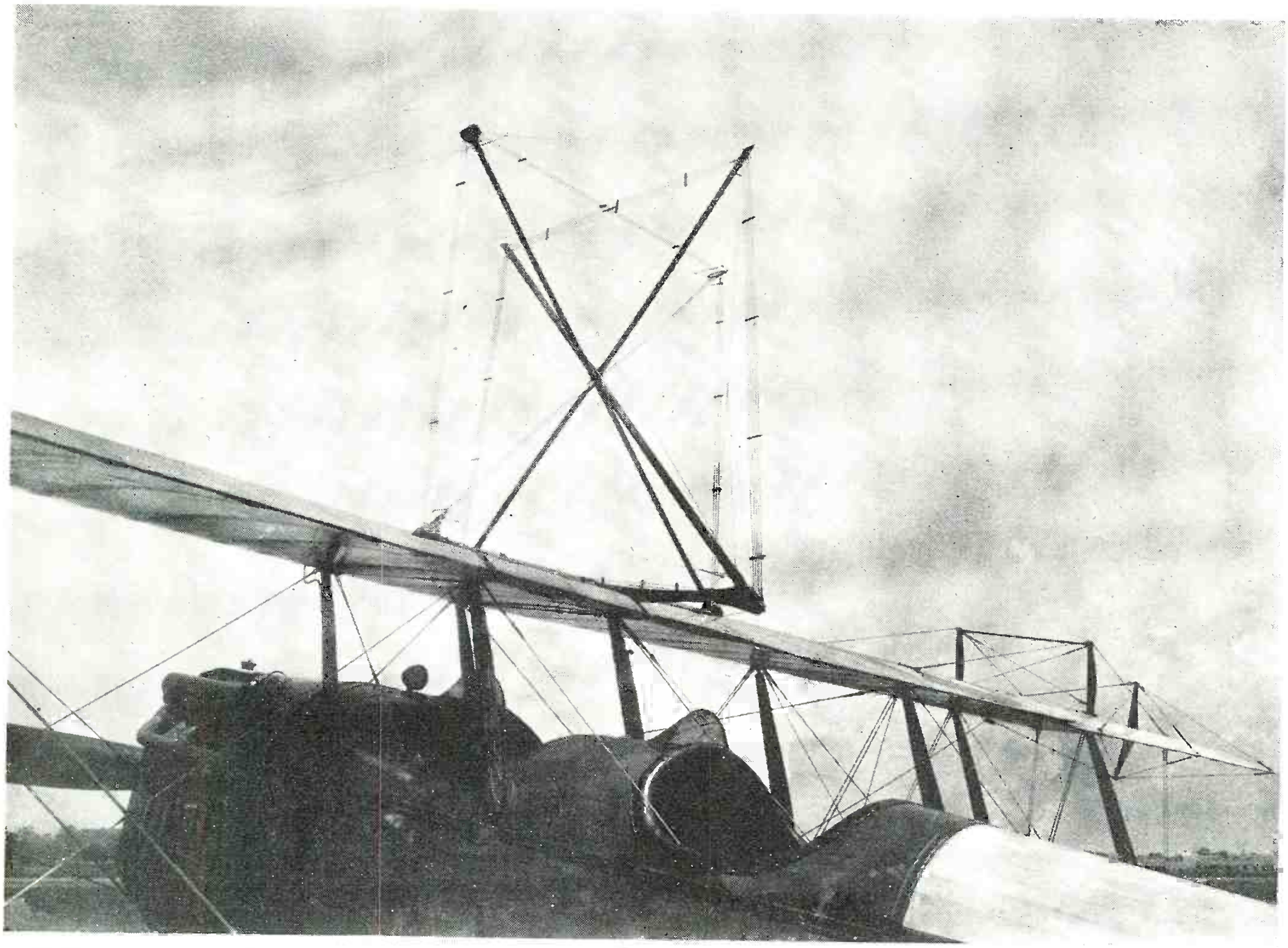
Take the kind of mass operations through which the R.A.F. and the American Army Air Forces are carrying destruction to Hitler where it hurts. The mass raids on German industry could not even be planned, much less carried out, were it not for the fact that from start to finish the boys carrying the bombs are in close touch with their home bases and with the high command.

You cannot even think of that other great phase of air fighting, cooperation with the ground forces, without radio. When bombing and strafing planes must work in split second cooperation with tanks, artillery and infantry, as they must in modern combat teams, it would be impossible to assure that the planes did not strafe their own forces, for instance, unless they had moment to moment knowledge of their progress.

All of this relates to land fighting. As I know only too well the failure of radio in operations over the sea is all too often a fatal failure.

The airlines and other phases of American peacetime aviation developed our aviation radio to the point where the boys in there fighting can count on it. They can count on it to save their own lives. They can count on it to carry through their missions successfully.

AIRCRAFT COMMUNICATION



Early form of direction-finder antenna from which much had to be learned before our present form of systems could be developed.

Modern radio communications, of paramount importance to our armed forces today, sprang from this illustrious group of early equipment as used in World War I.

by

Lieut. Col. WILLIS R. LANSFORD

Native of Lexington, Ky. Graduated in Accounting (BCS) and Law (LLB). Master Signal Electrician with Signal Corps, District of Columbia National Guard. Served on Mexican Border, 1916. Commissioned 1st Lt. Signal Corps, 1917. Served in France 1918-1919. Promoted to Captain, 1919; Major, 1929; Lt. Col., 1937. Division Signal Officer 3rd Bomb Wing, 1941. Organized, procured and trained at Ft. Monmouth and British Isles the Electronic Training Group, 1941-42. Now on duty in Office of Chief Signal Officer assigned to Army-Navy Electronics Production Agency.

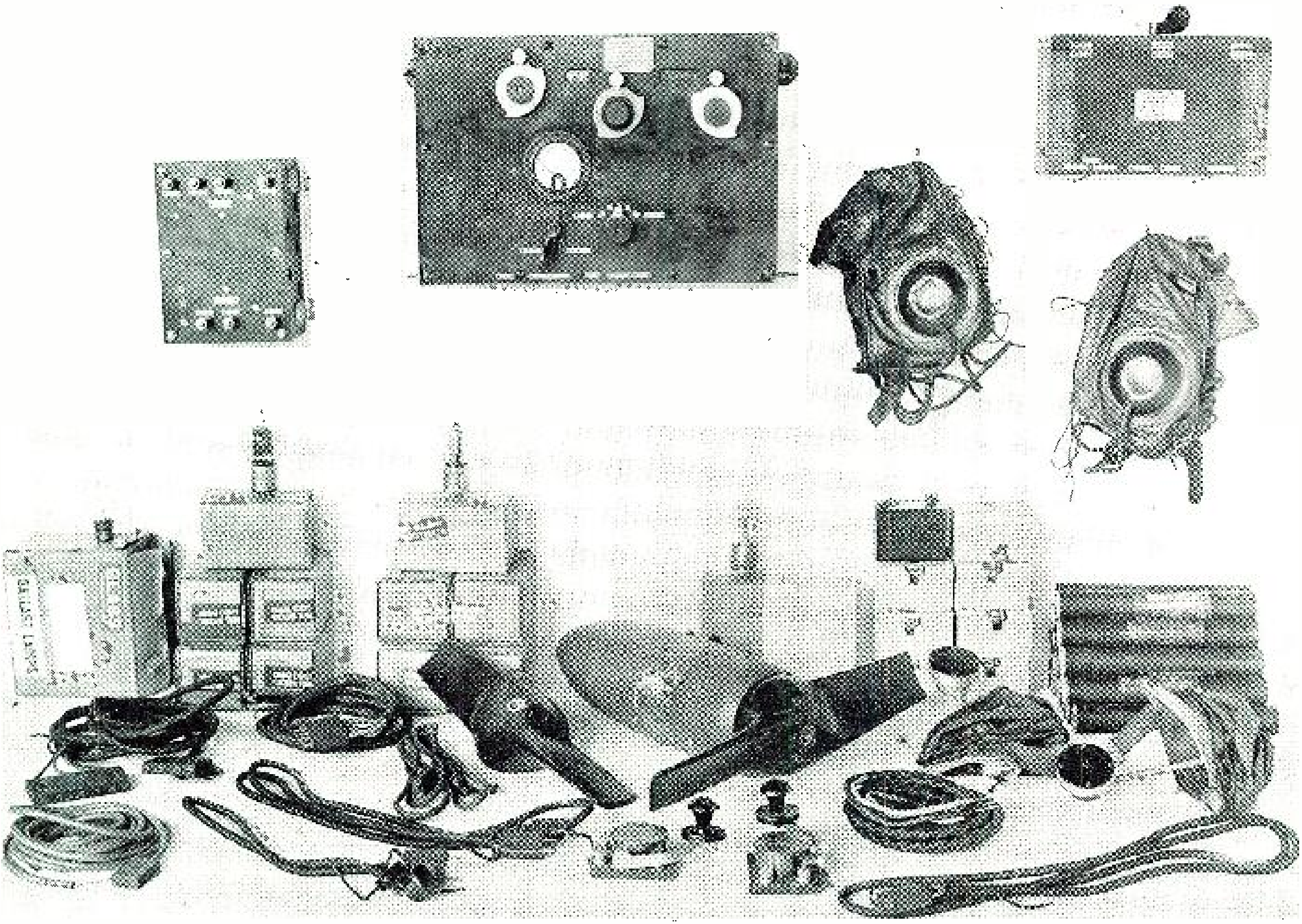
IN writing an article on the development of communication between airplanes and from air to ground during World War I, it is difficult to avoid making comparisons between the crude apparatus of those early days and the swift, dependable, and amazing facilities now being used by our fighting flyers in today's mighty conflict.

A recounting of some of the sequential events, simple and crude as they now seem, should be interesting as a highlight of the comparatively commonplace usages of today.

The airplane was first developed by the Signal Corps for military use as a means of swift communication. This development early had its tragic consequences in the first military airplane casualty resulting in the death of Lieut. Thomas E. Selfridge, Field Artillery, attached to the Signal Corps, who was killed making an official flight on September 17, 1908, at Ft. Myer, Virginia, and in whose honor Selfridge Field, near Detroit, Michigan, received its name. It was logical that men's minds should turn quickly to electrical communication means between the plane in the air and the ground base, and then to inter-communication between planes. Later, of course, the airplane became a formidable offensive weapon in its own right and resulted in the organization of the Army Air Corps, which developed into today's greatly expanded and powerful Army Air Forces.

The inception of the idea of using the airplane as a

IN WORLD WAR I ★ ★ ★ ★ ★



Communications equipment supplied for airplanes during World War I. Note the heavy sending keys made for use with gloves.

vehicle in transporting radio communication apparatus harks back to 1910. At that time Colonel C. C. Culver, then Captain of the U. S. Signal Corps, while watching a flock of eleven airplanes overhead at an aviation meet in Belmont Park, New York, remarked that if the pilots could only talk to each other another wonder would be accomplished.

This thought, in all probability, stayed with him during the ensuing years, for it was largely his insistent interest in the subject that resulted in successful studies of the utilization of radio telephone for various military purposes. And it was Colonel Culver, in 1918, who had the proud distinction of demonstrating in France the complete superiority of the American method of adapting radio telephony to aerial uses.

While radio telegraphy had been used in airplanes previous to our entry into the war for air to ground, fire control and scouting purposes, its field had not gone beyond that of one-way communication, and was confined practically to the use of simple spark-gap types of telegraph apparatus.

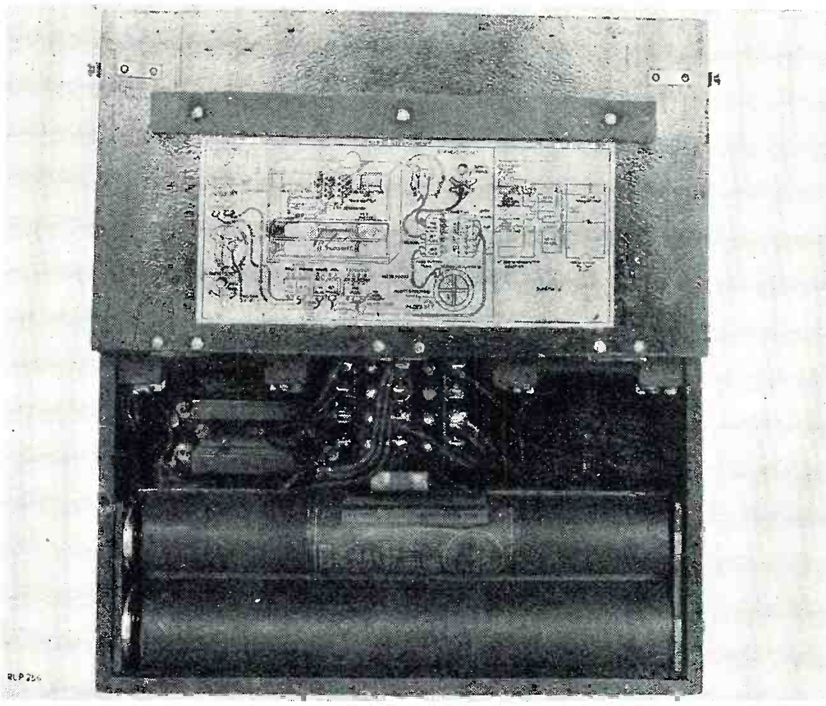
The most important and extensive use of radio apparatus by our Army during World War I was for directing artillery fire from airplanes. The system used for this purpose by all armies was essentially the same: the airplane circled over the target and the burst of the shells was noted by the observer, who telegraphed a code message back to a receiving station near the battery.

The French developed a set which consisted of several units, making the installation and operation complicated. The U. S. Signal Corps at that time developed a self-contained set, which although cumbersome by present day standards, by demonstration, proved far superior to any other airplane set. It consisted of three units—first the 200-watt, 900 cycle alternator, driven by a regulating air fan and containing in a streamline case attached to the generator all the elements of the radio set. The circuit used was of the synchronous-spark type, with four spark tones and nine wave lengths. The weight of the complete unit was only 23 pounds, and the size only 6 inches by 6 inches by 20 inches. A regulating air fan maintained the speed of the generator within four per cent of 4500 r.p.m., with air velocities between 60 and 200 miles an hour.

The remaining units of the complete set were a variometer or tuning coil, with antenna ammeter in series with the antenna system, the latter comprising a reel, insulated bushing and trailing antenna. Ranges of communication of 100 miles (160 km.) were accomplished with the set. Some of this set's peculiar problems are noteworthy.

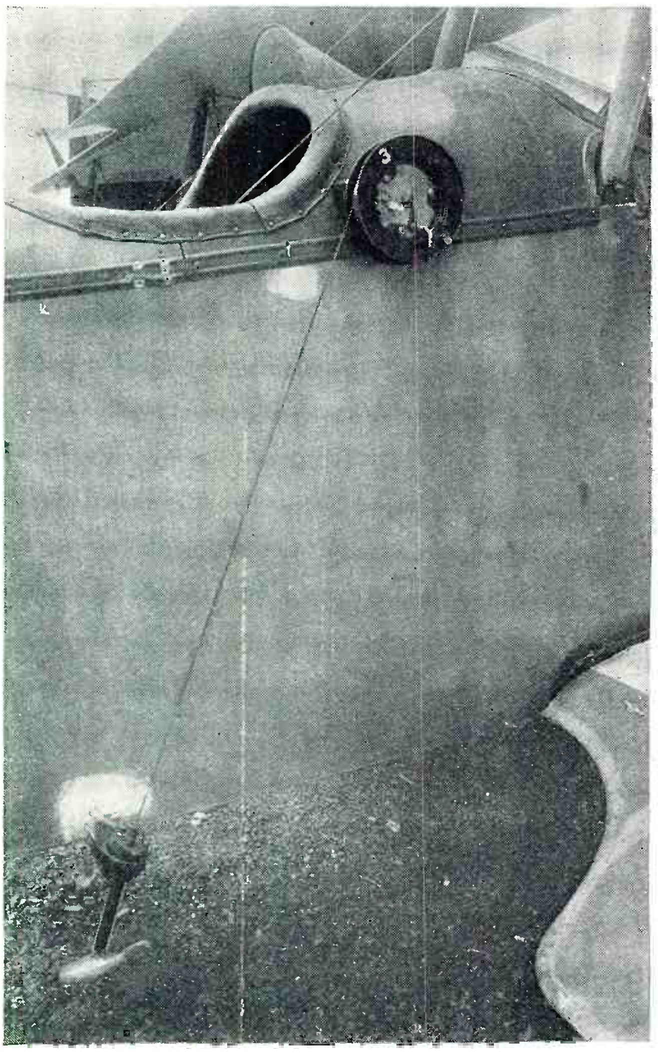
A requirement in designing the generator referred to in the foregoing was that it should always build up when the field switch was closed. It was found that occasionally in shutting down the set the condenser discharged back and destroyed the residual magnetization of the machine.

Pilot's helmet, with head-phones removed, used during the 1st World War.



An interphone set as used during World War I. These sets provided means of communication between a pilot and his crew. Though crude, they served their purpose.

An early type of reel antenna. Released from the plane, the weight at the end carried the antenna clear of the craft.



The comparatively low field voltage also led to occasional failures to build up due to brush resistance. Although the percentage of failures was small it was considered advisable on the first lot of machines to provide a small dry battery with a convenient switching arrangement for starting the excitation, if needed.

In the second lot of machines the use of higher field voltage, a damper winding around the field poles, and a change from the single phase winding to a split phase winding, which prevented the demagnetization of the field mentioned, entirely eliminated the failure to build up, and the dry battery was omitted.

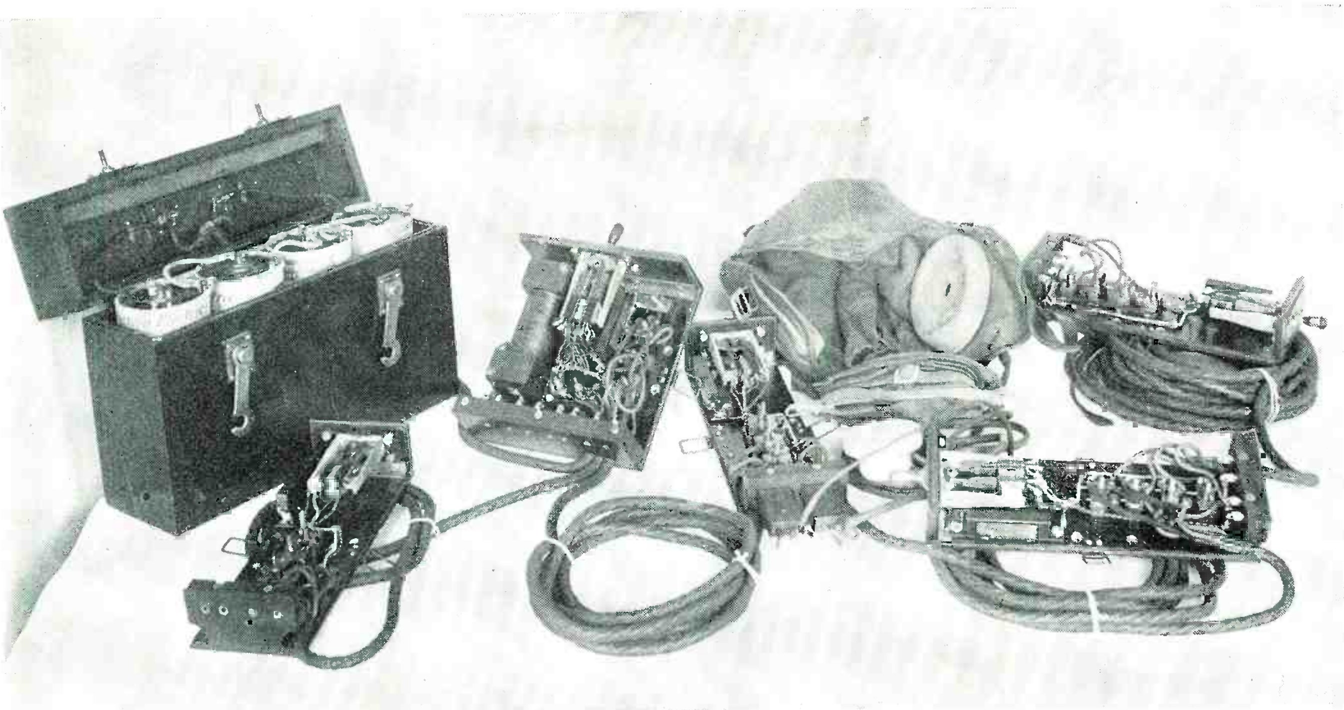
The keys, of which there were three for each set, were of flame-proof construction, and had very heavy knobs and levers with fairly stiff springs, since they were to be operated by men wearing heavy gloves.

This particular key design was developed by the General Radio Company, and modified by the Signal Corps to include a small incandescent lamp connected in parallel with the contacts. If the set was in working order, this lamp glowed when the key was not depressed, which feature was considered of great value. In addition, the lamp served to indicate to the pilot when the observer was sending and vice versa, since all lamps winked when any key was closed. The official Signal Corps designation of this set was "airplane radio-telegraph transmitting set, type SCR-73-A." It weighed 28 pounds.

The receiving set used with the transmitting set just described was generally installed in the neighborhood of its assigned artillery battery, with which it was connected by wire telephone. In this exposed position, it was often impracticable to supply charged storage batteries for use with vacuum-tube receivers or transmitters, hence the set was designed to use crystal detectors, galena or silicon being generally the specified mineral.

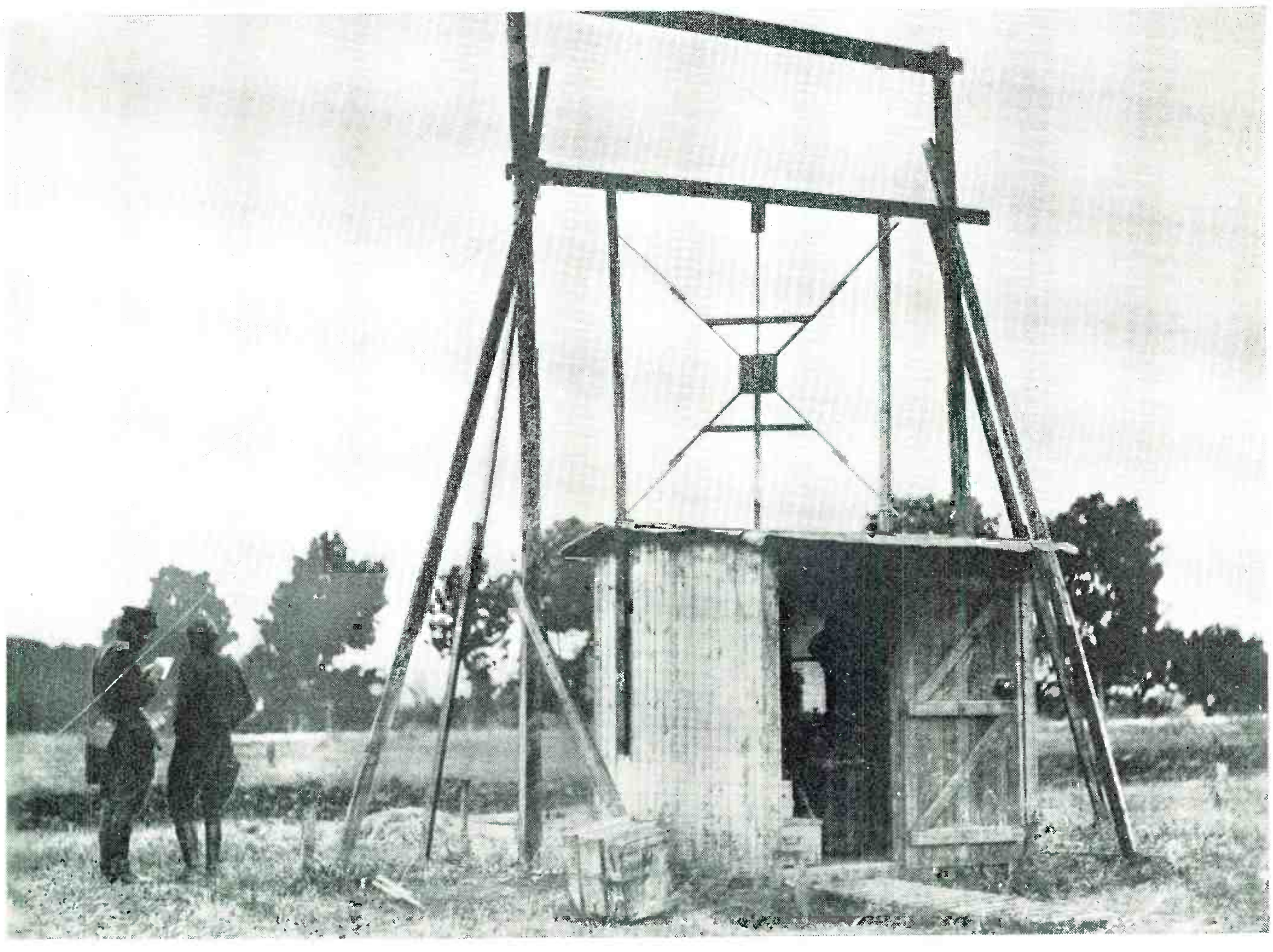
For pre-tuning to desired wave lengths there was a buzzer so connected as to excite the antenna circuit. This reacted on the calibrated secondary coil so that the operator could adjust this set to listen for a signal of predetermined wave length without the use of a separate wave meter at each receiving station.

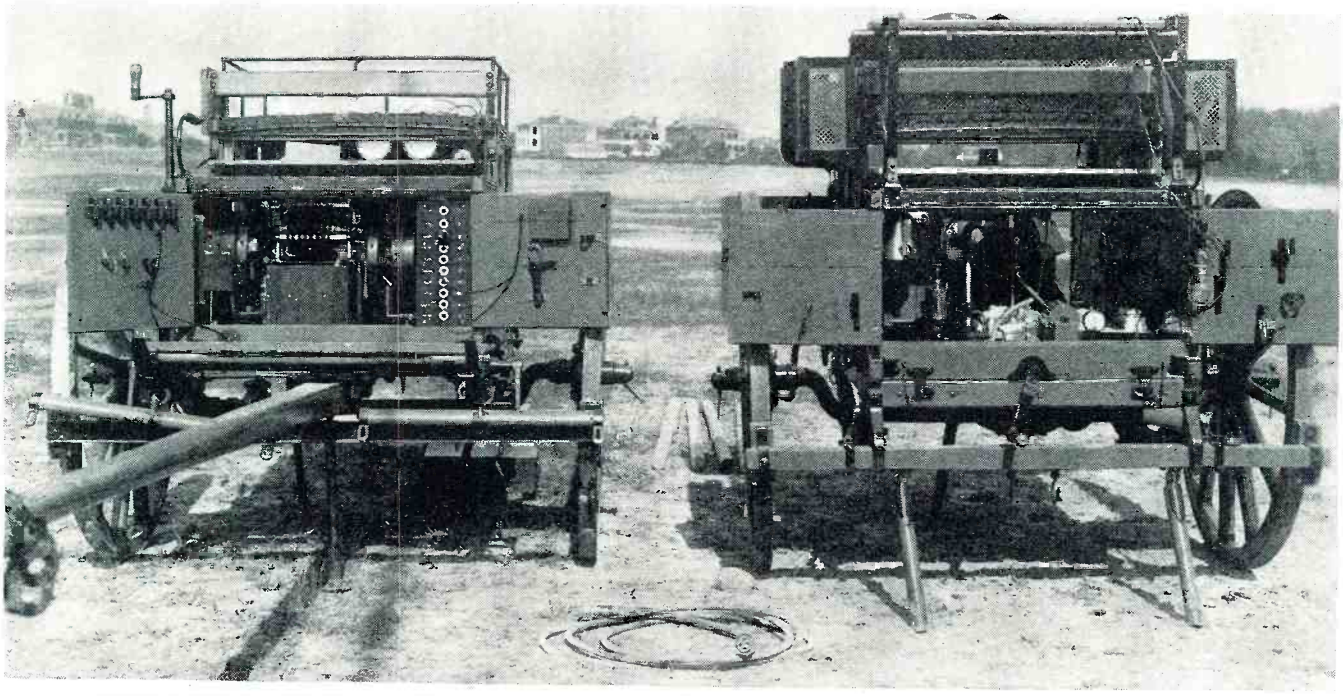
The exposed position occupied by these receiving stations made mechanical design of the antenna particularly important. It was light, inconspicuous, easily erected in a short time and adaptable to a variety of local conditions.



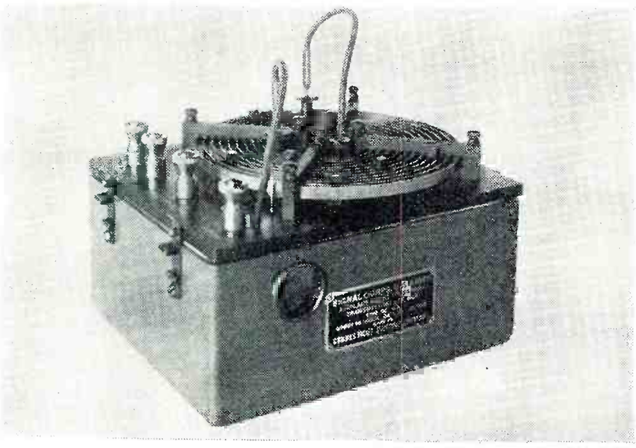
World War I aircraft radio equipment was rather cumbersome and bulky. It served its purpose well. Of particular interest are the key-type toggle switches, compared to our present form of switch.

An early type aero ground Goniometric station in use in France during World War I. These stations were a forerunner of the present elaborate directional antenna systems in use at our modern airports today.



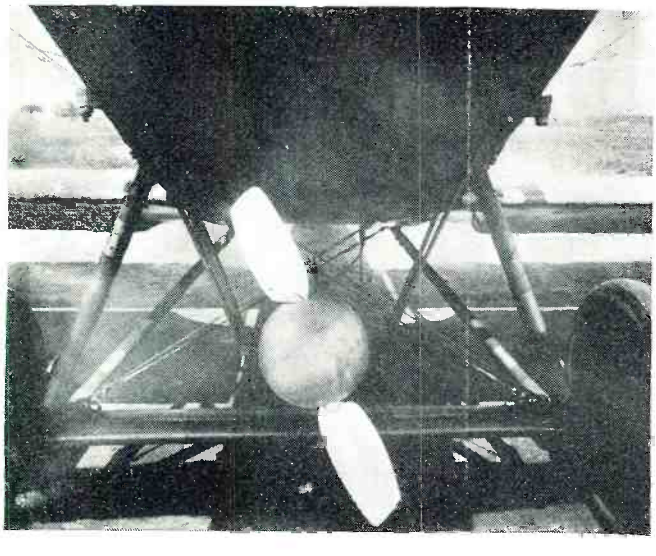


Mobile transmitter with its associated power supply. A 1919 model of a 2 kw. Telefunken wagon wireless sending set.



Airplane radio telegraph transmitting set built for Signal Corps in 1918. Coiled winding is tapped for proper frequency.

Early type auxiliary generator used to supply power to radio equipment installed in plane of the 1st World War.



In general, the antenna design used was a 60 degree "V", composed of two wires 100 feet (30 meters) long, and mounted approximately 20 feet (6 meters) from the ground. When trees or buildings were not available masts were required. After considerable experimenting the Signal Corps developed the mast made of spruce or pine wood, the sections being joined by a socket joint, slightly conical, the two parts being made of dissimilar metal to prevent rusting together. Simple strain insulators of bakelite material and light guy ropes were also provided.

The ground connection was made in a variety of ways, depending on local conditions. Generally, a woven copper mat in direct contact with the earth proved the most useful. In other cases insulated counterpoise wire was stretched along the ground, and in still other cases ground stakes were employed. Material for all of these was supplied with the sets.

The official designation for this set was "radio receiving set, type SCR-54-A."

Anticipating possible employment of radio telephony, the Western Electric Company's engineering organization carried on a considerable amount of experimental work in the way of applying the principles demonstrated in connection with earlier experiments in adapting long distance radio telephone to short range work. This work resulted in the development, in experimental form, of satisfactory short range apparatus.

On May 22, 1917, about a month and a half after our formal declaration of war on Germany, Major General George O. Squier, Chief Signal Officer of the Army, called a conference at Washington to consider the feasibility of intercommunication between airplanes while in flight by means of radio telephony. At that time plans were in the making for a tremendous aircraft program, and it was clear to all, that a successful means of telephonic communication between battle planes when flying in formations would be of inestimable value and would greatly increase the efficiency with which various formations could be maneuvered.

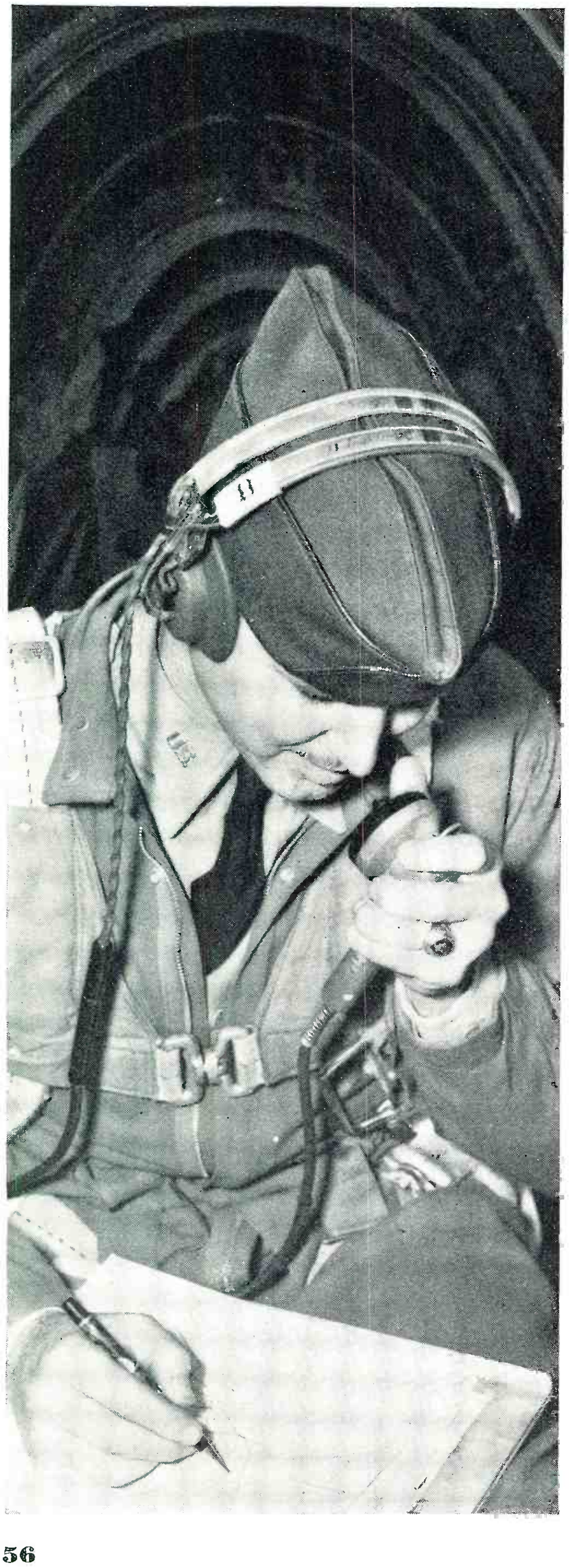
As a result of these conferences, orders were issued to rush the development of a wireless telephone system for the purpose. It was realized early that the principal difficulty in airplane telephony would be the noises due to the motor and the wind, so that attention was concentrated on the problem of providing against this difficulty both in the transmitting and receiving ends.

(*Continued on page* 208)

THE AIR FORCES

The Army Air Forces and the Army Signal Corps are working together to produce the finest of equipment and highly-skilled radio operators for world wide combat.

AIR FORCE RADIO



SPLIT-SECOND communication is the life-pulse of military tactics. Hilter's blitzkrieg on relatively well defended Poland, resulting in complete conquest in twenty-seven days, was carried through in record time because within the first couple of days the Luftwaffe roared over and smashed up the vital communications centers and put the air bases largely out of commission. This proved so completely disorganizing that victory was a comparatively easy job.

Flying and radio were both born at the dawn of the twentieth century, and for the development of flying in general, and especially military aviation, the interaction of one on the other has been of the highest importance. As soon as the airplane reached the point where it could fly several miles away from its starting point, with the possibility of getting off its course, running into bad weather, etc., the necessity for communication with the ground became imperative.

It was no accident that one of the great pioneers of American air power, the late Brig. Gen. Billy Mitchell, was an officer in the U. S. Army Signal Corps, and that in this capacity his restless imagination was constantly cooking up ways and means to radically improve the communications angle of warfare, often to the consternation of the staff officers who were not always sure what new rabbits were coming out of the hat next.

The story of air-to-ground communications by wireless goes back to the pioneering days of military aviation and involves some of the outstanding figures in the history of the Army Air Forces. In August 1909 the Chief Signal Officer, U. S. Army, Brig. Gen. James Allen recommended that the United States purchase a Wright biplane to be tested for observation during field maneuvers. In 1912, Lieut. J. O. Mauborgne, Army Signal Corps, was completing the development of an experimental wireless outfit with a view to adapting it to air-ground communications and so increase the value to the Army of its newest gadget, the military airplane. Lieut. Mauborgne later was to become Chief Signal Officer of the Army with the grade of major general. He retired from active duty shortly before the beginning of the present war.

After working through the summer of 1912 on his equipment, Lieut. Mauborgne was ready for the try-out of the first aerial communications set in the early fall. Lieut. Henry H. Arnold, Aviation Section, Signal Corps, now a four-star general and Commanding General, The Army Air Forces, flew one of the Army's 12 planes to Fort Riley, Kansas, for the experiments.

In this airplane, Lieut. Mauborgne, with Lieut. Arnold's assistance, installed a quenched-spark radio set and an antenna which they devised on the spot. The work was completed during the last week in October, 1912. A third officer was called upon to handle the first airplane radio set, while Lieut. Mauborgne handled the ground set. The first aerial radio operator was Lieut. Follett Bradley, a second lieutenant at Fort Riley. Today he is Major General Follett Bradley, on duty at Headquarters, as the Air Inspector.

The 1912 tests at Fort Riley had a two-fold purpose; first to send from an airplane in flight radio messages to a ground station, which had never been done anywhere in the world, and second, to adjust artillery fire from an airplane while the battery was firing at a target which the battery observer on the ground could not see.

Lieut. Bradley had been selected as operator of the airplane radio set because of some experience he had had in early wireless work. He had been transferred to the Army Signal Corps from the Navy, where he had been wireless officer aboard the battleship Michigan.

(Left) Observer of an Air Force plane checking with his pilot after completing sketch of particular area covered in mission.

Within a few days of their arrival everything was set, and on November 2, 1912 the experiment was made. With Lieut. Mauborgne manning the ground station, Lieut. Arnold took off from the flying field at Fort Riley with Lieut. Bradley beside him handling the wireless set. The experiment was highly successful. Lieut. Bradley's message from the airplane was clearly received by Lieut. Mauborgne at his ground station.

The second part of the test, adjustment of artillery fire from the airplane on targets which the battery commander could not see, also proved successful. This experiment also was conducted by the same team—Arnold, Bradley and Mauborgne. It marked another "first" in the world of aviation and of radio.

Two years later, in cooperation with Army flyers, Lieut. Mauborgne again introduced a new communications system to the world. In the autumn of 1914, for the first time in history, he conducted successful two-way radio communications between an airplane and a ground station by working with a complex receiver and transmitting set which he built and operated, and which he installed in a Burgess-Wright plane. The pilot was Lieut. Herbert A. Dargue, Aviation Section, Signal Corps. Lieut. Dargue attained the grade of major general in the Army Air Forces and was killed in a crash in California at the beginning of this war.

By 1913 the Army's aircraft radio set had a range of 30 miles and weighed about 75 pounds. Messages had been sent from altitudes of 1,500 feet and communications had been carried on without interruption between air and ground for periods of as much as one hour. There was no difficulty in receiving messages clearly in aircraft at altitudes up to 2,500 feet. The set then in use was a modification of the standard Signal Corps field set with one-eighth kilowatt generator output and a friction drive from the engine flywheel. The antenna was of hanging wire type contained on a reel.

The World War greatly stimulated the use of radio for aircraft, and rapid progress was made in the radio laboratories of the belligerents in the development of new radio apparatus, astonishingly efficient for its time. Radio direction finding, itself as old as radio, was being developed for use in connection with aircraft, and many problems peculiar to aeronautical direction finding were then discovered and solved.

It was in 1916 that the pilot of an Army Signal Corps airplane was able to *speak* by radio with the airport below, instead of sending his message in the Morse code. Thus radiotelephony, the future mainstay of aircraft radio communications, made its debut.

Remembering that in these days the military airplane was regarded almost wholly as an instrument of observation, it now became practicable for a commander to take a peek over the next hill and see what the enemy was up to and get a quick report and make his plans accordingly. Or, send a couple of planes over enemy territory equipped with cameras to take aerial shots of certain positions, send back a preliminary report by radio and return to develop the pictures. The artillery spotting angle was also simplified by being able to speak the corrections instead of sending them in code.

During 1917 when the United States became active in the World War, two types of aircraft radio were being used by the French and British armies—one having a power of between 20 and 40 watts and the other 150 watts. By the fall of 1917, 2-kilowatt installations were being made on large airplanes in England, not only for signalling, but to interfere with enemy stations.

The same principles were employed in these early air-

(Right) Navigator recording plane drift on his plotting board. In background another navigator taking a sun sight with aerial sextant.

Preparing for take-off on flight over enemy territory. Radio equipment being installed after routine checking.

craft radios as had been used first in the Marconi and Hertz experiments. There were no tuned oscillating circuits; simply a small induction coil with an independent vibrator, with the spark gap connected in parallel to an aerial and ground counter capacity.

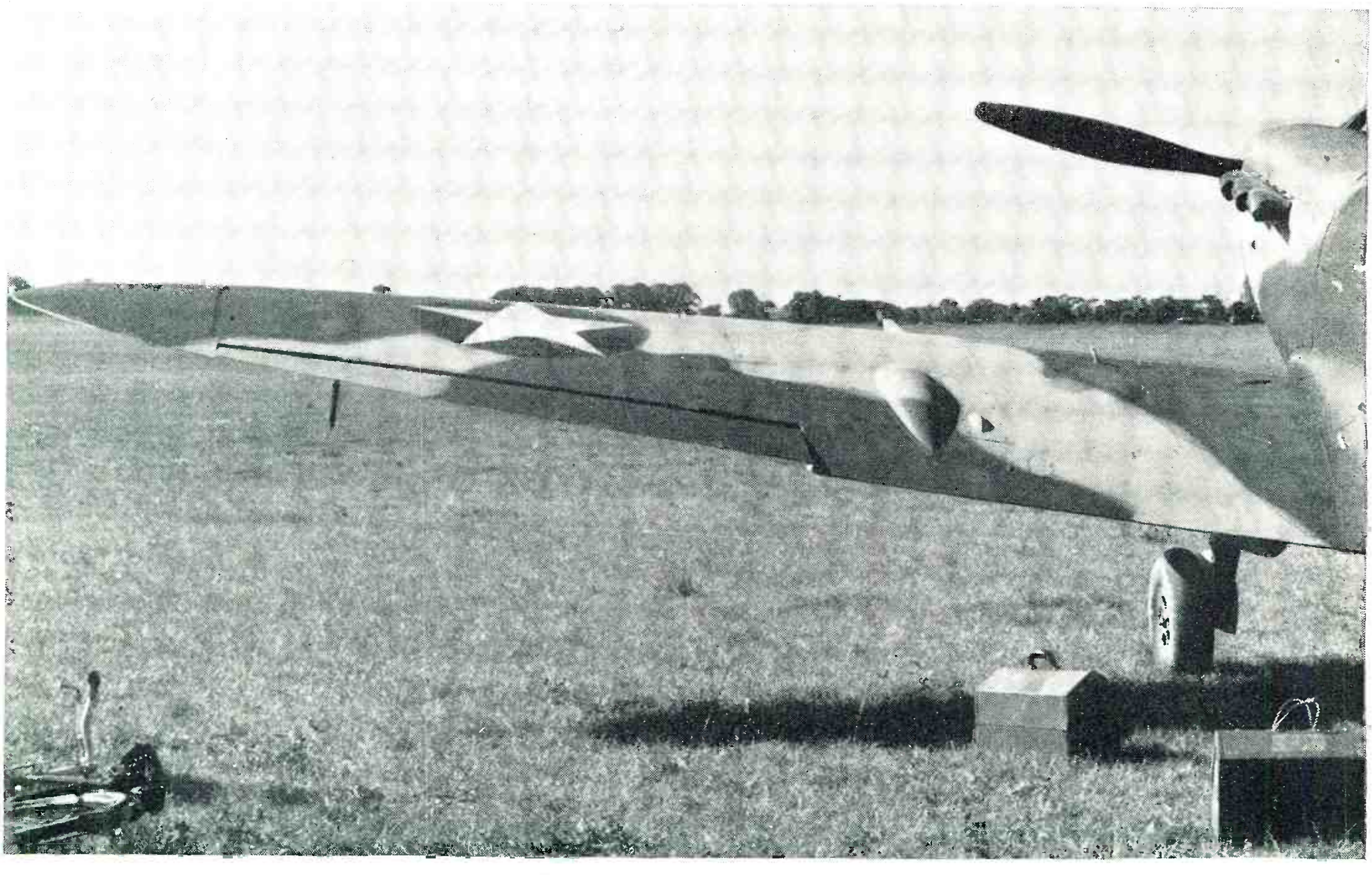
One of the sets most used by the Allies for aerial work had a capacity of 150 watts, the energy being obtained from an alternator driven by the airplane engine. The complete transmitter, including self-exciting generator, weighed only 37½ pounds, or less than half the weight of the smallest set made in the United States up to 1916. Communication was possible up to 50 miles. The operation of these outfits, however, required high voltages to charge the condenser. The set caused considerable interference and the high voltage constituted a very serious fire hazard.

Tube detectors began to come into general use, at first without amplification. Later amplifier tubes were incorporated in receiving sets. Radiophone sets, using tube-type transmitters and receivers, were used on certain types of Army and Navy aircraft as early as 1917. The Army was using both radiotelegraph and radiotelephone sets during the World War for reconnaissance purposes. During the summer of 1918 the Aviation Section of the Signal Corps developed a satisfactory two-way radio telephone set. It was put into immediate production and installed on American airplanes sent to the AEF in France during the closing months of war.

In 1918 to simplify command Army aviation activities were withdrawn from the Signal Corps and placed under a new combat branch, the Air Service. Demobilization after the war left the infant arm with only about 1,000 officers and 10,000 enlisted men, 6% of its World War strength. However, in March, 1919 an outline of radio activities for the Army Air Service was issued and listed the following items:

☆

Aircraft radio maintenance men removing communications equipment from a British Spitfire on a field somewhere in England.



transmitters, coils, meters and all the various parts that make up radio equipment; learn terms such as wave length, frequency, magnetism and its relationship to electricity.

In order to teach such subjects, unique classrooms have been born at Scott Field. Small groups of students form a semi-circle around equipment laid out on benches which line the room, and as instructors take up each point, familiarize themselves with the actual radio sets. They are helped by demonstrations on simple breadboard lay-out forms which are combinations of schematic diagrams and radio parts, set out on a board in relation to each other.

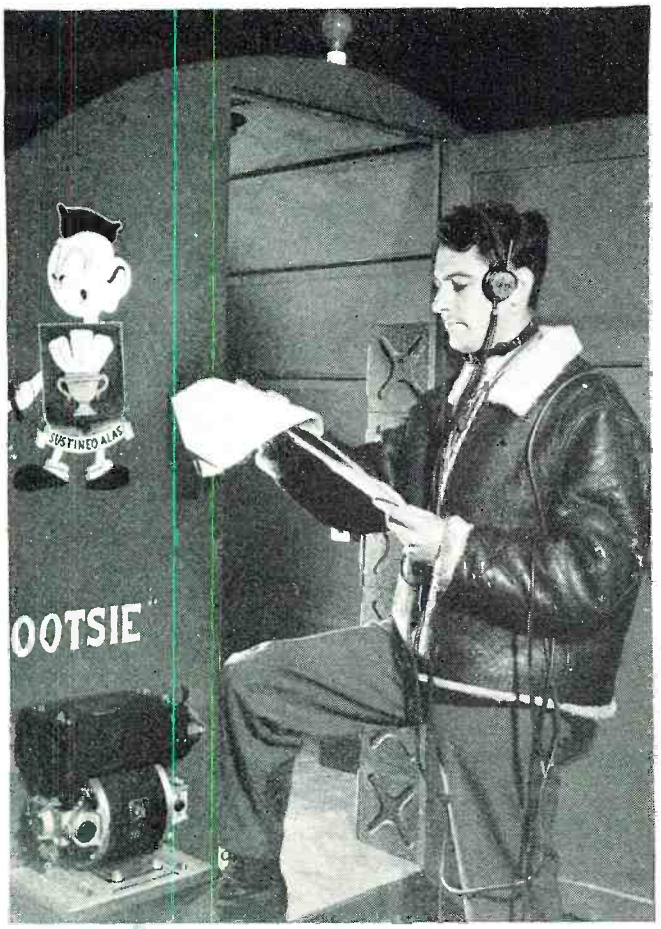
The instructors are of three kinds—there are enlisted men chosen for teaching jobs because they completed the regular course themselves with high grades. Augmenting them are men and women civilian instructors, graduates of special training schools. The Women instructors have been called WIRES—Women in Radio Electronics School.

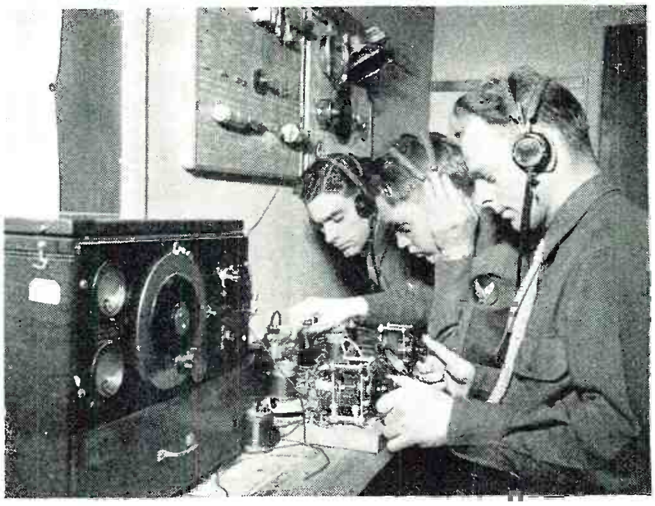
Laboratory experiments during the first weeks of the radio mechanics part of the course include application of measuring instruments and construction and analysis of basic circuits.

Following this, the soldier begins study of transmitter fundamentals and some of his subjects include: methods of generating radio frequency currents, use of quartz crystals in transmitters, uses of vacuum tubes for sending radio signals, methods of sending voice or music by radio, function of antennas, maintenance and operation of radio transmitting equipment, and ultra short-wave transmitters. Laboratory work now includes actual construction and operation of a small radio transmitter.

The receivers fundamentals course is of several weeks duration and the subjects include: principles of operation of radio receivers, various kinds of receiving antennas, methods of controlling volume, the superheterodyne receiver, automatic volume control, ultra short-wave receivers and several basic types of power supplies.

Operator wearing flying suit, throat mike, and headset.

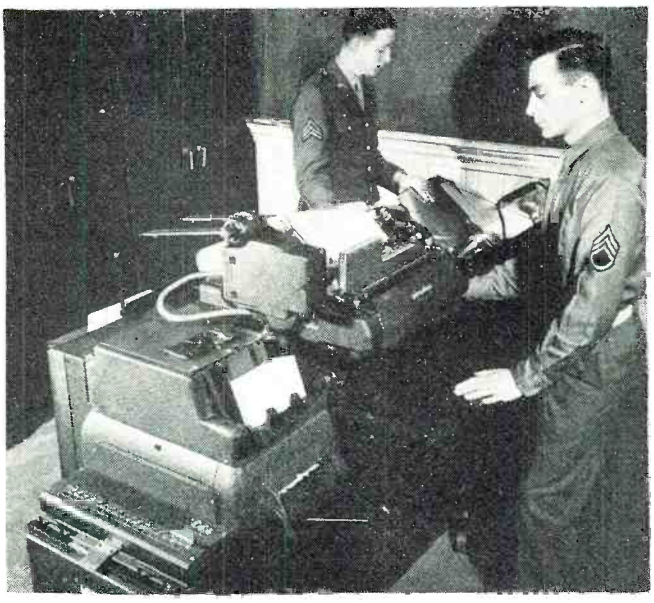


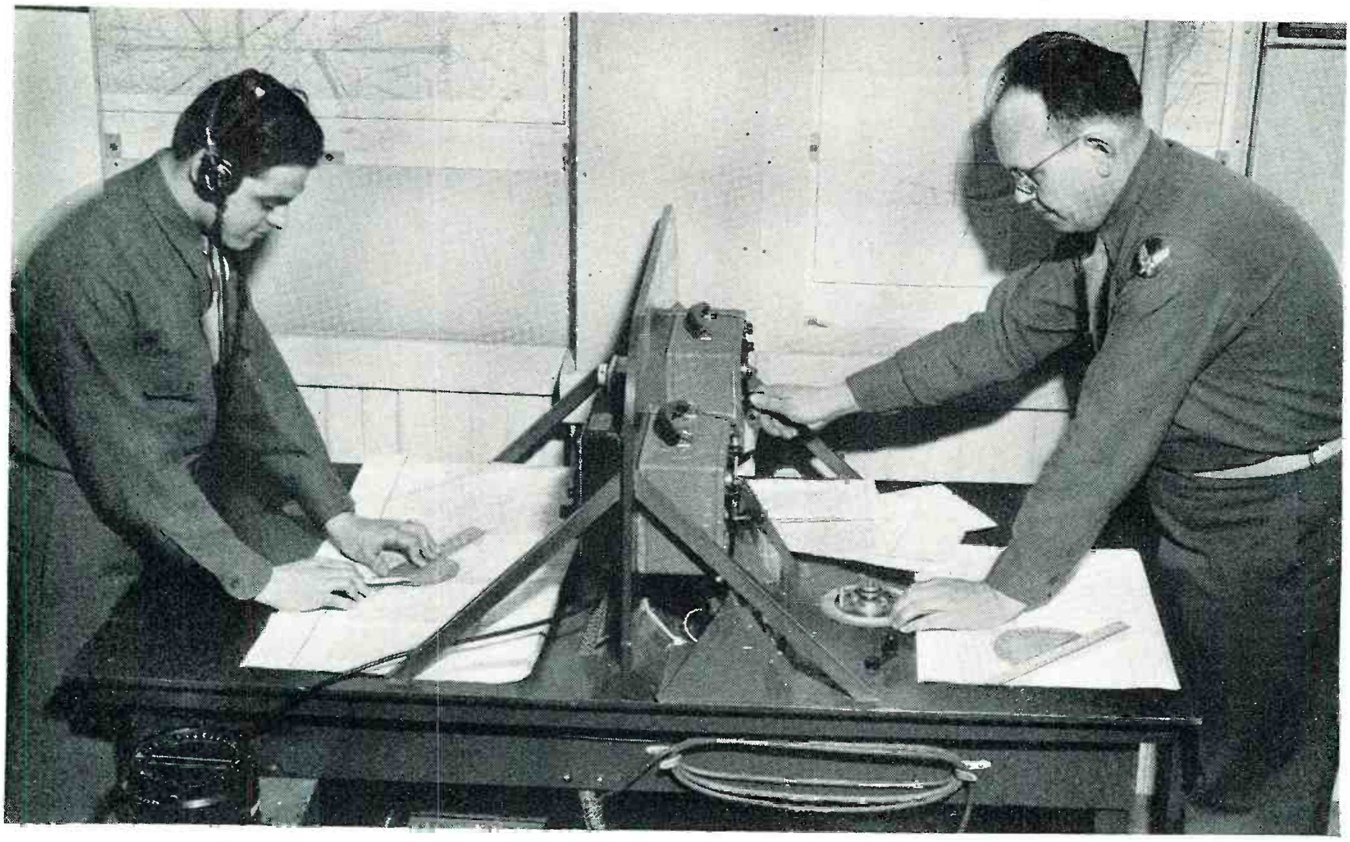


Part of Basic Receiver Laboratory where students build and operate breadboard-style receivers. Every part of the chassis is exposed for study.

Student brings tank tuning condenser to resonance with the large transmitter RF tank coil. Clips permit proper L/C ratio for best output.

Tabulating and Accounting machine and Transfer Posting machine complete tabulation of code speeds and scholastic records of all kinds.





"Shooting a Bearing" is an operational problem in which courses are plotted by radio students.

Above: Operating a Blinker light. A check is made at the end of each word. Below: Another group is shown in the process of exchanging messages for practice.

Once again in laboratory-classrooms with equipment laid out in order, students construct and wire five tube superheterodyne receivers.

In "Aircraft Radio" actual maintenance and operation of radio transmitters and receivers used on army aircraft are taken up. First, High Power and then Low Power sets are studied and finally the student ends up with service on the line.

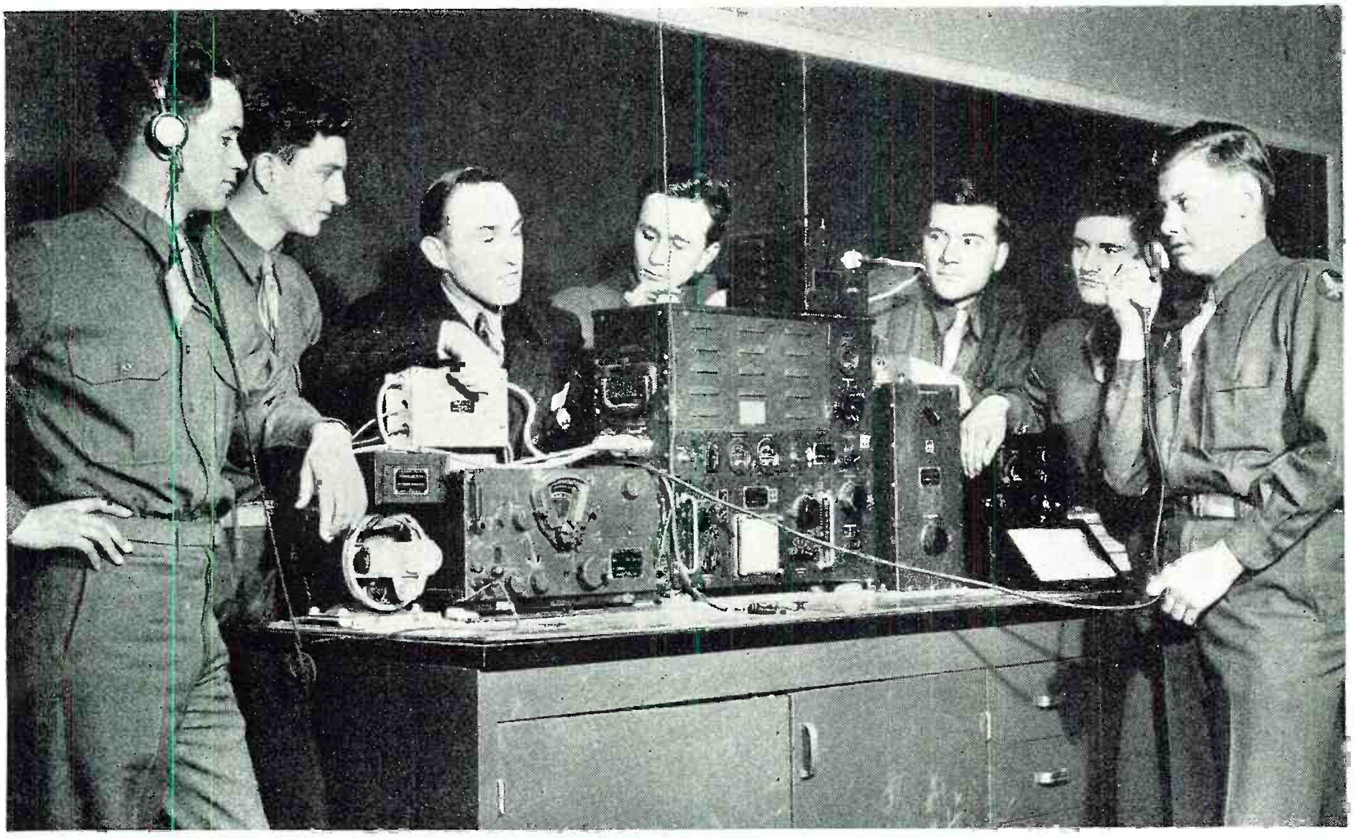
At the start of the Aircraft Radio branch classes, students go into the study of circuit analysis in a combination lecture room and laboratory. A high power liaison set is laid out in the simplest arrangement for study; power unit at the left, next the receiver, the transmitter, transmitter antenna tuning unit, and wave meter. A thorough analysis of circuit in relation to operation and maintenance is stressed.

In high power laboratories a liaison set is assembled in the exact relative position used in a bomber. Actual operation procedure such as plane-to-plane and ground-to-plane communication is studied, together with emergency maintenance such as replacement of tubes, correction of loose connections and other necessary repairs. The High Power Liaison set is used for voice and code communications. In code its range is practically unlimited.

Low Power Command Sets—used for just what the name suggests are the next problem. Over a Command Set orders are given by Squadron leaders from plane-to-plane and plane-to-tower for short distances. In the study of the intricate subject, the lower power phone unit is spread out over a bench in somewhat similar sequence to its mounting on a plane.

One of the most fascinating subjects taken up during this phase of study is the Radio Compass. In a lecture room outfitted with complete installation set-ups of the compass, men become familiar with its operation, maintenance and the exact use of each separate part.

An example of the new methods of instruction is the unit known as a dummy station signal generator. Through the medium of three small "radiator" loops in the unit, signals are given out in the same manner as from three "broadcasting stations." The large radio compass loop as



Circuit Analysis in combination lecture room and laboratory. Subject: High-power liaison set.

used in a plane is in the center of the unit and is attached to a dial calibrated in degrees. The compass loop may be turned to register the point at which each "station" is loudest and a radio location fix established from the three separate readings. This is called "students navigation" table.

Operational problems at which the instructor sets up a course on the signal generator and the student plots it on a map after shooting a series of bearing take up much of the time. The method has been developed to approximate as near as possible actual flight procedure.

All of this study in radio mechanics just outlined, remember, occupies only half of each working day. The other half is spent in actual radio operation and the learning of the International Morse Code.

At the very beginning of the course a code aptitude test is given each new student. This involves sending of a group of signals to each man who marks on a sheet of paper before him what he believes to be the correct answer. His final score will determine his ability to differentiate between a dot and dash or the audio-coordination between mind and ear.

Instruction in code consists of learning the International Morse code used in operation and it begins with the characters of the alphabet and the numerals. After this is accomplished a student attempts to acquire the required speeds in sending and receiving signals.

One of the first things he must do, then, is to learn to print letters correctly because in the field his receiving will be done largely by hand. So the code is first taught phonetically and the soldier is not allowed to see a copy of it until he has learned it by ear.

Scott Field men begin to learn their code in classrooms, sitting at desks equipped with a hand-key and earphones. The signals for some classrooms come from a group of automatic code-sending machines in a central code control room—and the "dits and dahs" are fed through hundreds of channels to the flight nets. An operator checks constantly for tone and quality of signals. Code speeds vary from four words per minute to more than 35 WPM.

(*Continued on page* 228)

This ingenious device generates signals which are similar to those of three broadcast stations. Large loop in center is radio loop proper as used in planes.

Instructor explains voltage control and regulator unit on a P-40 pursuit ship to students.

RADIO MECHANICS

by Col. FAY O. DICE

THE thousands of aircraft that roll from America's assembly lines, though they are the finest in the world, *would be useless without aircraft radio.*

At Truax Field, located near Madison, Wisconsin, radio operators and mechanics are trained to *equal* the quality of the aircraft they service.

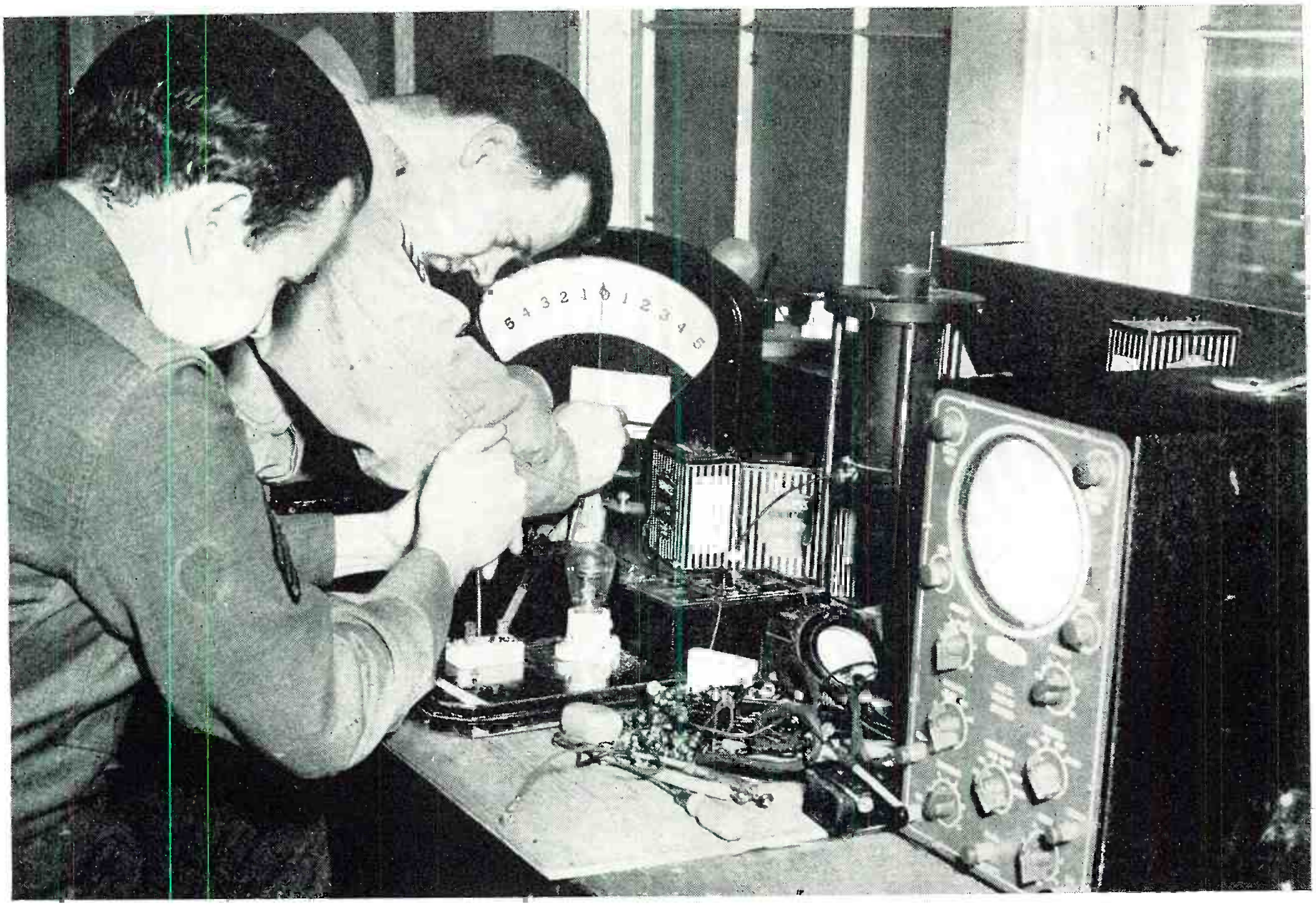
Oddly, "amateur radio" plays an important part in the training program at this school of the *Army Air Forces Technical Training Command.* The little boy who used to irk his mother by strewing radio parts all over his room now teaches all he learned to students at the field. The amateur learned radio the hard way—by doing. Now he teaches in much the same way, for one of the foremost principles used here is to make the student handle actual equipment as much as possible.

The radio amateur has an extensive background, and can instruct in almost any of the *Truax* courses. As an amateur he learned to improvise; to create needed parts that had worn out or that were unobtainable. He made an art of "makeshift." The radio mechanic on combat duty must know how to improvise, when required replacements are not available. He must be able to effect installations or repairs without schematic diagrams and with whatever

Born at Kewanee, Ill. Attended Lombard College, majoring in athletics, left in his sophomore year (1917) to become a civilian flying instructor at Scott Field, Ill. Was a student in an Army ground school at University of Illinois when World War 1 ended. Left the reserve in 1927 to be commissioned a Second Lieutenant; First Lieutenant 1933; Captain 1938; Major 1941 and Lieut. Col. and Col. in 1942. Was assistant commandant and post executive at Scott Field before going to Madison. Has 6,000 hours of flying to his credit. Is at present Director of Training, AAFTTC, Truax Field, Madison, Wis.

tools may be at hand. Along the road whereby his knowledge has been developed, common sense has been his chief tool, and that, too, he must instill into the student.

The radio mechanics' course is one which took approximately two years to teach on pre-war schedules. Now, the course is taught in about a sixth of that time. This means that instructors must be about six times as efficient, and that all unnecessary instruction be eliminated from the curriculum.



Radio instructors observe results of experiments with sensitive meters and oscilloscope.

Breadboard-style transmitter undergoes a series of tests while instructor gives helpful suggestions to students.

Training radio mechanics for the Air Forces is executed at the AAFTTC post (Camp Truax) located near Madison, Wisconsin.

The new course which fits men for the complexities they will encounter at the secret advanced schools starts innocently with a two weeks' review of high school mathematics, stressing problems which involve electrical circuits. As an example of the high degree of condensation which is necessary in courses which must be completed in a very brief period, the following paragraphs outline the material covered in the first two days of instruction.

The first day a mathematics examination is given to determine "blanks" in the student's background so that necessary extra instruction may be given. *Matter* is explained, in terms of definition and composition (molecular, atomic, electronic) with discussion of positive and negative charges, and their production. Rules are given concerning charges, the concept of electrical fields (as "di-electric"), with their magnitudes and directions. Potential differentials come next, followed by instruction in circuits and current flow, with the corallary, resistance. The varieties of conductors are discussed, and measurement of resistance is taught. This is just the morning's work. In the afternoon the various types of resistors are indicated, and their construction in terms of carbon, ceramic, and wire-wound is explained. The effect of temperatures on resistors is noted, and iden-

Operator entering a completely radio equipped mock-up of a B-26 bomber. Transmitter tuning units are in foreground.

tification colors are discussed. Then the classes go to laboratories, and spend hours determining resistor values.

On the second day much time is given to schematic diagramming and the identification of symbols, with a period in which to breed familiarity with switches, jacks, plugs, fuses, meters and nomenclature (such as the prefixes, Micro-, Milli-, Kilo-, Meg-, etc.), and their practical uses. Ohm's law is taught, and in the afternoon, in laboratory session, that law is used in experiments in the determination of resistance, voltage, amperage, and so forth.

Then the course gathers pace. Teachers begin to talk about coils, condensers and resistors. Magically these very articles appear on "breadboards" before each student. When the instructor says a resistor opposes the flow of electric current, the student has a mounted resistor in front of him, and a meter to measure the current. Training at the *Technical Training Command* schools is now practical.

Instructors are rewarded for dreaming up new breadboards to illustrate the finer points by simplifying each operation.

Training goes forward rapidly. The day comes when each student is given a large box of parts. Working three hours a day, he is expected to put together a receiver in six days. Later he puts together a transmitter in much the same way. Lieut. Col. S. W. Hulse, Jr., a young West Pointer is director of the mechanics division.

Using no texts, because the army has found that practice not theory is what counts, students learn to analyze the behavior of every transmitter or receiver in current use anywhere. They learn the principles of direct and alternating current, oscillators, amplifiers, transmitters and receiver circuits, and special circuits employing distorted wave forms.

Truax Field's outstanding accomplishment in the war effort is the rapidity and efficiency with which students are turned out as expert radio mechanics.

Maintaining a fast schedule for twenty-four hours a day and utilizing well managed buildings to fullest extent, students are taught the intricacies of aircraft radio and also how to "trouble shoot." Taught by specialists, expert in each phase, raw students rapidly absorb fundamentals and then the technical aspects of radio. But the results speak for themselves, in the large number of good radio mechanics now serving their country "out on the line."

The army's radio mechanics are just what the name implies. They *maintain* and *repair* radio sets. If a receiver gets a shell hit while on a bombing mission the mechanic must know how to redesign and rebuild it without delay. Maybe he'll take out a stage of amplification. Maybe he'll do something else. But the odds are good that he'll soon have that set operating.

Students are given ample time to experiment with and operate all the latest and best aircraft radio equipment that Uncle Sam has to offer.

Under constant supervision by especially trained laboratory men, the student is allowed to place all of the equipment in operation and see for himself how it works and how to remove "troubles" that have been purposely put in for him to remove or correct. Thus he puts into actual practice all the theory that he has learned in the classroom.

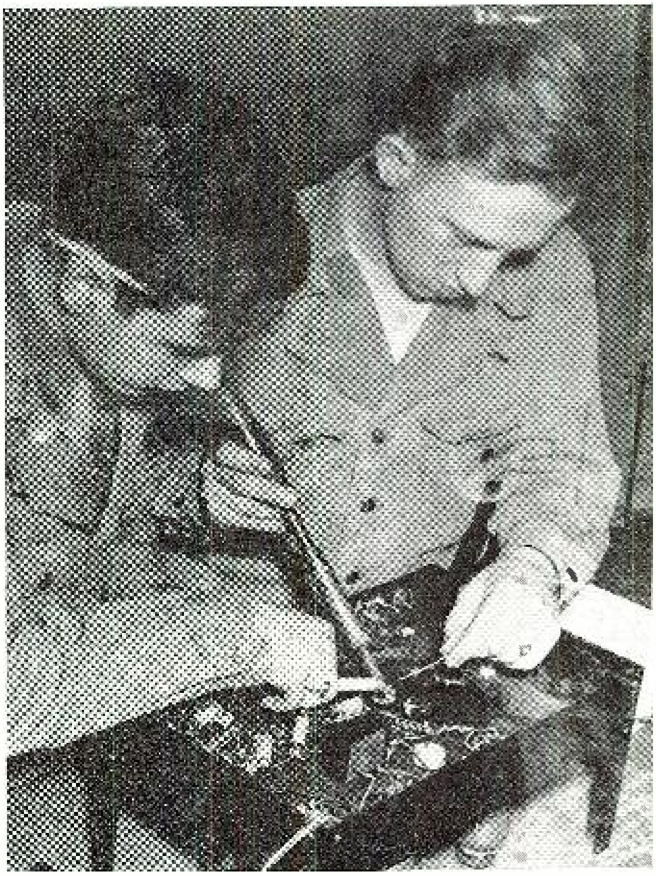
Practical application of theory is the prime function of a good radio mechanic. A man with a knowledge of radio theory and no practical experience with equipment is of no use to our Air Force in the combat field. This fact recognized, Truax Field has instituted a phase of training known as *Aircraft Radio Equipment,* or more familiarly, "ARE."

After a ten week study of radio fundamentals, students are advanced to the aircraft radio equipment phase. In the time spent the student acquires a thorough knowledge of operation, circuits, and maintenance of the five most commonly-used radio sets.

Class room lectures and demonstrations are paralleled by an equal amount of time in the laboratory. While there, students follow a carefully planned procedure in circuit tracing and tuning of equipment under supervision of trained lab instructors.

When a raw student is received at *Truax,* he is given a code aptitude test which determines his nervous reactions

Student constructing simplified radio circuit.



Radio mechanics learning soldering operation.

to sound. Some men—even Ph. D.'s—can never learn code. Such unpromising students are eliminated before they begin. Others with little educational background show up well.

From the moment the student enters aircraft radio, there is radio equipment of some type always before him. Through the use of written examinations and individual "checks" on the operation of equipment in the laboratory, the progress of the student is closely followed. In this manner, no student is sent on to the next phase without a complete understanding of radio equipment covered in this course.

Since the first class entered ARE last fall, the scope of activity has grown rapidly in size, subject matter and equipment until today its officers and men can boast of one of the most up-to-date study courses in the *Army Air Forces Technical Training Command.* In a short period of intensive work, future radio technicians are taught to put their previously acquired knowledge of theory into practice.

Let us look inside one of the classrooms where men are studying the medium-power liaison transmitter which is used on almost every one of our large bombers to keep a constant radio contact with remote bases while in flight. The instructor's lecture begins with a brief discussion of the range and the power requirements, the practical uses of the set, the physical location in the airplane, and a visual inspection of the transmitter which is mounted on the bench in front of the room. The position and purpose of each control is explained in detail, using, in conjunction with the set itself, the large schematic diagrams which cover the walls of the room. The transmitter is dismantled before the class and each mechanical part is explained fully to the students. Pieces of the set are passed around the room so the student can make sure he knows exactly where to look for a damaged or burned out part, and then the whole unit is reassembled.

A different atmosphere exists in aircraft radio equipment classes than in any others of the radio mechanics division. The difference is simply that here closer cooperation exists between students and instructors. Students have actual contact with radio equipment, which is natural focus of all preceding instruction. Classes are held down to a minimum number of students.

This work is divided into two phases, known as *aircraft radio equipment* and *radio maintenance.* The former phase introduces the student to radio equipment while maintenance is the end to which all theory leads.

Further instruction is given in the use of and adjustments to radio sets, including the marker beacon which is so important for navigational flying. Wiring practice on airplane interphone systems and becoming familiar with antenna ties develop skill in the learner's hands. Inspections are stressed, since valuable lives and equipment may depend on proper function of the equipment.

A training film and two whole days spent in "mock-ups" attest to the importance of this angle. Three days in the laboratory using measuring and testing equipment train the mind and hand to work more efficiently when he arrives "on the line."

RO students must learn the handling of all aircraft radio equipment, including the compass. The radio compass is the reason Berlin goes off the air when bombers approach. Allied pilots, flying on the radio beam, unerringly find their way to the target. Friendly beams are a necessity in blind flying.

Finally, the important subjects of circuit tracing and trouble shooting complete the training of our future radio mechanic. With this knowledge he is able to intelligently find and repair whatever may be wrong with a malfunctioning receiver or transmitter.

To aid in demonstrations, high-ranking students of every class are selected by the instructor to help the other members of the group who seem to have difficulty in the grasping of the subject. Not only does this system afford more individual instruction and to develop leadership, but it also creates a spirit of competition in the class (a competitive attitude in the classroom is one of the greatest teaching aids). It encourages confidence in the students.
(*Continued on page* 289)

Looking into the starboard side of mock-up bomber. Instructor gives tuning instructions to student.

RADIO OPERATORS FOR

The Army Air Forces Technical Training Command must furnish an average of 20 specially-trained men for each bomber.

by Major HAROLD A. EVANS

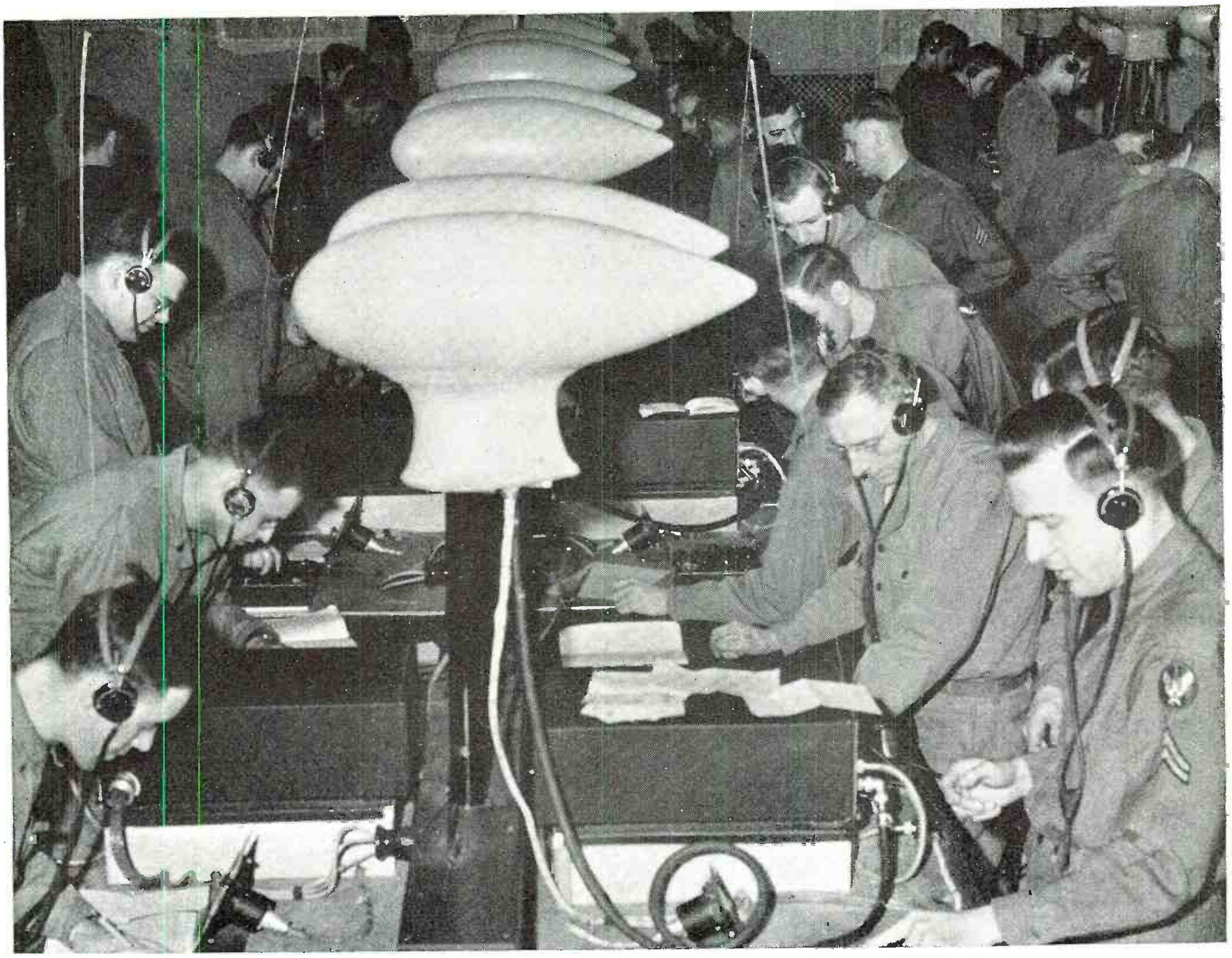
Born in 1910. At 18, was youngest commercial pilot in U. S. Studied electrical engineering at Carnegie Tech. Enlisted in 176th Field Artillery (1930); commissioned 2nd Lieut. and appointed Comm. Officer, 2nd Battal. Hq. Battery (1931). Became instructor at Keystone Radio Inst.; Transmission Engineer for radio stations. Entered active service as Captain (1941), Fort Meade and Scott Field. Commissioned Major in 1942, transferred to Sioux Falls where he organized army radio school. Present Director, Department of Communications, AAFTTC, Chicago, Ill.

TEACHING 8000 men to become radio operators in a modern heavy bombers in the very short time of 18 weeks is the almost impossible task now successfully achieved by the personnel of the Army Air Forces Technical Training Command in Chicago.

In order to accomplish such an undertaking in the limited time allowed, an entirely new system of teaching radio had to be devised by the author and his assistant Lt. Wayne Jones. Before delving into the technicalities of how this system was developed, we shall first acquaint you with the program under which the school operates.

The *Army Air Forces* have nine commands under their jurisdiction all under the command of Gen. H. H. Arnold. These commands consist of the Technical Training Command, Flying Training Command, Proving Ground Command, Materiel Command, Air Service Command, Air Transport Command, Troop Carrier Command, First Concentration Command and the Flight Control Command.

The Technical Training Command is by far the largest. This is explained by the fact that it takes an average of 20 specially trained men for every airplane. Its headquarters are at Knollwood Field, N. C., under the command of Maj. Gen. Walter R. Weaver. The activities of the Tech-



A group of radio operators learning how to use Radio Direction Finders in AAFTTC laboratory.

... JR BOMBERS ★ ★ ★ ★ ★

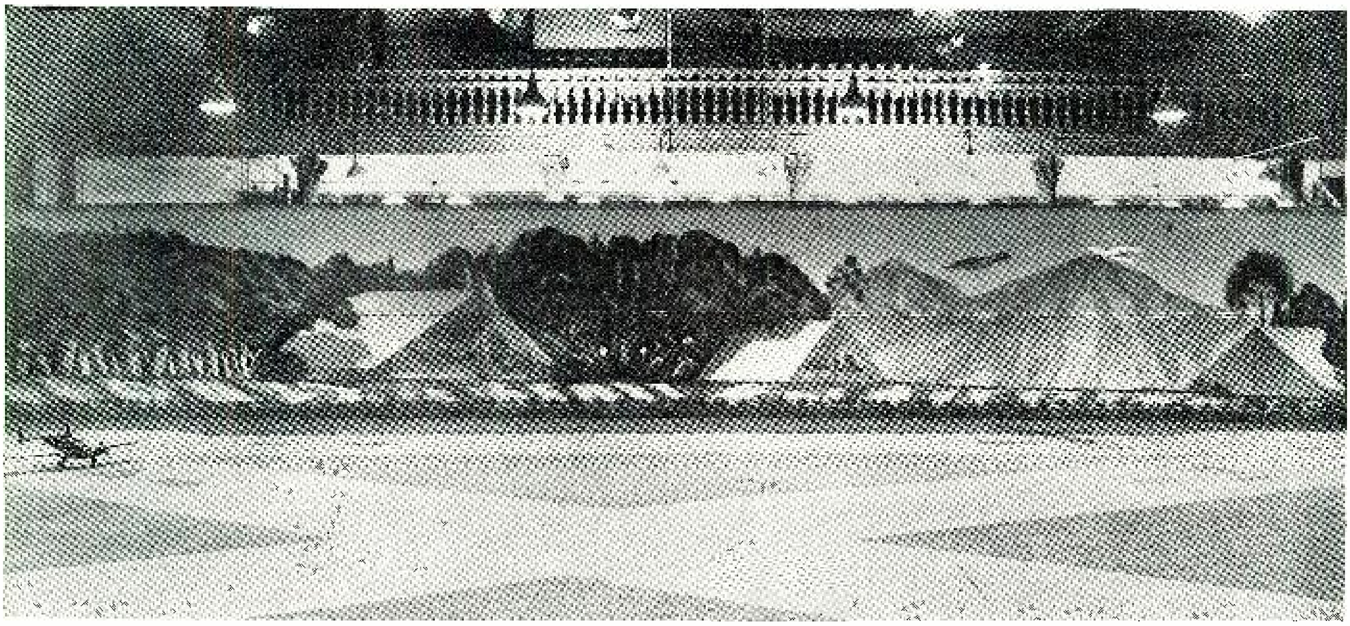
Enlisted men instruct others in this unique bomber mock-up.

nical Training Command include basic instruction of aircraft mechanics, machinists, armorers, metal workers, welders, link trainer instructors, parachute riggers, photographers, radio operators and mechanics, teletype operators, and weather observers. It also includes advanced instruction in bombsight maintenance, power plants, electricity, instruments, propellers, weather forecasting, power turret and gun sight maintenance, radio and related subjects.

The Technical Training Command, Chicago Schools, is under the command of Brig. Gen. Albert L. Sneed and consists of five components and training detachments. This command is in turn a component of the 2nd district of the Technical Training Command whose headquarters are in St. Louis, Mo., under the command of Maj. Gen. Fred L. Martin.

The largest installation of Chicago schools is the Air Forces Technical School which consists of Unit No. 1 (formerly the Stevens Hotel), Unit No. 2 (formerly the Congress Hotel), the Coliseum, the Eighth St. Theater, the Wetten Building, and the Electric Garage. This is one of the five schools in the country where radio is taught.

The Air Forces Technical school was inaugurated in



A model airport, in miniature, enables students to study radio under approximate tactical conditions.

Sept. 1942. In order to train such a large group of men, 1250 instructors were needed. Both men and women alike were appointed under civil service to one of several classifications according to their knowledge and experience in radio. The appointees not so well qualified were sent to St. Louis where they received a course in radio instruction. After completing this course they were sent back to the Chicago school to begin teaching.

After the school began to function, it was decided that a radically new system of teaching radio must be utilized if the students were to become proficient radio men in a comparatively short time. The lecture periods must be shortened considerably and they must be interspersed with demonstrations of the lecture.

This is necessary for two important reasons. The first being that since the students in most cases are very little acquainted with the subject of radio and electricity, the lecture would tend to be uninteresting unless it is demonstrated. The second and most important reason is that with the demonstration the student can see what is going on in an electrical or radio circuit instead of just merely being told what happens. In other words if the subject of Ohm's Law is being explained in a lecture, the student is forced to visualize in his mind the fact that the voltage across a given resistor is a product of the current flowing through it in amperes and the ohmic value of the resistance itself. This is immediately cleared up if he is given the actual resistor with a source of voltage and a voltmeter and ammeter. In this manner the student makes up Ohm's Law himself instead of being told what the functions involved consist of.

This same thing applied to radio circuits. If for instance a lecture is given on the subject of resonance in a conventional tank circuit with which he must become acquainted, the instructor can explain the formula of resonant frequency with the variable factors consisting of inductance and capacitance, even to the extent of proving them mathematically. This may take considerable time. However, if the lecture is accompanied by a demonstration, using a variable radio frequency oscillator coupled to a conventional tank circuit with some means of indicating resonance, and the student himself is allowed to increase the oscillator frequency and then discover that he must either decrease the inductance or capacity of the tank to bring back resonance, he can at once grasp the meaning of the formula.

This demonstration method of teaching is now being used exclusively with the result that the students are showing a zealous interest in their studies, much to their own benefit and to the satisfaction of their instructors.

Parts Problem Solved

In order to obtain the various component parts needed for this demonstration program, it was necessary to obtain every conceivable type of component used in radio circuits today. A single type of condenser, resistor, or transformer would not suffice because the student must be taught to recognize a component part no matter what size or shape it is in. When speaking of a condenser he must learn to distinguish between a mica condenser, a padding condenser, a variable air condenser, a tubular condenser and a filter condenser. He must also become acquainted with the many different types of each one of these respective condensers. Here again the little symbol of two parallel lines drawn on a blackboard signifying a condenser can mean one of dozens of different types.

The problem of obtaining these components was solved by asking the people of Chicago to donate their old radio receiving sets for this purpose. This drive resulted in thousands of old sets being brought to the school for dismantling. After considerable work the parts were sorted and mounted on hundreds of demonstrating boards. As many as ten different types of bypass condensers were mounted on a single board with their individual connections brought out to lugs. This same method was applied to resistors, transformers and other components. The student quickly learned to recognize these components and to measure their values with the proper instruments. In this manner they also learned to distinguish color codes by reading them directly from the components.

Type of Course

The complete radio course taught in the Air Force Technical schools consists of 18 weeks of intensified training in which half of the day is given to radio mechanics and the other half to radio operating. Each subject is taught 3½ hours making a total of 7 hours of instruction per day.

The first ten weeks of this course is called the basic instruction and the remaining 8 weeks the advanced course. The first ten weeks of radio mechanics is broken up into four parts including the following: 2 weeks of electrical fundamentals; 2 weeks of radio fundamentals; 3 weeks of transmitter operation and construction; and 3 weeks of receiver operation and construction.

The first ten weeks of operating consists of simple code instruction. After this basic course is completed, the last 8 weeks are devoted entirely to operation and maintenance of the signal equipment. The last 8 weeks of radio mechanics are broken up into the following components: 2 weeks of instruction and operation of the high powered liaison equipment; 2 weeks are spent with the multi-unit command set; 1 week with the ultra high frequency command set; 1 week with the radio compass equipment and the last 2 weeks a review of the operation, testing and repairing of all aircraft equipment. The last 8 weeks of the radio operating course consist of network practice, advanced code work and actual operating experience with aircraft equipment in its native surroundings.

The course is well balanced and the graduating student is not only a proficient radio operator for this particular type of work, but he is also a fairly good radio serviceman.

Details of Instruction

The manner in which the course is taught to the students can best be explained by following it from the beginning to end in the same manner a typical student would do during his entire term.

As mentioned previously, he would begin his basic ten week term with 3½ hours per day of electrical fundamentals and 3½ hours per day of simple code instruction for the first 2 weeks.

Here the student is introduced to the laws of electricity by explanation and demonstration. He is given the various component parts and the necessary meters and he works out his own computations thereby obtaining the full practical value of each fundamental law. As he is told the purpose of resistors and condensers, he is given a demonstration board with these parts mounted and told to distinguish the different types and measure their values. As he advances, he is given boards with the parts covered so that he must determine for himself, by the use of proper instruments, to what lugs these same parts are connected and their respective values. Since an important part of a radio operator's work in an aircraft will be trouble shooting of equipment that has become damaged in combat, he is thoroughly trained in tracing cables. A considerable amount of cabling is necessary in a modern aircraft and the operator must be familiar with cable tracing should some mishap occur while in flight. He is taught to use substitute equipment in case his continuity meter is damaged such as flashlight batteries with a bulb in series with a pair of test leads or even a flashlight battery and a pair of headphones in extreme emergencies. Demonstration boards with lengths of cable mounted are given to the students and they must trace the terminals of each end for continuity. Transformers, chokes and condensers are also mounted and the students must again test for opens, shorts and grounds.

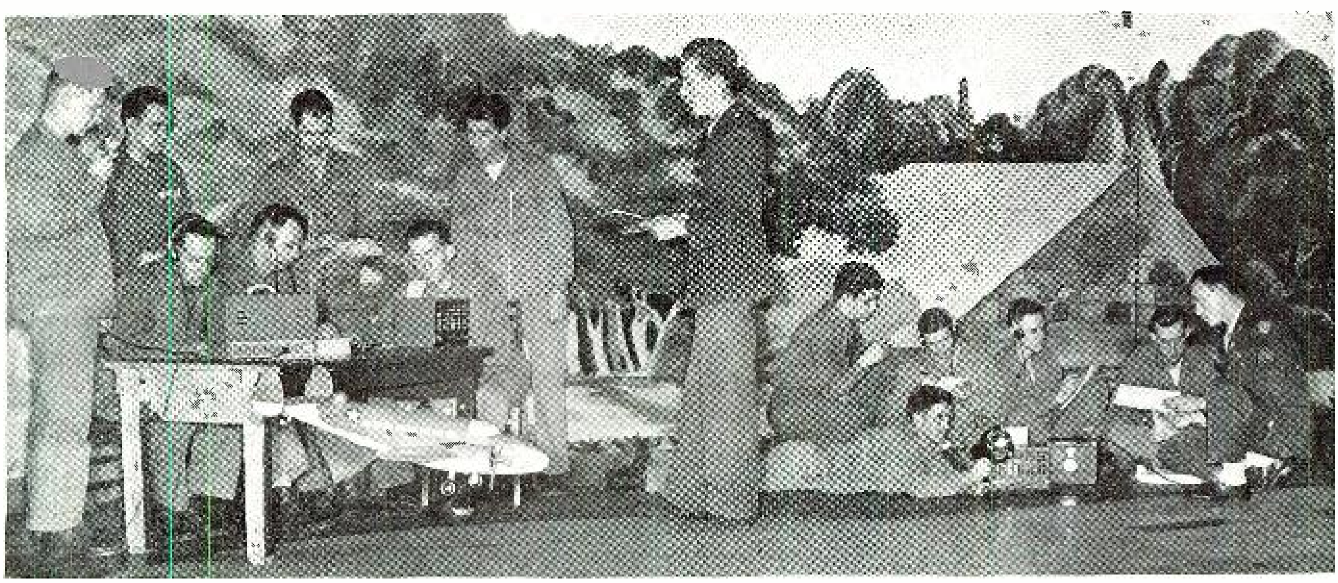
After the two weeks of fundamentals are mastered, the next two weeks consist of the same type of training in radio circuits. Here larger demonstration boards are used with complete radio and power supply circuits mounted with the terminals of each component part brought out to lugs. The students wire up these boards according to instructions and they measure the results of their wiring with test instruments. For instance they are given an audio amplifier to wire according to a wiring diagram. They hear and see the results with meters and a speaker. After a large demonstration board is wired, the instructor connects an oscilloscope to the circuit and demonstrates what happens to the wave patterns when various circuit components are changed. In the case of a power supply, the students actually see the difference between half wave and full wave rectification as well as the action of the filter condensers and chokes when they are temporarily removed. One type of demonstration board consists of a conventional radio frequency oscillator and amplifier. The tank inductances are brought out to lugs and the student must determine the proper taps for resonance. He can also see the advantages and disadvantages of link or direct coupling between the two stages.

The students are now familiar with radio and electrical circuits and the next three weeks are devoted to the construction of transmitters. Here they are given a kit of parts and a chassis together with the necessary tools, soldering iron, wiring diagrams and tube manual. Each student constructs his own transmitter at his own workbench. There is one instructor to approximately 6 students and this instructor remains with the same group of students for the entire six weeks of transmitter and receiver construction. This enables the instructor to become well acquainted with the respective student and to learn his weak points. In this manner he or she can also give the student all the private tutoring he needs. The transmitter that the student constructs is the same type of circuit as in the high powered liaison transmitter used in all the larger aircraft. Although the tubes and components are smaller, the basic circuit is the same.

The next three weeks are spent on constructing conventional receivers and making measurements of their performance. It is understood of course that the 10 weeks just previously described constitutes the radio mechanics course. The remaining half of each day was spent in learning the code. This code work merely constitutes copying tape recordings over wire circuits on a conventional code practice table. The student here is trained in the usual manner of picking out the characters by their sound and not by dots or dashes. The method of aural training in code work as used by the AAFTTC has shown very good results. At the beginning of the course the students are given an aptitude test to determine their aural coordination. The final results of this test determine the students' ability to differentiate between the sounds of dots and dashes transmitted from a code tape machine.

(*Continued on page* 198)

Group of students assembled to study simulated radio operations. The model bomber travels on wire.



Large transport glider carrying troops (equipped with high altitude flying togs) to one of our many fronts.

The Air Transport Command

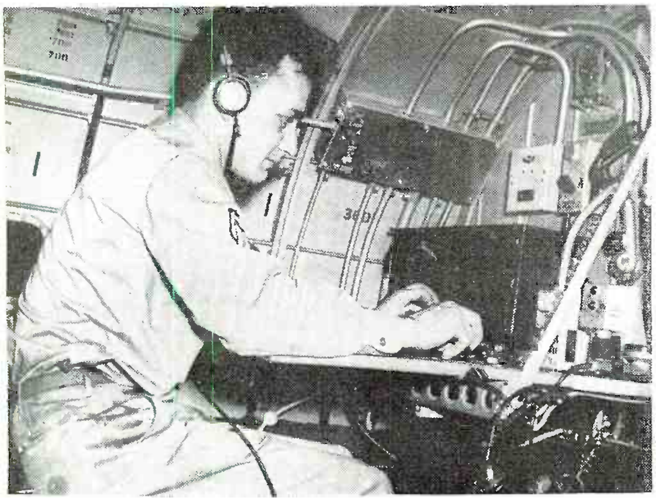
WITH a transportation and ferrying job to be done to the far corners of the world by the Air Transport Command, it can be imagined what a tremendous task faced the Army Air Forces in the matter of establishing communications for this vast enterprise. As the telegraph and telephone made railroad development possible, so has radio paralleled the development of air transportation. It was one thing, however, to develop radio communications and airway aids to navigation within our own United States under peacetime conditions, but a gargantuan task confronted the Air Transport Command and the associated Army Air Forces Communications System when demands became world-wide, when the order of the day was "haste," with effort complicated by a conflict global in its scope, and when supply lines were thousands of miles instead of hundreds. Great new demands were suddenly made on communications facilities and upon people experienced not only in the art of radio but also its application to aviation. Communications facilities and aids to air navigation were almost as necessary to the operation of A.T.C. as was the gasoline necessary to fly the ships that would use these facilities.

If the establishment of airports in heretofore "storied" places has written a story of pioneering and enterprise, so have those people who have been responsible for the building up of the associated communications system. From the most inaccessible jungle to windswept Arctic wastes, from desolate islands to the far reaches of the Sahara, there can be heard on the air today the results of the concerted effort to establish communications for the Air Transport Command. Some points where vigilant watch is now being maintained as a matter of course, special expeditions were required to be sent.

At some places no facilities of any description existed. Essentials for the barest of living had to be brought in by plane or sledge. Then came the construction, the erection of antennas, and the problem of establishing power supplies. Some places were only accessible for short periods during certain seasons. Communications personnel, radio equipment, and living facilities were frequently flown in.

Pilot checking with control tower before taking off.

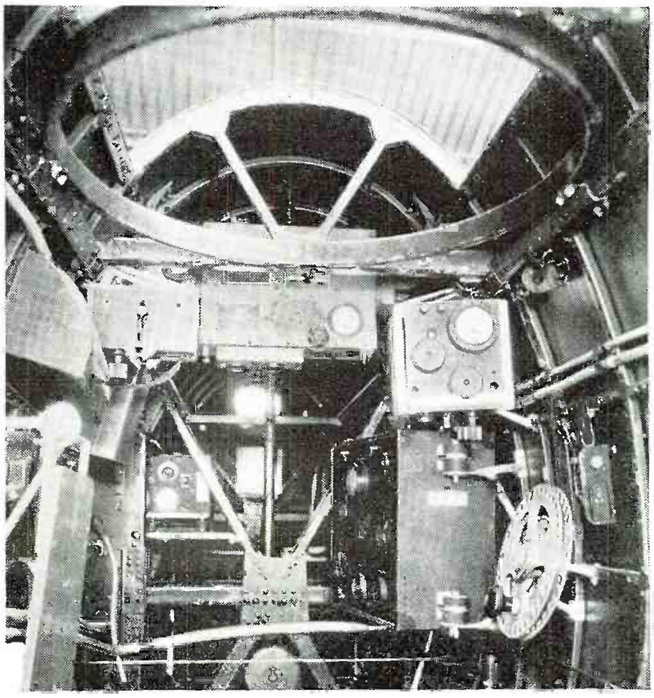
Navigator of one of our many large transport planes.



Radio operator at his post receiving flight orders.

Navigation Cadet using radio to check plane's location.

Radio equipment as installed in larger transport planes.



Radio helps the Air Transport Command deliver men and supplies to our world-wide battle fronts.

Here the size and weight of the apparatus called for careful consideration. Oftentimes a breakdown of the physical size of the radio units themselves was necessary. It is quite a different story when everything pertaining to a station has to be built up from scratch, and no small problem when the nearest hardware store and 110 volt line are some thousands of miles away.

With the advent of war many new requirements are quite naturally made upon the task of developing and operating any communications set-up. Take the matter of personnel, for example. Not only must they know the job of radio, but they must be well-trained soldiers as well. They must be able to handle themselves in the event they find themselves under fire, to live as soldiers and observe military discipline and rule. They must be trained in many cases in the art of not only living but working under adverse climatic conditions. All this takes time and increases the task of preparation. There are, in addition, new jobs that enter the picture. Take the matter of se-

(*Continued on page* 286)

For efficient operation—all members of bomber crew are equipped with interphone communications.

☆

INTERPHONES GO TO WAR

Proper coordination of all crew members is made possible by continuous communications over plane intercom. Enemy cannot eavesdrop on messages.

☆

CROSSING the Dutch coast, the Army Air Forces men aboard the "Teggie Ann" were tense that spring morning. Wilhelmshaven was the target of their B-24 Liberator—but 100 Nazi-infested miles lay between these airmen and the point where bombs could drop.

Suddenly the pilot's earphones crackled. The bombardier and the top gunner were both talking at once. "Here they come . . . ME on our tail, sir . . ."

Out of gray patchwork clouds 10,000 feet below, the FW-190's and Messerschmitts swarmed to attack. Captain Dessert rode steady on the controls. In his ears hummed the undertone of combat—the metallic whisper of the telephone line, waiting for voices too busy shooting Nazis to talk.

Then a voice cutting in. The top gunner again: "Three more at two o'clock . . ."

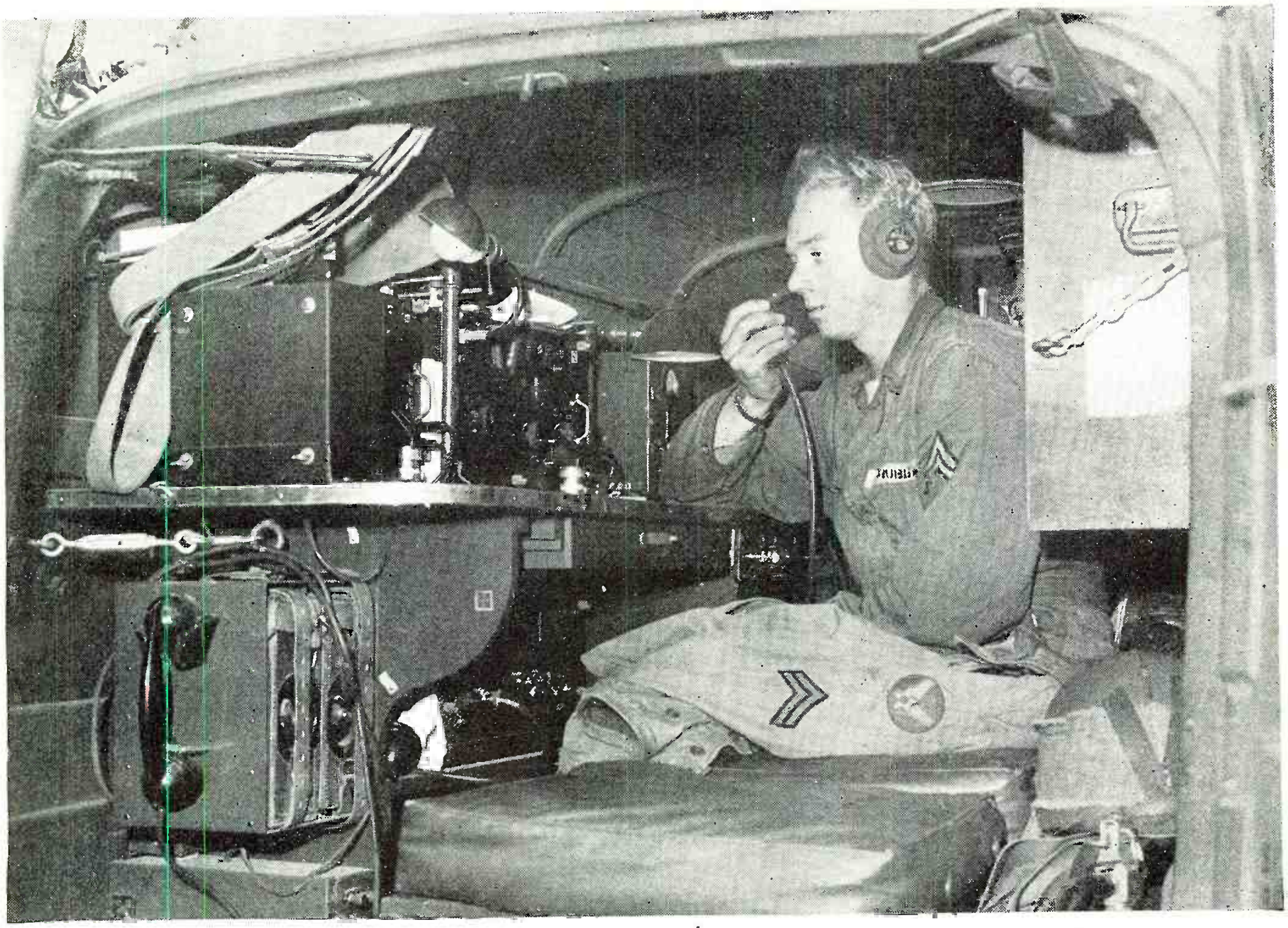
Droning miles of fury, hotter now. A one-ninety swooped past. Faint staccato in the earphones. Wilhelmshaven approaching. Captain Dessert knew it was time.

"Pilot to navigator . . . Give me the course—" Midway in the sentence, Dessert stopped. The hum had snapped to silence. Then Captain Schmid, the navigator, was shouting into Dessert's ear. "Interphone's shot out . . ."

If you suddenly knew your telephone, and your neighbor's, and every other telephone in your town had gone dead, you'd understand the immensity of this freak shot at the bomber's nerve center. Precision bombing is planned by telephone. The "Teggie Ann" could return to England without dropping her bombs, but at terrific waste of fuel and trained manpower.

The crew decided to try sign language—with their fingers crossed.

All that Schmid and Captain Culpepper, the bombardier,



Elaborate equipment of a mobile unit. Interphones are used for communications between driver and radio operator.

had to do was direct Dessert's course to Wilhelmshaven harbor. But in their usual positions these three officers couldn't even see each other.

Taking a blind chance, Culpepper and Schmid stood up in the bomber's nose and signaled Dessert through the celestial dome atop the plane. Culpepper would look through the bombsight, rise, and give hand signals with Schmid's help. One or two fingers would indicate the number of points to change course. The other hand would motion to right or left.

The "Teggie Ann" made a perfect run. Her bombs laid squarely on the target, she rumbled back to her English base with more than 300 bullet and shell holes to prove her toughness—and the ingenuity of her crew.

"Teggie Ann," say the Army Air Forces, is a prime example of how the interphone makes news—when it doesn't work. And a stray Nazi shot is about the only thing that would cut its efficiency.

This "party line of the air" is as nearly foolproof a piece of equipment as airmen fly with. Basically, it's the same two-way telephone invented by Alexander Graham Bell, with a few refinements for combat where hearing perfectly the first time is a life-and-death matter.

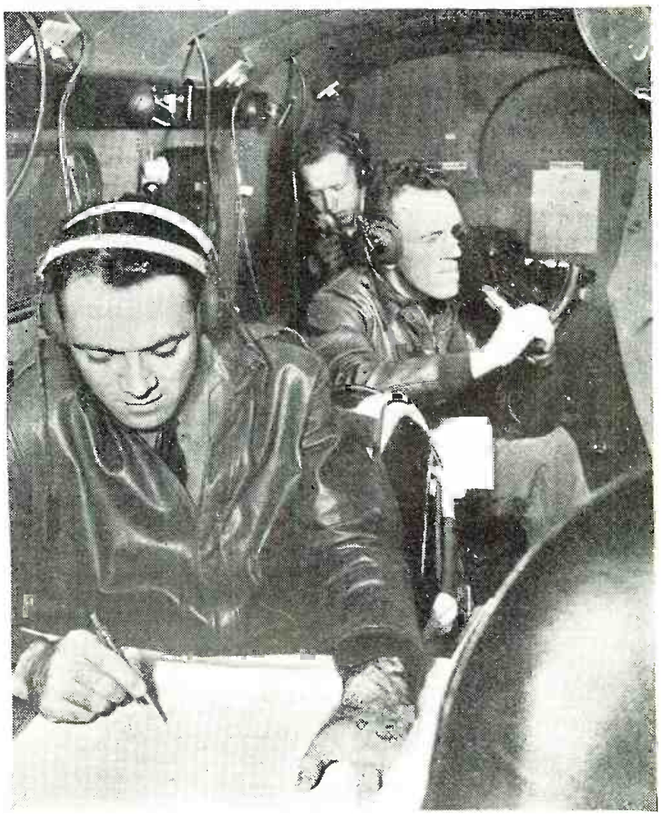
From training planes to America's heaviest bombers, interphones serve all military aircraft carrying two or more persons. Aircrews take this equipment for granted. They flick it on before take-off in the same casual way they adjust safety belts, and forget to notice what lets them talk "upstairs."

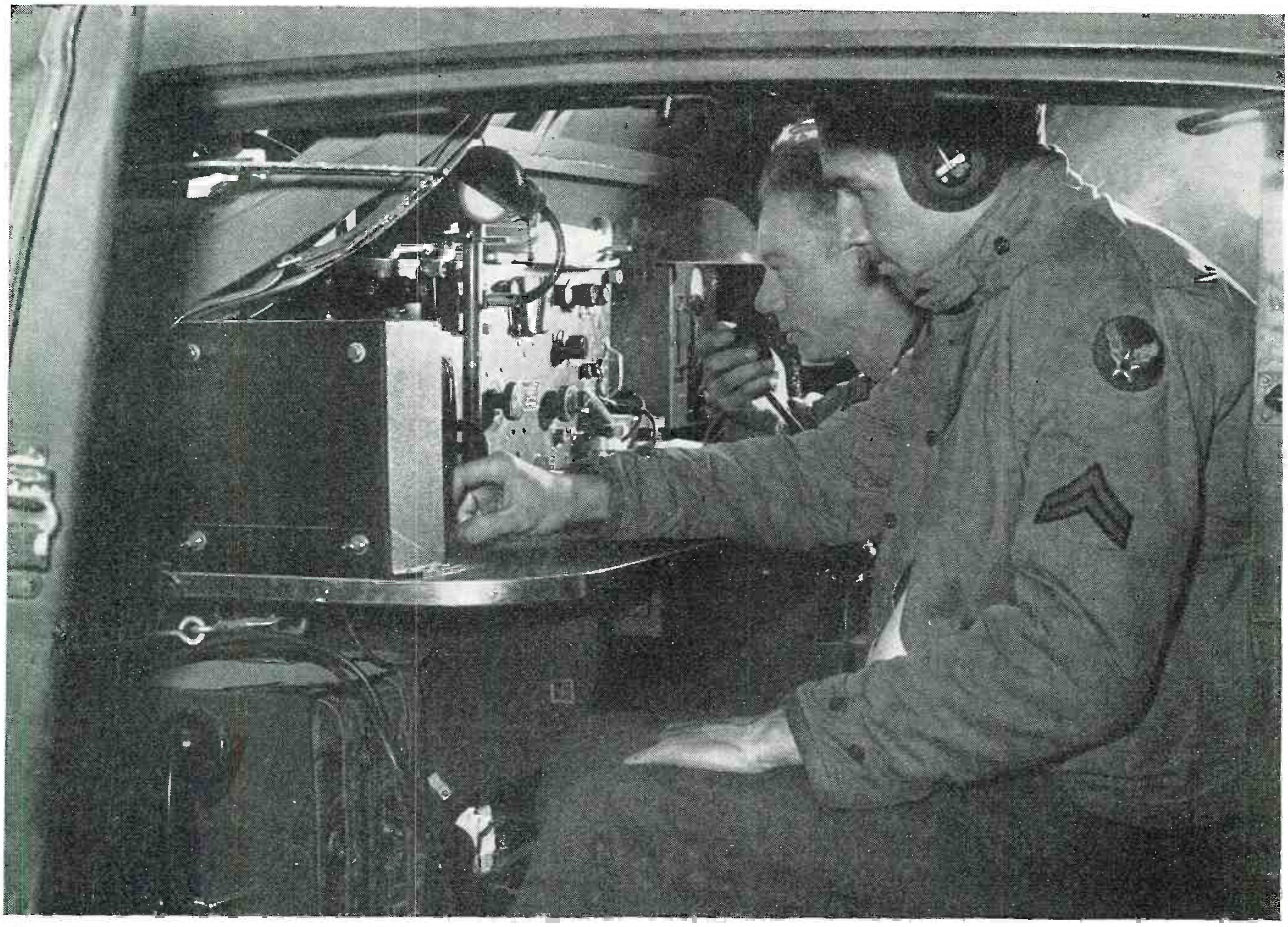
Then comes a "freeze" over Wilhelmshaven, and silence pours through the headsets and the key men of the bomber must exert unexpected cleverness to perform their mission. Lack of their gadget suddenly becomes spectacular.

Persons are apt to confuse interphone with radio, which

(*Continued on page* 180)

Crew of large bomber plotting course, making polar observations and directing the flight of plane over interphone system.





Operators of the Observation Squadron at Camp Polk, La., operating a mobile air-to-ground radio set.

Development Laboratories

By Major ROBERT E. WILLIAMS, Jr.

AIRCRAFT Radio . . . a true necessity in modern warfare! Radio is that one thin bond between airplane and earth which guides, advises, and commands in battle and in navigation.

When a household radio splutters and goes dead, part of a football game may be lost to the listener. When military aircraft radio fails in service, a mission fails—fighters loaded with TNT collide in murky clouds—or a huge bomber searches vainly for its base and finally, with human cargo, becomes a flaming pyre on a desolate mountain top.

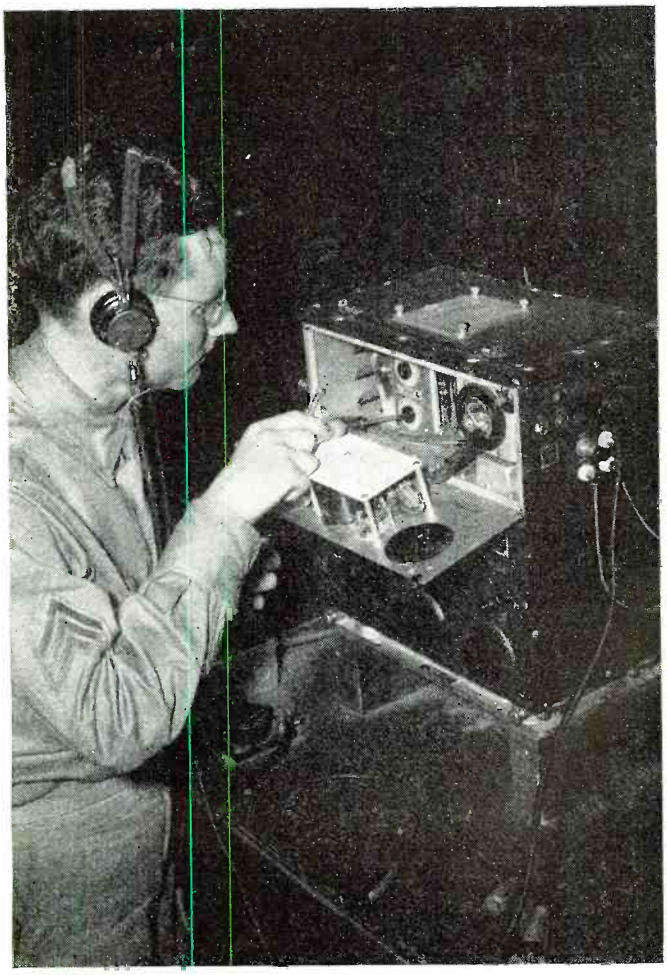
Into the brief space of this article one cannot cram the volumes concerning this fascinating type of equipment. Much, indeed, has been written about it, but—by the dictates of military security—little can be written about some of it. I shall try to briefly depict some radio equipment in operation—mention the organization which provides radio for the Army Air Forces—and then discuss some development and test problems associated with this equipment which makes up the "nerve system of the Army Air Forces." This equipment which is vital to organized offensive warfare must be accurately developed.

Graduated in 1937 from M.I.T. with SB and SM degrees and a 2nd Lieut. commission, Signal Corps Reserve. Was Electric Generation and Distribution Engineer for G.E. until ordered to active duty spring, 1941. Served at Fort Monmouth, N. J., and in the War Department before duty at Randolph Field and twin-engine flying school, Lubbock, Texas. Commissioned in regular army Oct., 1942. Is now the only Signal Corps officer with military pilot rating. On duty as Test Pilot and Electrical Project Engineer, Aircraft Radio Laboratory, Wright Field, Ohio.

Radio in Operation

Picture with me briefly a flight of a bomber which had just rolled off the assembly lines at a vast manufacturing plant—say, on the west coast. Picture the combat crew aboard and getting ready to take off.

As the engines roared to life, the "command" radio set was turned on and tuned to the airport tower frequency. The normal airbase traffic control was heard "on the air"



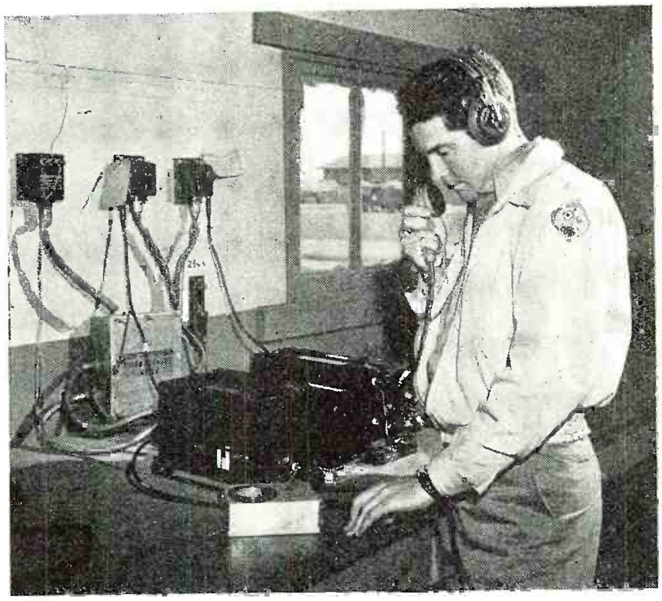
Trained radio technician adjusting a medium power liaison radio set. Aligning a radio unit is an important task.

Radio communications equipment must be tested thoroughly at the Wright Field Laboratories before acceptance for military aircraft.

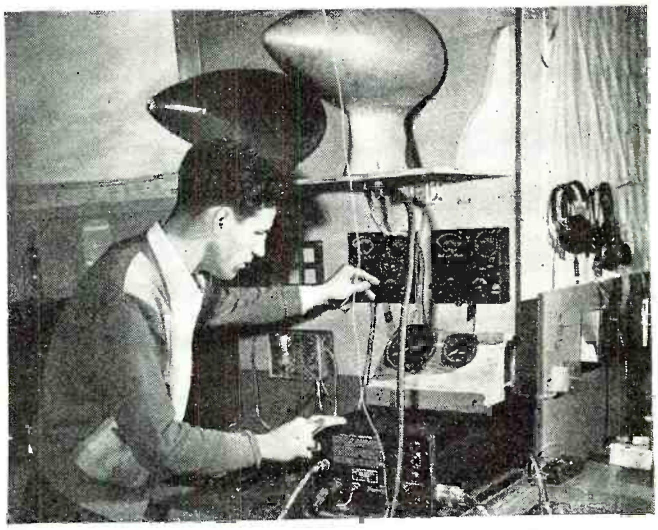
—the tower operator's voice coming through crisp and clear. The co-pilot picked up his microphone, turned his control box to "call" position and received an "OK" report from each crew member over the interphone system. He then switched back to "command" and called the tower for taxiing instructions. Constant radio contact was maintained with the tower while the monster was guided to take-off position and was given the latest weather. The tower operator relayed "clearance from the local control area for the aircraft to fly at 11,000 feet and designated air speed to Chicago, via airways, contacting Rock Springs radio, enroute." The engines were thoroughly warmed up and checked and the pilot cleared for take-off.

As the ship became airborne and the wheels retracted into the nacelles, the pilot tuned his radio to the airways frequency and flew along the right-hand edge of the "beam" guided by the distinctive sound in his headset as the large bomber climbed to its assigned altitude.

Simultaneously, the radio operator released a trailing wire antenna and tuned the "liaison" set for communication with Army ground stations. It is the radio operator who, through efficient use of radio, provides the vital link

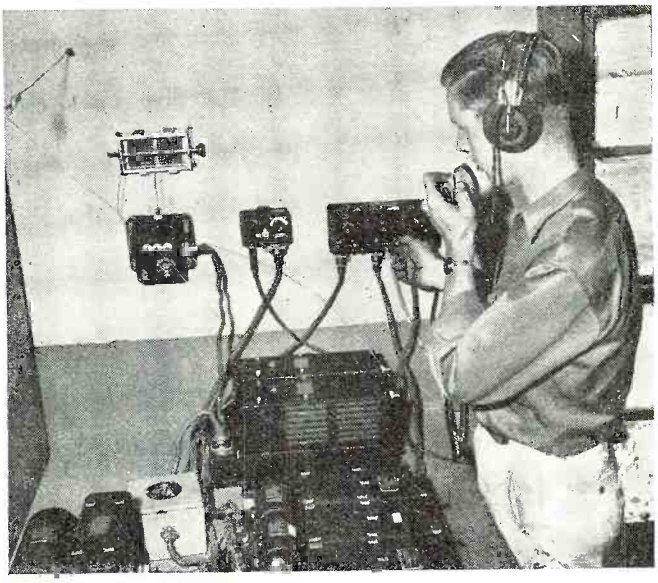


Radio set for aircraft undergoing an operational test before being installed permanently within military plane.



Civilian radio repairman tests pilot and co-pilot indicators by use of loop antennas at an unidentified air field.

Signal Corps civilian radio repairman testing hand-microphone designed for use in aviation communications unit.



Operating the latest aircraft command set. All such radio equipment is noted for its sturdy construction.

Radio repairmen remove transmitters and receivers from planes at regular intervals for a general checkup and test.

of coordination between air and ground forces in combat. In this peaceable instance he received instructions by "CW" from Fort Worth to proceed immediately to Tulsa, Oklahoma, to meet other ships of the bomber squadron. Clearance with airways traffic control centers was obtained by radio. The bomber was above the clouds but positive location was given by the receiver which automatically flashed in the pilot's cabin to announce arrival over the Salt Lake City Airways station, as the aircraft banked to take up its new course.

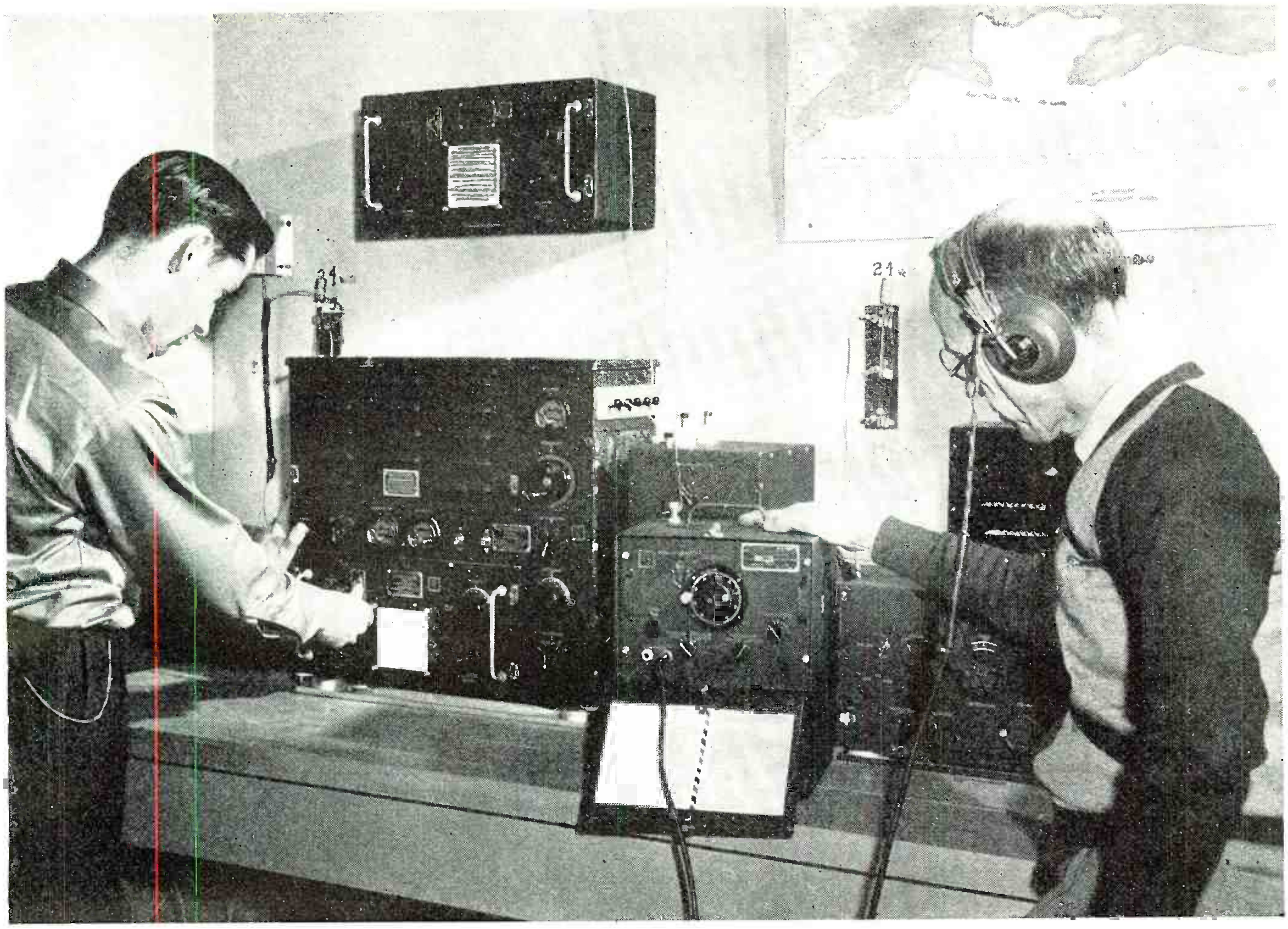
While enroute to Tulsa, the navigator found the "radio compass" particularly useful in determining the ship's position, at any moment. Again and again he tuned to two or more stations, plotted their bearings on his map and obtained a definite position "fix." He could not see the ground, but his instruments told him that the wind was blowing 65 miles per hour from 130 degrees.

Ice formed on the wings, but a special electronic device warned when it was of the right thickness for the deicers to be most effective, and it was soon removed.

The ship met two other bombers above the clouds over Tulsa as per radioed schedule and the Squadron Commander's ship gave radio instructions for formation flight direct to Tampa.

Weather information indicated low ceiling and visibility and light rain at Tampa, but the ships were equipped for instrument landing and because of the urgency of the stop-over and early departure for a foreign theatre, the flight proceeded. Out of sight of earth, each ship received detailed landing instructions and let down "on the beam."

Radioed signals operated an easily read indicator on the instrument panel and the pilot letting down through solid fog could see and hear that he was "lined up" with the proper runway. He glided down rapidly following the sig-



Maintenance men testing and realigning an aircraft communications receiver. Such equipment must be serviced periodically.

nal indicator until the plane glided to a gentle landing on a runway completely obscured by fog and drizzle.

And the above mentioned communications and navigation devices are only a few of the many radio equipments being installed in military aircraft today . . . a fascinating field with a fascinating future!

Who Provides the Equipment

An important factor is the Organization of the Signal Corps Aircraft Signal Service (SCASS) which has been set up to develop, procure, inspect, store, and plan maintenance techniques for aircraft radio equipment for the Army Air Forces. The SCASS organization is an outgrowth of the Signal Corps Aircraft Radio Laboratory at Wright Field, Ohio. A complete description of its functions is given by Colonel Hobart R. Yeager, Director, Aircraft Radio Laboratory in Radio News for November, 1942.

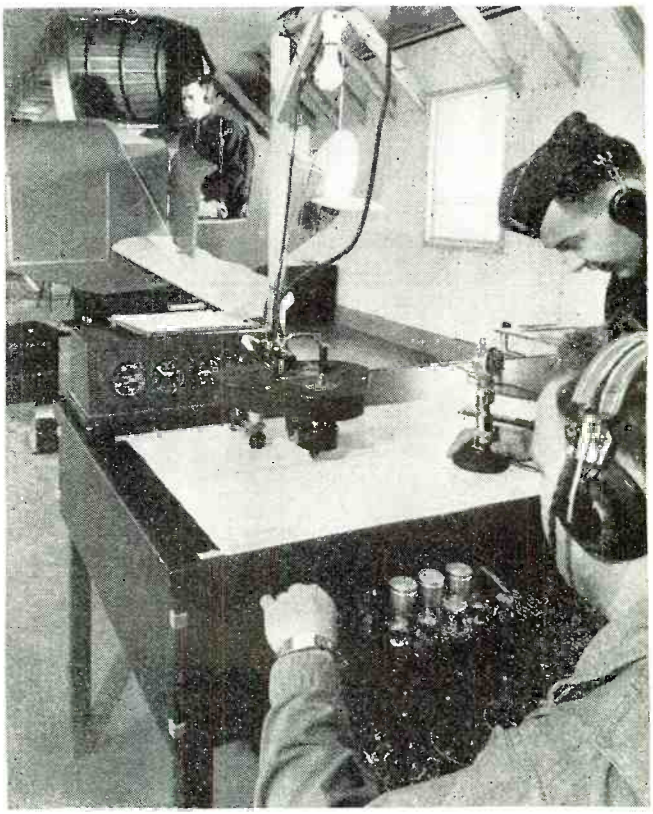
Together with the Navy and our allies, we must standardize and produce the best military radio equipment in the world . . . and we are doing that!

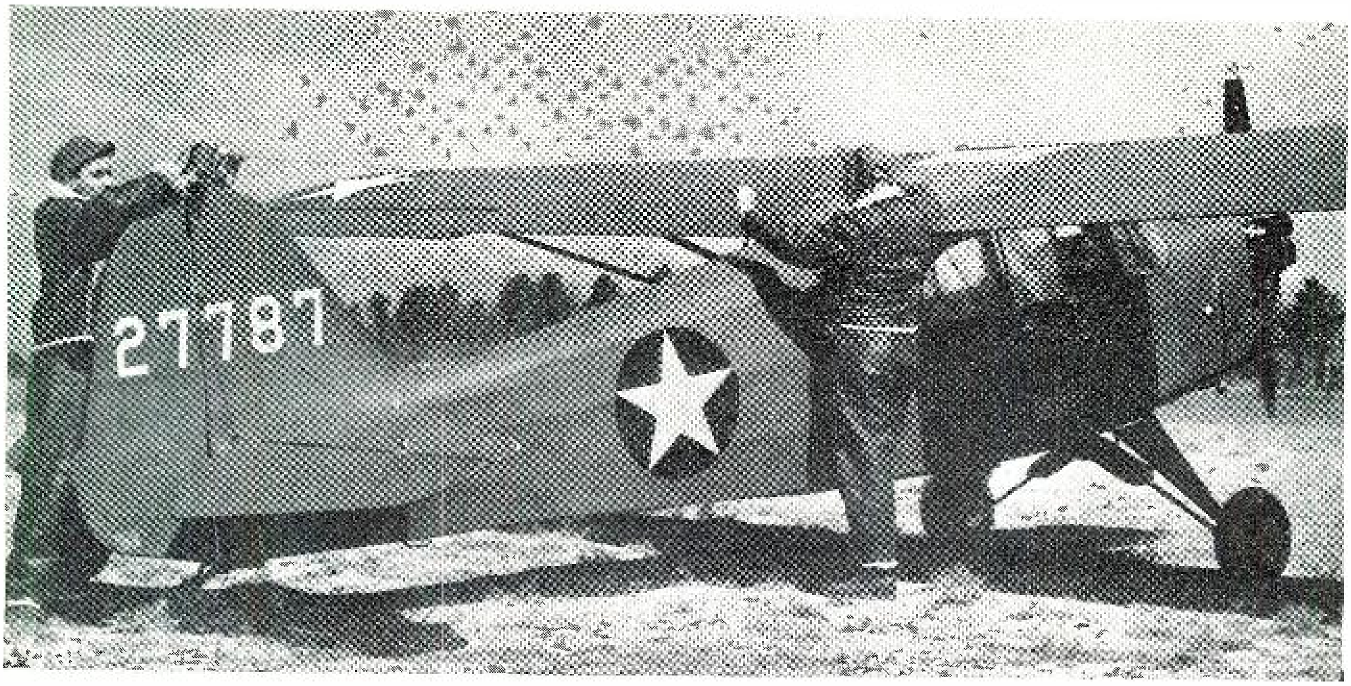
During production, we may modify, yes, but we *must not* re-design. Design must be carried on separately, and the Signal Corps Aircraft Signal Service, in addition to the facilities of the Aircraft Radio Laboratory, uses research facilities of industry to the greatest possible extent.

Many elements besides standardization and interchangeability and new applications influence design. Huge bombers roam the world, over U.S.A., Australia, India, Africa, Alaska *and Germany*. Fighters are in combat on all fronts under widely varying conditions and the equipment *must* be designed to withstand all those conditions, to operate on *all* the necessary frequencies and from below sea level to more than eight miles above the earth!

(*Continued on page* 238)

Operator of Link Trainer receiving instructions from imaginary headquarters. Radio equipment is checked at Wright Field.





Crew of the "grasshopper" plane prepares to make a reconnaissance flight for the Field Artillery.

THE GRASSHOPPERS

"Grasshopper" crew-pilot and observer are the eyes of the U. S. Field Artillery. Radio is used to transmit their observations.

"TWO-HUNDRED right . . . four-hundred over." The voice comes crisp and clear over the radio telephone from the small, low-flying plane almost invisible behind a row of trees.

The fire-control officer gives a command to the gun crew of the field artillery battery. The second salvo rips into the target, a perfect hit. The plane kicks up a swirl of dust as it lands on a country road. The pilot taxis it under a tree as a protection against enemy aircraft.

The battery commander looks at his watch. "Six minutes—we can do better next time!" he says with a smile to the pilot. Six minutes from the time that the pilot took off the ground, he has spotted a salvo, given by radio the necessary corrections in range for the next salvo, and returned to the command post.

This is all in the day's work at the Field Artillery Air Observation Post School in North Africa, the War Department is informed. Here, on a small, grass-covered air field turned over by the French, a group of officers and enlisted men of the Fifth Army are undergoing training similar to that given at Fort Sill, Oklahoma.

The classroom is a corner of a hangar. Sleeping quarters for some are the crates in which the planes are shipped from America. They are just the right size to accommodate four men. By ingenious use of hammer and saw, and a daub of paint, the men have fixed up comfortable homes, which are set in rows in a grove of olive trees.

During flying instruction, the student pilots, from sunrise to sunset, are practicing take-offs, landings, spotting, communications, and intricate flying maneuvers.

Seasoned pilots of fighters and bombers have been known to shake their heads in admiration at some of the stuff that the Field Artillery pilots do.

"Maybe some of the things we do seem crazy to other pilots," explained Lieutenant Colonel John D. Salmon, of Marion, South Carolina, director of the school, "but we have a specialized mission. We use small, light planes, the kind that youngsters back home used to fly all over the place before the war. They are comparatively slow. They would ordinarily be an easy target in the air for an enemy plane. That is why we have had to develop special evasive flying tactics to keep out of the way of the enemy's planes and guns. We go up, spot the fire of the guns, and get down as quickly as we can. Look over there. . . ."

Colonel Salmon pointed to the far end of the field. Two light bamboo sticks, with a string tied across the top, were stuck in the ground. A plane came over and its wheels barely missed the string. Then, the plane dropped quickly to the field and stopped within a few yards.

"That's to practice getting over a tree and down fast, to avoid the enemy," said Colonel Salmon. "We have a kitty, and every pilot who breaks the string must pay in 100 francs. So far we have collected only two hundred francs!"

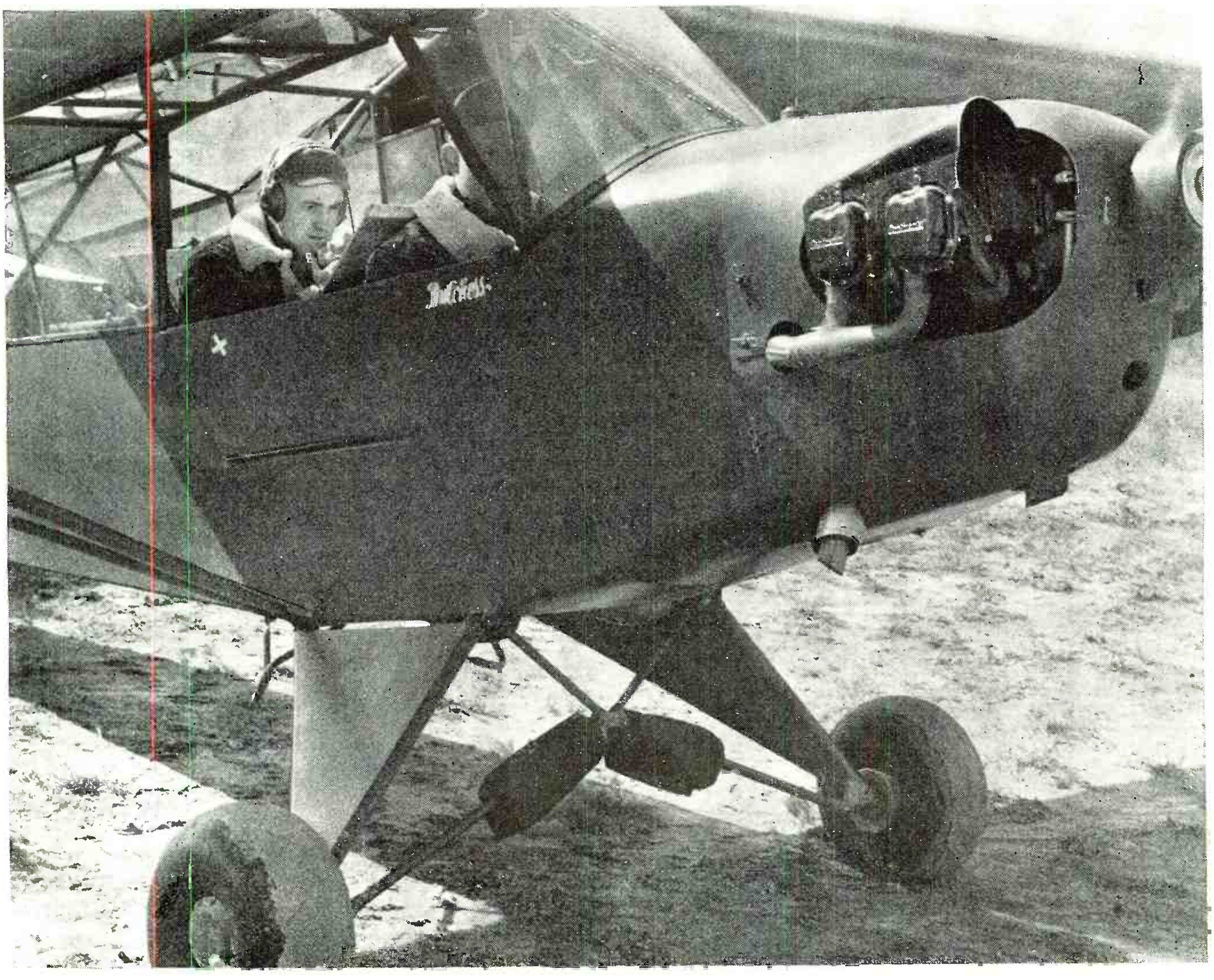
In the last war, the Field Artillery used stationary balloons for observation. They are too slow, cumbersome and vulnerable for modern warfare. So, pilots and observers in light planes are the eyes of the U. S. Field Artillery in this war. The Air Observation Post is attached to a regular artillery unit as an integral part of the battalion.

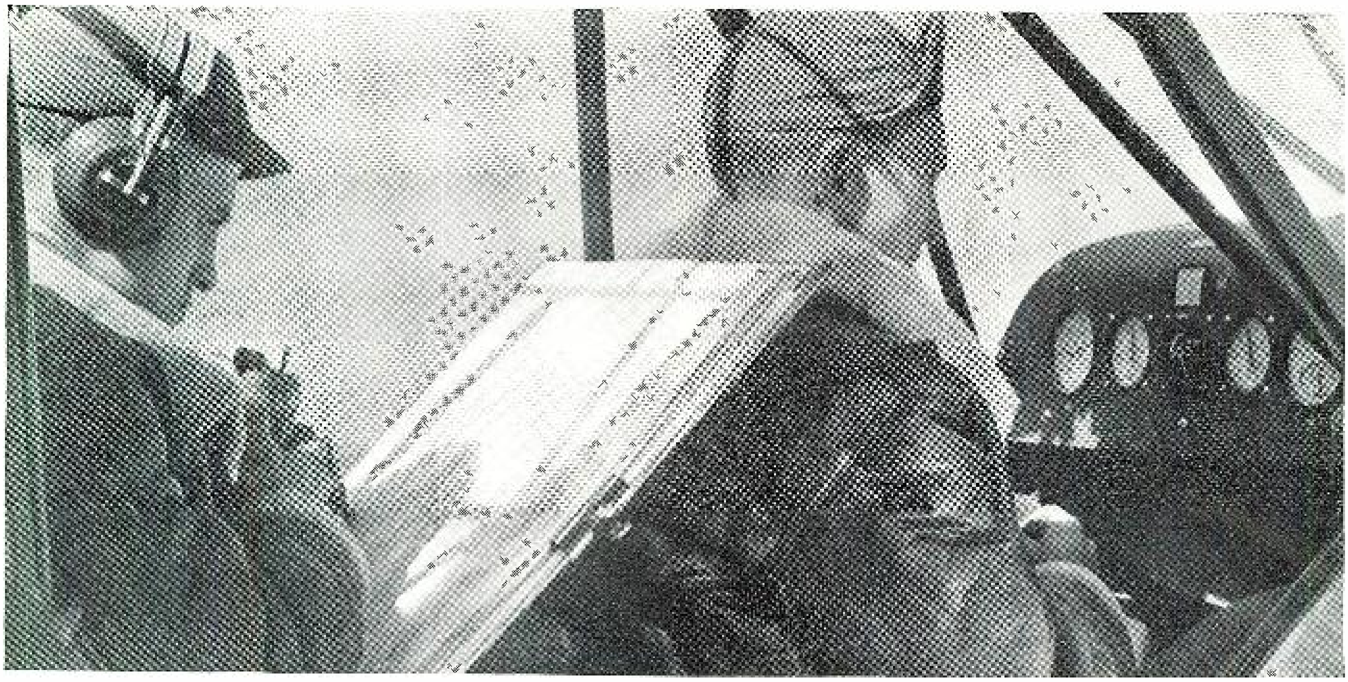
The school in North Africa recently graduated its first class of five members, and began its second class. It hopes to turn out 50 qualified Air Observation Post pilots every 6 to 10 weeks, and 50 aircraft mechanics every month. About half the present applicants hold private pilots' li-

Observer checking radio equipment before placing it in Cub plane. This equipment must be light in weight.

Inspecting the generator which furnishes power for the radio, used to keep in touch with the Field Artillery.

Observer describes territory over which they must make observations before their small plane takes off on its mission.





Two man crew of "grasshopper" plane in action. Observer with map of enemy locations reporting effect of artillery fire to headquarters.

censes at home. Many learned to fly while taking civil aeronautics courses which the Federal Government conducts in conjunction with colleges and universities.

The basic training these men receive, particularly while in the United States, also includes the operation of radio equipment. The duties of the personnel of these air observation groups vary in accordance with assignments that are made by the senior pilot in a battalion headquarters battery who commands the air observation section of this unique military unit.

The pilot is thoroughly schooled in artillery air adjustment and other observation functions as well as in his duties of flying the airplane. He should daily inspect his ship and radio equipment and be thoroughly acquainted with the tactical situation at all times. The observation officer or observer is charged with the responsibility of transmitting, by radio, his observations from the air. A mechanic, a driver who operates the truck assigned to the section, and a ground crew member who assists the mechanic, complete the crew.

There is no standard radio set built specifically for light plane observation. Any one of the radio sets of the firing batteries or the battalion command post may be used. These are generally rugged utility sets constructed for vehicular use such as reconnaissance cars, jeeps, half-tracs and the like. Although the most desirable location for the radio set is on the floor back of the rear seat, it is more often mounted on the shelf just to the rear of the observer's head where it will be in handy reach at all times. It is generally held in place by web-strapping so as to withstand the impact of a possible head-on crash. Certain types of liaison planes are so constructed as to have the pilot and observer sitting back to back giving both men greater area for observation and allowing the observer a more advantageous position for the operation of his radio set.

If failure of the set occurs during flight, the plane generally lands to correct the trouble. Panel messages are used only for simple prearranged purposes. Dropped messages from the plane prove adequate only where one-way communication is used. Wing signals are also used and are given to complete adjustment of artillery fire, particularly when radio communication is interrupted. A standard series of signals is used. Changes in range and deflection are made by the officer upon receipt of such signals which invariably convey information sufficiently clear for effectively carrying out the mission.

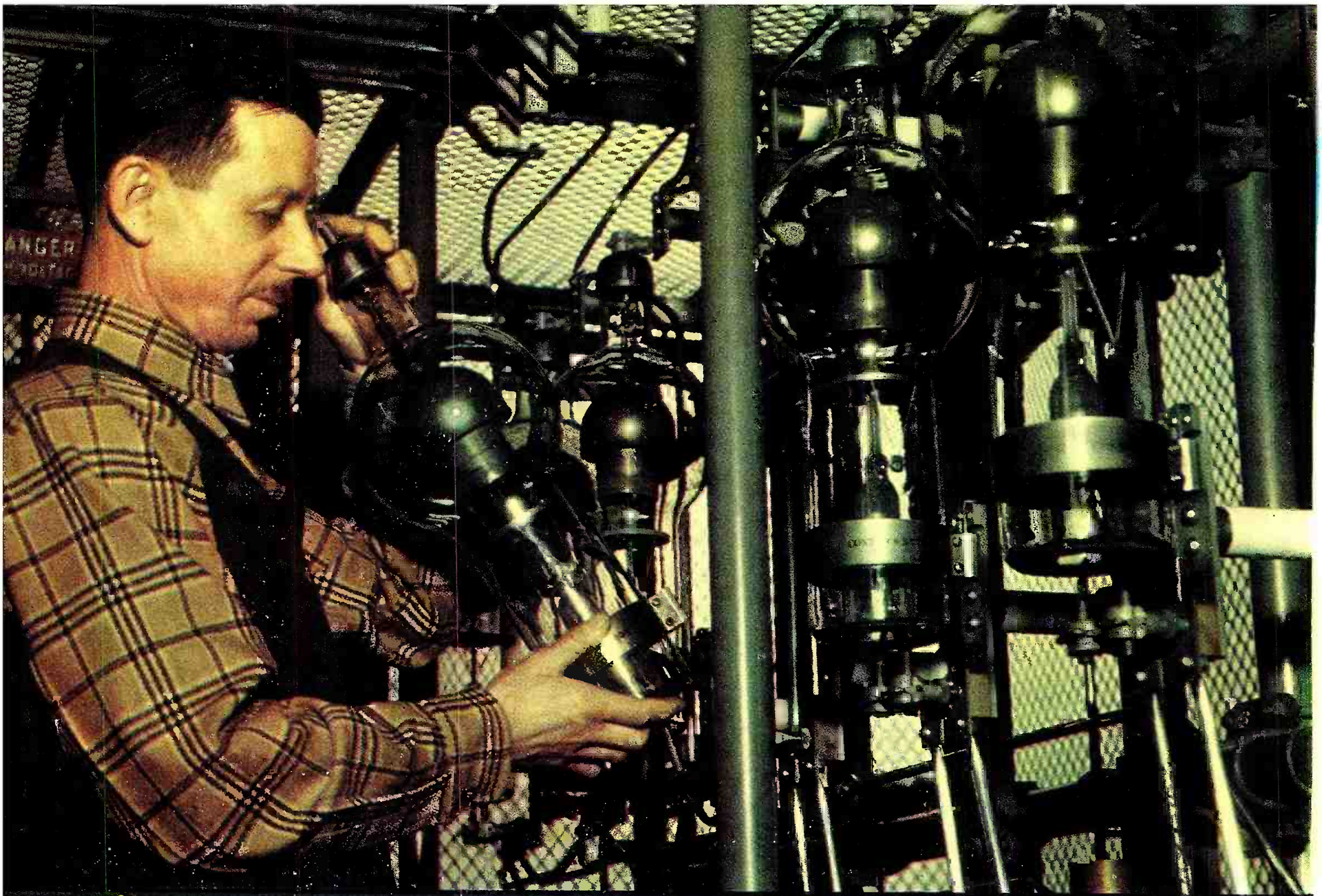
These light plane observation sections rely on wire communications between command posts and the landing field. The air sentry of the battalion, who generally is placed so as to be able to see the plane in flight, should be within voice range of the ground radio station. If not, he must have telephone communication with the radio ground station operating with the airplane.

—30—

☆ COLOR PHOTOGRAPHY ☆

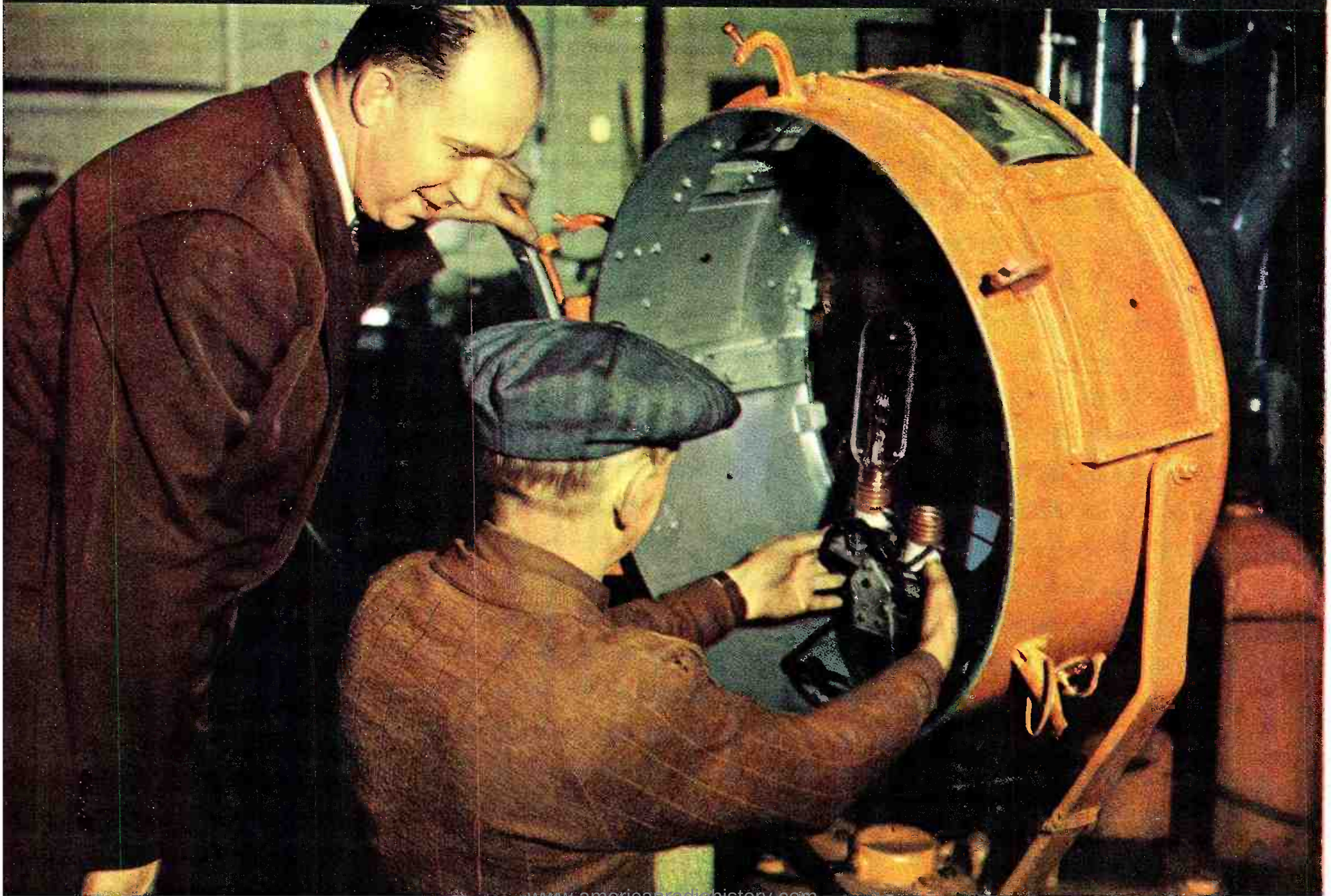
Color shots of radio subjects are rather unusual. The photographs on the following pages illustrate many of the activities of our various branches devoted to the task of providing communications for aviation

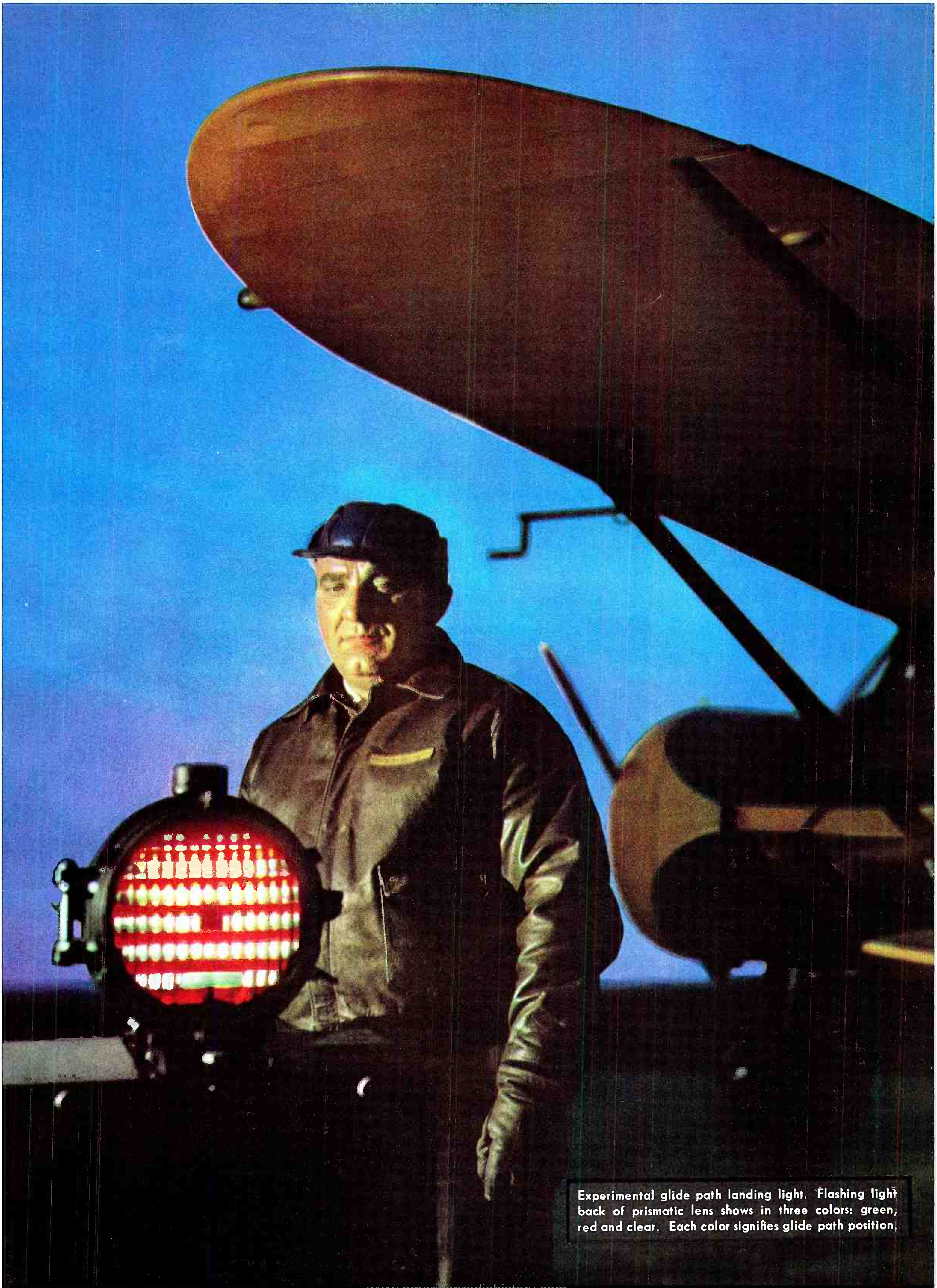
CHARLES INGRAM STANTON
Administrator of Civil Aeronautics



Technician replaces tube at CAA station. It has life of from 5,000 to 10,000 hours.

Technicians adjust a revolving air beacon. These situate about 10 miles apart along Civil Airways.

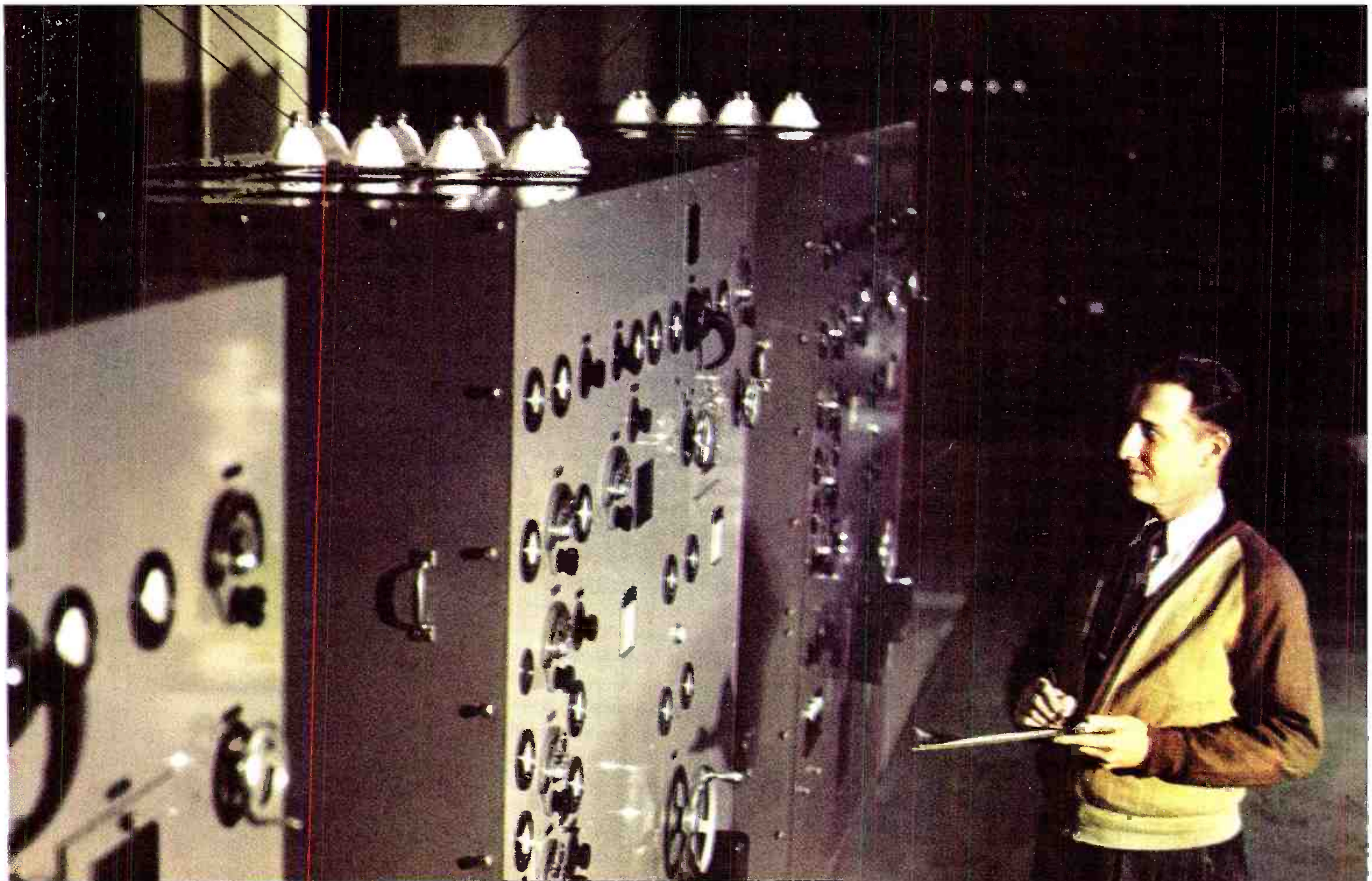




Experimental glide path landing light. Flashing light back of prismatic lens shows in three colors: green, red and clear. Each color signifies glide path position.

One of the most interesting pieces of equipment used by CAA engineers is this portable high-frequency localizer. It saves valuable testing time.

Experiments in developing instrument landing systems at the CAA Experimental Station, Indianapolis, Indiana. Equipment shown is used for localizer and glide path.



Specially-designed 20kw. transmitters at the CAA intercontinental radio station, Sayville, L. I., have world-wide coverage. Air-cooled tubes are used.

Tube-testing machine at CAA experimental station, designed by the Technical Development Division, for testing all tubes used by CAA in their radio equipment.

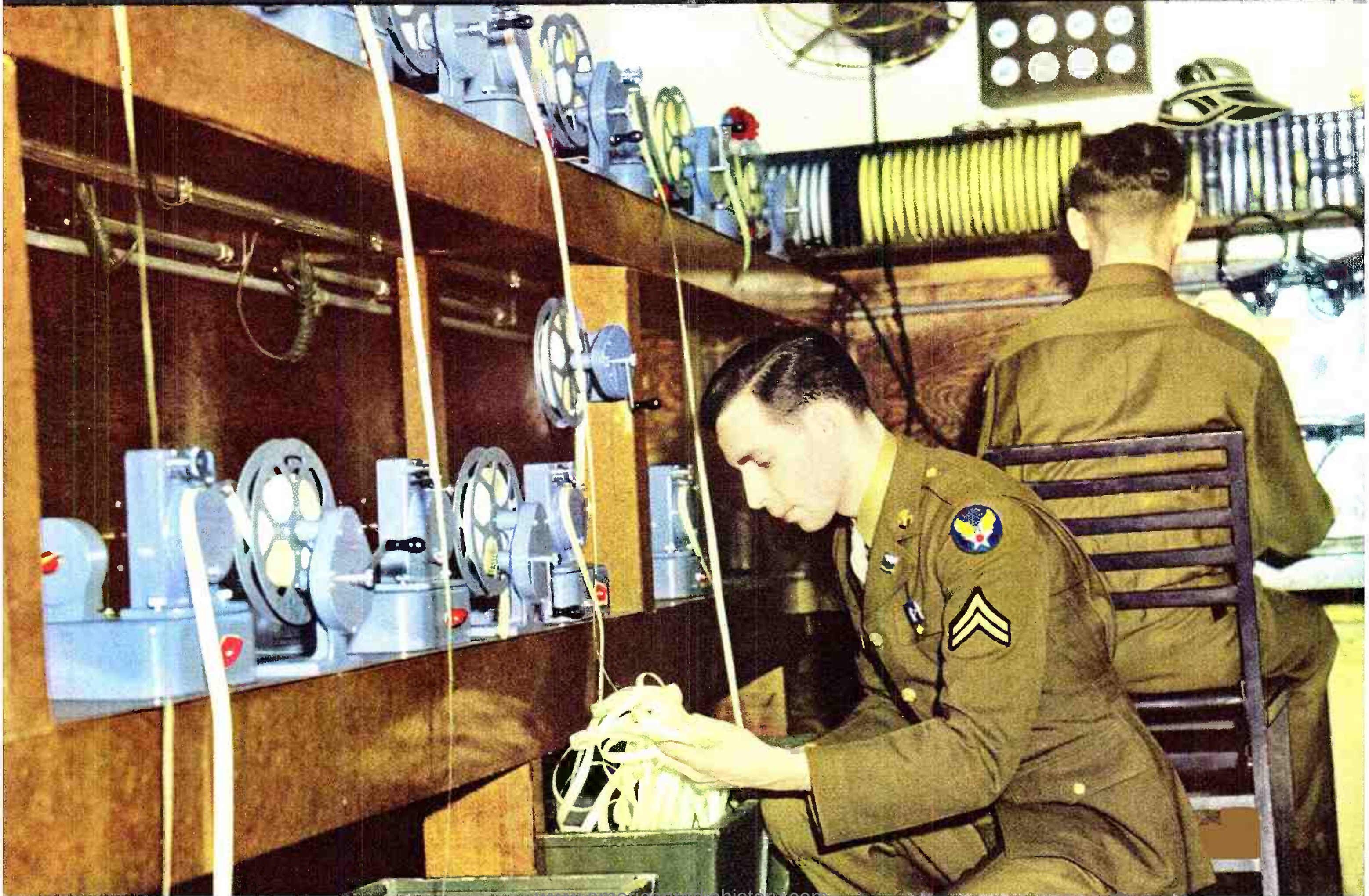
Airport Traffic Controller directing local aircraft movements. Typical phraseology—— " American Seven cleared for takeoff. ATC clears you to the Washington boundary to cruise at 5,000."

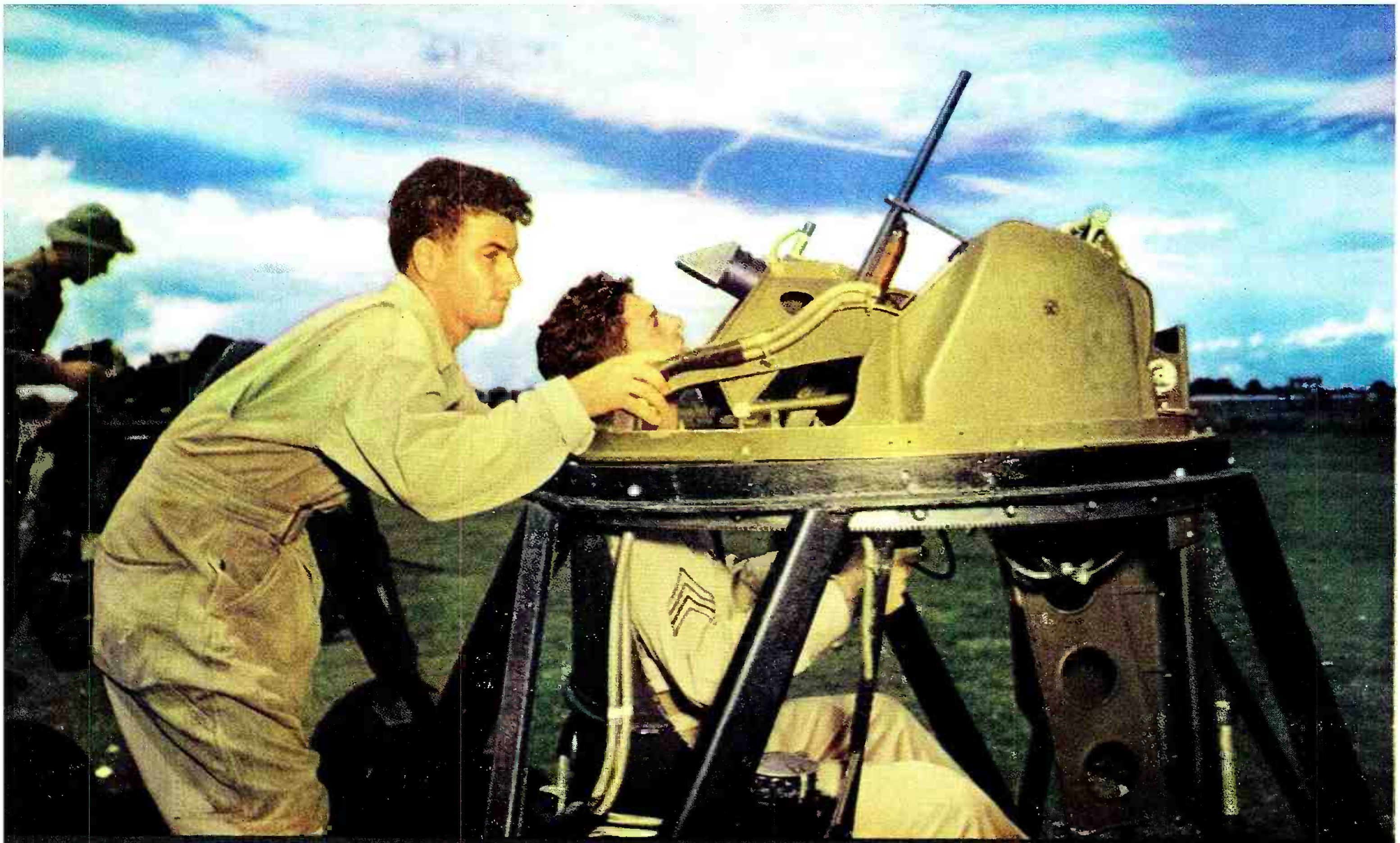
Portable testing apparatus called the "tea wagon" by CAA technicians. It is used for testing radio equipment under development by CAA engineers.

CADET PILOT ABOUT TO "TAKE OFF" ON SIMULATED FLIGHT IN LINK TRAINER

Students of the Air Force schools learn basic theory and operation by observing the results from experiments on these handy "breadboards".

Tapes from the many code senders feed into a group of special containers. They must be carefully examined at frequent intervals for tears.



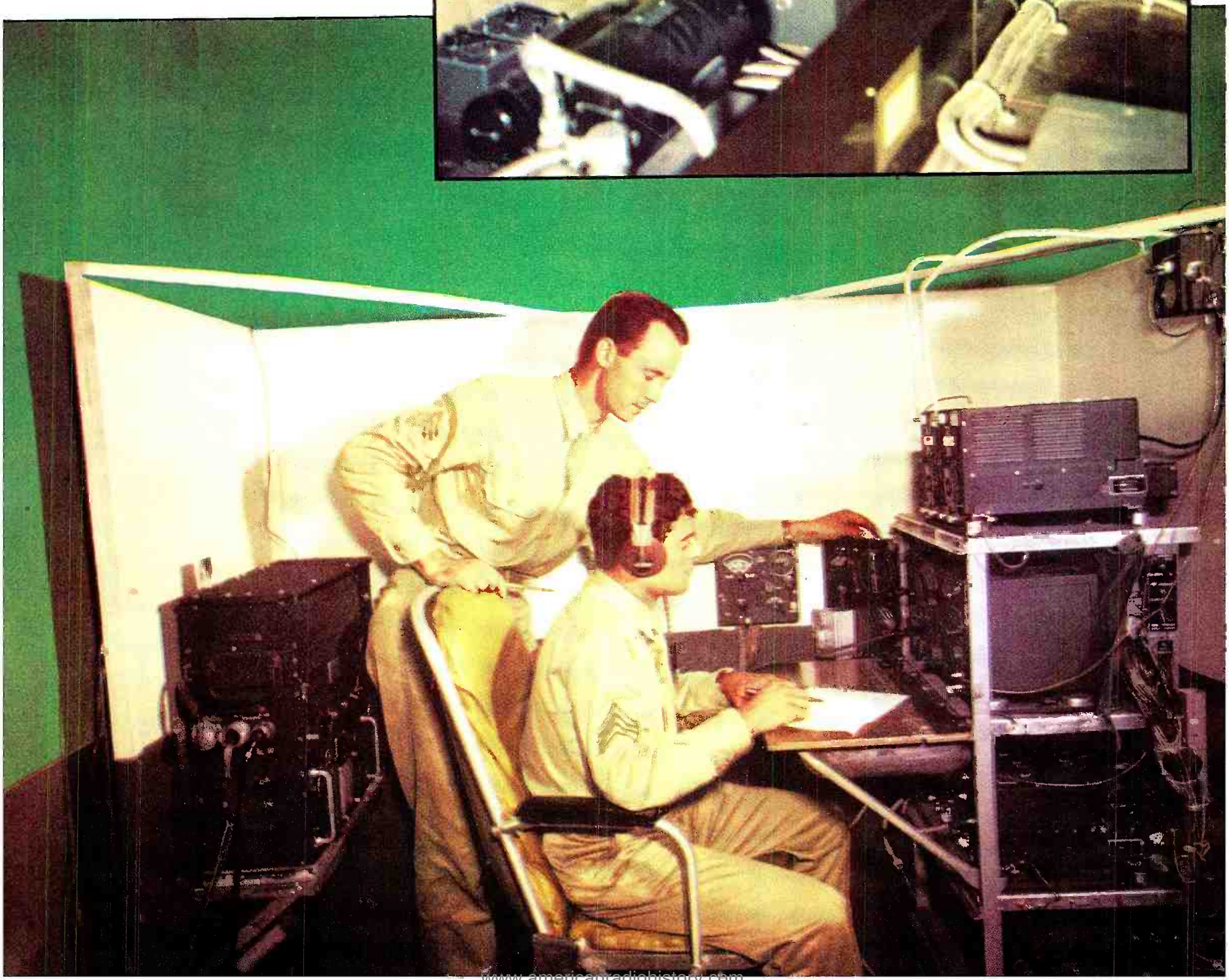


Getting the "feel" in operating a turret gun. The student eventually becomes a radioman-gunner in the bomber crew.

Students far above this panorama look down on miniature airports and surrounding countryside during instruction.

Directional loop antennas are studied for both construction and operational characteristics. They are used to pick up various radio beams.

Every student is required to be able to satisfy his instructors that he fully understands how to operate all of the equipment in compartment.



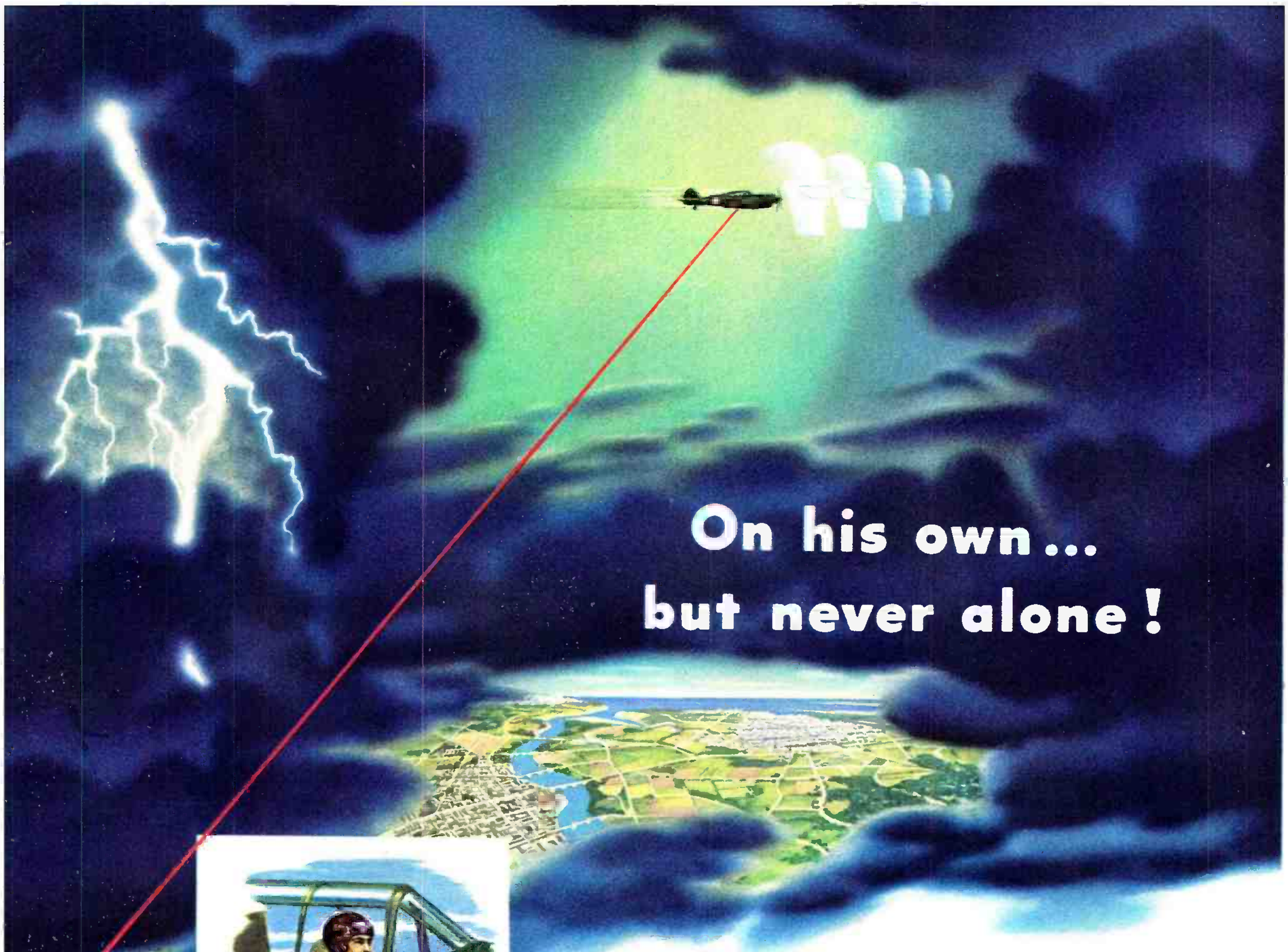
CLIMAX TO EXTENSIVE TRAINING COMES WHEN CREW IS READY FOR FIRST FLIGHT.

Plotting their course within the cabin of a Navy Blimp—these men will soon be hovering over waters infested with enemy submarines to "blast 'em out".

Pilots and crew members wear latest type headphones. Extremely rugged and designed for clear reception.

Aerial gunner is "jack of all trades". Becomes an excellent marksman and a highly skilled radioman.

This six-foot balloon carries ultra-compact transmitter aloft to send out signals for determining weather data. A small parachute returns equipment to the earth below.



On his own... but never alone!

This might be your boy, the kid who lives next door, or the lad from across the street.

Seems only yesterday that he was a little shaver . . . clutching your finger . . . taking his first wobbly flight across the nursery floor.

Well, today, he's taking another flight . . . for all of us. He's a full-fledged fighter now on his own up there in the skies . . . slicing his way through storms and fogs and enemy shells.

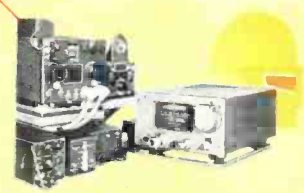
Yes, he's on his own . . . but never alone. For riding with him are the radiomen of "The Invisible Crew" of Bendix.

With these special aircraft radio devices, he picks up distant radio stations to guide him on his course. He "sees" what lies ahead, even through fog. He talks with comrades in other planes and on the ground.

On patrol, in battle and on long transport flights, through all kinds of weather, he's constantly informed, guided and counseled by information which comes to him . . . out of the ether.

Daily, he uses new electronic developments far too confidential to talk about now. But he'll tell you all about the wonders they work, when he comes flying home.

For through these engineering marvels that guide and protect him, he senses the secrets of the future . . . the future that he's fighting for.



RADIOMEN OF "THE INVISIBLE CREW"

Radio in flight involves many complex problems—extreme altitudes, vibration, changing temperatures, pressures. The "BENDIX" Aircraft Transmitter and Receiver (above) are engineered to overcome these difficulties. Other famous Radiomen of "The Invisible Crew" include the "BENDIX" Automatic Compass and many new electronic marvels.

Back America's invincible crew . . . our fighters on every front. Buy War Bonds and Stamps regularly.

★

More than 25 Bendix plants are speeding "The Invisible Crew" to world battle fronts.

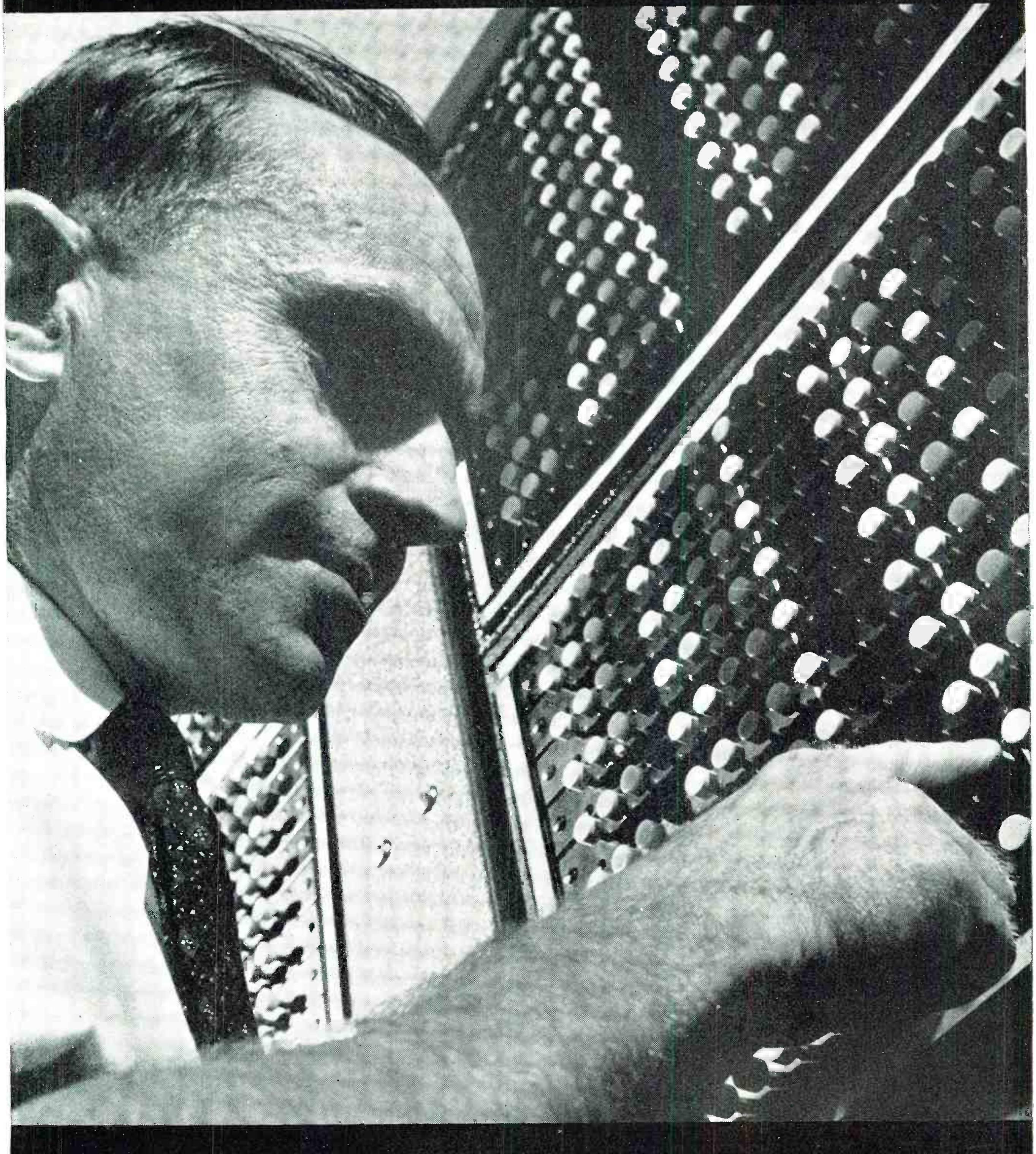
THE INVISIBLE CREW

PRECISION EQUIPMENT BY Bendix AVIATION CORPORATION

BENDIX RADIO

BENDIX RADIO DIVISION

THE CAA



The Civil Aeronautics Administration is charged with the safety of aircraft and in the planning of radio networks and devices that guide aircraft pilots in flight.

FEDERAL AIRWAYS

by CHARLES INGRAM STANTON

Administrator of Civil Aeronautics

Sometimes called "Father of the Federal Airways," Mr. Stanton rose steadily in government aviation posts. Won his wings as Army Cadet during World War I and commissioned at Kelly Field. Began commercial aviation 1919 as test pilot when he flew first air mail routes for U. S. government. Appointed Div. Supt., Supt. of Operations, and (1921) Asst. Gen. Supt. of Air Mail for U. S. Post Office. In 1926, Aeronautics Branch of Dept. of Comm., then Airway Extension Supt. Chief Airways Eng. (1933), Chief of Airways Eng. (1937), Director of Federal Airways.

THE history of the airways of the nation may be built around the development of its three most important elements.

The first element is, of course, the pilot. All air transportation has been built around him, and he was and still is the keystone of winged commerce.

The second element is a system of landing fields.

The third element is radio. At first only an experimental device—and at times a not very successful one, at that—it has grown in recent years to become one of the dominant instruments in airways operations. In 1932, expenditure for the maintenance and operation of radio and communications on Federal airways in the United States represented only 20 per cent of the total expenditure for all airways maintenance and operation; today it represents 60 per cent of that total. In the same period, the number of radio range stations on the airways jumped from 128 to 401. There were only 20 ultra-high-frequency fan markers on our airways in 1939; today there are more than 200. From a total of two in 1940, ultra-high-frequency range stations have increased forty fold.

To understand this development is first to understand the early history of airways, the development of pilots, and the problems which arose. It is a story of American enterprise which began with Yankee ingenuity in a very limited area and led to the four corners of the world.

Boeing plane circling Mount Ranier. Many of the old type planes could not obtain sufficient ceiling to cross higher peaks.

Carrying on the pioneering spirit of the Wright's and first Air-Mail, CAA pushes forward the frontiers of aviation to the four corners of the world.

When the need for the first U. S. airway arose, there was practically nothing from which to start. This was on May 15, 1918, when the first regular air mail was flown between New York and Washington, with a stop at Philadelphia. Army fliers made the first hops, the Post Office Department taking over with civilians early in August. One round trip was made daily except Sunday. There was no night flying. The first of the three leading elements—the pilot who could fly cross country on a regular schedule—began immediately to develop.

Until that time, he had, generally speaking, been not a little casual about flying from place to place. Trained as a war pilot or a barnstormer or both in planes not notable for the reliability of their engines, he had become accustomed to start out for a general destination, sit down when he had to, and not be too perturbed if several pastures intervened between point of departure and destination. Landing flares had been developed casually in France during the war to aid pilots coming in after dark; shortly after the Armistice, the first aerial beacon was built in England, but it was an experiment at best and was considered unfit for peacetime operations. The first U. S. airways beacons were bonfires built by farmers and villagers during a test night air mail flight in February, 1941. Night flying, at best, was considered extremely unwise.

At this point, the air mail pilot began to develop cross country techniques. He took his five senses and made them flight conscious. With his eyes he learned to use geographical features in addition to the "iron mike"—railways. He learned to judge his airspeed by the whine of the wind in the rigging, his engine by its roar, its temperature by the odor of the oil. Jack Knight tells of spotting a gas leak by tasting what first seemed like water dripping in his cockpit. Before they had gone very far, all of them developed a sixth sense which taught them to detour for tunnels when they were following the iron compass. They also developed a high sense of duty, as witness H. G. Boonstra, who crawled thirty-six hours on his hands and knees after a forced landing in the Rockies—and had the mail delivered.

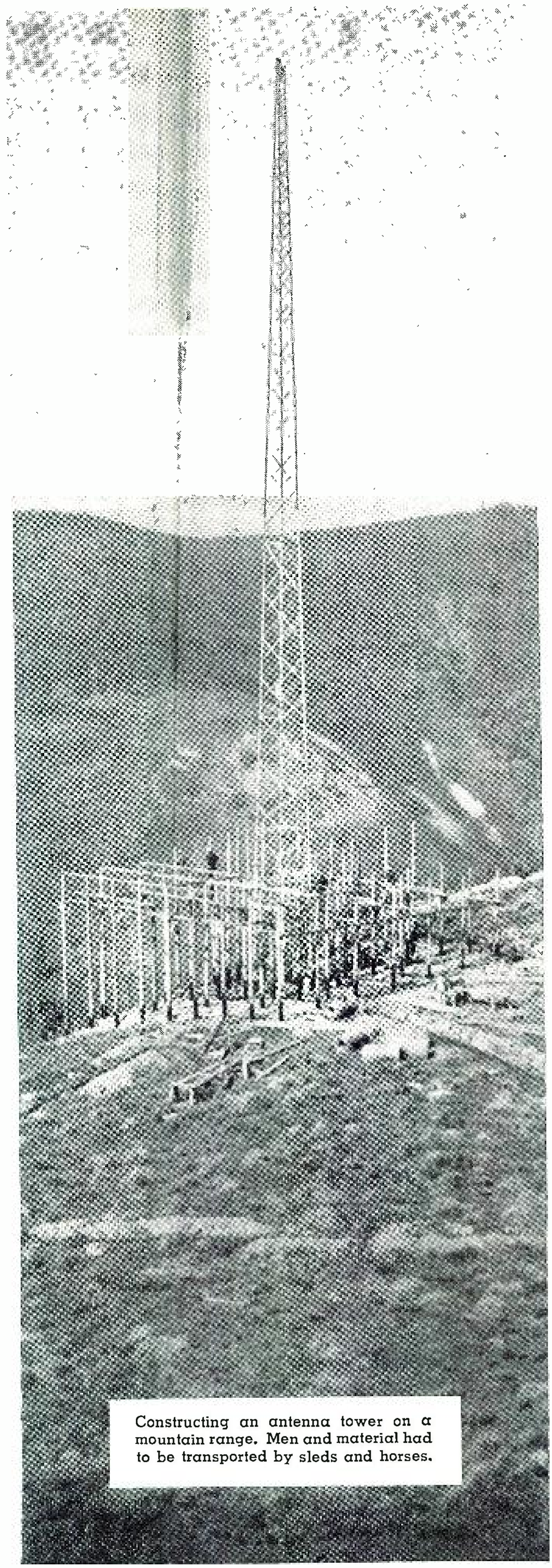
Although there were fewer than one hundred air mail pilots at any one time during the years that the operation was run by the Post Office Department, they proved remarkably efficient—and successful—without much in the way of instruments. During their first year they made a record of 92 per cent successful performance of schedules, transporting 7,720,840 letters. Modern air transportation hasn't raised that figure by much.

But almost from the beginning the air mail pioneers recognized that however skilled the pilot, dependable service was impossible without the development of aids to air navigation. The twin demons of the airways—weather and darkness—were constantly handicapping flight schedules.

Airways were laid out by engineers. Beacons were set up at approximately 10-mile intervals and the beacons themselves standardized. Intermediate fields were created, marked, and lighted. The weather service was coordinated with the airways program, and experimental work began on radio.

As early as 1919 the Post Office experimented with radio direction finder devices. By November 1920, seven radio stations were in operation and by July 1927, when a separate Federal Airways Division was established, there were 17 directive radio beacons. Radiotelephony equipment and other aids were ready for trial.

(*Continued on page* 260)



Constructing an antenna tower on a mountain range. Men and material had to be transported by sleds and horses.

Typical Airway Traffic Control Center equipped with manually operated Flight Progress Boards. An elaborate communications system, both telephone and radio, is necessary to record position of all planes in flight.

THE AIRWAYS LOOK AHEAI

by THOMAS B. BOURNE

Director of Federal Airways

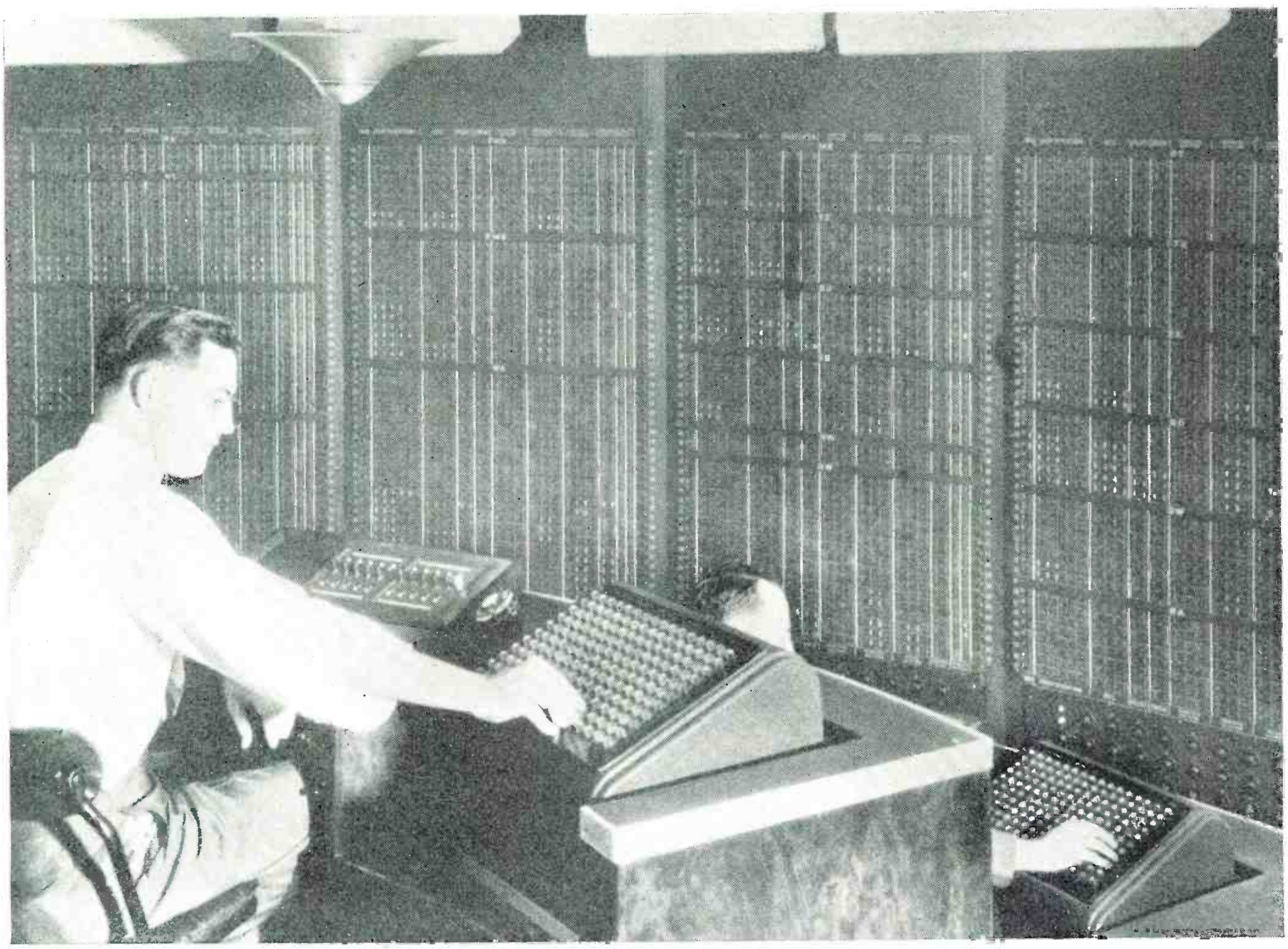
Born January 9, 1896 on a farm in Baltimore County, Maryland. Attended the Baltimore Polytechnic Institute and the Maryland Agricultural College, graduating from the latter in 1916. First world war, enlisted in the Army Air Corps, training at Princeton and Texas Universities and flight training at Rich Field, Waco and Love Field, Texas. Commissioned in 1919 and today holds pilot certificate No. 209. Held the posts of District Manager, Senior Airways Engineer, Assistant Chief and later Chief of the Airways Engineer Division.

Careful planning is necessary to assure efficient air traffic control in post-war period.

THE CAA airways system, long since enlisted for the war, has been performing yeoman service for the Army and Navy air forces not only in this country but in the far corners of the world. Today, more than 90 per cent of all traffic along the domestic airways consists of military and semi-military craft hurrying here and there on important missions. Through the Federal Airways (foreign) Section, manned by CAA experts who have volunteered for service abroad, we are assisting the armed forces in setting up an integrated system of airways communication for trans-oceanic flying and at far-flung points on all the continents—Australia, Asia, Africa, Europe, North and South America. These civilian volunteers have written an exciting chapter in the history of both aviation and radio, but for reasons of military security that story cannot yet be told. Yet those who know what is going on cannot help speculating about the meaning of this in terms of the future.

No one can confidently predict just which way we shall go in the post-war world. But as far as Airways are concerned, one does not need second sight to see that we shall go "radio." Let us try to focus as clearly as possible just what our Airways problem will be.

The end of the war will release for civilian purposes great quantities of materials, an immense manufacturing capacity, and a large skilled labor supply. It will find a world grown acutely air-conscious from training millions of pilots and aviation technicians, from the achievements of transport and fighting airplanes on all fronts, and from popularization of the concept of air as a hitherto unappreciated medium of travel. There is going to be a phenomenal growth in commercial and private flying after the war—as phenomenal as the growth in the uses of



First Automatic Flight Progress Board as originally installed in the Airway Traffic Control Center in Washington, D. C.

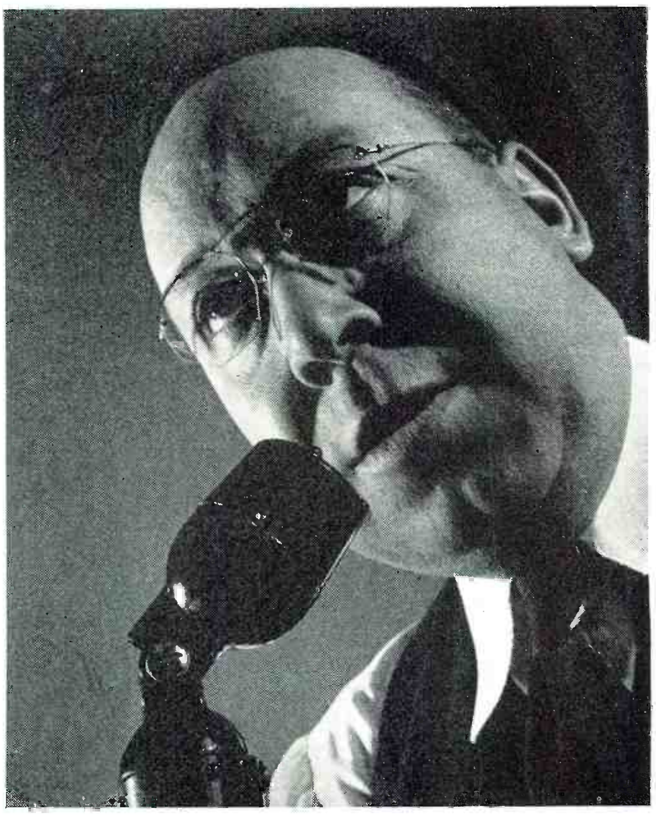
busses, trucks, and private automobiles after the last war.

Glenn Martin is planning a 250,000-pound flying boat capable of carrying 80 tons of bombs or cargo to Europe at a speed of more than 300 miles an hour. Major Alexander P. de Seversky predicts that the present radius of aircraft operations will be extended from three to five times within a few years, and that a round-the-world range of 25,000 miles is at most five years away. Igor Sikorsky believes that ten years after the conclusion of the war we shall see hundreds of short-run helicopter bus services, with hundreds of thousands and perhaps millions of privately-owned direct-lift machines carrying Americans about their business and their pleasures.

In its report on "Transportation and National Policy," transmitted to the Congress by the President in November, 1942, the National Resources Planning board states that "within the next decade or two, air travel in the United States will assume proportions equivalent to approximately 70 per cent of present-day Pullman rail travel, or about 6 billion revenue passenger-miles," which means the transportation of approximately 20,000,000 passengers a year. It is also anticipated that all first class mail will go by air. Regular air freight lines will be developed, with feeder airlines to smaller cities and pick-up service in the villages. Many experts agree that aviation is the most likely key to future prosperity and the many difficult problems of economic readjustment after the war, so that it is obvious that every possible step should be taken now to encourage the growth and expansion of aviation to the fullest extent.

One of our biggest problems will be air traffic control. An inadequate and inefficient air traffic control system will seriously restrict and retard air transportation. A study of air traffic trends reveals the magnitude of the problem.

Airport Traffic Controller must know at all times the position of every ship that is in his vicinity.



Pilot obtaining weather information prior to flight. An enormous amount of work is involved in obtaining and recording weather conditions over all aircraft routes.

During the fiscal year 1938, CAA airway traffic control centers handled approximately 300,000 movements of aircraft. In 1941 the number exceeded 1,500,000, and in 1942 jumped to more than 6,000,000. In 1943 it is estimated that between 13,000,000 and 14,000,000 movements will be handled. A careful analysis of all available data indicates that the 60,000,000 mark may be reached in 1950.

This would be quite impossible without radio, which constitutes the hub and most of the spokes of the air traffic control wheel, a major cog in the far-flung Federal Airways system.

To insure adequate and efficient air traffic control during the next decade, careful planning is necessary. Such planning must cover the problems not only of our domestic airways but also of intercontinental and trans-oceanic flying.

Non-scheduled flights normally account for most of the civilian flying in the United States. In 1939 the air carriers flew about 83,000,000 miles, whereas private aircraft flew about 180,000,000 miles, or more than twice as much. This was accomplished with less than 14,000 private planes, a small number indeed compared to the 32,000,000 automobiles registered in the United States at that time. By the end of 1941, thanks largely to the CAA pilot training program, the number of private planes had increased to almost 25,000. After the war this figure is bound to be multiplied many times over for two good reasons—(1) we shall have the mass production facilities and skills to produce inexpensive, safe, and easy-to-operate private planes in quantity, and (2) with several million men returning to civilian life from the military air forces, all of them trained as pilots or in some other phase of aviation, there will be an unprecedented market for such planes. Men who have enjoyed the freedom of cruising through the air will not again become earth-bound creatures if they can possibly avoid it.

Commercial flying will also increase many times over, both freight and passenger. The volume of air express has been rising rapidly and will continue to do so. This is already reflected in the operations of the air transport companies. Only cargo is now carried on Flight 17 of the United Air Lines between New York and Salt Lake City, while Panagra is running an all-freight route between the Canal Zone and Lima, Peru. For the year ending April 30, 1942, the domestic airlines flew 1,500,000,000 passenger miles. During 1946, according to a conservative estimate by the Civil Aeronautics Board, they will be flying six billion passenger miles, which will require a five-fold increase in the carrying capacity of the airlines. According to estimates using the same years as a basis of comparison, trans-oceanic and international air passenger traffic under the American flag will increase six times, and mail and express traffic at least eight times.

In addition, it is estimated that in the post-war period their will be well over 10,000 military planes on active service in the country.

All of this adds up to an air traffic control problem of great complexity, one that will tax all of our inventive genius, scientific knowledge, and practical ingenuity.

What specific steps are being taken to solve this problem so that we can be sure of satisfactorily meeting both present and future needs?

The Air Traffic Control Division of CAA has just completed a study which proposes that necessary expansion be carried out in three stages:

1. Immediate improvements in Air Traffic Control.
2. Improvements to be completed by 1945.
3. Post-war improvements.

The first program involves only those improvements which can be immediately initiated and completed within 12 months. It is designed to increase the capacity of present facilities and make the utmost use of available equipment. The second program aims at the completion of all details of a system for automatic handling of flight data and improvement in air traffic control ground-aircraft communication methods. It is hoped to complete all preparatory work on these projects during the war so that actual construction of equipment and facilities can be started immediately after peace is signed. The third phase of the program is concerned with improvements and developments up to 1950 approximately. It is our hope here to set up a master pattern of air traffic control. The details of this program will be profoundly affected, of course, by technical developments made during the war, most of which will have to be kept secret until hostilities cease.

The immediate post-war problem will be to rebuild the entire domestic airways radio system by substituting ultra high frequency for the old standby intermediate frequencies ranging between 200 and 400 k.c. Ultra high frequency will eliminate static and provide a visual as well as an aural course, if not omnidirectional courses. We see the necessity for two voice channels on every radio range station, the employment of ultra high frequency for traffic control, ultra high frequency localizers at all important airports, with glide path and ultra high frequency markers to permit the pilot to land under instrument conditions.

Let us project our imagination a bit into the future and make an instrument flight from Washington to New York, employing aids to air navigation such as do not now appear on the airways.

Well, let's start our imaginary flight. The traffic control gives us clearance out of Washington through the ultra high frequency equipment in the airport control tower, the pilot taxis out onto the runway, tunes in the localizer by pushing a button. The traffic control tower operator, through the use of new radionic devices, knows the location of every ship in his vicinity. When the path is clear, the pilot is instructed to take off and fly north on the Washington UHF radio range to check over the Baltimore fan marker. Let's make this fan marker automatic, so that when the ship passes through the pattern of the marker, a light will flash in the cockpit and inform the pilot of his location. At the same time, his position will be automatically recorded on flight progress boards at Washington, Baltimore, Philadelphia, and New York. No voice contact will be required unless the pilot fails to go through the marker. In that case, the traffic controller at Baltimore will advise the pilot of his location, for the ship will appear in the visual screen at Baltimore. Remember this is an instrument or blind flight.

(Continued on page 240)

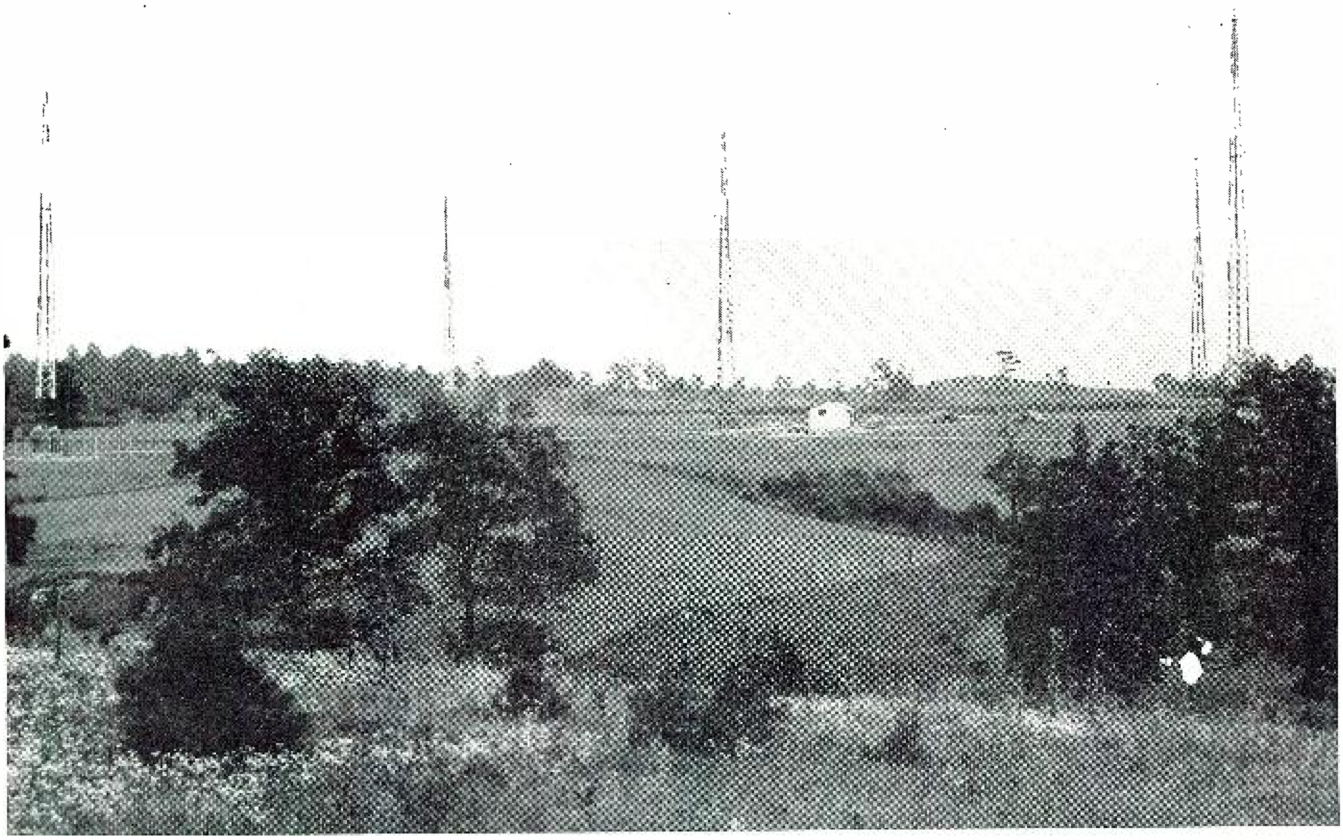


Fig. 1. Five 131-foot steel towers and panel-type building used for intermediate frequency range transmissions.

ENGINEERING

Safety of aircraft depends upon radio equipment that possesses extreme ruggedness—designed for continuous duty.

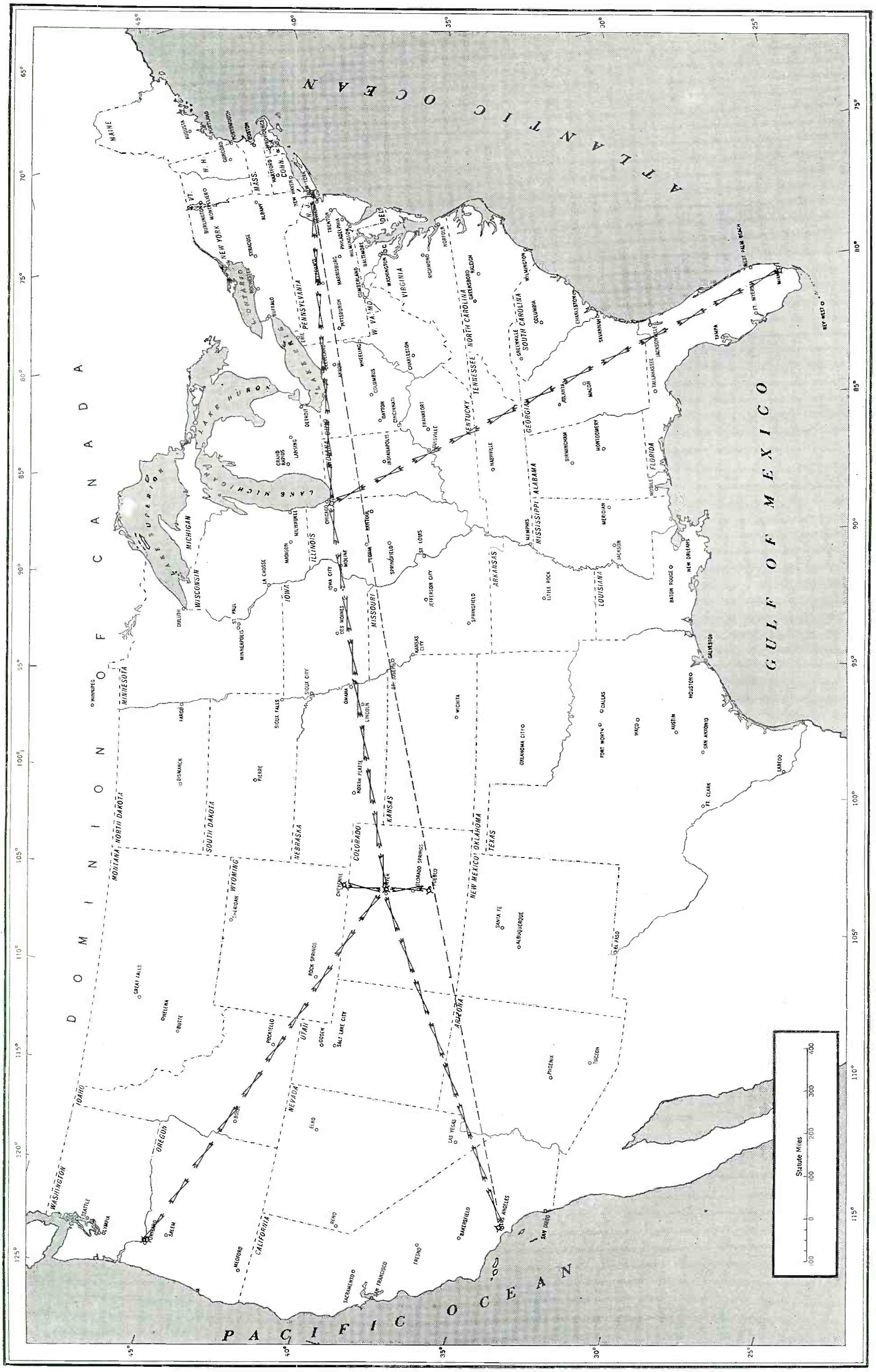
by ARTA H. HADFIELD

Assistant Chief, Engineering Division, CAA

Born in Smithfield, Utah. Holds degree of Civil Engineering, B.S., from the University of Utah. Is an astronomer; associated with the United States Naval Observer in that capacity for nearly two years before joining the Bureau of Lighthouses, Airways Division in 1929. Took time out to work in the Lighthouse Service in Portland, Ore., and on the Bonneville Dam before returning to the fold in 1935. Holds a private pilot's license. Is devoting his entire time to the engineering problems, both present and future, pertaining to the Civil Aeronautics Administration.

THE completion of a transmitter building and power shed, constructed with mahogany planks and boards sawed by hand from jungle trees, and erection of steel towers among ant hills 15 feet high, have made possible the installation of transmitters and other equipment forming the last link in a chain of stations 6,700 miles long connecting three continents. Additional stations located on islands, deserts, and mountains are being added, which will immeasurably increase the safety of operations over an aerial route girdling the earth.

One of the duties of the Airways Engineering Division of the Bureau of Federal Airways is to plan and lay out new routes, conduct aerial and ground surveys, select locations, assemble and transport materials and equipment, construct buildings, and erect tower and antenna systems for the establishment of radio range and communication stations. Few laymen—or, for that matter, few pilots—appreciate the difficulties involved and the effort required to place a radio station in operation at the many remote locations where facilities are now required. Within the United States availability of material and transportation facilities simplifies problems to a great extent, although in numerous instances material and equipment have been transported by horse and mule pack trains to mountain sites. In Alaska aerial transportation, tractor trains, and dog teams are used, and advance camps must be built to house and feed construction workers. Materials available at or near the site have been used wherever possible, but at many locations all material and construction personnel must be transported over long distances. In several instances native crews have been recruited and trained to perform all construction, including the erection of steel towers 180 feet in height. The five 131-foot steel towers used for intermediate-frequency ranges are shown in Fig. 1.



UHF RANGE AIRWAY

Proposed route of UHF range stations for airlines connecting the east and west coast.

As far back as 1941 preliminary studies were under way for the modernization and re-arrangement of the radio facilities serving the Federal airways. The problem of providing radio range and communication service is complex. One of the most important factors involved is the type of radio equipment selected for use. The locations and arrangement of the radio facilities will depend to a large extent upon the equipment transmission characteristics.

The type of facility with which future airways should be equipped has been the subject of considerable discussion and study. At this time it seems that the new type UHF range and communication station, which has been under development and test by the Technical Development Division of the Bureau of Federal Airways for the past four years, is likely to be selected for the range stations providing airway courses and the communication stations for airway and airport traffic control. Ultra-high-frequency transmitters are being utilized in the airport instrument landing systems now being installed at certain key airports. The principal advantage of ultra-high-frequency is that a wider range of frequencies will become available for use, allowing increased power with less interference between stations. Another important consideration is the increasing use of UHF radio in warfare, which is resulting in the development of manufacturing capacity sufficient to meet all anticipated peacetime requirements. We have already reached the stage of development where all planes making cross-country flights must be equipped for radio communications, and low cost equipment should be available for every airliner and "puddle jumper."

The Airways Engineering Division envisions traffic on the airways of tomorrow rivaling that on the highways before gas rationing, and is planning accordingly. There will be 24,000-horsepower, 250-passenger planes making the 3,000-mile transcontinental or Atlantic flight non-stop, smaller planes making numerous scheduled flights of 500 to 2,000 miles between the larger cities, feeder lines pouring increasing volumes of mail, passengers, and cargo into the main routes, and light planes by the thousands rising from every city, town, and crossroads.

There can be little doubt that the transcontinental and transoceanic mail and passenger planes of the future will follow the shortest routes, which are the great circle courses. These planes operating at altitudes above 20,000 feet, far above terrestrial obstructions and over clouds and accompanying storms, will be able to use celestial navigation and take direction finder bearings to supplement the airway radio aids. However, planes operating between the larger cities will encounter the same weather and ground hazards as now exist. Smaller planes operating over pick-up routes and the private craft, whether operating for business or pleasure, will increase the demand for more and better ground aids. The present system of airway radio range and communication stations has been developed in somewhat of a piece-meal manner to meet immediate needs of commercial and military operations. In modernizing this system, long-range planning is imperative, and the immediate needs of a particular operator or community must be subordinated to an over-all plan which will best serve the needs of the carriers, military services, and the general public.

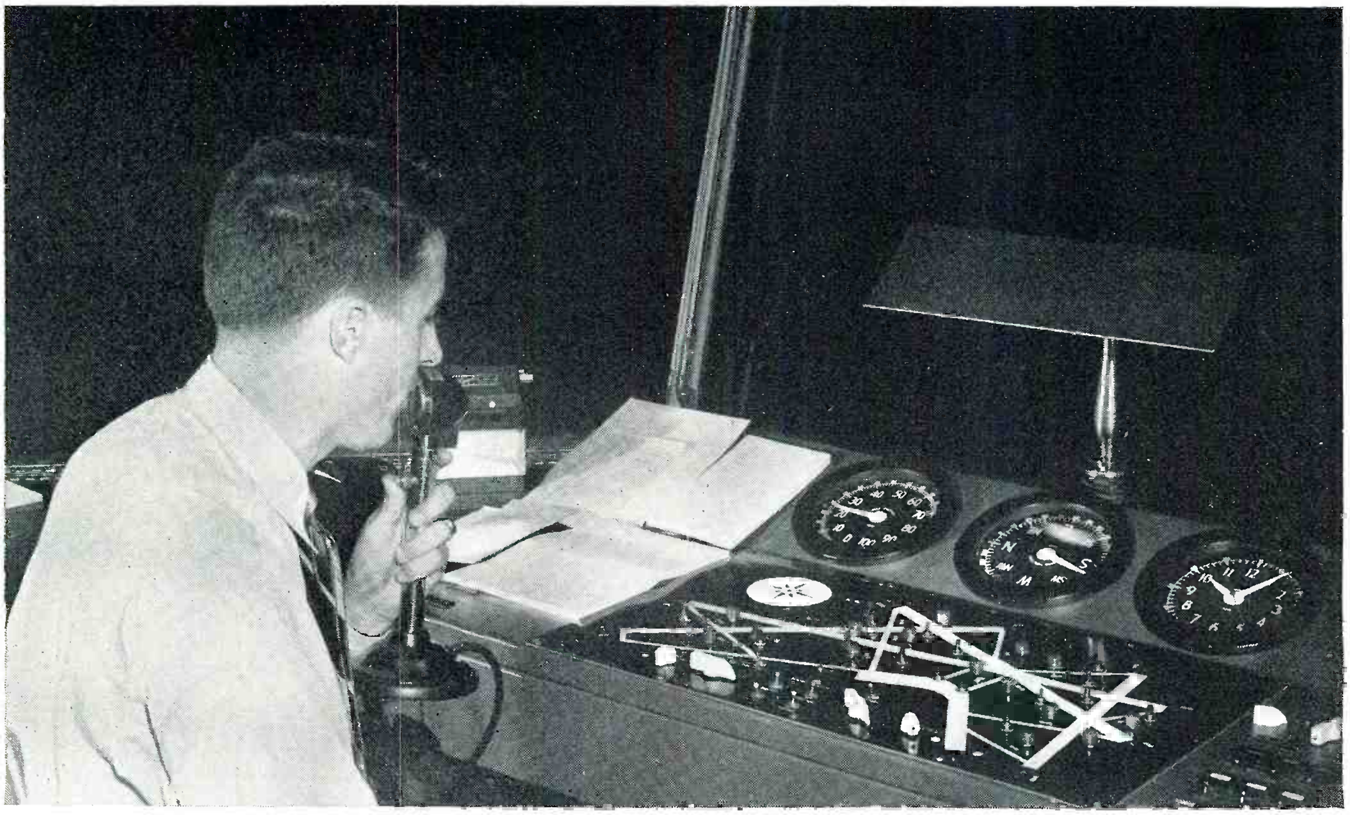
The San Francisco-Salt Lake-Omaha-Chicago-New York route was the first transcontinental airway to be implemented with air navigation facilities. If future routes are built to serve the need of the majority, it is likely that a route between New York and San Francisco, or New York and Los Angeles, will be selected as one of the first projects to be undertaken when reconstruction and modernization becomes possible.

Let us assume that the airway between Los Angeles and New York has been selected as the first of the new routes to be implemented with the new type UHF range and communication stations. The shortest distance between Los Angeles and New York is, of course, over the great circle route. Such a route would cross the 15,000-

(*Continued on page* 274)

Installing power wire on a Department of Commerce airways radio station antenna tower. Note the concrete base.

Fig. 2. Tower and building for UHF ranges. Many similar units will be needed to provide complete airway coverage.



Visual runway indicator in control tower of one of our larger airports used for safe landing of planes.

AIRPORT TRAFFIC CONTROL

by H. S. STOKES and **H. F. COLE**

Ass't. Chief Signals Division CAA

Chief Airport Traffic Control Section CAA

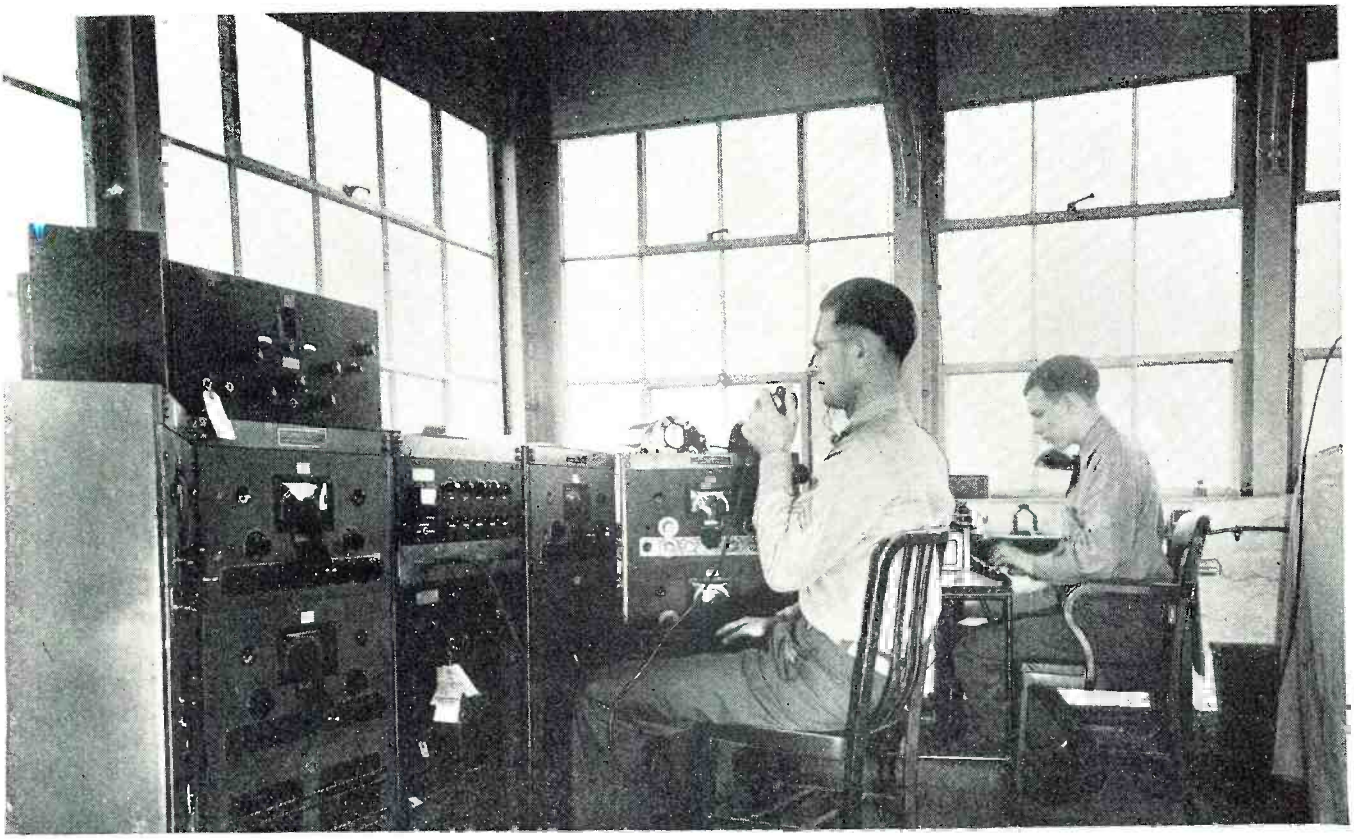
Was born at Chicago, Illinois, in 1908. Attended Armour Institute of Technology and graduated in 1929. He entered the technical field of radio at the age of 21, and since that time he has been employed by the United States Government, working on air-navigation radio aids and related problems. Has been noted for his outstanding engineering work on aircraft equipment designs. At the present time, he is Assistant Chief, Signals Division, Civil Aeronautics Administration, Dept. of Commerce.

Learned to fly at Vendome, France, as a member of Royal Flying Corps in 1916. Test pilot in France and England until end of World War I. After his return to this country was one of the few barnstormers who have become immortalized in fiction and who spread the gospel of aviation throughout the entire country. Began flying airmail (1929) Chicago-St. Paul for Northwst Airlines. Joined Airway Control service in Cleveland (1936). Chief of the Airport Traffic Control Section, CAA.

AN airport traffic controller leads a busy life, for his is an important and complicated job. He must prevent collisions between aircraft on the ground and in flight by carefully watching traffic on his airport and within the local control zone—that is, within a three-mile radius of the airport.

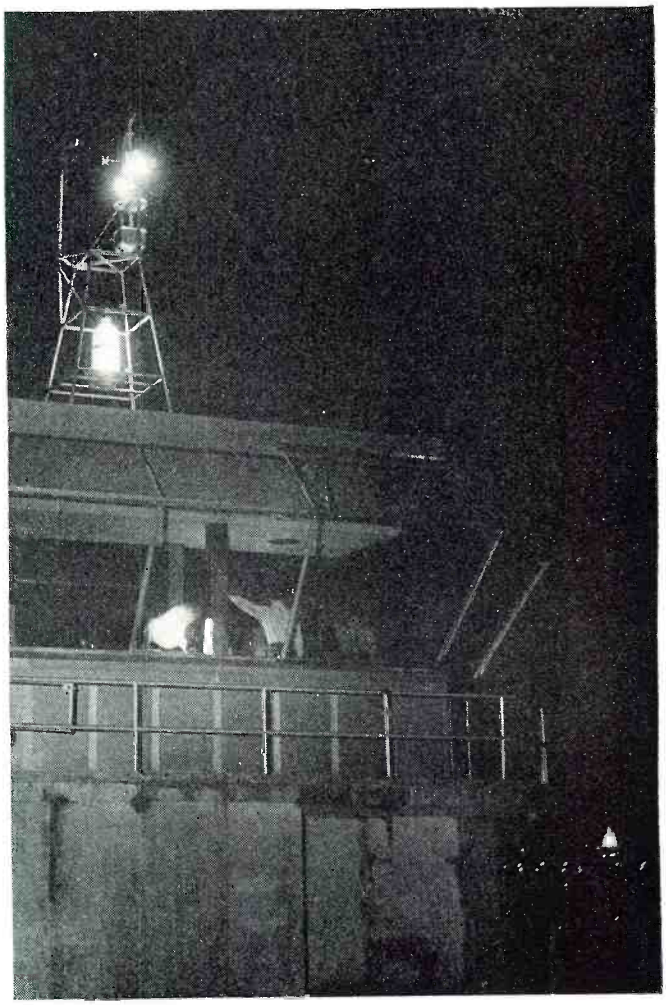
He issues traffic clearances and instructions, telling pilots when to come in, when to hold a certain altitude, when to take off, or how to taxi after landing. If traffic is congested, he issues landing sequence numbers. He advises pilots about wind conditions, possible obstructions on runways, and other hazards, such as snowdrifts in winter, and aids them in parking at the proper loading ramps. He is responsible for turning on floodlights and the operation of other visual aids. It is also his function to relay traffic clearances received from Airway Traffic Control Centers and to control local traffic during instrument flying conditions. In sum, he must devise and control traffic and taxiing patterns for the safest and most efficient use of his airport. And he does most of this by radio, but airport control towers are also equipped with light guns to transmit standard signals to pilots.

Now his job has been made even more complicated by the war, for military and semi-military planes have added heavily to the traffic at certain airports. At the request of the War Department, the Civil Aeronautics Administration is operating traffic control towers at 90 large airports, and others are being commissioned. These control towers were provided with an intermediate-frequency transmitter and several receivers. Some of this equipment was not of sufficiently high quality or was obsolete. Where suitable equipment was in use, additional necessary items were sup-



Scene in an Airdrome Control Tower. All movements of aircraft using this field are controlled by these operators.

Night view of world's most modern control tower, Washington, D. C.



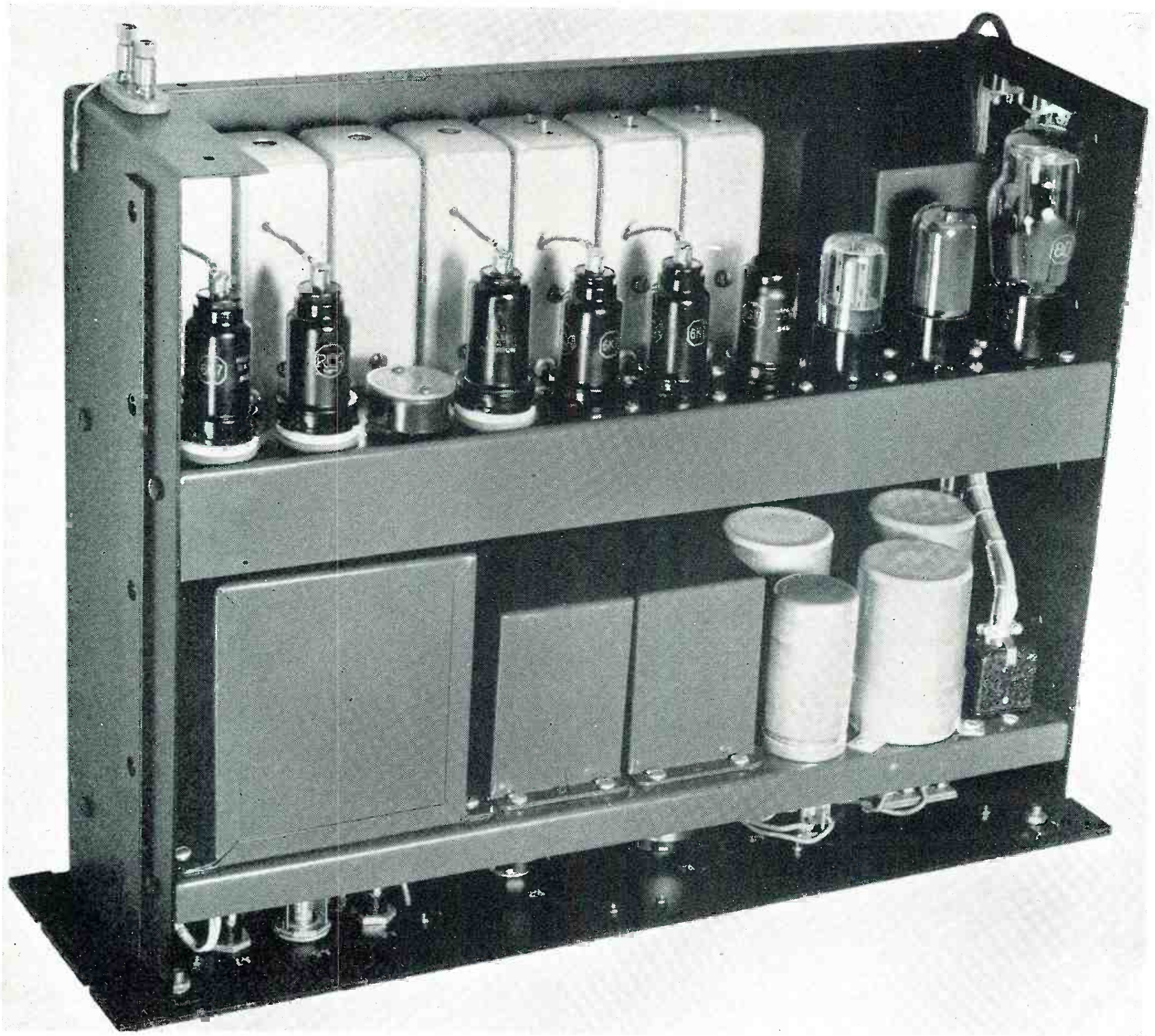
CAA, through modern equipment and engineering in airport control, has given America the safest Airways in the world.

plied. A large volume of such additional radio equipment was required, much of it incorporating novel features of interest to all students of radio.

It has been standard practice since airport control towers first came into use for the towers to transmit to aircraft on some frequency in the 200-400 kc. band, and for aircraft to transmit to the towers on a high frequency between 2500-7000 kc. Plans were made several years ago for a gradual transition to ultra-high frequency transmissions both to and from towers. Ultra high frequency receiving and transmitting equipment is under procurement at present which will be used to put these plans into effect at the earliest possible date. However, because of the urgent need for additional control towers, created by the war, priority has been given to procurement of additional intermediate and high frequency equipment to meet immediate needs.

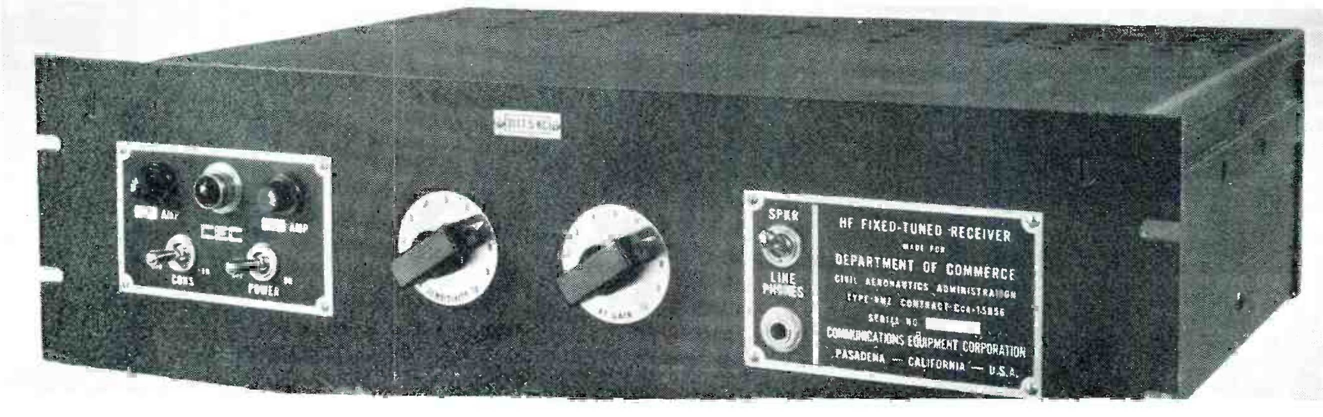
As radio transmitters are the most expensive and complex item of control tower equipment, their design was given a great deal of study. Several basic features were decided upon at the outset:

(1) All chassis should be of the "pull-out" type, similar to file drawers, to provide easy accessibility for purposes of maintenance.
(2) Intermediate- and ultra-high-frequency transmitters should have modulator units and power-supply units of identical design to provide interchangeability of parts, minimize design costs, simplify the problems of the maintenance man.
(3) Ventilating intakes and outlets, wiring ducts and knockouts, etc., should be so located that transmitters could be placed with their back or side against



FIXED-TUNED, HIGH-FREQUENCY RECEIVER

Present day model of a CAA high-frequency receiver for the Department of Commerce, shown with dust cover removed (above). All such units are sturdily constructed and well shielded from electrostatic pickup. Front view (below) shows simple design for ease of operation. Power supply is mounted on separated chassis and cabled to simplify maintenance operation.



a wall, or on top of one another whenever required.

In other respects the transmitters were of conventional design. Crystal control was used, of course, and provisions were made for tone modulation, as this could be added at little cost and it made the intermediate-frequency transmitter design suitable for use at another type of facility being installed by the Civil Aeronautics Administration. The antenna loading coil of the intermediate-frequency transmitter was arranged so that it could be removed from the transmitter and located in a small housing beneath the antenna at airports where the antenna could not be near the transmitter. Flexible coaxial transmission line is used to connect the transmitter to the remotely-located loading coil. Contactors were provided in the transmitted output circuit so that when a transmitter of the same type was provided for standby purposes, only the transmitter in use would be connected to the antenna system. A side view of the intermediate-frequency transmitter is shown in an adjoining picture, with all units withdrawn from the cabinet. These transmitters are now being completed and delivered at a fairly rapid rate, but deliveries of the ultra-high-frequency transmitters have not begun.

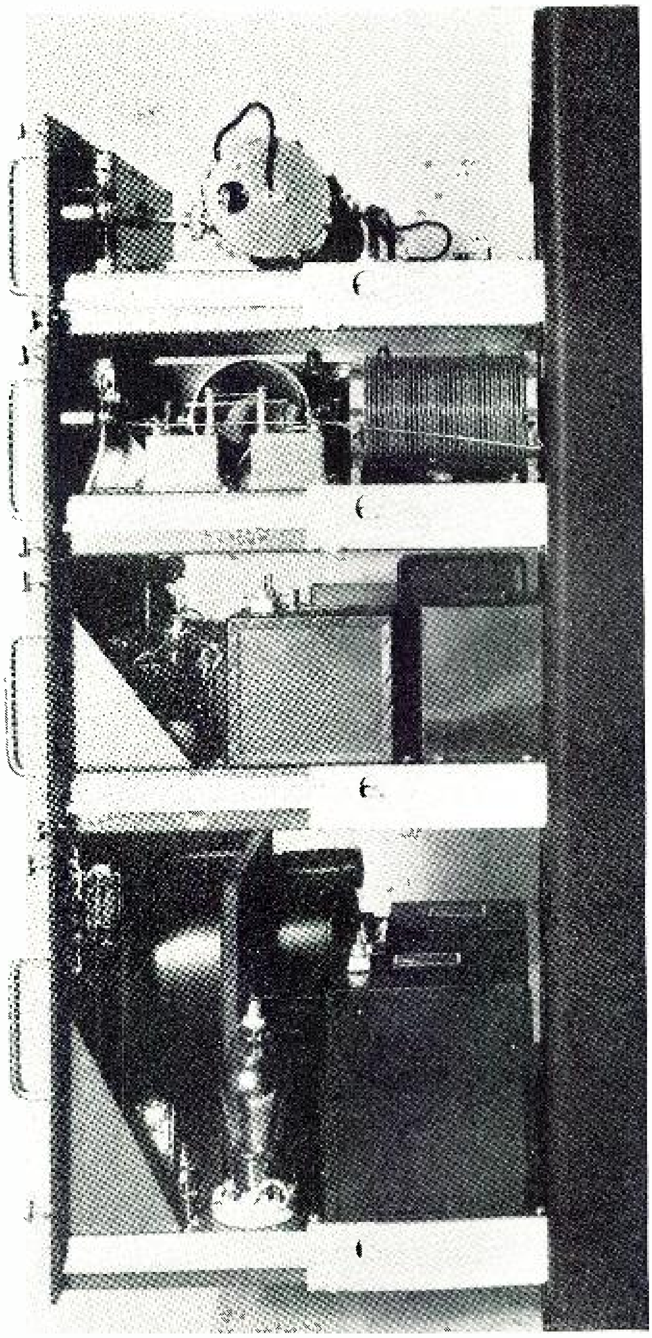
The transmitter control circuits received considerable thought so that they would be as simple as possible and yet perform all the necessary functions. It is intended as transmitters become available to build up each control tower's complement to two intermediate-frequency and two ultra-high-frequency transmitters, although only one intermediate-frequency and one ultra-high-frequency transmitter will be used at any one time. Two toggle switches will be provided in the control tower for changing transmitters in case of failure, one for the intermediate-frequency transmitters, and the other for the ultra-high-frequency transmitters.

When a transmitter in use fails, it will thus only be necessary that this switch be thrown to change to a standby transmitter. Two such identical units are considered necessary so that if one fails another is immediately available. It is imperative that radio communications is maintained at all times.

As switching of audio input circuits to the four transmitters that will be employed would require several relays, it appeared a simpler solution to increase the output of the speech amplifier so that all four transmitters receive audio input power at all times regardless of whether they are the transmitters in use or not. A transformer having a 600-ohm input and an output suitable for feeding the four transmitters was therefore incorporated in the control equipment for each tower. The two ultra-high-frequency transmitters are fed directly from this transformer, while the two intermediate-frequency transmitters are fed from this transformer through a single-section equalizer which compensates for the sideband cutting occurring in the output circuits of these transmitters. The equalizer used is of the bridged-T type with an adjustable attenuator, and the equalizer constants are so chosen that the response of the equalizer at the various settings of its attenuator are such as to compensate for the sideband cutting throughout the 200- to 400-kilocycle range.

The advantage of this type of equalizer is that when terminated with a 600-ohm resistive load, its input impedance is 600 ohms, purely resistive, for all frequencies, regardless of its adjustment; thus, it may be set on the basis of standard calibration curves, rather than requiring a "cut-and-try" procedure. There is a small hinged panel at the bottom of the main unit to permit "tipping out" the unit at the installations where it must be mounted in a shallow cabinet fastened to a wall, as will often be the case and although the unit is compact, it is easily accessible for routine maintenance.

Traffic controllers already have so many duties that they cannot be asked to hold their voice level constant and make careful adjustments of a gain control when they transmit, so that the transmitters will not be overmodulated. Instead, a level-governing speech amplifier capable of providing essentially constant output over a wide range of inputs must be used. The amplifiers being used are basically the same as the program-operated level-



Side view of the intermediate-frequency transmitter showing the arrangement of power supply and tuning mechanism.

governing amplifier described in the Proceedings of the IRE for November, 1941, and provide rapid and accurate regulation of output level. They have a maximum gain of 70 db., and have an output level sufficiently high to supply the required audio input power to four transmitters.

None of the standard microphone designs appeared entirely suitable for control tower use, so a specification was prepared describing our conception of the proper microphone for this application. The continuous use of the push-to-talk switch on the microphone had resulted in numerous switch failures in microphones tried previously, so a snap-action switch such as the Microswitch was specified for this use. It had also been found that the continuous handling of the microphones resulted in the finish wearing off the tubular metal stands, so a black phenolic stand was specified. A heavy ribbed cushion of rubber was specified for the base of the microphone to reduce the possibility of injury to the microphone element if the microphone were set down hurriedly or carelessly.

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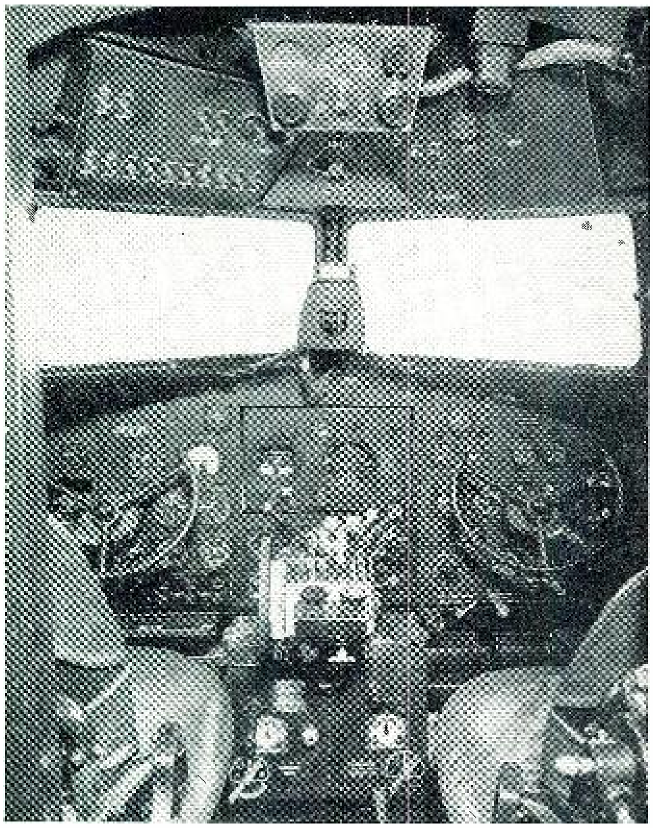


Interior view of cockpit of a large transport plane. Note the elaborate equipment necessary for safe navigation.

Radio operator at his post on the flight deck equipped with a complete broadcasting and receiving station.

COMMUNICATIONS

This branch of the CAA operates far-flung communication system and wire service for weather bureau.

by EUGENE SIBLEY

Chief, Communications Division, CAA

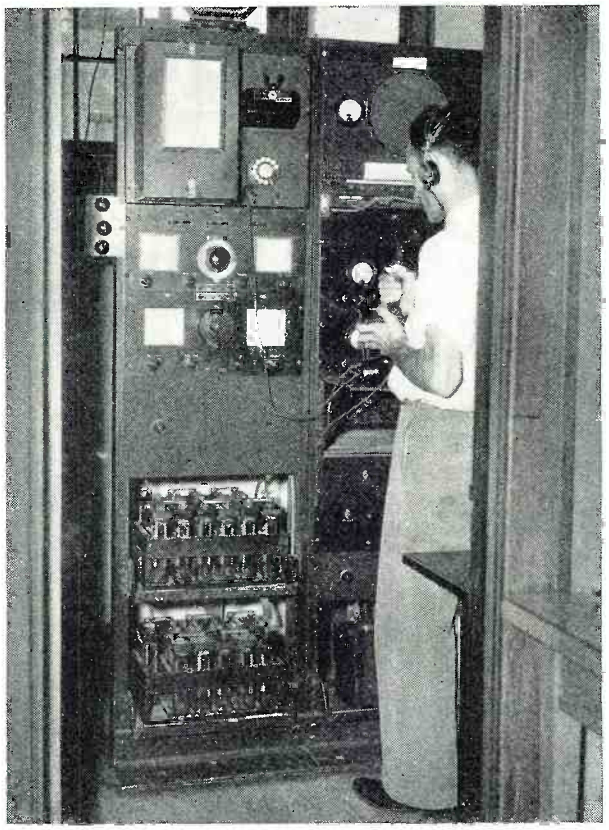
Born in Portland, Oregon. Has been in the aviation business since 1919 when he became associated with the Air Mail Service in an administrative capacity. Was a soldier and sailor, having served in the Navy from 1912 to 1917 and the Army from 1917 to 1919. Instructor in Radio Operations at Post Field, Fort Sill, Okla., during last war. Joined the Bureau of Lighthouses in 1928 and has been associated wth the Federal Airways in various capacities since that time. Now Chief of the Communications Division, Civil Aeronautics Administration.

IT is believed that all readers of this publication have some knowledge of the importance of an adequate communications service to the safety and overall efficiency of transportation by air, but it is doubtful if more than a few are aware of the extent of the service which must be provided to insure these. For our present purpose, the writer will not dwell at length upon the early development of aeronautical communications and the industry in general; instead, an effort will be made to set forth the scope of our present job, a description of the facilities available for the job, and information concerning the manner in which our men and women are doing the job.

The numerous aids to air transportation provided by the Federal Airways Service are located along the airways or closely adjacent thereto. These aids include emergency landing fields, airways beacons, radio range and voice communication stations, airway traffic control centers and airport traffic control towers.

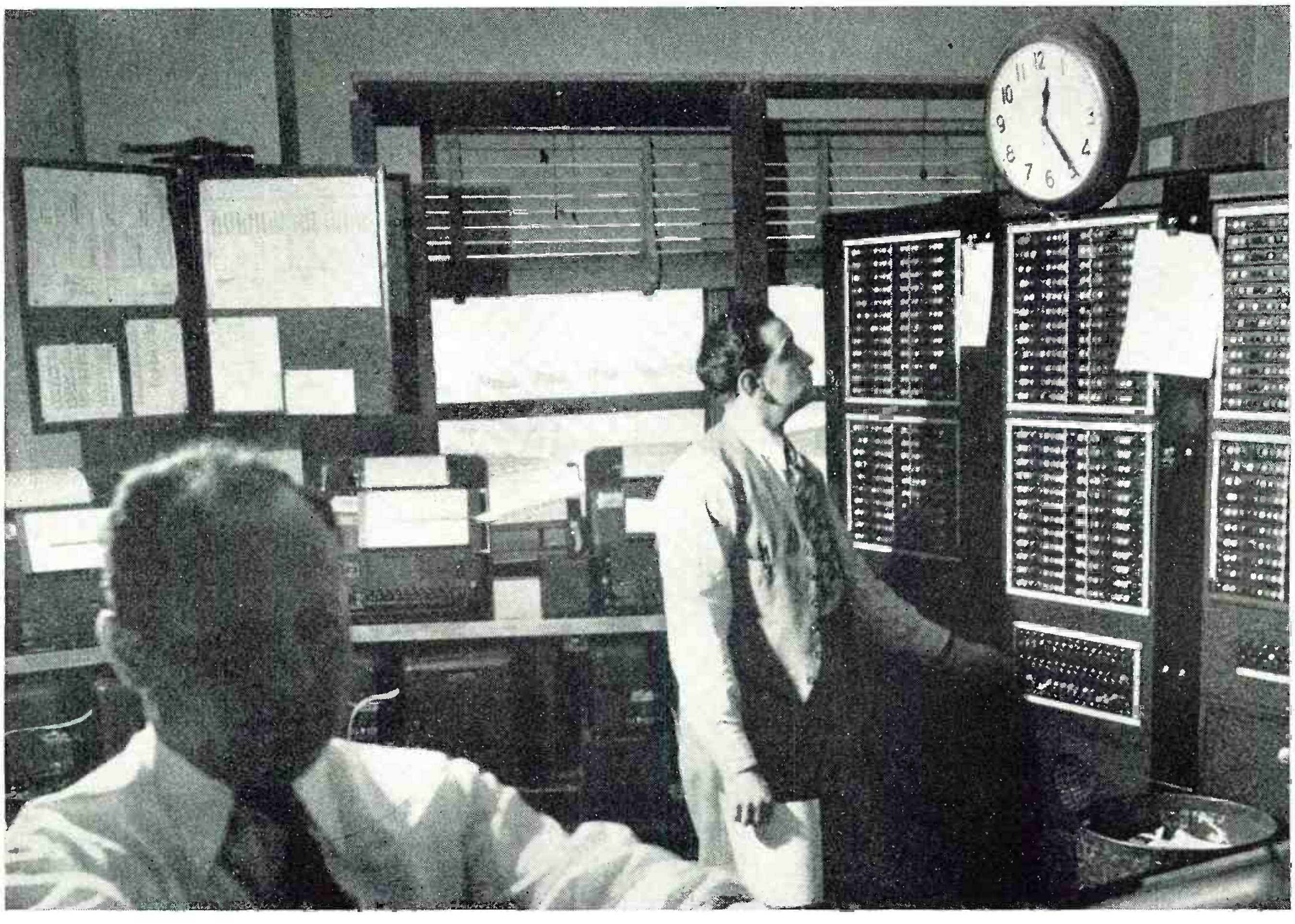
There were approximately 1,000,000 aircraft operations over the airways during the month of September 1942. Had these operations taken place consecutively, it would mean that every two and one-half seconds throughout the day and night of the month, a passenger, cargo carrying, or military aircraft was taking off or landing. This example was developed only to stress the fact that each aircraft operation required the direct attention of communications and air traffic control personnel at least once; some flights needed and received essential information and instructions many times. The pilot or radio operator of an aircraft en route from New York to Miami will, under normal circumstances, communicate with our ground personnel by radio at least ten times. The number of contacts may be doubled or trebled when unusual conditions prevail. Simple arithmetic and conservative estimates of

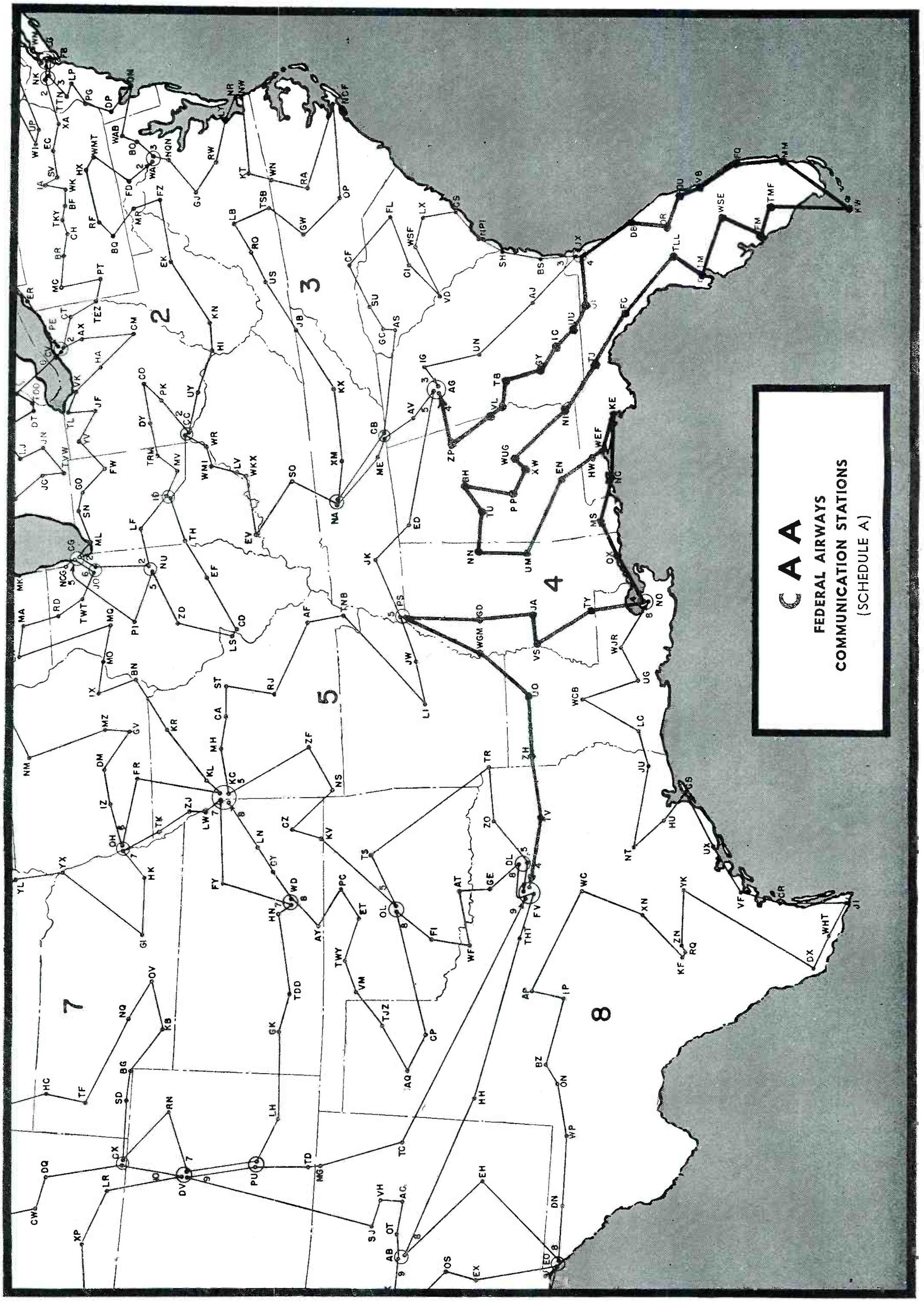
Airways Traffic Control Center. On each of these slots is recorded complete data of individual flights over Federal Airways.

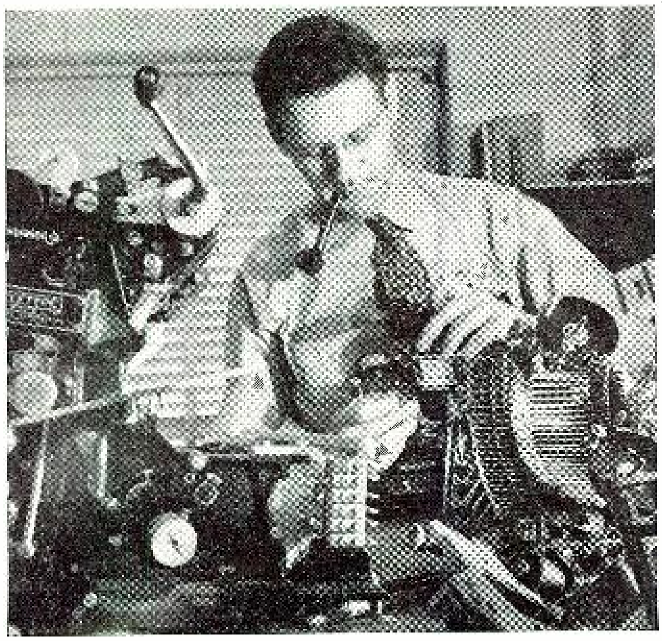


CAA airways station broadcast booth. Operator of equipment transmits message to another station.

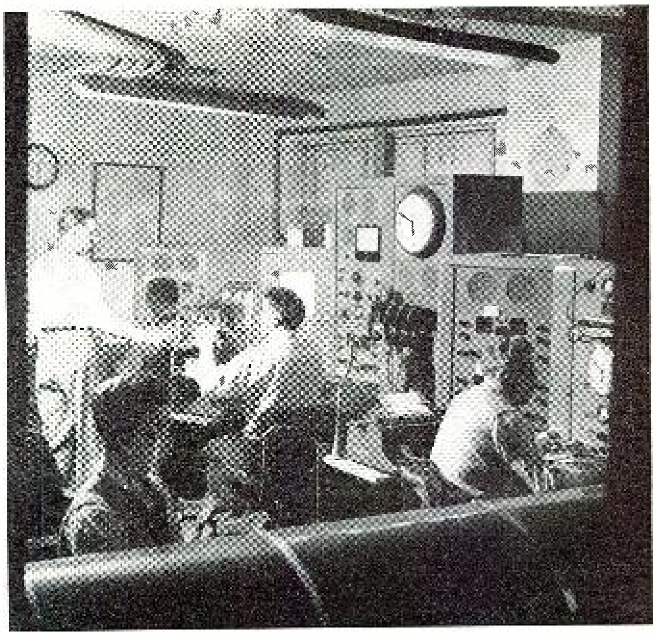
Interior of Airways Communications Station showing several teletype machines and radial board.




CAA
FEDERAL AIRWAYS
COMMUNICATION STATIONS
(SCHEDULE A)



CAA maintenance man overhauling teletype machine. Machines are used to transmit weather reports from other stations.



Intercontinental Airway Communications Station, where all intercontinental and transatlantic communications are received.

aircraft-to-ground calls made during routine flights will indicate partially the extent of the demands for service which we must be prepared to meet.

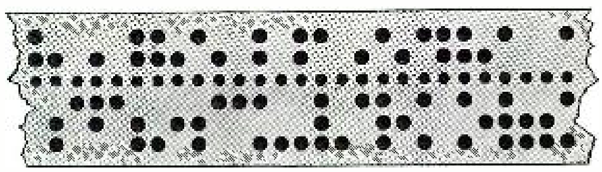
It might be well to mention several of the services required by the airman if a flight is to be conducted safely and efficiently. Two ever-present forces which constantly exert their influence upon airmen are those of Gravity and Weather. The first is under control and may be dismissed from present considerations; the second is as changeable as a woman's mind and, for several years, was responsible for more commercial aircraft accidents than all other factors combined. Before starting a flight, the first interest of a pilot is in the weather. We must, therefore, make available accurate reports covering weather conditions throughout the area over which he will travel. Clear skies may be present at the departure point, but storms of great intensity often lie just over the horizon. Hundreds of stations observe and report surface weather conditions hourly, or more frequently when important changes occur.

From these reports the pilot receives information of the height of clouds above the earth (ordinarily referred to as "ceiling"), the distance at which objects are clearly discernible by the naked eye (if 9 miles or less), and presence of snow, rain, fog, dust, smoke or other obstructions to vision. He will also know the temperature as recorded by dry and wet bulb thermometers (close proximity indicates probable formation of fog, rain or other precipitation), the direction from which the wind is blowing and the velocity in miles per hour, the atmospheric pressure, and miscellaneous remarks which will describe any conditions which may not be apparent through inspection of the preceding items. Proper interpretation of the surface weather reports will enable the pilot to evaluate the obstacles before him and plot a course which will carry him over, or around, the points where dangerous conditions may be encountered.

To assist in long range planning, forecasts are required showing the expected trend of weather conditions for a period of at least six hours. Such forecasts are prepared at Weather Bureau centers and must be distributed to all airports and communication stations along the Federal Airways for dissemination to airmen. The foregoing meteorological information is absolutely essential to safety. The matter of expedition must next be satisfied.

Advice as to the direction and velocity of winds above the earth is invaluable. At an elevation of 2,000 feet the wind might be from the East, velocity ten miles per hour, while at 12,000 feet the pilot might find the wind blowing from the West, velocity 60 m.p.h. If an aircraft with a normal speed of 150 m.p.h. in still air is favored with a tail wind of 60 m.p.h., the actual speed relative to the surface of the earth will be approximately 210 m.p.h. Conversely, if the aircraft is bucking a head wind of 60 m.p.h., the actual ground speed will be approximately 90 m.p.h. It is obviously advantageous for the pilot to select a flight altitude where the most favorable wind is to be found, as saving of time and fuel required for the journey will be considerable. It is part of our job to effect proper distribution of reports from the numerous stations at which balloon sounding of upper air conditions is accomplished.

REPORT PERFORATED ON TAPE
FOR AUTOMATIC TRANSMISSION



REPORT AS IT APPEARS IN THE TELETYPE COLLECTION

AG C 24 ⊕ 8 152/58/46 ↑ 14/996

REPORT AS IT APPEARS IN PLAIN ENGLISH
Atlanta. Contact flying conditions prevail. Ceiling two thousand four hundred feet. Sky overcast. Visibility eight miles. Pressure in millibars 152. Temperature fifty-eight degrees. Dew point forty-six degrees. Wind direction south velocity fourteen miles per hour. Setting for altimeter at elevation of this airport 2996.

Having made essential meteorological information available which enables the pilot to profit by favorable aspects of the weather and avoid unfavorable or dangerous conditions, we must give attention to other services conducive to flight safety.

The airway aids, landing fields, radio range stations, et cetera, have been mentioned previously. The airman must be immediately advised of any change in the status of these

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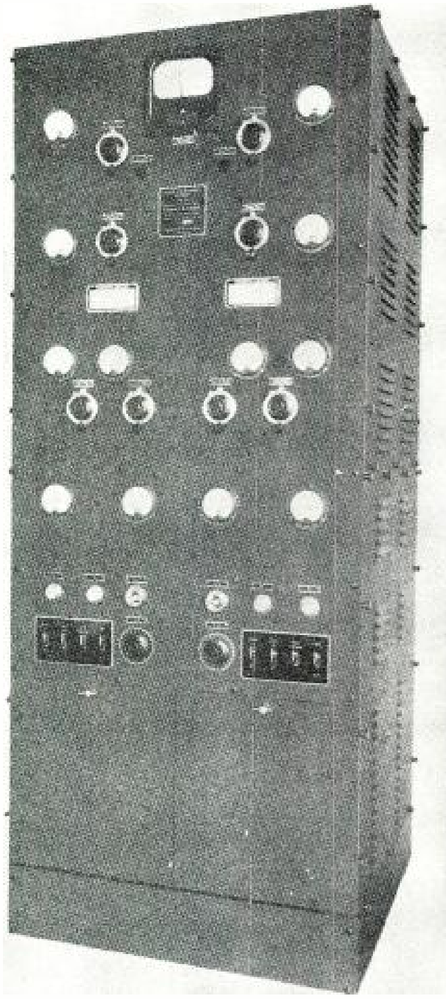


Modern 75 mc. marker transmitter.

AIRWAYS MAINTENANCE

by WILLIAM BOESCH, Jr. (Chief)
Airways Maintenance Section, Federal Airways Division, CAA

Born in New York City in 1903. Was graduated in Mechanical Engineering from New York University in 1924, and that same year began his airways career as an electrician with air Mail Service of Post Office Department. In 1927 was transferred to Airways Division of Lighthouse Service as Assistant Airways Engineer. Has been continuously engaged in the construction and maintenance of the Federal Airways System from its meager beginning in 1927 under CAA. Chief of Maintenance Section, 1941.

and J. F. TEUNISSON (Ass't. Chief)

Born in New Orleans, Louisiana, in 1901. Radio Amateur in 1915. Commercial Radio Operator, 1918-27. Entered Airways Division, Lighthouse Service, as Radio Operator, 1927. Appointed Communications Supervisor in charge of Operation and Maintenance of Airways Aids of Chicago Division in 1930, and Maintenance Supervisor, with headquarters at Washington, D. C., in 1934. In 1941, appointed Assistant Chief, Airways Maintenance Section, Federal Airways Division of Civil Aeranautics Administration.

Maintenance of all airway radio equipment is essential for efficient operation. All equipment is checked periodically.

CAA airways facilities extend from the Arctic circle to the equator, covering the United States and Alaska and much of the Caribbean and the Pacific. Its stations are to be found on mountains, in deserts, in large cities, in vast wildernesses and on remote and lonely islands. To assure airmen uninterrupted and dependable service over such an area requires a high degree of skill, initiative, and devotion to duty on the part of all CAA technicians, and not least on the part of those charged with the responsibility of keeping airways equipment at its highest level of efficiency and in constant state of good repair. In the last analysis standards of maintenance depend upon those who actually do the work in the field.

Maintenance of airways communication facilities is more difficult than that of almost any other communication service. First, airway facilities operate 24 hours a day. Second, they operate unattended except where the type of equipment requires frequent manual adjustment. Other complications arise from the many kinds of service offered, different types of equipment, the large number of facilities operated, and their widely scattered locations.

As an ounce of prevention is always worth a pound of cure, the primary concern of CAA maintenance is less the problem of repair after breakdown than of reducing the possibilities of equipment failures and operating irregularities to an absolute minimum. This is all the more important because pilots are continuously dependent upon airways communication facilities as navigation aids. A failure of ground equipment at one point can spell disaster far away in the air.

Who are these CAA maintenance technicians who keep the communications system open and functioning at all times? What do they do? How do they do it? What are their chances for advancement in the service, and how can others find a place in a steadily growing service which represents a fascinating combination of technology—radio and aviation?

Originally all maintenance of airways communication equipment at a particular station was handled by the radio operators on duty there. As the work of the operators expanded and new types of equipment were installed, it became evident that highly skilled technicians were required to keep communications functioning at all times. It was plainly impracticable to expect a man to be both an expert radio operator and a highly skilled technician—trouble shooter. Thus the CAA maintenance technician was born.

The present maintenance program is based upon:

1. Employment of competent technicians with sound theoretical background and broad practical experience as trouble shooters, each of whom is given full responsibility for the operation of facilities in his charge;

2. Training of technicians both by written instructions and personal contact to insure standardized methods and results;

3. Routine use of electrical tests and visual inspections to check equipment, with prompt action to correct unsatisfactory performance;

4. Adequate reporting of all irregularities and breakdowns;

5. Complete analysis of such reports to correct indicated weaknesses in existing equipment and to improve specifications and factory inspection techniques for new equipment.

Technicians are given complete responsibility for maintenance, adjustment, trouble-shooting, and normal repair. Proper maintenance requires periodic routine inspection and servicing of equipment. At most CAA stations this is performed daily, which makes it necessary to have trained personnel at such points. Reasons of economy, however, make it impractical to have specialists at all stations. Consequently, maintenance work falls into two categories: first, "sector" maintenance; second, "resident" maintenance.

Sector maintenance is in charge of a travelling radio technician who services a group of stations on a section of airway approximately 200 miles long. The sector electrician visits his stations once a month to perform the major routines. Between visits, the radio communicators take daily meter readings of equipment and replace defective tubes and fuses, but if an irregularity or a failure occurs the sector electrician is called. The sector system is used where the amount of equipment or the importance of the station does not justify having a specialist on hand at all times. Duplicate or "stand-by" equipment at such points reduces almost to zero the probability of prolonged interruptions to service.

Under the resident system a maintenance technician is either on the job or on call in case of trouble. This system is used at stations which have large amounts of equipment or where the complexity of the apparatus requires specially trained personnel.

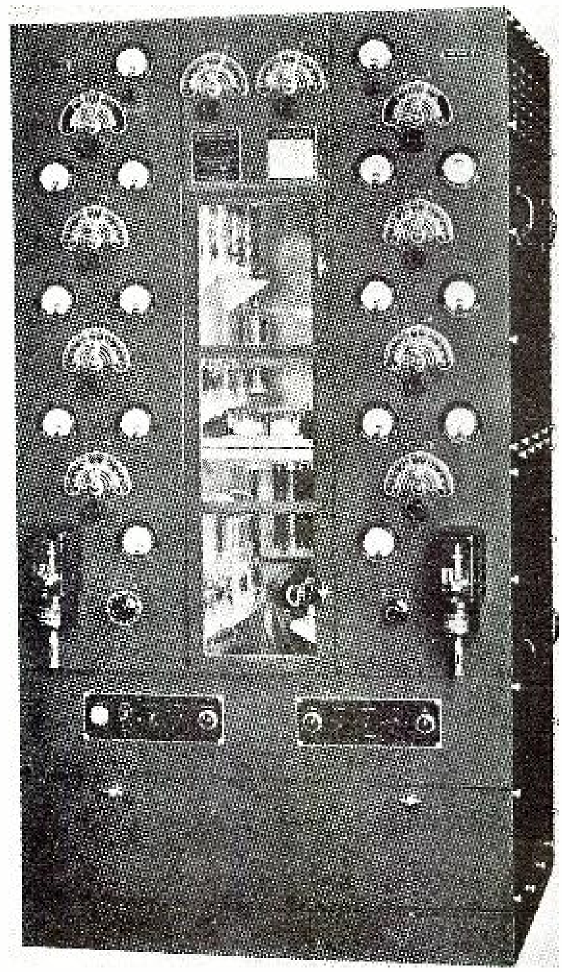
The majority of CAA maintenance technicians is responsible for the proper functioning of two or more fan marker stations and at least one radio range operated by remote control from the local airport. The control station at the airport has five or more superheterodyne receivers guarding intermediate and high frequency channels, a speech amplifier and moving coil microphone for broadcasting, teletype machines for collecting and transmitting reports on weather and aircraft movements, a gasoline engine-generator for emergency power supply.

At the radio range station there are two identical 200-400 kc. transmitters for simultaneous radio telephone and radio range service, which are used alternately, one serving as a stand-by for the other. Each of these transmitters consists of two separate single frequency transmitters operating in one frame to furnish the range voice service. This dual transmitter unit feeds through a coupling device two separate antenna systems, one for range course signals, the other for voice transmission. These antenna systems, tuned to frequencies differing by 1.2 kc., are phased to produce field patterns of definite shapes.

Another pair of transmitters for the station location marker operate continuously, unkeyed, on 75 mc. with a modulation frequency of 3,000 cycles. Equipped with a monitoring device which automatically switches on the standby transmitter in case of need, these transmitters are connected to a special antenna system so directed and phased that they project a narrow vertical beam of approximately circular cross section.

In the transmitter building there is a gasoline engine generator and an automatic switchboard. In case of failure or a drop in voltage of the commercial power supply, the engine is automatically cranked and operates an automatic throw-over switch, which puts the entire station load on this emergency power supply. When the commercial power is restored and has been steady for ten minutes, the load is automatically thrown back to commercial power, and the generator shut down.

Remote control equipment at the range permits the communicator at the airport to turn transmitters on and off, switch from regular to stand-by, turn on and off obstruction lights, etc. This control is exercised through a two-



Modern 400 watt broadcast and radio range transmitter.

motion 100 point Strowger switch controlled with an automatic telephone type of dial.

The fan marker stations, so called because of the shape of their radiated field patterns, are placed about twenty miles from the range station on different courses of the range. These stations operate on 75 mc. with 3,000 cycle modulation. Unlike the station location marker, the output is keyed to identify the station. These stations operate continuously without remote control and have dual transmitter with automatic switching to standby in case of drop in carrier or modulation.

In the voice transmitter the technician closely watches r.f. output, audio wave shape, percentage modulation, and overall frequency response. R.f. output is checked daily. Percentage modulation and wave shape are checked monthly. Audio response is checked semi-annually. Each technician is provided with an audio oscillator, AF attenuator, power level meter, and cathode ray oscilloscope. A modulation meter and distortion meter is sent to him from the regional office if required to locate trouble, but such instruments are not included in his set of test equipment.

The carrier, or lower r.f. frequency, of the range transmitter serves two purposes. Approximately 65 per cent of its power is available for voice modulation, and 30 per cent for range modulation. Thus the percentage modulation of such equipment is an important adjustment. If the percentage of voice is too high it may interfere with the range signal. If the percentage is too low, the voice does not carry well. Percentage modulation for the range signal is adjusted by varying the relative power output of the two transmitters. Optimum voice transmission is obtained through use of a constant output speech amplifier at the

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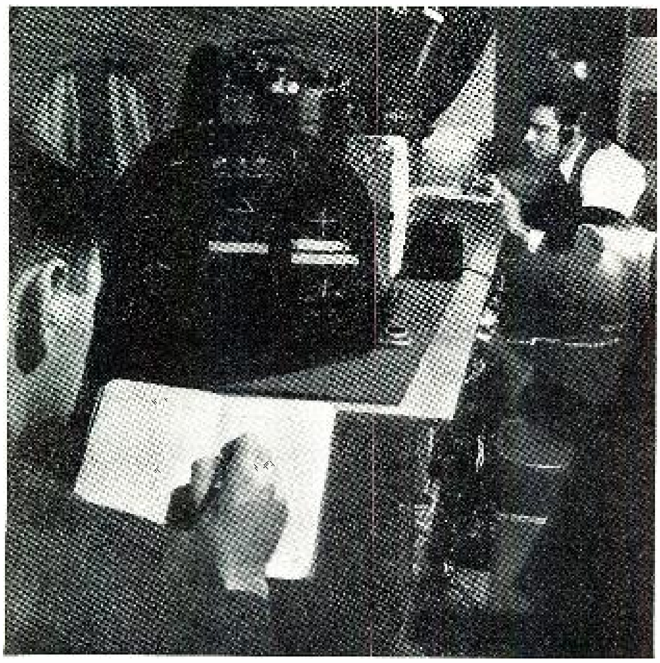
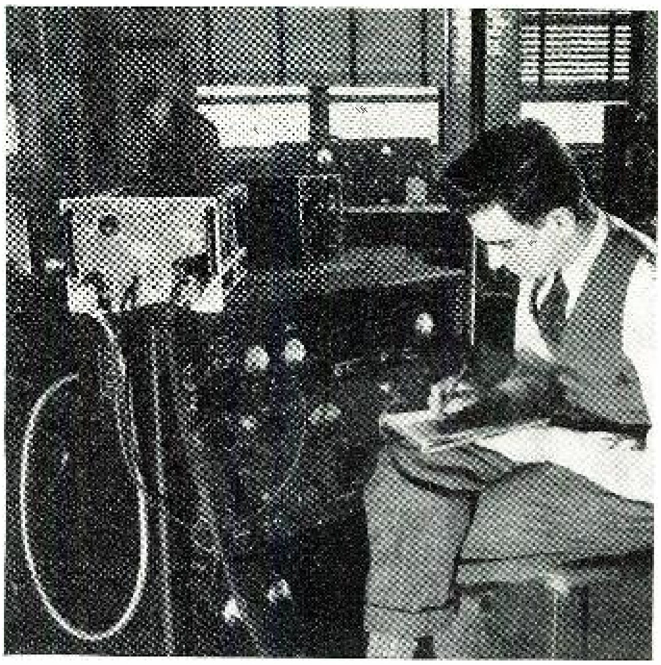


Inside the Boeing Flying Laboratory showing an instrument panel and flight instruments.



Receiver test measurements using portable "tea wagon" on one of the UHF receivers.

TECHNICAL DEVELOPMENT

Many of the most outstanding radio developments in this country have been perfected by the engineers of the CAA

by JOHN EASTON

Chief, Technical Development Div., CAA

Born in Scotland and came to the United States in 1923. Attended University of Edinburgh. Served with the Royal Navy and Royal Air Force during World War I. His first job in this country was with Chrysler (Detroit) from whence he got into aviation field. Was associated with Aircraft Development Corp., Buhl Verville Aircraft Co. In 1930, joined Aeronautics Branch of Department of Commerce as Asst. Chief of Engineering Section, and later as Asst. Chief of Aircraft Section. In 1940 became chief of Technical Development Division of CAA.

CONSTANTLY striving for safer and more efficient air transportation along the Federal Airways and across the oceans of the world, the Technical Development Division carries out the Civil Aeronautics Administration's applied research and technical development programs. These programs embrace all fields of development bearing upon the design, operation, and navigation of aircraft. They are necessary because the tremendous growth of air traffic, both civil and military, and the much greater volume of traffic expected after the war require not only that a continuous effort be made to improve aircraft, their power plants, instruments and appliances; but in addition airport soils, paving and drainage; radio aids to navigation and traffic control; aeronautical charts; aeronautical lights and other airway and airport equipment and in general any one of a number of facilities that will tend to increase the safety and efficiency of aircraft operation.

These air transportation problems apply equally to both civil and military flying. It was easy, therefore, to key the work of the Technical Development Division to the war effort and now the Division has no purely civil project on its program.

As a result of this continuous development, the United States has, at the present time, the finest and most complete system of radio-equipped airways in the world. However, progress in the improvement of radio aids to air navigation has not stopped. Research, development, and experimentation have proved the advantages and feasibility of the use of ultra-high frequencies for such aids and development work is now generally aimed at the transfer of facilities from the presently used low and intermediate frequencies to the ultra-high frequencies.

One successful application is the ultra-high frequency radio range. The final model, resulting from several years work, shows that the ultra-high frequency range is substantially free from bent or multiple courses; unsatisfactory features which have been present in most low frequency ranges in mountainous country. Further, this range is almost entirely free from thunderstorm static and precipitation static. Still further, with this range it is possible to eliminate interference between stations at great distances; a serious fault with the low frequency ranges.

In the development of the ultra-high frequency range, quadrant ambiguities, which are present with the low frequency, four-course aural range, have been eliminated. This is accomplished by a combination of visual and aural signals by which the pilot always knows whether he is North-East, South-East, South-West, or North-West of the range station without the necessity of performing a complicated orientation procedure wasteful of time and fuel.

Use is now being made of this development and, when circumstances permit, ultra-high frequency ranges will be installed throughout the Federal Airways. The presently used low frequency range, however, is not being neglected. The most recent development designed to increase the safety of its use is an automatic monitor. This device automatically advises the airport tower, the airways communication station, the airport offices of the several airlines utilizing the particular range, and also pilots in flight using the range of any malfunctioning of the range. A similar device has been developed to monitor Fan and Z markers. Incidentally, improved Fan and Z markers and a radio obstruction marker have been developed by the Technical Development Division. Work is continuing, in cooperation with other Federal agencies, on the development of means to eliminate precipitation static.

Experience in ultra-high frequency technique, gained in the development of the range, led to the development of ultra-high frequency airport traffic control equipment. As with the range, this equipment provides freedom from thunderstorm static and freedom from interference. Such equipment is now being installed throughout the country. Development of air traffic control devices, utilizing ultra-high frequencies is underway.

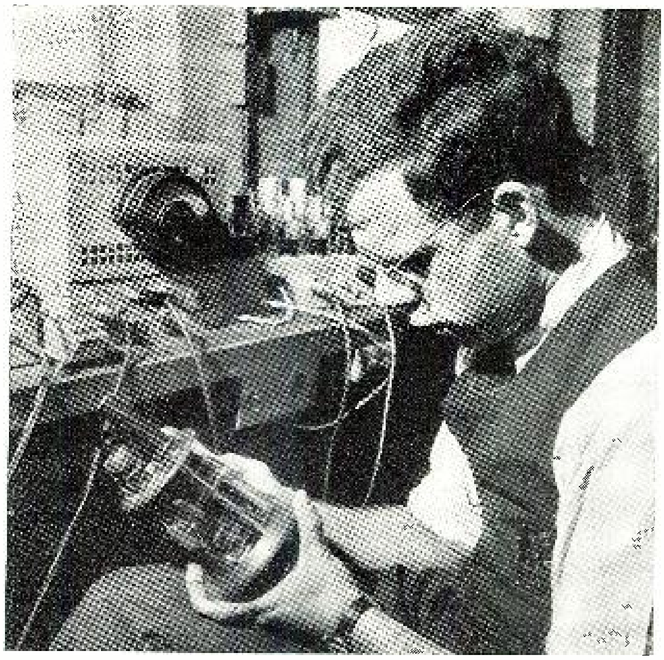
A very great deal of effort has been expended on the development of instrument landing systems. Of all the systems developed and tested, that developed, installed and operating at the Technical Development Division's Experimental Station at Indianapolis was considered the most satisfactory by the special committee appointed by the President in 1939 to study instrument landing and make appropriate recommendations. That committee recommended immediate adoption of the CAA system. The national defense emergency and then the war have considerably affected the civil installation program, but refinement and further development have continued.

The President's Committee also recommended the continued development of a microwave instrument landing system. Such a system had been under development by the Technical Development Division since 1937. Originally all the components of the system—glide-path, localizer, and markers—operated in the microwave band. Now, for a number of reasons, work is concentrated on the glide-path alone and the development is being carried on by both the Civil Aeronautics Administration and the Army in close cooperation.

For several years the Technical Development Division has been engaged in the development of ground direction finding equipment and, at the present time, three recently

Maintenance check on airways beacon light. This one has a 36" diameter lens.

Fan Marker (new type) being developed by CAA. Technician is taking readings from instrument that sends signals.



Indianapolis Experimental Station transmissometer—used to measure the transmission of light through atmosphere.

completed direction finders are in operation. Further refinement of this equipment is now progressing. In addition to ground direction finding equipment, aircraft direction finding equipment, operating in the ultra-high frequency band, is being developed.

Closely related to the development of air navigation facilities is the development of charts for the users of these facilities. The development of charts for the specific purpose of air navigation is becoming more and more important as advances are made in air navigation aids because aircraft, as a consequence, are flying in bad weather conditions where the ground is not visible. This type of flying necessitates the use of charts on which topographical details are not wanted but on which only radio aids, accurately depicted and easily interpreted, are shown.

The development of such charts, used for en route flying, airport approach and landing, is also an activity of the Technical Development Division. So too, is the development of charts for the specific use of seaplanes and flying boats. In this work, of course, the Division cooperates closely with the map and chart making agencies of the Federal Government and, at the present time, is using all of its specialized cartographic knowledge in the active prosecution of the war.

As important as the radio aids to air navigation are the visual aids such as lights and markers. In nearing the end of a flight through bad weather conditions in which he has not seen the ground since he took off, nothing is so satisfactory to a pilot as the sight of a light which he is able to recognize and interpret. The Technical Development Division is continuously endeavoring to improve aviation lighting.

Among aviation lights which have become more and more important as bad weather flying has increased are approach lights. As well as being an individual aid, the approach light lane has now become a complement to the instrument-landing system. A great deal of laboratory and field testing and experimenting has been done to develop approach lights satisfactory for guidance in very thick weather and these efforts are now showing some success. A permanent experimental approach light lane is now being constructed at the Division's Experimental Station where comparative tests of new lights and systems of lights can be conducted and pilot reaction to new lights obtained. A similar installation at the same place is being made for the comparative testing of airport boundary lights. Work continues on the further development of contact lights, traffic lights for taxiing aircraft, and lights for marking and numerous other purposes in spite of the complications brought about by war-time blackout requirements.

In lighting development, flying boats and seaplanes are not forgotten. The Division has been and still is actively engaged in the development of seadrome lights for marking landing and surface operating areas. This development program involves the design and development of buoys such as will not cause damage to aircraft if accidentally struck. It involves also cable-fed lights, self-contained lights operated by the sun, and radio controlled lights. Seadromes also require day markers and these too are under development by the Technical Development Division.

The proper planning and construction of airports present many other problems besides those connected with lighting. Airport size must be determined in the light of aircraft performance or inadequate airports of restricted value will result. The Division has conducted a very thorough investigation of this problem and, by photographing the performance of aircraft taking-off and landing at airports of various altitudes and under different conditions over the entire country, has determined airport size standards for the accommodation of all types of aircraft. Airport surfacing and paving must be adequate to withstand the loads imposed upon them. More or less arbitrary values have been used heretofore, but the Division is now actively engaged in determining the exact loads. Drainage problems too, are being thoroughly investigated.

In the interest of economy in airport construction, the Division for the past few years has been engaged in solving the many problems connected with soil stabilization. Now, due to the war, this activity and the development of equipment to effect soil stabilization have become very important parts of the Division's work.

The Technical Development Division is not concerned solely with ground equipment but concerns itself also with the aircraft in a continuous effort to improve the safety of operation. Some hazards to aircraft operation can be eliminated or rendered negligible by regulation, but a large number of them fall into a different category. These can be removed as barriers to safe operation only by development; development of a device which acts as a safeguard or development of adequate knowledge of the hazard so that recognition and avoidance are possible.

A more or less continuous project is that of developing

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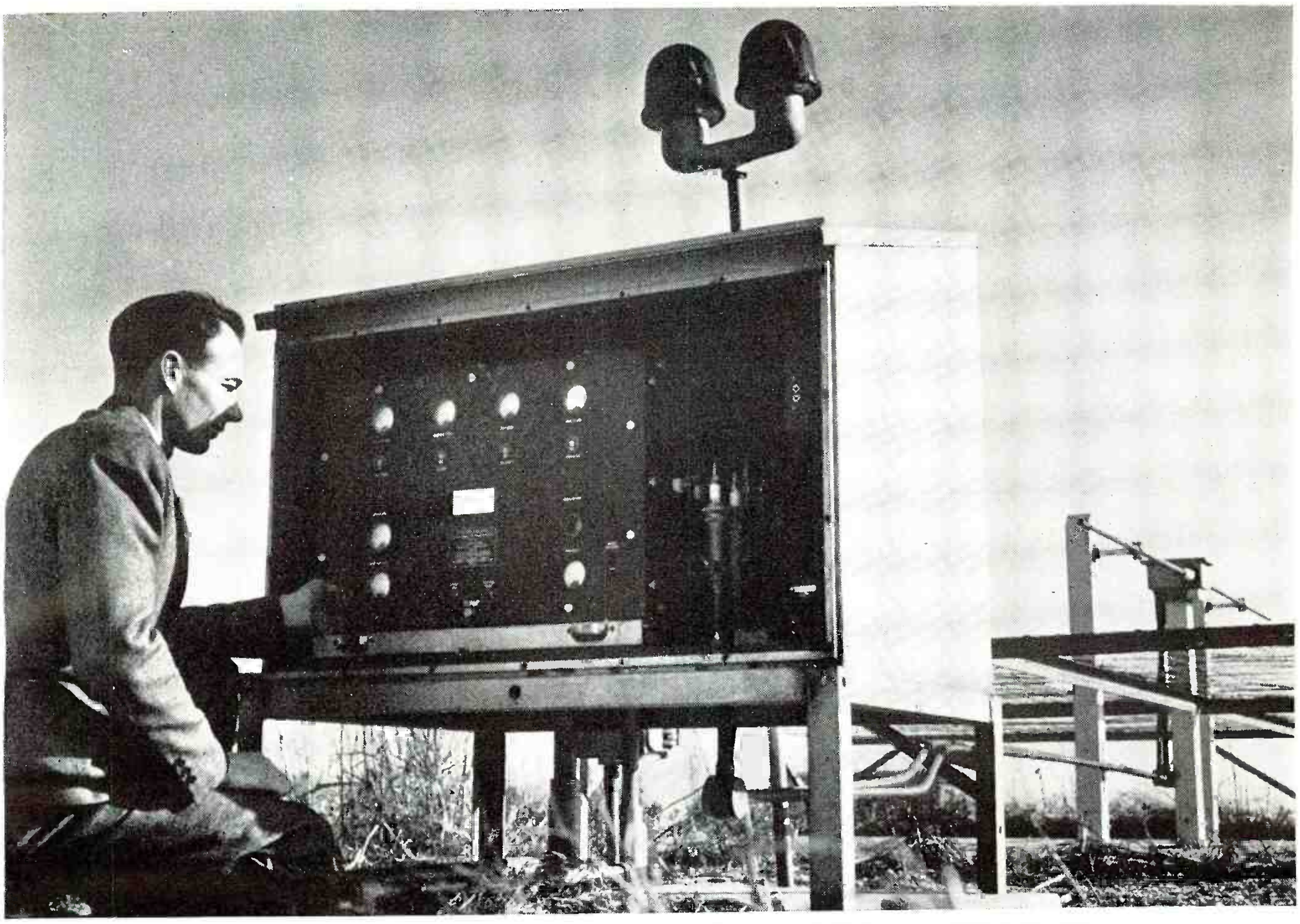


Fig. 1. Technician checking the marker beacon transmitter of a CAA instrument landing system.

Instrument Approach System

Airway transportation is dependent upon the automatic instrument approach system for aid in landing when adverse weather conditions exist.

by PETER CAPORALE
Chief, Radio Engineering Section.

Born in Philadelphia, Penn. Graduated from the University of Pennsylvania in 1928 and in 1929 with an Electrical Engineering degree. Became instructor in mathematics and electrical engineering at Temple University and later at Drexal Institute. Was employed by the RCA Victor Company as a Radio-Acoustic Research Engineer. In 1935 went with U. S. Signal Corps at Wright Field to promote research work on aircraft antenna and radio design. In 1937 was employed by the CAA as a Radio Engineer. Now chief of the Radio Engineering Section.

THE CAA, in cooperation with the War Department, is installing at various airports ultra-high-frequency radio transmitting equipment designed to permit aircraft with the proper receivers to make landings solely by the use of instruments (i.e. without the necessity of seeing the ground).

A complete system of this kind consists essentially of four separate transmitting stations located on or near the airport, as shown in Fig. 7. These four elements are known as the (1) localizer, (2) glide path, (3) boundary marker, and (4) outer marker. A third marker is being installed at some airports in the position shown dotted in Fig. 7. Although any number of markers may be used, two are usually sufficient.

The localizer provides a very accurate lateral guidance so that approaching aircraft can maintain a heading that will lead it over the center of the runway. The glide path provides vertical guidance enabling the aircraft to maintain the proper rate of descent. The markers provide reference points or "fixes" along the approach paths.

No glide path is included in current installations, for available equipment is not accurate and dependable enough. But a suitable glide path system is expected to be developed soon and will be installed as soon as it is available.

Use of the localizer and markers alone permits instrument approaches under weather conditions much less favorable than those now required. Thus, approaches to an airport with 100-ft. ceiling and ¼ mile visibility will become perfectly feasible, whereas present minimums are 400-ft. ceil-

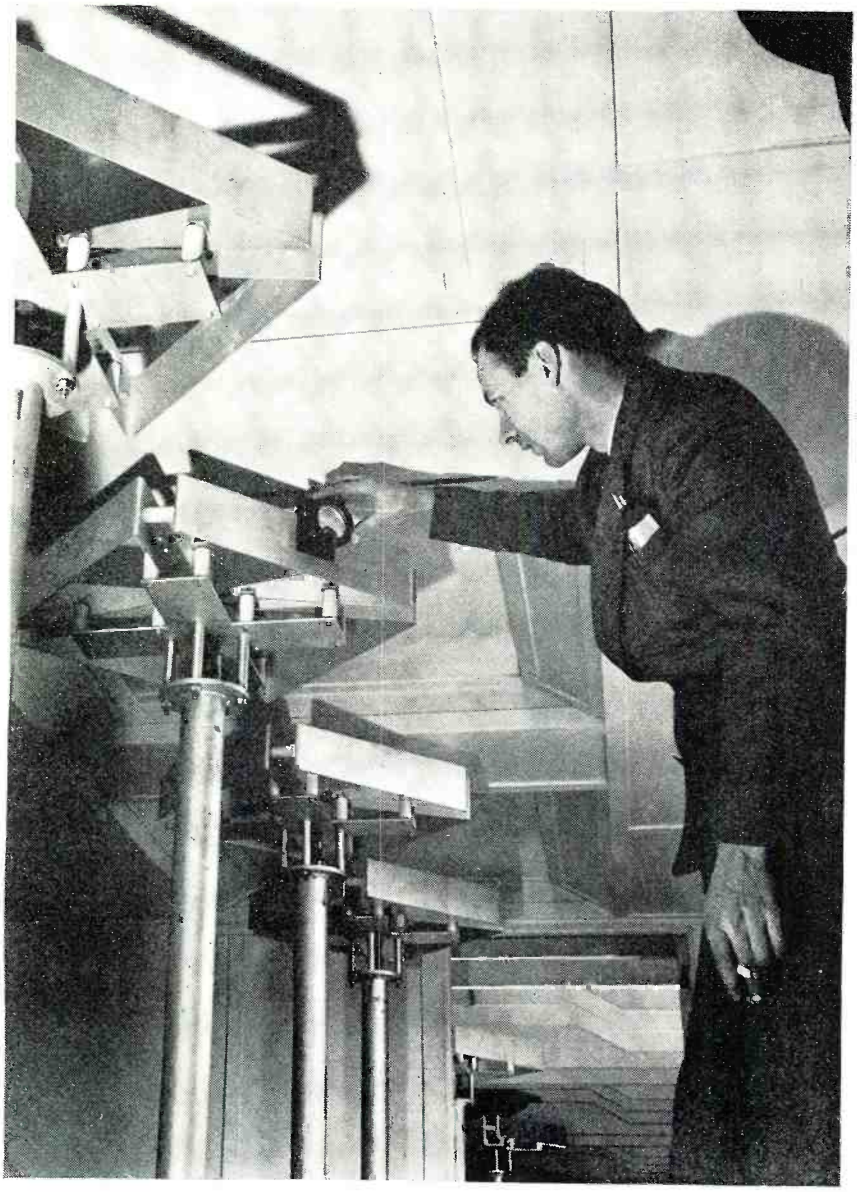


Fig. 2. Portion of localizer antenna array used at Washington National Airport.

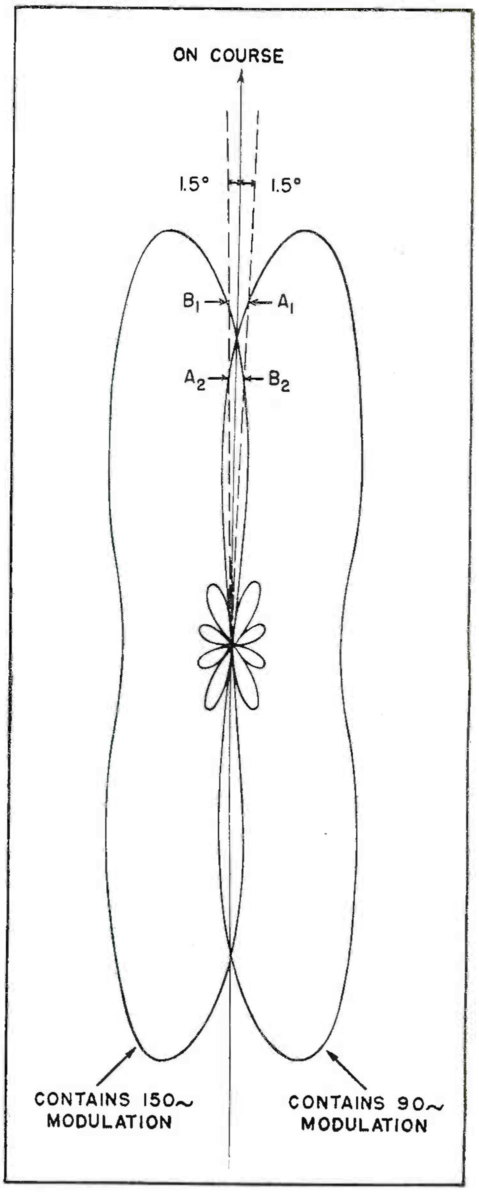
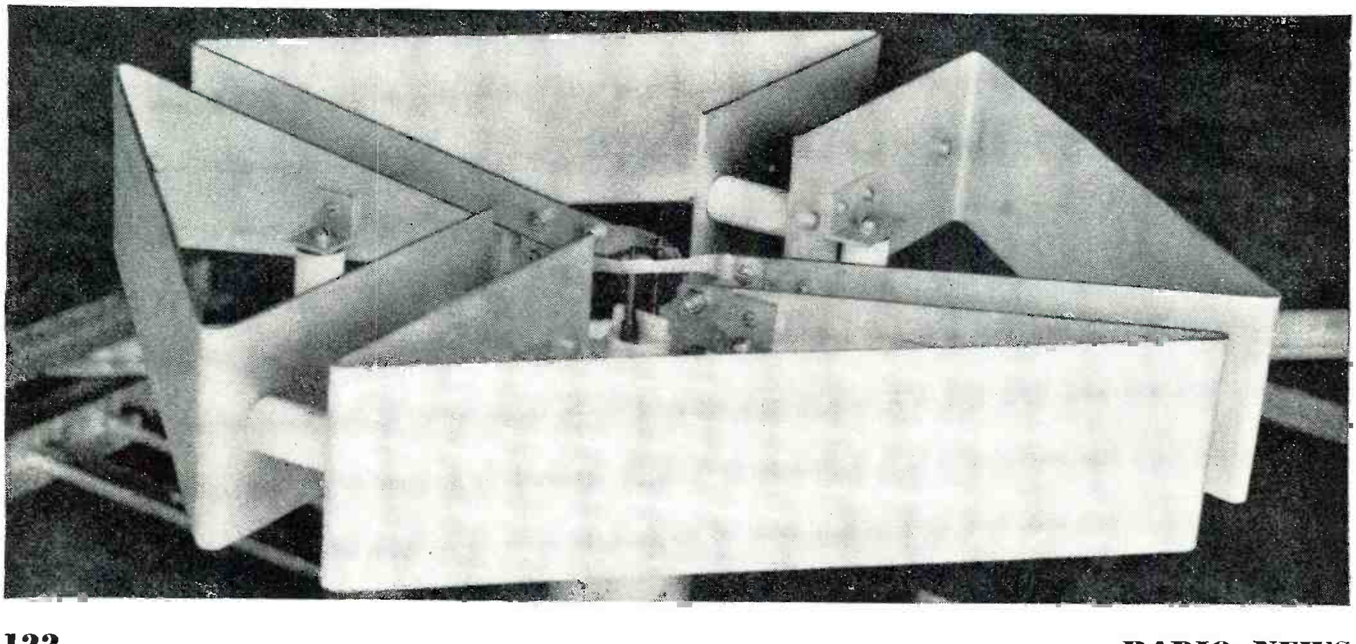


Fig. 3. Typical horizontal space patterns.

Fig. 4. Many of these antennas (10 at Washington Airport) are necessary to obviate local effects on the localizer course.



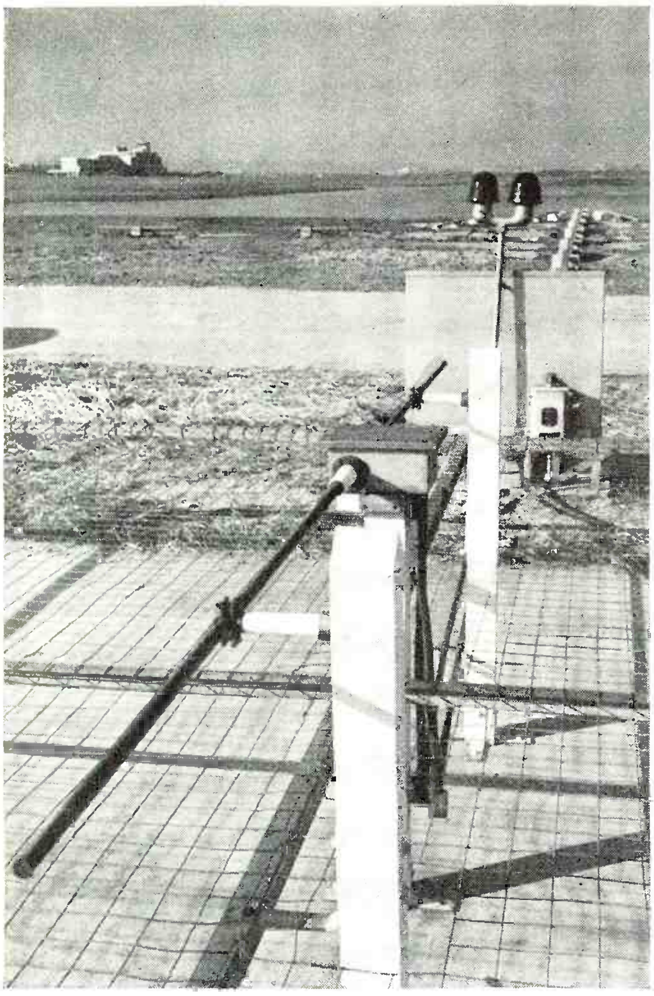


Fig. 5. Inner marker beacon for instrument landing system. Other markers are placed at various distances from the runway.

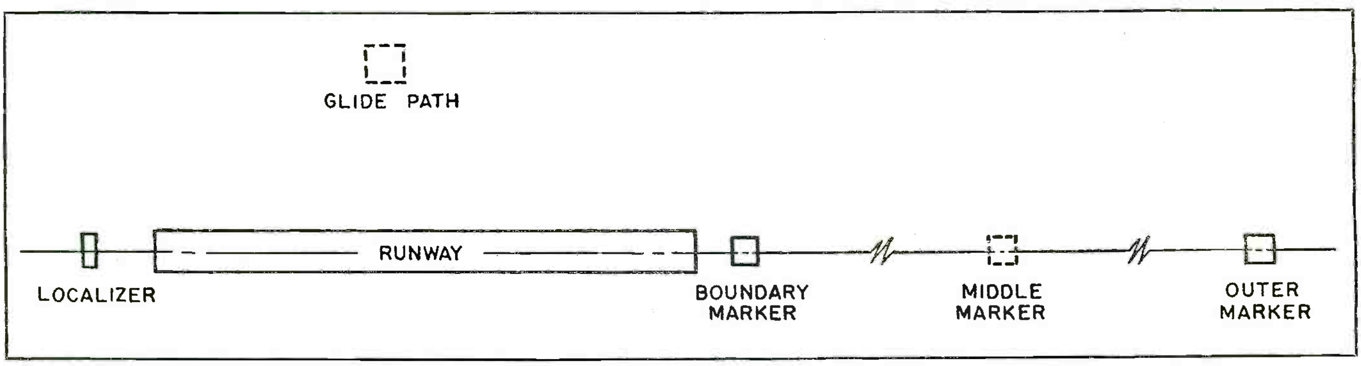
Fig. 6. Automatic monitor of localizer beam turns off instrument when the course of the beam deviates beyond established limits.

ing and one mile visibility. Furthermore, operation under these reduced minimum weather conditions is an excellent method of conditioning the pilot's psychology for the more difficult landings made completely by instruments. The value of flying instruments is no greater than the pilot's confidence in them, and the latter in turn depends upon his familiarity and experience with them.

The localizer is basically a two-course radio range operating at ultra-high frequencies. A linear array of horizontal loops is placed at right angles to the axis of the runway and radiates what amounts to two space patterns, as shown in Fig. 3. These patterns represent different modulation frequencies of the same carrier, viz., 90 cps. and 150 cps., which are rectified and separated in the aircraft receiver. The two resulting d.c. voltages are applied to a "cross-pointer" instrument (see Fig. 8) which indicates the difference between these voltages. (The vertical needle of the instrument is the one in question. The horizontal needle is for use with the glide path signals.) The indications are purely a function of the relative amplitudes of the modulating frequencies, provided the receiver is in AVC. For this reason, the usable distance of the localizer is the greatest distance at which the receiver remains in AVC. It will be seen from Fig. 3 that the two patterns cross only at the two points where the two signals are equal in amplitude.

Along these two directions, which are 180° apart, the cross-pointer instrument indicates zero or "on-course." Along any other direction the amplitudes of the patterns are different and the needle moves to the right or left, depending upon which of the two signals predominates. The rate at which the ratio of the amplitudes of the two pat-

Fig. 7. Instrument approach layout showing the position of various markers, localizer and glide path with respect to the runway.



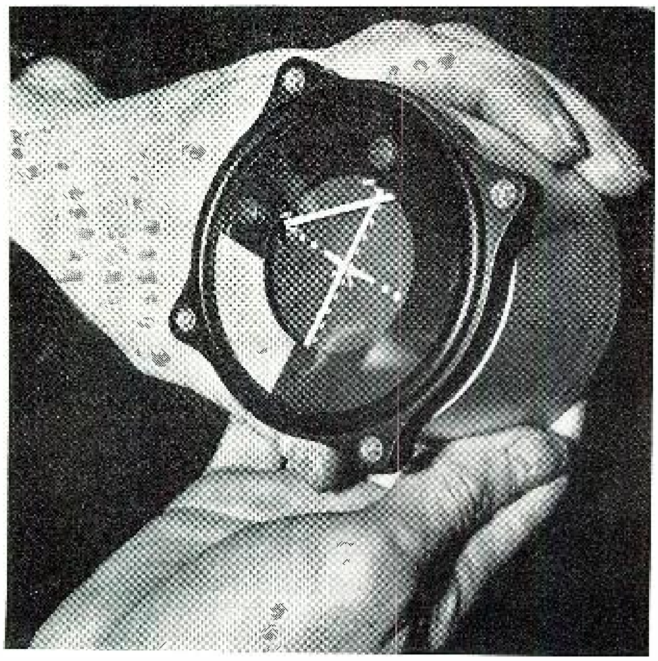


Fig. 8. Cross pointer instrument gives visual indication of plane in flight with respect to the runway. When the plane deviates to either side of the runway the vertical needle will show an "off-course" indication. The horizontal needle is for use with the glide path signals indicating height of plane.

Fig. 9. Operator making adjustment on the instrument landing system control rack. Elaborate equipment is necessary.

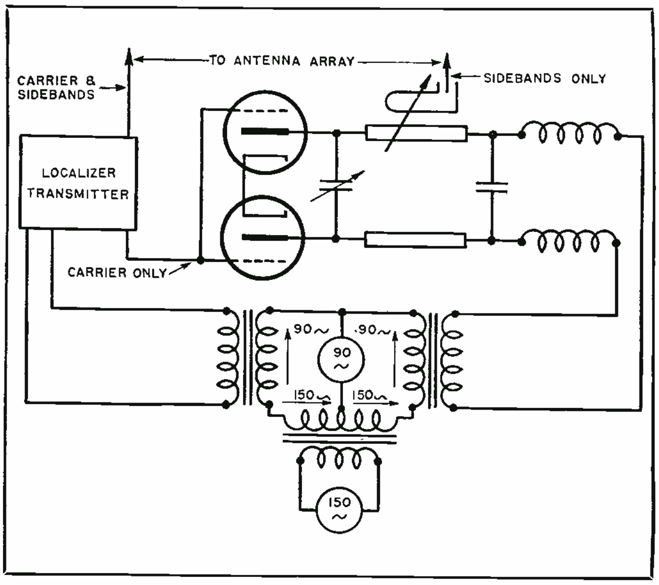
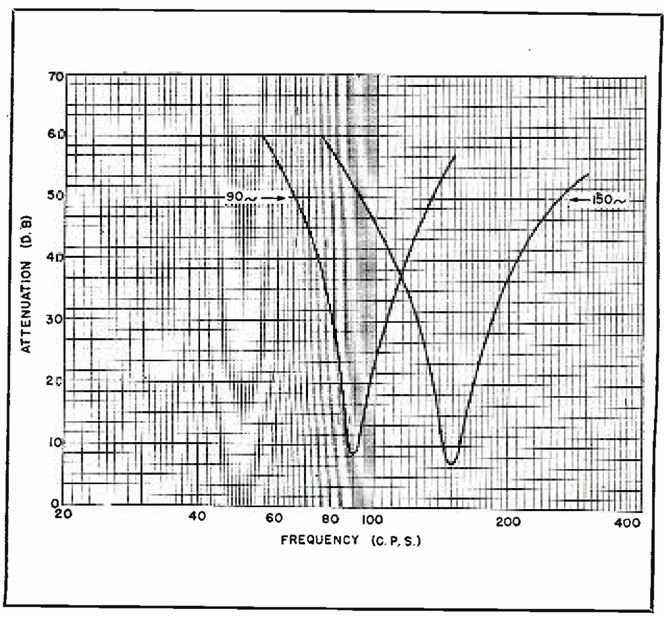


Fig. 10. Schematic diagram of sideband generator.

terns departs from unity, as the azimuth changes from the "on-course," determines the so-called "sharpness" of the course. More exactly, the latter is the ratio of the two patterns in a direction 1½ degrees from on-course. In general, the more directional the radiating system, the greater the sharpness. Furthermore, since the energy is concentrated within a relatively small angle near the on-course, this directivity reduces interfering phenomena caused by reflections from obstacles, buildings, etc., outside of this angle. This is, in fact, the major reason for a sharp course. In practice this sharpness varies from 2 db to 7 db or more.

There is another "sharpness" of more interest to the pilot. This is the deflection of the cross-pointer needle for a unit angular displacement of the airplane from on-course. While this depends upon sharpness as previously defined, i.e., of the radiated patterns, it is also a function of other factors, namely, AF sensitivity of the receiver and the sensitivity of the cross-pointer instrument itself. This can easily be seen from the fact that the instrument deflection (D) is proportional to the difference of the two applied voltages e_a and e_b (due to the two modulation frequencies), or $D=K(e_a-e_b)$. If the AF gain of the receiver is changed so that $e'_a=ke_a$ and $e'_b=ke_b$, then obviously $D'=kD$. This

Fig. 11. Audio frequency filter characteristics for localizer.



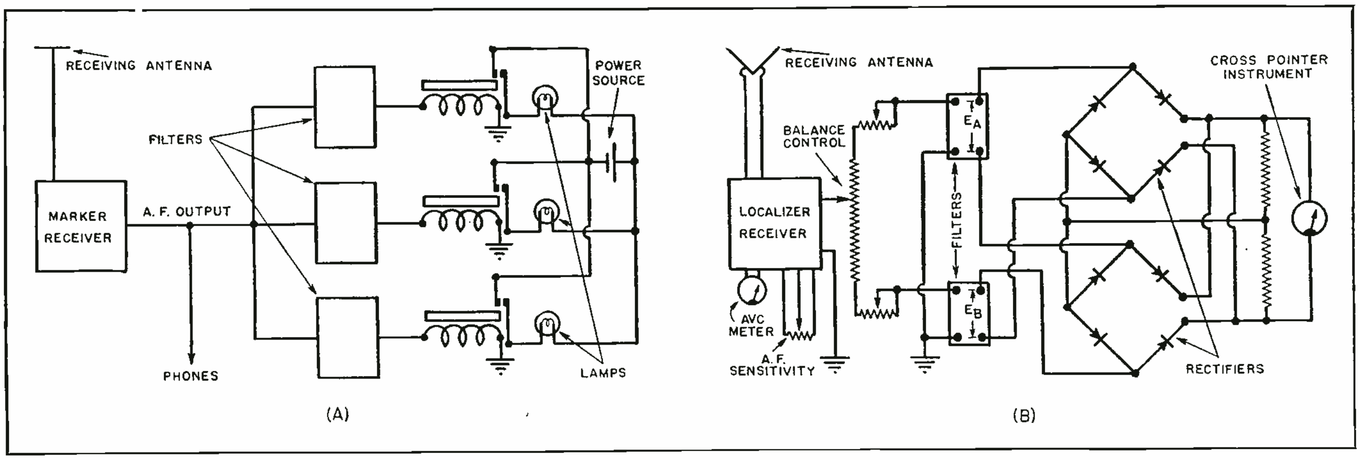


Fig. 12. Schematic diagram of an aircraft receiving apparatus consisting of marker and localizer receiver.

may be called the "apparent or effective sharpness" and may be controlled, within limits, by adjusting the audio gain of the aircraft receiver.

The actual flying experience of many pilots will be required to determine what the optimum effective sharpness is, but certain rough limits can be set. With the airplane on the runway at the point of contact, a deflection of fifteen degrees or more should be obtained when the plane is moved from the center of the runway to either edge (for a runway width of, say, 200 feet). On the other hand, an excessively sharp course is difficult to follow, particularly in the vicinity of the airport. However, experience so far indicates that effective sharpness should be greater rather than less than necessary.

The antenna system for producing the required space patterns consists of a linear array of radiators, with its axis parallel to the ground and at right angles to the runway. A typical array with ten radiators is shown in Fig. 14, with representative current distribution. Fig. 14 also indicates the manner in which the array is fed. As shown, the center pair is fed with carrier modulated at both 90 cps. and 150 cps., whereas the rest of the radiators, all grouped in pairs, are fed only with the sidebands arising from these two frequencies. The sideband phases are so adjusted that the 150 cycle sidebands fed to the center radiators are in phase with those fed to the other radiators, whereas the 90 cycle sidebands in the former are in opposite phase to those in the latter.

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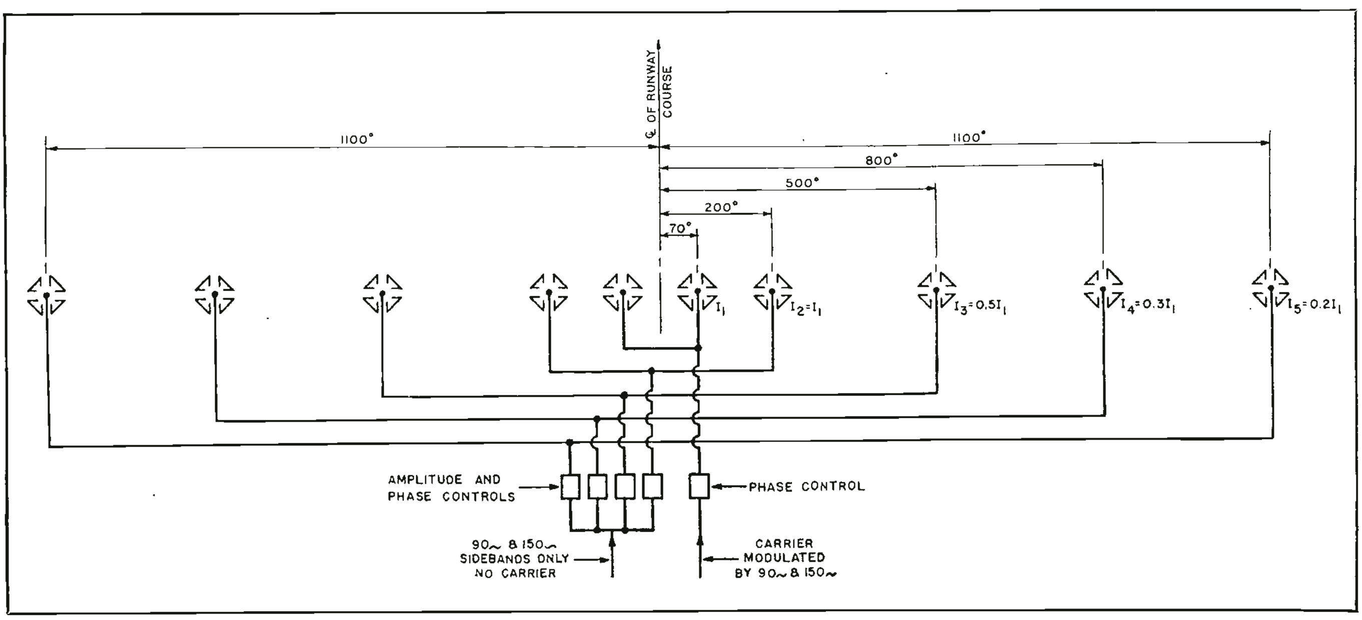
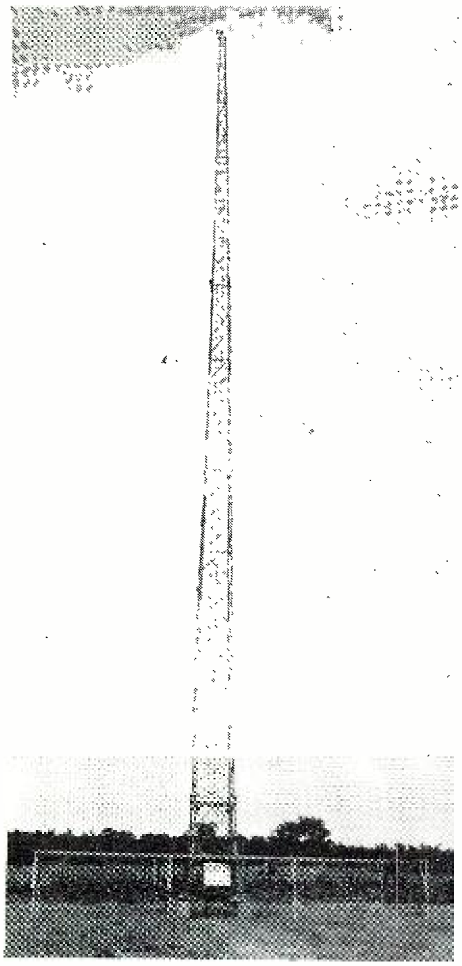
Fig. 13. Monitoring device advises airport control tower whether accurate signals are being radiated.

Fig. 14. Typical localizer antenna array with ten radiators indicating the manner in which the array is fed.





Radio range installation tower.

RADIO RANGES

by DONALD M. STUART

Chief, Airways Inspection, CAA

Born Des Moines, Iowa, in 1905. B.S., University of Minnesota, 1928. Radio Engineer, Radio Section National Bureau of Standards, 1929-34. Radio Engineer, Radio Development Section Bureau of Air Commerce, 1934-39. Senior Airway Inspector (Flight), Civil Aeronautics Administration, 1939-41. Chief of Airways Flight Inspection, 1941 to present time. Work since 1933 has been in the field of radio aids to air navigation including research and development and flight testing. Flying experience dates from 1934—3000 hours.

Radio ranges are essential for the safe operation of aircraft when adverse weather prevails.

"FLYING a range" simply means steering an aircraft in such a way that it progresses along a predetermined straight course. When weather conditions permit observation of the ground, it is usually a simple matter to keep the aircraft lined up by means of topographical features known to lie along the desired course. When a range is flown along a line between two prominent landmarks, a heading is established for the aircraft which corrects for wind drift. Once the proper heading has been determined, the magnetic compass will indicate the direction that must be steered to follow the desired course.

The airway radio range is designed to provide a straight reference line or range course, defined by radio signals, for flights conducted on instruments, or over the top of the overcast, or otherwise without visual contact with the ground. The radio range provides a singularly simple means of navigation and is frequently used with less effort than other systems even when weather conditions are good and contact flying is possible.

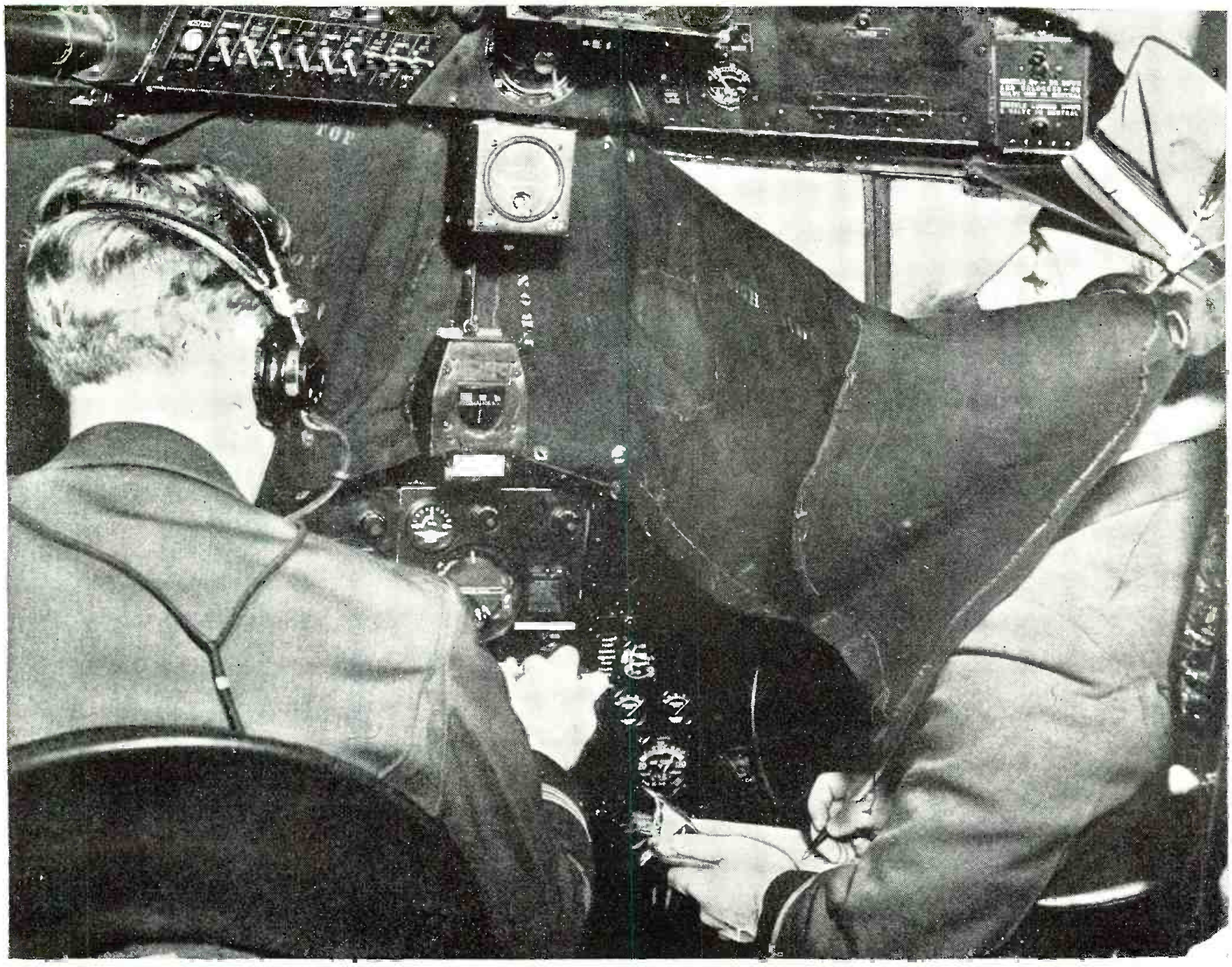
An airway system based upon the use of radio ranges has the distinct advantage over other systems of radio navigation in that the only equipment required aboard the aircraft is a simple radio receiver. The essential information needed by the pilot to pursue a straight course is obtained from the characteristics of the received signals, and no other communication with the aircraft is necessary for navigational purposes.

The radio range system of the Civil Aeronautics Administration for the continental United States is shown on figure 1. The range stations indicated on the map are all of the four-course aural type operating in the radio frequency band of 200 to 400 kilocycles.

The fundamental principles of operation of the four-course aural radio range are very simple. The antenna system consists of five insulated self-supporting steel towers 125 feet high, which are themselves the radiators. Four of these towers are located at the corners of a square with a diagonal spacing of 600 feet, which is of the order of 0.1 wavelength at the operating frequencies. The fifth tower is located at the exact center of the square. A station building housing the transmitting equipment is located approximately 30 feet from the center tower. This transmitting equipment is connected to each of the towers by means of buried transmission lines which terminate in antenna tuning houses at the base of the towers.

When one pair of diagonally opposite towers is excited with radio frequency energy so that the currents in them are 180 degrees out of phase, the amplitude of the resulting radiated field varies with azimuth, since it is the vector sum of the fields from the individual radiating elements. A polar plot of field intensity at constant distance resembles a figure 8, with lobes extending in the direction of the tower line, and a null or zero signal along a line equidistant from the two towers. The other pair of towers, of course, produces an identical field except that it is rotated 90 degrees in space.

The four-course radio range operates on the principle that there are four radial lines from the range station along which equal field intensities are produced by radiation from either of the pairs of towers. These equi-signal lines are called the range courses, and are identified by alternately keying radio frequency energy first into one pair of towers and then into the other, so that the signal intensities can be aurally compared in the output of the aircraft receiver. The keying sequence is an interlocked series of Morse code groups for the letters A and N. The dash of the N is keyed into the first pair of towers, the dot of the A is then keyed into the second pair, then the dot of the N into the first pair, and finally the dash of the A into the second, and so on. The switching of energy between the pairs of towers is done by means of a double throw relay



Pilot of plane making a blind landing entirely with instruments. Co-pilot has complete visual observation of landing.

so that the keying process is continuous. Consequently, when a pilot is on one side of a course, a stronger signal is received from the pair of towers transmitting the N signal, so that the letter N predominates over an apparently continuous background, which is actually the A signal from the pair of towers producing the weaker signal. On the other side of the same course, the situation is reversed and the A signal predominates over the N background. Directly on course, the keying does not produce any changes in field intensity so that the received signal is a constant uninterrupted tone.

In flying a radio range, the aircraft is initially steered in a heading that will cause it to intersect the desired course. Approach to the course will be indicated by approaching equality of the A and N signals. When the steady on-course tone is received, the aircraft is turned to a heading coinciding with the published magnetic bearing of the course. If there is no cross wind to cause drift, the aircraft will remain on course, and the steady tone signal will continue to be received. If the aircraft drifts off course, it will be indicated by a predominating A or N signal, and the heading must be changed slightly to bring the aircraft back to the course. The aircraft is then steered slightly into the wind to correct for the observed drift. Determining the correct compass heading to stay on course is accomplished by trial and error, and is usually a continuous process since the direction and velocity of the wind change from point to point.

The center tower at the range station is excited with radio frequency energy at the station's assigned frequency and radiates equally in all directions. The transmitter feeding the center tower is speech-modulated, and is used for transmitting meteorological and air traffic communications to aircraft in flight. The tone for the range signals is produced by the fact that the transmitter supplying power to the corner antennas is operated at a frequency 1020 cycles above that supplying power to the center antenna. Thus, the carrier from the center antenna is modulated by a single side band from the corner towers, 1020 cycles above the carrier frequency, and also directly modulated by speech in the conventional manner.

Speech and range signals are transmitted simultaneously. The modulation levels are adjusted so that no interference occurs between the two services, and either can be selected at will by means of a band-pass, band-elimination filter system in the output of the aircraft receiver. Good results may also be obtained without the use of the aircraft filter by careful tuning of the receiver and concentration on the desired service.

Radio ranges are, in general, located within two or three miles of an airport, with one of the four courses directed over the landing area. It is thus possible to utilize the range in making approaches to the airport under conditions of low ceiling and restricted visibility, as well as for navigation along the airway. The radiation characteristics of the range antenna system are such that the field intensity is reduced to a very low value directly over the station. This area of reduced field intensity is confined to a very narrow solid angle and is known as the cone of silence. When an aircraft passes through the cone of silence, its position is exactly determined and can be used as a reference point from which to start descent to the airport. Standardized procedures have been worked out for instrument let-down and approach to the field for each range station serving a terminal airport, and these pro-

CAA RADIO RANGE SYSTEM

Fig. 1. Range stations are all of the four-course aural type operating within the radio frequency band of 200 to 400 kilocycles. Each antenna system consists of five insulated steel towers 125 feet high.

Ultra-high-frequency four course radio range station, needed to safely operate our many airways.

cedures are used as a routine matter in air transport operations for instrument approaches under minimum weather conditions.

The four-course radio range has played an important part in the development of the air transport industry in the United States. It has enabled air carrier operations to maintain schedules under the most adverse weather conditions, and has contributed a great deal toward the excellent safety record of our airlines. The principal limitations upon the use of the present type of range are its relative susceptibility to static interference because of the low operating frequencies, and the extremely crowded condition of the 200 to 400 kc. radio frequency band. Present radio range frequency assignments are spaced only 3.0 kilocycles apart, and it is necessary to operate a number of stations on each available frequency, relying upon geographical separation to limit interference. A saturation point has already been reached, and few if any frequencies are available for future expansion of the range system.

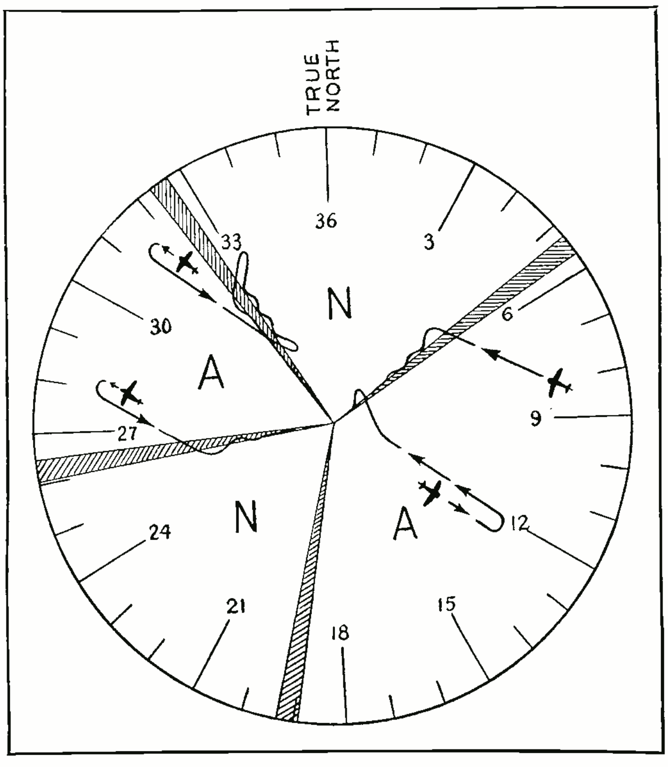
To overcome the limitations of the low frequency ranges and provide for future expansion of the airways system, the Civil Aeronautics Administration has for several years been engaged in the development of an ultra-high-frequency radio range to operate in the frequency band 119 to 126 megacycles. At these frequencies static interference is practically non-existent, and interference between stations on the same frequency will not occur, provided their geographical separation is 200 miles or more, because of the quasi-optical propagation of the ultra short waves.

The ultra-high-frequency range developed by the CAA operates on a somewhat different principle from the low frequency ranges, and provides one pair of courses indicated visually in the aircraft by a zero-center left-right meter and another pair of courses at right angles to the visual courses, which are indicated by A-N interlocked keying of 1020 cycle tone modulation.

The antenna system of the UHF range is similar to that of the low frequency range except that its physical size is very much smaller while the electrical spacing of the radiating elements in terms of the operating wave length is very much greater. The five radiating elements may be either horizontal loops or vertical rods, depending upon whether horizontal or vertical polarization is desired. One pair of diagonally opposite corner radiators and the center radiator constitute a complete two-course range antenna so that the two pairs of diagonally opposite radiators form two two-course range antenna systems independent of each other except for the common center element. The pair of antennas radiating the signals that register on the visual indicator are excited 180 degrees out of phase by side band energy arising from modulation of the carrier frequency by 90 cycles and 150 cycles simultaneously, but from which the carrier frequency itself has been suppressed. The center element radiates the carrier frequency and also 90 cycle and 150 cycle side bands. The side band

(*Continued on page* 266)

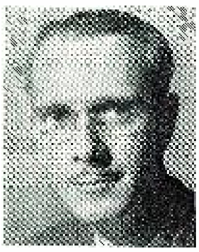
A method of orientation by radio range using fade out method. Note all flight turns are in one direction (left).



International Airways Radio Communications

by LLOYD H. SIMSON

Radio Communications Coordinator, CAA.



Began his career experimenting with "wireless" obtaining professional license as marine operator 1914. Enlisted in Navy 1914 assigned to naval radio laboratory. Later on sea duty in Armed Guard Detail between United States and France. Postwar experience included various communication assignments in the U. S. Shipping Board, Principal of Radio School Oregon Institute of Technology and was active in building and operating some of the earliest broadcasting stations. Joined CAA 1929. He represented the Department of Commerce and the CAA at various international communications conferences.

The assignment of specific channels for radio communications for aircraft is imperative for the safety of planes.

Radio operator at his controls aboard a U. S. Clipper plane. Equipment must be capable of world-wide performance.

THE news today is filled with debate about freedom of the air. Such freedom has two aspects—freedom of the atmosphere, the invisible element which enables an airplane to fly, and freedom of the ether, the hypothetical "x" by which scientists explain the phenomenon of radio.

Freedom of the ether was conclusively settled—or so it seemed—in 1927 when the nations of the world subscribed to a convention solemnly recognizing the sovereign rights of each nation to use any radio channel it desired. But the representatives of 76 nations soon met in Washington and drafted a detailed set of technical regulations for international use of radio channels which drastically limited theoretical freedom of the ether.

The seas are technically free beyond the limits of territorial waters. All navigable air space could likewise be declared free by mutual consent of the nations of the world. But the ether, though theoretically free to all, can never actually be free because radio chaos would result if sovereign rights were ever invoked. No method has yet been or is ever likely to be found to keep out "foreign" waves of radio energy. Trespassing ships or aircraft can be destroyed or turned back, but what can be done about a wandering wave in the ether? If neighboring nations simultaneously use the same wave channel, only mutual interference results. The only practical protection against international conflicts in radio is equitable control of the field by voluntary regulation on a world-wide basis. Detailed regulations have been established, and the world observes them with surprising fidelity, even in war time.

Modern aviation would be impossible without radio. When the latter first demonstrated its potential ability to free the airplane from some of the serious limitations imposed upon it by weather and other natural hazards, all of the then useful wave bands of the radio spectrum had already been staked out and claimed by the established wireless services. Aviation was a newcomer and succeeded in acquiring only relatively few radio channels against the opposition of competitors already well entrenched on the more desirable operating frequencies. Aeronautical engineers soon found that a saturation point for airways radio communications was approaching with the rapid growth of air commerce.

Necessity thus stimulated aeronautical radio development. Aviation radio took the lead in using quartz crystals to stabilize the frequency of radio transmitters and receivers, resulting in the first successful high-frequency airway radiotelephone system. This proved faster for domestic use by providing direct communication between the pilot and the ground station, and reduced the time required for international messages.

The number of usable radio channels were also increased by technical developments. Improved frequency stability permitted closer spacing of operating frequencies so that two channels were sometimes created where formerly there had been only one. Radiotelephone channels

(*Continued on page 224*)

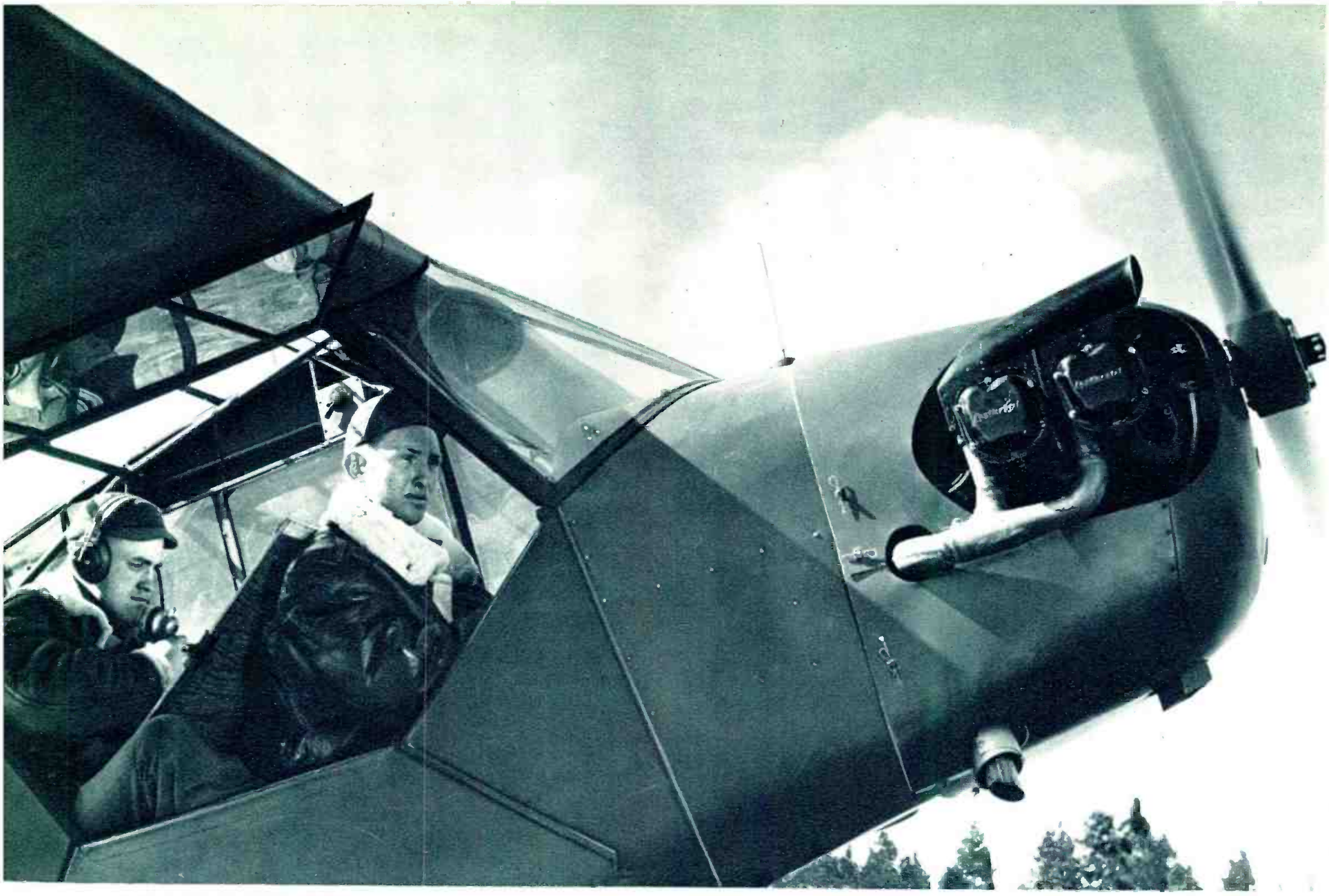
GRAVURE PHOTOGRAPHS

FOR TECHNICAL DATA SEE PAGE 238

Salon Section

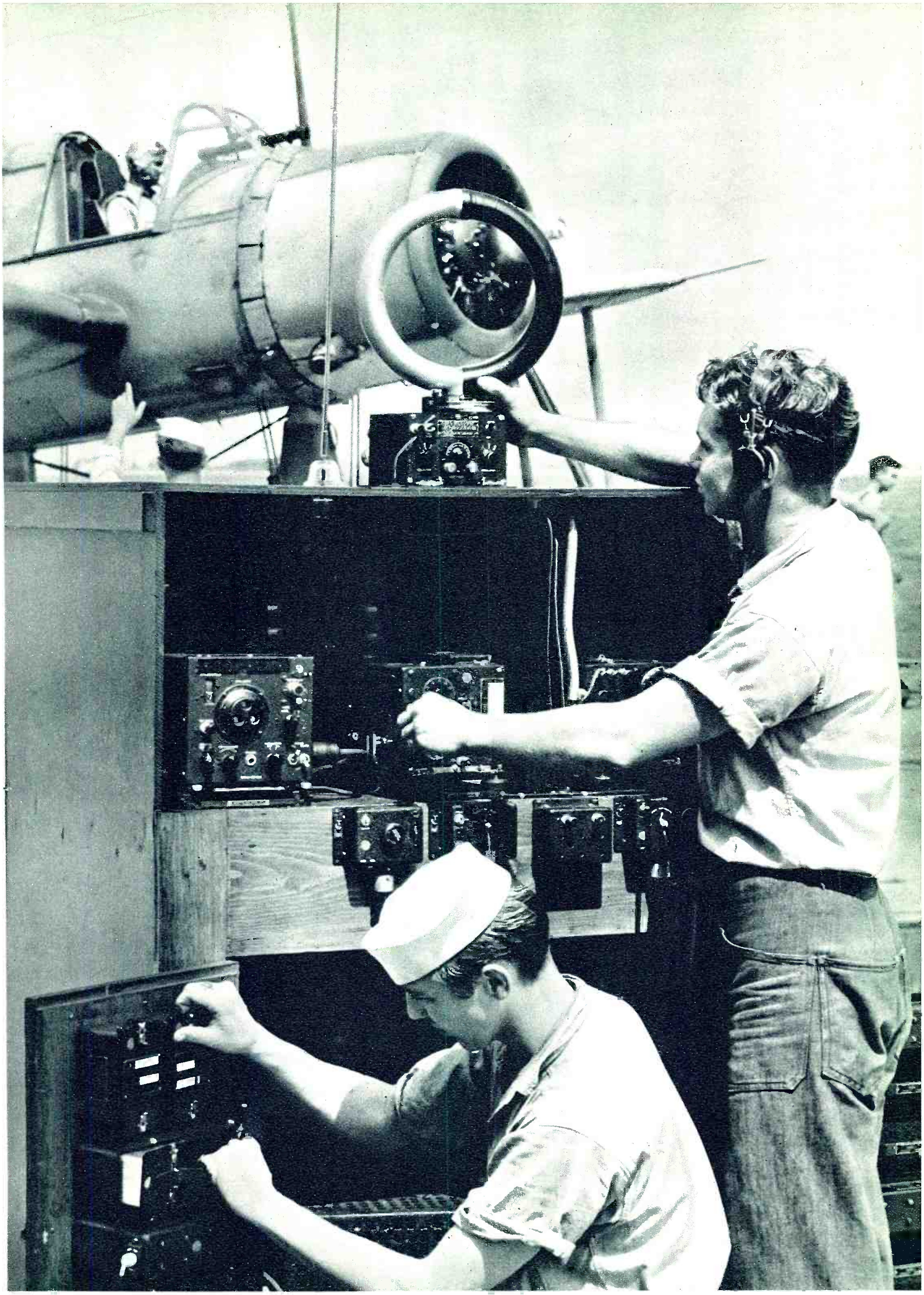
Communications in our Air Force, Navy, Signal Corps, CAA and CAP is dramatized in the photographs to follow. Most of them were taken especially for this issue.

MOCK-UP

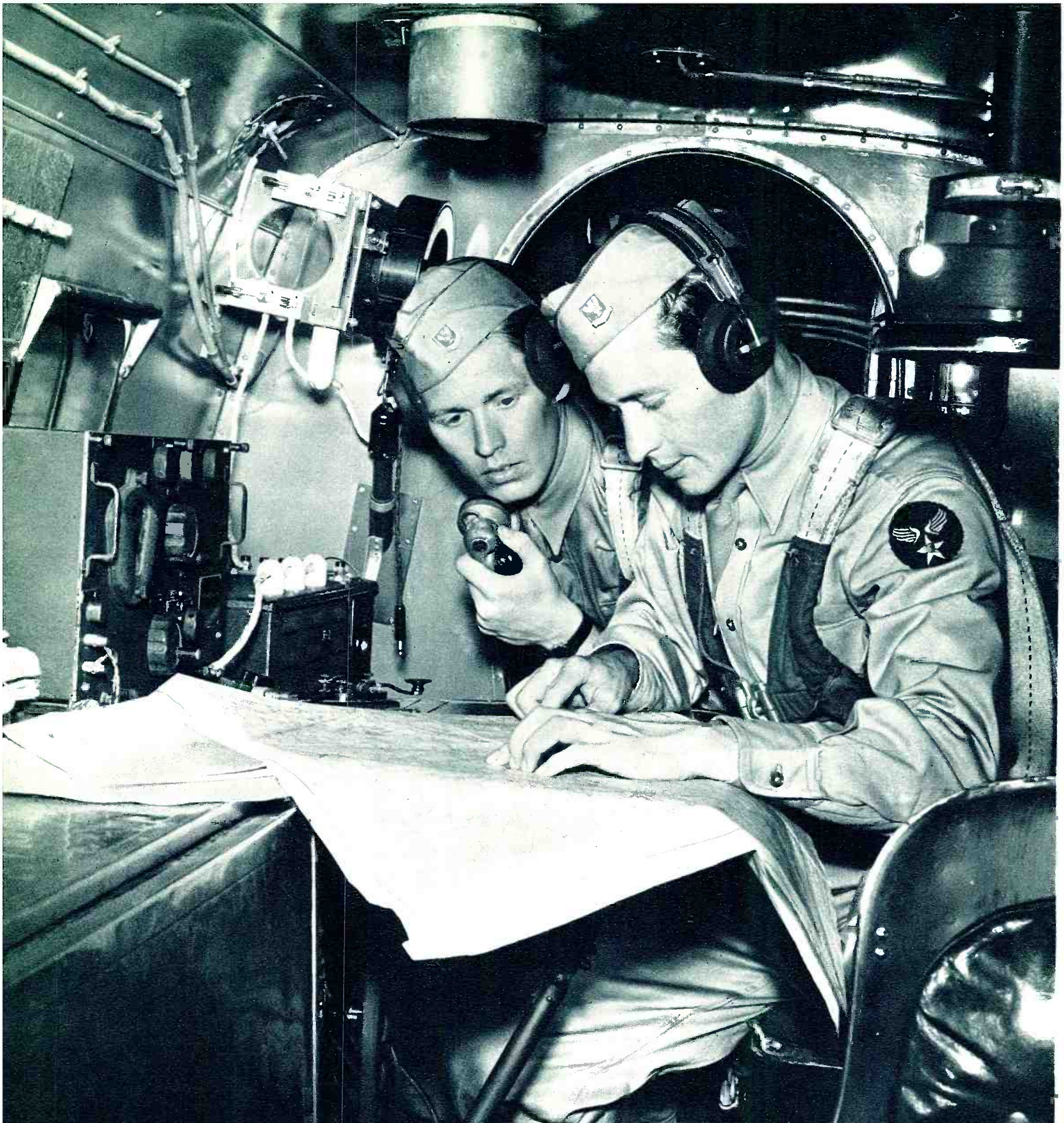


GRASSHOPPER

AT EASE

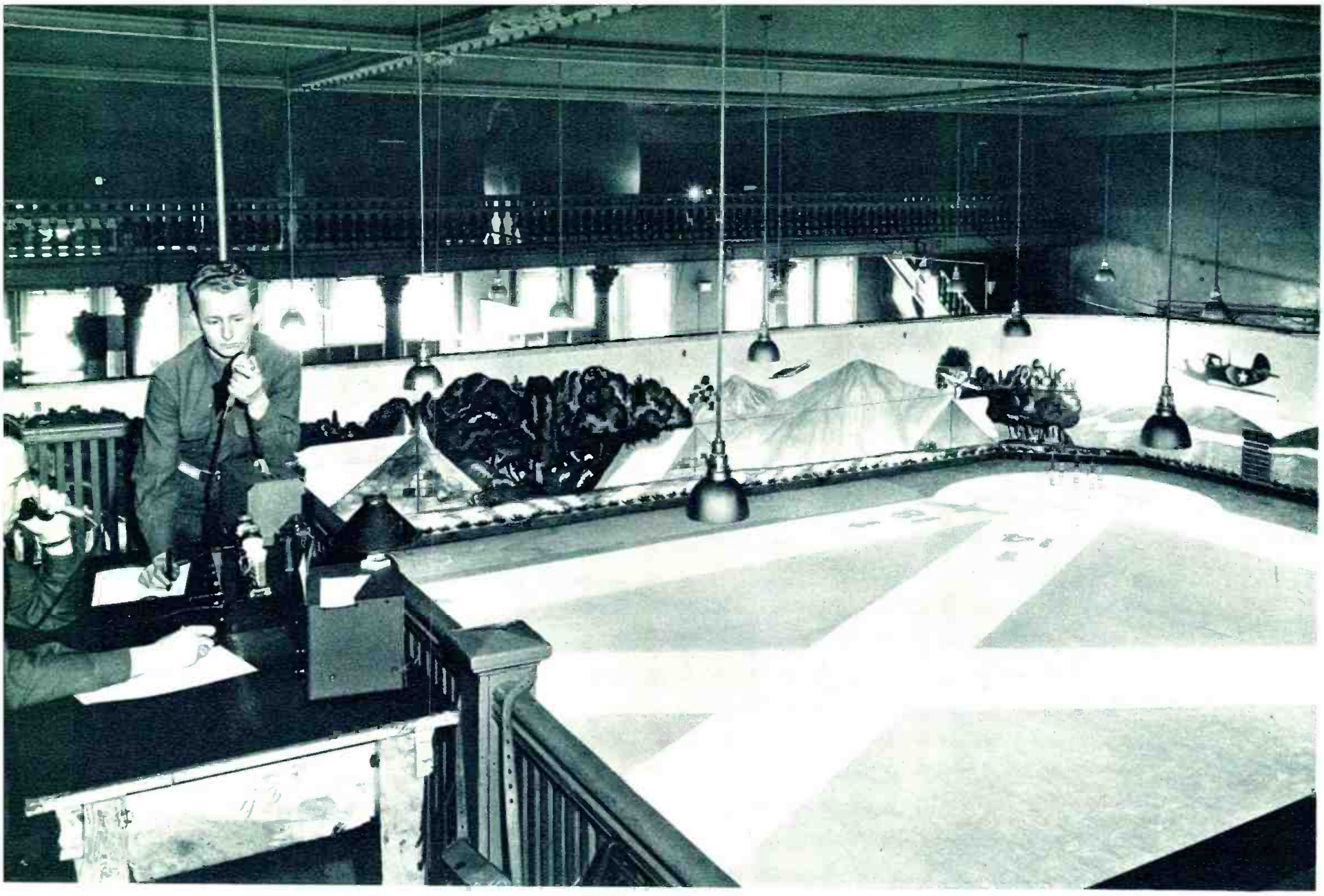


CALIBRATION



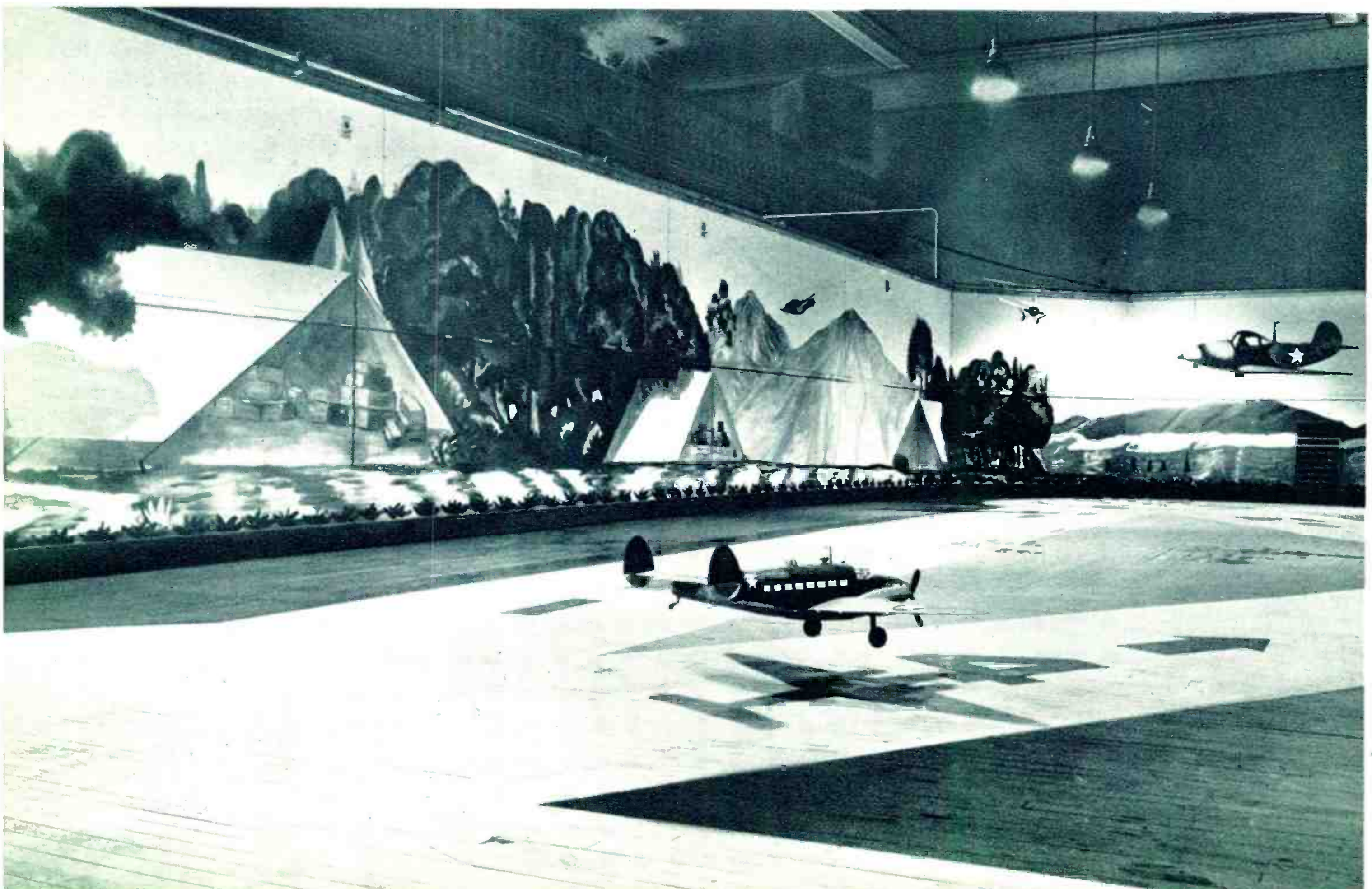
NAVIGATOR

FORMATION



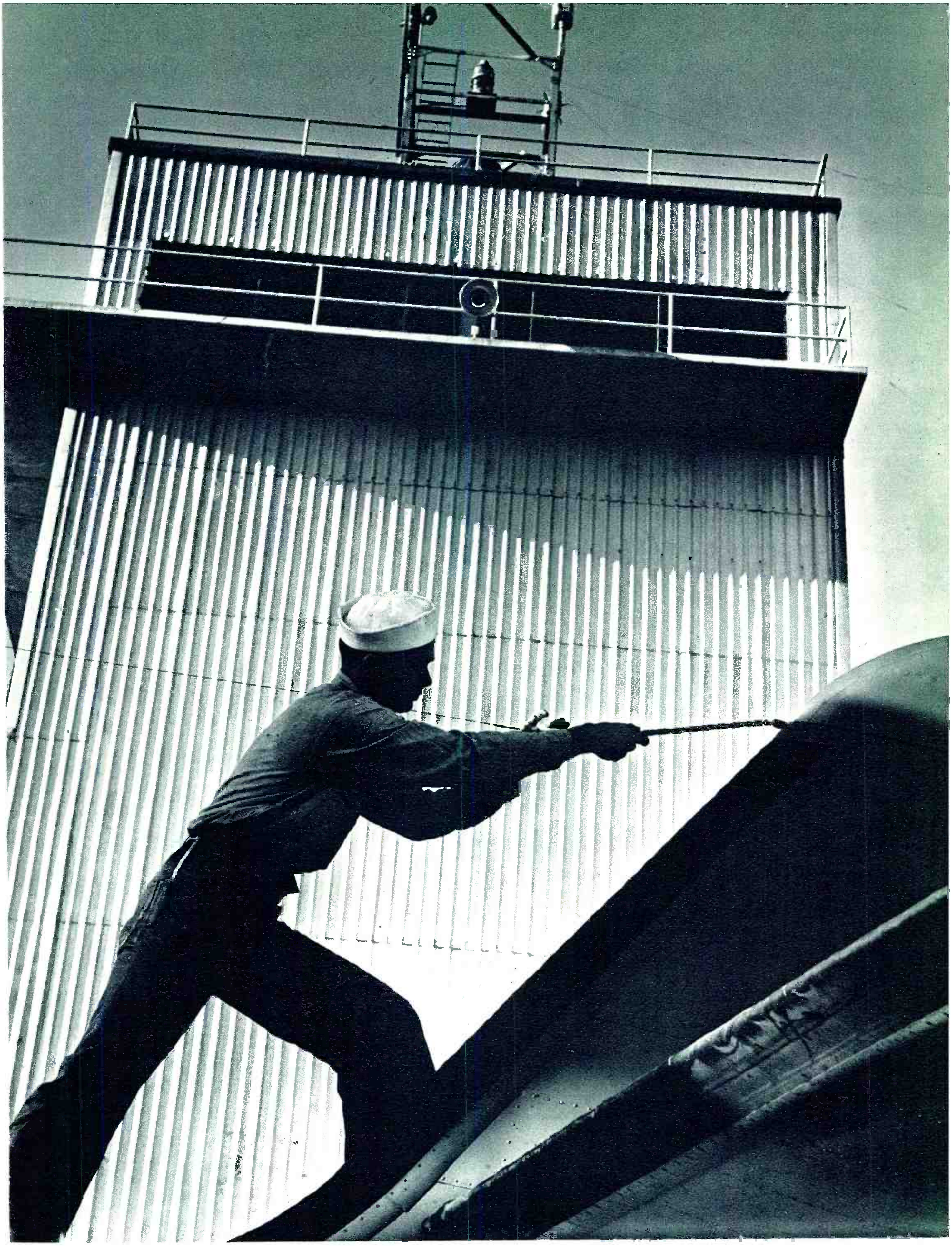
INDOOR AIRPORT

COMING IN



CONTROL TOWER

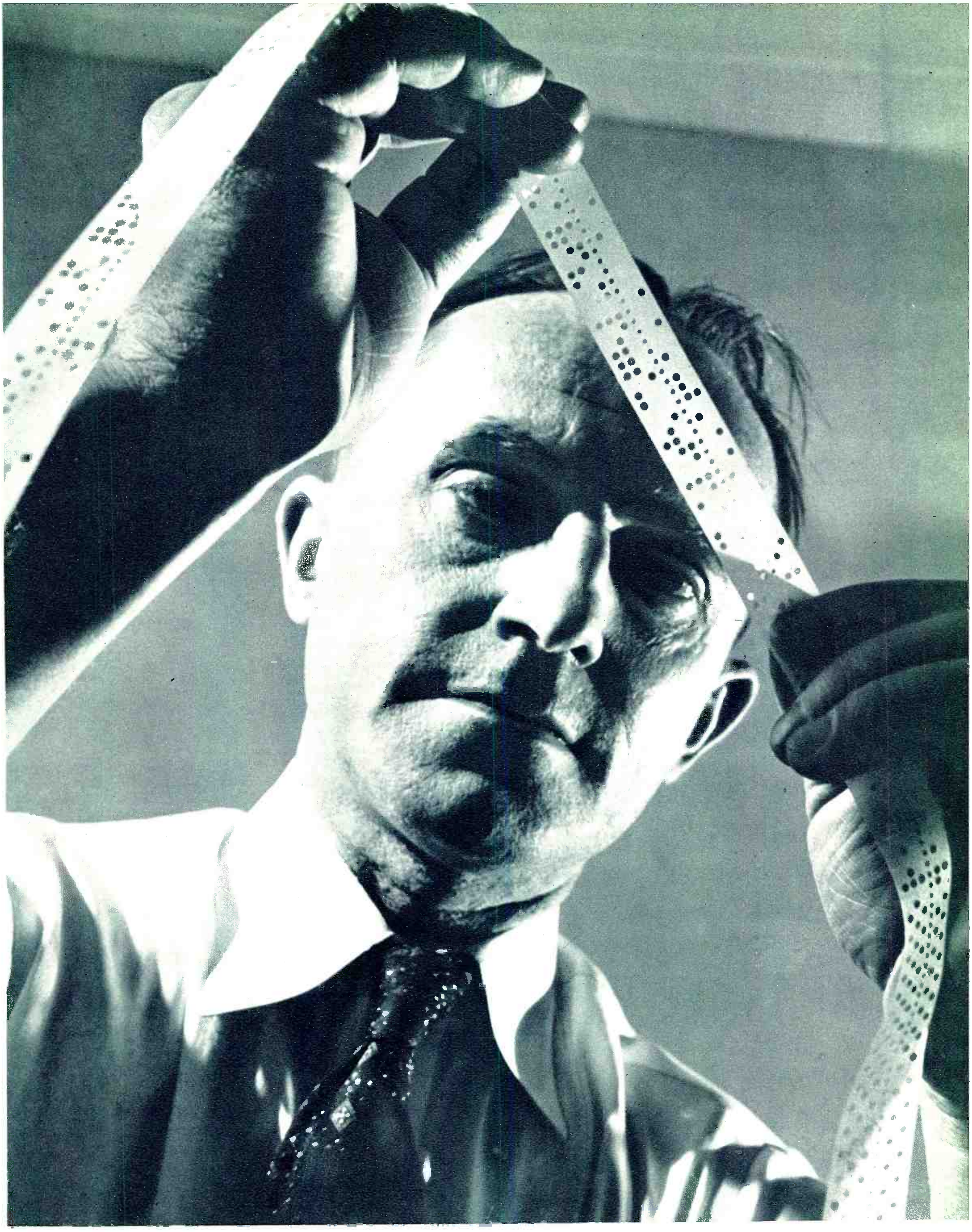
SHOP



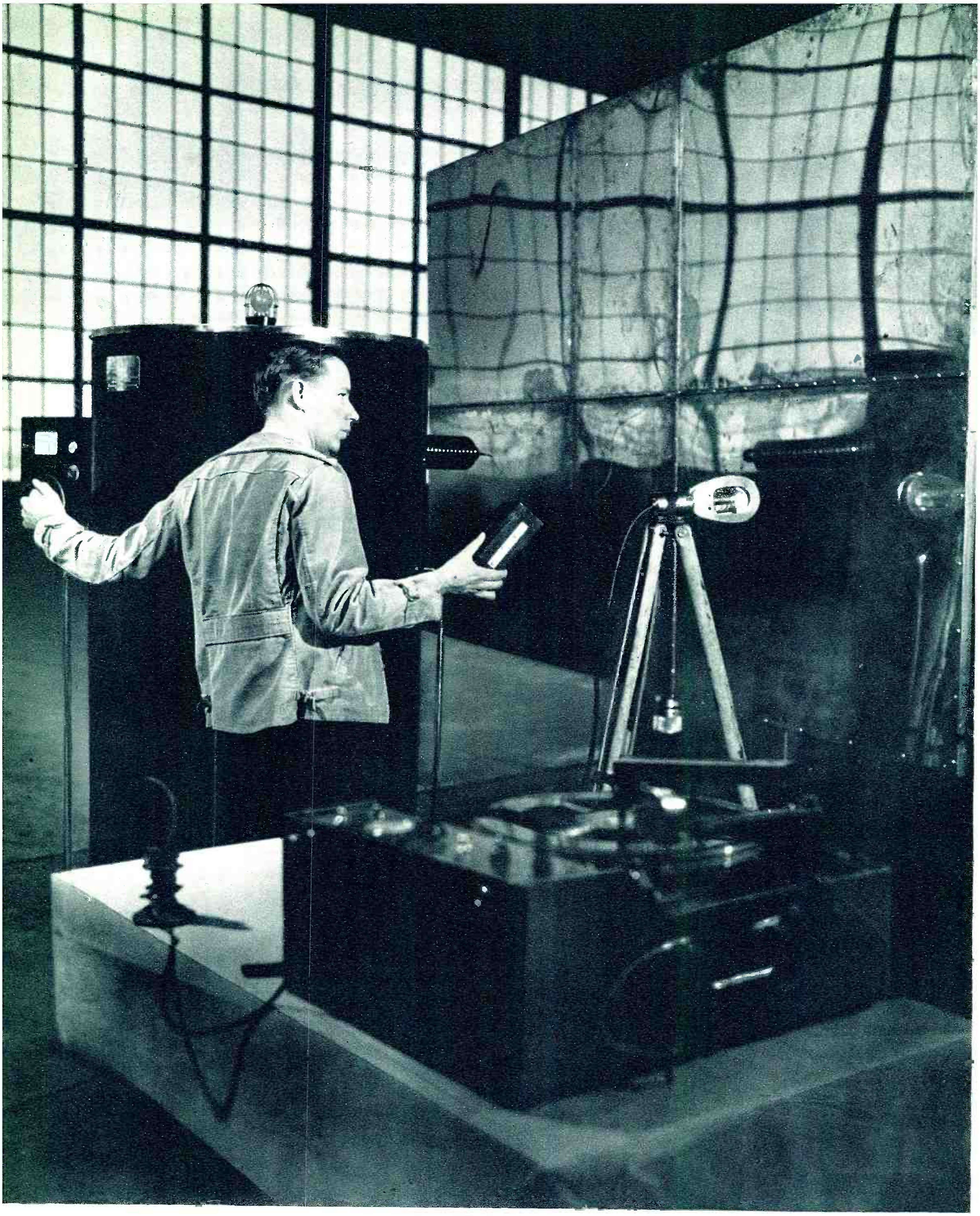
SERVICE


U.S. DEPARTMENT OF COMMERCE
CIVIL AERONAUTICS ADMINISTRATION

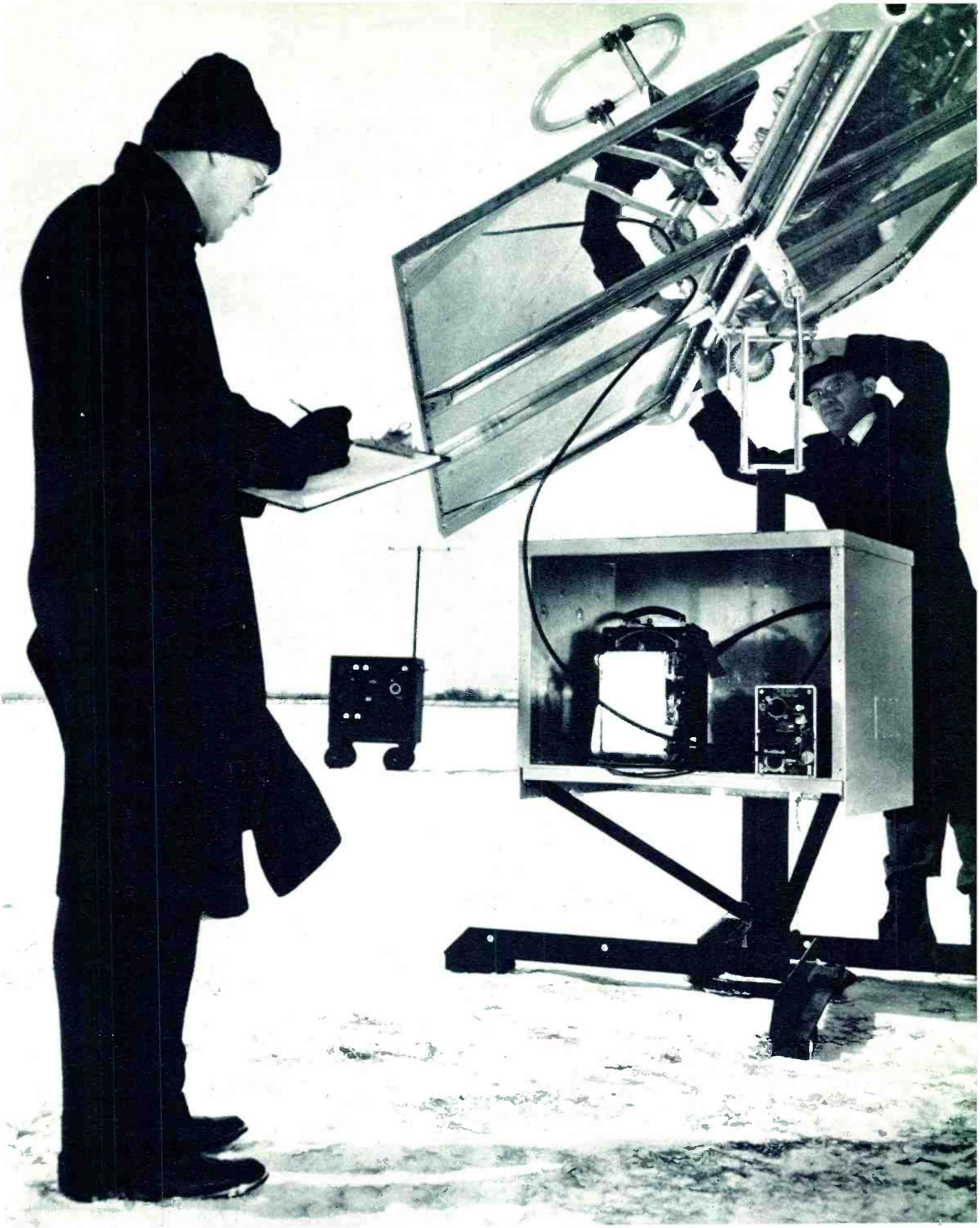
MESSAGE



TAPE TALK

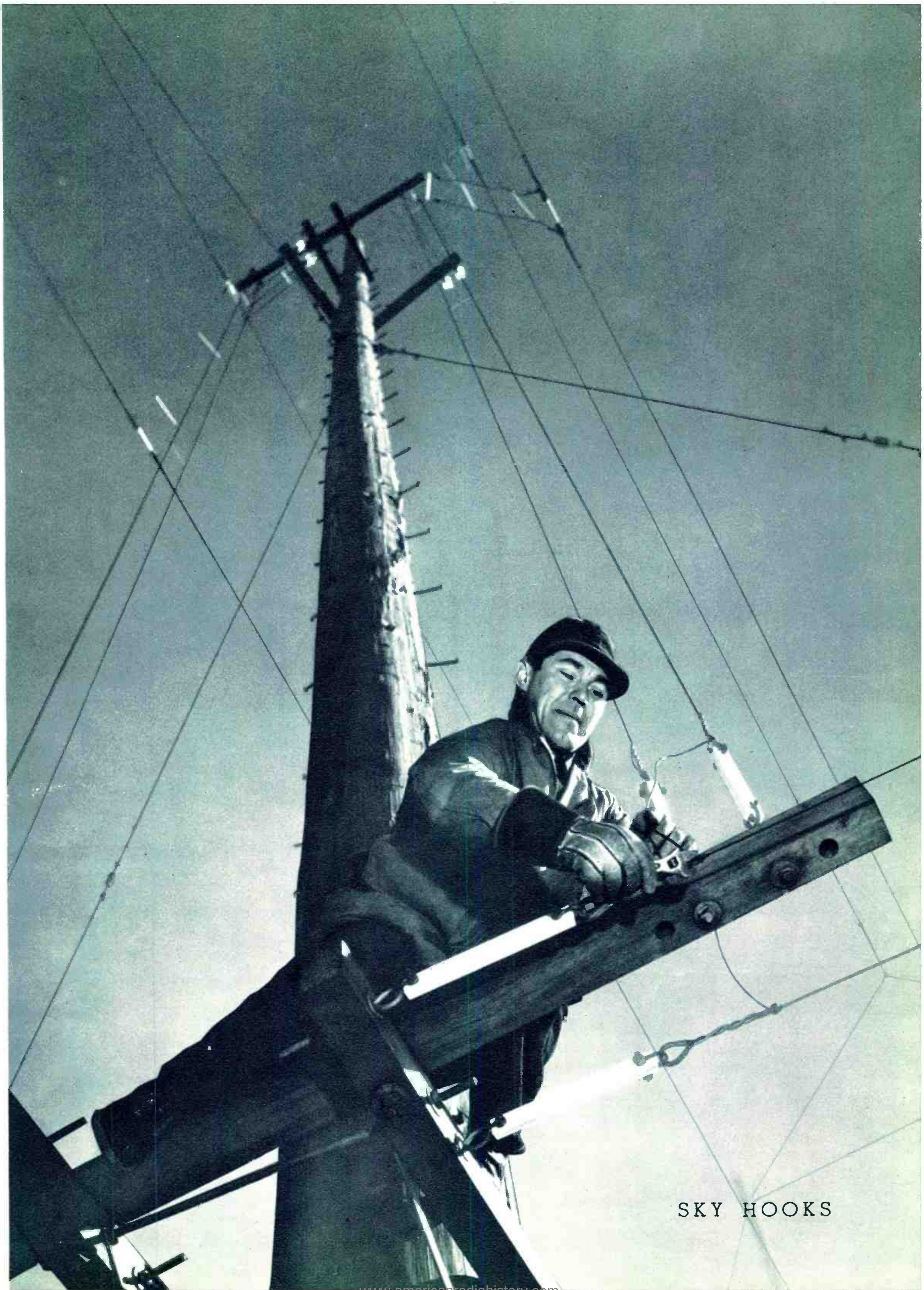


REFLECTIONS



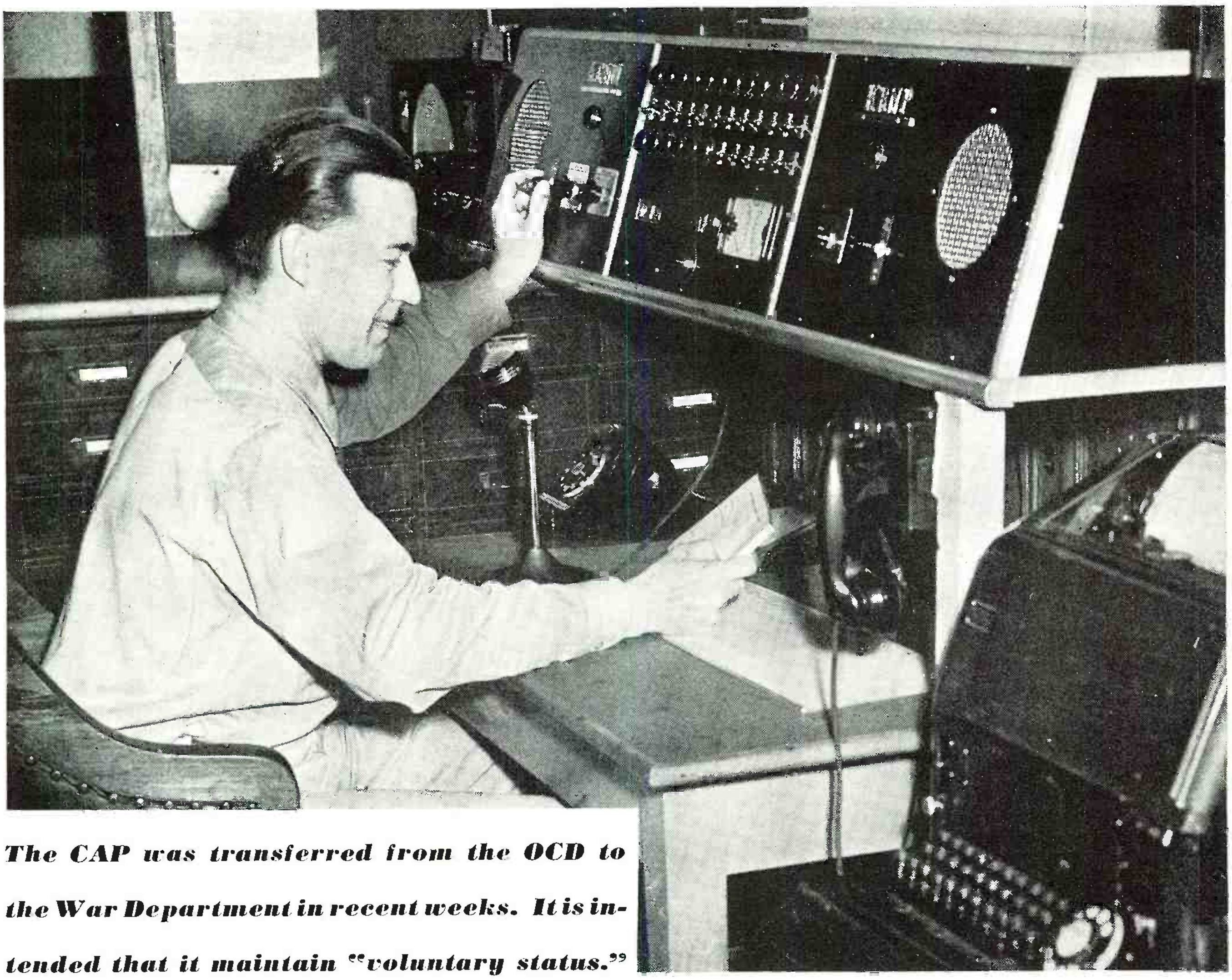
RESEARCH

SALVAGE



SKY HOOKS

FLIGHT COMPLETED



The CAP was transferred from the OCD to the War Department in recent weeks. It is intended that it maintain "voluntary status."

Elaborate equipment in control room of CAP station.

The CIVIL AIR PATROL

by Capt. KENDALL K. HOYT

Born in Washington, D. C., October 16, 1903. Graduated Cornell University, 1925. Consulting Engineer (Aviation), 1925-27; Publicity Director Interstate Airways Comm., 1937-38; Member, Aviation Writers Assn., National Press Club. Was a Washington correspondent, specializing in aviation news and public relations. Prior to entering the service, he was manager of the National Aeronautic Association, starting initial work in setting up the CAP. At present, Captain, Army Air Corps, National Intelligence Officer, Civil Air Patrol.

RADIO has played an important part in the training and operations of Civil Air Patrol over the past year. Under the new rules recently approved by the Federal Communications Commission, CAP units are permitted to set up their own special portable stations for local practice in radio procedures.

CAP was founded a week before Pearl Harbor to mobilize civil airmen, auxiliary workers, and their equipment for volunteer duties in the war effort. The Patrol was organized as a division of the Office of Civilian Defense but from an early stage its main work has been in the performance of missions for the Army Air Forces.

The most important job of CAP is the Coastal Patrol operating with a series of special CAP bases along the Atlantic and Gulf Coasts. In single-motor land planes, the CAP volunteers on these bases are on continual watch for enemy submarines. Since these ships carry their own bombs, the service has been highly effective in protecting the vital coastwise shipping which supplies both our battle lines and our seaboard industries.

Airplane and shore radio is essential to this operation. Every base has its own transmitter and every plane is equipped with 2-way radio so as to keep in constant touch with the base. Thus the position of each plane is accurately charted on a plotting board. The CAP pilots are good navigators and report their latitude and longitude correctly so when they sight a sub Army and Navy bombers can be summoned for the kill.

While the Coastal Patrol is a highly secret operation, it

Plotting board, where positions of all planes in flight are recorded. Planes must report positions at regular intervals.

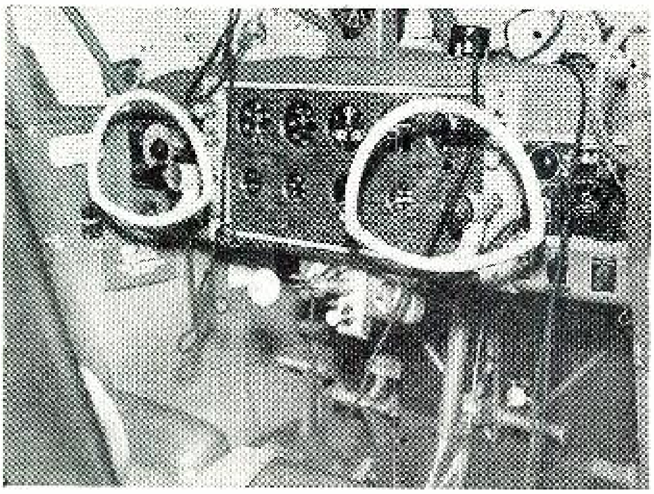
has been officially revealed that U-boats spotted by CAP observers have been sunk; other subs about to attack convoys have crash dived on the approach of CAP planes; merchant vessels in distress have been saved; and survivors have been rescued as a result of radio reports from CAP planes at sea.

Thus the job of Communications Officer at a Coastal Patrol base is an important one. These posts are held by men who received their radio experience as civilian amateurs or professionals. The radio equipment at the bases is all the property of private individuals and has been donated or loaned for the anti-submarine campaign as have the airplanes and almost all the other equipment used by the Coastal Patrol.

Back of the Coastal operations and the other active missions of CAP throughout the country is the CAP organization under a group of Army Air Corps Officers assigned to CAP National Headquarters in Washington. In each of the 48 States, there is a Wing of CAP subdivided into Groups, Squadrons, Flights, and Sections. Local units are active at more than 1,000 airports and local flying fields in all parts of the country. Even in the coastal areas where private flying has been grounded, the local units have carried on with vigorous training programs.

More than 73,000 men and women have enlisted in CAP since the beginning. Of these, a good many thousand have entered the armed forces with their CAP training and experience back of them. Thousands more are serving on active missions of the CAP itself and the rest are available to carry on the work of the local units. A typical Squadron of the Patrol is composed of about a third of pilots, a third student pilots and the rest with auxiliary skills in radio, photography, and other necessary ground duties. In addition to the regular organization, many CAP Squadrons and Flights have formed CAP Cadet units organized and trained under substantially the same program that the senior members follow.

Instrument panel of Stinson 10-A used on CAP coastal patrol. All equipment used in planes and stations loaned by civilians.



The radio work of a typical local Squadron is under the direction of the Squadron Communications Officer, usually a local radio amateur with plenty of experience. Reporting to him is a Communications Section of a dozen or so members headed by a Technical Sergeant with a Corporal as an assistant.

Every member is required to take upwards of 200 hours of CAP training, including a thorough course in military communications. Morse code is a required subject. If you were to visit a meeting of your local CAP unit, you might see a class taking code through head phones, listening to an oscillator, or watching a blinker to get their speed up to at least the minimum requirement of 8 words per minute.

Not only is this knowledge of code important in active missions such as the Coastal Patrol but it can mean the saving of lives in local emergency. For example in Churubusco, Ind., Horace Hinshaw and his wife, both CAP members, observed an Army plane circling overhead in a snowstorm, obviously lost and looking for a place to land. They called out the fire and police departments, illuminated a field, and signaled landing directions to the pilot with an auto spotlight with code they had learned in CAP classes. By coincidence, the Army pilot was a former CAP member who likewise learned his International Code from the Patrol.

In another case, CAP member Arthur Hawkes, while practicing code reception at his home in Portland, Me., intercepted a message from an Army plane in distress and promptly relayed the message so the lost ship was located.

With their intensive training, the CAP units in all areas are ready to go into action. When a barge was adrift in a raging storm on Lake Erie, Lt. Clara Livingston, a CAP pilot, located the vessel through a rift in the snowstorm and radioed its position to shore. In disasters such as floods, tornadoes, and forest fires, reconnaissance flights are made by radio-equipped planes of the Patrol.

Throughout the West, it is becoming regular routine for searches for lost military aircraft to be flown by CAP. The Nevada Wing maintains cavalry and motorized units for the ground crews completely outfitted with supplies, medical equipment, radios, and carrier pigeons as an auxiliary means of communication. Similarly, the New Hampshire Wing sends out planes which can land on skis. In winter rescue missions, the pilot radios instructions to ground crews on snowshoes.

Although minimum standards of training are set in the regular CAP program, local units are continually using their initiative in devising new ideas and in improvising equipment. One unit secured a number of obsolete telephone instruments from a rural company to provide a signal system for its ground maneuvers.

All this training and experience helps personnel to learn the use of radio which, since the war began, has a new importance to aviation.

Before the war, although radio beams and weather sequences were flashing on all the Federal airways, few pilots had much knowledge of radio. A typical private plane would hedge-hop without radio aids or the pilot might carry a portable receiver to get weather reports.

Today, the detailed regulations necessary for all wartime flying require two-way radio for take-offs and landings at most of the larger airports. Regular courses in control-tower procedure are given in CAP classes so that a member will know the correct phrasing of messages. The average CAP member soon acquires a 3rd Class Radio Telephone Operator's license.

One of the most extensive jobs which CAP is doing for the Army Air Forces is the flying of courier routes between Army posts in the West. Similar work, together with tracking flights to give aiming practice to the anti-aircraft gunners, tests of the air-raid spotter system, and a wide variety of other missions, is being conducted in the East. Pilots on these assignments must check out in radio procedures before they can fly in and out of Army fields.

(*Continued on page* 252)

THE NAVY

The Navy uses many kinds of communications for guiding ships and in maintaining contact with members of our fleet and the many other branches of our services.

Pilots, guided by radio, are responsible for the safety of their crews and the successful completion of their objective.

RADIO IN NAVAL AVIATION

by Comdr. FRANK AKERS

Commander Akers was born in Nashville, Tenn., March 28, 1901. Graduated from the Naval Academy in 1922. After spending several years on duty in the Fleet service was transferred to Pensacola where he received his basic flight training, graduating in 1925. Then spent several years in various air units. Had a three-year tour of duty under post-graduate instruction in communication engineering. His past experience shows the vital role radio is playing in air transportation. Holds the DFC and a commendation for extraordinary achievement.

EACH of the armed forces has a vital need for communications in this fast moving war. Perhaps the most dependent on radio are the ships and planes that keep the enemy from invading our shores and which hit him wherever he can be found, for they work in the limitless wastes of the sea and air, often cut off from the rest of the world save for the nebulous energy waves traveling through the ether.

Just as each service performs a different function in the war, so does each require different equipment. Radio is no exception; very special problems are encountered in communications equipment for use in naval aviation.

The prime requirements for such apparatus are the ability to stand high humidity, great vibration and extreme accelerations. The sets must be light, compact, economical of current, sensitive, powerful, selective, and capable of rapid installation and removal from planes. A discussion of these problems and the solutions of some of them follows, but first we shall consider how naval aviation radio is developed from its original conception and is brought to the cockpits of the planes.

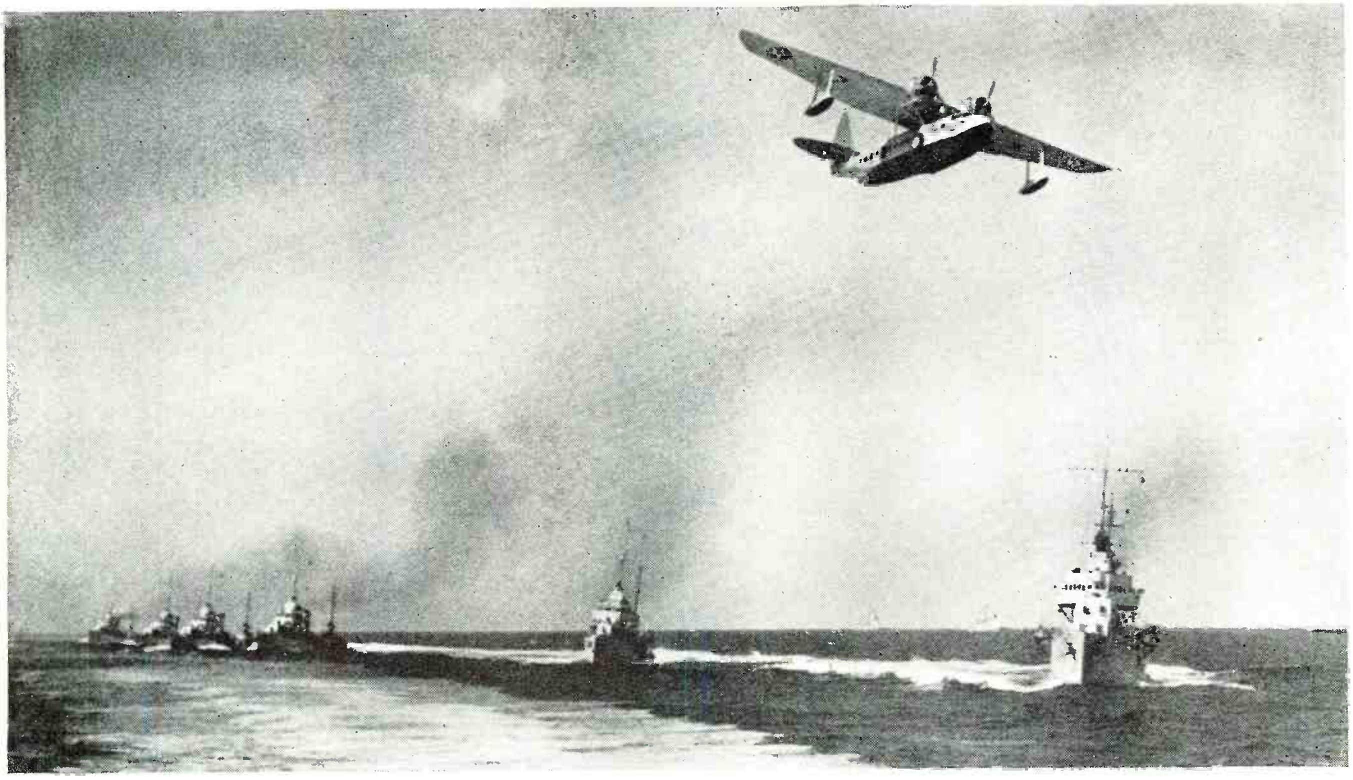
The Bureau of Aeronautics sets up the operational requirements and general specifications including the permissible size and weight.

The Bureau of Ships prepares the detailed specifications and deals with the equipment manufacturers.

Specifications for a radio receiver, for example, will state the maximum size and weight permitted, the required sensitivity in microvolts per meter, the necessary selectivity, the amount of pressure which the equipment must be expected to withstand (i.e., the number of "G's" it must be prepared to take when a plane pulls out of a dive), the temperatures and the degree of humidity it will encounter, the altitudes at which it will have to operate, and the number of hours it must undergo a test in salt spray.

The specifications, for example, may state that the set must deliver a specified performance at all temperatures between certain limits, that it must perform equally well at sea level, when 30,000 feet in the air and at humidities from 0 to 95 per cent.

In peacetime, contracts ordinarily were awarded to the lowest bidder. Now, however, the facilities of the various manufacturers are examined, together with their present and planned engineering and production load. This is done to make sure that they are capable of producing the equipment as rapidly as required, of the quality specified, and to insure that one plant is not overloaded while others



U. S. Fleet on maneuvers in the Pacific. Radio communications between plane and fleet is vital for organized offensive.

have men and facilities idle. The safety of our country depends upon our fighting men and their equipment; they must have the equipment when needed and it must be able to serve their needs dependably twenty-four hours a day.

Once the contract has been awarded, the manufacturer goes to work. He produces a few pre-production models (known to the Navy as X models) for test by the Naval Research Laboratory at the Naval Air Station, Anacosta, D. C. These equipments are subjected to every possible test, including many hours in a humidity chamber where they are cycled from absolute dryness to high humidity. They are tested at Arctic and tropic temperatures and are put into vibration machines where they are subjected to severe shaking. They are also moved at a high rate of speed and stopped short, this test being known as the gravity or "G" test. During the time this equipment is undergoing the various tests, they must provide their rated output if they are transmitters or their rated sensitivity and selectivity if they are receivers. When they are finally placed under a salt spray for a number of hours and have survived this ordeal, they must still be up to standard. The equipment need not be 100% perfect after undergoing all the necessary tests as some tolerances are permitted but it must be extremely close to perfection.

When the tests are completed, the equipment is rated either as satisfactory or unsatisfactory. If satisfactory, production proceeds but if unsatisfactory, the design or construction is altered until the apparatus can be passed with complete approval.

Perhaps the greatest difference between communications as used by naval aviation and the other air services is that our equipment must have unusual ability to withstand high humidity. The reason is obvious; virtually its entire useful life is spent over the sea, where the moisture content of the air is comparatively great. Despite this condition, the set must perform according to specifications and hold to the tolerances allowed. Various means are employed to attain this end. Waxes, shellacs and phenolic compounds are used to seal resistors, transformers, etc.; metal surfaces are given protective coatings of highly resistant paints or are plated with non-corrosive metals. A

The navigator is responsible for knowing the position of the plane at all times. Radio bearings on key stations are used.

A convoy, scores of ships in formation, heading across the Atlantic. Silence on all radio communications is kept except in emergencies.

person unacquainted with these problems and having a knowledge of the prices paid by the government for radio communications equipment may think the cost excessive but the informed engineer realizes that military apparatus cannot be compared to commercial equipment as the military apparatus is designed and constructed to perform reliably and efficiently under conditions which would quickly render most commercial equipment inoperative.

However, whenever possible, commercial models are used as costs are lowered and procurement facilitated. Radio tubes may be taken as an example. Commercial types are used almost exclusively and the number of different types employed is held to the minimum which is compatible with optimum performance. This results in simplifying the problem of maintaining radio apparatus.

Vibration is a bugaboo for all airborne apparatus. Unless special designs and construction are used, delicate instruments will be upset, poor or variable contacts will be produced, ordinary soldered joints may be loosened and many other defects (not blamable upon Gremlins) may arise. These effects are obviated by testing samples at vibrations in excess of those which they will normally be required to withstand in actual combat flying and by correcting any faults before production is started.

Less easily understood by those not versed in aeronautical terms is gravity or "G". To say that a piece of apparatus is tested at 5G means little until one is informed that this term means that the apparatus must continue to function in accordance with specifications even when it is subject to stresses five times as great as the pull of gravity. These strains are encountered in combat flying when a plane suddenly changes its direction of flight. Unless the radio apparatus has been constructed with such stresses in mind, heavier parts, such as transformers and the like may be completely torn from their mountings and variable units, such as tuning condensers, may change their settings if not properly counterbalanced.

In addition, as every pound of radio equipment means one less pound of gasoline or bombs with which to smash the Axis, weight is kept as low as possible, commensurate with performance. Indeed, weight is, if anything, even more of a factor with naval aircraft radio than with any other type, for planes at sea do not have the landing facilities that are afforded land-based planes operating over land. Then, too, they are called upon to make lengthy reconnaissance flights where an extra gallon or two of gasoline may mean the difference between completing a mission successfully or failure.

For similar reasons, and because of the extreme distances covered by navy planes, many of the installations are required to have communication ranges in excess of those which are ordinarily provided. While specific distances cannot be disclosed, the reader may recall that navy planes have flown non-stop from San Diego, California to Honolulu for many years, and may draw his own conclusions from this fact.

Despite the performance requirements, the apparatus must be compact and afford as much room as possible for personnel and weapons and must be economical in electrical power drain so that the weight and size of the primary power equipment can also be kept as low as possible.

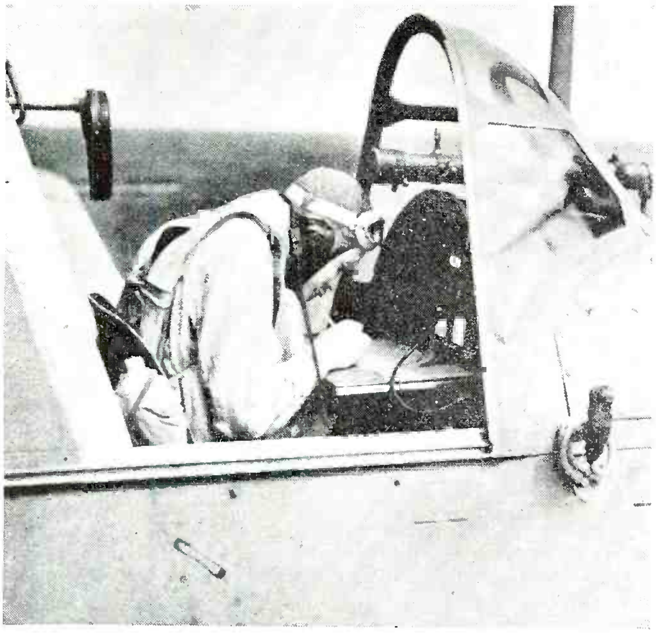
Mention has been made of the fact that equipment must be suitable for rapid installation and removal from planes. When a failure occurs, there may not be time to make repairs and instead, the defective equipment is quickly removed and a perfect replacement is made thereby enabling the plane to fly and fight with but a few minutes delay.

Although standardization is attempted and commercial components from a list of tested and approved products are employed whenever possible, many different types of equipment are required for the widely varying tasks performed by naval aviation. Communications must be carried on not only between planes, but between planes and ships, and between planes and shore. This requires that the receivers must be selective enough to cut through the unwanted stations but still receive a band of sufficient width so that the wanted stations can be held without excessively fine tuning or frequent re-tuning.

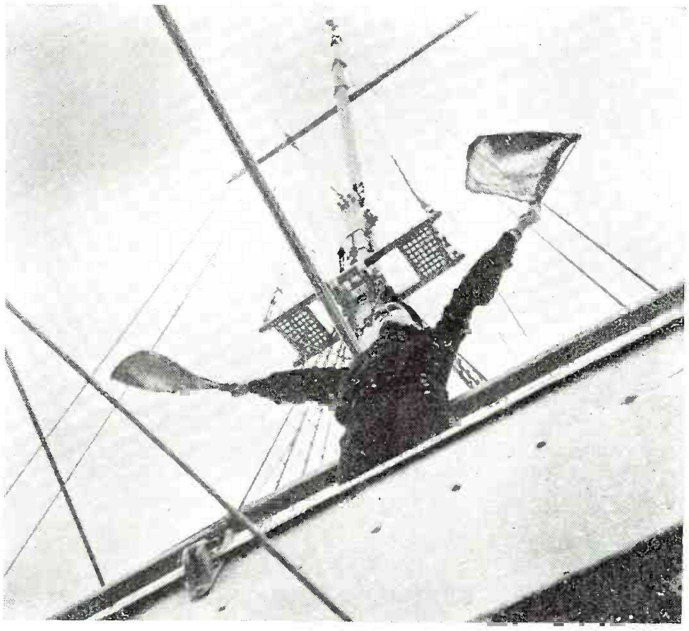
Not all naval radio is communication equipment, and while much of it cannot be discussed until after the war, it is no secret that direction finding is employed. Direction finding methods generally consist of the usual directional antenna which is rotated until a null point is found and the intensity of the signal determined aurally or visually. Another method employed for "homing" is the radio beam which has long been used by commercial air-lines.

The uses of planes by the navy are widely varied. Perhaps the best known is for scouting, in which a plane or number of planes are sent out to scout the enemy's position or strength. The information obtained is transmitted back to the ship or fleet by radio, and by the same means, further orders to the crew of the plane are issued.

The great range of modern naval armaments enables ships to fire at targets which they cannot see, targets which may be beyond the horizon and still within range.



A United States Navy pilot calculates the position of his plane after taking various radio bearings.



Coded semaphore, the silent partner of radio—one of first means of communications still plays important role.

Japanese transports burning on Guadalcanal. An example of the potency of Naval and Air Forces with unified radio communications.

Likewise, our gunners' targets may be obscured by smoke screens laid down by enemy units which are attempting to escape the havoc wreaked by our guns. In this case, radio is used to permit plane crews to act as target observers and inform the ships where the shells are falling in respect to the enemy's vessels or shore installations, thus enabling the ship to direct fire against invisible targets.

War and weather are interlocked—a fact known to all newspaper readers and therefore accurate forecasting is essential to a well planned attack. Radiosonde is used to check the air pressure, temperature and humidity at the substratosphere altitudes. A radiosonde is nothing more than a balloon carrying the necessary measuring equipment and a small automatic radio transmitter which sends out signals at predetermined intervals to convey the readings of the meteorological instruments which it carries. Formerly, planes were used for this purpose, but now higher altitudes may be reached and more frequent observations can be made by means of radiosonde; this results not only in greater accuracy but in advance information as to the kind of flying weather which may be anticipated.

Simple servicing, such as the testing and replacement of tubes may be done by operating personnel, which includes not only the aviation radioman who operates the equipment, but also the aviation radio technician, whose task it is to see that it is kept functioning properly. The latter makes various minor repairs such as the replacement of by-pass condensers, resistors, etc. Major repairs which might call for realignment, etc., are made by maintenance bases; small ones are in operation on the larger ships and large, well equipped shops set up on shore.

Of course, many other radio devices are used by naval aviation but these are not for public discussion, though the technician who is well acquainted with various radio instrumentalities in use commercially before the outbreak of war may be able to hazard a guess as to what they are. Whether such a guess may be accurate or far wide of the mark cannot be suggested here. As a matter of fact, certain devices now used for military purposes may be valuable additions to civilian use after the war is won.

It may not be out of place to mention here that as a result of pioneering by the armed services during the last war, civilian radio was born. A large share of the equipment used in the war was adapted for civilian service. From the laboratory of war come other improvements and refinements later used solely for civilian radio. World War II will be no exception in this respect. With the whole world as a proving ground, the advancement of civilian radio will be almost beyond belief.

You will have noted that considerable secrecy surrounds naval aviation equipment. Even more is attached to its use. All messages are sent in code and prior to an engagement the use of radio is kept at a minimum to avoid detection by the enemy. And although we concede that all this hush-hush is vital to the speedy and victorious outcome of this war, it is with ill concealed impatience that we look forward to the time when the many extraordinary and revolutionary innovations may be disclosed.

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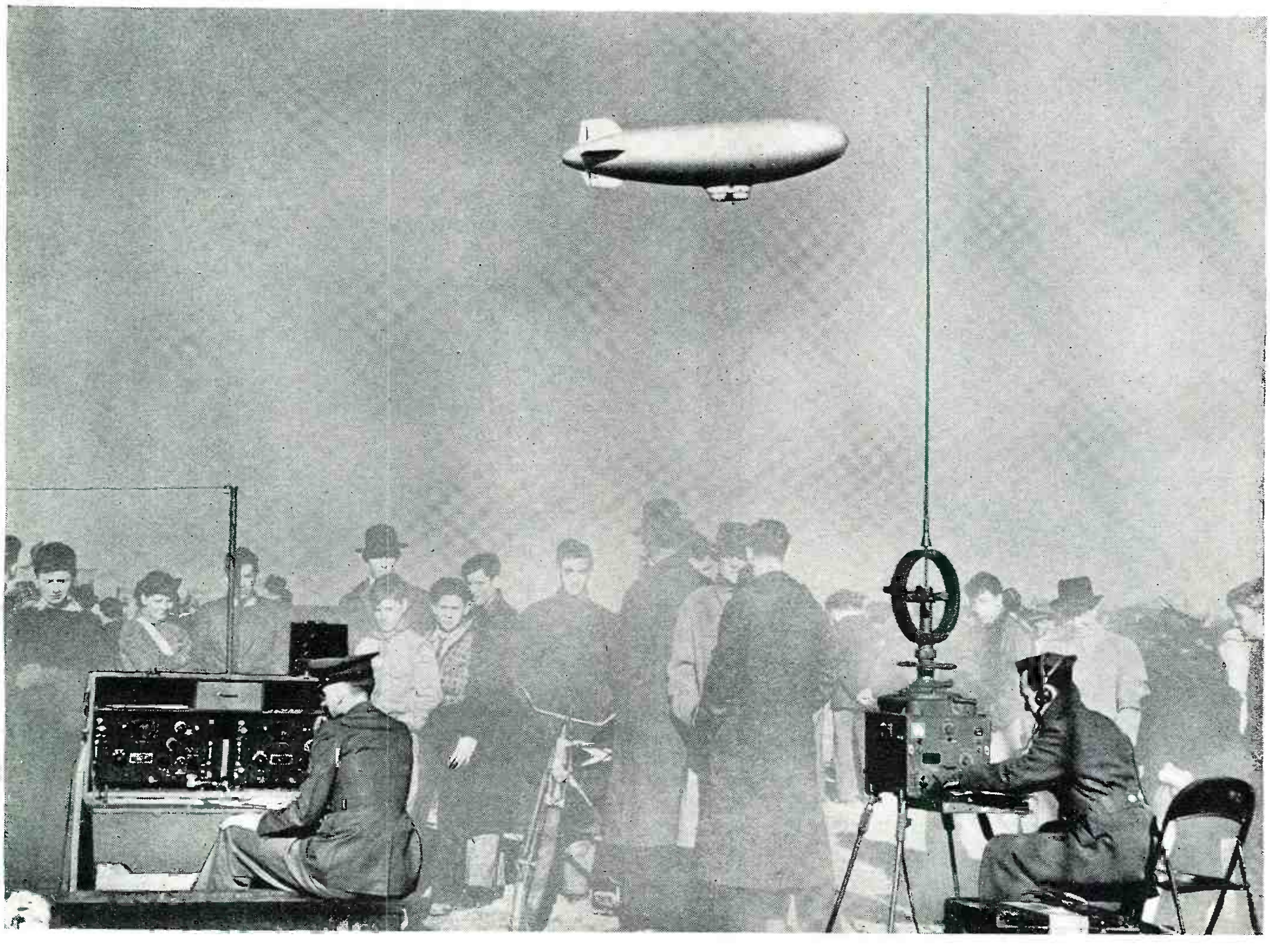
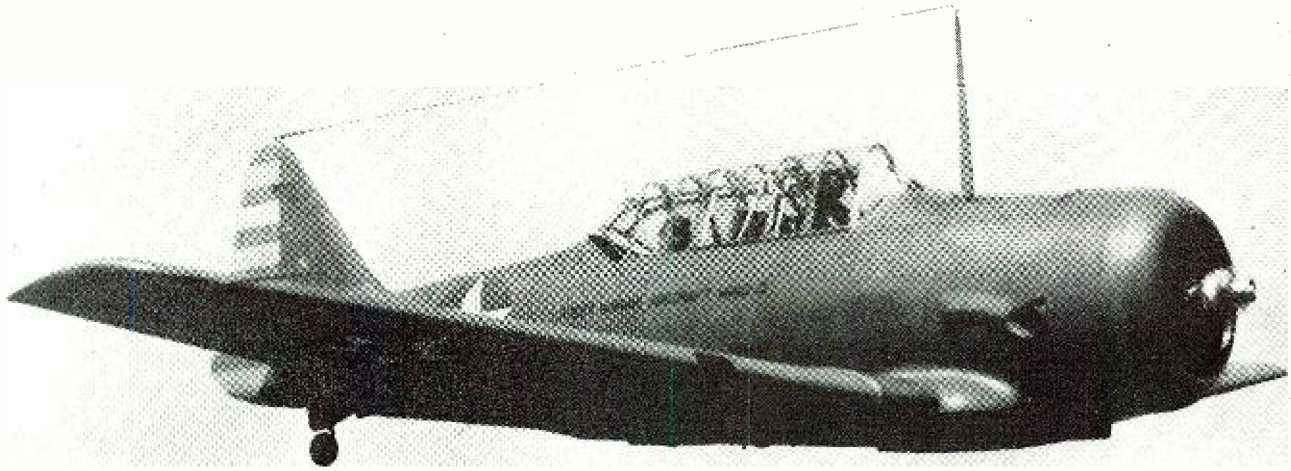
(The views expressed in the foregoing article are those of the author and do not necessarily express the official opinions of the Navy Department.)

A Navy blimp flies overhead demonstrating ship-to-ground communications with members of the Ft. Monmouth Signal Corps School.



RADIO IN THE MARINES



Staff plane used for aerial photographic training. Antenna structure must withstand the full wind pressure at high speeds.

The Marines are scattered throughout the world and must rely on radio for keeping in touch with every field of operation.

by Lieut. Col. EDWARD C. DYER

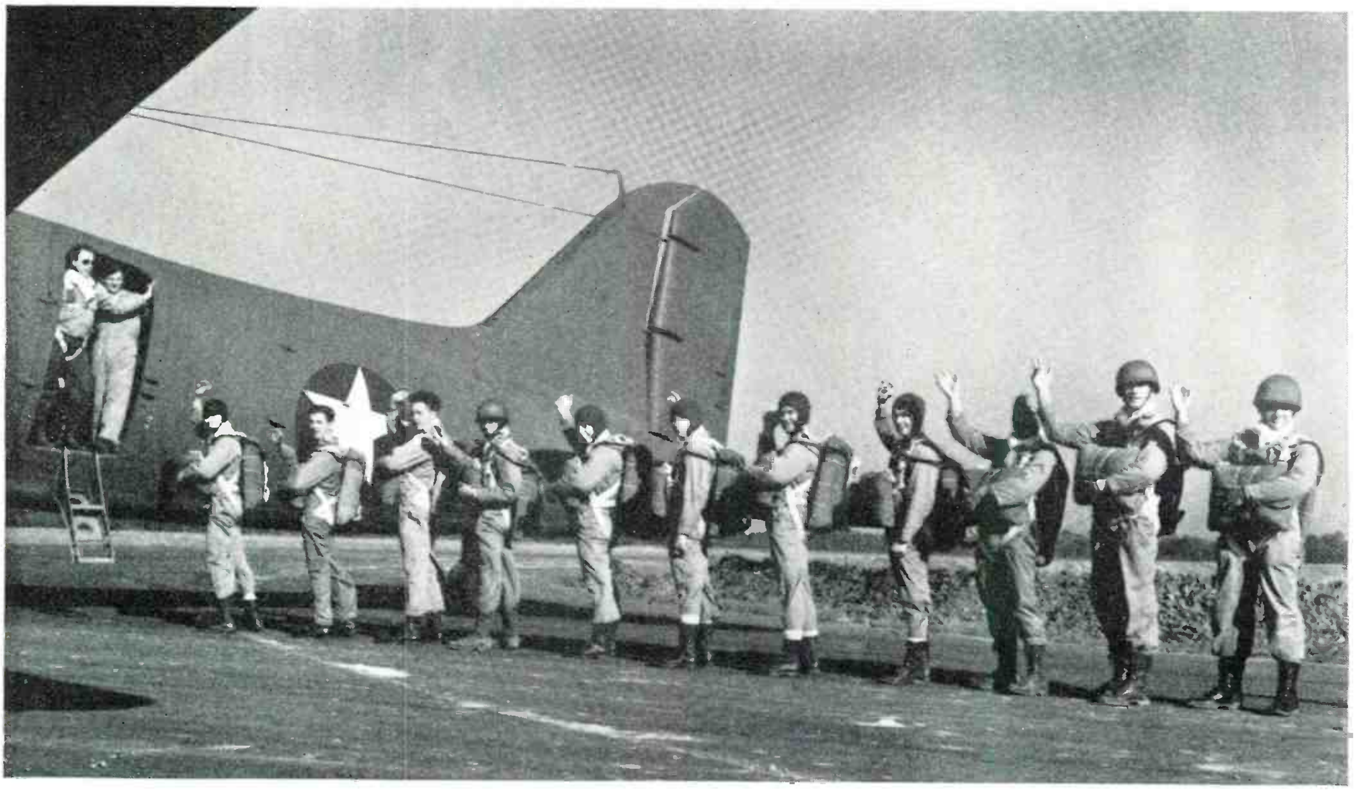
Born Jan. 18, 1907. Attended U. S. Naval Academy, graduating in 1929, receiving a 2nd Lieut. commission in the Marine Corps the same year. Received flight training at Pensacola 1930, made squadron officer 1931 and later squadron communication and radio officer. 1st Lieut. 1934, Captain 1936. Sent to the American Embassy in London and from there to Cairo. Returned to Wash. 1941 and attached to the Division of Aviation. Promoted to Major 1942 and made assistant to the director of Aviation. Appointed Lieut. Col. 1942 and stationed at Cherry Point, N. C.

MARINES are sea borne shock troops, serving on the land and on sea. They are trained to strike lightning blows, to seize and hold a beachhead, clearing the way for larger bodies of troops to land and extend the foothold the Marines have gained. Our occupation of Guadalcanal was a perfect example of a successful landing operation. In these operations our ground troops are supported by our marine aviators operated from the navy's aircraft carriers or from a nearby shore base. Our problems are probably more varied than that faced by any other service.

First of all, for a landing operation launched entirely from the sea, with our aircraft operating from carriers and without benefit of nearby supporting land bases there is the overall problem of maintaining contact with our troops from the time they embark in their boats until they have landed, seized the beach and made it possible for our aviators to base ashore. This involves careful planning, detailed and thorough training of personnel and very reliable equipment. Once the expedition has left its home port there is little chance for revision of plans or for liaison between aviators and ground troops, for the transports carrying the landing forces and the aircraft carriers may be miles apart in the approach to the scene of the attack and radio cannot be used. Radio silence in the approach to an attack imposes another difficulty for no opportunity is presented for tuning or testing of equipment in the last few days before the operation. All must be in order before embarkation. This requires that our equipment be absolutely reliable, calibrations must be accurate and frequency drifting cannot be tolerated. Planning and training must be completed.

Meanwhile, our squadrons aboard the aircraft carriers are operating precisely the same as the Navy squadrons. They are running far ahead of the force on scouting missions or perhaps overhead as a part of the fighter cover. Our marines are trained and equipped so that they fit into the Naval Communications System without variation from routing procedure. Aircraft and aircraft radio equipment alike are developed by the Navy. Both the Navy and the Marines have had every experience in aircraft operation in the tropics so that our radios are well able to stand both the rigors of Tropical climate and rough usage of carrier operations.

On the day of the landing, while our aircraft are protecting our landing boats and bombing the enemy on the beaches our ground equipment must be taken ashore preparatory for operations from the beach. This gear has been stowed in the holds of our transports and now must be put over the side and ferried to the beach by small boat or by lighter—often through surf. For a job of this kind, our ground equipment must be easily stowed and handled, light, tough and most certainly water-proofed or at least sprayproof. The Navy has developed equipment of this sort for the Marines and for advanced Naval bases. Marine Aviation uses it. Once on the beach, our radio and telephone equipment must be hurried to the airdrome



"Paramarines" of the U. S. Marine Corps. Such squadrons are equipped with radio sets for communication with ground forces.

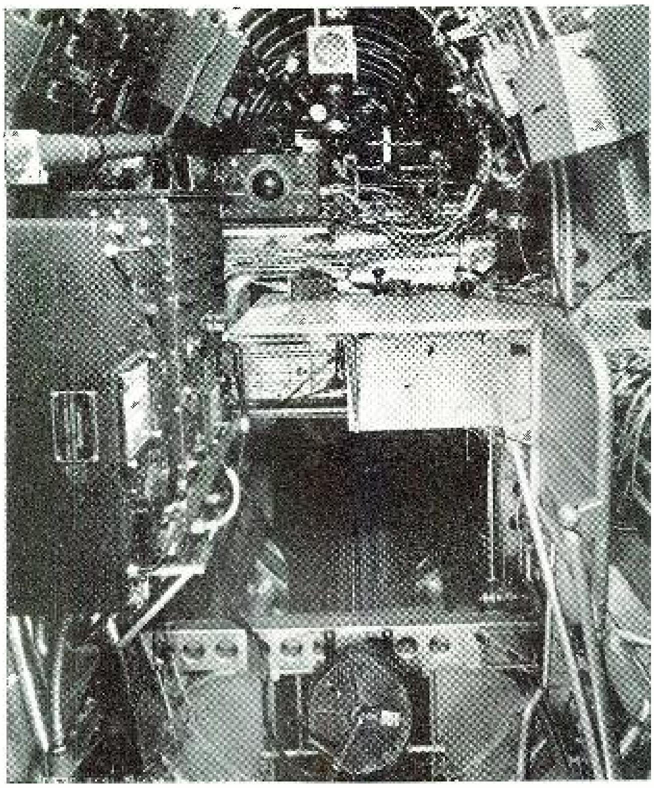
our ground forces have captured. Later, when the situation permits the establishment of proper landing facilities, we turn to the Army and use the more powerful but much heavier equipment developed by our ground forces for mobile operations.

With our beachhead established the problem resolves itself into building a complete communication system for aircraft operations. Commencing with the few pieces of equipment that can be brought ashore in the early days of the operation, we lay telephone circuits, install radio aids to navigation and erect more efficient radio communication installations. Our communication centers are dug in sometimes as much as twenty feet underground. Parallel communication facilities are established so that no single lucky hit can easily disrupt the system.

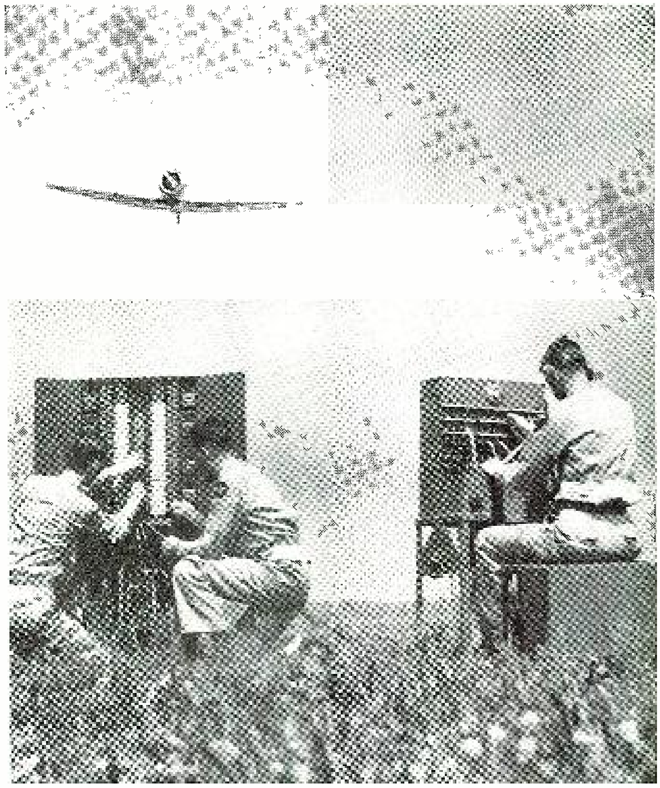
From what has been said it can be seen that the Marine Corps use of radio and wire communication does not differ from that of the other services but rather we combine the operations of both the Army and the Navy. We do not have different problems but rather are faced with both their problems. Our equipment must stand the effects of salt air and the dust of the beach. Our men must be at home aboard ship but able to be good communications men ashore.

We do not, in general, develop our own equipment, but since we serve on land and sea, we turn to the Navy for aircraft equipment and for landing equipment and to the Army for our heavier ground equipment—using the best that each of the services can supply. As a general rule, we prefer the lighter and more mobile types of apparatus but occasionally we modify other types to suit our needs. For example, where the Army might use a long two wheel trailer, perfect for land base operations, we might reduce its length to permit stowage in a ship's hold, add hoisting slings for ready loading and add two more wheels to make the equipment more easily towed over rough terrain.

Marine fighter plane comes home to roost at Guadalcanal. Radio is playing an important role in reporting enemy locations.



Martin B-10B airplane showing internal radio installation.



Cadets operating central field set and telephone switchboard.

Marine radiomen are trained in the Navy Trade School System, where enlisted men rapidly become operators and repairmen. More advanced training is received in the schools of both the Army and the Navy; comparatively few radio men receive their radio training directly from the Marine Corps. This system is employed to minimize overhead; there is no need for the Marines to maintain elaborate institutions of learning when such fine schools as are operated by the Army and Navy are already in existence. Instead, the Marine Corps makes a contribution to the upkeep of the schools, usually providing instructors in proportion to the Marines receiving instruction.

After graduation from the schools, these men are given further military instruction, and are then ready to take their places on our fighting fronts. Marine radio materiel men must be resourceful for there are commonly no extensive repair facilities when units are in forward positions. They lack the major overhaul facilities and must be able to make the best possible use of such equipment and materiel as they have. They are real fighters, too, as well as highly trained technicians. A glance at awards of honors proves this, as a few examples will show.

Here, for instance, is the citation made when Private First Class Reed T. Ramsey, U.S.M.C., was awarded the Distinguished Flying Cross:

"For extraordinary achievement while participating in an aerial flight as radioman-gunner in a Marine Scout Bombing Squadron during action against enemy Japanese forces in the Battle of Midway, June 4 and 5, 1942. Under overwhelming fire from enemy fighter planes and antiaircraft batteries, Private First Class Ramsey shot down a Japanese fighter who had persistently attacked him. With courageous efficiency and utter disregard for his own personal safety, he manned his rear-seat machine gun and radio on the night flight of June 4, and again the following morning during an attack in which an enemy battleship was damaged. His gallant devotion to duty was in keeping with the highest traditions of the Naval Services."

Similar honor was paid to Private First Class Arthur B. Whittington, also a radioman-gunner, for his participation in the same action. The citation reads, "In a determined attack against the invading Japanese fleet, Private First Class Whittington, serving as rear seat machine-gunner, maintained fire in the face of overwhelming enemy fighter opposition and fierce anti-aircraft barrage with the result that he probably shot down one enemy fighter plane. Further, he operated his machine-gun and radio during a search and attack flight on the night of June 4 but failed to return from this mission. His courage and devotion to duty were in keeping with the highest traditions of the United States Naval Service."

Other Marine Corps radio personnel to receive the Distinguished Flying Cross for heroism in the Battle of Midway include Pfc. Raymond R. Brown, Pfc. Edby M. Colvin, Pvt. Anthony J. Maday, Pfc. Joseph T. Piraneo, Pfc. Harry M. Radford, Sgt. Elza L. Raymond, Sgt. Charles W. Recke, Cpl. Lee W. Reininger, Pfc. Edward O. Smith.

Perhaps no more striking examples are needed than those quoted above to show the efficiency and thoroughness of the program used by the navy in training its radio personnel.

When one realizes how complicated radio circuits and associated equipment are and how much of a job it is under the best of circumstances to keep it operating only then can one know what a herculean job has been done by these men. Considering the lack of all facilities, such as bench space, tools, testing equipment, and repair parts to which must be added the inevitable hazards of enemy activity, it is indeed a bright page that these men are writing in the history of radio.

The ruggedness and dependability of the equipment are a credit to American Industry which supplies them; however an enemy bullet is no respecter of delicate meters, coils, or personnel. When such destruction takes place the successful repair depends on the brains and ingenuity of the radio man.

After all, the most important factor in the success of any communication equipment—including that used by Marine Corps aviation—is the men who operate it. The citations quoted above will give some idea of our men—their courage—their devotion to duty even unto death—their high efficiency. In reading these citations keep in mind that they are accurate, unadorned statements of facts by very realistic commanding officers—examples of what Marine Corps radio men have done in combat.

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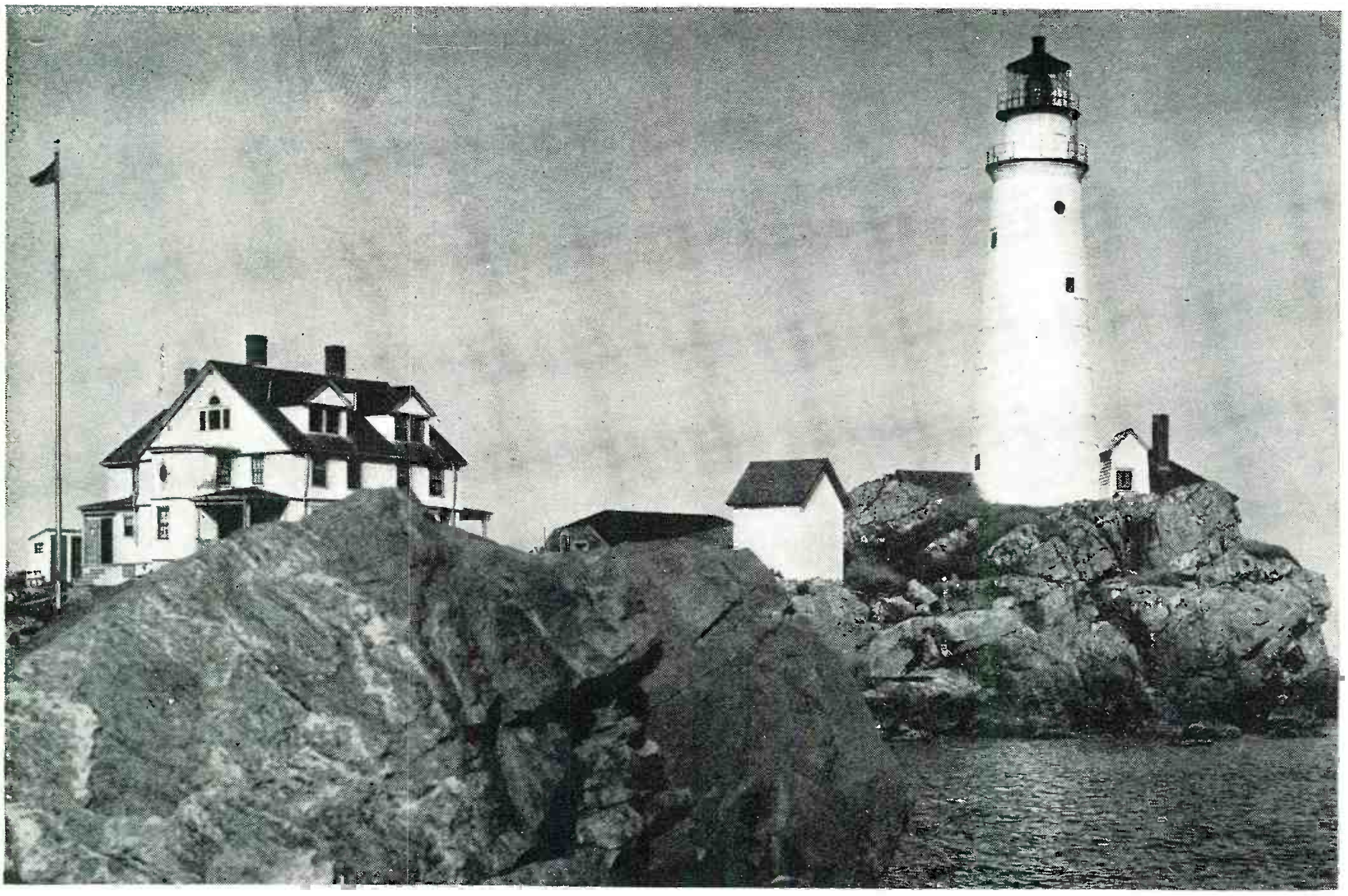


Boston Harbor Light station marking the entrance to Boston Harbor, founded in 1716, is the oldest U. S. lighthouse still standing.

COAST GUARD RADIO
IN WAR AND PEACE

Coast Guard performs errands of mercy in peace and war, and hunts enemy submarines in time of conflict by patrol of our coastal regions.

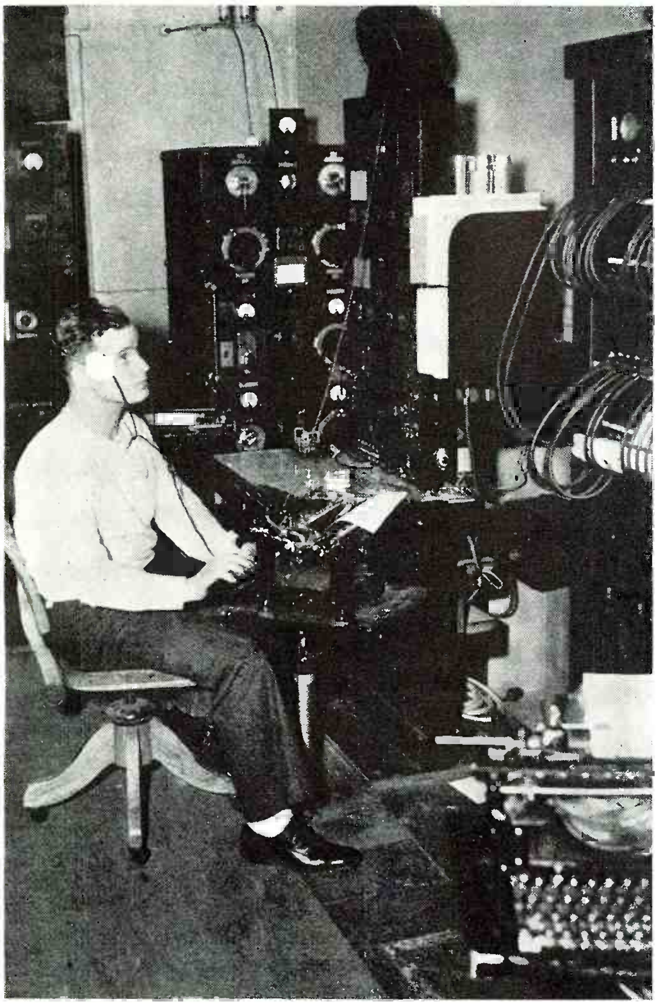
IN 1915, Coast Guard Aviation came into being at the Port of Hampton Roads. It was established first as an aid to saving the lives of seamen whose vessels were wrecked off the shores of the United States.

Then came World War I. The Coast Guard continued its work of saving lives—the lives of men whose ships had been blown up under them—and it expanded its duties to include combat. But the first World War was a war of position, and aviation was not nearly as important then as now. Instead of increasing its aerial activities, Coast Guard Aviation lost its identity, as its personnel was dispersed through the Navy. Many of them, it might be added, eventually became commanding officers of Naval Air Stations.

Nor did the Coast Guard resume its aviation activities immediately after the close of the war, for it was necessary to convince personnel that aviation was necessary to Coast Guard's peacetime activities. Little was done for the eight years following the Armistice, though a few tent hangars were set up. It was not until 1926 that Coast Guard Aviation made its real start—and even this was pitifully small when judged by modern standards. Congress appropriated the insignificant sum of $152,000 for the purpose, and with it the Coast Guard established an air station at Cape May, N. J., another at Gloucester, Mass., and bought five small planes. By this time, radio had become an established part of aviation, and the planes as well as the stations were radio equipped.

Between 1932 and the outbreak of World War II, the picture changed. Nine more coast guard stations, on the West coast as well as the East, came into being. In contrast to the early tent hangars, these were complete installations, with seaplane ramps leading directly to the mammoth hangars—landing lights—mooring buoys—radio stations—communication centers—repair shops and all the other facilities needed for seaplanes. The number of planes used by the Coast Guard had increased ten-fold in fifteen years.

All this time the Coast Guard had been operating under the Treasury Department. Its radio equipment was the best of standard communications sets; its ninety-two pilots, graduates of the Naval Air Station at Pensacola.



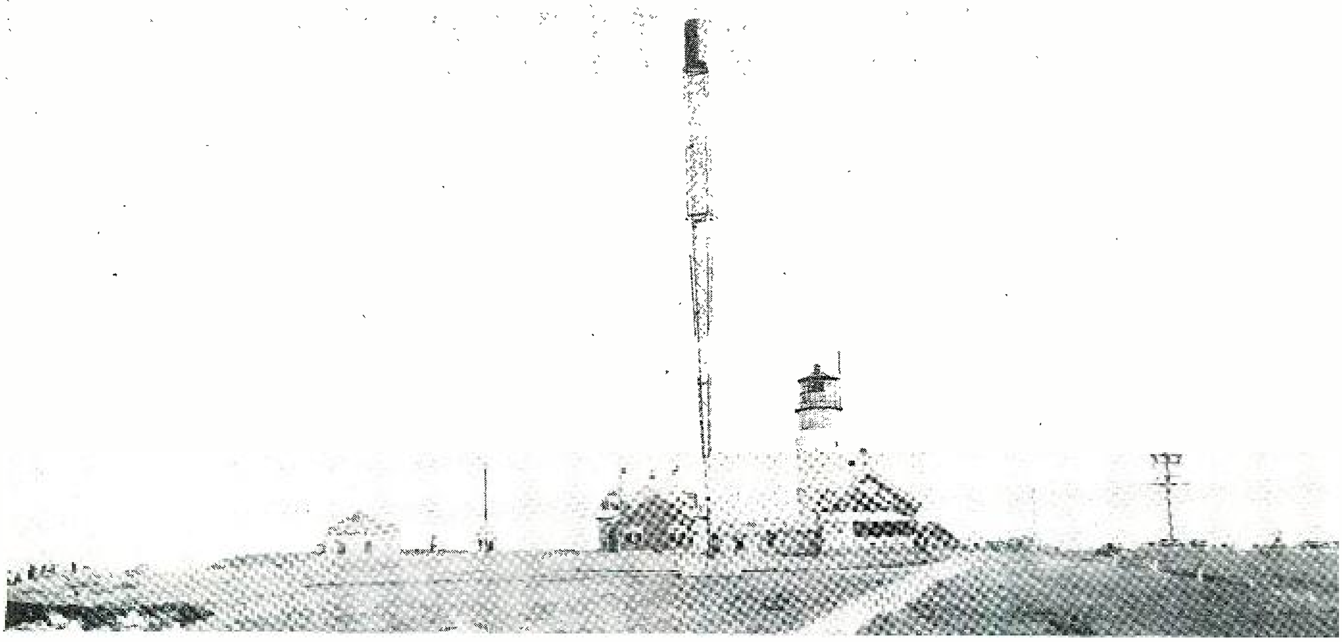
(Above) Radio control room of Cape May Coast Guard station. Operator at his post receiving transmission from a coast patrol ship.

(Right) Coast Guard radioman aboard a cutter transmitting information to headquarters by means of the radio telephone.

Then came World War II. Even before our entry was forced, a far-sighted government had shifted control of the Coast Guard to the Navy Department. No longer was its work confined to saving seamen and (as during prohibition) chasing an occasional rum-runner. True, it continued saving the lives of torpedoed sailors—and both radio and aviation play a big part in this, as will be explained—but its functions became less those of the seagoing policeman concerned with protecting life and property on the seas, and were transformed virtually overnight to those of the full-fledged warrior, engaged, as Prime Minister Churchill has said, in crushing the Axis to "death, dust, and ashes."

"Put my Johnnie in the Coast Guard, where he'll be safe," has become a standing joke among these hardened veterans of sea warfare, whose larger cutters escort convoys all the way across the oceans, whose small cutters are on anti-submarine patrol along our shores, whose members are often at the tillers of American landing barges at the far-flung fronts of the world.

Coast Guard Aviation is likewise at war up to the hilt. Though under Navy direction, it has retained its identity for administrative purposes. Coast Guard personnel, under the direction of Commander Frank A. Leamy, Senior Pilot, and the Headquarters Chief of Aviation Operations, man the Coast Guard Air Stations. The planes are no longer flying ambulances or maritime police: they are equipped with Naval radio apparatus, depth bombs, and other armament for blasting the submarine wolf-pack out of the seas.



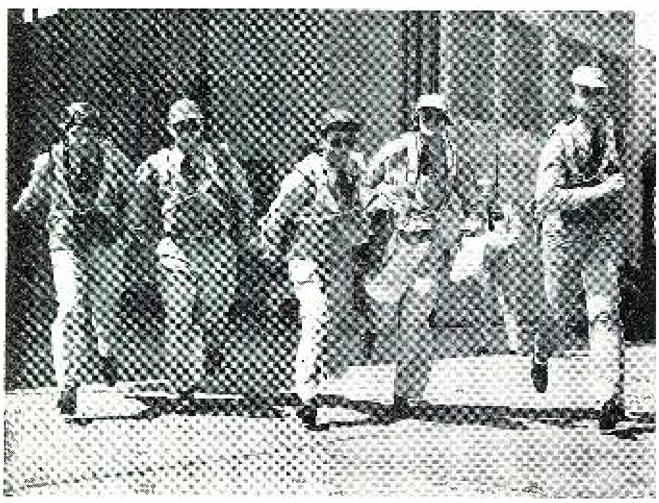
Coast Guard Radio beacon, light, fog signal and radio direction finder station. Vertical radio beam antenna mast in foreground.

The radio equipment used by the warring Coast Guard differs in no way from that used by purely Naval aviation. It is designed, procured and operated in precisely the same manner. To describe it here would be mere redundancy. But the Coast Guard's use of it makes a different—and thrilling—story.

In the first seven months after Pearl Harbor, Coast Guard fliers were in the air 23,442 hours, during which they searched and patrolled 17,842,231 square miles; in the same period, Coast Guard cutters cruised about one-eighth this distance. There were 6,032 patrol flights which resulted in the identification of 63,233 vessels and 12,951 planes. This gigantic task was accomplished by 107 pilots, and as many radiomen, in about 100 planes, and although their primary purpose was military, 310 flights to aid survivors of sinkings were made, and surface vessels were directed to the lifeboats and rafts by radio, resulting in the rescue of 508 seamen and maritime officers.

The importance of radio in this particular work was exemplified in a rescue which A. M. Cupples, Machinist's Mate First Class, a pilot, made of the crew of the *Sturtevant.* Cupples was flying alone when he sighted the survivors of a sinking. He tried to communicate with shore, but a pilot is not a radioman; he failed to get through. With throttle wide, he flew to a Navy base and arranged for a boat to go to the rescue. At the same time, he picked up a radioman and flew back to the scene. From his position in the air, he could see that the boat would be inadequate for the job, so a message was radioed back and another rescue ship was sent.

Men of the U. S. Coast Guard on the alert after alarm is given. They are serving in every phase of the present global war.



The normal crew of a small Coast Guard plane consists of pilot and radioman. On patrol, both act as observers. When a sub is sighted, they maneuvre into position, drop bombs or depth charges, and radio for reinforcements if there is not immediate and unmistakable evidence that the undersea craft has been destroyed.

One of the peace-time radio activities of the Coast Guard which still finds war use is the maintenance and operation of radio direction finder stations. These stations are so located that they cover virtually all coastal waters surrounding the United States. Prior to the United States' entry into the war, the stations served as an aid to navigation, for a ship which wished to know its position would send out a radio call to the Coast Guard. Signals from its transmitter would be picked up by two or three Coast Guard stations using direction finders, and by triangulation the exact position of the vessel would be determined. The same service is still maintained for friendly shipping.

The location of some of these stations has been made public, and gives some idea of the close coverage which radio provides along strategic portions of the coast. For example, there are 5 direction finding stations on the shores of California, 2 along the Coast of Massachusetts, and 2 each near the coastal waters of New Jersey, Delaware, North Carolina and Oregon. Numerous other direction finding stations are operated by the Coast Guard.

Before the war, the Coast Guard had more than 150 radio beacons in operation, to enable ships to find their own position and to make their way to our shores. They send out radio signals in all directions on the band from 285 to 315 kc., each beacon having its signal identified with an individual code. A ship provided with a direction finder or radio compass merely took bearings of two or more radio beacons, plotted their direction, and thus found its own position both accurately and rapidly.

The war, however, has curtailed the use of such equipment, for enemy ships and planes would find these a great advantage toward setting their courses to our major seacoast industrial cities and shipping centers.

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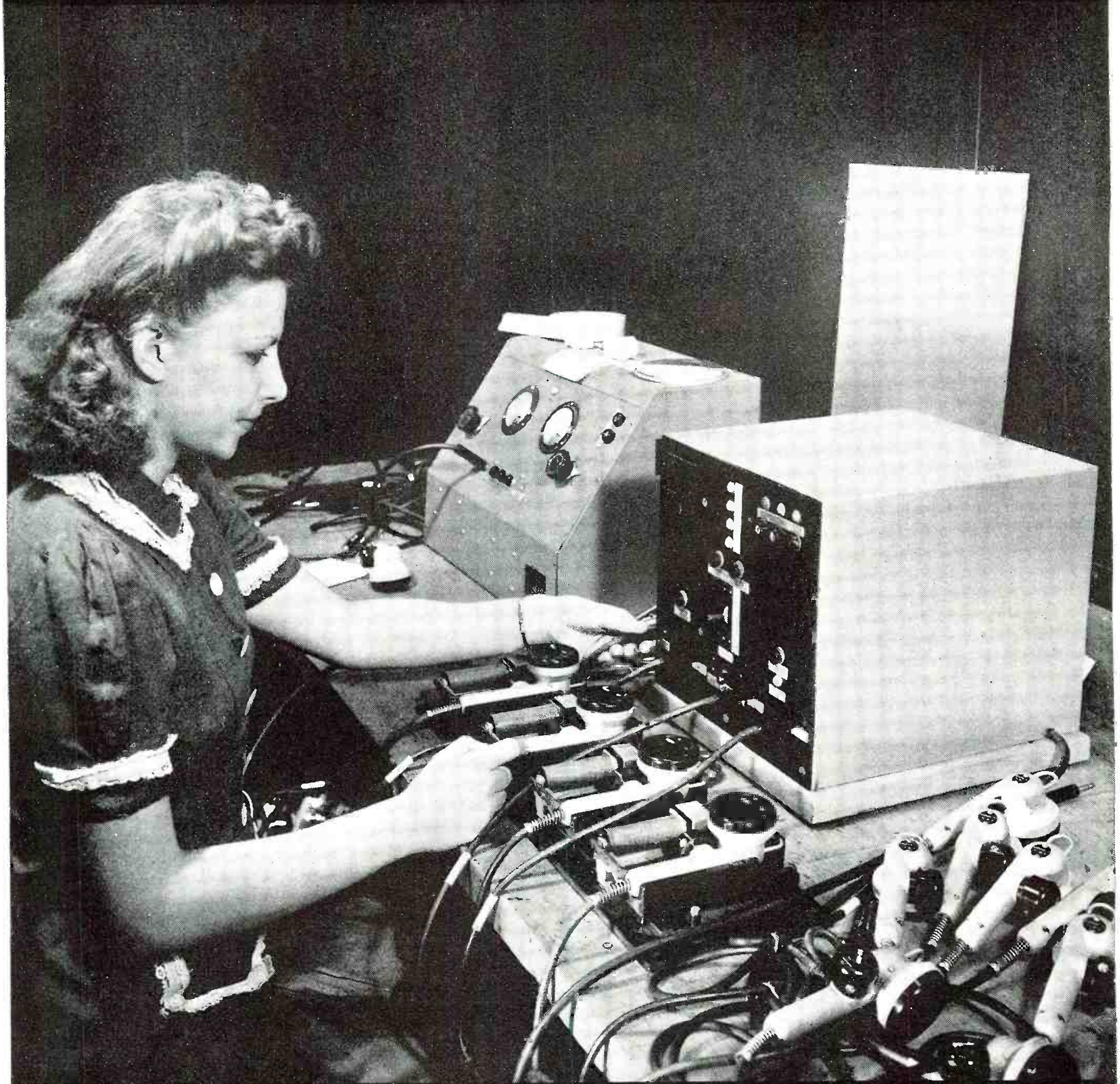
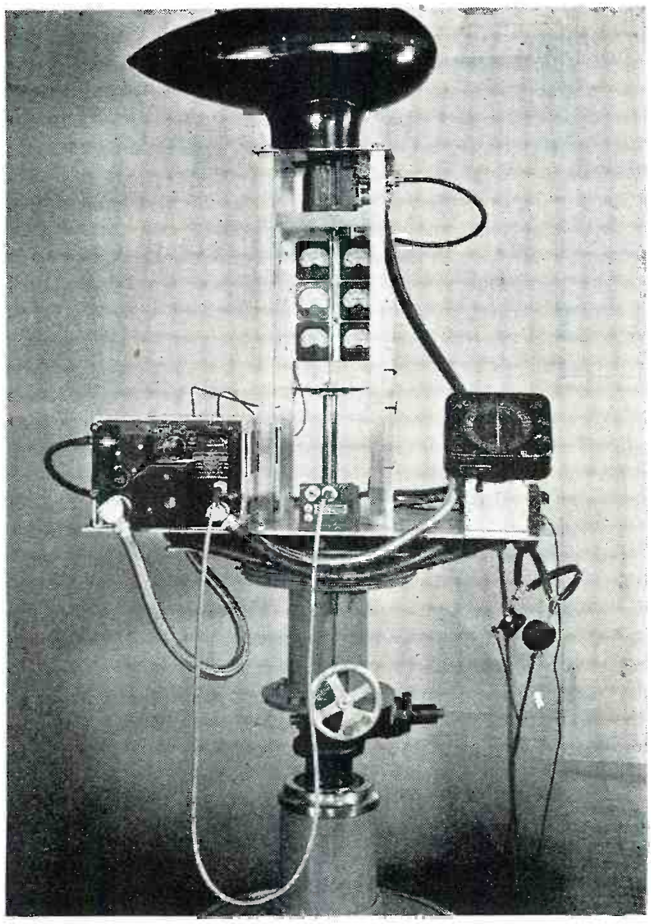
THE RADIO INDUSTRY



American production methods and engineering skill have made it possible for our Army and Navy to possess the finest radio equipment in all the world.

Rotary tuning system in a modern combination receiver-transmitter designed specifically for aircraft communications.



Special test stand used to check and service the newest type of direction finder units. It mounts inside of screen room.

AIRCRAFT RADIO INDUSTRY

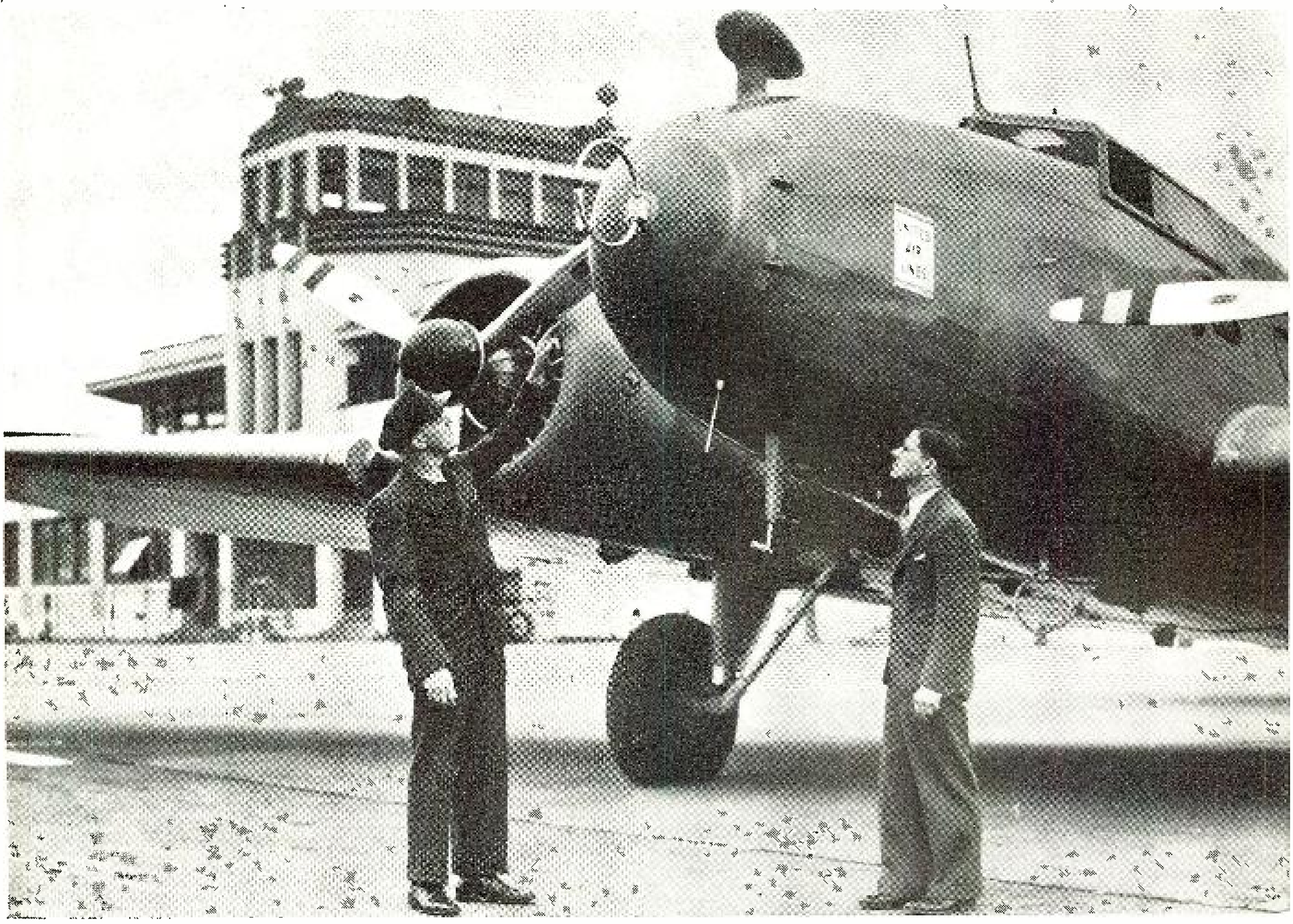
Converted to war production almost overnight—the radio industry has produced the finest of communications sets for our aircraft.

ALTHOUGH two-way plane-to-ground communications by way of radio, had its inception during World War I in 1917, almost a decade past, before any commercial service began. This lapse was not due to the inefficiency of the military equipment of the World War days, but rather to the period of readjustment that followed the conclusion of the war. It actually took the mail plane service to reintroduce aeronautical communications. Although the designers of the early commercial equipment were familiar with the developments employed in the original military units, they were not, unfortunately, able to incorporate as many of the features as they had anticipated. This was caused by the difference in the plane structure, its size and particularly the distances which the planes had to travel. The military equipment, designed for comparatively short distance coverage, was not, of course, suitable to the commercial airplane, traveling as it did over much greater distances and over difficult terrain.

The first commercial communication units were not of the two-way type either. The single-engined mail planes of that day were equipped with 200-to-400 kilocycle radio-beacon receivers. This afforded reception of voice weather reports, messages from the ground and reception of the directional radio range. They were very simple receivers using from 2-to-3-stages of tuned radio frequency. Batteries were used at first and later came the dynamotors.

As the sizes of the planes increased, and long distance flying became quite a commonplace factor, it became necessary to use a two-way system. In 1929, engineers of the Boeing Air Transport Service used the first two-way system, flying out across the Rocky Mountains to Reno, Nevada, from San Francisco. The tests were made in a Boeing 40 with Eddie Allen, the famous test pilot who was recently killed, as the pilot of the plane.

The equipment in this plane, developed by Ralph Bair, W. C. Tinus, and R. H. Freeman of the Bell Laboratories, consisted of a 50-watt transmitter and a 6-tube tuned radio



Four anti-static antennas developed to study static suppression. Types included are the pear-shaped unit mounted on top of the plane's nose, the "ring-in-the-nose" type projecting from the nose, and the rotatable ring under the belly of ship. Fourth unit in plane.

frequency receiver. Aware of the importance of radio, too, were those of Western Air Express, whose radio engineer at that time was Herbert Hoover, Jr. Accordingly they too installed a similar system and used it in flights from Los Angeles to Salt Lake City.

As a result of the development of this equipment, many unusual and vital components and accessories were born. As for example, in the early days, it was the pilot, who, although very unfamiliar with the radio apparatus, still had to operate it. Thus simplicity of operation was the keynote in design. It was because of this fact, that remote control was developed. Because, too, the pilot did not know how to operate keys to transmit code, not only did voice have to be employed completely, but the audio system had to be a comparatively high-fidelity type. Thus, it was, that the first attempt at quality audio amplification was attempted.

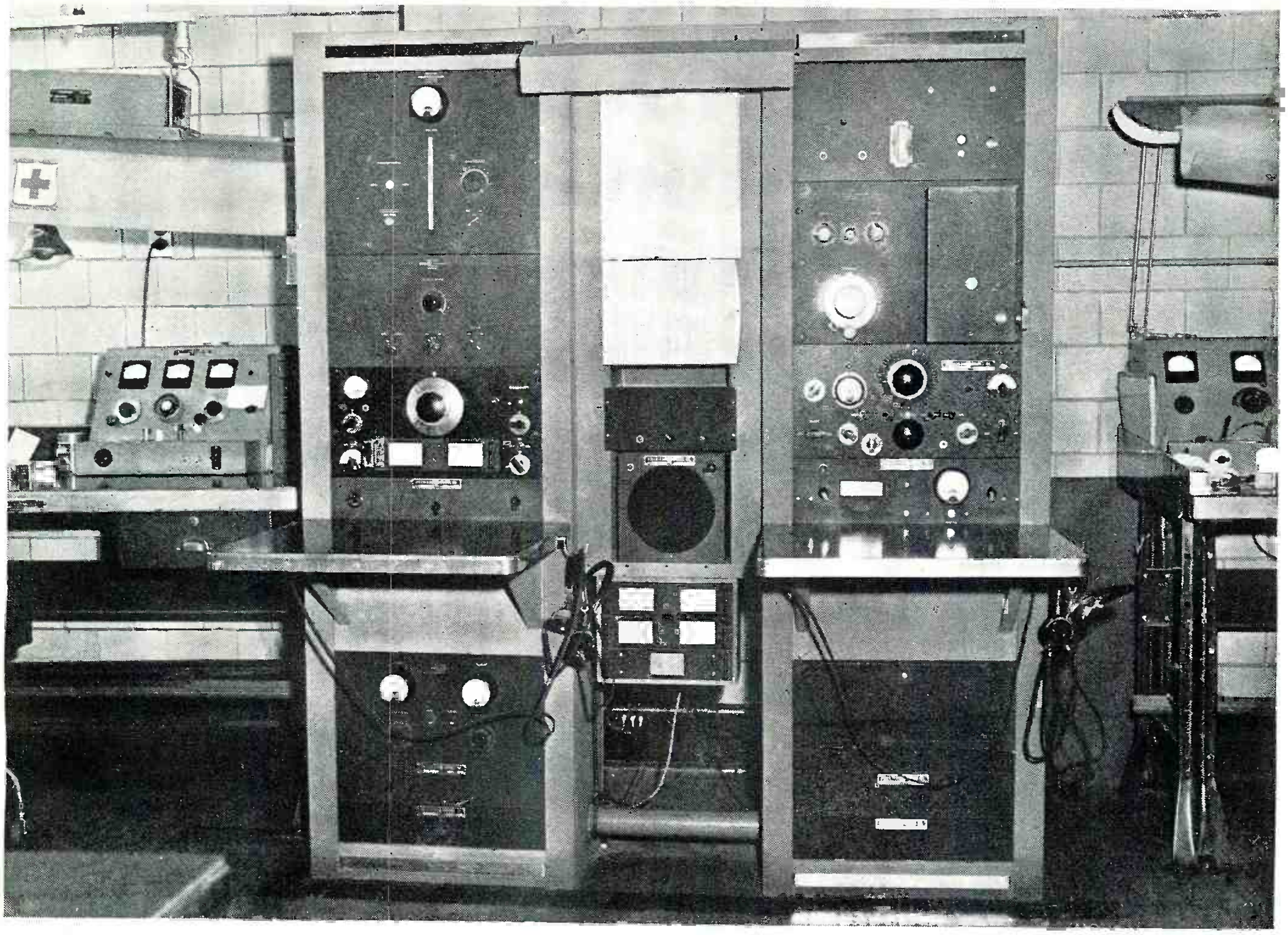
Since the equipment had to be encased in extremely light weight covers and built on light weight chassis, it was necessary to utilize magnesium castings. Here was another *first* in the development stage. Incidentally, the castings were made by the Goodyear Tire folks. They had been experimenting with castings of this type for other similar light-weight projects, and were thus able to produce these too. We all know how important magnesium castings are today, and how much more important they will be, after the war.

Since it was necessary to employ three stages of tuned radio frequency, for maximum efficiency, it was also necessary to have a three-gang variable condenser. Accordingly the famous multi-section condenser patent of John Hogan, was used for the first time in aircraft communication.

Since it was also necessary to assure maximum transfer of signals to the pilot, the ordinary head phones were supplanted by small molded earpieces, which fitted snugly into the ears. This development was the forerunner to the hearing-aid earpieces, now so popular. The familiar method of making plaster-of-paris molds to produce exact fittings for the ear was used then, as it is now.

As the years went by, night-flying became as commonplace, as day-flying. Thus the problem again became complex. Because of the peculiar propagation characteristics of electromagnetic waves, it was necessary to use different frequencies for day and night. This shift from day-to-night frequency had to be an automatic one. Thus special equipment providing coverage of a day frequency of 5500 kilocycles and a night frequency of 3 megacycles, was developed. With the increase in flying, came the need for more sensitive receivers. The superheterodyne was thus introduced. Since the superheterodyne was a sharp tuning unit, some means had to be devised to simplify tuning. The quartz crystal thus came into the picture.

The first quartz crystal controls, were quite unique. It was realized that some method of temperature control of the crystals was essential. Accordingly a temperature controlled unit was devised, and it was quite an affair. The unit was assembled in an isolantite holder. The quartz crystal was clamped between two metal electrodes, one of which was held at a temperature of 55° C by an electrical heater. The heater was controlled automatically by a thermostat of the mercury-column, contact-making type. This complex piece of mechanism was naturally difficult to control in view of the extremely varying temperatures at the ground and in the air. The variation, many times, ranged from minus 20° in flight to 90°-100° on the ground. As a result of these difficulties, a truly vital communication invention resulted. Extensive



Many crystals are used in aircraft communications equipment. Special laboratory test units are needed to check each crystal.

laboratory study produced the famous *AT* cut crystal. To Lack, Willard and Fair of Bell Labs. the industry owes its thanks for this work. Incidentally Mr. Lack is now with that famous expediting agency in Washington known as the ANEPA. This development, announced in 1934, also produced the first treatise on crystal grinding, a treatise that has been a standard of study and practice.

The transmitters, first employed, used a simple crystal oscillator and power amplifier with plate modulation. This was succeeded by a multi-channel pretuned crystal control transmitter. The frequencies used at this time were 2500 to 8000 kilocycles for two-way conversation, and 200 to 400 kilocycles for the beacon ranges.

As plane travel increased, necessitating traffic control, it became necessary to have a second beacon receiver on the plane. And to provide simultaneous range and voice communications from the beacon stations, the old loop-type range ground stations, had to be changed to tuned-loop type beacon-range ground units. This particular change required the use of range filters and new methods of mixing controls in planes. At this time several types of equipment were designed and used successfully.

As bearing-taking became more and more important, special types of shielded loop antennas were developed to reduce the effects of rain and snow static and also to supplement the directional characteristics of range stations. In addition, improved beacon antennas were also put into use, namely, the famous Whip type of antenna. As the size of the planes increased, the trailing wire antenna was replaced by a fixed antenna.

Traffic, still on the increase, soon demanded additional control. Thus it was that the control tower was put into effect. These towers were assigned to a frequency of 278 kilocycles. As the service grew in importance, a special receiver for this purpose had to be developed. This unit contained pretuned channels for the 278, 362 and other assigned frequencies. With traffic control so important a factor, requiring the use of many channels, a decided trend to ultra-high frequencies was begun. The ultra-high frequency marker receiver was one of the developments prompted by this situation.

For further assistance in guiding the navigator and pilot of a plane, the automatic radio compass was developed and installed aboard the plane.

The success of ultra-high frequency applications resulted in compact multi-channel receivers—transmitters, that are today serving so well in commercial and military aircraft.

In the foregoing paragraphs, we have sketched the highlights of commercial aeronautical communication development. Now let us look a little more closely into each of these developments.

The first one-way receiving unit was designed to cover from 600 to 1200 meters. Five tubes were used; three of them being in RF stages. The detector was a space-charged grid type, followed by a simple one-stage transformer coupled audio frequency unit. Cathode type tubes were used then. This was necessary since a dynamotor operated from a 12-volt plane battery was used to supply the filament voltage. To maintain filament current constancy, a ballast tube, similar to the type we now use, was used then.

The short-wave receiver used by the Boeing engineers was also a 5-tube affair with three RF stages, a space-charge grid detector and a single stage of audio. Its frequency range was from 50 to 200 meters.

One of the problems experienced during the initial tests on the Boeing planes concerned ignition noise interference. The motors in the ships were equipped with two high voltage magnetos which were veritable broadcast stations. The ignition interference was so great that it paralyzed the tubes and blocked all attempts at reception. A special harness completely shielding all of the ignition wires was therefore developed. It consisted of a ring of aluminum encasing the ignition wires from the point of emergence from the magnetos, where the individual wires branched off to the respective cylinders. The individual wires were then encased in small aluminum tubes clamped at one end to the main ring and at the other connected to special spark plugs, with a short piece of double braid, so placed that it could not readily be soaked with oil. The spark plugs themselves also offered obstacles along the interference lane.

Special shielded plugs were developed wherein the outer end of the plugs terminated in a long bronze tube lined with mica and containing the terminal at the bottom. The ignition wire fitted into a mica tube, which in turn was inserted into the mica lined bronze tube, allowing the end of the wire to come in contact with the terminal of the plug. A bronze cap was fitted over the end of the tube and soldered to the shielding. The mica was replaced later on with bakelite. This improvement further eliminated ignition interference trouble.

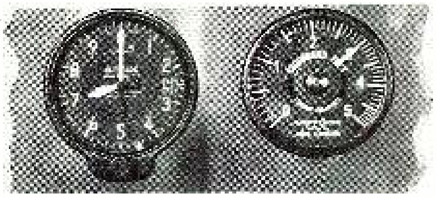
Since the trailing wire offered many obstacles, it was necessary to develop what was then called "a streamlined antenna." This consisted of a vertical duraluminum streamlined mast, about eight feet long, self-supporting and mounted at the front end of the upper wing. The mast was insulated from the ship and used for both transmitting and receiving.

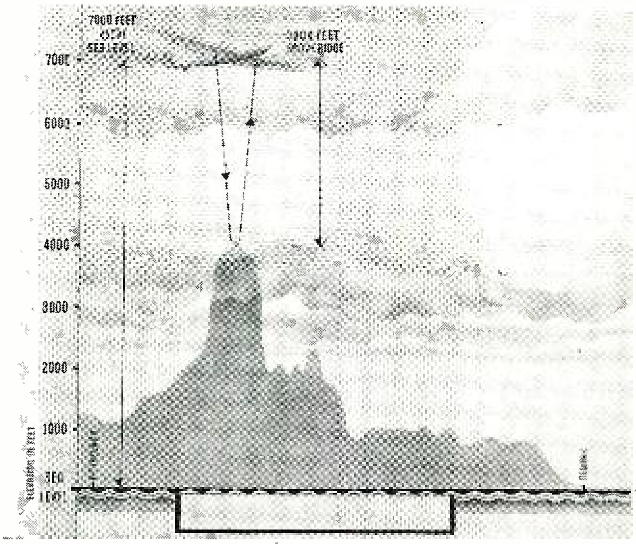
In the superheterodyne receivers, wherein crystal control was used for the first time, seven tubes were employed and in a very novel way. For, there was one stage of tuned-radio frequency amplification, a first detector, three stages of intermediate frequency amplification at 385 kilocycles, a detector and automatic volume control tube, and a stage of audio frequency amplification. A separate tuned circuit for each frequency was used in the radio-frequency stage and in the oscillator. By using a shifting mechanism, the proper circuits for the frequencies desired was selected, these circuits having been properly tuned while the plane was on the ground.

In contrast to this equipment, we have the present-day units that are combination transmitters and receivers and provide frequency coverage of from 2,500 to 13,000 kilocycles, in ten fixed-crystal controlled channels. In one of the instruments developed, a turret unit is used to house the crystals and the coils. By simply shifting this turret position, complete circuits are put in or out of the necessary operating position.

The IF stages in this unit used transformers with closed iron cores in the primary secondary windings. With this design, it is possible to realize an attenuation of image and all undesired frequencies of 60 DB or greater up to 10,000 kilocycles and not less than 50 DB above 10,000 kilocycles. In addition the sensitivity is such that an input of 2 microvolts modulated 30 percent at 400 cycles, will produce an output of 50 milliwatts, at a signal to noise ratio of 6 DB. This compares with an approximate output of 6 milliwatts of the early type of equipment, where the input was 5 microvolts.

Although private planes were used quite extensively over a decade ago, communication equipment for them had not received any special attention, until about seven years ago. At that time, manufacturers began developing two-band units to cover the beacon-weather and broadcast bands or beacon-weather and communication bands. Capitalizing on the advancements made by commercial instruments, these units were quite unique. Employing but one tuning dial, a volume control, and a simple band switch, they provided the pilot with the simple means of maintaining contact with the ground sources. Realizing the necessity for a single receiver that would cover reception of traffic control, radio range and weather broadcasts, as well as airline stations and other aircraft in flight, an improved model of the foregoing unit appeared several years later. This device incidentally, also provided reception of standard broadcasts. The advent of the control towers made radio bearing reception an important factor.





Comparative results of conventional barometric altimeter (upper left) and terrain clearance indicator or altimeter which operated via radio, supplied navigators with an additional accurate aid.

★ ★ ★

One of the first U. S. Mail planes equipped with radiotelephone equipment. Note the odd type microphone used by the pilot.

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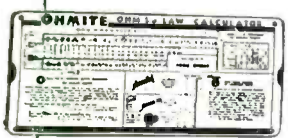

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2

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Extremely light weight planes, developed during the last few years for pleasure travelling, required the development of unusually compact receivers. These units having but five tubes, operate on dry batteries and provide reception in the beacon or broadcast bands, with facilities for instantaneous shift to the airport traffic control frequency. Either a standard wire-type beacon antenna or an electrostatically shielded loop can be used with these models. In some of the types developed, the IF channel is composed of a two-stage amplifier and three permeability tuned transformers. One of these receivers weighs only three and one-half pounds, which is quite a contrast to the original types.

A rapid change of the operating frequency prompted by increased night flying, required special equipment . . . equipment that would permit all stations in the transport system, including planes in flight, to change frequency simultaneously. Accordingly a new transmitter was designed which not only provided this shift, but also provided a third frequency channel that could be selected by the same control that changed from night-to-day frequencies. This arrangement contributed greatly to safety, since the Department of Commerce Stations, at that time, kept a constant watch on 3105 kilocycles, a frequency which was not assigned to any transport company. Therefore, by being able to transmit on this frequency, the pilot was able to communicate with any Department of Commerce station and request weather reports or other information, or emergency assistance.

This unique transmitter had several "firsts" in design, too. A four element tube, to eliminate the neutralizing adjustment, a very advantageous portable equipment requirement, was developed by H. E. Mendenhall, of Bell Labs. These screen grid tubes were used in the radio frequency circuits, consisting of a crystal-controlled oscillator and two stages of amplification. Plug-in assemblies were used quite extensively in this transmitter, to simplify tuning and adjustment. For instance, two of the radio frequency transformers were built on a single plug-in unit. The crystals were also arranged in plug-in style. A combination of coil and mica capacitor constituted the antenna coupling. This unit was quite interesting, in that it incorporated many features which are still basics of design today. For instance, the high insulating ceramic, isolantite, was used as the coil cylinder. On this was wound a continuous winding of bare tinned copper. Clips on a slide rod were used to make contact with the winding and provide inductance adjustment.

A new system of modulation was also introduced in this new transmitter permitting deep modulation of the 50-watt carrier with only about 1 watt of audio frequency power. The transmitter was, of course, designed for telephone operation. It was, however, adaptable for continuous wave operation, when necessary.

As advanced as the preceding model of transmitter was, it soon became antiquated, with the rapid progress of laboratory developments. As transport service expanded and as traffic increased, it was necessary to have equipment that would cover a variety of frequencies and with extreme rapidity of control. A rotating motor-driven turret-unit, with tuning units solved this problem. As many as ten pre-tuned crystal controlled frequencies were available with this system. Some transmitters used a telephone dial selector system, others a push button method and still others a rotating switch.

The operation of this turret was most interesting. And, incidentally this turret system is still incorporated in many of the modern type transmitters. In operation, a selection commutator on the turret shaft and the ten-position selector switch are so connected, that when the turret reaches the same relative position as the switch, a control relay circuit is completed to ground, thus disengaging a clutch. Either the rotating dial or other dial device on the transmitter panel, and an indicator lamp in the remote control unit, indicates the completion of frequency shifts. And here is the interesting part about this mechanical shifting device: The change from one frequency to another, takes only from one to ten-seconds, varying with the position of the tuning unit in the turret, at the time selection is made.

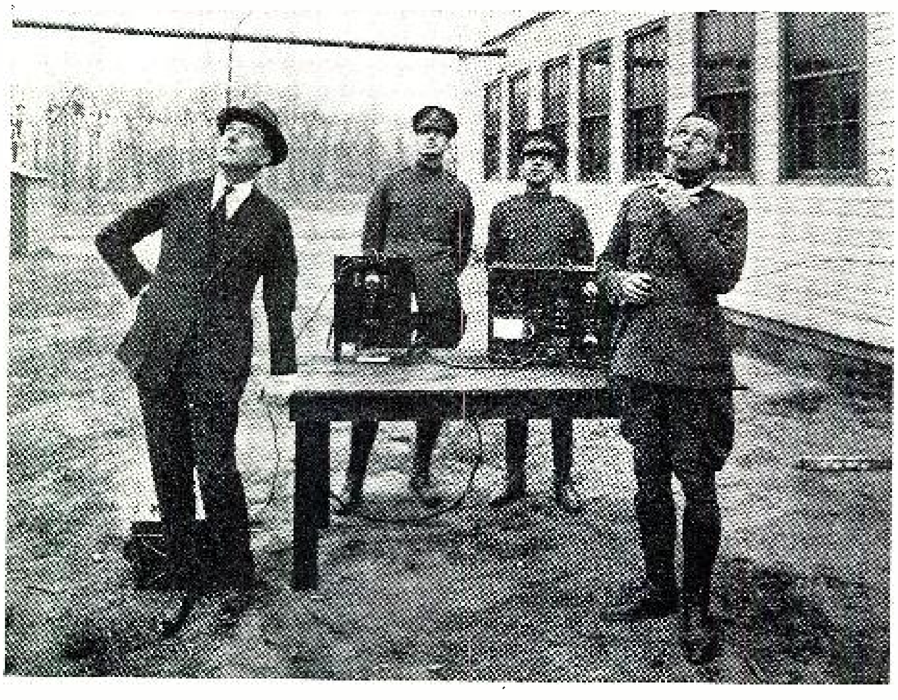
Although most of the design of this new unit was completely new, there were a few features originated in the older equipment that were still retained in a basic way. We refer to the isolantite tube on which was wound the bare copper wire to which contact was made by way of a sliding clip.

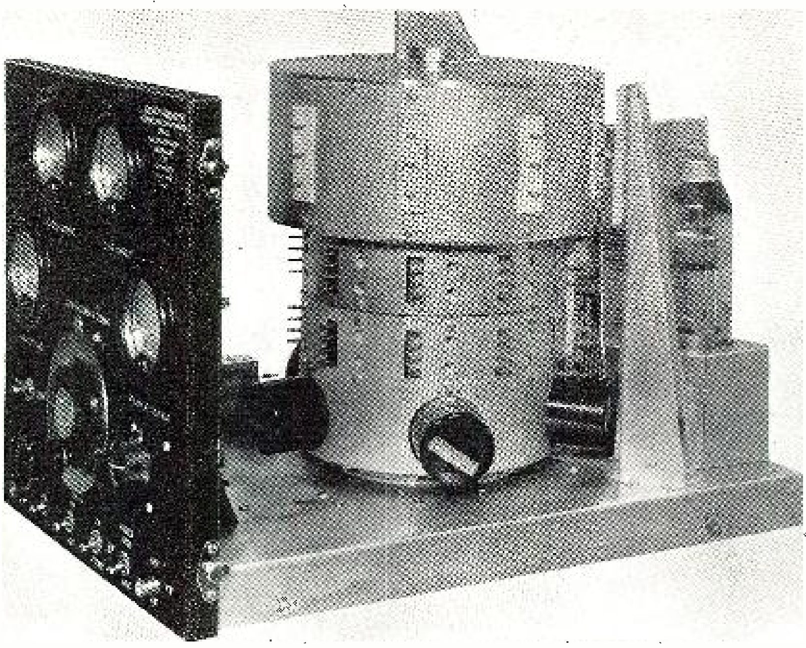
These transmitters are of course, of the higher power type covering from 125 to 150 watts. Medium powered 50-watt combination transmitter-receivers affording 100% modulation have been developed too. These instruments were designed in accordance with specifications agreed upon by the major airlines at round table conferences. The specifications were supplied to a central administrative and engineering body known as Aeronautical Radio, Inc. This body has done much to standardize and develop aeronautical communication equipment for the airlines. We shall discuss its interesting activities later on.

For private plane use, it was necessary to have transmitters of the 15-to-20-watt class. The first units designed some ten years ago, covered a frequency range of from 2000 to 6500 kilocycles. Class B modulation in the telephone circuits provided 100% modulation. The familiar master oscillator, power amplifier type of circuit, was used in most instances.

While the foregoing transmitter was an efficient one it did not, of course, cover the many frequencies later allocated due to increased traffic. Neither did it stand up as well in the high speed planes that were developed. Accordingly midget transmitters, extremely ruggedly built and covering from 2,800 to 6,210 kilocycles, were brought out. To prove their rigidity of construction many mechanical tests, which are in use today, were employed. For instance, one type of a transmitter was submitted to a "dropping test," where in the unit was dropped 100 times at distances up to 18 inches. Another test used was the soaking test, wherein the unit was steeped in a humid box where the rela-

Experimental aircraft radio telephone installation during World War I (1917).





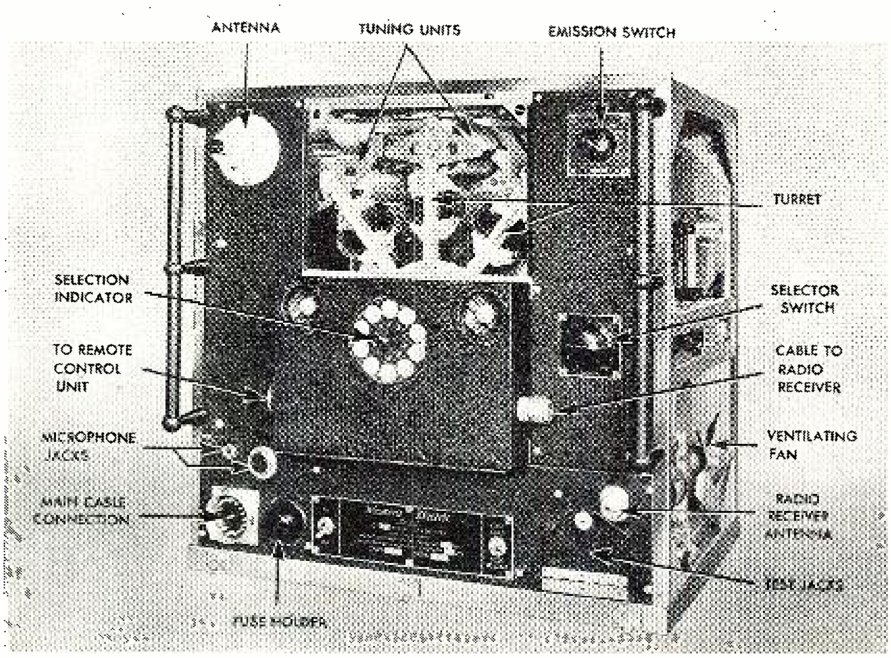
Unusual turret tuning-control system of a nine band transmitter.

tive humidity was 95% at 120 degrees Fahrenheit. This test kept up for two days. It was one of the many which were devised by the Civil Aeronautics Administration, which had begun functioning a few years prior. Their work in establishing these tests and other vital design standards was truly outstanding. For it prompted an accelerated engineering trend, that brought aeronautical communications development to the top rung of engineering practice.

With the advent of the small light planes came the need for battery-powered push-button controlled transmitters. It was in this type of unit that permeability tuned circuits made their first appearance. These instruments also featured built-in loading coils which obviated necessity for extra coils and relays to load the antenna to resonance, when making ground transmissions. The coil was not tapped, but continuously variable.

Component parts design has also played its role in the successful design of communication for aircraft. Many of the parts were developed and produced by the manufacturers of the complete equipment, but quite a few items were developed and produced by other sources. These products, based on aircraft requisites, prompted, in most instances, development of industry standards. They also provided a

Modern 10 frequency 125 watt transmitter showing controls.

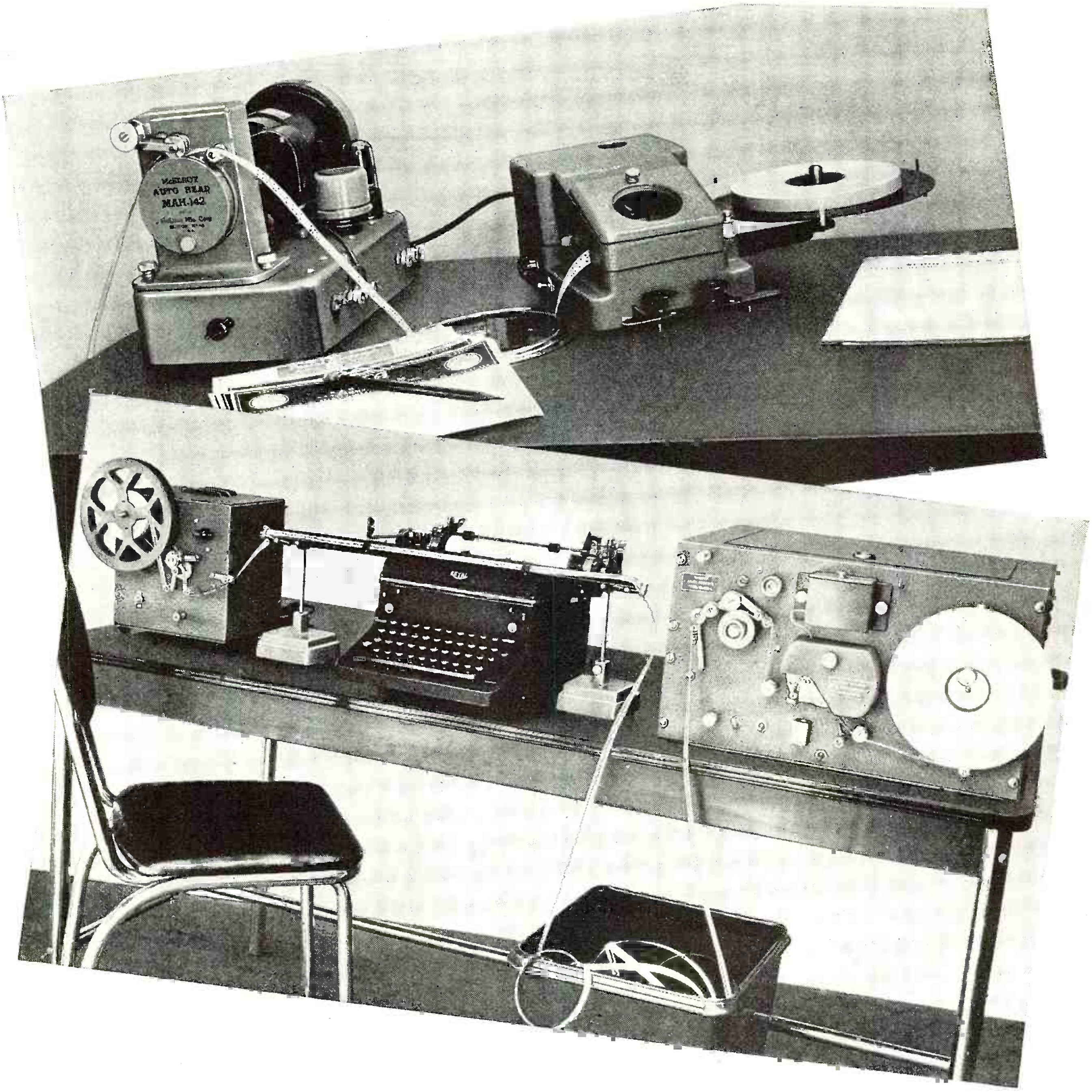


source of supply for other manufacturers of *radionic* equipment, whose requirements were just as stringent as those of the aircraft communications industry. In antenna relays, we have an outstanding example of this condition. As we know relays in the antenna circuit are quite an important linking factor. Collection of dust, dirt or corrosive action on the contacts forms a high resistance which voids the signal. To overcome this, the vacuum type antenna relay was designed. The moving part of the armature proper was enclosed in a glass envelope with a low pressure vacuum. These relays are of the single pole, double throw type, affording selection of the antenna for the receiver and transmitter. The relays have been designed so that they can handle relatively high voltages to avoid any possible voltage breakdown in the vacuum.

In fuses, we have another interesting component design solution. These little simple devices are quite important in aircraft equipment. Their deficiency, causing a break or a short in power supply, can cause plenty of trouble during flight. In view of the delicate construction of the fuse element in standard types, they cannot stand vibration, nor are they able to tolerate the wide range of temperature changes. The drop of some 50 degrees during the airplane's rise from ground, in about a minute, prompts a coefficient expansion that causes a terrific stress. This expansion crystallizes the element. To eliminate this a fuse with a small expansion link or expansion element has been developed. And to eliminate the vibration factor, a small supporting tie bar has been included within the glass envelope. To provide additional mechanical strength, some manufacturers have coated the fuse link with a rosin mixture.

Some airline engineering departments have applied circuit breakers to replace the fuse. Of course, the ordinary circuit breaker could not be used and accordingly a type employing a bi-metallic strip has been tried. In this circuit breaker, which is quite compact, the bi-metallic strip "snaps" and breaks the circuit. This expansion is caused by an overload or underload condition. The use of these breakers affords the elimination of the fuse panel, in that it permits both switching and protection simultaneously and as such can be included directly in the equipment itself.

In plugs, peculiar situations have arisen too. Plugs, of course, enter into the power and radio frequency sequence of design. While the radio frequency problem is quite apparent, it was difficult to see how the power problem could be of any consequence. However, we must remember that although the voltages are not exceedingly high, they are high enough to be dangerous to the equipment and to the operator, unless the current path is complete and direct at all times. With vibration as a factor and with tem-



High-Speed Automatic Radiotelegraph Assemblies

These two photographs illustrate a complete automatic transmitting assembly (upper photograph) and an automatic receiving assembly (lower photograph). Installations of this type are typical of the high-speed radio telegraph equipment employed by such international commercial companies as R.C.A. Communications, Mackay Radio, Globe Wireless, Press Wireless . . . and Military and Naval services everywhere.

Each piece of equipment is illustrated individually and described more fully in the pages following. Technical manuals and operating instructions may be secured by writing direct to the manufacturer.

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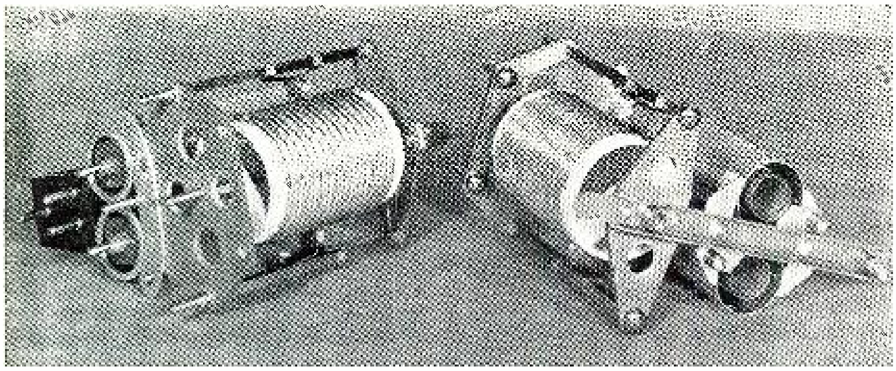


One of the simple tuning elements used in the ten channel transmitter.

perature changes as another consideration, it is easy to see that even these small components demanded special attention. In addition it was also necessary to produce some standard type plug that would fit a variety of installations and thus eliminate the confusion that existed with the many types that had been available. Through the facilities of the group serving Aeronautical Radio, Inc., that engineering branch we mentioned before, a standard type of plug was evolved. It contained all of the virtues required and has been so successful that it is being used by manufacturers of other than aircraft equipment where stress, strain, temperature variation and standards are essential factors.

The radio-frequency plug, which has come into popularity with the advent of ultra-high frequencies, is of course a more involved project and dependent on the particular situation at hand. Nevertheless standards have been developed here, for use with coaxial lines and so on.

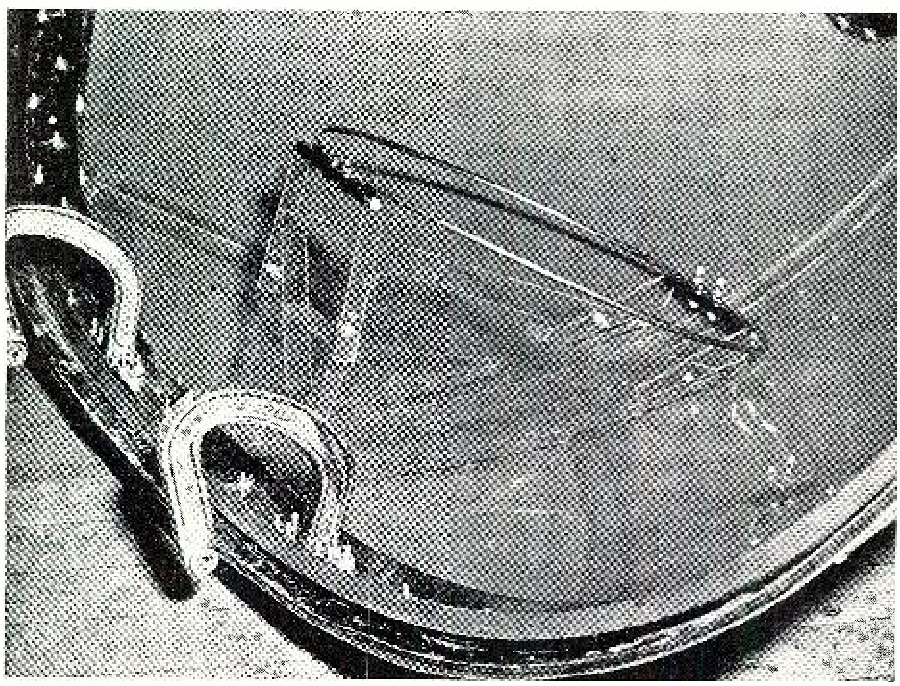
Variable condensers have also been predominate factors in the special design class. Here again, both the physical and electrical problem were vital considerations. As a result these condensers have gone through a multiplicity of design stages, ranging from extremely heavy plate and heavy casing construction, to light-weight, but thick plates, with a minimum of casing. This transition called for the use of new types of material, material that although light-weight and rugged, would not change its electrical characteristics during the rapid temperature changes encountered in aircraft. A material popularly used for this purpose was invar. This alloy has a very low thermal expansion. In fact its expansion is only 1/10 that of carbon steel at temperatures up to 400° Fahrenheit. By using this alloy in the rotor section and brass or steel in the stator section, a perfect balance of expansion control was effected. Incidentally, it was during the development of these condensers that the use of the popular sealing and binding chemical, glyptal, became quite popular. Today, this is used extensively in hundreds of industries for countless applications.

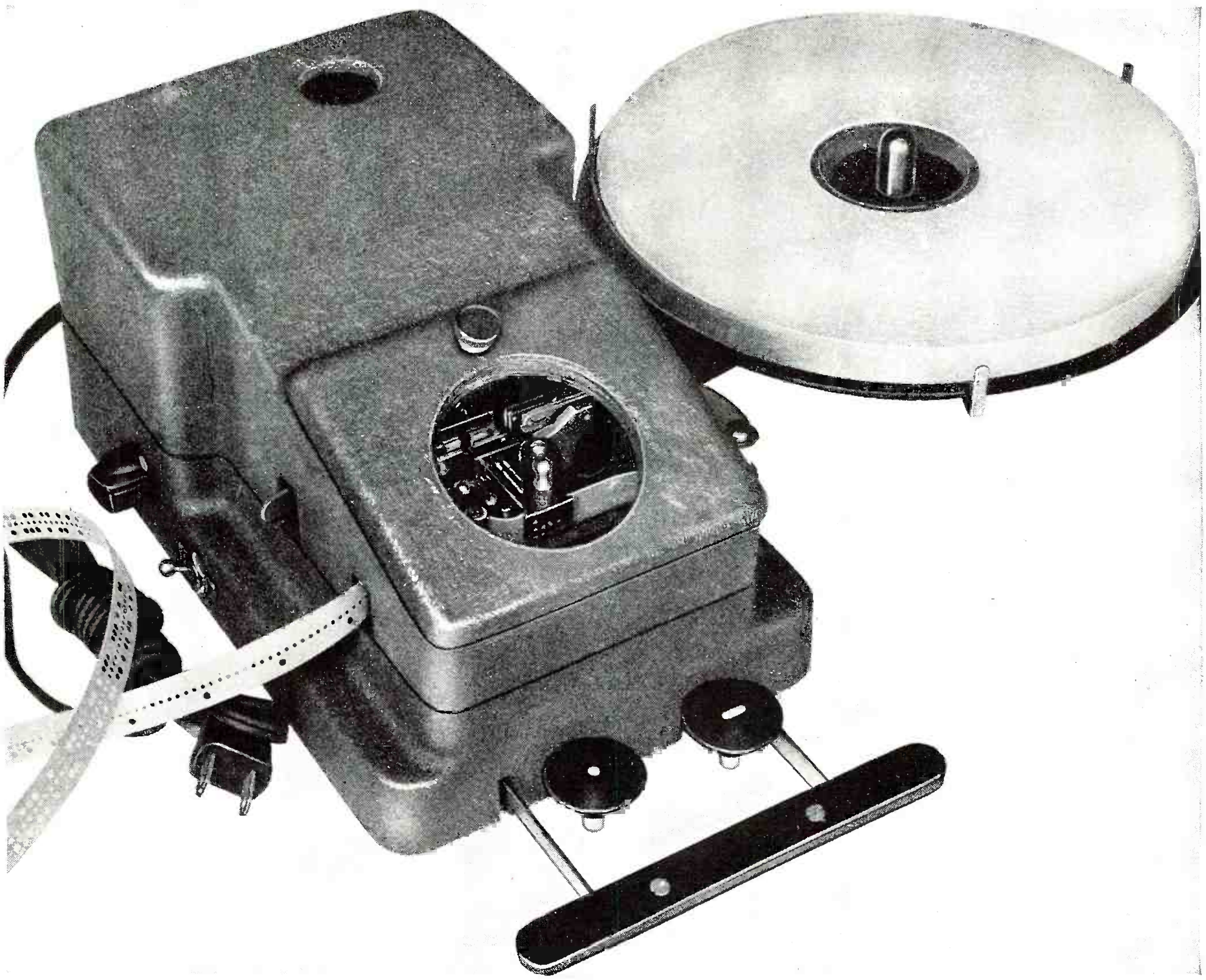
It will be noted that each of the components described above was designed not only at the suggestion of the aircraft communication equipment manufacturers, but in accordance with their designs. Unfortunately, very few manufacturers produced special components for aircraft communication receivers or transmitters or accessories, of their own initiative. Thus many additional hours of development and production had to be entertained, because the standard parts available did not suit the stringent aircraft requirements. However, fortunately there is now a trend towards the special manufacture of components for aircraft communications equipment. A study of the advertisements and technical journals reveal this trend quite lucidly. It is particularly noticeable with relays, variable condensers and even coils. We now find gravity, humidity, and foreign-element-reaction among the highlight features of component design. It is quite evident, therefore, that many manufacturers will be able to supply parts for aircraft communications. And they will be parts that have been specifically designed to operate under aircraft conditions.

Peculiar circumstances, such as those surrounding the design of the "AT" crystal, prevailed requiring the development of other alternates that, like the crystal, become impressive basics of design. Let us take the audio output selector box as an example. With the advent of additional receivers on the plane, and resultant multiplex audio channel outputs, it became necessary to devise some means to select the proper output. Thus a selective box was devised making it possible for the operator to independently select and listen to any receiver.

The frequency shifting condition previously discussed had an interesting evolution of design. When the equipment was either of the one or two channel-control type, used on a plane flying from New York to Chicago, the instrument would be tuned to the day and night frequency. Upon arriving at the terminal point, let us say Chicago, it was necessary for the radio department man to remove the crystal and tune up the transmitter and receiver for another frequency, which the airline would be using west of Chicago. This, of course, was always an inconvenience. And, in many cases, time was always short at the terminal stops, and work was done under limited time and pressure. This condition also limited the alternate routes that the pilot might select in the case of adverse weather conditions. That is, since this communication equipment covered only a specific frequency and route he could not change his flight plan to fly over another route. For the frequency of his communication equipment would not match those of the ground station. All airlines have certain frequencies allotted to them in different sections of the country between cities. However with the advent of multi-frequency

Latest type of instrument landing antenna, housed in plastic nose of plane.





McElroy PFR-443, Wheatstone Code Tape Perforator

Ted McElroy is justifiably proud of this remarkable unit. It assures perfect transmission of radio telegraph signals, thereby replacing inadequate hand-sending that often results in errors and repetition requests. Manual deficiencies contribute largely to unnecessary use of radio transmitters, with consequent congestion of the radio spectrum.

The Wheatstone Code Tape Perforator is unquestionably one of the outstanding contributions to the art of radio telegraphy. Actuated by 110 volt AC or DC current, this model PFR-443 prepares tape cleanly and accurately at speeds up to 50 words per minute, for feeding through automatic transmitters.

It does not necessarily require experienced radiomen to operate it effectively. Anyone with a basic knowledge of the dots and dashes comprising signal codes can prepare perfect tape for transmission, not only in International Morse, but in other codes used throughout the world, such as Japanese, Russian, Turkish, Arabic, Greek, etc.

The method of operation is simplicity itself. The unit is placed in a position similar to a hand telegraph key and may be operated with a feather-light touch of the index finger, middle finger and thumb of the right hand. Depressing the dot, dash or space closes electrical contacts actuating a powerful die mechanism.

This perforator may be used fully automatic, providing a continuous series of characters, and with a variable speed control—or may be operated semi-automatically to form only one character at a time.

This method of machine sending will prove of great value in improving the efficiency of radio communications on ships and at all other radio stations.

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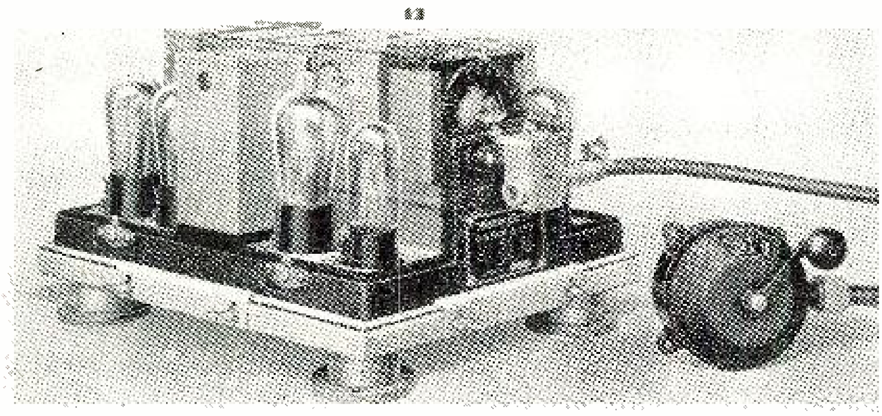


Early type tuned radio frequency receiver with remote tuning mechanism shown.

communication equipment in the late thirties, it was possible to set up a variable frequency system, so that the pilot could select the required frequencies at will with a control box in the cockpit. A simple panel with these frequencies identified was thus designed by some airlines. This voided all possibility of misadjustment and required only one check when the plane came into port.

Laboratories, tests and maintenance shops have become important factors in airline and even private plane systems. While the airline always maintained some form of a test bench and laboratory service, of late these services have been expanded considerably. Some laboratories, for instance, have complete crystal grinding facilities. Five years ago, the grinding of crystals was believed to be a procedure for only a few in the country. This does not mean that crystal grinding is a very simple project. But it does mean that many of the tricks have been learned quite effectively. To provide this service these laboratories have, in addition to the crystal grinding equipment, a special crystal oscillator which checks the activity of the crystal, a secondary standard, and a monitoring rack for checking frequencies.

Another laboratory standard for checking purposes is the intermediate frequency test unit. This provides a crystal controlled intermediate crystal frequency voltage for lining up the intermediate frequency transformers of not only the equipment in the plane, but of the equipment in the various ground stations as well. This intermediate frequency alignment project is exceedingly important, for in crystal control operation it is imperative that the intermediate frequencies be exact.

We mentioned a while ago that in an effort to standardize equipment and also devise units that would include every possible technical advantage, the major airlines conceived a unit known as Aeronautical Radio, Inc. Owned and chartered by the communications departments, this unique service consists of engineers and an administrative staff. It was through the efforts of this unit, that the ultra-high frequency program gained momentum.

In operation, the organization culls the various plans and methods submitted to them by the airlines and discusses them at a round table conference with manufacturers, members of the FCC, the CAA and of course engineers of the airlines themselves. These meetings, which occurred in Washington, have, of course, temporarily been halted by the present war. However, the coordinated effort and conference plan is still maintained.

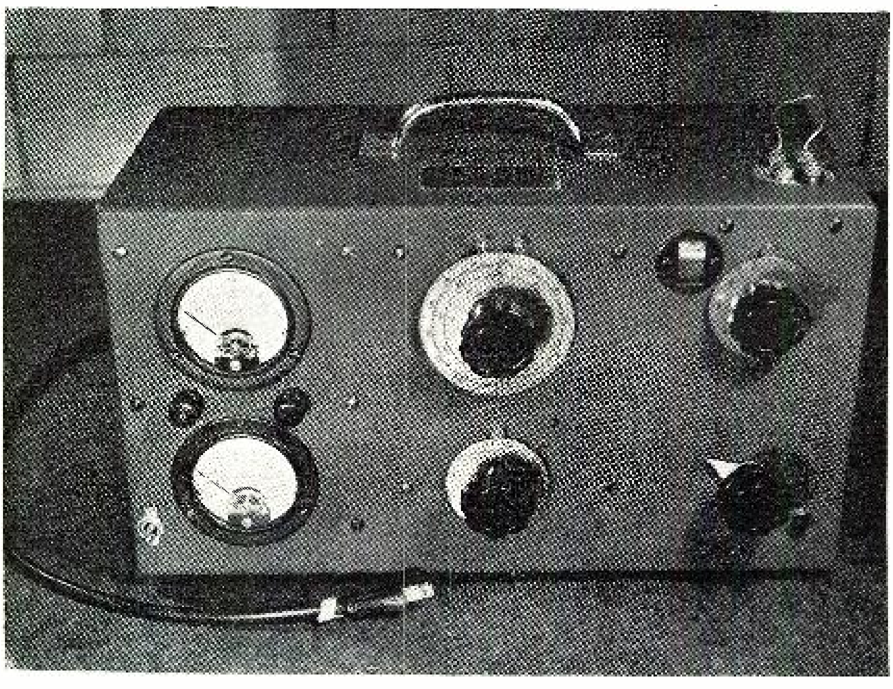
We mentioned that the ultra-high frequency program received its impetus through this unit. The first development actually was the 75 megacycle marker receiver. Previously there was no such device. To obtain fixed location information, the cone of silence over the range station was used. However with that system it was necessary at times to interrupt the range signal to broadcast weather information to the pilot. As a result, the pilot or other pilots were often without the necessary range facilities. This new device sends up an inverted cone of signal (conical shape of signal), which is received by the 75 megacycle receiver providing an audible tone to the pilot. An indicator pilot light signal on the instrument panel also lights up, upon signal reception, indicating to the pilot that he is directly above the range station.

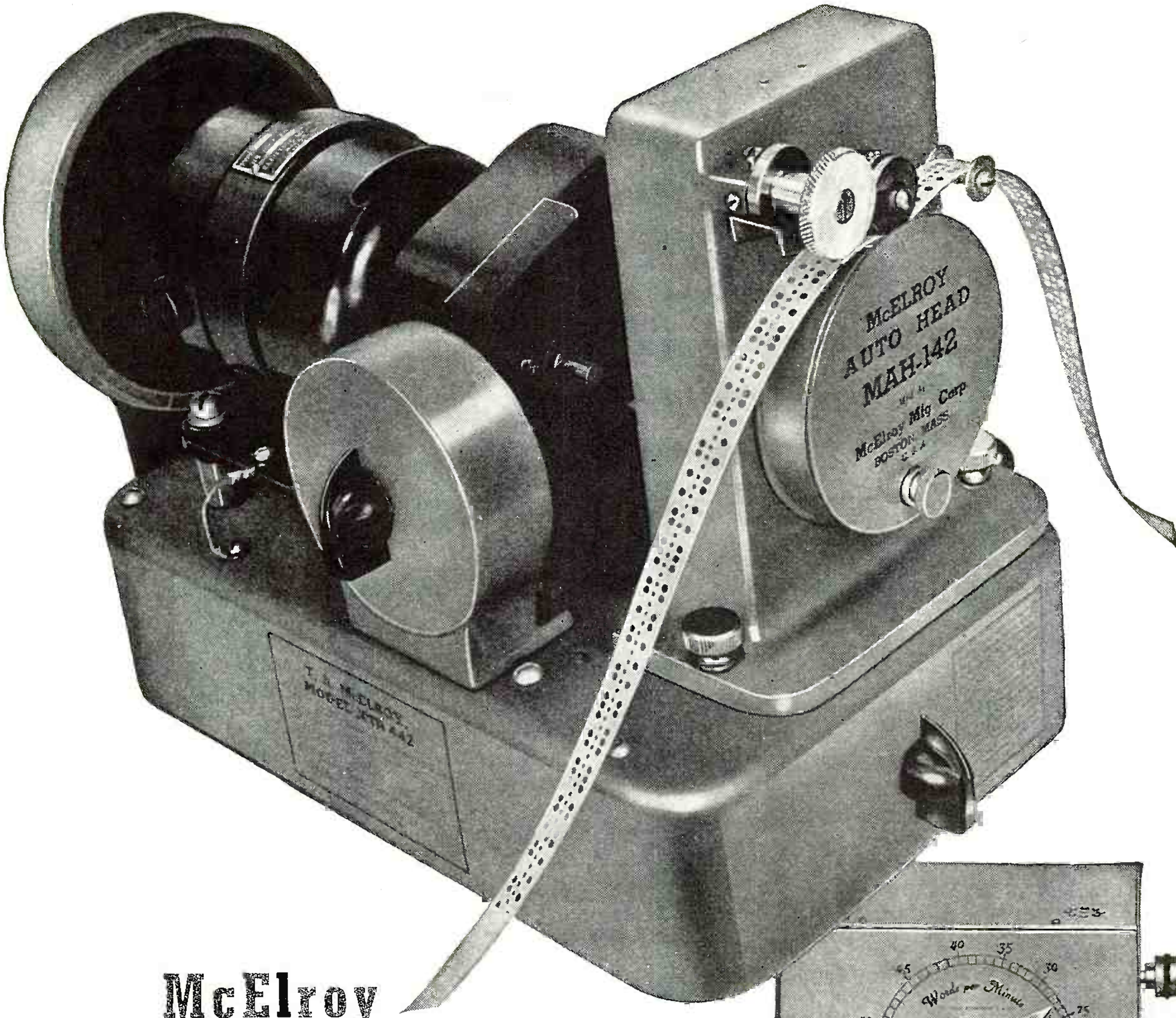
Through the facilities of this group the first ultra-high frequency, two-way communication transmitter-receiver units operating beyond 100 megacycles were designed. So effective was the design of this device that it is being used by many branches of the military services. Incidentally, the equipment was to have been used commercially in the DC-4 transport plane. The unit is so designed, that not only is two-way plane-to-ground communication possible, but due to a dual radio frequency input system, continuous monitoring for interplane communication is also possible.

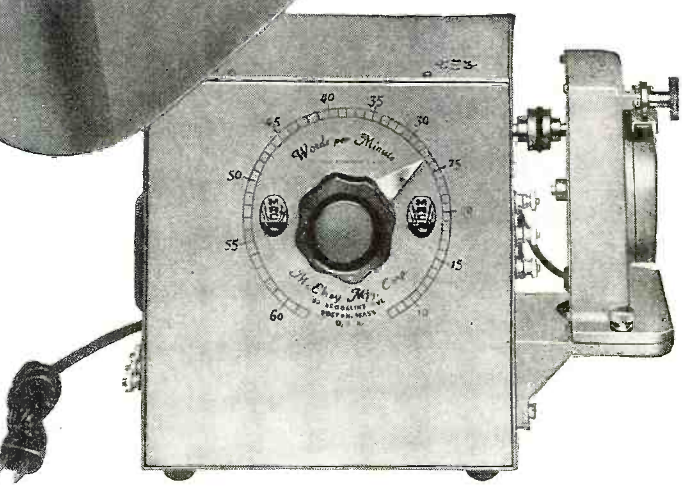
Other accomplishments of this airline unit, have been standardization of the physical sizes of transmitter-receiver equipment affording complete interchangeability. Most of the standardized units are of the same electrical manufacture, also. Standardized, also, are conduit runs, control boxes, antennas, etc.

This standardized form of production is extremely important to the airplane manufacturer. It enables him to plan on standardized type of installations in planes during the actual designing and development of the plane. In other words, the plane design can be conceived with the communication equipment as an integral unit of the plane and not as simply an accessory. This not only provides for better plane and communication equipment coordination, but also for mass production possibilities of planes.

Special "Q" meter used to check coils at ultra-highs where losses must be avoided.







McElroy Automatic Transmitter

MODELS XTR-442 and XTR-442A

The McELROY AUTOMATIC TRANSMITTER, MODEL XTR-442, in response to Wheatstone perforated tape, will open and close a keying circuit to execute mechanically precise signal elements, dots and dashes. It will key either the intermediate relay of a radiotelegraph station for communications purposes, or an audio oscillator for training radiotelegraph operators.

In any service, the XTR-442 will execute radiotelegraph signals with exactly fixed relative lengths. It consists of the McElroy MAH-142 Auto Head, which accepts the perforated tape, the motor which drives the Auto Head including its associated speed control, an electronic polarizing circuit, and a relay.

The motor which energizes the MAH-142 is capable of driving the Transmitter at a speed range of from 4 to 300 words per minute. A rheostat enables gradual and positive control of speed through the entire range.

Model XTR-442A, like the XTR-442, offers constant control at all available transmitting speeds. The rate of transmission is indicated directly upon the dial, calibrated in words per minute.

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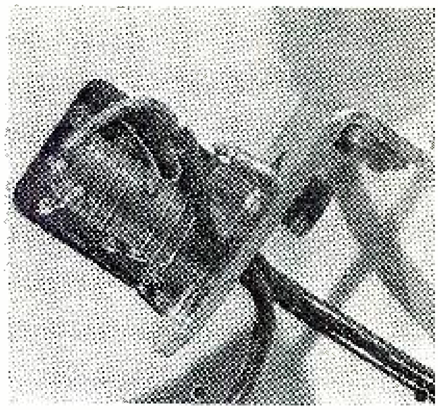
The evolution of the 75-megacycle equipment prompted the corresponding development and use of many special devices for testing. One such device was a signal generator, crystal controlled. Another was an ultra-high frequency "Q" meter to check coils. The unit is also used to check automatic direction finder loops to secure the highest possible "Q." The "Q" meter shows whether or not the loop has moisture, that would accordingly have to be baked out. The instrument is also used in the same capacity to check on a transmission line.

Probably one of the most interesting test devices designed was the ultra-high frequency test oscillator, that provides a means of checking up on the aircraft marker receiver in a plane, before the plane leaves the ground. This is accomplished by duplicating the transmission characteristics of the permanent ground transmitter. The device is quite compact employing but two 6N7 tubes. A vertical beam of comparatively small horizontal area is projected by the antenna. The oscillator is also used to check up on the efficiency of other components in the equipment.

Thus far, we have been discussing the basic receivers and transmitters. There is, however, an important allied piece of equipment, that is as essential as receiver and transmitter. We refer of course to the automatic radio direction finder. The direction finder supplies continuous and automatic non-ambiguous bearing indication and simultaneous headphone reception in the 200 to 500 kilocycle and 500 to 1500 bands. Its visual indications are given naturally on a horizontal dial. Navigation scales are provided so that relative, magnetic or true bearings may be read without reference to tables and without the necessity for mental calculations. Accurate cross bearings can be obtained almost as quickly as the various stations can be tuned in. The equipment usually consists of a control and indicating unit, a sense antenna, receiver and a streamline housing in which is mounted a pair of shielded loops.

It was in 1937 that the idea of this device was conceived for transport planes. And, to a series of test flights, conducted at this time, goes the credit for the development. Research engineers of Sperry Gyroscope and RCA who were conducting these tests, required an approach on a range station with a "right-left" direction finder. The loop of their direction finder had to be driven by hand, which, of course, was a hindrance to their other work. The engineers substituted sensitive relays for the "right-left" meter and used a windshield wiper motor to drive the loop to the null.

A standard direction finder available, at that time, was converted from "left-right" indication to automatic operation by using a pair of 6V6's in push pull, driving one-phase of a two-phase motor which was, in turn, geared



A 75 megacycle coupling transformer.

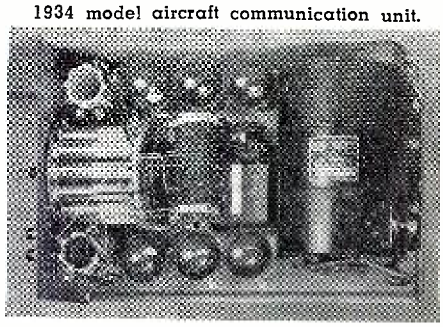
to the loop. The rotation of the loop was coupled through a tache type shaft to a modification of a standard azimuth indicator. In the late fall of 1937, thanks to the development work of Donald S. Bond and Edward Blodgott of RCA and Francis L. Mosely of Sperry, a four-band receiver with automatic compass operation in the two lower frequency bands was developed. The first installation was made in a DC-2 plane flown by James Flynn, who was then communications superintendent of American Air Lines.

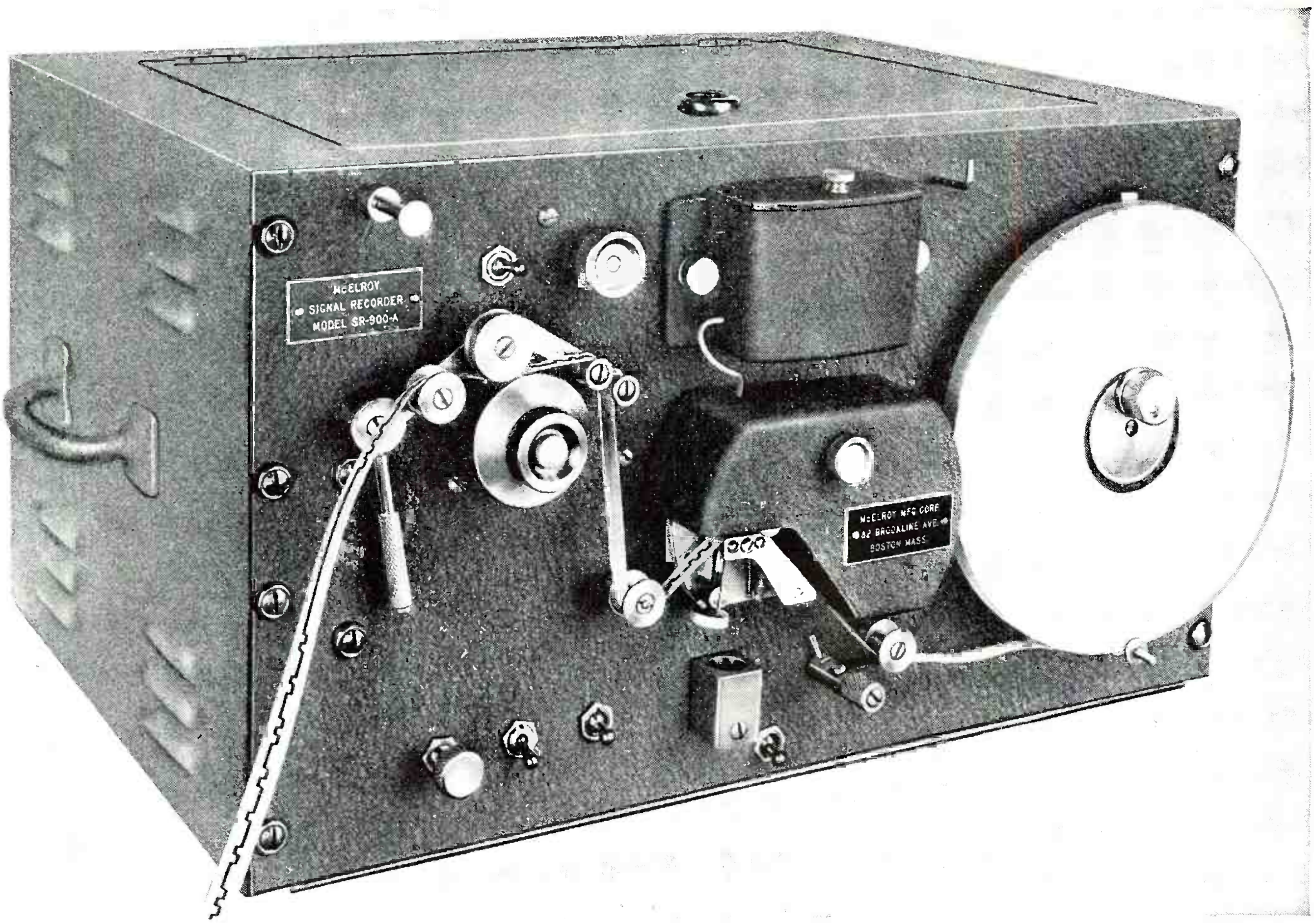
The original equipment consisted of a loop amplifier, a balanced modulator, two stages of radio-frequency amplification, a mixer with a separate oscillator, three intermediate-frequency amplifiers, a second detector and avc, a phone output tube, two stages of tone amplification and push-pull 6V6's to drive the loop motor. An anti-hunt system was incorporated to prevent overshooting the null on drive-in. The power was obtained from a motor generator set which was speed-controlled to operate through the range of 10 to 14 volts input with no deviation in speed. This equipment was very effective in operation but was too heavy and electrically inefficient for aircraft use.

The present system consists of a loop amplifier with its own avc system for percentage of modulation control, a balanced modulator, one RF stage, a tuned pre-selector, detector oscillator, two IF stages, second detector and AVC, phone output with dual isolated channels, a two stage tone amplifier and phase shift controlled thyratrons for driving the two-phase loop motor. The B supply is derived from a self-rectifying vibrator and the a-c supply is taken from a special 100-cycle vibrator system.

Not only did this development pro-

1934 model aircraft communication unit.





McElroy High-Speed Recorder, Model SR-900-A

This entirely new and different recorder has many unique advantages which permit it to record signals at a maximum speed approximating 1,000 words per minute.

Recorders of earlier design have been limited because signals to be recorded were required to overcome the inertia of mechanical spring action. In the McElroy SR-900-A, the return of the exciter coil and ink stylus to the signal base line is not dependent upon a spring. With the exciter coil constantly energized, a change in polarity occurs when a signal impulse is transmitted to it. The coil and ink stylus is moved without resistance. At the end of the signal impulse, the polarity of the coil is changed again and it is returned to its no-signal position with equal force. Lightly balanced and delicately but sturdily pivoted, the coil and inking stylus float freely without restriction.

The Model SR-900-A operates directly from the tone signal of any radio receiver, rejecting all but the signal of the highest level, reducing the effects of interference to a minimum. Background noises, weaker interfering signals and static are rejected by the amplifier and selector incorporated in this recorder.

The inking mechanism feeds directly down with the pen recording in a vertical position, presenting a distinct advantage over other types which record with the pen touching the tape in a horizontal position. While the tape puller, with adjustments for three speeds is built-in, the tape reel is mounted on the panel.

Designed to accommodate mounting in a standard radio panel, if desired for monitoring purposes, the recorder is nevertheless completely enclosed for table operation at high speeds. In addition, a separate pull-motor can be utilized for normal speeds when operator desires to transcribe direct signals.

With the McElroy High-Speed Recorder, clean and readable signals are assured where other recorders might respond with hopelessly jumbled and undecipherable copy.

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vide an unusual ally for aircraft communications equipment but it also was responsible for the development of the thyratron tubes, more popularly known as the 2050 type. These gas type tubes are now available and used in any number of control circuit applications.

This device, although designed essentially for air transport service, served as the basis for many other similar compass-type automatic devices that followed.

Important to the operation of communication equipment aboard a plane are the loops and antennas. In the design of these, particularly the loop, has gone an unusual degree of study. The problem surrounding loop efficiency is that of rain and snow static. This, of course, must be eliminated. The early method included the use of a covered wire instead of a bare wire. It was then found that a coil surrounded by a housing would work well. Developments were made in this direction so that the loop could be used effectively as a bearing indicator and aural null direction finder.

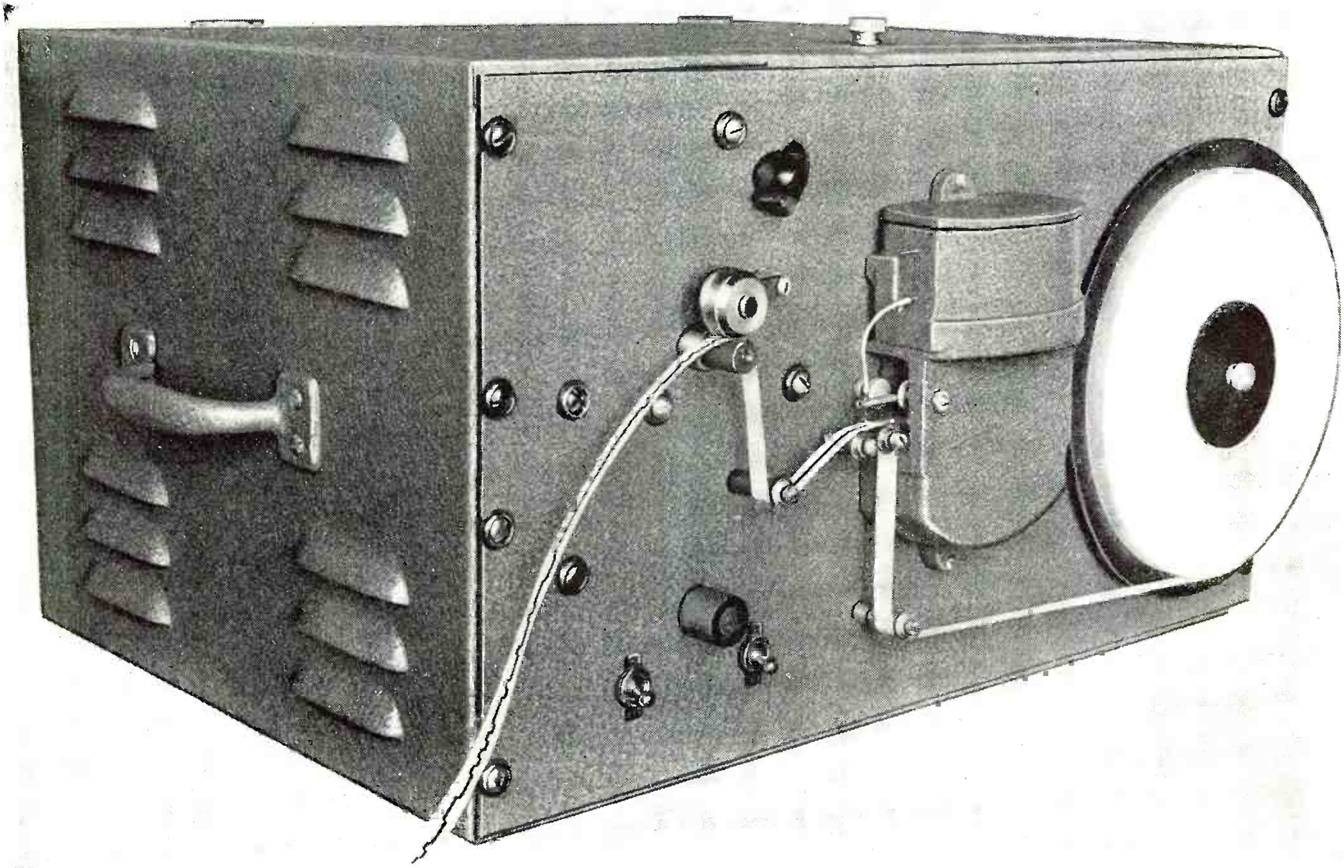
The most recent developments of this loop provide a mounting of the antenna in the nose of the plane, protection from the elements being offered by a plastic cover.

For ultra-high frequency reception the vertical rod antenna is being replaced by a streamlined horizontal type that also assists in reducing the aerodynamic drag.

We have been hearing, of late, a great deal about the use of microwaves and aircraft. It was in the radio altimeter, that much of the present day thought began. The radio altimeter replaced the barometric pressure altimeter as a height indicating instrument, in some installations over a score of years ago. In 1923 Dr. Ross Gunn, then in charge of the high frequency laboratory of the physics department of Yale University, began working on the radio altimeter. In 1925, he submitted a working model to the military authorities, and it was tried out at McCook Field in Dayton, Ohio. Later Dr. Gunn joined the Naval Research Laboratory to continue his research. Almost a decade later, another type of radio altimeter was announced, and again the microwave principle was introduced. Absolute altitude above the terrain was provided for, as against the barometric unit that was 50% off in tests. The device operating from 420 to 445 megacycles and employing ultra-high frequency diode rectifier and transmitter tubes, required no adjustment by the pilot, and was not affected by static.

The development of this device and subsequent projects, have given the industry and others as well, a medium that has not only meant improved air travel, but safety and comfort. In addition, it has also opened the doors to a field of study that has untold possibilities for countless projects.

A myriad of other developments, among which we find the omnidirectional radio-range system, azimuth in-



McElroy Model G-913-A School Recorder
with Tape Puller Model TP-845

Sturdily housed in one complete unit for table operation, the school recorder may also be incorporated in a panel rack. Because most satisfactory performances can be secured when using the recorder with this particular tape puller, both units have been combined into this one compact instrument, at no increase in cost over the price of the recorder when purchased singly.

Both units which comprise the G-913-A School Recorder are ruggedly built but should be accorded the care and attention normally given to laboratory equipment. Properly operated, this instrument will be trouble-free. Forty-eight of these recorders are in daily operation, 24 hours each day, in the production of G-15-AA sets of practice tapes at our factory.

The School Recorder is indispensable for teaching, since operators are enabled to examine actual printed examples of their own techniques. It demonstrates visually to the students any defects in his hand sending and can also re-transmit to him accurate reproductions of the signals he has sent. With the faithfulness of a sound recording mechanism it offers an operator the opportunity to study and improve the rhythm and spacing of his keying.

The model G-913-A School Recorder will operate at speeds up to 100 words per minute, recording clearly signals of readable strength from any radio communication receiver.

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dicator for flying fields, etc., have catapulted the aeronautical communication industry to a vital post in our daily life. Today the complete industry is serving the military in a truly outstanding way, providing equipment and material assistance that means complete victory.

So rapid is our development now, that the post-war era will see developments that are truly miracles of design and production. We shall see automatic facsimile equipment that will enable the pilots to receive maps, weather charts and communications for review at their convenience. We shall see complete instrument landing facilities controlled within planes themselves. We shall see collision warning equipment. These are a few of the *radionic* developments that we shall see . . . developments that are not idle thoughts. They are developments that American engineering skill will give to us!

Our sincerest thanks to the following for their cooperation and assistance on this article: Charles W. McKee, Eastern Air Lines; W. L. Webb, Bendix Radio; H. A. Wolf, American Air Lines; Wayne E. Price, Sperry Gyroscope Company; H. R. Carty, RCA; F. C. McMullen, Western Electric; G. E. Smith, Communication Company; J. V. Wilcox, Wilcox Electric; Stanley Irwin, American Air Lines; R. A. Marsen, Lear Avia.

Photographs appearing in this article were furnished by the following:
Western Electric .... 161, 165, 168, 170 (Bottom), 172 (Top), 174 (Top)
United Airlines .... 162 (Left), 163
Sperry Gyroscope Co. Inc. ... 162 (Right)
American Airlines 164
172 (Bottom), 174 (Bottom), 176 (Top)
Lear Avia .... 170 (Top)
RCA .... 176 (Bottom)

—30—

Interphones Go to War

(*Continued from page* 75)

it is not, any more than the "radio" outlet of a hotel room. Both are wired communication.

Essentially, the interphone consists of an amplifier and two or more jack boxes which contain a switch for radio and for talk between crewmen. It is the nervous system of a bomber crew, who otherwise would be isolated in the innards of the big plane. One speaks through a mouthpiece or, in all high-altitude ships, a "throat-mike" that takes vocal impulses directly from the vibrations of the larynx.

Interphones aren't new. Even the name dates back to 1911, when Army Signal Corps men first installed a telephone set in an airplane "for communication between pilot and observer." This was only a year after the Army had bought its first plane from the Wright Brothers. Engine noise and faulty insulation were too much for this pioneer interphone.

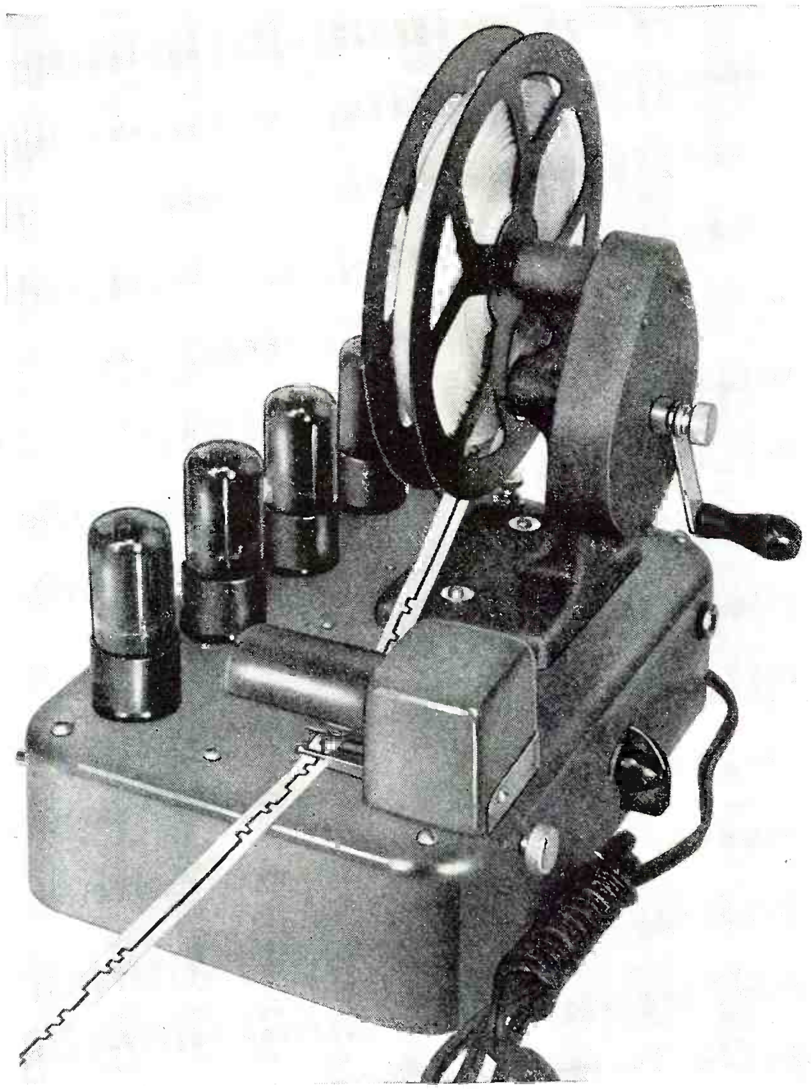
The first practical model was installed in an Army plane in August,

McElroy Electronic Keyer
Model G-813-A

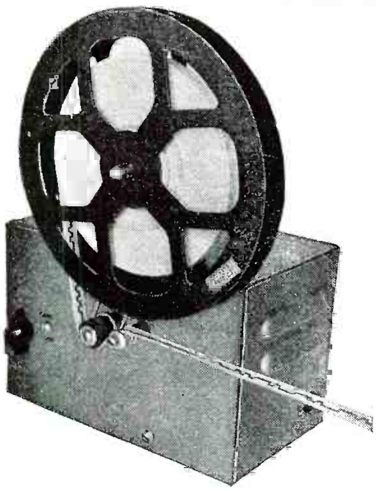
The Electronic Keyer, an original McElroy development, converts into sound, code signals which have been transcribed in ink on standard 3/8 inch paper tape at any speed chosen by the operator. The clarity and even spacing with which the signals are reproduced will assist students in rapidly mastering correctly sent code.

The Model G-813-A continues to be the only instrument of its kind which has the outstanding practical advantage of keying only the signal line of the tape. Speed control is constant to a maximum of 40 words per minute. Tapes which undergo the effects of excessive wear will operate this unit with an efficiency impossible to achieve with imitations of the McElroy Electronic Keyer.

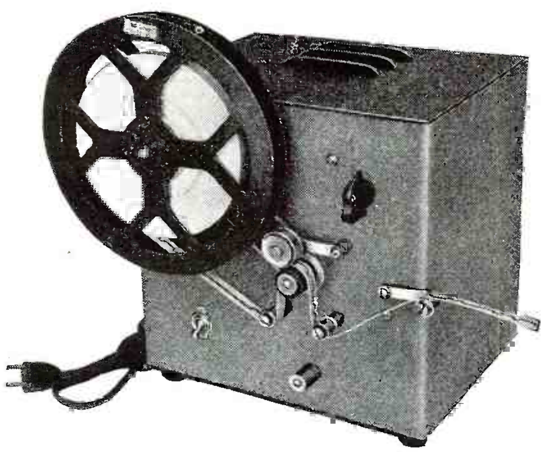
Cumulative developments through years of experience with the photo keying unit, an original McElroy achievement, have resulted in many inherent advantages that continue to build widespread acceptance for this unit.



McElroy Tape Pullers, Model TP-845-A and Model TP-890-A
with constant control over wide speed ranges



By far the most important consideration in the planning of these units is the incorporation of newly designed motors, oversized and capable of sustaining constant speeds. Model TP-890-A (illustrated at the right) is recommended for high-speed applications, while the Model TP-845-A (at left) is principally used in conjunction with training equipment. Both will operate at maximum efficiency with a minimum of required maintenance.



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1917. Frankly experimental, it included a set box, telephone transmitter, head set and connecting cords and was powered by dry cells. The headphones were heavily padded and enclosed in a leather helmet with "elephant ear" flaps. Today's tank crews wear similar equipment, and for the same reason: To exclude noise and protect the head.

Before 1919, the Army had a five-station interphone used in the largest bombers of World War I. It weighed nine pounds complete.

Most early Army aircraft had no power installation except the ignition. Interphone was out of the question, and pilots and observers signalled in strange ways. They kicked the rudder. They jerked the stick. They flashed red lights. More often, in a small plane, the observer simply tapped the pilot's shoulder and wigwagged. Other airmen installed speaking tubes.

Between the 1917 model and today's complex installations lie years of research, all directed toward helping the message get through in spite of noise, combat and excitement.

Sagas like the "Teggie Ann" make news, but the unfailing performance of the interphone is making history in every war theater. In England or North Africa or the Southwest Pacific, wherever American bombers fly against an Axis target, success of the mission depends on that hidden wire of communication.

A Flying Fortress "somewhere in New Guinea" is assigned to bomb a new Jap base north of the Solomons. Bombs are loaded, final checks made. The crew climbs aboard and scatters through the bomber's belly and eyes and tail. First thing, each man switches on his interphone. He plugs in the headset and flicks a black plastic finger to the position marked "INTER" on the control chamber known as the "jack box."

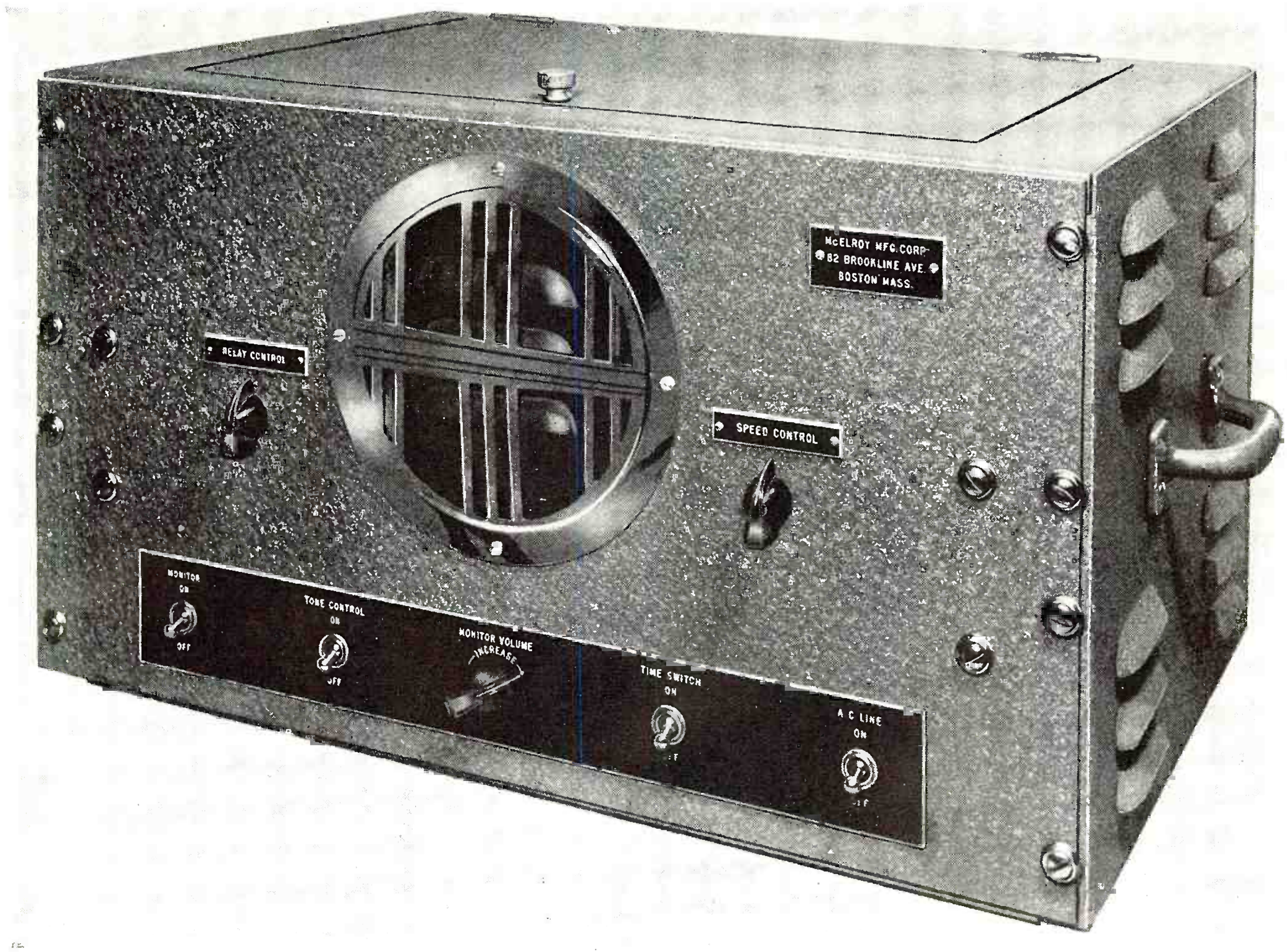
Before take-off, the bomber crew reports to the pilot.

"Co-pilot . . . Navigator . . . Bombardier. . . ."

Then the voices of a radioman and five gunners manning the top and bottom turrets, the waists and the "stinger" in the Fortress' tail. No bomber pilot would think of taking off without "roll call." There are at least ten men aboard a big bomber, and most of them are tucked into odd compartments on three different levels from nose to tail. Headset to headset, interphone literally ties the bomber crew together.

Once the big plane leaves its island base, it rises fast and smoothly above the Pacific. This will be a high-level attack against a target that was nothing but a sleepy coral lagoon two years ago. Now Jap transports and seaplane Zeros are based in the harbor, and ack-ack guns crowd the cocoanut palms.

Still climbing, the pilot checks his crew again. This is a safety precau-



McElroy Radio Beam Keyer, Model RBK-1142

The Radio Beam Keyer was developed to fill a need for a reliable instrument which would operate as a constant source of specific information; repeating that information in code characters at any speed within a range of from 5 to 75 words per minute.

The Keyer can be adjusted quickly for continuous and timed transmissions, without tape or other media of limited durability, of signals in any order required. In addition, it can open or close the circuit it keys for a determined length of time to provide either a period of uninterrupted silence or a dash of specified length.

The most obvious commercial applications for an instrument of this type are keying high-frequency beam transmitters for blind landings . . . keying station and frequency calls, etc. . . . However, its adaptability to almost any requirements makes it a most flexible instrument for a multitude of other needs.

The Model RBK-1142 is designed to fit standard rack assemblies and may be mounted with the same fixtures that secure it in its sturdy, enclosed housing.

To the Future . . .

Ted McElroy is operating the largest laboratory and plant devoted exclusively to the design and production of equipment for the transmission and reception of dots and dashes. There, within the limitations of a full-scale war production, we are compiling a practical knowledge of not only all the complex phases of the radio-telegraph art but also the associated applications of electronic apparatus for industry.

Today we are limiting productive capacity to our field where, as creative telegraphic engineers, we are leaders. We create. We design. We build. We do not imitate and we do not copy. And we can deliver. In the future, when it will be possible for us to manufacture new products, we will be ready with a wealth of experience in electronic techniques.

High-frequency heating will speed production of innumerable commodities. Medical science can see new wonders ahead. Electric controls will check the foods we eat, the air we breathe, the colors we see . . . The opportunities for development are limitless.

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tion and also a test of two-way reception through the head-sets. The "party line" must have no coughs or grunts to interfere with rapid-fire commands in combat. "Tail gunner . . . Check. . . ."

At 8,000 feet the pilot reaches for his face-piece. "Oxygen," he says. "Acknowledge."

Again the roll call as the men don masks and fumble with portable tanks near by.

This is the reason for the "throat mike"—the short-cut voice that picks up speech in the form of larynx vibrations. The airmen seem to be talking into their masks, yet the sounds the interphone picks up already have left their throats.

Leveling off "above 10,000," the bomber drones northeast. Every 15 minutes while they're on oxygen, this aircrew will check in with the pilot, one at a time, in order. Silence from any man's station brings an instant search. Thanks to this vigilance, many a sick or wounded man has lived.

There's little idle chatter among a trained crew at altitude. They're intent on the target ahead. They know their routines without prompting. Most important, a man doesn't feel like wasting words while he's taking oxygen.

Combat, any airman will tell you, does enough to raise blood pressure without mentioning blondes. Women, of course, are not an unknown subject over interphone. But this is saved for low altitude, on the way home, after the Zeros and Messerschmitts have dropped back.

Now the Fortress is only a half-hour from the Jap base. No enemy fighters are in view. It looks like a surprise raid. The port gunner cuts in: "Ship at nine o'clock."

A quick look, but no turning. Some native craft is ranging the only no man's land left to the islanders. The bomber speeds toward a dark mass that seems to float on limitless water.

A crisp, familiar phrase from the pilot. "Pilot to navigator. . . . Give me correct course to target."

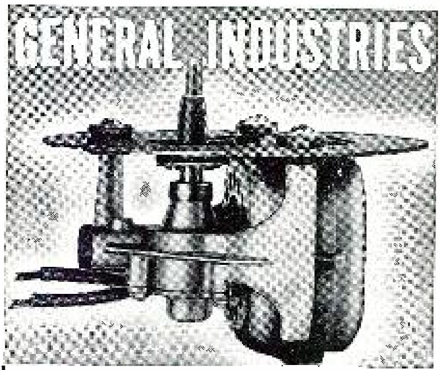
In a moment, brisk directions flash through the earphones. "Navigator to pilot. . . . Swing two left . . . one right . . . steady."

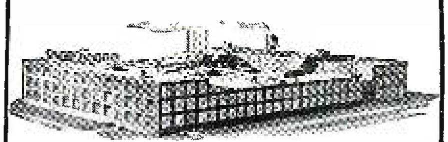
Casual as two business men in conference, these young Americans are bridging the wall that divides their specialized jobs.

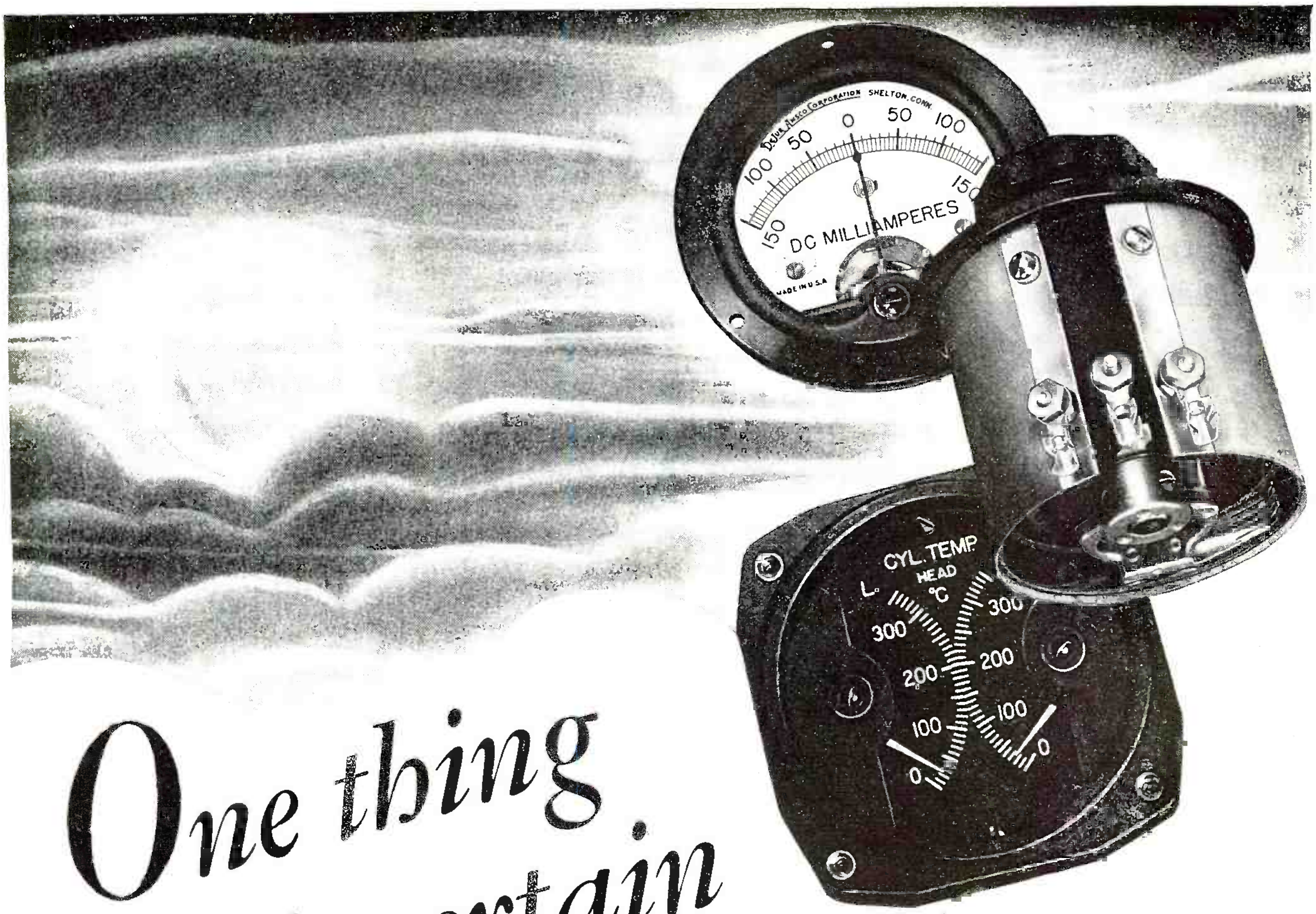
Altitude 11,000, course steady. Time for the bombardier to take over. He gives the final polish to direction. There can be no change in altitude now. The lagoon and its ships are coming into the bombsight.

"Bombardier to pilot . . . Two right . . . three left. . . ."

At split-second intervals, he corrects the course. Nothing—not even news of Zeros on the Fortress' tail—must interrupt the bombardier now. The bomb-bay doors are open. He alone has the line, and his voice guides the pilot's hands on the controls. No turning back now. No change of course.







One thing is certain

...the American Military Machine must be equipped with superior materials of war. To this end, DeJur Aircraft and Electrical Instruments, Potentiometers and Rheostats are built to the most critical standards of quality and precision. Behind them are twenty-five years of experience and laboratory research. Before them stands the future of the democratic way of life. Neither you nor ourselves can afford to falter now.

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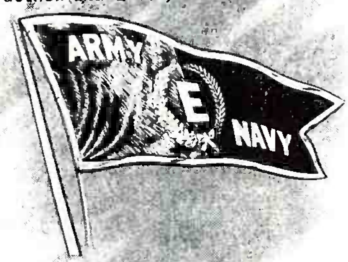

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MORE THAN EVER... it's important to keep buying War Bonds and Stamps

For good or bad, this run is history.

Today's bombardiers rarely say "Bombs away!" despite the fiction writers. Sudden emptiness fills the earphones of each man on the ship, and he knows the bombs are dropping and looks downward, if he can, to watch the deadly eggs scream toward the lagoon.

The first bomb hits water. The second, third and fourth are hits. Black figures swarm the transport's decks like ants and more black specks dot the water. Flames break out, and smoke rolls up oily and black.

The raid has caught the Japs completely. Zeros rise from the water, too late to be more than nuisances in the rear as the Fortress turns toward home.

A sudden break in the tenseness aboard the bomber. "Nice work, Joe. . . ."

Congratulations. But few words, until the home-stretch. Until they can quit roll call and dispense with oxygen.

The run climaxes the bomber's mission. Ack-ack or enemy fighters make the mission grimmer, but do not add one word to the clear-channel communication enjoyed by the bombardier at the instant he pulls the trigger.

It's no different on a Mitchell over Burma or a Liberator bombing Naples. Even a B-18 on Caribbean patrol goes through the same measured convulsions of its interphone when a sub is sighted.

Variations in the routine are minor. Some pilots order oxygen by calling: "Put on the snood." Bombardiers, if there's time, will report a play-by-play account. "Doors open," they'll say. "Dropped two eggs . . . two more."

Sometimes, after the bomb-release is pulled, a gunner will chime in: "Looks like a miss."

Aircrews of medium bombers usually check with the pilot at half-hour intervals, or longer. They're fewer and not so far apart in emergencies.

A typical interphone system on our biggest bombers has a 24-volt direct-current primary power source. It provides intra-plane communication between the various stations, plus switching facilities for partial control of two complete radio sets and one other radio receiver.

There are two principal parts, the amplifier and several "jack boxes" at individual stations. The 200-volt nominal plate voltage for operating the amplifier normally is obtained from a command set dynamotor which is supplied from the 24-volt primary source.

The amplifier, a compact chamber less than 6 inches high, is a single stage push-pull type utilizing one twin-triode vacuum tube. The output circuit can supply as many as 25 headsets in parallel.

Each jack box has a five-position selector switch assembly. This connects the microphone and headset circuits to either of five contacts—the compass receiver, the liaison set, the command set, the two-way interphone channel—"INTER" and "CALL."


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Variable resistance in series with the headset provides limited control of volume heard at each of the three radio positions.

Normally, each member of the bomber crew except the pilot and radioman switches to "INTER" before take-off and leaves it there. His "in" circuit is always open and he flicks his selector to "CALL" only when he wants to get the pilot's attention. This special switch is the result of the long battle to "raise the pilot" by flashing lights, hand signals and much shouting.

When a gunner, for instance, wants to flash news of enemy planes, he flicks his switch to "CALL." The message will reach the pilot regardless of whether he is on interphone or on one of the three radio channels, because the gunner's voice will cut over the volume of any other message.

For student training and low-altitude flying, the mouthpiece is the time-honored equipment. All altitude planes, however, now use the "throat mike"—a transmitter with two buttons clamped against the throat and leading directly to the wired connections. An airman "talks through his neck," because the buttons pick up the vibrations of the vocal cords.

No other arrangement would work in modern combat. The face is free for wearing oxygen masks during all altitude flying. No noise of wind, guns or engines can seep in on this direct-contact circuit. Equally important, the busy hands of today's crewmen are free to shoot guns and plot courses and poise eagerly above the bomb-release switch.

Early during the war in the Southwest Pacific, one bombardment group had a few throat mikes but no connecting lines. These pioneer airmen scoured all nearby trash cans and spare-parts boxes for enough wire to outfit the bombers. A smart radioman did the rest. The installation, put in without factory instructions, worked fine.

Bomber crews get few chances to improvise on this equipment, the Air Forces boast. It requires no maintenance, and the chances of some Nazi fighter getting a dead shot—as in the case of "Teggie Ann"—are about one in ten thousand. Because of this reliability, the interphone gives the same sense of security that the "party line" in the country affords an isolated farm community.

Caribbean bomber patrols cruise for days without incident. They crack jokes and brag about their girls. Even the rear gunner is never lonely, because his pal Jim is just around the corner upstairs. Interphone keeps them together, ready for an emergency. And when an enemy sub or fighter plane is sighted, everyone is galvanized into action.

Teamwork never flags because the interphone has kept them neighborly in the vastness of the sky. It lets every man do his job and help the other fellow do his, too. The gunner

is the pilot's rearview mirror. The navigator guides the bombardier toward the bomb run.

From end to end of the droning ship, interphone flashes warnings and battle-cries with the speed of light. Ceaseless research is keeping its reception unmarred at higher and higher altitudes. This nerve center of air power must have no nervous upsets in global war.

—30—

Traffic Control

(*Continued from page* 111)

A microphone of the moving-coil type was specified to provide high quality and to insure satisfactory operation. Specifications required that the output and performance remain fairly constant over a wide range of ambient temperatures. A number of microphones complying with our specification have already been made, and these units appear to be very satisfactory for control tower use on the basis of our experience to date.

There will normally be two traffic controllers on duty at the tower and both will be provided with microphones. The press-to-talk switch on both microphones will control the transmitter carriers, but will make operative only the microphone on which the switch is depressed. This latter feature is essential, as undesired conversation and noise might be transmitted if the second, unused microphone were also made operative. This arrangement makes it possible for one traffic controller to make a transmission without delay in emergencies, even though the other traffic controller may already be transmitting; by raising his voice well above the normal level, he is able to make the voice of the other controller drop into the background, and yet the transmission is not seriously overmodulated due to the regulating properties of the level-governing amplifier.

Four different types of receivers are required for control towers, i.e., fixed-tuned and tuneable for both high and ultra-high frequencies. Fixed-tuned receivers are used for guarding aircraft frequencies on which the transmissions are generally very close to the nominal frequency. Tuneable receivers are used for guarding frequencies employed by aircraft having transmitters of relatively poor stability. Tuneable receivers are also used for standby purposes, and where several frequencies must be guarded, but no two simultaneously. The tuneable high-frequency receivers being used are essentially the same design used for a number of years past by the Civil Aeronautics Administration and its predecessors. Specifications were prepared for the three remaining types of receivers, and a number of the fixed-tuned high-frequency receivers have already been completed.

These fixed-tuned, high-frequency

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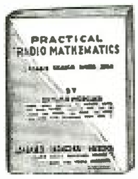

Introduces and explains the use of arithmetic and elementary algebra in connection with units, color code, meter scales, Ohm's Law, alternating currents, ohmmeter testing, wattage rating, series and parallel connections, capacity, inductance, mixed circuits, vacuum tubes, curves, the decibel, etc., etc., and has numerous examples. Plainly written and easy to understand **25c**

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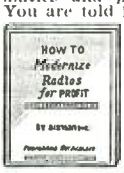

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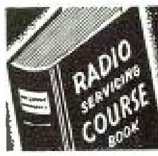

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receivers are conventional in most respects, but have several interesting features. Front and rear views of this receiver are shown on page 110. By putting the power-supply components on a separate chassis toward the front of the receiver, it was possible to put all tubes and tuning adjustments on a rear chassis accessible from the back of the unit. This permitted the rack space required by the receiver to be reduced to 5¼ inches, and yet there was no crowding to necessitate the use of small component parts of inferior performance.

In regard to electrical characteristics, the receiver uses a crystal-controlled oscillator and has two r.f. and two i.f. stages. It has a noise limiter incorporated in it, as well as intercarrier noise suppression or "squelch," although this latter feature may be made inoperative by means of a front panel switch when not desired. Unlike most communication receivers, no provision has been made for adjusting the operating point of the noise suppressor, as incorrect adjustments seemed to be a possibility; instead, the noise-suppressor operating point is fixed at a second-detector output voltage corresponding to approximately 35 percent of the voltage obtained when a.v.c. is fully operative.

When static is severe, the receiver r.f. gain control can be set so that the noise suppressor operating point is just a little above the static level, and the slight increase in detector output voltage produced by a signal will open the noise suppressor. The receiver specification required that an output of 35 milliwatts with signal-to-noise ratio of six db. be obtained with a 2½-microvolt input, but production receivers are performing far better than this.

Space is limited in many control towers and much equipment must be placed in them. So as not to obstruct the view in any direction, the cabinet relay racks used are all of the short type (approximately 43 inches in overall height). To hold the number of racks required to a minimum, the loudspeakers are all being mounted overhead in a housing with the speakers directed downward. The cabinet relay racks will generally be located toward the rear of the tower and it would be inconvenient for the controller to walk to them every time a receiver volume control adjustment had to be made. It is therefore planned to have a compact control unit located at the front of the tower that will permit all loudspeaker levels to be adjusted at that point. Cable consisting of twelve individually-shielded pairs will run from the receivers to this control unit and thence to the speaker housing.

In many cases the airport control tower will not be the only CAA group at an airport that will be required to guard aircraft frequencies, as at numerous airports the CAA Airway Communication Station will likewise guard these frequencies. At the more important terminal airports, the CAA Airway Traffic Control Center may also desire to listen on certain frequencies at times. This makes it practical for the same group of receivers to be used for the two or three CAA facilities at an airport in some cases. The receivers at these points will generally be at some remote location where receiving conditions are favorable and will be of the fixed-tuned type.

Dual amplifiers on 3½-inch rack panels have been purchased for use in control towers, communication stations, and traffic control centers where remote receivers are employed. Only a total of four tubes are required for the two channels, and the amplifiers are suitable for either bridging across or terminating a 600-ohm audio line.

In all of the above it can be seen that the human element is being eliminated wherever possible. This procedure does two things; first it relieves the personnel of a lot of routine operations which can be performed by instruments and secondly it provides a check and a guarantee of operation under all conditions with less possibility of error than is attendant on purely human operation.

Work has also been done on voice recorders for recording outgoing transmissions, ultra-high-frequency antennas, and devices to insure reliable operation. The completion of this program of providing equipment for airport control towers will set, we feel sure, a new high standard for control tower operation.

—30—

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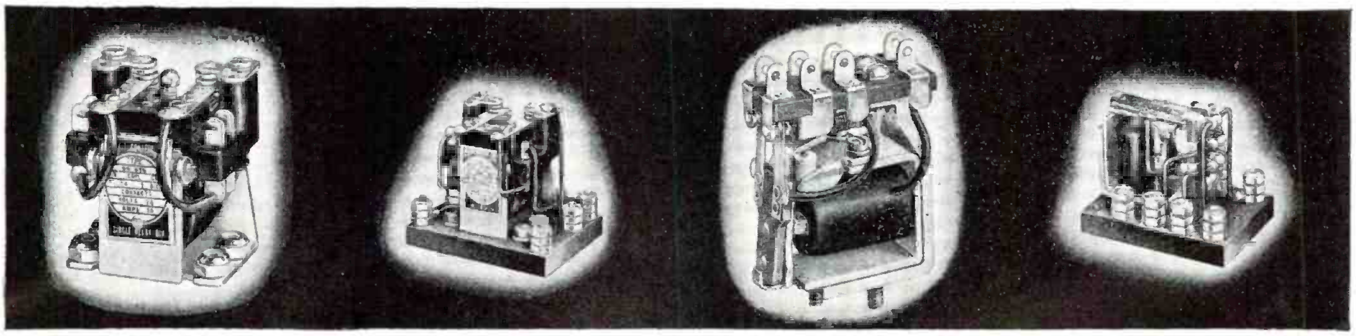
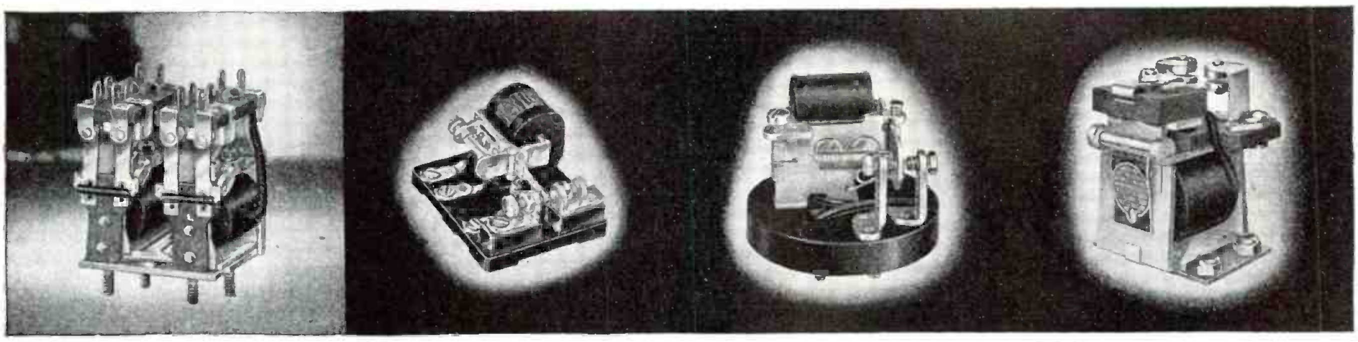


BO *a compactly designed 2½ watt relay, rated 15 amperes at 24 volts DC or 110 volts AC, standard is double pole double throw and also made in 3 and 4 pole double throw — (model BOB when mounted on Bakelite Base).*

BJ *a small compactly designed 2 watt relay, rated 5 amperes at 24 volts DC or 110 volts AC, standard is double pole double throw — (model BJB when mounted on Bakelite Base).*

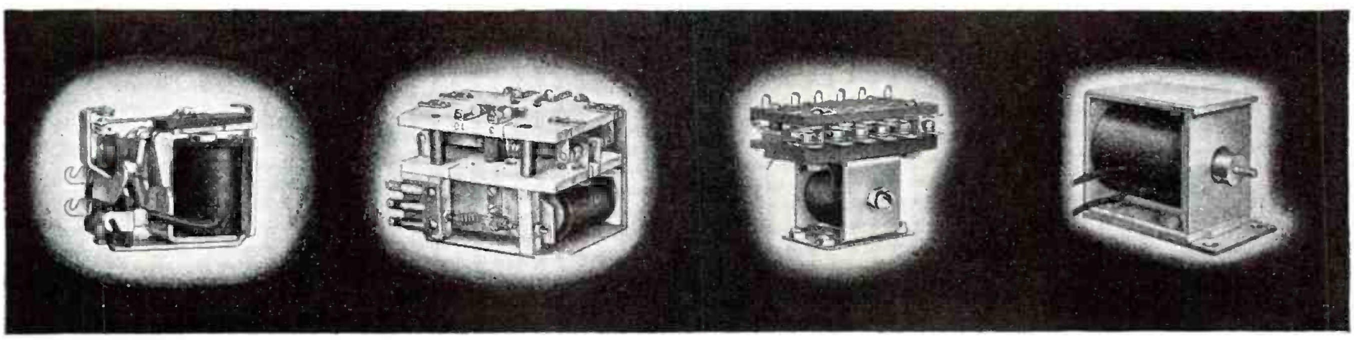


BJU *a latching relay for aircraft; maximum rating 5 amperes per contact, non-inductive.*

B *a sensitive relay operating at 0.012 watts*

G *a sensitive relay operating at 0.05 watts*

AN *a power relay handling up to 75 amperes at 24 volts DC*



AR *a featherweight relay with 5 ampere contacts and weighing 50 grams*

AK *a high speed Keying Relay, 20 cycles per second . . Contact rating 1000 volts at 30,000 ft . 20 megacycles . . 4 pole double throw*

BN *a multiple contact relay, 6 pole double throw handling 10 amperes at 24 volts DC*

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Approach System
(*Continued from page* 125)

Fig. 15 shows the pattern from the center pair alone and from other radiators without center pair. As the former pattern is of constant phase (with azimuth), and the phase of the latter reverses at each null, it is evident that the sum of the two will be a very flat cardiod with one or more minor lobes, and that the position of the cardiod will depend upon the relative phases of the component patterns. Thus Figs. 15a and 15b differ only in the phase of one of the patterns. The above arrangement therefore results in two of these cardiods, as shown in Fig. 3. Figs. 2 and 4 show part of the radiators used.

The system thus requires an RF source of carrier modulated with 90 and 150 cps., and a source of sidebands of these two modulations only, together with some means of maintaining proper phase relationships between the sidebands in the two sources. One means is an r.f. bridge arrangement, as shown in Fig. 16, which indicates that at a-a there will be no carrier because of the cross-over at x, but both groups of sidebands will be present, while at bb both carrier and sidebands are present. The 90 cycle sidebands at a-a are in phase, whereas the 150 cycle sidebands at these two points are out of phase. The bridge is made up of sections of coaxial copper line with suitable ceramic beads. This arrangement has been employed in some installations at LaGuardia Airport, Chicago, and other fields.

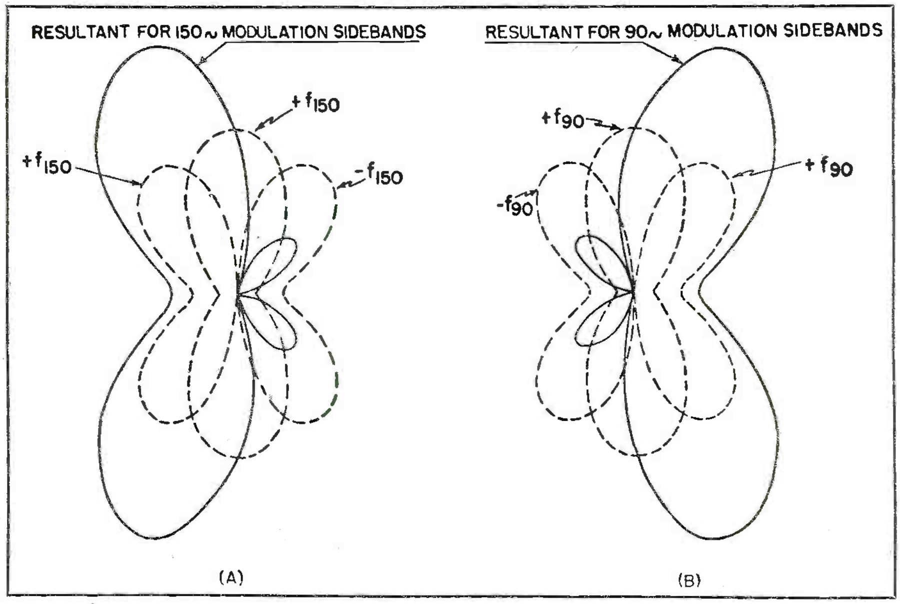

Fig. 15. Components and resultant horizontal space pattern 90 & 150 cycle modulation.

Another method of separating and phasing sidebands and carrier is shown schematically in Fig. 10. In this case the modulation frequencies are applied simultaneously to the transmitter proper and to a so-called sideband generator, the latter being essentially a two-tube modulator stage with the grids in parallel and the plates in push-pull. The output of such a modulator contains only sidebands and no carrier. The reversal in phase of one of the sidebands, as described above, is here accomplished prior to modulation, in the a.f. circuit, by means of a balanced transformer.

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A single horizontal dipole over a counterpoise, fed by a very low power (3 watts) UHF transmitter, serves for the markers. Each of the markers in a system is modulated by an audio frequency to distinguish it from other markers. Usually a frequency between 400 cps. and 3000 cps. is chosen for this purpose. Fig. 5 shows a marker station.

Since every portion of the system should operate properly when desired, a monitoring and control system has been worked out so that a complete check of each component can be made by the operator at any time. For this purpose monitor signals are brought from each part of the system to the control room where an instrument panel continuously indicates the performance of all equipment. A graphic recorder provides permanent records and an alarm system, involving both lights and a gong, warns the operator of any malfunctioning. Any shift of the localizer course, for example, can be detected on the corresponding instrument on the operator's panel. When the shift exceeds a predetermined amount, both the visual and aural alarm operate to warn the operator. Similarly, any change in intensity of radiated signals can be read on corresponding instruments, and these changes control the alarms in the same manner. Telephone circuits are available from the control quarters to the localizer and each marker, affording communication with personnel who may be making adjustments or repairs. This greatly facilitates maintenance. The control rack is shown in Fig. 9, and the field monitor in Fig. 6.

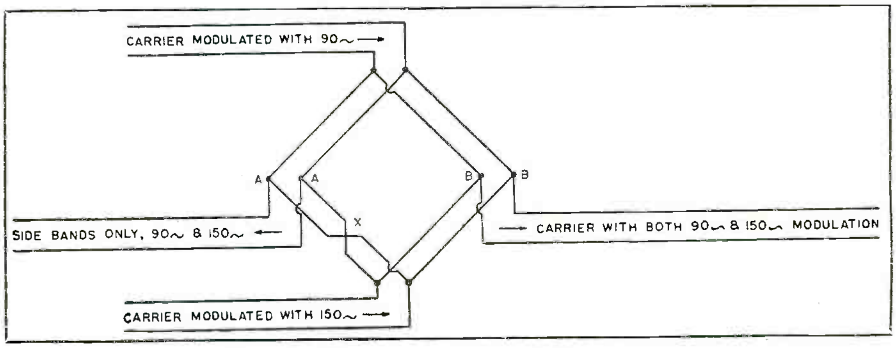


Fig. 16. Schematic of antenna bridge circuit.

As is true of other radio aids for air navigation, this equipment must operate properly over a large range of service conditions. For example, the ambient temperature may vary from minus twenty degrees C. or less, to plus forty or fifty degrees C.; the humidity may vary from zero to one hundred per cent; the primary power supply may not be very constant in voltage, etc. All power sources are therefore voltage-regulated; all r.f. transmission lines are filled with nitrogen at low pressure (5-10 lbs./sq. in.); the crystals are provided with heaters; all frames plated and painted to prevent corrosion.

Photo in the color section, page 86, shows a portable form of localizer of the type used in fixed installations, but without monitor facilities. Although it is generally possible to predict the effect of such obstructions as buildings and trees, there are certain locations where the possibility of satisfactory operation appears doubtful. In such cases, the portable system permits an initial survey to determine the feasibility of a fixed installation and what precautions must be taken.

The aircraft receiving apparatus consists of a small marker receiver and a localizer receiver (see Fig. 12). The output of the former is fed into three filters (Fig. 12A), each of which controls a pilot light. Thus, if the modulation happens to be 400 cps., the corresponding filter functions to close the power circuit to its pilot light. By this means the pilot knows what marker is being received.

To receive the horizontally polarized localizer signal, either a horizontal loop or a horizontal receiving antenna is placed on the airplane above the fuselage. The latter is a pair of elements approximately ¼ wavelength long, grounded at the junction point. The line is tapped on either side of this junction to obtain an approximate match of impedances. As already mentioned, the satisfactory use of the localizer depends upon the AVC in the receiver being operative. Otherwise, the indications of the cross-pointer instrument will be misleading. In the extreme case of zero carrier signal, the instrument will indicate on-course for any position of the airplane. An AVC current meter is therefore mounted on the instrument board to advise the pilot when he can or cannot rely upon the indications of the cross-pointer instrument.

The AF output of the receiver is fed to the two filters (Fig. 12B) used for separating the 90 cps. and 150 cps. components, and the outputs of these are connected to the C.P. instrument so that the latter's deflection is proportional to the difference of the two outputs. Fig. 11 shows the characteristics of these filters.

More than 100 instrument landing systems are being installed throughout the country, which represents the emergence of UHF as a full-time aid to air navigation. Maintenance personnel must now be familiar with the techniques peculiar to the higher frequencies as well as those of the lower frequencies to which they have been accustomed (200 kc.—400 kc.).

-30-

Radio Ops for Bombers

(*Continued from page* 71)

The one unusual thing concerning this basic code instruction is that the student is taught right from the beginning the art of copying behind. After the student is able to copy about four words per minute, he is given memory tests in which the instructor begins by sending a two letter word. The student after hearing the word then picks up his pencil and writes it down. The tests advance to both three and four letter words and the student again writes them down after he has received the whole word. This is a comparatively simple but effective way of teaching to copy behind.

The basic radio mechanics course and basic course now being completed, the student is ready to advance into the practical operation and maintenance of the Air Forces radio equipment constituting the last 8 weeks of the course.

Advanced Course

The first two weeks of the advanced course in radio mechanics is utilized

to practical operation of the high powered liaison transmitter and receiver. Each classroom has several of the complete units mounted on benches. The class is divided into groups and each group familiarizes itself with one of these units. They are taught the tuning of the equipment, the placement of parts, the average meter readings, etc. The diagrams of the units are enlarged to mural size and stretch the length of the walls. Dummy antennas are provided for tuning purposes. Within the two weeks the student has time to completely acquaint himself with every terminal block and cable. He knows what to look for in case of failure and where the replacement parts and fuses are located.

The second two weeks of the advanced course, radio mechanics, are devoted to the multi-unit command set. The same manner of instruction as previously outlined is used, and the students acquaint themselves well with this unit.

The student now enters his 15th week and he is instructed in the operation and maintenance of the ultra high frequency command set. This also includes operation of the small beacon receiver used by the pilot in landing on airfields so equipped with marker beacon stations.

The 16th week includes the study of radio compass equipment. Many of the radio compass receivers are mounted on tall structures with a streamlined loop antenna on top. Although the operation of these instruments is simple since the loop automatically rotates to the signal tuned to, and no manual operation is necessary, the manner in which the units operate is thoroughly covered by the instructors. Small signal generators are placed in operation at different positions in the room and the manner in which the device "homes" on the signal is demonstrated.

The last two weeks of the course of instruction in radio mechanics consists of a complete review of all aircraft equipment. Since the student is familiar with the equipment, he continues to tune the various units until tuning operations become mechanical. He now knows where to look in case of any failure. He knows the number of feet to play out the high powered transmitting antenna for resonance on a certain wavelength. He also knows the peculiarities of every piece of equipment and its immediate remedies.

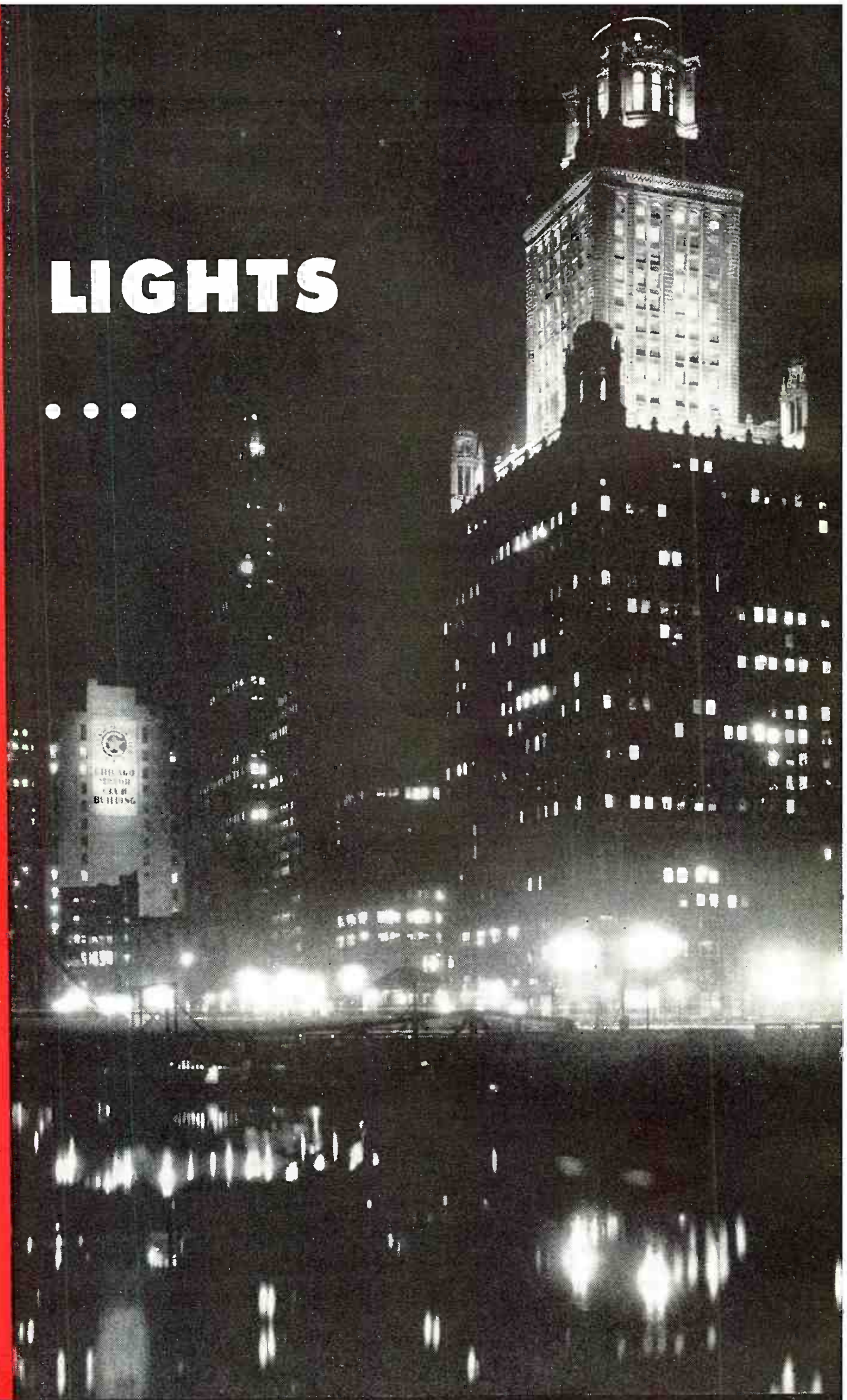
Operating Procedure

Besides the intensified study in radio mechanics during the last 8 weeks as just described, the student must spend the other half of his school day in radio operating procedure. Since he has mastered his basic code course, he is now ready for actual network practice and the art of copying code through background noise and interference.

At the higher speed code tables,

★

WHEN THE LIGHTS GO ON AGAIN . . .



★ To hasten the day when victory will once again restore the cherished blessings of peace . . . the entire resources of both great Admiral plants, including a competent designing and engineering staff, are devoted to a single purpose: the building of vital communication equipment for our Armed Forces.

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several commercial receivers are fed into the code lines producing a background noise level or interference if desired. The student must copy his code signals through atmospheric conditions which actually exist.

In teaching network procedure, several groups of students are enclosed in a booth with individual receivers and a telegraph key. They each represent an aircraft station, and each group has its instructor in the center with his receiver and key. The instructor also has a microphone by which he can issue verbal instructions. In another enclosed room several instructors sit at a large desk equipped with receivers and telegraph keys. Each one of these instructors has a small transmitter or signal generator on a certain frequency keyed by him. The students must tune their receivers to these various signal generators in the same manner in which they would tune the receivers in their aircraft to maintain communication with other stations.

After spending many hours on this type of instruction, the student enters his last and most important course in radio operating, consisting of operational net practice. Here the student is given the opportunity to put into actual practice the principals of radio communication he has absorbed in the preceding weeks.

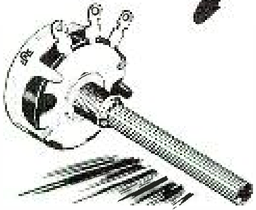
The classroom is a model airport, complete in all detail, with radio stations, control tower and "mock-up" aircraft, built to actual aircraft specifications. The mockup consists of a portion of a flying fortress in which the radio operator is located. It is actual size and includes all equipment placed exactly as it is in regular aircraft of this type. The students are assigned to these radio stations and aircraft, and under the guidance of the instructors, perform all the various duties that are required of a radio operator under actual conditions. This will include operation and adjustment of equipment, changing frequencies, maintaining a radio log, proper operating procedure in code, radio telephone and visual signaling and the responsibility of encoding and decoding messages.

In order that instruction will be uniform and discipline maintained, student work assignments are given as radio operating problems. These "problems" will give a word picture of a definite mission to be accomplished, with the various radio operating steps of the problem being executed by the student. These problems, in many instances, are written around the actual experiences of radio operators and thus a great degree of realism is injected into the practice.

The following is an example of a radio operational net "problem" and will show in detail some of the various duties performed during the operation of an aircraft mission.

Congratulations...

IRC CONTEST WINNERS!



In accordance with the considered opinion of the Judges, five gentlemen have been named winners in IRC's "Here's How" Volume Control Contest and each has been sent a $100 U. S. WAR BOND—in all, $500 in Bonds. Four winners are pictured . . . no photo available of the fifth, Mr. W. Pelham, New Harmony, Indiana.

E. PAT SHULTZ
10412 McCormick St.
North Hollywood, Calif.

JAMES G. RAPP
83 Raynor Street
Freeport, N. Y.

RAY PENTECOST
4314 Elston Avenue
Chicago, Illinois

CARL W. CONCELMAN
Riverview Drive
Brielle, New Jersey

and Thanks...Everybody!

Yes, "thanks a million" to you Radio Service Men of America for your response to IRC's "Here's How" Volume Control Contest! You really gave the judges a tough problem in trying to pick the five best ideas from among the hundreds received.

Fine Spirit Shown

While everyone can't be a winner, all of us can be proud of the enthusiastic way in which you cooperated for the good of the Industry. You not only came through in a manner that far exceeded even the most optimistic expectations but many of you wrote stating that whether you won or not, you hoped your experience would be helpful to someone else.

Many Original and Valuable Ideas

We asked for ideas and we got them! We asked you to tell how you were able to replace a volume control and get the radio set working satisfactorily—when you couldn't obtain the unit you would ordinarily have used.

From every section of the country suggestions poured in . . . emergency repair methods relating both to mechanical changes in the controls and to electrical changes in the circuits, which would do the trick when exact duplicates were not obtainable.

We plan to make the most practical ideas available to Radio Service Men throughout the Industry. Watch for further announcements.

ARMY E NAVY

PREFERRED FOR PERFORMANCE
IRC
FIXED & VARIABLE RESISTORS

INTERNATIONAL RESISTANCE COMPANY

Dept. O • 401 N. BROAD STREET • PHILADELPHIA, PA.

An army aircraft on routine submarine patrol discovers a surfaced submarine refueling from an enemy tanker. It is obvious that the submarine and the tanker should be attacked simultaneously, which would require the use of bomber aircraft and depth charges.

The duties of the patrol aircraft will be to immediately transmit a radio message describing the situation and requesting aid, and then maintain visual contact with the objective until the bombers arrive, reporting immediately any change in the situation. It will be the duties of the bomber aircraft to establish contact with the patrol aircraft and plan and execute the attack to the best possible advantage. All aircraft will keep bomber command headquarters informed by radio of developments.

Prior to the start of the operational problem the students will be assigned to their proper stations and will equip themselves with the necessary log sheets, message blanks and coding device.

The instructor will act as pilot of the aircraft, or as communication officer at the ground station of the bomber command.

Upon discovery of the submarine and surface tanker, the pilot of the patrol aircraft gives message in plain text to the radio operator for encoding and transmission to headquarters, bomber command. The message will state the situation, give position and request aid. (The radio operator will encode this information, draft it into message form, address it to the proper authorities and be responsible for its proper and efficient transmission.)

The radio operator in bomber aircraft "A" will start the equipment in his aircraft, call the control tower and ask for a radio check by voice.

Radio operator in bomber aircraft "B" will start up his equipment and call control tower and ask for a radio check. (voice)

Bomber "A" calls control tower and asks for "taxi" instructions.

Bomber "B" calls control tower and asks for taxi instructions, (Control tower will state which taxi strip to use, which runway for take-off and give a coded weather report.)

Bomber "A" calls control tower and asks for permission to take off.

Bomber "B" calls control tower and asks permission to take off.

After aircraft are airborne the radio operator will adjust his transmitter for radio telegraph operation.

Pilot in bomber "A" gives plain text message to radio operator to encode and transmit to the bomber command ground station and for the information of the patrol aircraft at the scene of the operations. This message will include present position of the bombers, their present air speed, and will indicate the probable time of arrival over objective.

Pilot of aircraft gives message to his radio operator stating that the

EVERY MINUTE *Counts!*

PRODUCTION LINES MUST NOT SLOW DOWN!

Lafayette Radio is strategically located to give you *quick* deliveries on radio and electronic parts and equipment. Millions of items have been shipped from Chicago, the shipping hub of the nation, to industrials, training schools and all branches of the armed services. Lafayette's procurement and expediting service has helped to prevent work stoppages on many vital war production lines.

Many instances are on record wherein Lafayette has made immediate delivery on hard-to-find key items, eliminating costly delays in giant armament programs. This is because Lafayette handles the products of every nationally known manufacturer in the radio and electronic field. A single order to Lafayette, no matter how large or how small, will bring prompt delivery of *all* your requirements.

Free — *130 page Catalog — "Radio and Electronic Parts and Equipment." Write 901 W. Jackson, Chicago, Ill. Dept. 6E3.*

LAFAYETTE RADIO CORP. CHICAGO

★ ★ ★ ★ ★ ★ ★

"Quick Delivery of Radio and Electronic Parts and Equipment"

submarine has completed refueling and is preparing to get underway. The radio operator will encode this message and address it to headquarters bomber command, and for the information of bomber "A" and "B."

Pilot in bomber "B" gives his radio operator a message stating that he has sighted the objective. This message will be encoded and transmitted to the patrol plane, and for the information of the Headquarters Bombing Command and for bomber "A."

Pilot of bomber "A" also sights objective and gives message to radio operator for encoding and transmission to the patrol plane and for the information of Headquarters, Bomber Command. This message will outline plan of attack and will instruct patrol plane to act as reconnaissance.

Patrol aircraft performing reconnaissance during the attack transmits a message to bomber "A" and "B" and for the information of Headquarters Bomber Command giving the results of the first attack.

Bomber "B" sends message to Headquarters Bomber Command stating that submarine has crash-dived and aircraft is preparing to make second attack with depth charges.

Bomber "A" sends message to Headquarters Bomber Command stating that he encountered heavy anti-aircraft fire from the surface vessel on first bombing run. No casualties aboard. Preparing for second bombing run.

Patrol plane sends message to Headquarters Bombing Command and for the information of bomber "B" that large oil slick appeared on water after first depth charge attack.

Bomber "A" sends message to Headquarters Bomber Command, stating than tanker set afire on second bombing run and crew abandoning ship.

Headquarters Bomber Command sends message to bomber "A" and "B" with instructions to return to base.

Headquarters Bomber Command sends message to Patrol plane to maintain reconnaissance until arrival of destroyer to pick up survivors of tanker.

Bomber "A" sends message to Headquarters, Bomber Command stating that both aircraft are returning to base.

Radio operators in both aircraft adjust transmitters for voice operation.

Bomber "A" calls tower and asks for "initial" approach.

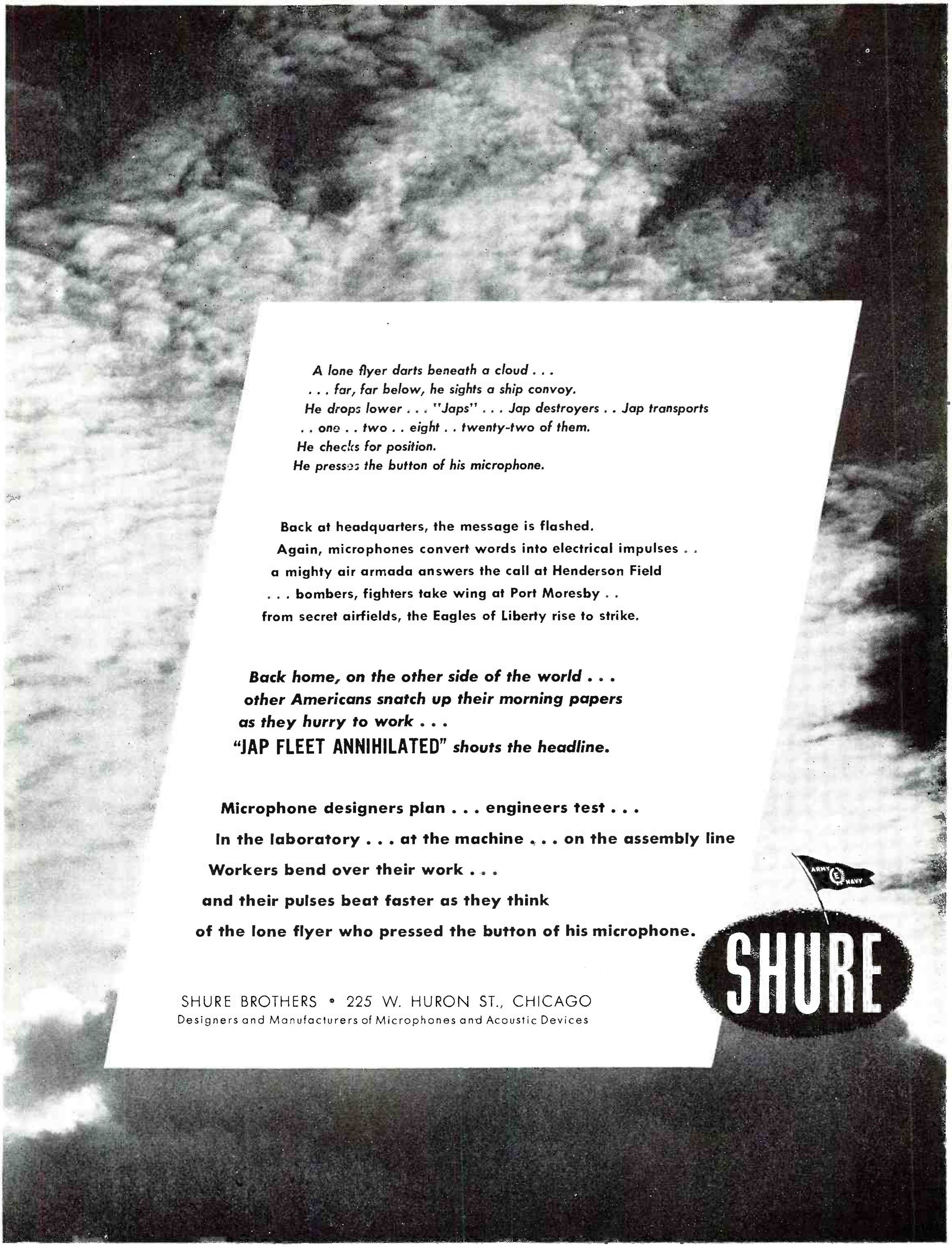
Bomber "B" calls tower and asks for "initial" approach.

Bomber "A" calls tower and asks for final approach.

Bomber "B" calls tower and asks for final approach.

When aircraft has landed control tower will give instructions for taxiing to hangar.

Operators in aircraft will secure their radio equipment and all students and instructors who partici-


A lone flyer darts beneath a cloud . . .
. . . far, far below, he sights a ship convoy.
He drops lower . . . "Japs" . . . Jap destroyers . . Jap transports
. . one . . two . . eight . . twenty-two of them.
He checks for position.
He presses the button of his microphone.
Back at headquarters, the message is flashed.
Again, microphones convert words into electrical impulses . .
a mighty air armada answers the call at Henderson Field
. . . bombers, fighters take wing at Port Moresby . .
from secret airfields, the Eagles of Liberty rise to strike.
Back home, on the other side of the world . . .
other Americans snatch up their morning papers
as they hurry to work . . .
"JAP FLEET ANNIHILATED" shouts the headline.
Microphone designers plan . . . engineers test . . .
In the laboratory . . . at the machine . . . on the assembly line
Workers bend over their work . . .
and their pulses beat faster as they think
of the lone flyer who pressed the button of his microphone.
ARMY E NAVY
SHURE
SHURE BROTHERS • 225 W. HURON ST., CHICAGO
Designers and Manufacturers of Microphones and Acoustic Devices

pated in the problem will gather for a "round robin" discussion of the mission just completed.

The actual experience received in the last few weeks of the course in this operational net practice plus the intensified course in radio mechanics previously received enables the student to be thoroughly familiar with the work he will be assigned to after graduating. Upon satisfactory completion of the course, the student is given his corporal stripes and assigned to active duty.

We feel that he is a very capable operator and will handle his job as efficiently as possible. We know that he will feel at home as he enters his first aircraft, and together with his knowledge of the equipment and its operation, we feel extremely confident that he will perform his duties to the best of his ability.

—30—

Aircraft Communication

(Continued from page 54)

Laboratory work was directed particularly toward producing a form of telephone transmitter or microphone which would be as insensitive as possible to these extraneous noises, and at the same time be selective to voice frequencies. To carry on this work under comparatively normal conditions a sound-proof room was constructed and a device provided which reproduced accurately the noises of the engine exhaust.

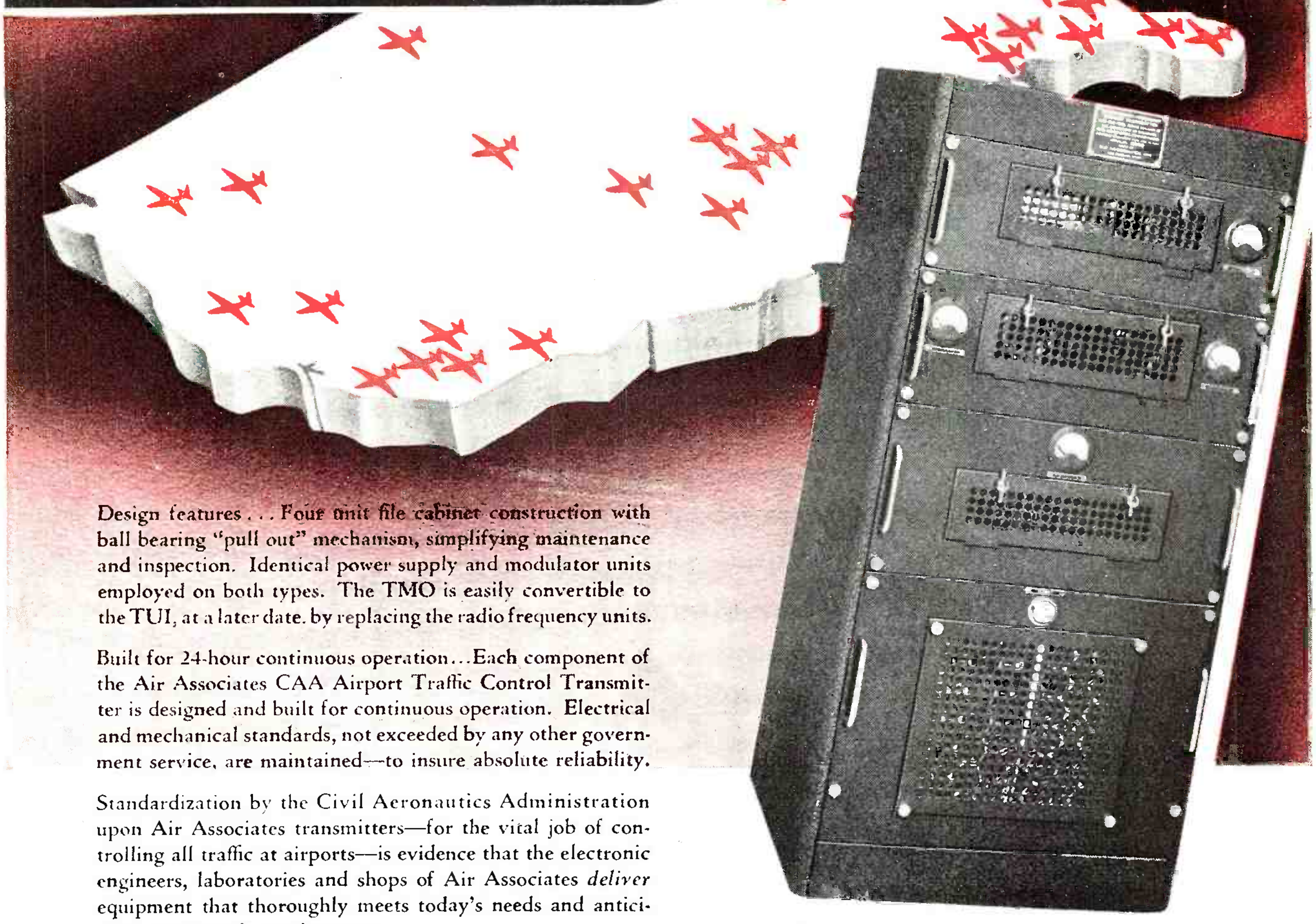
The utmost latitude consistent with military requirements was accorded industrial engineering concerns in the development of radio apparatus. The various parts of a set were often assigned for development to different companies specializing in a particular line of work involved.

In addition to the Bell system and the Western Electric Company, development work of the greatest value was done, among others, by the Westinghouse Electric and Manufacturing Company, the General Electric Company, International Radio Company, the General Radio Company, the De Forest Telephone & Telegraph Company, the National Electric Supply Company, and the Marconi Wireless Telegraph Company.

By the first of July, 1917, progress had been made to the point where tests in the field could be made. On July 2, of that year, a set comprising complete radio telephone transmitting equipment was taken into the air and speech of good volume and quality was received on the ground with the transmitting plane two miles away.

The development of a suitable receiving head set was carried on simultaneously and it was found possible to devise a leather helmet with the receiving elements so disposed and screened from external noises that the weak radio signals could be readily heard. On July 4, an experimental receiving set was taken into the air and

Airport Traffic at *all* CAA airports controlled by *Air Associates'* low and ultra high frequency transmitters



Design features . . . Four unit file cabinet construction with ball bearing "pull out" mechanism, simplifying maintenance and inspection. Identical power supply and modulator units employed on both types. The TMO is easily convertible to the TUI, at a later date, by replacing the radio frequency units.

Built for 24-hour continuous operation . . . Each component of the Air Associates CAA Airport Traffic Control Transmitter is designed and built for continuous operation. Electrical and mechanical standards, not exceeded by any other government service, are maintained—to insure absolute reliability.

Standardization by the Civil Aeronautics Administration upon Air Associates transmitters—for the vital job of controlling all traffic at airports—is evidence that the electronic engineers, laboratories and shops of Air Associates *deliver* equipment that thoroughly meets today's needs and anticipates tomorrow's requirements.

In addition to these transmitters, Air Associates' Radio Division also manufactures a complete line of receivers and transmitters for light planes and transports, police motorcycle receivers and receiver-transmitters, interphones, and complete ground stations—also accessory equipment such as automatic antenna systems, selector boxes, loading coils and relays, headphones and microphones.

★ Developed expressly for the Civil Aeronautics Administration . . . Built to their rigid specification CAA-509, Air Associates has produced the Type TMO low frequency, and the Type TUI, ultra high frequency airport transmitters, which *fully meet* the requirements of extreme temperature and humidity conditions specified. The original order of over 300 units has been increased by more than 60%.

★ Type TMO low frequency transmitter . . . A 50-watt, 200-400 kc, voice and tone modulated equipment which operates into practically any antenna suitable for Airport installation.

★ Type TUI Ultra high frequency transmitter . . . A 50-watt, 126-132 MC voice and tone modulated equipment, for operation into a 70 ohm transmission line.

AIR ASSOCIATES INC.

AIR ASSOCIATES, INC.

LOS ANGELES, CALIFORNIA

FACTORIES: LOS ANGELES • DALLAS • CHICAGO • BENDIX, N.J.

the operator successfully received speech from the ground at a distance of several miles.

With the information resulting from these tests, the development of a practical airplane set began at once. The problem now was to produce sets of minimum size and weight with physical structures which would withstand the extreme vibrations and jars encountered in flying, especially in landing. Other problems were the most convenient disposition of control elements, suitable sources of power for both high and low voltage, and a form of antenna which would not interfere with the evolutions of a flying plane in formation. The design of the sets was founded on using a trailing wire ant.

Field tests proceeded speedily and on August 20, 1917, the first two-way telephone conversation between two planes in the air was successfully accomplished. At that time two general schemes of control were considered—manual means for transferring from the transmitting to the receiving position, and automatic means for accomplishing the same result through the operation of a remote control relay.

It was concluded, because of its simpler construction, to employ the manual means of control, the idea being to locate the set in the observer's position in the plane.

On August 22, 1917, an informal demonstration of talk from airplane to ground was given for Secretary of War Newton D. Baker, and several army officers at Langley Field. The experiments conclusively demonstrated the practicability of the system and apparatus.

To digress a moment to the subject of vacuum tubes, while the vacuum tubes that had been developed in 1915 and 1916, and earlier, were satisfactory in operation under normal conditions, it was found that the mechanical vibration encountered in the air was such as to necessitate special structures to withstand them. New forms of vacuum tubes which successfully met these requirements were developed.

The tubes used in this work were of the so-called "Wehnelt Cathode" type—that is, the electron-emitting cathode consisting of a metal filament (usually platinum) was coated with a mixture of oxides which, when heated to a moderate temperature, augmented the stream of electrons normally emitted by the bare wire.

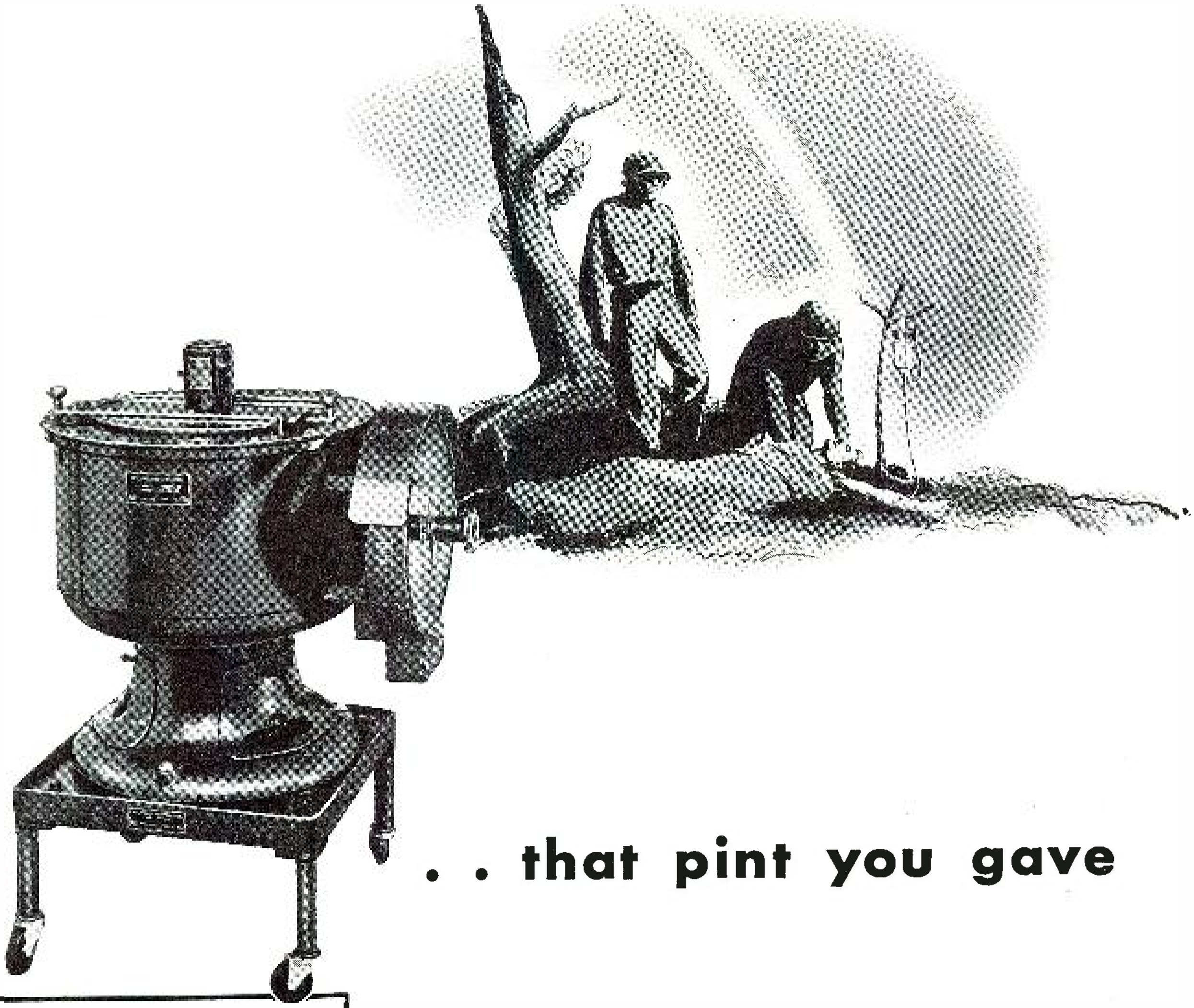
It was found that for transmitting and receiving purposes, two types of tubes could be standardized on. The tube for receiving purposes was designated as the VT 1 by the Signal Corps, and as the CW 933 by the Navy. A transmitting tube capable of delivering a moderate amount of power—from 3 to 5 watts high-frequency output—was known as the VT 2 by the Signal Corps, and as the CW 931 by the Navy.

By October 6, 1917, progress had reached the point where extensive demonstrations were undertaken. On that date, at Langley Field, tests were made in the presence of several Army officials. The sets operated very successfully and official demonstrations of a two-way communication set were presented. This set was made up of a combined control panel and receiver with two stages of amplification and a separate transmitting set, the electrical inter-connections being made by flexible cords.

By means of a multi-contact manually operated switch located on the control panel, the operator could receive or transmit as desired. The receiver consisted of a single tuned circuit of the very simplest type, with the amplifier adjustable at the convenience of the observer.

While the original requirement was that communication should be maintained at a minimum distance of 2,000 yards, all tests indicated that successful communication could be obtained at much greater distances. On October 16, 1917, again at Langley Field, an official distance test resulted in communication between planes being maintained at a distance of 23 miles, and from plane to ground, 45 miles. The conditions under which these tests were made were extremely favorable. The success of these tests finally established a representative service standard of transmission of *three miles* from set to set!

A number of these sets were immediately constructed and complete



. . that pint you gave

RHEOSTATS

Rheostats of the type shown on the International Blood Plasma Centrifuge are available in a wide range of sizes for multi- and single-mounting, for manual and motor driven operation. Ward Leonard also manufactures laboratory rheostats with and without micro drive and ring type rheostats. Send for bulletins describing Ward Leonard Rheostats of interest to you.

It may be that many months will pass before the blood you so generously gave will save a life . . . the place may be thousands of miles away.

The preparation of plasma from donor's blood is a meticulous process in which a special type centrifuge plays an important part. Centrifugal force developed at enormous speed, with smooth acceleration, packs down the red cells and increases the yield of blood plasma. This calls for sturdy equipment, built for continuous duty; for when blood is coming in, the centrifuges are working day and night.

The Ward Leonard pressed steel rheostat was selected as the motor controller because of its absolute dependability and its large number of accurate steps. An electric interlock designed by Ward Leonard assures a slow start irrespective of when the switch is closed. The centrifuge will not operate until the rheostat is in minimum speed position.

WARD LEONARD

RELAYS • RESISTORS • RHEOSTATS

Electric control (WL) devices since 1892.

WARD LEONARD ELECTRIC COMPANY, 47 SOUTH STREET, MOUNT VERNON, NEW YORK equipment, in charge of Colonel Culver and other Signal Corps officers, was sent overseas for the criticism of our military forces. Subsequently, in January, 1918, a cable was received from high officials of the American Expeditionary Forces in France, declaring that American radio telephone apparatus was found to be superior to all others, and that with minor modifications would be used on all airplanes except those used for fire control and photographic purposes.

Several more demonstrations of similar apparatus were made, culminating in the official trials at Dayton, Ohio, on December 2, 1917, at which were present members of the Aircraft Production Board, members of the joint Army and Navy Technical Board, and various officers of the Signal Corps.

Here the demonstrations consisted of three-cornered conversations between two planes in the air and a ground station. At the ground station a loud-speaker was connected to a receiving set so that the entire party of about thirty could overhear the conversation between the fliers, and also the talk between the planes and the ground.

It is interesting to record here the skepticism with which the proposed demonstration was looked upon by some of the high officials of the Army and Navy at that time. Mr. Edward B. Craft, later Major, an engineer of the Western Electric Company, who was associated with the experimental work, enthusiastically describes the events of that historic day in an article as follows:

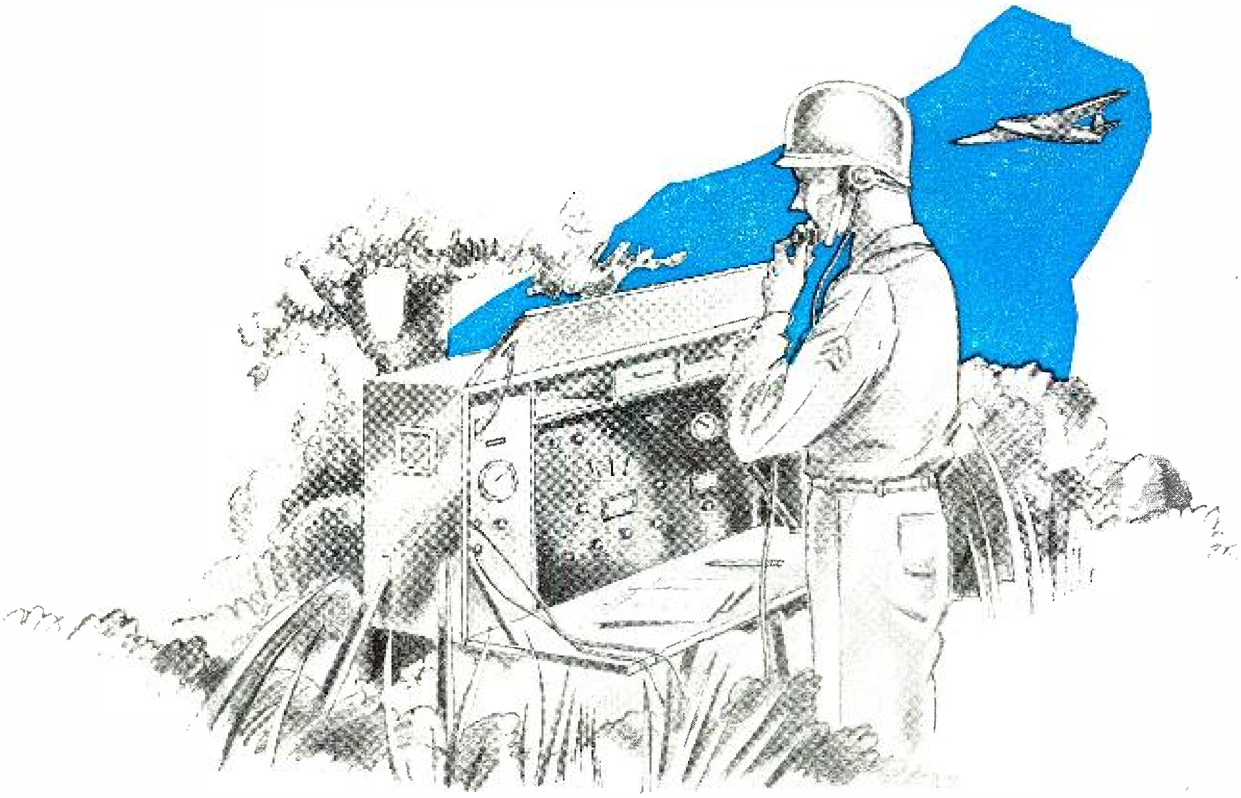
"It must be remembered that the idea had not yet been told to any but the wild enthusiasts who had been living with the job for the past six months. Pilots are, to say the least, fussy about what is loaded into the planes they are to fly, to say nothing of the trailing wires which serve as antennas. Designers and constructors hold much the same view, so it took a lot of maneuvering and diplomatic jockeying to get our stuff aboard."

After narrating at some length concerning the preparations made on the eve of the tests, Mr. Craft described the assembling, the following morning, of the officials, who "had to be shown," in a little station on a hill, where they viewed the apparatus in the planes and were given an explanation of what it was expected to do.

"The planes left the ground," he continued, "and after what seemed an interminable length of time we got the first sounds in the receiver, which indicated that they were ready to perform. The spectators were only mildly interested—some even seemed a bit bored.

"Suddenly out of the horn of the loud speaker came the words, 'Hello, ground station. This is Plane No. 1 speaking. Do you get me all right?' The bored expression immediately faded and looks of amazement came over all their faces.

"Soon we got the same signal from



THE BETTER INSULATION FOR BETTER RADIOS!

THE wartime radios that are now coming through are much better than any similar instruments that have ever been mass-produced. These better devices require better insulation—and wartime developments have enabled Formica to provide it. The new MF grades—glass mat base—are so good that they will do most of the things it was once thought necessary to use ceramics for. Yet they may be machined and worked with ordinary tools providing an adaptability that is impossible in molded forms.

For the television radar and radio development after the war these new materials—born of new synthetic varnishes and new fibre bases—will be available for the big commercial development which is sure to follow.

FORMICA

THE FORMICA INSULATION COMPANY, 4638 SPRING GROVE AVE., CINCINNATI, OHIO

No. 2 and the show was on. Under command from the ground the planes manuevered all over that part of the country. They were sent on scouting expeditions, and reported what they saw as they traveled through the air. Continuous conversation was carried on, even when the planes were out of sight, and finally upon command they came flying back out of space and landed as directed."

The skeptical listeners then became enthusiastic in their comments, said Mr. Craft, concluding "from that moment the radio telephone was sold."

The maximum distance of the planes from the ground station was about eight miles, at which distance they were invisible. These tests so conclusively demonstrated the possibilities of the successful use of this apparatus that quantity orders were immediately placed by the Signal Corps.

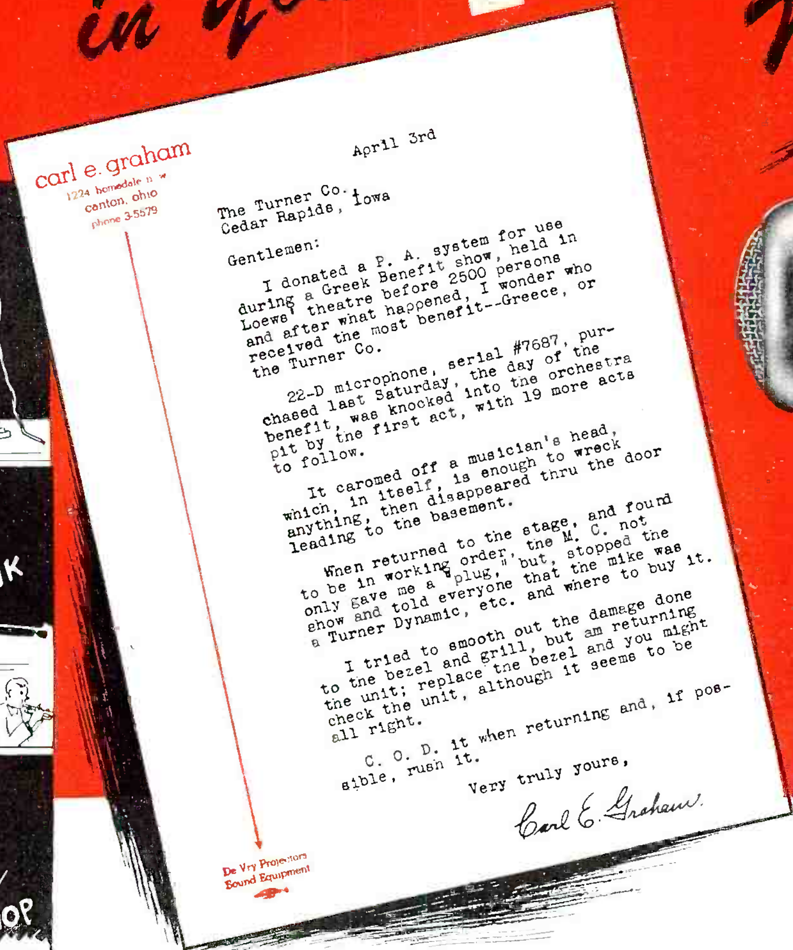
With the time element very short and the necessity of adapting the designs from commercial types to quantity manufacture, the problems were many and intricate. The apparatus represented not what would have been designed and built under normal conditions with ample time available for proper study of all the technical features involved, but the best compromise, bringing in such factors as use of as many standard parts as feasible, available manufacturing facilities, and finally, the imperative need of haste. Information from abroad appeared at times conflicting and inadequate so that the Signal Corps officers in Washington were often required to render decisions on important points under exceedingly difficult circumstances.

The final standardized form of the two-way airplane set, as adopted, was known by the Signal Corps as the SCR-68 set. The elements were so arranged that they could be mounted in any available space in various parts of the machine. The location of the main set, however, necessitated its being accessible to the operator. A switch box was provided for facilitating communication between pilot and observer by means of the same helmets and microphones as were used for radio communication.

The transmitter and receiver of this set were approximately 17 by 10 by 7 inches in dimensions, and weighed 21 pounds. The weight of the complete equipment including generator and two operators' sets was approximately 58 pounds. When a receiver only was installed power was supplied to the filaments by a small storage battery.

Modifications of the SCR-68 sets were quickly adapted to different classes of service and were manufactured in some quantity, one of the principal adaptations being a combination transmitting and receiving set for use on the ground. This set was employed principally for training purposes. With this means of communication at hand, the performance of the student could be observed in the air and his faults corrected by the instructor on the ground. Energy for this adaptation

Keep that Fight in Your TURNER Mike



carl e. graham
1224 homedale n. w.
canton, ohio
phone 3-5579

April 3rd

The Turner Co.,
Cedar Rapids, Iowa

Gentlemen:

I donated a P. A. system for use during a Greek Benefit show, held in Loewe' theatre before 2500 persons and after what happened, I wonder who received the most benefit--Greece, or the Turner Co.

22-D microphone, serial #7687, purchased last Saturday, the day of the benefit, was knocked into the orchestra pit by the first act, with 19 more acts to follow.

It caromed off a musician's head, which, in itself, is enough to wreck anything, then disappeared thru the door leading to the basement.

When returned to the stage, and found to be in working order, the M. C. not only gave me a "plug," but, stopped the show and told everyone that the mike was a Turner Dynamic, etc. and where to buy it.

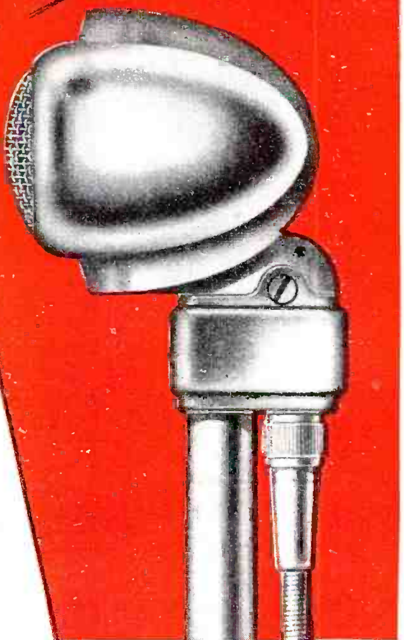
I tried to smooth out the damage done to the bezel and grill, but am returning the unit; replace the bezel and you might check the unit, although it seems to be all right.

C. O. D. it when returning and, if possible, rush it.

Very truly yours,

Carl E. Graham

De Vry Projectors
Sound Equipment



TURNER
Model **22-D**

Turn to Turner---for a Mike with "Built-In" Fight

Whatever your need for a Microphone, you can be sure of complete satisfaction under any acoustic or climatic condition when you specify Turner. Thousands of satisfied users can vouch for the rugged construction, the accurate response and superb performance of Turner Microphones under the toughest usage.

Today's Turner Microphones are being used for vital war communications, in War Plants, Airdromes, Ordnance Plants, Docks, Army Camps, Broadcasting Studios, Police Transmitters and other highly sensitive spots where accuracy is essential. IF YOU HAVE A HIGH PRIORITY RATING, you can still buy Turner Microphones. Write today, explaining your problem, and we will help you select the Turner unit best suited to your needs.

The Turner Company
CEDAR RAPIDS, IOWA

GET THIS *free* TURNER CATALOG

. . . Write now to obtain your Free copy of Turner's new 8-page, fully illustrated, colorful Microphone Catalog. Select the one you need, at the price you want to pay.

Turner Crystal Microphones licensed under patents of the Brush Development Co.

was provided by storage batteries, a dynamotor being operated by the storage battery to supply the plate potential.

The pioneering spirit exemplified in these early and seemingly crude efforts of the radio technicians constitute a fitting chapter paralleling the coincidental progress of the airplane which was to become the flying laboratory of communications leading to the elaborate and amazing developments of later years.

—30—

Air Force Radio
(*Continued from page* 59)

cated ground direction finding stations.

The year 1927 marked the beginning of awakened public interest in the possibilities of air transportation. Lindbergh's spectacular non-stop flight to Paris was the spark that touched it off. A few leaders in the infant air transportation industry realized the importance of aircraft radio, and embarked with Bell Telephone Laboratories on a program of research in what radio could do to make flying safe. 1927 was also the year that the newly organized Aeronautics Branch of the Department of Commerce (which in 1938 became the Civil Aeronautics Authority) took over from the Post Office Department the airways of the country. At this time the total comprised some 2,700 miles, with 17 radio communications stations.

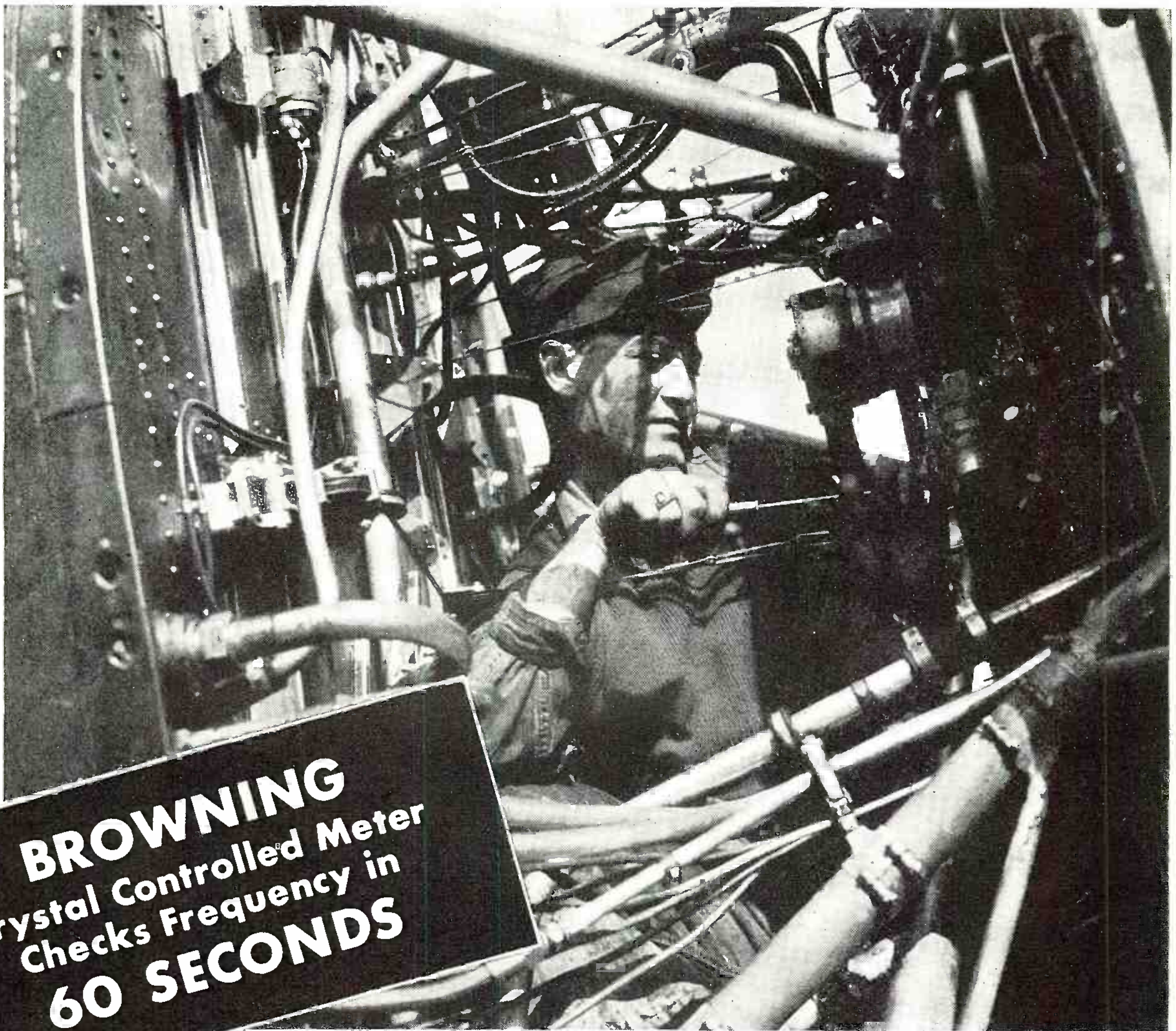
The following year brought a radically new development, based on a new theory of radio navigation of aircraft—the radio range system. A series of radio beacons, each marking out four ranges by automatically transmitted Morse code signals, were to stretch along the nation's airways tracing invisible, but very real, lanes in the sky. One signal was the letter A (-—) and the other was N (—-), and when a plane was flying "on the beam" only the dash (—) would sound as a continuous buzz.

The Army Air Corps (as it was then called) not only cooperated enthusiastically with these developments, seeing their immense significance for military aviation, but in two laboratory units at Wright Field, Dayton (transferred there from McCook) were leading the way in important new developments which eventually brought great benefits to commercial aviation. These units were the Air Navigation Unit and the Communications Unit.

The Air Navigation Unit conducted research in such radio navigation aids as radio compasses, radio altimeters, ground radio range stations and instrument landing developments.

The Communications Unit was concerned with improved radio receivers, transmitters and antennas for airplanes and airport stations.

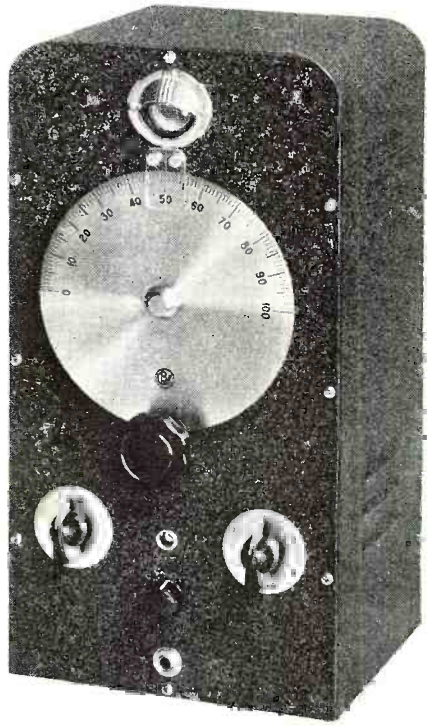
On September 24, 1929, when stock



BROWNING
Crystal Controlled Meter
Checks Frequency in
60 SECONDS

. . . and does it with precision

Speedy and accurate frequency checks are achieved with the Browning Frequency Meter—whether for the transmitter going into this fighter plane, or for other mobile units. Suitable for both FM and AM transmitters, the Browning Frequency Meter comes with one, two, three or four bands, from 1.5 to 120 mc. Write or wire for full data on this capable, compact instrument.



BROWNING
LABORATORIES
INCORPORATED . . . WINCHESTER, MASS.

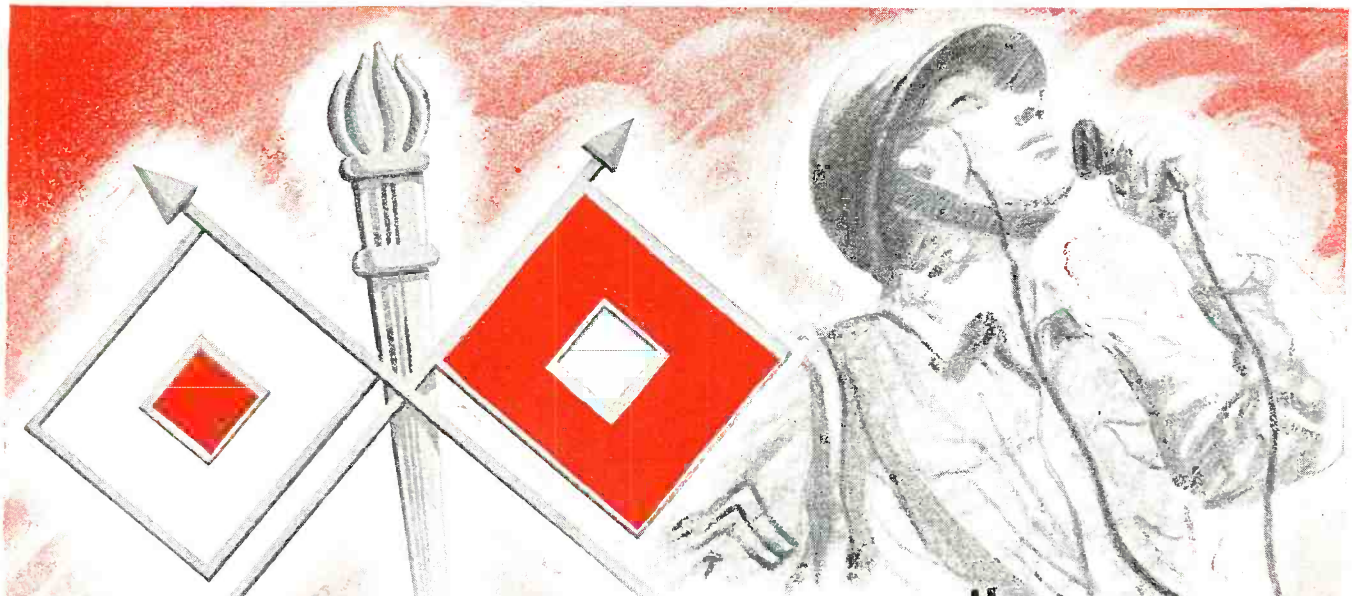
values were in a tail-spin, there was one thing that failed to crash. Lieut. James H. Doolittle (now a major general commanding the 12th Air Force and all bombing operations in North Africa) gave a public demonstration of instrument flying in which he accomplished a take-off and a landing by instruments alone, in a hooded cockpit at Mitchel Field, Long Island.

About two and a half years later, May 9, 1932, Capt. Albert F. Hegenberger accomplished the first blind flight, using instruments exclusively.

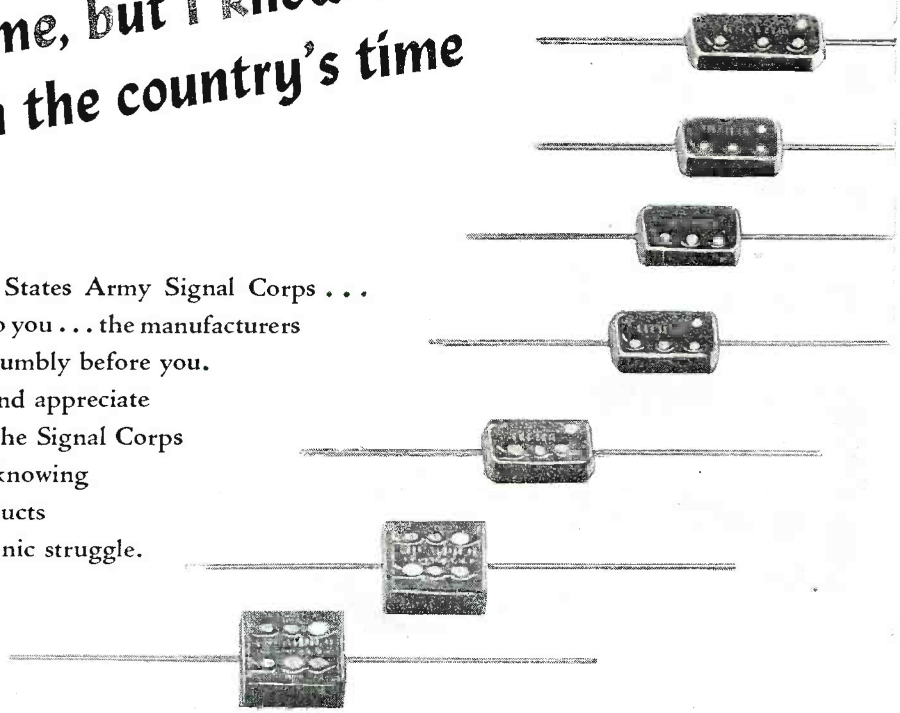
In 1935 a most important step was taken in connection with Army aviation. The GHQ Air Force was organized, embracing all tactical Air Corps units within the continental United States; this was to be the fighting outfit. The Air Corps as such continued its function of training personnel and developing and procuring aviation equipment. On August 29, 1935, the radio compass proved its merit when Air Corps engineers made the first flight wherein radio navigation by automatic pilot was accomplished. The GHQ Air Force leaders, including General Arnold, Andrews, Emmons, Kenney and Olds, held strongly to the conception of the heavy long-range bomber as the keystone of air power. This means navigation, to reach that enemy fleet steaming in our direction, or to get right over that vital industrial target 400 miles away and back again, both in any kind of weather or no weather at all.

One of the best rabbits out of the Wright Field hat to date received a dramatic demonstration on August 23, 1937. Two Wright Field officers and a civilian engineer made a completely automatic landing, without touching the controls. The pilot simply put the ship into proper position and altitude at a specified distance from the field, closed the master switch, and kept his fingers crossed. The entire process was carried on by a series of relays, actuated by impulses from the four radio marker beacons spaced at intervals across the landing area. At a specified interval after the plane passed over the last beacon, the wheels touched the runway and the brakes were automatically applied to the wheels. Five years later a Pan-American captain said to the writer, "Flying isn't fun any more. You just push a button or two and the instruments do the rest." This slightly bored reaction of an old-timer may be an oversimplification as well as an exaggeration, but it is well on its way toward the truth at that.

As part of the Air Corps expansion program begun in April 1939 to provide 5,500 planes, with additional flying and ground personnel and air bases, the Air Corps technical training program was stepped up considerably. Our air leaders realized the global character of the coming war and made provision on their planning for a large number of aerial navigators and radio operators and mechanics. In April,



With miles of wire, through acres of hell
Glued to my phones, ducking shot and shell
I wish I were home, but I know damned well
I can't dream on the country's time



To the Men of the United States Army Signal Corps . . . and to those who are so dear to you . . . the manufacturers of *Micamold Products* stand humbly before you. We gratefully acknowledge and appreciate the brilliant performance of the Signal Corps . . . and take fierce pride in knowing that you have chosen our products to accompany you in this titanic struggle.

There is only one MICAMOLD *. . . but there's a* MICAMOLD CAPACITOR *for all communications and electronic applications.*

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Receiving and Transmitting Mica Capacitors ★ Molded Paper Capacitors ★ Oil Impregnated Capacitors Dry Electrolytic Capacitors ★ Molded Wire Wound Resistors

1940, a school to train weather observers was transferred from Scott Field, Illinois, to Chanute Field, and Scott Field became the center of a large program to train radio operators and mechanics. In April, 1941, a plan was announced to train 100,000 technicians per year, which raised the sights again at Scott Field. After Pearl Harbor the sky was the limit, and as part of a tremendously expanded program of the Air Force Technical Training Command, one of Chicago's largest hotels was taken over and thousands of enlisted men are receiving their preliminary training in aircraft radio there. They then proceed to Scott Field, Madison, or Sioux Falls for their advanced work.

The radio operator has an important job in modern air warfare. He keeps in contact with the home base and receives orders, instructions and weather data. In actual combat, when radio apparatus must be silenced to prevent giving information to the enemy, the radio operator has other duties to perform. As part of his training he takes a short course in aerial gunnery, and when Jap or Nazi fighter planes attack he has his own gun to man or he may be called on to pinch hit for some other gunner who has become a casualty.

The 18 weeks course is divided into two parts, the Radio Operating division and the Radio Mechanics division. During the Operators course "Radio Joe" must attain a minimum of 16 words a minute, receiving and sending the International Morse code. After he had mastered 12 words a minute, he is taught operational procedure, including methods of establishing communications, message handling, the use of various signals used by the United Nations, direction finding procedure, radio bearings, position fixes, and blind letdown procedure. In the Radio Mechanics course the candidate's time is about evenly divided between classroom and laboratory work on actual equipment, including parts from old radios. First he is taught the fundamentals of direct current, alternating current, radio frequency current, and how they apply to equipment used in the service. Then he learns about radio transmitters, operation of aircraft radio equipment and fundamentals of receivers, including time with actual service equipment. He also studies circuit analysis and theory, radio telephone technique and instrument maintenance.

Without aircraft radio the Bismark would still be loose on the high seas, General Kenney would not have had the necessary tip to prepare the full-scale air plastering which won the decisive air-power-over-sea-power victory of the Bismark Sea. Without aircraft radio the split-second ground-air cooperation which helped drive the Afrika Korps from Egypt and Libya would not have been possible. Without radio the strongest Air Force would be grounded.

—30—

We're... "ALL WORK TO WIN THE WAR!"
ENLISTED BEFORE PEARL HARBOR ... EVERY DIVISION IN THE "GUTHMAN ARMY"
Edwin I. Guthman & Co. and our affiliated Lincoln Machine and Tool Corporation were converted to 100% war production prior to Pearl Harbor: Tool & Die Division ... Machine Division (Production Milling Machines, Lathes, etc.) ... Punch Press Division (Presses up to 150 tons) ... Automatic Screw Machine Division (00G - 2G B. & S. Machines) ... Zinc Shield Can Fabrication (in affiliation with Hegeler Zinc Co.) ... RF, IF and Choke Coil Division ... Condenser Division (Special Molded Paper and Mica, and Trimmer Condensers) ... Wire Insulation Division (Litzendraht and Textile Covered Magnet Wire) ... Electro-Plating and Finishing Division (with completely
Conveyors and Barrels) ... General Assembly Division of Complete Units incorporating the above items such as complete RF Tuning Assemblies, Intercommunication Units, etc.
IN THIS BOMBER IS MORE THAN ONE VITAL GUTHMAN PRODUCT
We can not tell what these important units are, but we are working hard so that these products can keep up essential communications. The pride of being selected for such war time tasks is reflected in the skilled efforts of our 700 employees. Guthman-made radio units are being supplied for tank, plane, and command car transmitters and receivers, and other army and navy signal corps equipment. Housed in our 60,000 square foot building is one of the most modern radio, electrical and chemical labratories. Our plant is 100% concrete and brick, completely sprinkler-equipped.
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PRECISION MANUFACTURERS AND ENGINEERS OF RADIO AND ELECTRICAL EQUIPMENT

Int. Airways Radio
(*Continued from page* 130)

were compressed under the usual 10-kilocycle bands still standard for broadcasting, and adjacent channel interference was proportionately reduced without impairing speech intelligibility.

Civil aviation has necessarily made the best possible use of the relatively few radio channels it has been able to acquire at international conference tables. The first such conference was held in 1919 for the purpose of standardizing and coordinating aeronautical radio communications, customs regulations, and similar problems connected with air travel. Out of this meeting, conducted under the aegis of the League of Nations, came the International Committee for Air Navigation, known as the C. I. N. A. It dealt largely with European problems for two reasons—first, such problems were the most urgent and, second, the U. S. was not a member of the League of Nations and therefore not represented.

The first serious attempt to straighten out aeronautical problems in the western hemisphere was made at the Lima Pan-American Conference in 1937, at which time a permanent aviation committee known as the C. A. P. A. was established. The recommendations made at this conference were studied at the Havana communications conference later in the same year, but up to the outbreak of war little progress had been made in coordinating aeronautical communications between the two Americas.

At the last International Telecommunication Conference at Cairo in 1938, the United States and Great Britain took the lead in a determined effort to obtain world-wide recognition of the urgent need for radio channels exclusively reserved for intercontinental aeronautical communications. At this time aircraft were still compelled to share mobile service frequency bands with surface vessels and powerful coastal stations of the maritime service. The relatively low-power radio transmitters aboard aircraft were at a great disadvantage and suffered destructive interference. Aeronautical frequency assignments between continents were still uncoordinated. Frequencies used for aviation in one part of the world were often employed for some quite different service elsewhere. No one frequency channel could therefore be depended upon for communication throughout the length of any international route.

At the Cairo conference an aviation committee was organized to work on the difficult and detailed problem of selecting frequencies which might be cleared for coordinated use on a global basis. After prolonged negotiations, which were in part at least successful, agreements were reached on what have come to be referred to as the Cairo Intercontinental Route Frequencies. Frequencies were allotted for seven intercontinental routes—(1) Europe-North America, (2) Europe-South America, (3) Europe-Africa, (4) Europe-Asia-Australia, (5) Inter-American, (6) Trans-Pacific, and (7) Transpolar. Each route was assigned three channels each in the following frequencies—(1) 6 Mc., (2) 8 Mc., (3) 11-12 Mc., (4) 17 Mc., and (5) 23 Mc.

Another world conference was held at Paris early in 1939 to consider plans for use of the frequencies allocated at Cairo. A sub-committee of this conference met at Cracow, Poland, a few months later to draft a detailed plan for intercontinental aeronautical communications to be submitted to the next world conference scheduled to be held at Berlin in December, 1939. This conference was never held, of course, but the plans made at Cracow have been put into operation so far as world conditions permit and are playing an important part in solving the difficult communication problems involved in our overseas flight operations.

They constitute a nucleus around which an integrated world-wide system of aeronautical communication circuits can be built. This will require expansion of these radio communications circuits to provide the meteorological information, flight control, and operational communications to meet the needs of the great fleets of aircraft which nations of the world will have in the air after the war.

—30—

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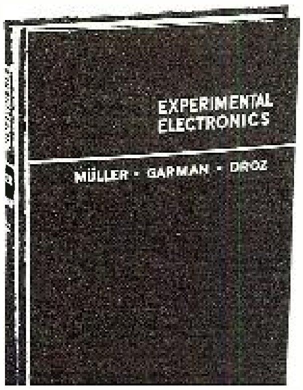

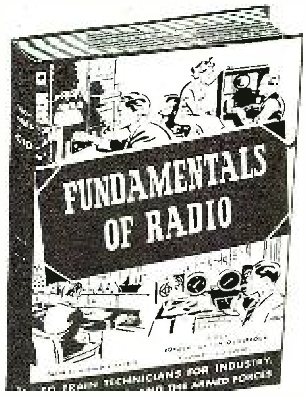

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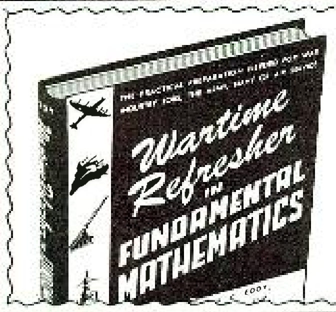

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NAME..

ADDRESS..

CITY & STATE..

AAFTTC Radio Ops
(*Continued from page 63*)

At the end of eight weeks a soldier is supposed to be able to send and receive at least 10 WPM. At the 16-week mark 16 WPM are required.

The first actual sending is done by hand-key method. The code characters are grouped in easily remembered groups which are taken up in order of importance, thus preventing confusion between them.

As the student develops his code receiving and sending ability in the classrooms, he works into lamp signalling. After being shown how blinker systems work in the field, he participates in actual demonstrations. Teams of four men are formed, a sender, recorder, coder and messenger. Each team takes up a post outside at the corner of classroom and by means of flashing lights handles IMC messages. This system of communication will later prove invaluable where it is necessary to send messages and use of radio would betray location of the sending station to the enemy.

While code is poured into ears of the students throughout their course, they eventually progress to the point where instruction is given in Radio Operating Procedure, including proper uses of abbreviations, methods of handling messages, methods of identifying sending and receiving stations and proper methods of calling and answering calls.

When a man is ready to apply all of the instruction received previously, he is introduced to Wire Nets—desks wired with receivers and transmitters on which class problems in radio operating procedure are carried out.

With headphones and key, connected by wire networks to those of other students, the soldier listens in as broadcasts from three different radio stations are simulated in the classroom. General communications of weather and orders are carried on between these units and abbreviations previously learned are put to use. Instructors monitor every net to help correct errors.

As instruction in Radio Nets begins, the new operator "goes on the air" for the first time. The system used is similar to that in wire nets except that in this phase the soldier actually uses a small sending set and receiver.

In other words he's a sending and receiving station in himself. He may be given the name of a large city or an aircraft. Regular "traffic" schedules are handled.

With the fundamental knowledge gained in Radio Mechanics and Radio Operation courses, the soldier is eager to tackle the full powered radio transmitter and receiver of a bomber.

So he meets Mock-Ups and Flight Nets.

Radio mock-ups are plywood replicas of the radioman's section of a

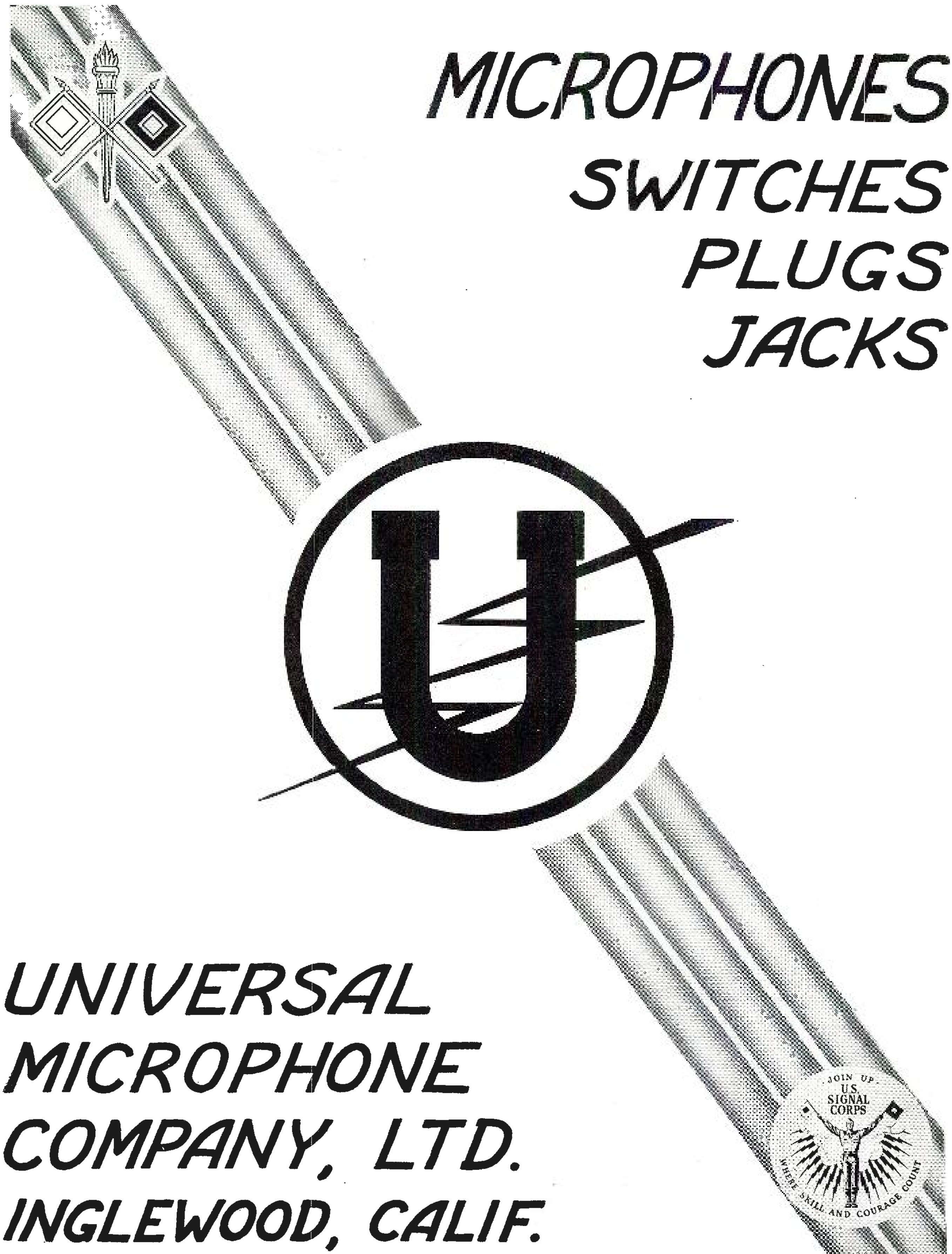
MICROPHONES
SWITCHES
PLUGS
JACKS
JOIN UP
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PHOTO BY U. S. ARMY SIGNAL CORPS

LOOK FOR THE ANTENNA

Radio equipment has become the symbol of the modern instrument of war. The fast action, quick decisions and perfect coordination of today's war of movement demands perfect communications, and radio provides communication "on the move." We are proud of the part that National Radio Equipment is playing.

NC

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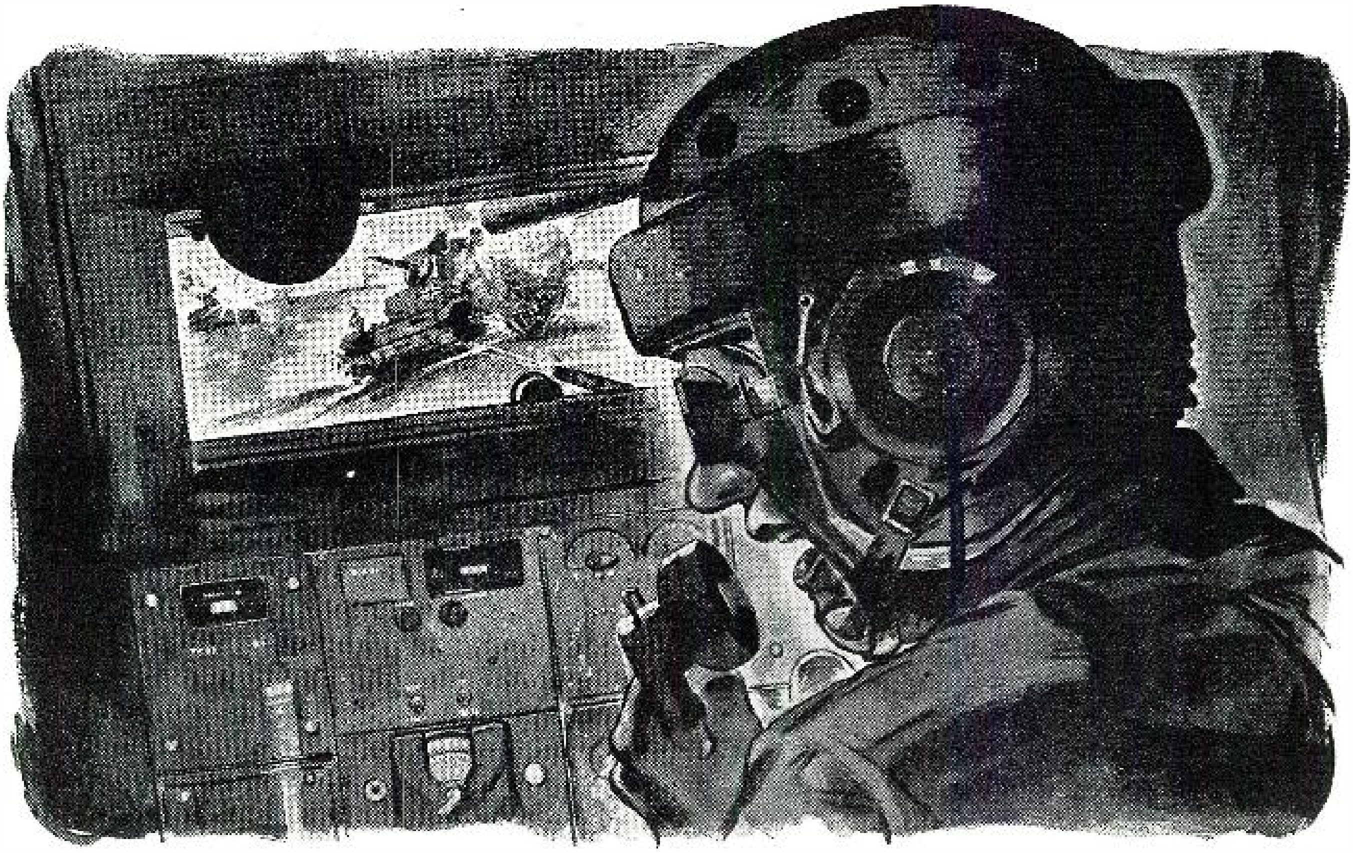
WAR... WIRED FOR SOUND



AMERICA'S fighting men roar through the frigid silences of the sub-stratosphere in 400-mile-an-hour planes, they cut through the surface of the sea in ships, and rumble over the ground in monstrous tanks. Wherever they fight—in whatever theater or element—they are knit into a trim, efficient fighting team by invisible lines of radio communication.

In this far-flung global war, actions a world apart are correlated by voices flicked silently and light-fast through the air. In localized encounters, tank and air commanders link their craft into tight, deadly combat units . . . by radio.

This is truly war wired for sound.

Many of today's combat and command voices are sent into the air, and recaptured clear and true, by equipment made by the Farnsworth Television & Radio Corporation. Farnsworth is devoting its every facility to improving and making the complex communication devices needed by our tough, skilled fighting men.

Great technical advances have evolved out of this war-born intensification of research and production. After the war, these advances will enable Farnsworth to supply you with finer radio, radio-phonograph and television equipment than ever before.

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Farnsworth Television & Radio Corporation, Fort Wayne, Indiana. Manufacturers of Radio and Television Transmitters and Receivers; Aircraft Radio Equipment; the Farnsworth Dissector Tube; the Capehart, the Capehart-Panamuse, and the Farnsworth Phonograph-Radios.

we are Minute-Pinchers

To take each minute and work it to the bone . . . to squeeze it dry for the last split-second of productive capacity—that is the meaning of a Minute-Pincher!

TRANSFORMERS gave us a living before the war...now they are helping to save something even more important than a living—America's Bill of Rights and the precious liberties these Rights hold for us. Knowing this, we seek no alternative other than to produce faster...to conquer time...to build into the Kenyon "Mark of Excellence" a transformer which is second to none.

Until the last gun is fired . . . until the last bomb is dropped and the words "Unconditional Surrender" are flashed around the world we remain, yours truly, Kenyon Minute-Pinchers!

Pinch your minutes to help the War effort . . . pinch your dollars to buy More War Bonds and Stamps

THE MARK OF EXCELLENCE

KENYON TRANSFORMER CO., inc. 840 BARRY STREET NEW YORK, U. S. A.

bomber, built to scale and containing the standard equipment of a plane. Camouflaged and given colorful names such as "Tootsie" and "Pluto" they are mounted on pivots or balances so they can be rocked back and forth to simulate actual flight conditions.

Before he enters his mock-up the radio operator is given his briefing—or flying instructions. Inside the "plane" the student uses the high power liaison sets which keep him in touch with a simulated ground station and the other two planes in his "flight," located across the room and also operated by student soldiers.

Thus a cross country "flight" complete for radio purposes down to the last detail can be made in one room.

Every bit of radio telephone and operating procedure, learned in the previous weeks, is brought into play during the "trip" which is usually made from one "city" to another. With the mock-up rocking back and forth, the new radio operators, clad in fur lined flying suits, wearing chutes, and even carrying paper bags for use in case of air sickness, experience most of the conditions that would be met in real flying. And while training in mock-ups they aren't losing the time that would necessarily be lost if real planes and actual flights had to be employed.

Advance mock-ups are so designed that all positions in the bomber are duplicated—such as those of pilot, gunner, navigator and radio operator. In this way the radioman can become familiar with his post in relationship to the other members of his team.

For a Scott Field man is trained to be a fighting member of a bomber crew. When he leaves this school it's usually for a gunnery school where he will learn the other half of a radioman's job in a Flying Fortress.

But he leaves Scott Field, confident that he'll be able to play a big part in those bombing raids that must eventually knock out the Axis. He's sure he knows the why and wherefore of that sign over the southeast entrance to the field:

"Through These Gates Pass the Best Damned Radio Operators in the World."

-30-

Technical Development

(*Continued from page* 120)

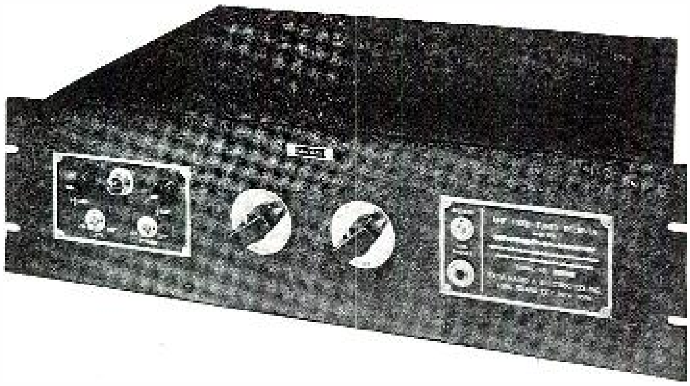
means for detecting and extinguishing fires in the air. Equipment for detecting and extinguishing fires in engine nacelles of the type common in air-carrier aircraft of the last few years has been developed. Similar equipment has been developed for the newer, more closely cowled air-carrier aircraft now making their appearance. Some types of private-owner aircraft also have had fire extinguishing equipment developed for them. This work is going on now and will continue as long as new types of power plant installations and new methods of cowling continue to present problems from the fire fighting viewpoint.

As a result of several accidents and near accidents to airline aircraft, a test program is underway to develop a "birdproof" windshield; that is a windshield which, in flight, will resist the impact of a large bird. With the cooperation of glass and plastic manufacturers, a windshield has been developed which can stop a 15 pound bird at a speed in excess of 200 miles per hour. With further development, it is hoped to better this result. This work is being done in close cooperation with other work being performed to develop a windshield capable of being properly de-iced. The objective is an "ice-proof" and "bird-proof" windshield.

With the demand for larger and larger aircraft capable of flying at higher and higher speeds, designers have been faced with many problems in designing aircraft free from vibration and flutter which, at these high speeds, can easily reach catastrophic proportions. To assist designers in solving the very complex problems associated with the phenomenon of vibration and flutter and to assist the Civil Aeronautics Administration's engineers in their task of determining the airworthiness of aircraft for certification purposes, the Technical Development Division has been engaged for

FADA Radio

On Duty in the New Aircraft Communication Spectrum



Designed and built by FADA to most rigorous government specifications, the receiver illustrated is possibly the first public glimpse of the new equipment which had to be created to make possible the proposed shift of aircraft communication from "MF" to "VHF" — from the 3—6 megacycle "medium frequencies" to the 115—160 megacycle "very high frequencies."

Two tuned r.f. *amplifying* stages .... crystal controlled oscillator-quadruplers .... precision construction for 24-hour continuous operation in all kinds of weather .... amplified A.V.C. .... carrier-operated noise suppressor .... automatic noise limiter .... built-in a.c. power supply .... sensitivity four microvolts .... image and spurious response rejectivity running up to thousands of times .... all on a 5¼" relay rack panel .... yet "wide open" for easy servicing ....

FADA is rather proud of the part its engineering skill is privileged to play in this and other aircraft radio equipments .... in the opening up of new communication frequency spectrums which were still but dreams only a few years ago.

This new FADA receiver is shown as one of numerous tangible examples of new products of FADA research and engineering today being built for many departments of our government .... examples which indicate concretely that FADA will be the source of startlingly changed .... simplified .... improved radio/electronics .... for *you* .... post war.

FADA RADIO AND ELECTRIC COMPANY, INC.
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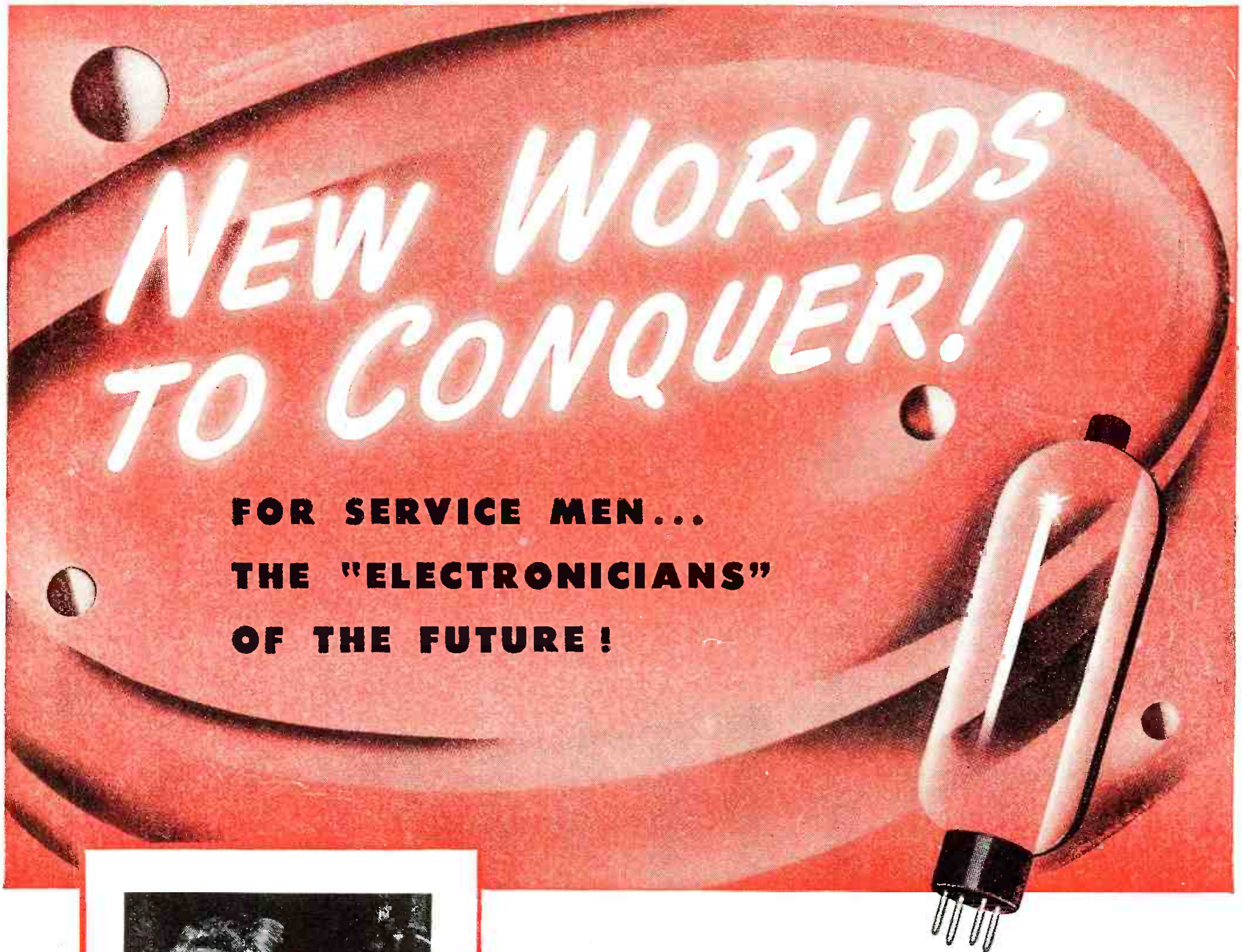
1920 SINCE BROADCASTING BEGAN 1943



PRECISION

Under the guidance of highly skilled operators, the finest precision machines are employed to insure uniform high quality in all National Union tubes. In this photograph a bending machine in the Stem Department is shown doing its war job of helping to provide this year the largest number of the finest electronic tubes National Union has ever built.

Sure, winning the War is our big job right now. To that end we here at National Union are exerting our every thought and energy—both on our production lines and in our research laboratories. But after the war—what then? For you as a service man the post war outlook is especially promising. Countless new peacetime products will emerge from today's ever increasing use of electronic tubes to help win the war. New applications of electronics in the home will add new and profitable service activities to your already established business. From radio technician you will expand to become your community's "electronician." And National Union will have ready for you the tubes, the test equipment and a plan of action to help you make the most of this great new opportunity.

Transmitting Tubes • Cathode Ray Tubes • Receiving Tubes • Special Purpose Tubes • Condensers • Volume Controls • Photo Electric Cells • Exciter Lamps • Panel Lamps • Flashlight Bulbs

NATIONAL UNION RADIO CORPORATION

NEWARK, NEW JERSEY LANSDALE, PENNSYLVANIA

some time in the development of detecting, measuring, and analyzing apparatus for the investigation of these phenomena. The first apparatus developed under this program is now being used in connection with airworthiness tests of both civil and military aircraft. More complete and more flexible apparatus is now being developed.

Airworthiness tests involve the accurate determination of the aircraft's performance characteristics. To obtain the necessary data, the Division is engaged in the development of photographic flight recording apparatus and apparatus for analyzing these photographic records. Photographic instrument recording apparatus also is being developed. This apparatus makes use of infra-red illumination so as to cause no impairment of the pilot's vision. Another development now underway is an aircraft control characteristics recorder which measures and records the forces applied to the several controls of the aircraft during specific maneuvers and, at the same time, records the corresponding movements of the controls. Further to assist in airworthiness tests, a fabric testing device for determining the airworthiness of fabric covering recently has been developed.

A large number of accidents result from the inadvertent stalling of the airplane. To combat this type of accident, a stall-warning indicator for small private-owner type of aircraft has been developed. Work is now progressing on an indicator for air-carrier type aircraft which will indicate correctly regardless of ice which may have accumulated on the wings of the aircraft.

As the war has focused more and more attention upon aviation, technical development in all fields of aeronautics becomes more and more important. The Civil Aeronautics Administration's development programs, carried out by the Technical Development Division, therefore, are of primary importance to safe civil aeronautics, the national defense, and the conduct of the war.

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Development Labs

(*Continued from page* 79)

Above all, laboratory design and slight improvements in operation must often be compromised in favor of 100% reliability, maintenance and supply. Untried gadgets are paid for in blood.

Models of proposed equipments are constructed and tested in the Laboratory until the circuit is finally found to give the required performance and military characteristics. Then every item, every component, must be chosen with care to insure that it will function during long hard service under every conceivable condition. Sometimes many trial lay-outs are made and flight tested to see that performance, size, and arrangement of control is satisfactory and that the set will fit into the required spaces. Every ship must be under engineering supervision to determine that the simplest and most improved methods of assembly are employed and that the design is capable of duplication by mass pro-

Checking antenna mast of a large bomber.

duction methods. We are at war. Although light weight *must* be achieved, many basic light metals such as aluminum and magnesium are not available in sufficient quantities for production needs. Sacrifices must be made . . . and on a sound engineering basis.

A saving of one pound of radio may save three pounds of fuel. Standard components must fit many types of aircraft . . . Army, Navy and British. Replacement parts must be interchangeable—quickly. Little space is available on instrument panels; therefore, many indicators must be built in specially elongated shapes. In single-seater fighters, ease of adjustment is *paramount* for the pilot must "juggle" the radio while flying. In all planes, ease of adjustment is important because in combat, all radio operators are also gunners. Radio control boxes must be within easy reach of the user —be he pilot, co-pilot, navigator, bombardier, engineer, or gunner and indicators must be easy to read at night. Crystal frequencies may not often be

TECHNICAL DATA SALON SECTION

used because of the many frequencies required and procurement difficulties.

Besides these long accepted design problems, the sphere of operation of the modern air weapon of destruction has placed emphasis on design and special tests for temperature, humidity, altitude and acceleration.

Our bombers roam the world, and our fighters' guns are blazing on all fronts. The radio equipment used in these airplanes must be designed and actually tested to stand ambient temperatures ranging from —67° F. to 185° F. A further complication is introduced by the fact that, when fighters are dive bombing, rapid changes of temperature may take place. The equipment is tested for changes as great as 7.2° F. per minute. Resistors must hold resistance; condensers must hold capacitance; inductors must hold inductance . . . overall operation must be maintained.

The abovementioned temperature changes introduce the problem of profuse condensation of moisture as the equipment moves from a cold atmosphere to a warm, moist one. The humidity and condensation problem is also introduced when airplanes must operate over a tropical territory and remain on the ground under extremely humid conditions. If moisture gets into cracks in the equipment, a frequent difficulty is arcing. Equipments are tested up to 100% relative humidity and when taken from this atmosphere at normal temperatures, they are required to operate satisfactorily when immediately plunged into an ambient temperature of —67° F. An example of a humidity test for wire is to subject it to six (6) hours of steam at 180° F. and then cool it for eighteen (18) hours in the same chamber with the steam turned off. This test is repeated and after a fifteen (15) minute drying period. the wire must withstand 5,000 volts.

High Altitude Condition

Another special condition is the reduced atmospheric pressure (down to about 150 millibars) which exists at an altitude of 50,000 feet. Under these conditions, the most serious

(*Continued on page* 292)

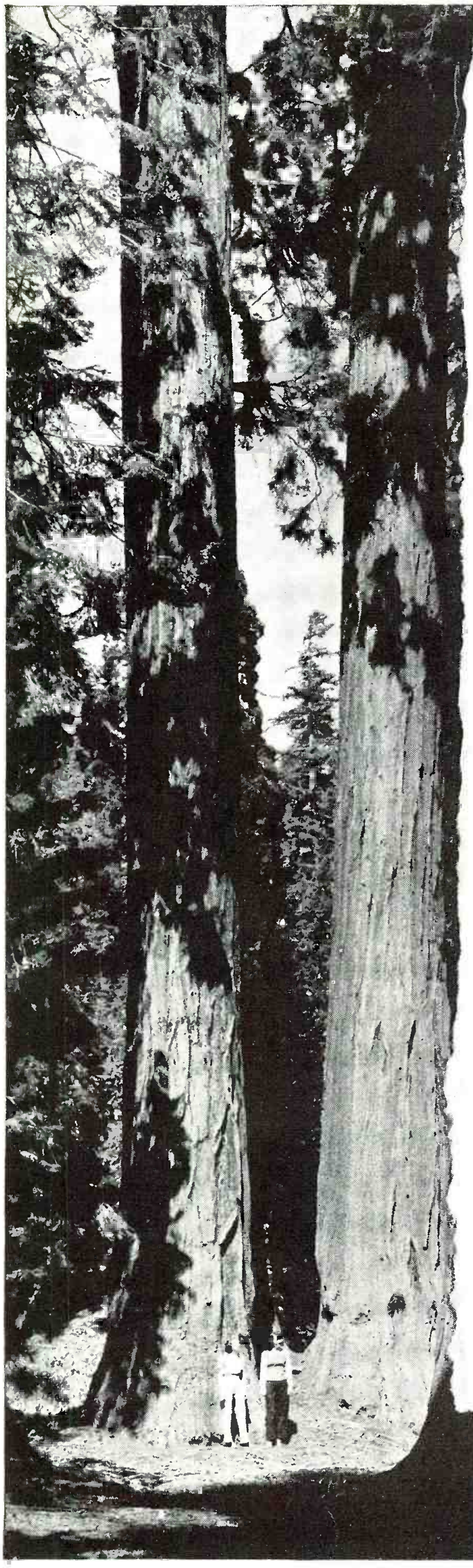
Airways Look Ahead

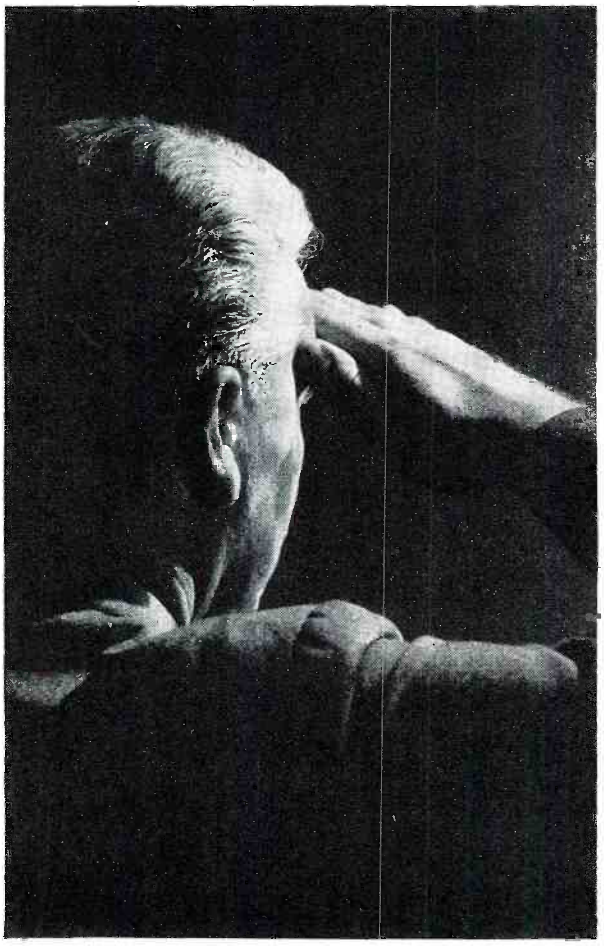
(*Continued from page* 104)

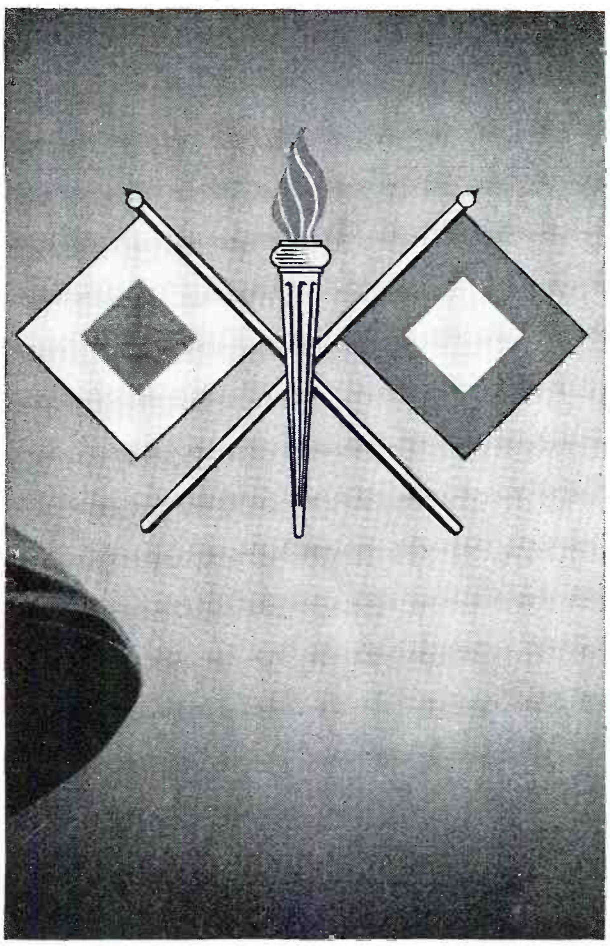
As the flight progresses to Philadelphia, the pilot's position will again be automatically recorded at New York but will no longer appear on the flight progress board at Washington. The ship will next appear over a holding point some ten or fifteen miles from the New York airport. At this point the pilot will be given instructions by the traffic controller to proceed on the instrument landing system to make his landing at New York, regardless of the visibility. During his descent on the instrument landing system, the traffic controller will be able to tell the pilot his distance from the airport, height above the ground, and his exact position relative to the runway—whether he is to the right or left, or right on it. It will be noted that in this flight of the not too distant future two things have been accomplished to aid the pilot without eliminating his responsibility for completing the flight on his own initiative—the necessity for numerous radio contacts, and a system for eliminating or quickly correcting a pilot's mistakes.

There is one more link that will bring all flights up to a daylight basis. That is the employment of *radionic* devices to permit every pilot to see the ships in his vicinity. The accomplishment of this will require considerable further development, particularly in designing equipment light enough to be carried on all airplanes.

In planning these future airways, the five Divisions of the Federal Airways Service are all conscious of their responsibility in continuing to lead the world in the development of safe flying. The men in these organizations are all veterans in the specialized field of airways. Other articles by some of our CAA experts will give an insight into the specific operation of these five Divisions. It may be well to point out just how much they depend upon one another in a closely integrated whole. The Technical Development Division is primarily interested in new things, such as improvement of instrument landing systems, new types of lights, new types of radio ranges, and other air navigation facilities. The Signals







ALL OUT FOR VICTORY

To the directing genius of our Air Forces . . . to the engineers and to all other men of high purpose and firm resolve who are waging the war of communication . . . we again and again pay tribute.

Emerson's entire resources and all of our devotion are being given wholeheartedly in support of that magnificent service.

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"A", "B" and "C"

Serve the U. S. Flying Forces

We are proud to say that "Eveready" Radio Batteries, including the famous "Eveready" "Mini-Max" Radio "B" Batteries, have been accepted for use in U. S. Aviation Communications. Illustrated are a few of the many types of "Eveready" "Mini-Max" batteries now serving the various branches of our fighting forces.

The Batteries Illustrated Above Made Portable Radio Really Portable

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TO OUR DEALERS

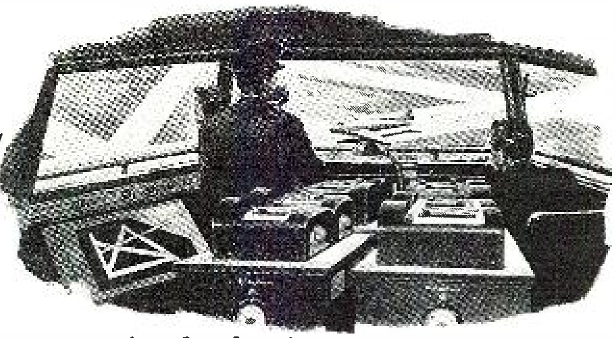
Sorry, there are no "Eveready" "Mini-Max" batteries available for civilian use today. The armed forces have not only accepted them for service, but are taking all our expanded facilities can produce.

THE LONGEST MEMORY ON RECORD

The man in the tower loses not a syllable of the instructions he speaks to homing pilots . . . nor of their replies.

Every word is caught indelibly on the plastic recording belt of the Dictaphone Electricord Belt Recorder. These belts are inexpensive, tough and practically unbreakable. A great many of them may be filed flat in a small space.

Dual recording and reproducing units provide continuous operation. Since the sound track speed is constant on the entire recording surface, it is possible to listen back at any point, while the machine continues to record.

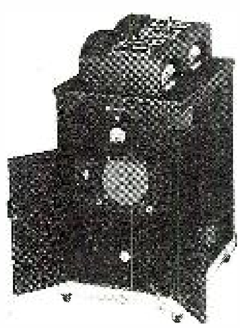


Developed to meet requirements of the Civil Aeronautics Authority, these Electricord units also serve the U. S. Army Signal Corps and other services.

These new developments are the results of continuing Dictaphone research. They are a portent of what will come when the Dictaphone plant is once more converted from ordnance production to the making of sound recording equipment.

Dictaphone Corporation, 420 Lexington Avenue, New York, N. Y.

The Dictaphone Portable Belt Reproducer, with variable speed control



The Dictaphone Electricord Belt Recorder—Reproducer

DICTAPHONE

ACOUSTICORD DICTATING EQUIPMENT
ELECTRICORD RECORDING EQUIPMENT

The word DICTAPHONE is the Registered Trade-Mark of Dictaphone Corporation, Makers of Dictating Machines and Accessories to which said Trade-Mark is applied.

For Continuing Achievement

A STAR FOR WESTON

—evidence that the vital instrument situation rests in good hands!

A star now adorns the ARMY-NAVY "E" pennant awarded to WESTON just 6 months ago . . . the first such pennant awarded in this highly specialized instrument field.

It's a star that has *real meaning*. Because, from the very beginning of our defense period, the responsibility for producing the vast quantities of instruments vital to the success of our country's efforts, has rested largely on the instrument leader.

This star signifies that the responsibility *rests in good hands*. "The men and women of the WESTON Electrical Instrument Corporation," writes the Chairman of the Navy Board for Production Awards, "have achieved a signal honor by continuing their splendid production in such volume as to justify this award . . . indicating their solid determination and ability to support our fighting forces with equipment necessary for victory."

But a great instrument task still remains . . . before victory is ours. So WESTON workers continue reaching for new goals . . . with the same determination, the same painstaking devotion to the quality ideal, responsible for WESTON'S *continuing leadership* in the instrument field.

WESTON ELECTRICAL INSTRUMENT CORPORATION, NEWARK, NEW JERSEY

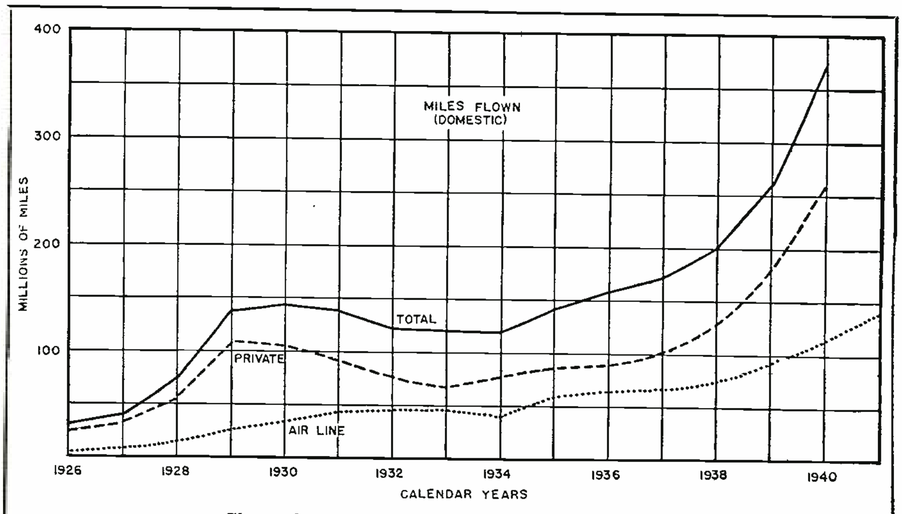


Chart showing growth of U. S. Civil Aviation.

Division of the CAA selects the radio equipment best adapted to the job and improves, installs, and maintains all air navigation facilities of the Federal Airways System. The Communications Division operates the far-flung communications system and acts as the wire service for the Weather Bureau. The Air Traffic Control Division controls all traffic along the Federal Airways and at 117 airports jointly occupied by the military and the civil. Traffic control cannot be accomplished without communications and other air navigation facilities. Neither communications nor air traffic control can be efficient without expert maintenance, while maintenance requires the services of qualified engineering personnel to plan, establish, and maintain the whole system.

As for the present war activities of the Service, every man employed in the development, establishment, and maintenance of the airways system both at home and abroad is making a vital contribution to victory by providing Army, Navy, and civil aircraft reliable and efficient means of navigation, by making possible for the Services of Supply to deliver aircraft to all the fighting fronts, and by providing facilities on which Army and Navy pilots can be trained.

The Federal Airways Service is now operating six intercontinental stations capable of communicating with aircraft at any point on the globe. These stations are the most efficient of their kind in the world and have been of inestimable value to the armed forces, placing the United States several years ahead of any other nation in the development of intercontinental airways. At the present time little can be said about these stations and their contributions to the war except this, and it is a tribute to the far-sighted policies of the Civil Aeronautics Administration and the magnificent job accomplished by our radio engineers—those stations were there waiting when the need suddenly arose to dispatch our planes by the thousands on long distance flights.

There has been much speculation about whether or not this organization should be made a part of the Armed Forces. We have but one statement to make—wherever this organization is placed, it is distinctly in the public interest to keep the organization intact and operating as a unit for the benefit of the men who fly.

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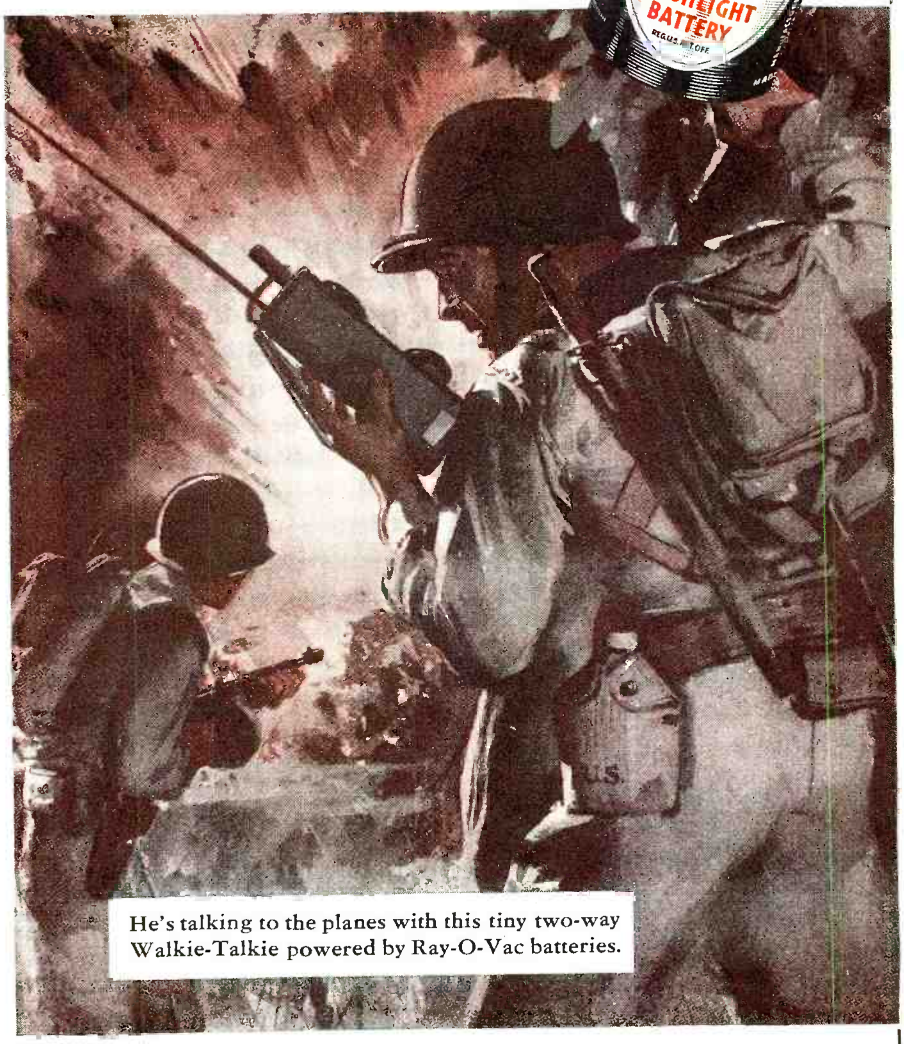
THE LINK

between sky and earth



He's talking to the planes with this tiny two-way Walkie-Talkie powered by Ray-O-Vac batteries.

AVIATION COMMUNICATIONS

demand dependable power. Despite the freezing cold of the Arctic, the blazing sun of the desert, Ray-O-Vac Batteries do their work surely and safely. That's why Ray-O-Vac batteries are used so extensively on every fighting front . . . powering the Walkie-Talkies that link the ground forces with the planes.

In addition, the entire production of Ray-O-Vac LEAKPROOF batteries are going to the armed forces. Certainly our fighters, before all others, deserve the world's finest!

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RAY-O-VAC *Leakproof* FLASHLIGHT BATTERIES

BUY WAR STAMPS RAY-O-VAC **BUY WAR BONDS**

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EXCHANGE—BUY—SELL

Your Own Ad Run FREE

The "Trading Post" is Sprague's way of helping radio servicemen obtain the parts and equipment they need, or dispose of the things they do not need during this period of wartime shortages. Send in your own ad today—to appear free of charge in this or one of the various other leading radio magazines in which this feature appears. Keep it short—WRITE CLEARLY—and confine it to radio items. "Emergency" ads will receive first attention. Address it to:

SPRAGUE PRODUCTS CO., Dept. RN36
North Adams, Mass.

WANTED—Overhead cutter, 16" table, heavy duty professional recorder, Presto preferred. State condition and price. Valley Radio-Electric Service, 711 Broad St., Central Falls, R. I.

ANALYZER NEEDED—In good condition; also small table-model radios. Cash. Loyal Helweg, 415 Matson, Norfolk, Neb.

TO SWAP OR SELL—Epsom A and B power unit a-c Homecharger, type R. Good condition. Make offer. Ramsay, 118 W. 112th St., New York, N. Y.

BATTERIES WANTED—Eveready 467 or 455 or equivalent, for use in R.C.A. B.P.-10 portable sets. Will pay cash. The Radio Man, 1724 Central Ave., Middletown, Ohio.

SWAP OR SELL—Supreme #560-A vedolyzer; Bogen PV-20 20-watt amplifier; RCA #954-#955 acorn tubes. Want anything in photography or radio. Make best offer. A. A. Mogull, 305 Adams Ave., West Hempstead, N. Y.

RADIOS & COMBINATIONS WANTED—New or used. Any quantity, small or large. Also tubes. Will pay cash. Berman Radio, 20 Stuart St., Boston, Mass.

WANTED—A.C.-D.C.Multitester, new or in good condition. State details and price. Also want late model tube-tester. Irving Treuman, 40 Lincoln Rd., Brooklyn, N. Y.

AMPLIFIER AND CHANALYST FOR SALE—Erwood mobile 30-watt amplifier with two University trumpet speakers and Astatic mike and stand; also Rider Chanalyst. Guaranteed in perfect condition. Send offer. Rogers Appliance Shop, 210 W. Broadway, Red Lion, Pa.

WANTED—Volt-Ohymst, Jr., Hickok 202 or Precision EV-10; also power transformer for Thordarson 1" Oscilloscope. R. B. Gough, 835 Blue Hills Ave., Bloomfield, Conn.

NEED TUBES—Will pay wholesale price for 1½V. tubes. Cash for small sets a soldier can carry. Also need Tel-O-Mike or similar. Have 703 Radio City tube-tester, and 200-W, DC to AC vibrator, convertor to dispose of. Robert W. West, Parker, Arizona.

WILL SWAP—1-1C5G, 4-32 and 2-34 tubes, 1 pair of Frost 1000-ohm headphones, and one 6" magnetic speaker, in good condition, for type 201-A or type 30 tubes, or for volt-ohmmeter and ammeter. Also have some 1¾x2x4½" cans for shielding coils. M. O. Smith, Box 265, Pagosa Springs, Colo.

WANTED—Tube and set tester—Triplett 1183 or RCP 802A, or similar. Will pay cash or trade Savage .32 automatic pistol in good condition. Morgan H. Arnold, Alaska Communication System, Box 24, Ketchikan, Alaska.

FOR SALE—Nelson's "Fundamentals of Radio Servicing"; Ghirardi's "Radio Physics Course"; Rider's "Cathode Ray Tube at Work"; 2-465-KC IF Filter crystals with holders, and various radio parts. Write for list. Want Jackson tube checker, V.O.M. Model 580 and good candid camera. Cash difference if necessary. Anthony Pusateri, 1101 Fleming St., Coraopolis, Pa.

AMATEUR RECEIVER WANTED—Preferably a Hallicrafters or Howard. Will pay top cash price. Robert W. Stankas, 435 Post Ave., Lyndhurst, N. J.

VOLT-OHM-MILLIAMMETER WANTED—Spot cash, or will swap tubes for same. Jesse Moore, 18155 Greeley, Detroit, Mich.

WANTED—Oscilloscope 2" or 3", meters, tubes, cathode-ray tubes, parts and all kinds of testing equipment, for cash. Give full details. Scott Radio Service, 163 Hanover St., Bridgeport, Conn.

FOR SALE—20-tube, 5-band, 40-watt, twin speaker, true fidelity; G. E. A205 Radio chassis $60; also several G. E. $55 dynamic speakers (new), $18 each. Will consider test equipment in trade. Scott Radio Service, 163 Hanover St., Bridgeport, Conn.

SWAP OR EXCHANGE—Hallicrafter SX-24 Receiver (brand new) for sale or swap for modern testing equipment. Waldwick Radio Service, 121 Prospect St., Waldwick, N. J.

TUBES TO SWAP OR SELL—Will sell or exchange the following tubes: OZ4; 1A1; 1A5; 1A6; 1B4; 1C1; 1C7; 1D1; 1E5; 1Y1; 1Z1; 2A6; 2A7; 2B7; 2E5; 3A8; 5X4; 6C7; 6C5; 6B8; 99X; 182B; V199; X199; 6R7S; 6A3; 6A5; #4; #6; #9; #10; #15; #17; #18; #19; #22; #31; #33; #34; #46; #48; #52; #53; #55; #56; #57; #79; #81; #82; #89. Traveltone Radio Co., 2014 Broadway, New York, N. Y.

METERS WANTED—A C and DC voltmeters, frequency milliammeters, or what have you? Also headphones. PFC. Ferrad Campbell, 56 M Sq., Air Corps Technical School, Gulfport Field, Miss.

WANTED TO BUY—An oscilloscope 2" tube preferred; will consider 1" tube. Any make or composite. Will also consider the tube alone, either RCA 902 or 913. Send price and description. Radio Station WMRN, Box 518, N. Main St., Marion, O.

WILL TRADE—New tubes in original carton, 50, 33 and UV876; and Volume 1 of Gernsback's Manual—for tube checker. Smith Radio, 132 So. 7th St., Steubenville, Ohio.

WILL BUY OUTRIGHT—Portable volt-ohmmeter. Will pay list prices on 12SA7, 12SK7, 12SQ7, 12SJ7, 35Z5GT, 50L6GT, and 35L6GT tubes; also used electric radios, table types, not over 5 years old. Peavyhouse & Co., Radio Service Dept., Mt. Sterling, Ky.

WE BUY AND SELL—Foreign radio equipment and tubes of all makes; also interested in foreign and late American tube testers. Aladdin Camera & Radio Exchange, 4 East 32nd St., New York, N. Y.

FOR SALE—400-watt E. C. O. XTL, 'Phone and C. W. Transmitter—$250; 2 RK20 tubes—$6 each; Weston 50 m.a. dc 301 meter—$4.50; 1 used 2-speed Green flyer motor and XTL pick-up—$12; 6 2MF 2000 W.V. paper condensers—$1.50 each; 6 1MF 2000 W.V. paper condensers—$1.00 each; 25 2MF 200 W.V. paper condensers canned—15c each; 1 wood lathe—$12. All F.O.B., 1 week's trial. Al. R. Dayes, 1418 81st St., Brooklyn, N. Y.

WANTED—#739 Triplett V.O.M. to go in pocket tester. Crossno Radio Service, Route 2, Paris, Ark

WANTED—Condenser tester Solar model CC or CB, for cash; also D.B. meter. Henry Gombeyski, 22 Manuel Ave., Johnston, R. I.

THESE ARE THE LATEST SPRAGUE STYLES

Here are some of the Sprague Condenser and Koolohm Resistor types being supplied in tremendous quantities for war requirements. Many of these represent outstanding engineering achievements which will be reflected in Sprague radio service and industrial components for post war needs. Meanwhile—as always—you can count on Sprague Condensers for utmost dependability for today's radio service needs. Busy as we are with war work, we're also doing our level best to keep you supplied with Atom Midget Dry Electrolytics, TC Tubular By-Pass Condensers and other types needed to keep radios working on the home front. Ask for them by name!

SPRAGUE
PRODUCTS CO.
North Adams, Mass.

SPRAGUE CONDENSERS
AND KOOLOHM RESISTORS

Obviously, Sprague cannot assume any responsibility for, or guarantee goods, etc., which might be sold or exchanged through above classified advertisements.


—ALL we can
—the BEST we can
—as FAST as we can
This is America's simple formula for victory. Nothing less is good enough in the urgency of battle. And nothing less, on the home front, is worthy of our valiant fighting men. To them, we at Simpson make this report. We are manufacturing many times more Simpson Instruments than ever before . . . making them the best that skill and experience, and resolution, can produce . . . and turning them out at a pace we would have thought impossible just a short while ago.
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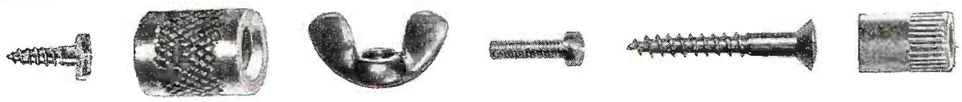
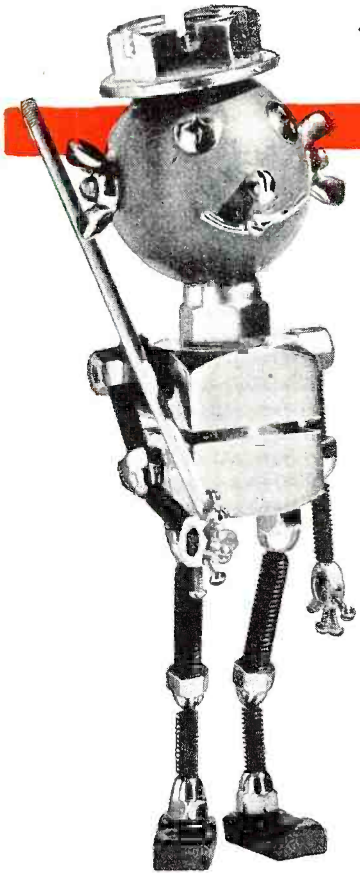
INSTRUMENTS THAT STAY ACCURATE
Buy War Bonds and Stamps for Victory

WHAT TO DO

If You Need

FASTENING DEVICES





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From the tiniest screw, bolt, nut or rivet to the very largest equipment, so complete and diverse is The National Screw & Mfg. Company line, that we can supply or make most any size or type of fastening.

National research men are constantly looking for new and better methods for the use of fastening devices in industry. Thus, if you have any questions or if you need help to solve any particular problem, write us at once. We'll give you full benefit of our 53 years of headed and threaded product experience.

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PRODUCTS

THE NATIONAL SCREW & MFG. CO., 2440 E. 75TH ST., CLEVELAND, O.

Civil Air Patrol

(*Continued from page* 148)

Not only are pilots learning about radio in CAP, but many radio amateurs are being taught the fundamentals of aviation and a goodly number of them are learning to fly. It is the policy of the Patrol that all flying personnel must become expert in the auxiliary ground duties and all ground personnel must learn about aviation so that each unit will be manned by highly skilled people from the officers down to the private in the rear rank.

This program offers radio enthusiasts an unparalleled opportunity to develop their technical skill along practical lines both for war work and for the post-war development of aviation. Under the new FCC rules for special CAP stations, CAP's radio personnel have the best break that any radio amateurs have had since the war began.

When the ban on issuance of new aircraft station licenses, except those directly serving the war effort, was laid down last year, FCC continued to license the transmitters required for CAP active missions. Because the Patrol never abused this privilege and never asked for a station that was not for bona fide use, the new program has developed on a basis of mutual trust between the two agencies. Under the military discipline of the CAP units, the establishment of CAP stations is going forward under careful supervision to prevent cluttering the air with messages other than those which are correct and proper in a program of war training and operations.

A separate class of service within the War Emergency Radio Service has been provided by the Federal Communications Commission for the use of CAP. All activities of this new system are to be confined strictly to official operations within the State boundaries of each station licensee or Wing.

These new CAP Stations may be used for essential communications directly relating to Civil Air Patrol activities when other communications facilities are inadequate or do not exist, covering also such uses as communication between plane and ground. The stations may be used also during emergencies endangering life, public safety or important property. Communication with stations in the war emergency radio service and with stations in the emergency radio service such as police, forestry, special emergency and marine fire-stations, or with United States Government stations is authorized in cases which require cooperation or coordination of activities.

The method of assigning operating specifications to equipment used by stations in the war emergency radio service is not unlike that of other radio systems. Frequencies, types of emission, selection of frequencies, frequency stability and measurement procedure are determined by FCC rules and regulations which govern the CAP radio station participation. Changes in equipment, the maximum unmodulated power input and modulation limits that must be adhered to are all a part of the well planned radio system which will make CAP, in its myriad duties, even more efficient.

Many former "hams," ruled off the air for the duration, will find a most fascinating opportunity in serving in the CAP. An applicant must hold a radio operator license or permit of any class issued by FCC and be able to comply with various provisions of the Commission to be eligible for a war emergency radio service operator permit.

Membership in CAP is open to citizens 16 or over. Both men and women are eligible. Applications are received only through local Squadrons and Flights and must be approved by the local unit commander. If you are interested in joining and the local unit commander approves your application, you will be accepted as a provisional member of the unit and put through a 25-hour course emphasizing military drill and discipline. On the satisfactory completion of this course, you will be eligible to receive your CAP identification and after an additional 25 hours may wear the CAP uniform consisting of regulation Army garments with special CAP insignia.

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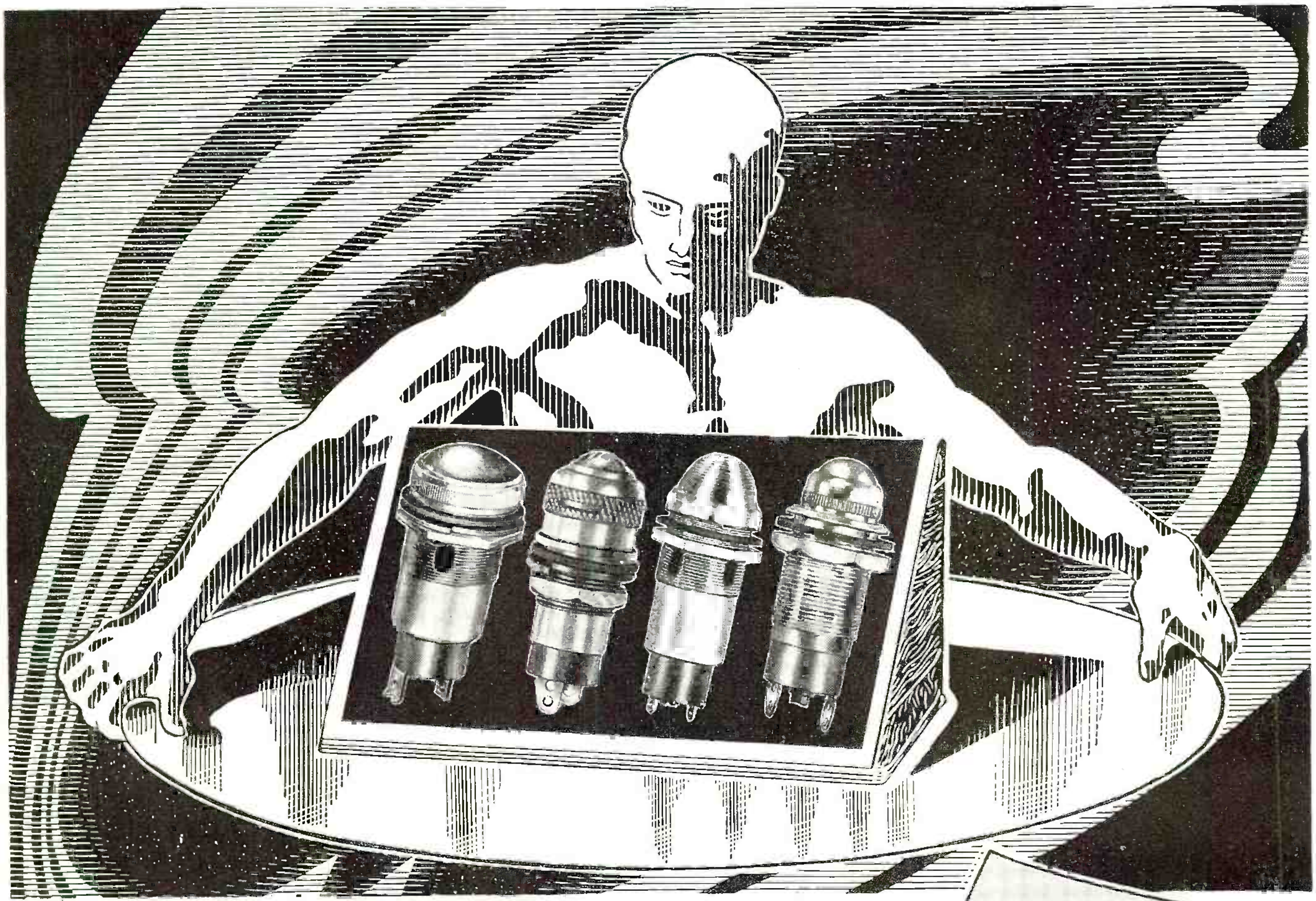


A JOB FOR A GIANT

PRODUCTION for Victory is a job for a giant. *That giant is American Industry* . . . Born of the love of liberty, reared in the spirit of pioneering, hardened by storm and strife, he is today the mightiest single power on earth!

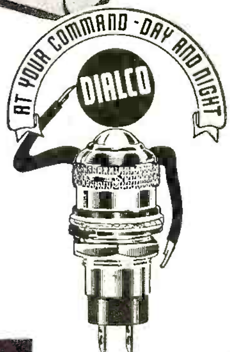
And yet, he does have weaknesses—small weak points inherent in the many parts of which he is made, each part being the individual manufacturer . . . *To avoid being the Achilles heel is the fighting duty of every plant and factory!*

We at DIALCO have long attuned our minds to the urgent tempo of the war . . . *We are nerve-tensed to produce and deliver —to deliver on time, on time, on time!*

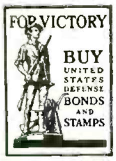
That is our function in this Job for a Giant!

The **DIALCO POLICY**

- 24-hour service, 7-days-a-week.
- Emergency overnight deliveries.
- Special sample units designed and submitted without charge.
- Bonus in quality, above specified requirements.
- To make such improvements today as will become the standards of tomorrow.



We manufacture the most extensive line of WARNING and SIGNAL PILOT LIGHT ASSEMBLIES, covering every conceivable Electrical, Electronic, Radio, Aircraft and Industrial application.



Your problem should find ready solution in one of our standard units. But if not, we will rapidly design and submit a special unit for your approval. . . . Write or wire us today . . . attention Dept. RN.

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To Our Armed Forces

During the 75 years of our existance as manufacturers of vehicles, we never have shirked an assignment. For this reason, we have a record for producing many *firsts* in specialized motor vehicles serving the army, navy, marine corps, coast guard and veterans' organizations. We welcome such assignments. A large part of our facilities are engaged in manufacturing products listed as "confidential".

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Manufacturer of Specialized Motor Vehicles
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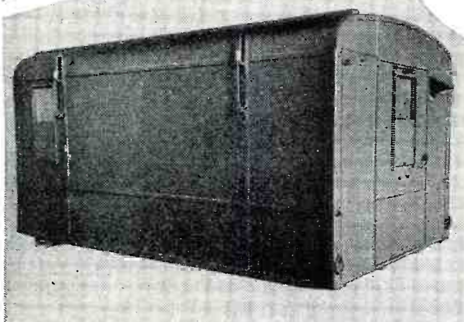

Field Type Radio Shelter

Radio Crystal Units

Civilian Defense Evacuation Unit

That Plane You Heard While in Bed Last Night—

WHAT did it suggest to you as you lay there, half-dreaming in the moonlight? Were you imagining combat planes in action, huge bombers droning towards their deadly mission?

Or did it make you think of the part the airplane will play in the postwar world? Because, more likely than not it was neither bomber nor fighter, but something more prosaic—a cargo plane, the "Flying Boxcar" of the war effort. Perhaps it was flying materials cross-country; it might have been bound for Africa.

But the hum of its motors is a portent of the future—a glimpse of the reality that, speed the day, will be converted from war effort into the culmination of a better Peaceful World.

That plane is not just the output of one aircraft manufacturer. It is the triumph of engineering technique, production art and laboring skill of hundreds of industries.

Could you but envision the complexities of the roughly one hundred thousand parts that make that plane, you would gain surprising comprehension of how industrial cooperation is furthering the instruments with which we shall enjoy Freedom in the Future.

Probably, many Mallory parts—unsung, unseen precision parts—function in that plane. The Mallory business is devoted to the production of metallurgical and electronic devices, most of them factors in the new advances of inventive skill. The same impulses that control functions important to the operation of a plane are, in part at least, vital in a home radio set, in an automatic washing machine, in the processing of new materials, in the development of better fruits and vegetables, in other directions too numerous to detail.

In common with others, Mallory is converted to Victory production. But among the developments which are contributing to the success of war machines, are many which will make us rub our eyes in wonder when they are applied to the necessities of a better Civilian Life.

Next time you hear a plane overhead, think of the promise which it makes for your future happiness.

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MALLORY SERVES THE AERONAUTICAL, AUTOMOTIVE, ELECTRICAL, GEOPHYSICAL, RADIO AND INDUSTRIAL FIELDS WITH . . . RESISTANCE WELDING ELECTRODES NON-FERROUS ALLOYS, POWDER METALLURGY AND BI-METALS . . . ELECTRICAL CONTACTS, . . . THE MALLOSIL* PROCESS—BEARINGS . . . SPECIALIZED PRECISION ELECTRONIC PRODUCTS

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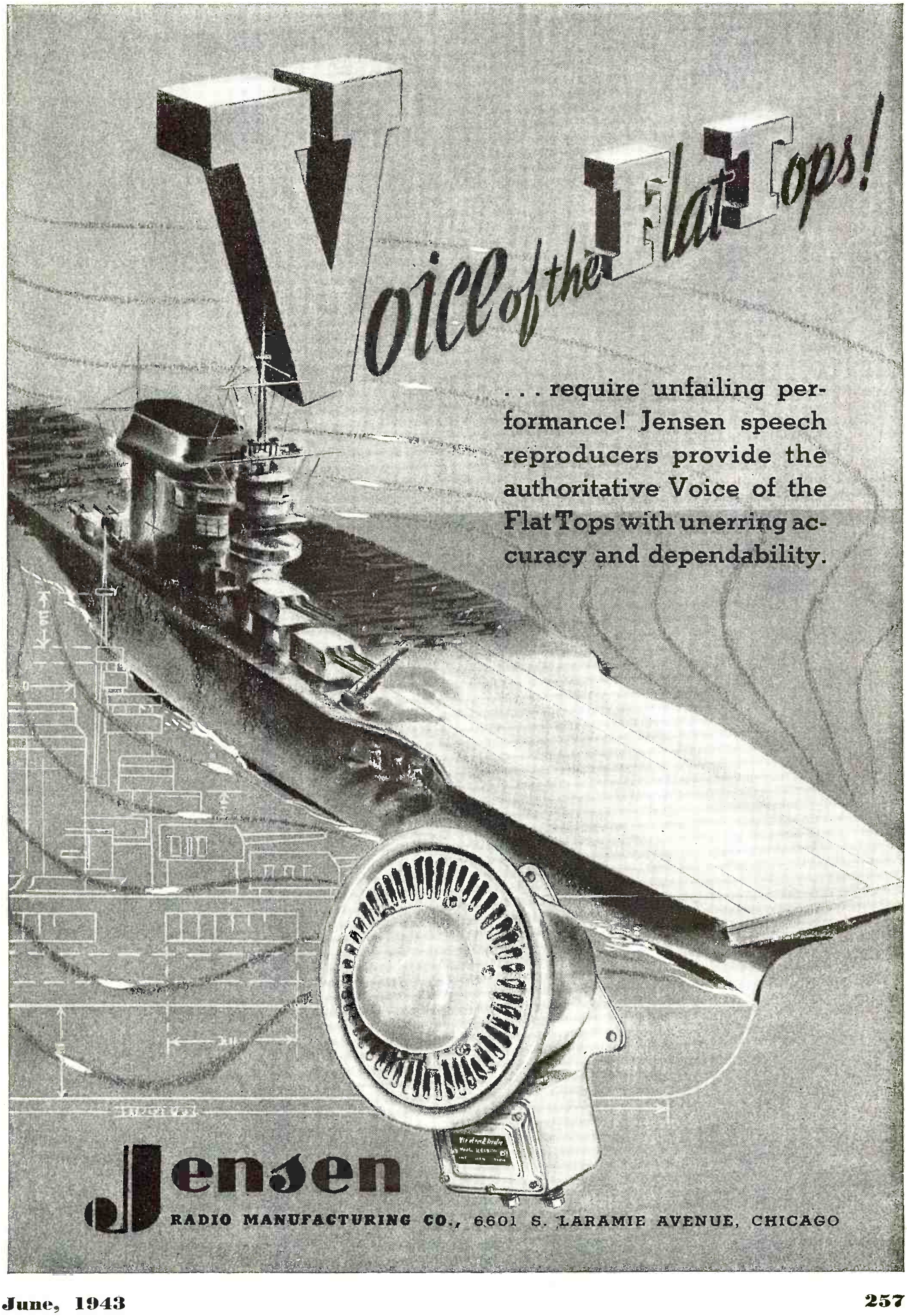
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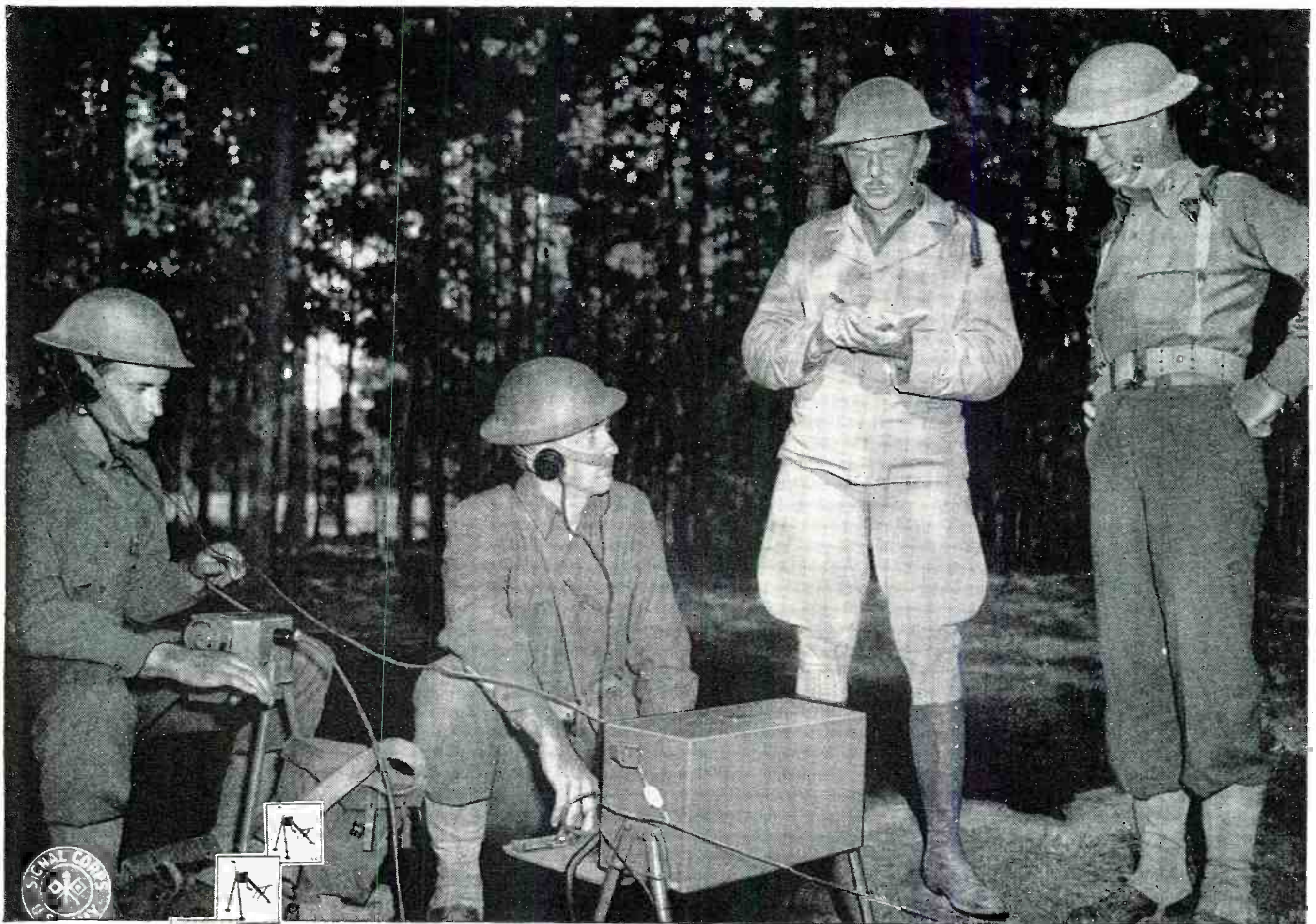
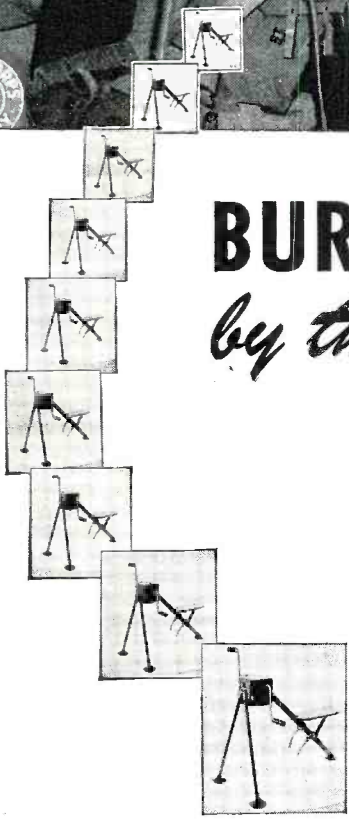


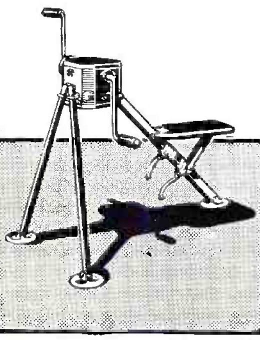
ABOVE PHOTO, COURTESY OF U. S. SIGNAL CORPS



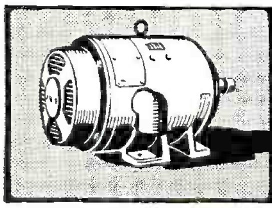
BURKE HAND GENERATOR UNITS

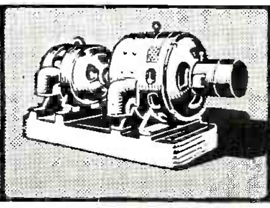
by the thousands for all fronts

CONTACT is vital between all units of our armed forces. Burke is helping in this important service by supplying hand-operated generator sets by the thousands ● Burke was first to design and build hand-operated generators. They are light and sturdy to provide a dependable source of power for radio transmitting and receiving sets wherever fighting men can carry them ● Burke for over 50 years has been known for its ability to design and build special generating equipment in all sizes up to 1000 K. W. for land and sea applications.



BURKE ELECTRIC COMPANY · ERIE, PA. **SINCE 1891**





D. C. Equipment to 1500 H. P. and 1000 K. W.
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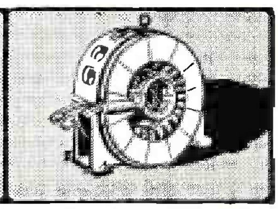
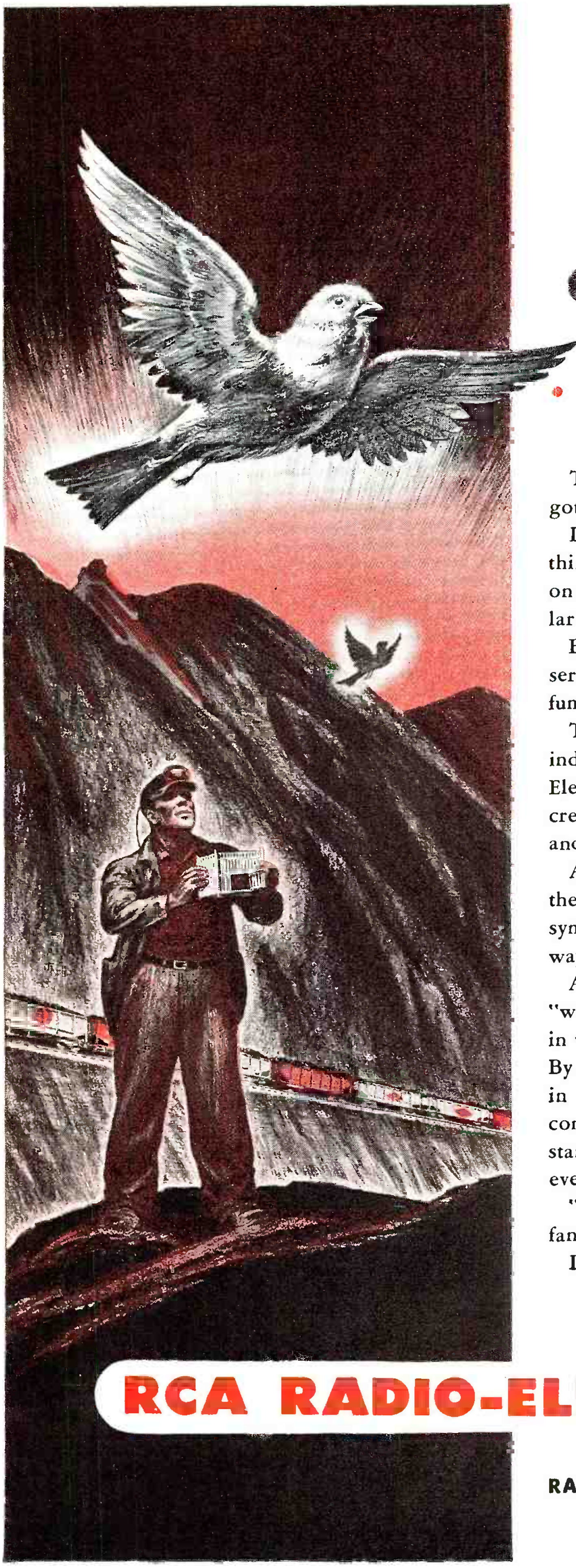




GOODBYE, CANARY BIRDS

. . . hello, serviceman!

This might well be entitled: "What has a vacuum tube got that a canary bird hasn't?"

If so, it could be answered by saying that, among other things, a tube has far greater dependability and durability on the job of detecting poisonous gases in mines, vehicular traffic tunnels and the like.

For, in the old days B. E. (Before Electronics), canaries served as "gas alarms." At the first trace of poisonous fumes in a mine they'd keel over in their cages.

Today, this is just one of the countless tasks throughout industry that are being done better, more dependably The Electronic Way. It is one of many developments that are creating vast new potentialities for RCA Distributors and Servicemen.

Actually, Electronics is merely a new word describing the newer uses of the radio tube and its derivations. It is a symbol of the radio-electronic circuit at work in new ways, and in widely different fields.

All of which means simply this: Since the days when "wireless" itself was still a scientific novelty, RCA has led in what we now know as Electronic Tube development. By the same token, it means that, as long-time specialists in servicing radio-electronic circuits or supplying their components, RCA Tube and Equipment Distributors now stand on the threshold of a far greater market than ever before.

"Goodbye, Canary Birds—hello, Serviceman!" is not fantasy.

It is an actual glimpse into our future—*and yours.*

RCA RADIO-ELECTRONIC TUBES

RCA Victor Division

RADIO CORPORATION OF AMERICA, Camden, N. J.

BUY U. S. WAR BONDS AND STAMPS

Federal Airways
(*Continued from page* 101)

These last marked the introduction of airways' third great element—radio—into the program as a major factor.

Radio's lot had not been, up to this time, an easy one. It came out of its experimental stages in the summer of 1926 when work got under way on a station at College Park, Maryland. Until that time there had been no airfield, airplane, or other equipment for this type of work.

Difficulties were incessant and at times seemed almost insurmountable. But by December the first model of the directive radio beacon was completed, and initial tests were made. A small marker beacon was also constructed at College Park during this period.

College Park, although today it looks like just another local airport, was an incubator for aviation radio development, and its results have spread over the world.

A loan of former Station WCAP at Washington was secured from the American Telephone and Telegraph Company, and control lines were set up between there and College Park. Federal Airways representatives conferred and exchanged ideas with radio engineers from all over the world. By the following summer when the airways were transformed to the Department of Commerce, major radio beacons had been projected at widespread spots across the nation.

Between 1928 and 1932 intermediate frequency directive radio range stations of the crossed loop type which had been developed at College Park were installed along the key airways. These ranges were later redesigned to use vertical tower radiators instead of loop antennas. This later facilitated joining the broadcast stations to form the simultaneous radio range and communications stations which transmit radio range signals and weather broadcasts or communications to aircraft on practically identical radio frequencies.

Low-power radio marker beacons were installed at the intersections of radio range courses and at various critical spots. There were 89 beacons in 1929. Today there are more than 200 marker stations of all kinds, the majority of them on ultra-high-frequency.

The use of radio for communication with aircraft was in general a one-way affair until 1930 when transmitters were installed in planes flying between Chicago and New York for communication with airways receiving stations which had been especially set up for this purpose by the Department of Commerce.

The same year saw the creation of a committee to bring Federal workers and radio equipment manufacturers more closely together. This cooperation has been a vital factor in the development of radio aids to flying, particularly from the viewpoint of quantity production of aircraft receiving sets.

Still another 1930 first was the work started on instrument landing systems at the College Park experimental station. Today the instrument approach system is a reality, having been installed at airports in seven key cities. Because of the war it may be some time before commercial aircraft can procure the necessary instruments to use these facilities, but when peace returns, they will make possible safe landings in weather conditions that now close up a field.

In 1931 experiments were undertaken to prevent collision of aircraft under conditions of low visibility by means of an ultra-high-frequency radio system giving automatic warning of the presence and position of other aircraft within a radius of approximately three miles. This can now be done, according to CAA technicians, but inexpensive and light equipment must be devised before the average plane can be equipped with it. Work along this line will undoubtedly be significant if private flying in the postwar period reaches expected proportions.

Remote control of radio facilities was begun in 1933. Two years later we installed special transmitters at radio range stations to project a signal directly upward, giving the pilot positive identification of the position so that he did not have to depend entirely upon the cone of silence, which was essentially a discontinuance of range signals.

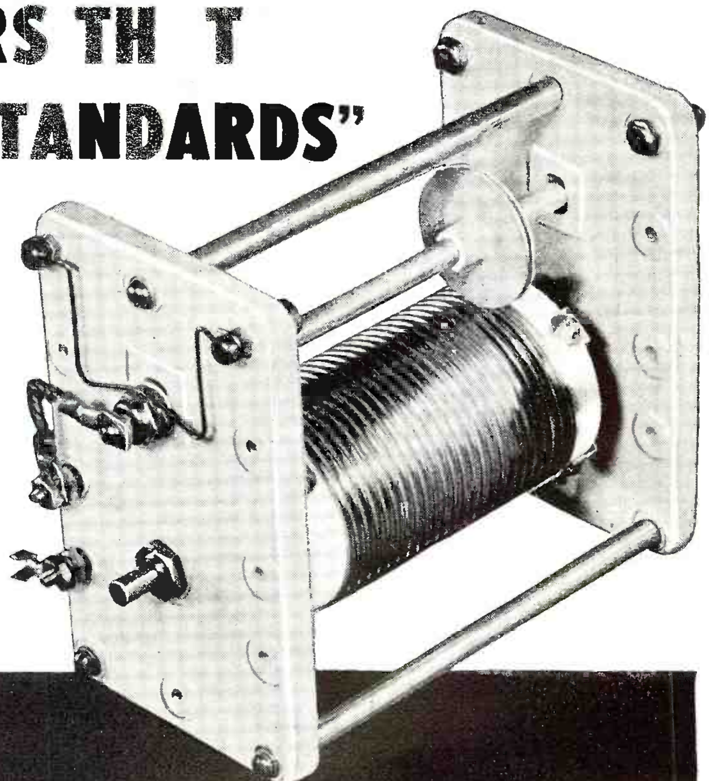
Development of an omnidirectional radio beacon got under way in 1938, and this may eventually replace today's standard radio range.

The period of 1937-39 was one of extensive modernization and expansion of the radio facilities of the Federal Airways System, made necessary by curtailment of expenditures for such purposes during the preceding depression years. The establishment of simultaneous radio range and communications stations took place on a large scale at this time.

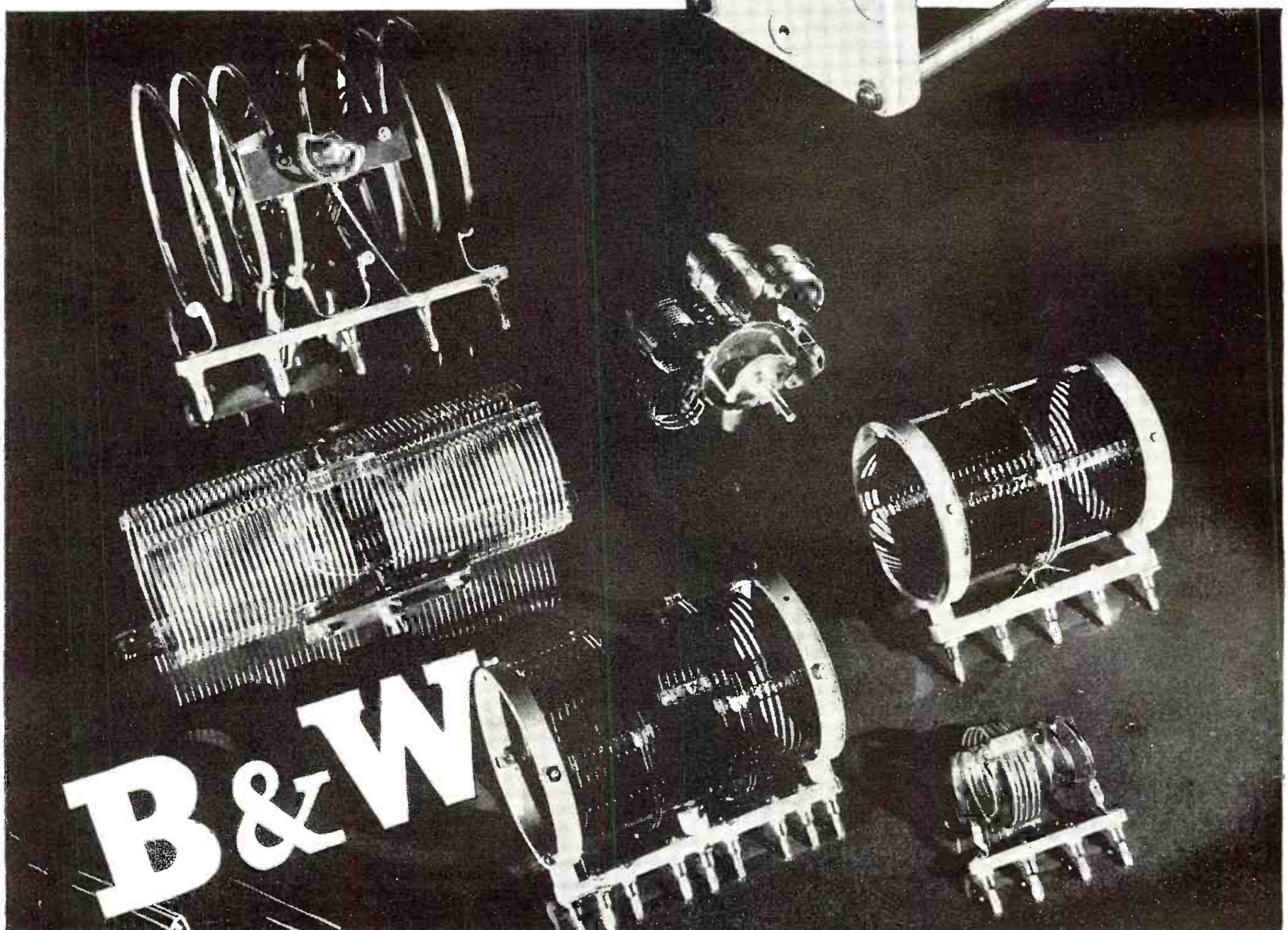
By 1938, the radio installations on the airways had become so complicated and so extensive that a special corps of electricians was established for maintenance work, instead of assigning it to radio operators to handle between watches.

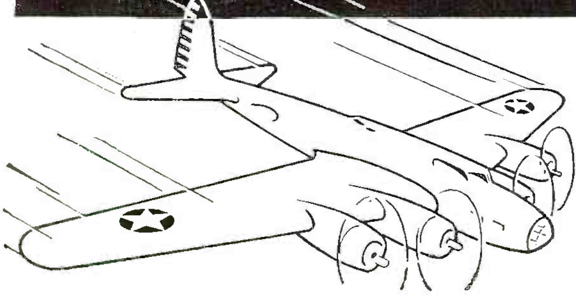
Extension of airways radio facilities into Alaska got under way in 1939, and in the following year CAA operations took on even more of an international aspect, with the commissioning of Station WSY at New York, providing two-way radio communication with aircraft operating across the Atlantic; the completion of radio range and communications stations in the Hawaiian Islands; and the start of work on communications stations at other key Pacific islands. The importance of these CAA

"THE AIR INDUC ORS TH T SE THE QUALITY STANDARDS"



PERHAPS no radio components have seen greater engineering advances in recent years than Air Inductor coils—and B&W engineering has consistently led the field at every turn. Built to exacting tolerances, durably constructed for the most strenuous wartime uses, and available in a wide variety of types and assemblies, B&W Air Inductors have established new, higher standards of quality wherever coils are used. That's because they're produced by men to whom quality coil-making is not only a specialized business, but a matter of intense personal pride as well.





In the group photo, are shown five standard B&W "fixed for fightin'" Air Inductors and one of the famous B&W turret assemblies. At top is a special rotary coil unit.

Bring your problems to Air Inductor headquarters! Fast deliveries on both standard models and wartime adaptations!

BARKER & WILLIAMSON

Manufacturers of Quality Electronic Components for 10 Years

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"PRECISION ENGINEERING APPLIED TO THE END OF A WIRE"

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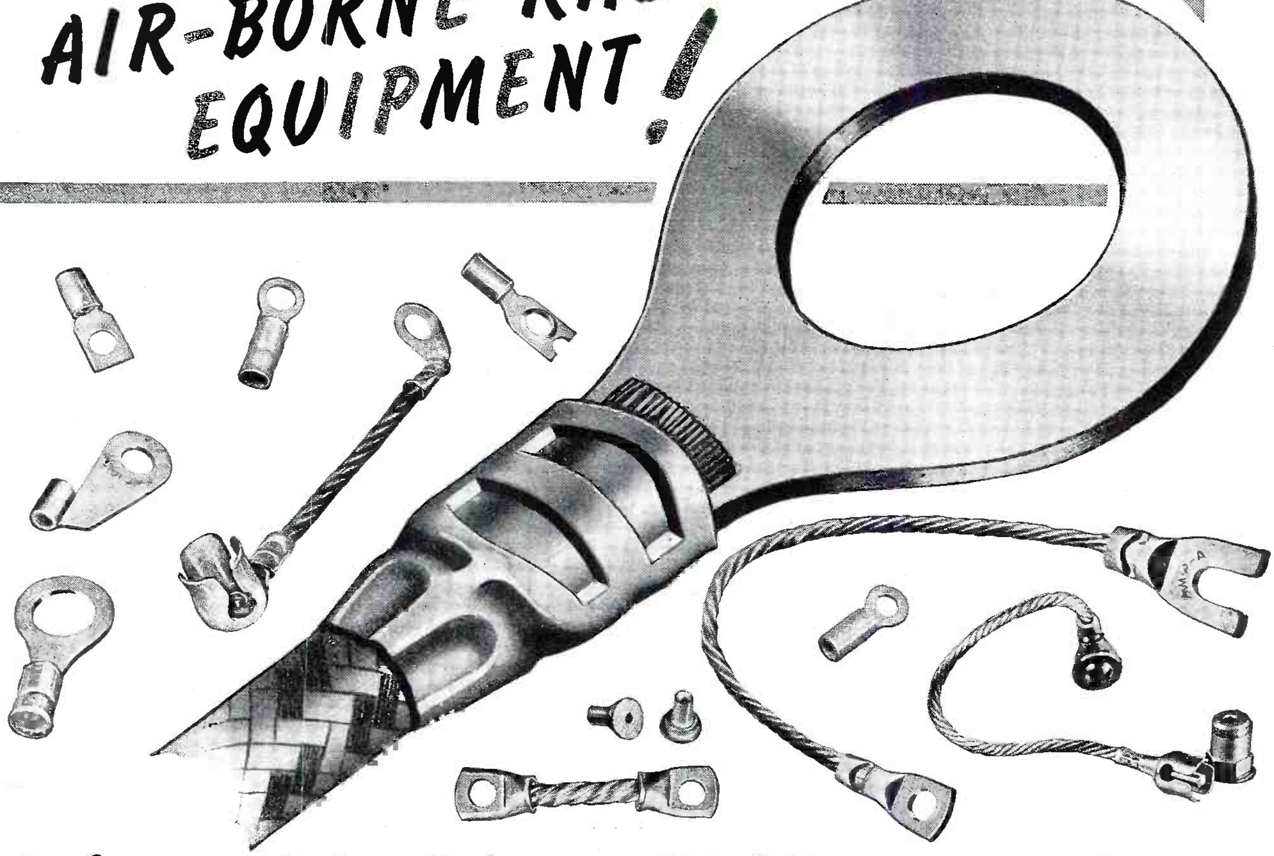
AMP *Solderless* WIRING DEVICES

FOR AIR-BORNE RADIO EQUIPMENT!



Top Performance In Low Voltage and High Frequency Requirements

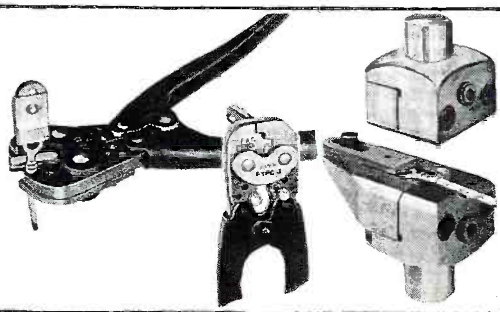
The AMP Diamond Grip Solderless Insulation Support Terminal is daily maintaining the highest quality electrical and mechanical connections under the severe conditions required in gun control, aircraft communications, and electronic use. This pure copper terminal, which is 1/32″ shorter and approximately 32% lighter in weight, has been engineered for the aircraft industry to meet every requirement of production as well as actual service.

Exceptional production efficiency is the result of special terminal design, and AMP Precision-Die Installation Tools, illustrated below.

AIRCRAFT-MARINE PRODUCTS INC. DEPT. R 286 N. BROAD ST., ELIZABETH, N. J.

AIRCRAFT-MARINE PRODUCTS INC. AMP SOLDERLESS WIRING DEVICES

Canadian Representative: A & M ACCESSORIES, LTD., TORONTO, CANADA



THREE PERFECT CRIMPS AT ONE TIME

Diamond Grip Precision-die hand, foot and power operated installation tools materially reduce production time and assure uniformity of application without the necessity of worker pre-training. These self-gauging tools make three perfect crimps at one time—every installed terminal is the exact duplicate of all others in the line.

THE AMP SYSTEM OF SOLDERLESS WIRING

Unbiased laboratory tests of AMP Diamond Grip Terminals show no significant change in resistance even under the severest operating conditions, including a multiplicity of circuits, variations in current, voltage, temperatures and corrosion.

Write today for Bulletin No. 19.


TAYLOR TUBES
...Veterans in Freedom's Cause!
...WHEN YOU'RE IN THE THICK OF IT
You Realize the Value of Superior Equipment
Long before America herself was at war, Taylor Transmitting Tubes proved they could stand up under the gruelling stress of actual combat on many Allied Battlefronts.
Today, thousands of Uncle Sam's fighting communications men know the assurance of Taylor dependability — know that Taylor Tubes deliver maximum power and extra hours of performance far beyond the needs of normal service.
With each passing day, the growing production of Taylor Tubes becomes an increasingly decisive contribution toward Victory. With this goal attained, Taylor will again supply many advanced types of "More Watts Per Dollar" tubes to peacetime America.
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"OVER TO YOU - OVER —··· —·—"

"The listening is often as important in this man's war as the doing or the talking—so when I throw it over to a reconnaissance plane, an observation post or general headquarters—this headset better work and work right."

ROGER—soldier, it *will* work okay! It will work as right as precision manufacturing, careful inspection and the determination of Utah workmen can make it.

Headphones are only one of the many products now being manufactured by Utah for the armed forces. A wide range of electrical and electronic devices is now being built in the Utah factories—important parts that must be made with split-hair precision in order to take their vital places on the fighting or war production fronts.

Utah is aiding in the solution of vital wartime problems in many plants—gathering a great store of electrical and electronic experience. "Tomorrow" that knowledge and experience will be aiding you. Because of the great advances necessitated by war, peacetime America will know greater enjoyment in the home—greater efficiency in the plant.

UTAH RADIO PRODUCTS COMPANY

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PARTS FOR RADIO, ELECTRICAL AND ELECTRONIC DEVICES, INCLUDING SPEAKERS, TRANSFORMERS, VIBRATORS, UTAH-CARTER PARTS, ELECTRIC MOTORS


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MULTIPLE ELECTRICAL CONNECTORS – The newest type Breeze Connectors, carrying from 1 to 47 contacts, conform to latest A-N specifications. Designed in sizes and types to meet practically every need in modern electrical control and communications systems, they provide a means of connecting and disconnecting many circuits simultaneously, quickly, and with safety.
FLEXIBLE SHIELDING CONDUIT – Breeze Flexible Shielding Conduit, enclosing the wires of an electrical system, prevents radiation or absorption of radio frequency interference. Breeze Conduit is furnished in numerous types and sizes to meet the specifications of various U. S. Government services.
RADIO IGNITION SHIELDING – Breeze engineers pioneered the development of shielding harnesses for hundreds of types of aircraft, marine, and automotive engines. The design of assemblies for Army, Navy, Coast Guard, and commercial installations, enables Breeze to furnish correct equipment for any shielding requirement.
These are only a few of the many Breeze products, but they make up a communications team that is helping coordinate America's drive to Victory.
BREEZE MARK
Breeze
BREEZE CORPORATIONS, INC.
Newark, New Jersey

projects in our world-wide war effort is obvious though not always recognized.

In 1941, service testing of ultra-high-frequency radio ranges was conducted on the Chicago-New York airway. On the basis of this experience, which confirmed the experimental findings of CAA engineers over a three-year period, the present rapid conversion to UHF is taking place, which will prove of great value in minimizing interference and distortion, particularly in mountainous country.

Ultra-high-frequency development in 1942 standardized our two-course visual and aural ranges.

With emphasis upon war needs, the intercontinental station at New York was supplemented in 1942 with similar facilities at San Francisco; Everett, Washington; Anchorage, Alaska; Honolulu; and New Orleans. Their usefulness will, of course, continue after the war.

I shall leave it to Tommy Bourne, the CAA's Director of Federal Airways, to predict the probable future developments of our airways system and the radio's part in it. But this brief review makes plain, I believe, that airways radio pioneered an untouched field. Starting with nothing, it has become in 25 years a major factor in building the world's greatest system of airways.

But in creating what we have today, we have merely opened up avenues to a future use of radio in aviation which may make our present level of development seem primitive. The CAA, in cooperation with the radio industry and other interested agencies, will do everything in its power to push forward along these paths.

—30—

Radio Ranges

(*Continued from page* 129)

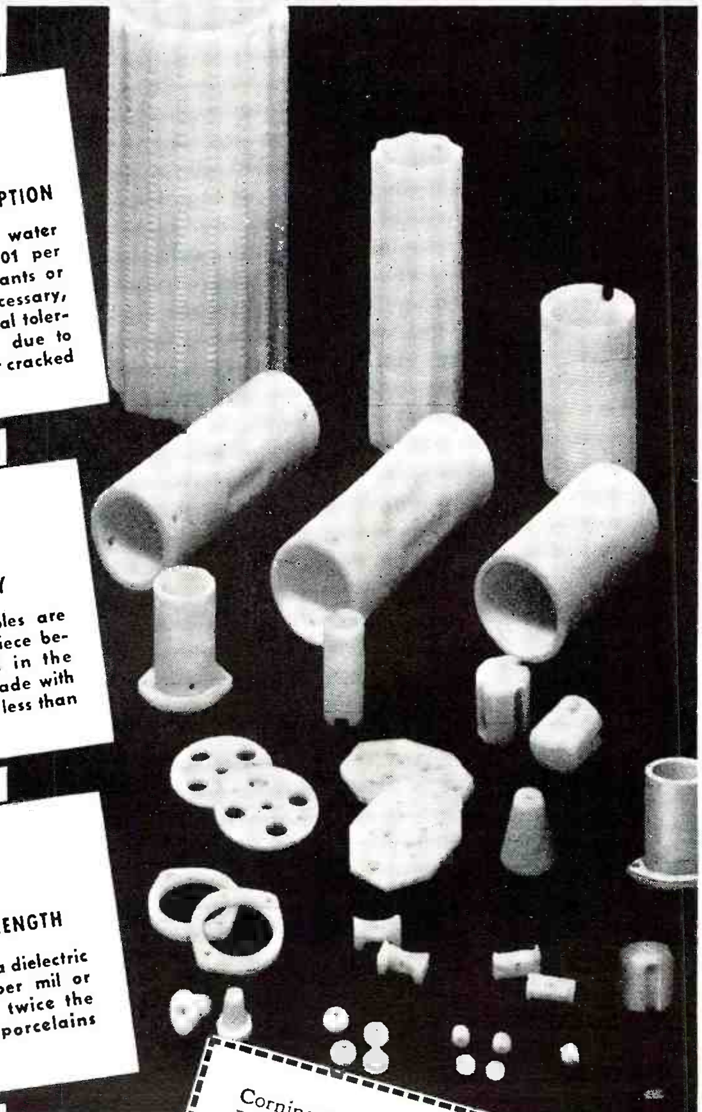
energy radiated from the center element combines vectorially with the radiation from the corner elements to produce a field pattern resembling two cardioids with axes extending in opposite directions along the line of radiators, and two points of intersection directly at right angles to the line of radiators. In one of these cardioid patterns the 90 cycle modulation predominates, in the other the 150 cycle modulation, while at the points of intersection both modulations are equal. Thus, the line of intersections defines a course with modulation at one frequency greater on the one side and the other frequency greater on the other side.

The other pair of radiators produce aural courses at right angles to the visual courses in exactly the same way, except that a single modulation tone frequency is used and the courses are defined by keying an N into one cardioid and an A into the other. The center antenna common to both systems must radiate the carrier frequency

ENGINEERS!

CHECK THESE SIX OUTSTANDING FEATURES OF

NEW CORNING MULTIFORM GLASS INSULATION



1
MINIMUM FREQUENCY DRIFT

Absence of hot flow and cold flow, maximum dimensional stability and minimum expansion combine to provide a minimum of frequency drift. Often it is not necessary to use crystals or other compensating devices.

2
NEGLIGIBLE WATER ABSORPTION

Multiform glasses show a water absorption of less than 0.01 per cent (24 hours). Impregnants or added glazes are unnecessary, assuring better dimensional tolerances. Loss of efficiency due to improper impregnation or cracked glaze is eliminated.

3
LOW LOSS FACTOR

Insulators, made from Multiform glasses, offer you definitely greater efficiency. Multiform glass #707, for example, has a loss factor of only 0.40 at 20°C,—1 Meg.

4
UNIFORM ACCURACY

Threads, grooves and holes are accurate from piece to piece because they are molded in the piece. All sizes can be made with tolerances of ±2.0%, not less than ±0.010″.

5
EXTREMELY WIDE RANGE OF SIZES AND SHAPES

There's almost no limit on shapes, cylindrical or flat. In size, pieces range from tiny beads, several thousand to the pound, to 25-lb. pieces 15″ or more across.

6
HIGH DIELECTRIC STRENGTH

Multiform glasses have a dielectric strength of 500 volts per mil or more—approximately twice the dielectric strength of porcelains and steatites.

MAIL COUPON TODAY FOR FREE SAMPLE AND DATA

Corning Glass Works, Corning, N. Y.
Insulation Division, Dept. RN-6

Please send me immediately, without charge, sample and descriptive booklet on new Pyrex brand Multiform Insulators.

Name..............................

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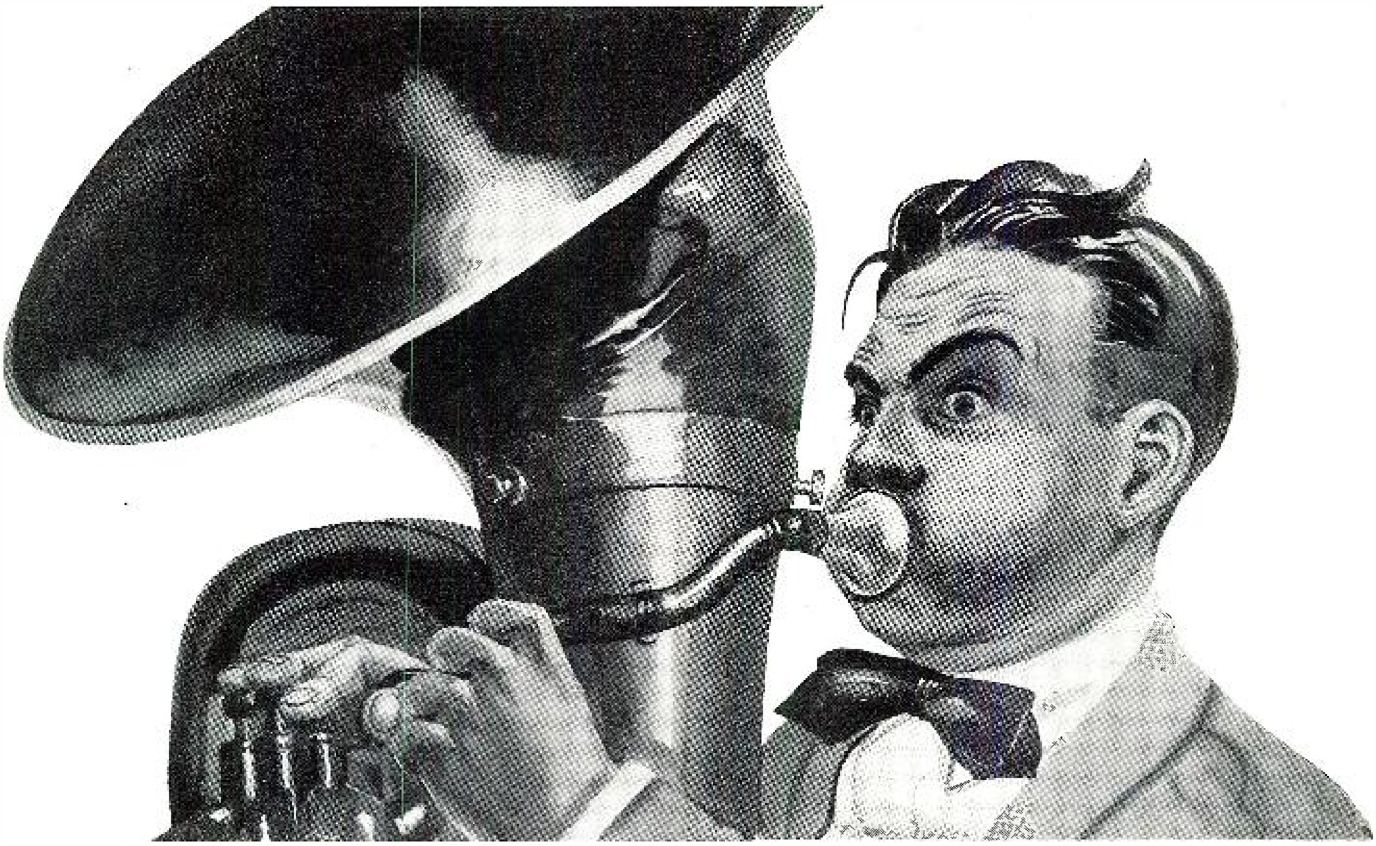
Pyrex Insulators
BRAND

"PYREX" is a registered trade-mark and indicates manufacture by Corning Glass Works



HORN-TOOTING

We have never boasted of our accomplishments. We knew we were doing a good job . . . our customers knew it, too.

The smaller, but paradoxically more publicized division of our organization, was devoted to the manufacture of **FEDERAL ENLARGERS** . . . precision optical and mechanical instruments for the photographic market. The major portion of Federal facilities has been serving the Signal Corps and leading radio equipment manufacturers for more than fifteen years.

Came Pearl Harbor . . . and our **entire** productive capacity immediately was placed at the disposal of the Armed Forces. With justifiable pride we can say that we were among the first to receive the coveted Army-Navy "E."

With production efficiently geared, we are now sufficiently far ahead of all current schedules to permit us to solicit additional contracts. We invite orders for the manufacture of large and small assemblies to precise tolerances . . . electrical and mechanical.

At this time, would an occasional "horn-toot" be excusable?

FEDERAL

Electronics

Division of

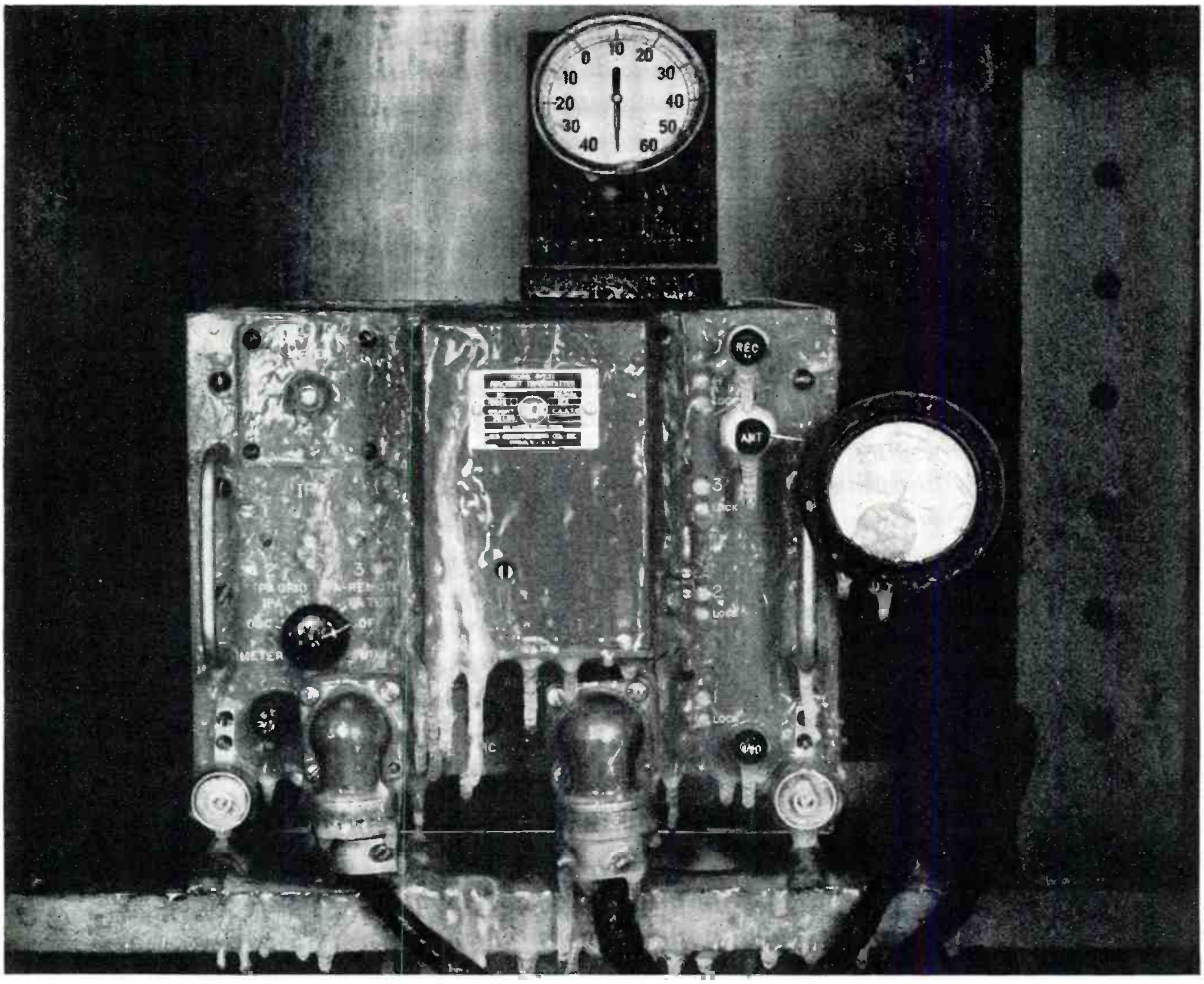
FEDERAL MANUFACTURING AND ENGINEERING CORPORATION

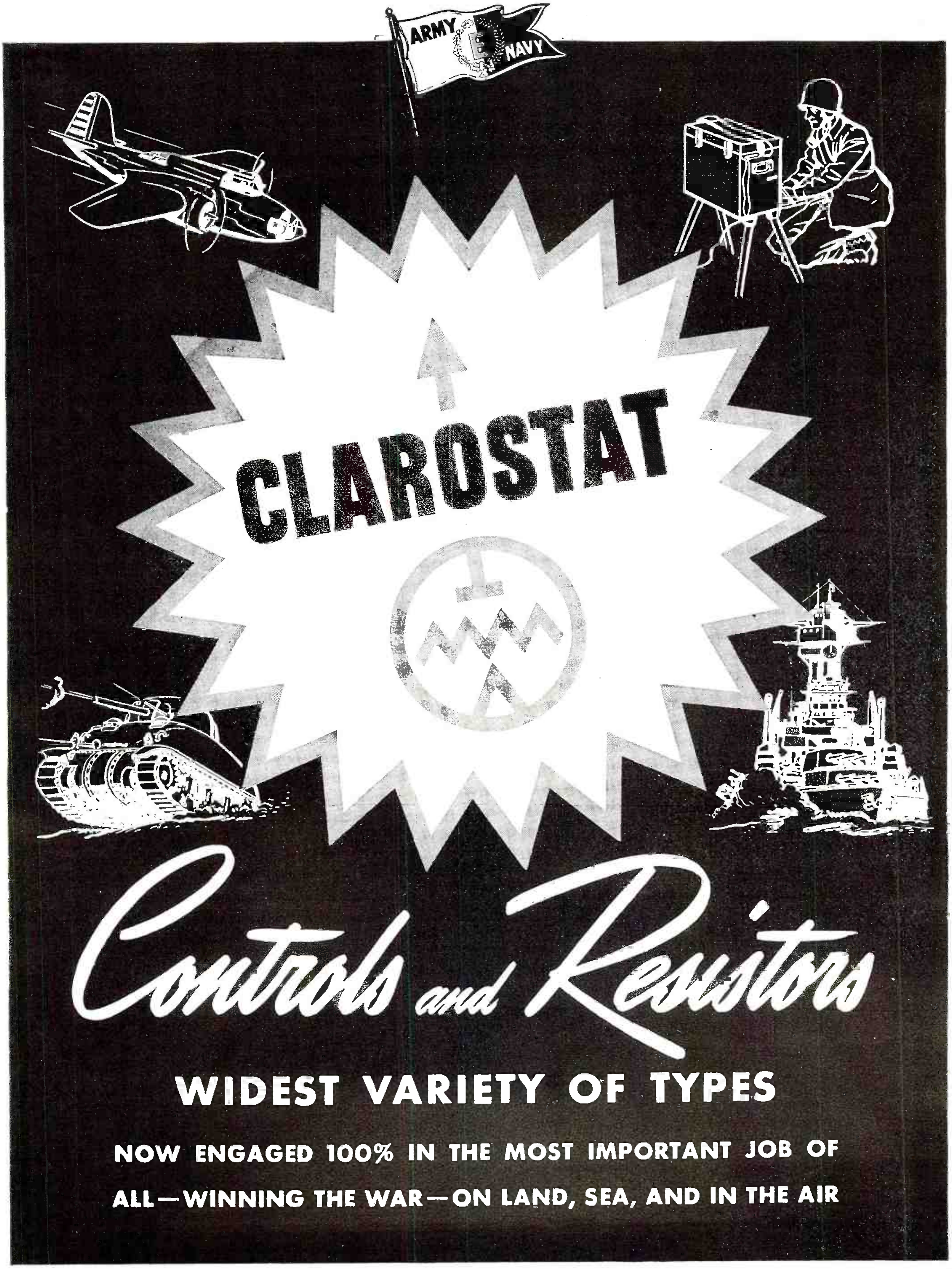
Manufacturers of FEDERAL ENLARGERS

209 Steuben Street — Brooklyn, New York

ARMY E NAVY

★ ★ ★ ★ ★ AWARDED TO FEDERAL MANUFACTURING & ENGINEERING CORP. FOR HIGH ACHIEVEMENT





CLAROSTAT MFG. CO., Inc. • 285-7 N. 6th St., Brooklyn, N. Y.

and all of the side bands required to produce the desired directional patterns in combination with the radiation from the corner antennas.

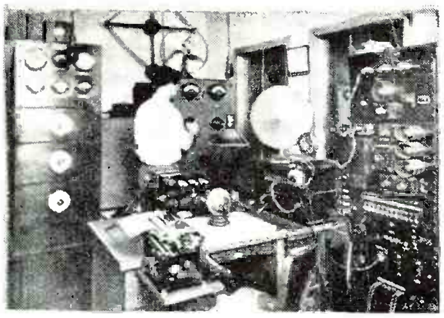
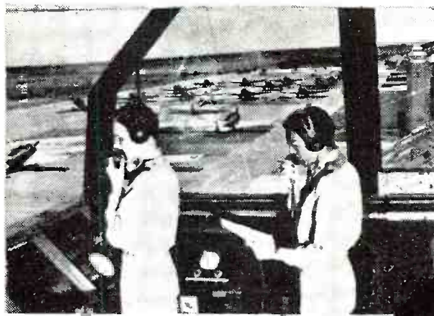
The aircraft receiver for use with the UHF range is of conventional design. It has two independent output circuits; one for the 90 and 150 cycle frequencies which actuate the visual meter, and the other for the tone frequency and speech. The 90 and 150 cycle frequencies are separated by two band pass filters. The outputs of the filter sections are rectified, and the resulting d.c. voltages are applied in opposition to the zero-center meter so that it deflects to one side or the other depending upon whether the 90 cycle or 150 cycle signal is the stronger.

The two-course-aural and two-course-visual range system has a number of important advantages over the four-course aural range in addition to those already cited. In the case of the four-course range, the same "off course" signal is heard in either of two opposite quadrants. When a pilot is completely lost and must rely upon a four-course range for orientation, it may be a tedious and time-consuming process to determine which of two quadrants he is in. The two-course-aural and two-course-visual range, on the other hand, has no quadrant ambiguity, since its courses are formed by four unidirectional patterns rather than two bi-directional patterns. In this, too, the course indications are produced by varying modulation levels in the field about the station while the carrier itself is radiated in a circular pattern and does not vary with azimuth. It is thus possible to use automatic volume control in the aircraft receiver to eliminate or reduce fades and surges in the signal level over rough terrain without affecting the definition of the courses.

In 1941 the Civil Aeronautics Administration initiated a five-year program to shift its radio range system to ultra high frequency operation. This program has been interrupted by the war, but it is safe to say that ultra-high frequency aids to navigation will play an important part in our future airways.

—30—

BE A RADIO TECHNICIAN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Engineering
(*Continued from page* 107)

foot Continental Divide in the Rockies about due west of Pueblo, Colorado, and then proceed 100 miles south of Omaha and 75 miles south of Chicago. While strict adherence to this direct route would please the non-stop transcontinental stratoliner operators, the important intermediate cities of Denver, Omaha, Chicago, and others would be too far off the route to make full use of the radio aids by planes serving these intermediate points. Diversion from the great circle route, required to route the traffic through Denver and Chicago, would add a negligible distance and make possible the serving of these major centers of population.

Having determined the routing of the airway and selected the type of radio aids to be installed, consideration must next be given to the general plan for establishing and operating radio range and communication stations. The two principal factors in a plan designed to serve the needs of all are:

(a) the problem of providing radio courses over the airway as well as courses for instrument letdowns into airports, and

(b) provision for the ever-increasing traffic control requirements.

From available information and experience gained through extensive study in experimentation with a test installation of six UHF ranges (Fig. 2 shows tower and building used for UHF ranges), it appears that no attempt should be made to locate airway ranges to provide range courses for letdowns at intermediate airports. Rather, sites should be so selected that the ranges will best serve the primary purpose of providing airway coverage. UHF radio range transmitters from a ground station follow a so-called line of sight, or a line tangent to the earth's surface. If there are no intervening obstructions above the line connecting the plane's receiver and the transmitting station, the earth's curvature is such that at a distance of 50 miles from a UHF transmitter there is little or no signal strength below an elevation of 900 feet. Therefore, to eliminate the necessity of having planes fly at extreme heights, which is impracticable for short hops, range stations should be installed at intervals of not more than 100 miles. Terrain characteristics will necessitate deviation from this pattern and, in general, will require placing stations on higher elevations.

With such a system of airway ranges there will be no problem in getting on the course or beam after taking off from either the terminal or intermediate points. The arrangement will be such that the airport will be on course, and a plane immediately after takeoff can assume a proper heading and

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pick up the range signal within two minutes of the time required to climb up to the signal area. For letdown purposes many airports, including those at Los Angeles, Chicago, and New York, are being equipped with UHF instrument landing systems. The localizer of this system, which has a range of from 12 to 16 miles, will provide the course on which the instrument approaches and letdowns can be made. To connect off-course cities, such as Pueblo and Cheyenne, for example, additional ranges will be required, but in all cases the ranges will be installed with a view to serving the airway rather than airports. Cities such as Omaha will be sufficiently close to the line of airway ranges to enable the plane to pick up the localizer course and proceed into the airport on an instrument approach without an intermediate range.

Traffic control over such an airway presents numerous problems, but certainly none that are more complicated or vexatious than those now existing in the vicinity of the larger municipal airports and military training bases. The airway communications could possibly be handled best over our proposed Los Angeles-New York route by establishing UHF communication stations at alternate intermediate range locations along the airway and providing facilities and personnel at such stations for the control and handling of all airway traffic. This would relieve the congestion now existing at major airport terminals where airway and airport traffic control are both centered at the airport. It would also enable a plane to communicate successively with the airway control stations during progress over the route and enter into communication with the airport traffic control station only in the event a landing is to be made. Thus, every airport traffic control center would be relieved of the necessity of handling any traffic with planes not intending to land at that airport. Planes making through flights would be handled by the airway control and communication stations exclusively.

In the foregoing discussion only general problems involved have been touched upon. No attempt has been made to discuss in detail the problems encountered in conducting surveys, awarding contracts, supervising construction, and other things that must be done prior to the installation of any radio equipment.

On the attached chart the arrangement of UHF range stations serving the proposed route between Los Angeles and New York, with connecting lines to the Pacific Northwest and Florida, is shown. These routes were selected merely for the purpose of illustration.

It can be seen from the above remarks that considerable progress has been made on these installations. It must of necessity await full completion until such a time as peace is again with us.

—30—

Communications
(*Continued from page* 115)

facilities. Fields are inspected frequently, and the radio ranges are monitored continuously. Should a field become unsafe, or operation of a radio facility become erratic, a Notice to Airmen is transmitted promptly and adequate distribution insured by posting on bulletin boards at airports and broadcasting the information by radio for aircraft in flight.

Before taking off on a flight along the airways, the pilot files a flight plan with our personnel. Information includes the altitude at which he wishes to fly, the route, point of first intended landing, proposed cruising speed, radio transmitting frequency, estimated elapsed time for flight and the alternate airport at which he would land if unfavorable weather prevented a landing at the intended destination. The flight plan must be transmitted to communication stations and traffic control centers along the flight path of the aircraft in order that its approximate position can be estimated by ground personnel at any time.

While the aircraft is en route, our communications men and women maintain a continuous radio receiving watch on the frequencies which may be utilized by the pilot in communicating with the ground. They must stand ready every minute of the hour, every hour of the day and night to furnish every service at their command. From this most important duty the title of our operating personnel "Aircraft Communicator" has sprung.

The Facilities

To more clearly describe the operation of our facilities, the landlines and radio communication services will first be considered separately. There are 98,483 miles of landlines facilities in operation. These are divided for specific services and identified as follows:

Schedule A (Teletype)* Collection and dissemination of hourly and special surface weather reports; Notices to Airmen; coded aircraft landing and meteorological advice; winds aloft reports and limited forecasts.

Schedule B (Teletype)* Aircraft movement and control information.

Schedule C (Teletype)* Collection and dissemination of synoptic weather reports used in preparation of weather maps, airway and terminal forecasts, winds aloft reports.

Schedule F (Interphone) Communications relative to the movement and control of air traffic.

* NOTE: Radiotelegraph point-to-point communication is utilized where landline facilities are not available, principally in Alaska.

Space does not permit a detailed description of all landlines communications facilities, but I should like to describe features of at least one. For this purpose the Schedule "A" network will be selected, and the reader will refer to the chart on the CAA Federal Airways Communication Stations (Page 114). This drawing indicates the points from which hourly and special weather observations are made available for airmen. The numerals shown in the body of the drawing identify circuit numbers. To establish an example of circuit operation, let us refer to Circuit No. 4, one terminal of which is at Atlanta and the other at Fort Worth (indicated by arrows). The collection of hourly weather reports begins at 30 minutes past the hour. A few minutes before "collection" time, weather observations are made, and the reports perforated on tape for automatic transmission.

At exactly 30 minutes past the hour, the communicator on duty at Fort Worth throws a switch controlling the equipment which transmits the Fort Worth weather report to Circuit No. 4. His report, and those following from other stations, will be received simultaneously on teletypewriter machines at all stations on this circuit. Upon completion of the Fort Worth report, the communicator at Atlanta switches his transmitter into operation, and the Atlanta report is received at all Circuit 4 stations. This procedure continues until all stations have transmitted their local weather reports in the established order. All reports will then be available at all stations on the circuit, and the collection is considered complete.

See (Page 115) for an example of a weather report perforated on tape for automatic transmission, the same report as received on the teletypewriter and the translation of the report into plain language. The symbols utilized in transmission were developed in order to accommodate the volume of reports required for safety and efficiency of aircraft operations. The saving in circuit time is obvious.

The collection of weather reports from the 49 stations on circuit 4 is completed within eight minutes and ten seconds. Many of the reports are required in other parts of the country, and reports from other areas are needed at stations on Circuit 4. While this collection is in progress similar collections are being made on all of the circuits of the Schedule "A" network. Immediately upon completion of the collections the automatic teletype relay stations begin the intercircuit relays of selected reports. For example, weather reports from Miami and other southern stations are required in Chicago, Washington, and New York for flight dispatching purposes. Chicago is on Circuit 5, Washington and New York are on Circuit 3. The Circuit 4 reports from the south are therefore relayed to Circuits 3 and 5 by Atlanta, which is on all three circuits. Similar intercircuit relays are carried on over the entire system—the goal being to have the proper weather reports at the points where they are needed for flight planning. Scheduling of the teletype operations has, of necessity, been developed to the highest possible degree. Every second of the minute is considered in the National Communication Schedule, and failure of the communicators to adhere to this schedule faithfully would result in indescribable confusion. The personnel at our communication stations is probably more "time conscious" than any other individuals in the world.

The other landline facilities, Schedules "B", "C", and "F" will not be described in detail. All carry information vital to the safe operation of aircraft, which requires that transmissions be accomplished with the utmost dispatch. We are striving constantly to improve this service, and the assistance of friendly gremlins who can shorten the time required for an electrical impulse to travel from here to there will be appreciated greatly.

Radio communication is clamoring for attention and, having seniority in the airway service, cannot be longer denied. Back in 1918 radio carried the news that some chap had taken off from New York for Chicago in one of those airplanes with a few sacks of mail. Everyone felt sure the airplane would arrive at its destination if the motor didn't "conk", the fabric didn't tear off the wings in a strong wind, and the pilot was able to dodge the mountains en route. Providence was kind and most of the intrepid "giants" of the early air mail service did manage to get through—sometime during the week. This encouraged everyone and before long the air mail radio stations were announcing the departure of aircraft for destinations across the continent. The pilot had no radio contact with the ground, but the number of stations had increased and upon landing he was fortunate enough to have a weather report from the station ahead and might know whether to expect "snow in the mountains and rain in the valleys." Then—oh, happy day—the experts "dreamed up" radio equipment for aircraft, radio ranges and weather broadcast stations. With these "luxuries" and the addition of reliable instruments in vastly improved aircraft the more rugged individuals were soon "busting" right into the overcast, flying "blind" for hundreds of miles and "breaking out" over an airport at which a safe landing could be made. Thus did the age of modern air transportation begin.

Today the Communications Division operates 415 radio stations throughout the United States, Territories and Possessions. The radio ranges, "sound paths of the sky," guide thousands of aircraft to their destinations, whether journey's end be Miami, Nome, or Honolulu. As in the case of the landlines, radio communication has necessarily been streamlined to the 'nth degree. Loquacious airmen and those disposed to make unnecessary contacts are becoming increasingly unpopular. Where landline facilities are not feasible for the dissemination of weather information, point-to-point radiotelegraph fills the gap. Here again streamlining is the watchword. For example, the sky condition "high, thin scattered clouds" is transmitted on the radiotelegraph circuits as "–···– ––··–– –··–·" which saves 59 characters and spaces over the full plain language transmission.

Simultaneous radio range and voice communication stations are now in general usage. This permits voice communication with an airman without discontinuance of the radio range transmission, which other airmen may be using to work out navigation or landing problems.

Our several intercontinental radio stations are, as the name implies, engaged in world-wide aeronautical communication work. This service, like interstate communications, has definitely gone to war. Our communicators regularly contact aircraft thousands of miles from our shores, providing service to facilitate the completion of missions which hasten the day of victory.

Technical details concerning the radio transmitters and receivers operated by our communicators are shown on other pages of this publication. Let it suffice to say here that the engineering and maintenance divisions of the CAA are constantly on the alert to provide and maintain the finest communications equipment available at this stage of development.

The Men and Women on the Job

The finest communication equipment in the world goes for naught if the communicator at the controls is "asleep at the switch." Our foremost objective, then, is to assure ourselves that the human element shall not be wanting when the need for service arises. The aircraft communicator must possess a deep sense of responsibility for the safety of those who fly the airways and be able to utilize properly every facility which may be available to insure safety. We are attempting, therefore, to develop an army of super-efficient men and women. They must carefully note the passage of seconds and meet scheduled operations on the teletype or radio circuits. They must listen to the disturbance arising from the operation of several radio receivers, teletypewriters, interphones, and stand ready to respond to every call for service from pilots who want to go somewhere, and get there in a hurry.

I believe we'll have our supermen and superwomen. Incidentally, the girls joined us in the operating field after this country entered the war, and several hundred, after an intensive course of training, are now at our field stations. (Reports from the "provinces" indicate that they are really "on the job.") We are fortunate in being able to retain many of our seasoned communicators who are happy to take the newcomers in hand and show them how to "take care of the airways." Many unusual incidents are coming to our attention wherein aircraft communicators definitely establish the fact that they are helping to "keep 'em flying, safely." Still, we are not content, for we are becoming aware of many additional ways in which to improve the Federal Airways Communications Service. Additional equipment will be necessary in some cases; intensified training of personnel is the only solution to other problems.

We look to the day in the near future when our men and women will be able to provide the ultimate in service. They will have a thorough understanding of the problem faced by a pilot when he "hoists the anchor." The communicators, with improved facilities at their disposal, will scan flight conditions far in advance of the aircraft and recognize those which are potentially dangerous. The pilot will then be advised concerning unsafe conditions ahead which he, because of his detached position, cannot forsee.

In closing, I should like to mention the need of this Service for additional personnel. We are presently engaged in a long range program for the training of suitably qualified people in the exacting and highly responsible duties of the aircraft communicator. Unlimited horizons are ahead, and we anticipate the need for hundreds of men and women who are qualified, both through education and temperament, to assist in the expansion of the air frontiers. To those of you with vision who are not afraid to work, and who are willing to accept the heavy responsibilities —the field of aeronautical communications is open. Our activities extend north of the Arctic Circle and south to the Equator, and our surface transportation facilities include the dog sled and the outrigger canoe. Adventure can be yours in both work and play. In the work, particularly, you will find great satisfaction through contributing intelligent human endeavor to the end that those who fly the airways may do so with maximum safety.

—30—

Airway Maintenance

(*Continued from page* 117)

range station, which prevents overmodulation and tends to compensate for varying levels of the communicator's speech. The correct adjustment of the constant output amplifier is thus an important part of the technician's routine, and this adjustment is checked monthly, as well as the audio response or wave form check.

The smaller tubes in the transmitters are checked with a portable tube checker, the larger tubes, through the use of meters in the transmitter, a sufficient number being installed in each transmitter to check plate current in each of the higher stages. Transmitter output and antenna meters assist in maintaining proper output.

The radio range course signals, the most important function of the range station, are produced by the use of radiated field patterns of definite shapes. These patterns are dependent upon proper phasing of currents in antennas, and to a lesser extent upon the values of such currents. The most reliable check of the field patterns and of the courses is through actual field measurements by means of a battery-operated receiver, installed on each technician's truck. In addition the latter is furnished with an r.f. impedance measuring set to determine whether the r.f. transmission lines are properly terminated. The courses are ground-checked daily where there is a resident electrician and daily at other stations during the visits of the sector electrician. Line terminations are checked for sign and value of the reactance once a month. Termination of intermediate circuits is checked once each six months and during course realignment if necessary. In general, the ground-check is the most reliable, and impedance checks are useful in forecasting future trouble.

The testing of station location markers and fan markers is done by checking tubes, meter readings, and currents in the antenna elements, and by adjusting to standard output. As these transmitters cannot be given a ground check, reliance must be placed in antenna current checks and reports of pilots. At the range control station all tubes are checked monthly and whenever other tests indicate the presence of poor tubes. The sensitivity of all receivers is checked monthly, and the gain of amplifiers checked when percentage modulation of the transmitter is measured. Each technician is furnished with an r.f. signal generator, a "wobbulator," and an output meter for receiver checking. Where remote receiving antennas are used, the technician checks the tuning of such systems either by operating his signal generator as an antenna and noting output of station receiver, or by connecting the generator to the station end of receiving antenna transmission line and picking up transmitted signal on his truck receiver.

In addition to these electrical tests, all equipment is given careful visual inspection, especially relays and other operating parts, such as motor-driven keying devices. The Strowger switch must be periodically inspected and lubricated. The engine generator is checked for quick starting, proper frequency and voltage, satisfactory transfer of load, and proper adjustment of voltage controlled relays. Teletype equipment must be cleaned, lubricated, and adjusted, as well as the line relay.

In view of the importance of these radio aids to the successful functioning of the Federal Airways it might seem that they are not checked sufficiently often. It should be borne in mind, however, that the stations operate continuously 24 hours a day, and it is necessary to obtain the consent of many parties before they can be shut down, and then only under certain specified weather conditions. Even in good flying weather permission is difficult to obtain, for stations are frequently being used by pilots for training instrument flying.

In an organization as far-flung as CAA and with most of its maintenance technicians functioning alone without direct supervision, the achievement of a high uniform standard of performance is absolutely essential. A pilot judges our service as a whole and not by the relative efficiency of its several parts and administrative regions. In these days of instrument flying a pilot relies chiefly upon the airways facilities to check his progress and determine his whereabouts. Written instructions are used, of course, to establish and maintain uniform standards, but such instructions are not likely to be uniformly interpreted unless supplemented by the discussions and explanations made possible by personal contact. These contacts are made by maintenance inspectors, psychologically and technically qualified to instruct and counsel maintenance technicians and judge the quality of their work. The maintenance inspector is the big brother of the maintenance technician, looking out for the interests of the technician in his contacts with the regional office, bringing to the technician the viewpoint of that office.

Approximately twice a year each facility is visited by a maintenance inspector, accompanied by the maintenance technician. On these visits the inspector goes over the technician's file of instruction, explains any new ones that may have been issued, checks the latter's test equipment, and assists him in making his routine tests. Together they go through routines not required of the technician alone. The inspector thus determines the condition of the equipment and observes the electrician's skill. Upon completion of the tests the inspector outlines any corrective action to be taken and instructs the technician on how to accomplish it. Where practicable, the work is done before the inspector leaves the station. The whole procedure is one of friendly cooperation, the inspector helping the electrician by letting him do the work, thus combining training-by-doing with inspection.

Inspectors are always recruited from the ranks of the maintenance technicians. They are men who know from experience the problems of the latter. They are thoroughly familiar with the equipment to be inspected and always alert to signs of future trouble. These men are selected upon the basis of their technical background, their knowledge of the CAA service and its aims, and their personal qualities—

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INTERNATIONAL FLAG SIGNALS

A Undergoing speed trial
B Taking on or discharging explosives
C Yes (Affirmative)
D Keep clear, I am maneuvering with difficulty
E Directing course to starboard
F Disabled, communicate with me
G I require a pilot
H I have a pilot on board
I Directing course to port
J Sending a message by semaphore
K Stop your vessel instantly
L Stop, something important to communicate
M I have a doctor on board
N No (Negative)

INTERNATIONAL MORSE
(CONTINENTAL CODE)

LETTERS: A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

OPTIONAL LETTERS: ä, á or å, ch, é, ñ, ö, ü

FIGURES: 1 2 3 4 5 6 7 8 9 0

FIGURES IN ROUTINE REPETITIONS: 1 2 3 4 5 6 7 8 9 0

PUNCTUATIONS AND OTHER SIGNS: Period, Comma, Colon, Question mark, Apostrophe, Hyphen, Fraction bar, Brackets, Double hyphen, Underline, Understood, Error, End of message, Invitation to transmit, Wait, End of work, Starting signal, Separation signal, *Semicolon, *Quotation mark

Numerals and punctuation marks are the same in the codes for all languages.
*Not official but in general use.

COMMERCIAL "Z" SIGNALS

Signals take the form of advices when question mark is omitted. These signals are used on commercial radiotelegraph circuits throughout the world.

ZAL	Alter your wavelength.	ZTA	Transmit by auto.
ZHC	How are your receiving conditions?	ZBY	Break, go back yard. (Metro.)
ZAN	We can receive absolutely nothing.	ZBN	Break and go ahead with new slip.
ZSU	Your signals are unreadable.	ZPR	Rerun slip of present running.
ZWR	Your signals weak but readable.	ZRL	Rerun slip before one now running.
ZSR	Your signals strong readable.	ZPP	Punch plain only.
ZGF	........signals good for........w.p.m.	ZFB	Signals are fading badly.
ZGS	Your signals getting stronger.	ZFA	Failing auto.
ZGW	Your signals getting weaker.	ZRA	Reversed auto tape.
ZVS	Signals varying in intensity.	ZYS	What is your speed of transmission?
ZSH	Static heavy here.	ZSV	Your speed varying.
ZLS	We are suffering from a lightning storm.	ZBS	Your signals blurring.
ZWC	Wipers or clicks here.	ZDH	Your dots are too heavy (long), adjust lighter.
ZVP	Send V's please.	ZDL	Your dots are too light (short), adjust heavier.
ZWO	Send words once.	ZDM	Your dots missing.
ZWT	Send words twice.	ZDV	Your dots varying length, please remedy.
ZCT	Send code twice.	ZFS	Signals are fading slightly.
ZPO	Send plain once.	ZTH	Transmit by hand.
ZPT	Send plain twice.	ZHS	Send high speed auto..........w.p.m.
ZCD	Your collation is different.	ZSO	Transmit slips once.
ZCO	Your collation omitted.	ZST	Transmit slips twice.
ZSF	Send faster.	ZOR	Transmit revs continuously.
ZSS	Send slower.	ZIB	Give long breaks, please.
ZRO	Are you receiving ok?	ZUB	We have been unable to break you.
ZOK	We are receiving ok.	ZNB	We do not get your breaks, we send twice.
ZIR	Your transmitter has strong idle radiation.	ZLD	We are getting long dash from you.
ZRC	Can you receive code?	ZAP	Acknowledge, please.
ZNG	Receiving conditions no good for code.	ZMQ	Stand bi for ....
ZNN	All clear of traffic.	ZMO	Stand bi moment.
ZHY	We are holding your	ZKQ	Say when ready to resume.
ZCS	Cease sending.	ZOH	What traffic have you on hand?
ZMP	Mispunch or perforator failures.	ZVF	Signals varying in frequency.
ZCW	Are you in direct communication with ....?	ZFF	Please observe and furnish frame code reports on .... (call-letters and frequency) kilocycles.
ZHA	How are your conditions for auto reception?	ZOA	We have checked (transmitter call-letters) .... Signals are radiating on air ok.
ZUA	Our conditions unsuitable for undulator or automatic recording.	ZCP	Local receiving conditions poor; please increase to maximum.

AERONAUTICAL "Q" SIGNALS
Used Especially in Airways Communications by Authority of the FCC.

QAA	At what time do you expect to arrive at ....?	QBC	Can you transmit to me the meteorological observation at present made by you from the aircraft?
QAB	Are you making for ....?	QBE	I am about to wind in my aerial.
QAC	Are you returning to ....?	QBF	Are you flying in cloud?
QAD	At what time did you leave .... (place of departure)?	QBG	Are you flying above cloud?
QAE	Have you news of .... (call sign of the aircraft station)?	QBH	Are you flying below cloud?
QAF	At what time did you pass ....?	QBI	The bad visibility regulations are in force.
QAG	Arrange your flight in order to arrive at ...... (time) at ...... (place). OR I am arranging my flight in order to arrive at ...... (time) at ...... (place)	QBJ	At what height is the upper limit of cloud?
QAH	What is your height?	QBM	Has .... sent any message for me?
QAI	Has any aircraft been signalled in my vicinity?	QBN	Are you flying between two layers of cloud?
QAJ	Shall I try to search for an aircraft in my vicinity (or by any other indication)? OR Shall I try to search for aircraft ...... in my vicinity (or by any other indication)?	QBT	You are missing your dots.
QAK	Is another aircraft flying in my vicinity, involving a risk of collision? OR Is aircraft ...... flying in my vicinity involving a risk of collision?	QBU	Are you sure of the accuracy of telegram ....?
QAL	Are you going to land at ....?	QBW	Did you receive the telegram sent at .... (time)?
QAM	Can you give me the latest meteorological weather report for .... (place of observation)?	QCA	You are causing delay by your slowness in answering.
QAN	Can you give me the latest meteorological report concerning surface wind for .... (place of observation)?	QCB	You are causing delay by answering out of your turn.
QAO	Can you give me the latest meteorological report concerning upper wind for .... (place of observation)?	QCG	Shall I stand guard for you on the frequency of .... kilocycles (wave length of .... metres)?
QAP	Shall I listen for you (or for ......) on ...... kilocycles (or ...... metres)?	QCM	There seems to be a defect in your transmission.
QAQ	Am I in the vicinity of a prohibited area or of .... prohibited area (name of the prohibited area)?	QCP	Your note is bad.
QAR	May I stop listening on the watch wave for .... minutes?	QCS	My reception on long waves has broken down.
QAS	You are flying over a prohibited area or over .... prohibited area (name of prohibited area).	QCT	My reception on short waves has broken down.
QAT	Shall I continue to send?	QCY	I am working on trailing aerial OR Work on trailing aerial.
QAX	Have you in your aircraft the following person for whom I have a waiting radiotelegram? (Here follows the designation of the person as it appears in the address of the radiotelegram: name and qualifications).	QDB	Have you sent telegram .... to?
QAZ	Are you flying in a thunderstorm?	QDC	Telegram ...... has been sent by wire.
QBA	What is the visibility at ......, (place)?	QDD	Telegram No. ...... has been refused by ...... as not in order. Please inform sender.
QBB	What is the height of the cloud base at .... (place)?	QDH	What is causing the present interference?
		QDK	Answer in the alphabetical order of the call signs.
		QDL	Do you intend to ask me for a series of bearings?
		QDM	What is the magnetic course to steer with no wind to make for you or for ....?
		QDO	Can you have transmitted by .... station, on its working wave (or on the .... wave), its call sign followed by a prolonged dash for ...... minutes, in order to permit me to use my aircraft D/F installation?
		QDR	What is my magnetic bearing in relation to you or to ....?

(Complete code available on request)

Certain other codes and signals are omitted because of present day restrictions.

AMERICAN MORSE

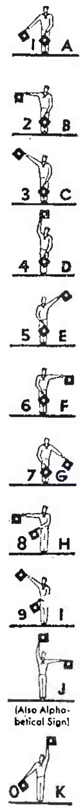
Letters: A B C D E F G H I J K L M N O P Q R S T U V W X Y Z &

Figures: 1 2 3 4 5 6 7 8 9 0

Signs: Period, Comma, Hyphen, Question mark, Exclamation mark, Colon, Parenthesis (......), Quotation, End of quotation, Colon dash, Capitalized letter, Small letter, Colon followed by quotation, Semicolon, Paragraph, Apostrophe, Dollar, Cents, Pound Sterling, Shilling, Percent

Punctuation composed by Walter P. Phillips in 1876. He also made a compilation of few letter abbreviations of about 2000 commonly used words. This "Phillips Code" is used by newspaper telegraphers.

SEMAPHORE CODE



(Also Alphabetical Sign)

THE McELROY METHOD
FOR TRANSCRIPTION OF RADIO TELEGRAPH SIGNALS

1 2 3 4 5 6 7 8 9 0 – =
Q W E R T Y U I O P ( )
A S D F G H J K L : ;

GREEK

GREEK LETTER	MORSE SYMBOL	
Α		Alpha
Β		Beta
Γ		Gamma
Δ		Delta
Ε		Epsilon
Ζ		Zeta
Η		Eta

RUSSIAN

RUSSIAN LETTER	MORSE SYMBOL	
А		A
Б		B
В		V
Г		G
Д		D
Е,Э		E
Ж		J

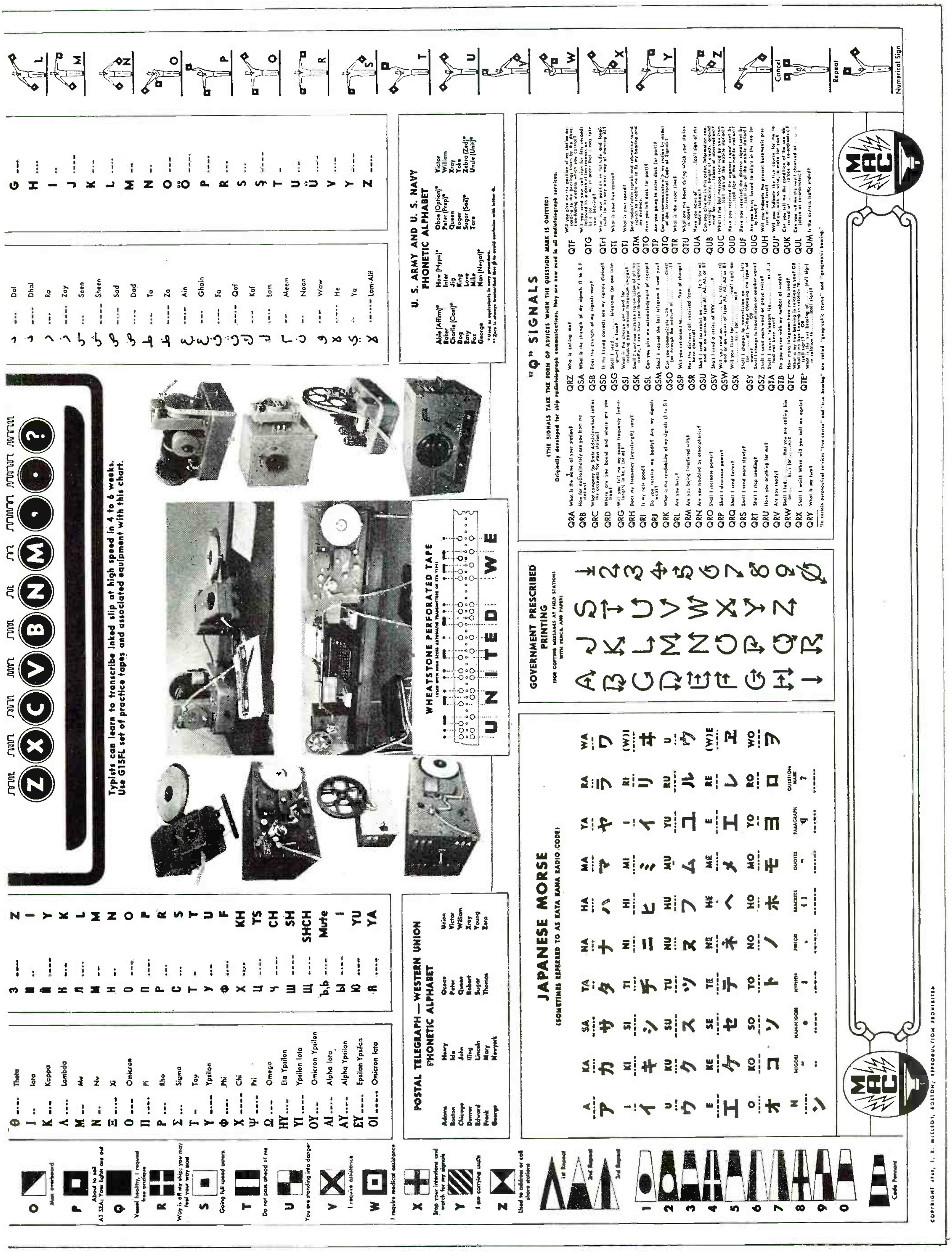
ARABIC

ARABIC LETTER	MORSE SYMBOL	
ا		Alif
ب		Ba
ت		Ta
ث		Tha
ج		Jeem
ح		Ha
خ		Kha

TURKISH

A, B, C, Ç, D, E, F

THIS chart appears through the courtesy of T. R. McElroy. The chart is 38"x25", linenbacked and beautifully lithographed in six colors. For full information as to how to obtain this chart see page No. 169.



tact, sympathy, ability to instruct, and initiative.

The majority of CAA maintenance technicians are former CAA radio operators, men whose main interest has been in the technical side of radio and have had the foresight to prepare themselves technically. As radio aids increase and more use is made of the ultra-high frequencies for special functions, there is growing need in the service of additional men with formal engineering training. To provide instruction in the operation, adjustment, and servicing of the special equipment used by the CAA, a special training center is being established at Fort Worth, Texas. Men from 17 to 40 years of age will be accepted as trainees if they have had a high school education or equivalent study in mathematics and physics, and have had at least two years of experience in radio service work or as an active licensed radio amateur.

Here is an opportunity for qualified men in radio, for CAA maintenance technicians have an opportunity to gain the broadest possible experience by working on practically every type of radio equipment now in general use.

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Air Transport Command

(*Continued from page* 73)

curity, for example, and people trained in cryptographic work. This means many additional people required to do an equivalent job of a peacetime system. Besides this, the trend in the domestic aviation picture before the war was toward a greater use of radio telephone. With the requirement, however, of great distances to be covered and in many cases the limitations of size and weight and restrictions in power imposed upon the communications equipment to be used, radio telegraph re-entered the picture on a grand scale. It became necessary to train thousands upon thousands of additional personnel in radio operating as well as in the art of cryptography, message handling, and weather service operation. Then, finally, there is the matter of maintaining this gigantic new world-wide communications network, and the vast numbers of people trained to do it.

In the communications system established today along Air Transport Command routes is found every facility in the radio "book." First, are the point-to-point radio circuits that handle aircraft operational traffic and in many cases administrative traffic as well; then the weather circuits that are collecting and disseminating weather information in a never-ending stream. Next, there are the ground-to-air circuits for the direct control and assistance of aircraft enroute. Supporting this and an integral part of any station is the message center that properly routes and distributes all messages, and the Crypto Section for the encoding and decoding of the majority of messages that are sent. Finally comes the tie-in with the Air Transport Command Aircraft Operations Office itself.

It will be interesting to consider the radio aids to air navigation. In peacetime America, aids to air navigation, such as beacons, ranges, direction finding facilities, and weather reporting systems were operated for the most part by Federal Agencies. In those days the airlines were concerned mostly with establishing only their own Company communications. But when war struck, it became necessary for the Army Airways Communications System to provide every aid and facility and to do so with the utmost haste. To install such aids and make them function properly is no small task under ideal conditions, and is a tremendously complicated job to carry out in far remote locations with few personnel and even fewer means of doing the job.

No time for extensive and long-drawn out surveys and analysis of locations can be allotted here when a Nation is at war. Little selection of ideal "spots" took place. Rather, it was a matter of establishing a route between two points. Then a certain point on this route came under consideration. It must have a particular aid to navigation, and so there it was to be established. In many cases, it seemed that Nature herself was against the cause. Many strange quirks had to be overcome. Raw, rugged mountains, hardly explored, proved that they must have contained unknown metallic deposits for the erratic conditions that they caused, and where bare rock failed to provide an adequate "ground." In the higher latitudes, engineers were confronted with the peculiarities of the Northern Lights that played havoc with the best of plans—Northern Lights that confounded pilots and ground operators alike, sometimes for days at a time.

Throughout the whole tremendous development, it was a case of making the most of whatever was at hand, of devising new short cut means and methods, of exploring the frequency bands for new solutions. With this came new developments by the Signal Corps to aid the cause, to solve new and difficult problems. From the Civil Aeronautics Authority came equipment and engineering talent; from the Federal Communications Commission, assistance and cooperation. The airborne radio receivers and transmitters are excellently engineered Signal Corps equipment for the most part. In addition, there is one piece of apparatus that has repeatedly proved its great worth. That item is the airborne radio compass. There are several different types in current use, and for that matter were before the war. The emergency, however, has brought many new improvements and refinements. From the old "aural null" radio compass to the newest automatic direction finders is a long stride and a fortunate one for the pilots who are flying the vast distances of today. Celestial navigation has come a long way in connection with its application to aviation. It is a "must" aboard any long range aircraft, but when sun or stars are blanketed, the sole remaining direct aid to the pilot is frequently his radio compass. Here any remote marine radio beacon or barely audible broadcast station on some distant coast may well prove to be a veritable salvation.

In the opening days of the conflict, those pilots who flew for the Ferrying Command, as it was then known, well realized what it meant to have little or no communications. With their ships on well nigh unchartered courses, it took every resource of the radio operator, the navigator and the pilot to pull the ship through. A number of radio operators were subsequently decorated, along with their pilots and navigators, for the fine pioneering work that they did under difficult conditions of the early days of the war. As a great assistance in those days to many a vexed radio operator was the opportunity to utilize some of the existing facilities that had been instituted by the Royal Air Force. The great problem on long-range aircraft operation where many uncertain and variable conditions exist for the pilot, is the matter of knowing his position, of getting a "fix." To miscalculate a position and not be able to obtain a fix either celestially, by radio compass or from land based direction finding stations might well land a ship in the lap of waiting Japs or the open arms of the enemy on the French Coast. One operator told the story of flying the Atlantic. Severe storms were encountered. They went to 25,000 feet. The oxygen failed, and the navigator lost consciousness. They should be nearing the English Coast. Repeatedly the radio operator tried to establish contact. Finally he raised a British direction finding station only to find that they were hundreds of miles off course and headed straight for the Norway Coast.

When one compares the communications system of the United States before the war with the immense world lay-out of today, it shrinks into but a small comparison. Today a constant flood of traffic and a ceaseless vigil is being maintained over air routes that measure five, ten, or fifteen thousand miles in their extent. Radio aids and secretive devices must be kept operating on untiring schedules in hundreds of remote locations. The maintenance of this vast network means the successful operation today of the lone cargo plane, tomorrow the formation of heavy bombardment, and the next day perhaps "clouds" of airplanes of every type and description all bent on beating the Axis.

The Air Transport Command has pioneered and Communications have pioneered with it to carry out the most extensive movement of men and materials and the most concerted movement of aircraft that few would have believed possible but a few years back.

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Radio Mechanics

(*Continued from page* 67)

Strictest class discipline and attentiveness are maintained in ARE. The men in charge realize the importance of having the students learn thoroughly in the least possible time, and the phrase "time is short" has almost become a pass-word.

The officers of ARE have realized the strain that is put on their enlisted and civilian instructors in the classroom and laboratory, and every effort has been made to provide a comfortable place for the men to smoke, read, and study, in their spare time. An instructors' lobby has been furnished with easy chairs, writing desks and tables, and current magazines and newspapers.

When the student leaves the school after six hours of intensive study, he has absorbed an amazing amount of information. Of course his schooling is not over for that day—he still has homework and study to do at the barracks to prepare for the next day's class. And when he leaves ARE he has gained a knowledge of radio that would take many weeks to learn in a normal college course.

The men of ARE are proud of their course. They take a decided interest in all that pertains to their work, and feel a direct responsibility for the training of each and every man. Though the instructors many times wish they were out on the front lines with the men they have seen in their classes, they realize that they hold an important position in maintaining the ever-vital lines of communication for the Air Force.

Truax Field has only been in operation since last July. The first class started August 3, 1942, but already its graduates have become known as among the best in the Air Force. Col. O. L. Rogers, the commandant, assigns all credit to his instructors and staff, whom he calls "the best in the world." No doubt there is much in what he says, but on visiting the school, an outsider notes the complete absence of strain and fear, the good fellowship which permeates every classroom and the hard-working absorption of every man—all that indicates efficient and humane administration.

A student in a radio school, just as any student, looks forward to the day he will graduate and can go out "on the line" for active duty or be selected to go to an advanced radio school. One might think that after several weeks spent in strenuous, nerve-racking study there would be a tendency to "let down" in the final phases of the course. Radio maintenance being the final topic, offers things to the student from a practical standpoint, simulating school work with tasks that will actually be done out on the field of action. That does away with this so-called "let down." The student's interest is increased by using the different instruments and operating the different sets.

As a new development in training technique, airplane mock-ups came into existence with the arrival of a P-40 *(Warhawk)* fighter.

A technician was assigned the task of preparing the ship so that it could be used in connection with routine inspections by radio maintenance classes. During the following months, a B-25 *(Mitchell)* and a B-26-A *(Marauder)* were added to the section. Equipment was installed and students put to work, actually doing the type of job they will be called on to do when they are finally graduated as mechanics.

Mock-ups of the big bomber fuselages are used to give reality. Radio "shacks" in the larger planes are like small private offices, crammed with equipment. They are like offices, too, in that a certain amount of paperwork falls to the mechanics. They must learn how to fill out forms and reports, and how to use the Signal Corps catalogs.

At present, APM (airplane mockups) can boast of having in addition to the above mentioned ships, a wooden mock-up of the radio compartments of a B-17 *(Flying Fortress)*, a B-24 *(Liberator)*, a B-25 and a B-26. These ships and mock-ups are in constant use, 24 hours a day. When "Pfc. Smith" finally arrives in "Radio Maintenance," he is sent over to APM with the rest of his class and is assigned to a crew of eight or ten men under a "crew chief" (instructor). He spends the day on a tour of all ships and mock-ups getting acquainted with the installations and other interesting features. This is usually the first time that the average student ever gets into an army ship. Needless to say, "Pfc. Smith" is greatly interested. There is no need to make him keep awake; he is all eyes and ears and most eager to "dig in!"

The second day that Smith reports for duty at APM, he is again assigned to a crew and placed very much on his own. This is the day that he has been waiting for. His first assignment happens to be a pre-flight inspection on the P-40. He is given the inspection form and turned loose. Every part of the radio equipment is checked and noted on his form. Upon completion of this "pre-flight check," he is given the job of performing a "50-hour check" on the B-25. This is a little different, and Smith really begins to work. As time passes, he is given, in addition, a "100" and perhaps a "200 hour" inspection on the B-26, or B-24, or it may be that he is given the same tasks on the B-17 or other 'planes.

Interphone circuits, the blinker towers and radio nets precede graduation. The nets are interesting. Five students receive code in each room—each on a different frequency. The code is piped from another room where it is fed automatically from tapes. Because frequencies differ, each man must rely on himself alone. Devices called "echophones" mix static and interference with the code for realism.

Every RO student must go through the "pest hole" before graduating. That would be the equipment check room, where hard-hearted instructors hold a stop watch while the student races to set equipment at a given frequency. This is how a master sergeant described the operation.

First the student must adjust his frequency meter to the crystal oscillator for true frequency check. With the oscillator set to a given frequency the student brings his transmitter up to frequency by "beating" the two signals together on a receiver.

A light bulb flashes and the instructor eyes his watch. Excellent students complete the procedure in as low as 35 seconds time.

Two roving patrol trucks, filled with equipment, are kept busy 24 hours a day. In charge of a Non-com, each truck has a driver and three operators under orders to proceed to certain places and there to take over communications in voice and code. Sometimes the men are required to operate "en route".

The last course given to mechanics is called *aircraft radio maintenance,* in which contact with actual equipment in combat ships is used to gather all previously studied theory and practice into a compact, practical whole. In this class the student studies diagrams of aircraft radio transmitters and receivers, power units and junction and switch boxes. He learns the methods of observing and finding "trouble."

Inspections, which are necessary at regular intervals "on the line" as a means of locating trouble as well as finding potential trouble before it happens, are coordinated with "trouble shooting." Time is spent by the class in going through actual airplanes (complete with radio equipment) to acquaint each student with the "feel" of being inside. Inspections are carried on in routine manner and the prospective mechanic gets acquainted with other positions in the airplane as well as the duties of other crew personnel.

In the laboratory, classroom instruction is again coordinated and made real. Diagrams are followed and wiring is done on equipment. Transmitters are tuned to proper frequencies as determined by a frequency meter, radio sets are repaired by methods of "trouble shooting," and test equipment is used to the fullest extent.

March 1 was a big day on the operators' side of the fence at *Truax.* The new AACS (Army Airways Communication System) courses for operators began—the only one in the country.

This is an advanced course. In the regular operators' course men learn to send and receive a minimum of 16 words of code a minute plus 10 words a minute on the blinker system; and gain a knowledge of command and liaison sets, frequency meters and radio compasses. Thus primed, they are ready for air combat duty.

The AACS men are ground specialists. They sent the report of the *Casablanca conference,* and they have been the communication backbone of the North Africa drive.

They must be able to send and receive at least 25 code words a minute, transcribing on the typewriter at the same time. They must know weather intercepts, telephone and telegraph procedure, and operation of code and voice nets.

Like the RO (radio operator) course which it follows, the AACS course is 14 weeks long. (NOTE: These men have had 4 weeks or so of preliminary training elsewhere.)

To the careful observer, it is most apparent that these men are anxious to learn radio as quickly and as thoroughly as possible, in order to contribute their knowledge and experience when they reach our world-wide fighting fronts. They are willing, yes, *more than willing,* to do their bit towards achieving final victory. They are all true Americans, fully confident of their newly acquired powers of tearing apart and repairing complicated radio and electrical equipment. They realize, too, that their knowledge will, in most cases, be of greatest personal value in the post-war radio era. Never before has there been such a golden opportunity for the well-trained radioman to find his place in a more lucrative field than that embracing *"Radionics"* in all of its many phases. At present, they are devoting all their energies to combating our enemies, but when victory has been achieved, they will again return to civil life far better equipped, thanks to the complete training given to Uncle Sam's Radiomen!

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Development Labs
(Continued from page 240)

problem is in controlling corona. Special care is necessary even at voltages as low as 1,000 volts. Equipment is operated and tested in special low pressure chambers. An installation problem is often introduced with the necessity of seeing that sharp edges on terminals are avoided and some installations even require going to spherical terminal posts to reduce corona tendency (20,000 volt cable (at sea-level) breaks down at 5,000 volts at 15,000 feet!). Enclosed places with openings to the atmosphere (for example, in insulators) introduce the danger of condensation. The danger of electrical leakage under such conditions is, of course, greatly increased at higher altitudes.

Brush trouble and increased ignition "noises" require extra attention in rarefied atmospheres. Another difficulty at high altitudes, of course, is the design of microphones and headsets so that they will operate in conjunction with oxygen masks and associated equipment. Rarefied atmosphere will not conduct sound as readily from the mouth to the microphone and often the mere effort of speaking is a factor under the weakened condition of personnel operating at high altitudes.

Acceleration

Are you a pilot? If so, you have probably at one time or another made some very hard landings . . . most pilots have . . . particularly when operating out of "front line" bases. These landings are not good for radio equipment. As a result of landing and maneuvering, the aircraft structure may experience extreme acceleration. The disposition of the radio equipment in aircraft cannot be fixed, but must vary with each installation. It is essential that radio equipment, with its normal shock-absorber mounting, be able to withstand acceleration up to *Ten* G in any direction without damage!

Special vibration tables and shock tables are used in testing equipment. In aircraft, the take-off vibration amplitude is often excessive. (Particularly in modern high-performance military aircraft.) In addition, the equipment must be able to withstand the continuous vibration attendant upon airplanes in flight. Every piece of equipment and its components are tested at frequencies from 20 to 100 cycles per second with particular attention paid to any tendency for mechanical resonance within this range. Experiment has shown that "stiffening," so as to bring the resonance frequency up to several hundred cycles per second, is often effective in keeping the amplitude of vibration of the radio equipment down to safe values.

At first, cathode-ray tubes suffered from acceleration and vibration. They were satisfactory for ground equipment use and general television applications . . . but would not stand more than 5 G acceleration. Improved design, including strengthened internal mounting, has resulted; cathode tubes are now tested for 10 G!

Shock and Shatter Tests

All equipment must stand the shock of gun-fire and shell-bursts.

Tests with the idea of reducing weight and the use of critical materials are conducted whenever design and production requirements allow. Plastic and other materials are subjected to shock and shatter tests at actual temperatures of —67° F. at which they are most brittle.

In this connection, packaging is important in the supply question of radio equipment, particularly replacement parts. An example of requirements is the specification for radio tubes. The packed cartons must be capable of withstanding being dropped four times (once on their tops and bottoms, and once on each of two adjacent sides) from a height of three feet above a concrete surface.

The vacuum tube is, of course, a very important element in radio equipment, and a minimum of vacuum tube failures in service must be obtained. A typical specification for vacuum tubes is that the assembled glass tubes shall be submerged in water at a temperature of 122° F. for 18 hours, and then cooled for one hour at room temperature. The cases and caps shall then be subjected to gradually applied torques as high as forty inch-pounds without loosening the assembly. Often it is required that the tubes shall be immersed in ice water for five seconds without cracking. Also, continuous salt sprays for 100 hours must produce no corrosion or deterioration. Often tubes are placed in an atmosphere of lower than —40° C. for over one hour and filament power is applied immediately upon removal from the cold chamber for a minimum period of 30 minutes. Still another test which must not affect tube operation is to hit the tube with a rubber hammer weighing two pounds and suspended on a four-foot pendulum.

Most important, all tubes *must* be standard. It is evident, that if a specified range and quality of communication for combat aircraft is to be maintained, replacement tubes must measure up to the performance of those originally installed. Until recently, vacuum tubes were an example of extreme lack of standardization. Of over 225 different types of tubes in airborne equipment, 80% were used in less than 5 different equipments! Supply standardization problems, such as these, are being solved by engineering design, coordination, and rigid specification tests.

Installation and Tests

Of course, actual flight test of the finished equipment in military aircraft is a most important overall test. Antenna lead-ins must be short, ignition shielding and bonding must be accomplished, filters must be installed to remove noise at its source, and the power leads must be as short as feasible. The antenna installation is critical and differs for each type of aircraft. A fundamental antenna problem is the fact that the aircraft itself must act as the counterpoise. Structural limitations of the aircraft often govern antenna lengths and the distance of the antenna from the skin of the ship (an important capacity factor in metal aircraft). Further considerations are icing which may take place on the antennamast and on the antenna itself and introduce both dynamic and operational problems.

Often the best antenna location is one at which the antenna would soon be shot up by the ship's own combat gunfire.

All equipment is, of course, shock mounted and (particularly in fighter aircraft) must be capable of operating under "upside down" condition. The antenna structure must stay on when the airplane is in a high speed dive and it must not hit a resonant frequency, so that its amplitude of vibration would rip it from the aircraft—causing radio failure and actual danger to the aircraft itself.

The manufacturer of the first airplane in a new series usually makes a full-sized wooden model so that all equipment may be tentatively placed and power leads tentatively routed. When the first airplane arrives, it is thoroughly tested and during this test period, the installation of the radio equipment is modified for ease of operation and replacement. It is flight tested under all service conditions and photographs, blueprints, and instructions are prepared for future installations of the particular type of radio equipment involved.

An example of a special service test is one of last summer, at which time 25 fighter aircraft were placed in service over an extended period in the desert lands of California and Arizona. Valuable information was thus obtained, particularly in connection with the present African campaign. Equipment is now subjected to artificial sandstorms and special static tests. A recognized static problem exists in desert regions of high reflected heat and finely divided sand.

Further valuable information is received from flights in combat and from captured enemy equipment.

Other Applications

Many applications, of course, cannot be mentioned because of military security or space in this article. Electronic devices are used in the Air Forces in an ever-growing number of applications such as in ground instrument flying trainers which must obtain accurate simulation of aircraft communication and navigational aids.

An interesting interphone problem is the requirement that when any of the crew is using a radio channel, he must still be available on emergency interphone connection without interfering with the radio transmission. At the same time, provision must be made so that control of the radio equipment may be taken from any member of the crew who may be killed while using it.

For voice communication, a handheld microphone is used in trainers, cargo ships, and transports, but in fighter aircraft it is often necessary to use throat or oxygen mask microphones so that the pilot or gunner or bombardier may have his hands free.

Several radio test flights each day test new ideas and new equipments under actual conditions in the various types of modern aircraft and under all pertinent weather conditions. Equipment must work. Preventive maintenance is not always feasible. An aircraft out of commission for routine radio check is one less in the air over the enemy. Also, it is unpleasant to service radio within range of bullets.

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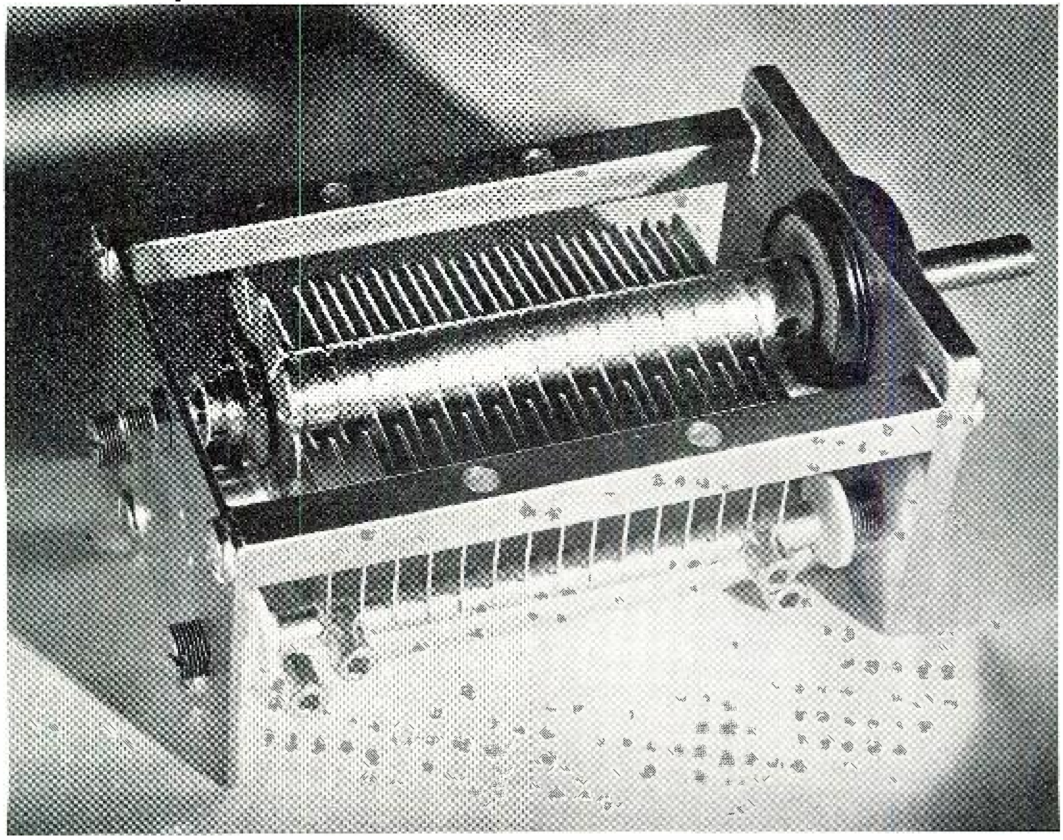

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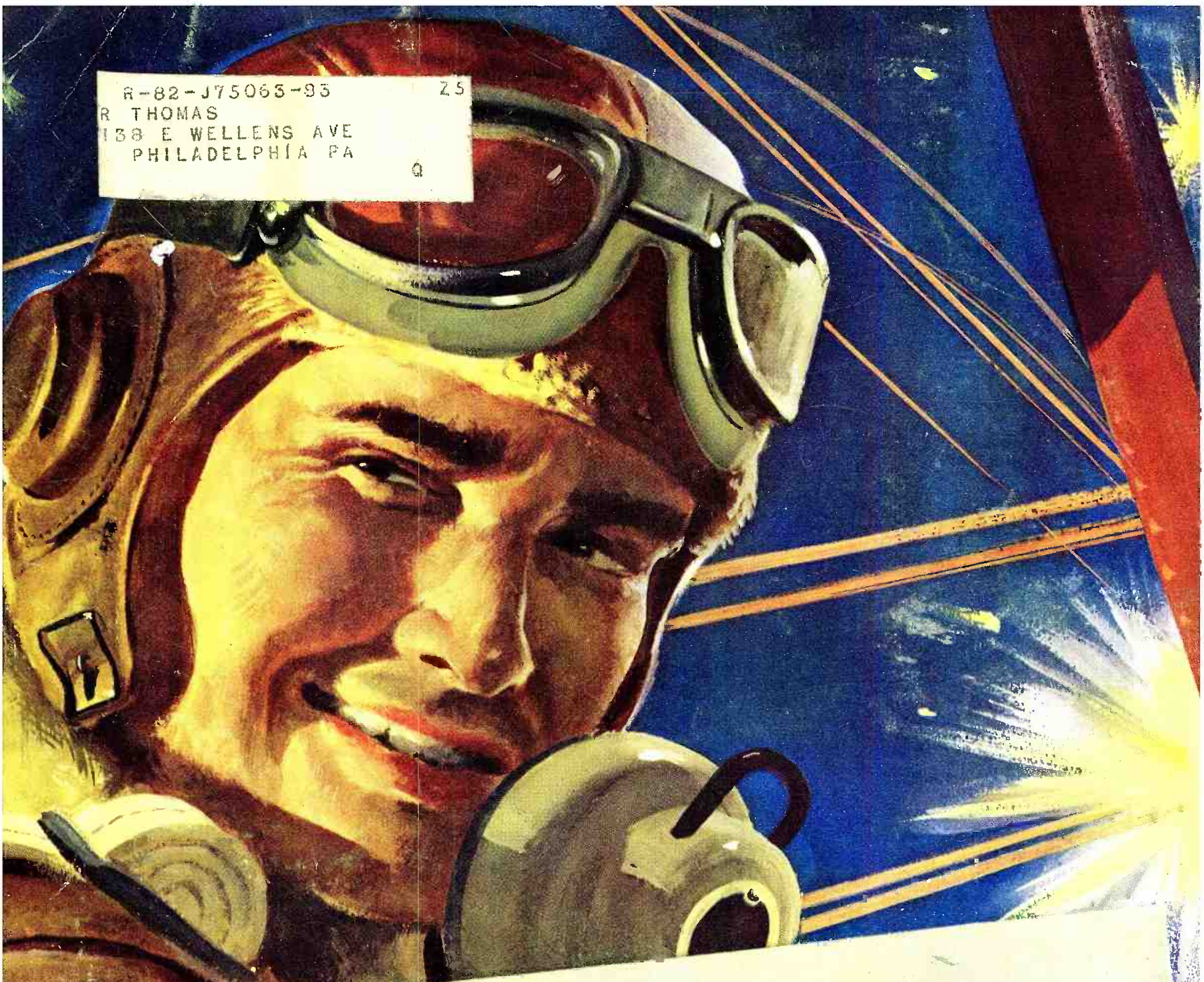

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