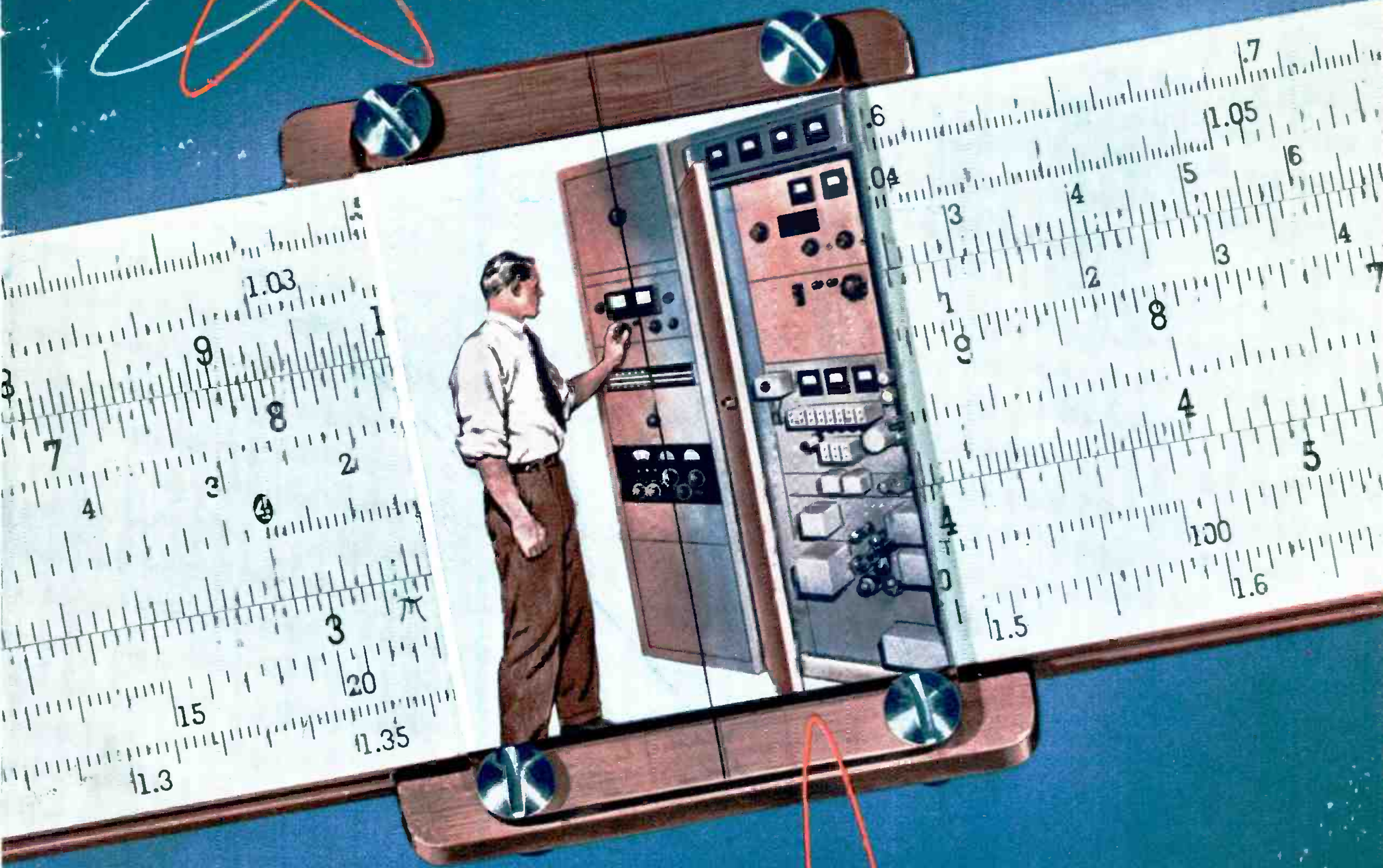

your future in the new world of ELECTRONICS

NAVY

INDUSTRIAL

CAA

MILITARY

BROADCASTING
AM FM TV

COMMUNICATIONS

SERVICING

AERONAUTICAL

MANUFACTURING

CAPITOL RADIO ENGINEERING INSTITUTE · WASHINGTON 10, D. C.

"CREI Training builds into the professional radioman a usable working knowledge of Practical Radio-Electronics Engineering; it develops that sure confidence in his own ability which enables him to go after the better jobs—and get them!"

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Illustration is that of the CREI Administration Building located at 16th Street and Park Road, N. W., in Washington, D. C.

CAPITOL RADIO

Founded 1927—Washington, D. C.

ENGINEERING INSTITUTE

Home Study Courses in Practical Radio-Electronics and Television Engineering, and Television and FM Servicing

For Professional Self-Improvement in the Fields of Radio-Electronics, Television and Electronic Maintenance

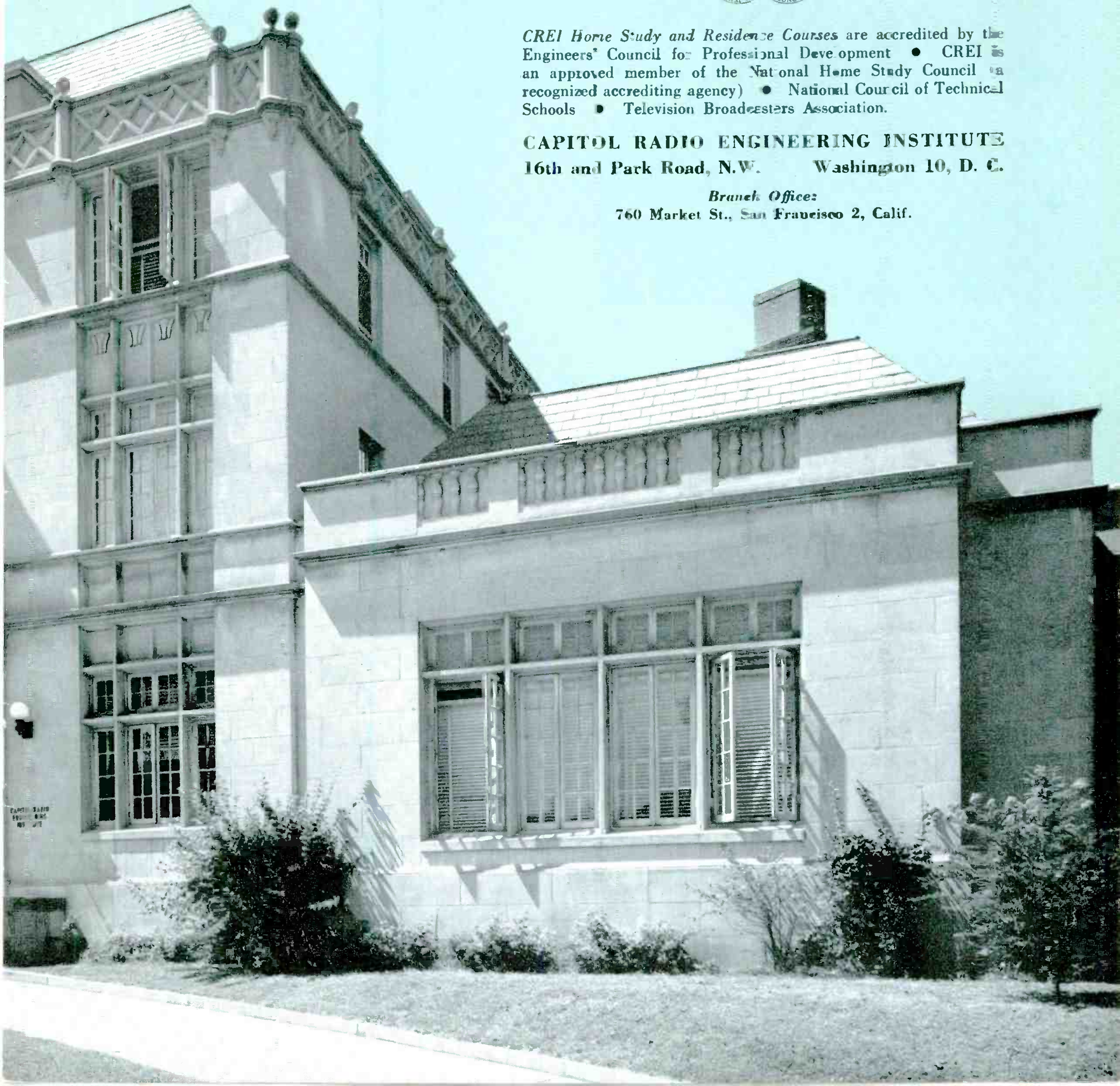
CREI Home Study and Residence Courses are accredited by the Engineers' Council for Professional Development • CREI is an approved member of the National Home Study Council (a recognized accrediting agency) • National Council of Technical Schools • Television Broadcasters Association.

CAPITOL RADIO ENGINEERING INSTITUTE

16th and Park Road, N.W. Washington 10, D. C.

Branch Office:

760 Market St., San Francisco 2, Calif.



E. H. Rietzke

Founder and President of CREI

President, Holmes Institute, an institution devoted to Training and Industrial Management

Chairman of the Board, Lacy's Inc., a chain of retail radio and television appliance stores

Senior Partner, Management Training Associates, a consulting organization which advises on problems of engineering and management

Member of

The Institute of Radio Engineers (Senior)
American Institute of Electrical Engineers
Veteran Wireless Operators Association
American Society for Engineering Education
Armed Forces Communications Association

MR. RIETZKE has been prominently identified with radio and technical education for many years. He entered radio as an amateur in 1913 and his professional radio career started when he joined the Navy as a radioman in 1917. He was the original Chief Instructor of the Navy's Advanced Radio Materiel School at the Naval Research Laboratory in 1924 and held that position for three and one-half years until he left to devote his full time to Capitol Radio Engineering Institute which he founded in 1927.

Actively engaged in all phases of technical institute work, Mr. Rietzke in 1944 was elected President of the National Council of Technical Schools of which he is one of the founders. He was re-elected in 1945, 1946 and 1947. First Vice President (1946-51) of the National Home Study Council, he also represents (1945-51) the proprietary technical schools of the United States on the Technical Institute Sub-Committee of Engineers' Council for Professional Development. He is a past Chairman (1938) Washington Section, Institute of Radio Engineers, and for a number of years represented that body as a delegate to the D. C. Council of Engineering and Architectural Societies. He is a member (1948-51) of the Educational Committee of the Television Broadcasters Association.

The intensive interest and extensive contacts of Mr. Rietzke in the fields of radio engineering and technical education are your assurance of the maintenance by CREI of the highest possible standards of practical radio engineering courses.

Home Study Paves the Way for Advancement

THE Home Study Method is a thoroughly tried and tested means of preparing yourself for advancement. You will find home study superior in many ways. Your working experience is an ideal background for this practical course. Studying at home, in your leisure time, you do not lose valuable time and money by absence from your job. You can apply what you learn while you work. You proceed at your own speed—never are you held back by a slow member of the class—never rushed or forced to "cram" your knowledge.

The United States Government through its Bureau of Education has very ably stated the case for home study in this extract from Bulletin No. 20. It states: "The method of instruction is the essential thing. Whether the student receives his lessons and submits his examinations in person or through the mails is not of importance—the value of home study lies in the fact that each student is a class of one; he proceeds in accordance with his own abilities, as slowly or as rapidly as he desires; if confused he may obtain from his instructor additional explanatory matter in writing which he may then study at his leisure—he does not have to remember what his instructor told him in class as does the classroom student; he must answer every question in every examination. This makes for thoroughness of training."

This Bulletin further states: "This makes correspondence study especially desirable for those who wish instruction in special subjects allied to their everyday lives." This statement reflects the many hundreds of reports from our students telling us of the usefulness of their CREI home study course in their daily work. Almost from the very beginning of the course the student may start to apply his increased knowledge.

CREI was founded to provide the highest level of technical home study training for you. The officers and faculty who are responsible for the course, its study methods and training techniques, have years of successful experience in home study education as well as in the practical radio-electronics field.

Is home study practical? Ask the leaders in any organization—many of them will tell you that home study started them on the road to success. All agree that it is one of the best ways to fit yourself for a better job. Walter P. Chrysler, the late Chairman, Chrysler Corporation, said: "To start, a man must have a certain amount of ability. But if he never increases or develops that ability, he will not go far. He must continually strive to improve himself. The man who utilizes his leisure by studying at home is usually increasing his ability. I can subscribe to that method because I studied that way and know its benefits."

Over one and one-half million people were continuing their education by home study this past year. Over five thousand industrial and commercial organizations have some kind of working arrangement with home study schools for their employees. CREI technical training is now used for training technical staffs in many of the country's great industrial organizations, including such companies as: United Air Lines; Canadian Broadcasting Corporation; Canadian Aviation Electronics, Ltd.; Canadian Marconi; Trans-Canada Air Lines; Radio Corporation of America, RCA Victor Division; Trans-World Airlines; Submarine Signal Co.; Bendix Products Division, Bendix Aviation Corporation; All-American Cables and Radio, Inc., and Pan-American Airlines.

Yes, home study IS practical! A few hours invested each week this year can be returned to you many times over next year and in the years to come—in job satisfaction and in prestige, in greater income and things that greater income makes possible. SUCCESS begins, not at 40 or at 20 or with a particular promotion, but the day —the very hour and minute—you decide to do something specific and tangible about *your* future.

Since 1927 CREI has prepared hundreds and hundreds for advancement. CREI training can be the first step up for you as you read the interesting story of opportunities on the following pages.

Opportunities In The Radio-Electronics Industry for Technically Educated Men

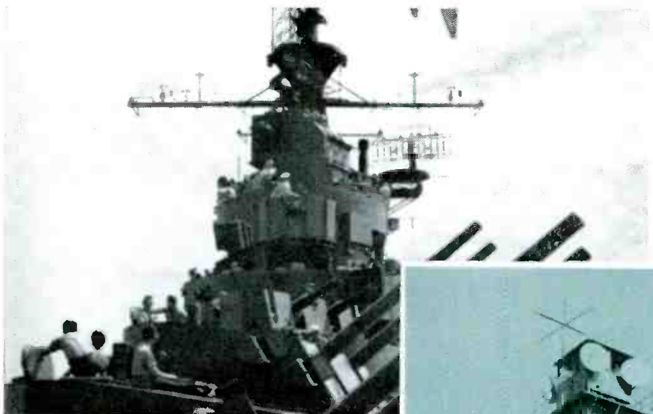
All-electronic penicillin drying system. This radio heat bulk-reducer completes in 30 minutes a dehydration process requiring 24 hours by conventional methods. (RCA photo)

MODERN technical education is necessary if you want to advance in the Radio-Electronics industry. Mr. Niles Trammell, Chairman of the Board of NBC, has said, "Radio faces a new and revolutionary era of technical advances that will demand the utilization of new resources, new skills, new training, new techniques and new operating experience and pioneering courage."

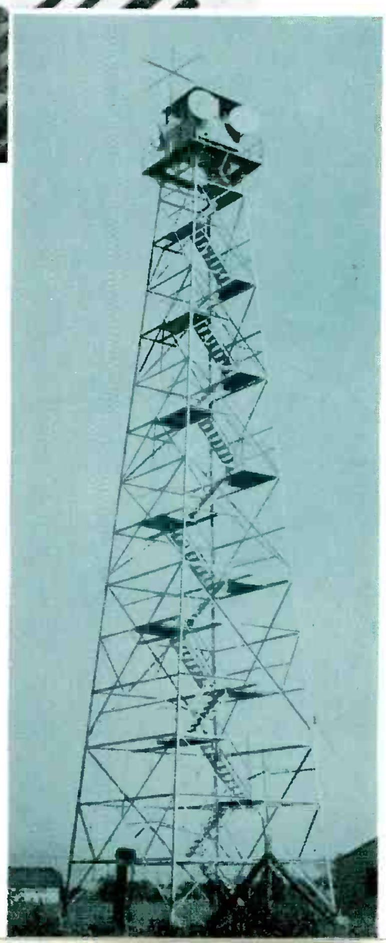
The result of this tremendous growth is JOBS . . . jobs by which highly skilled engineers and technicians working with specialized equipment can produce more at less cost, with resulting improvement in the general standards of living.

Radio-Electronic devices, discoveries and new developments are today in use in every industry, commercial enterprise, profession and governmental department. Here are but a few of the newer developments now in use that indicate the tremendous, all-encompassing field that Radio-Electronics now serves: Microwave radio relay systems; Precipitron filtering systems; Fathometer detecting devices; Electronic irrigation control; Radio Spectograph: Radio controlled aircraft; Fluoroscopic X-ray image amplifier; Teleran aircraft navigation and traffic control; Ship-to-shore and ship-to-ship communications; Electronic heating; Highway radiophone service; Facsimile and Ultrafax; Mariners' Pathfinder radar; Electronic stethoscope, cardiograph and other medical applications; Dielectric cooking; Electronic microscope; Radar controlled traffic lights; Electronic mathematical computers; Electronically controlled machinery; Radio-Telefax and electronic musical instruments.

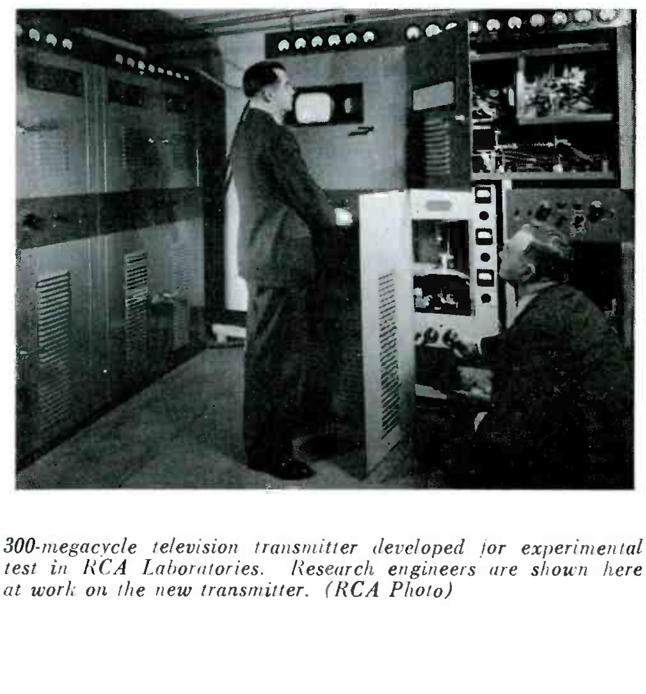
The communications field alone has a program of expansion that carries tremendous opportunities. The Federal Communications Commission has predicted there



(Above) Typical Navy radar installation—the silent weapon of World War II. The intricate equipment can be seen in the trellis work outlined against the sky on the superstructure. (U. S. Navy Photo)



(Right) Automatic, unattended radio relay tower used by RCA in cooperation with Western Union in new communication system that may ultimately replace thousands of miles of telegraph and telephone lines to transmit telegraph and telephone messages, facsimile, FM, radio-photos, etc.



300-megacycle television transmitter developed for experimental test in RCA Laboratories. Research engineers are shown here at work on the new transmitter. (RCA Photo)

(Left) Scene in CBS Television Studio where special boxing ring has been set up to televise amateur boxing show.

(Above) Railroad radio is rapidly growing throughout the country. It provides constant communication between locomotive and caboose, or between engineer and dispatcher. (Westinghouse Photo)

will be over 4000 commercial broadcasting and industrial communications stations on the air in a few years. Just look at the growth of the broadcasting industry in the few years since World War II. Latest* FCC figures show these comparisons:

	1945	**1951**
AM Broadcasting Stations	965	2,353
Applications pending		*273*
FM Broadcasting Stations	62	683
Applications pending		*12*
Television Stations	9	109
Applications pending		*385*

FCC estimates also indicate that in the next few years there will be:

- More than 2500 Aviation Ground Stations
- More than 150 radio-equipped Railroads
- More than 5000 radio-equipped Fire Departments
- Plus communications equipment for all types of public utility and industrial users.

* March 1, 1951

FCC recently announced plans for licensing 1,807 new television stations—mostly in the ultra-high frequency transmitting channels . . . and indicated that sets would soon be selling at the rate of 6,500,000 per year. It is estimated by responsible industry sources that television in

Trouble shooting on Television receiver. Circuits are complex and many misadjustments that would be relatively unimportant in standard broadcast receivers can completely spoil the operation at Television and FM frequencies.

Radio equipment used in United Airlines Mainliners is shown here being tested at Maintenance Base.

the next four years will require twice the labor capacity of present-day radio.

These progressive developments involve expenditures of at least a quarter billion dollars, and if just half the AM sets are replaced with FM receivers in the next four years, that's another $1,500,000,000 of consumer expenditure.

This inspiring growth of Radio-Electronics has assumed such astonishing proportions that it leaves even those men now high up in radio quite breathless. This industry is branching out so rapidly that it has become a giant avalanche, growing from day to day with ever-increasing momentum.

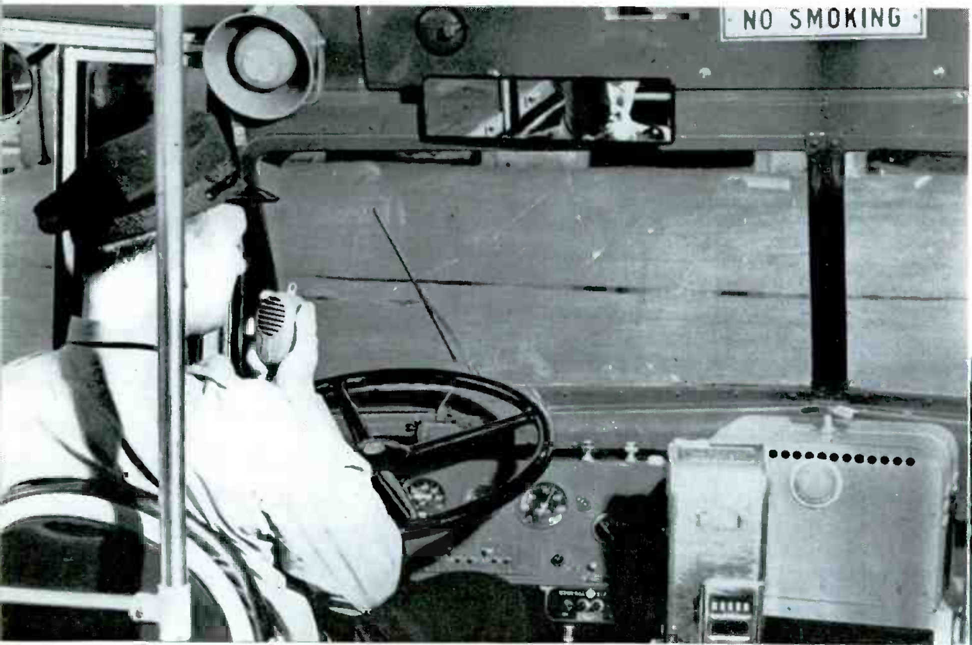
It is doubtful if there is any radio engineer today who can say truthfully that he knows intimately all the various ramifications of Radio-Electronics.

The field has become so huge, particularly since World War II, that it is impossible for professional radiomen to keep pace with all its developments. Radio literature, plentiful as it is today, finds it difficult even to report all progress achieved in electronic and allied devices. Soon radio engineers will be in greater demand in the atomic field. The field of guided missiles alone already furnishes employment to many electronic engineers and technicians.

Consider the Cyclotron, the Betatron and other instruments in the same class. They all require Radio-Electronic components with devices such as special vacuum tubes and cathode-ray tubes in a profusion of complicated hook-ups. For the detecting and measuring of radio-activity, atomic scientists require Geiger-Mueller counters, photo-electric multiplier cells and ionization chambers. These, in turn, require special direct current amplifiers, audio oscillators, radio activity indicators and many other Radio-Electronic components. Remember, too, that the Atomic Giant is still in its infancy, and its peacetime applications are just being developed.

This briefly is what is happening in the expanding Radio-Electronics world today. This startling pace of progress should make every professional radioman personally take stock of himself, his position, his technical education and his experience.

Can you in your present position figure out just where you will fit into this picture? Where will the skilled, highly trained manpower come from to carry on this important program? Few men are in a position to advance with this great industry without *additional technical education* in the new techniques and applications that we have mentioned here. Top men in every phase of the industry spend many hours each week studying just so they will stay on top. Radio-Electronics offers one of the greatest opportunities for technically educated men that has ever existed in a major industry. That is why



(Left) Radio-equipped bus uses two-way communications between bus operator and company headquarters. Bus operator can report immediately any emergency confronting him, thus speeding up service, or perhaps saving a life in case of accident. 250-watt transmitter is used. (G-E Photo)

(Right) Serviceman is shown checking vertical sweep voltage generator in Television receiver. The waveform is checked step by step until the defect is located. Large numbers of different wave forms are encountered in television and the technician must be thoroughly familiar with each.

the industry's top ranking men are urging their own employees and all professional radiomen in every field "not to stand still," but to study, prepare and progress to the unlimited opportunities ahead.

To the men and women who see the handwriting on the wall, and its message of a better job and more money, *CREI has an important message:*

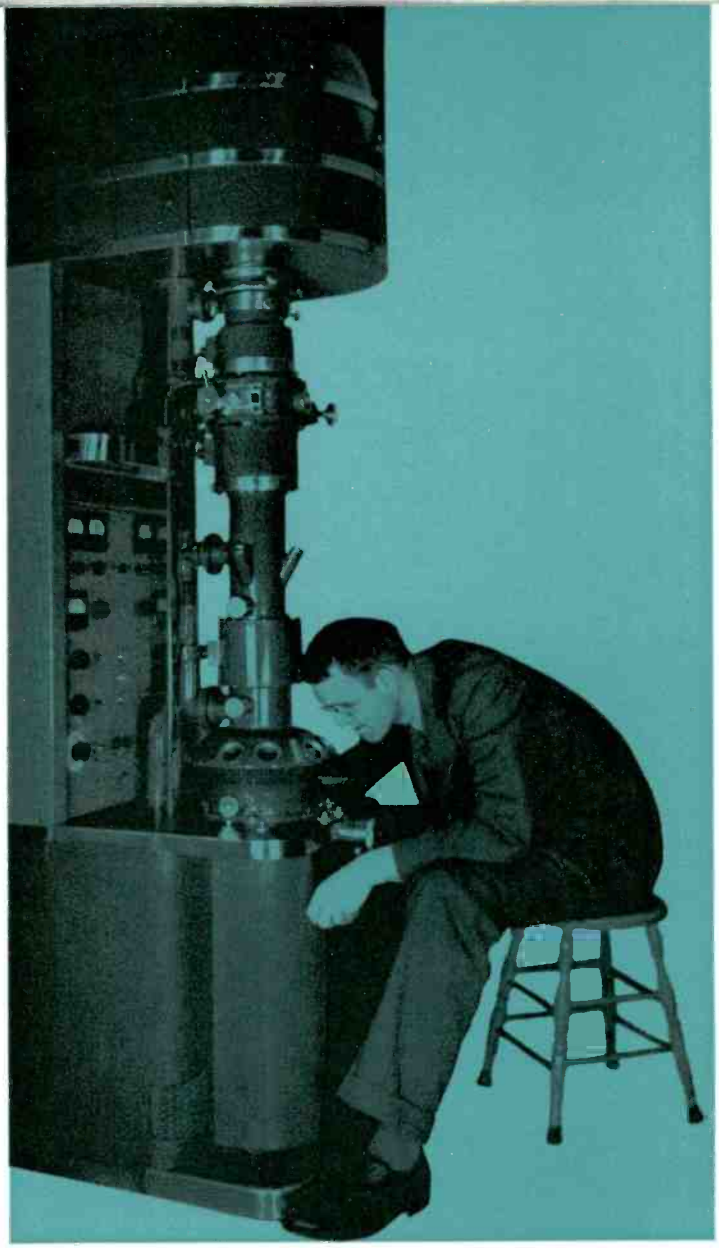
—if you now hold a commonplace job . . .
—if you hold a temporary job and long for a permanent future in Radio-Electronics . . .
—if you are now in Armed Forces Radio and would like to advance to a higher rating . . .
—if you are a radio "ham" who would like to make your avocation an income-producing vocation . . .
—if you are a practical radioman who wishes to advance to a job requiring technical ability of high caliber . . .
—if you have the ambition and desire to hold a position of greater responsibility with higher pay . . .

. . . CREI can furnish the technical education that will prepare you for your place in this new world of Electronics.

CREI practical home study courses will supplement your present radio experience with the advanced, modern technical education that can lead you to security and a better paying job. It is an intensive program, but one which fits into the most crowded schedule. It is only for those who see the opportunities before them . . . those who see this urgent need for increased technical ability if they are to be up in front with the better educated men that the industry now demands.

Many thousands of professional men in all branches of Radio and Electronics have enrolled with CREI. Many of them are men who are holding good positions today, but looking ahead, have the foresight and ambition to prepare for the better jobs that can be theirs.

Your opportunity is here, now! By investing a small part of your income, a reasonable portion of your spare time in CREI practical Radio-Electronics education, you will be on your way to lasting success and the security and happiness you seek.



Giant electronic microscope which has many important applications in modern industrial and scientific laboratories. (Electronic Industries Photo)

"Electronic Navigator" that sends out radar impulses to detect obstacles in path of a ship as far as thirty miles away. Instrument indicates land masses, other ships, lighthouses, buoys, even though natural vision is severely limited. (G-E Photo)

Who Are Qualified for CREI Courses?

Airlines
Radio Operators
Technicians

Amateurs

Army
Operators
Technicians
Instructors

Broadcasting
Operators
Technicians
Engineers

Sound & Service
Repair men
Public address men
Sound recorders
Installers
Maintenance Men

Shore Communications
(Shore-to-ship, point-to-point)

Operators
Technicians
Maintenance Men

Civil Aeronautics Administration (CAA)
Operators
Maintenance Men
Electricians
Engineers

Army and Navy Depots and Laboratories
Mechanics
Technicians
Engineering aides
Engineers
Inspectors
Laboratory assistants

Federal Communications Commission (FCC)
Operators
Monitoring Officers
Maintenance Men
Inspectors

Instructors (civilian)
Army radio schools
Navy radio schools
Civilian radio schools

Manufacturing
Installers
Laboratory aides
Testers
Inspectors
Engineers

Merchant Marine
Operators
Maintenance Men

Navy
Radiomen
Radarmen
Sonarmen
Electronic Technicians
Fire Control Technicians
Electricians
Aviation Electronic Technicians
Aviation Radiomen

Police
Operators
Maintenance Men

Students of Radio
Students and graduates of elementary residence and Home Study Courses.

CREI home study courses are planned and written for men who are now engaged in, or who have had *practical experience* in professional or amateur radio. A survey made by the Institute shows that 98% of all students enrolled in a 12 months' period were employed in radio, or had previous radio experience.

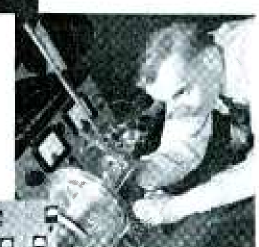
The amount of practical experience is not of great importance, but *some* experience is desirable because the student is then able to obtain the greatest value from his studies.

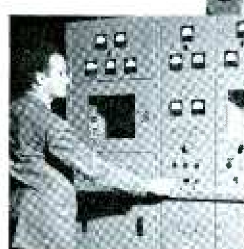
CREI students range from radio amateurs to men with engineering degrees and with experience extending from 3 months to many years.

Practically all CREI students are actively employed in radio work at the time of their enrollment. This is most desirable because the student can apply his CREI education in his daily work almost immediately.

The home study student body includes Armed Forces radiomen, broadcast technicians and engineers in hundreds of stations, hundreds of students already employed by or in the CAA, U. S. Merchant Marine, Airlines, Police Radio, Manufacturing and Servicing Fields. In fact, students and graduates of CREI are employed in every branch of the radio industry.

CREI has provided technical education for thousands of professional radiomen since 1927





CREI introduced the first home study course in practical radio engineering for the experienced radioman. It has expanded this program of advanced type of technical education so that it is available now to all professional radiomen in every branch of the industry. Today, CREI is recognized as one of the foremost technical institutes in the country, with successful students and graduates in all parts of the world.

CREI has kept pace with Radio-Electronics. A group of modern, completely equipped buildings now houses its home study division, laboratories and residence school facilities.

During World War II, CREI was selected to conduct a special technical course for the training of men in the U. S. Signal Corps and Coast Guard. An entire plant was erected in suburban Silver Spring, Maryland, where thousands of members of the Armed Forces received specialized training, directed completely by CREI.

The officers and faculty of the school have long enjoyed wide acquaintance and contacts with leading men throughout the technical radio world. These valuable connections have provided CREI with extensive facilities for collecting important current technical information that is constantly being added to CREI home study courses.

Twenty-four years of successful planning, building, experimenting and *teaching*—have developed an organization that knows how to teach advanced technical subjects in an easily understood, practical manner.

CREI technical education has been adopted by some of the world's leading organizations. United Air Lines; Canadian Broadcasting Corporation; Canadian Aviation Electronics, Ltd.; Canadian Marconi; Trans-Canada Air Lines; Radio Corporation of America, RCA Victor Division; Trans-World Airlines; Submarine Signal Co.; Bendix Products Division, Bendix Aviation Corporation; All-American Cables and Radio, Inc., and Pan-American Airlines, and others are among those companies which have selected CREI for group training of their technical personnel. Recognition from top-flight companies such as these, where skilled technicians are a vital factor in the successful performance of their services, indicates the high regard with which CREI is held among the leading organizations of the business world.

Advanced technical education is necessary if you want to advance in the world of Radio-Electronics.

Radio-Electronics is an industry that has expanded greatly within the last decade. Accelerated by the fast pace and new discoveries demanded by war-time necessity, it has grown today into a billion dollar industry—a leader in the industrial world. Its infinite applications touch the lives of everyone.

Radio-Electronics has grown so quickly and expanded so rapidly that the need for technically educated men to work in its many diversified fields has vastly exceeded the supply available.

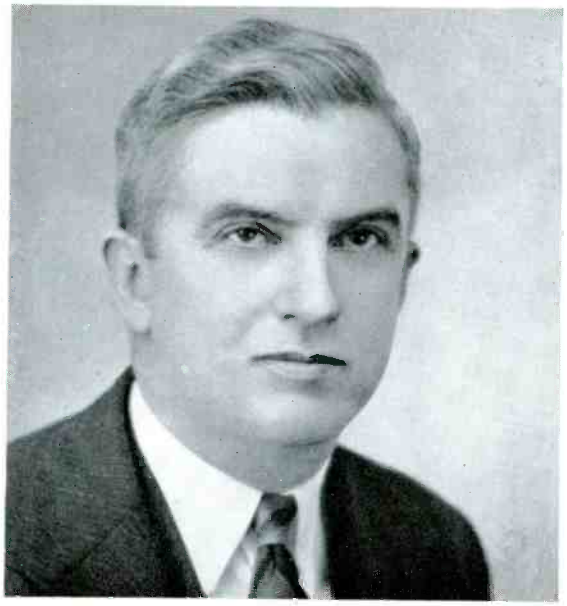
ALBERT PREISMAN

Vice-President in Charge of Engineering

Mr. Preisman is in charge of radio engineering activities of the Institute, the development of new lesson material and of keeping lesson texts up-to-date. In this important function, he works closely with President E. H. Rietzke.

Upon graduation from Columbia University with AB and EE degrees, he was employed as engineer with The Wagner Electric Corp.; engineering assistant at the New York Edison Co.; then followed 13 years with RCA. Particularly notable is his work in television, both as an engineer and as a writer. Immediately preceding his association with CREI he was senior engineer at Federal Telephone and Radio Corp.

Mr. Preisman's background of engineering education and experience is made available to CREI students through personal, professional consultation with him on special engineering problems.



HAROLD R. CALLAHAN

Educational Director

Mr. Callahan received his Bachelor's degree in 1925. He attended Loras College and the University of Minnesota. In 1937 he received his M.S. degree in Education from Kansas State College. For five years he was teacher and principal at high schools in Montana. He later taught Physics and Communications at senior high schools in Kansas. Later he was employed by Kansas University as a representative of the Audio Visual education department. Mr. Callahan has had over twenty years of teaching experience, and is in charge of the instruction department for both the home study and residence schools.

M. H. BISER
Vice-President

E. A. COREY
Registrar

B. A. COSTELLO
Controller

O. D. McKENZIE
Administrative Vice President

FACULTY

Heads Are Experienced Engineers and Instructors

E. G. BOND
Chief Laboratory Instructor

J. R. KELLEY
Chief Instructor—Home Study

R. E. ALTOMARE
Chief Theory Instructor

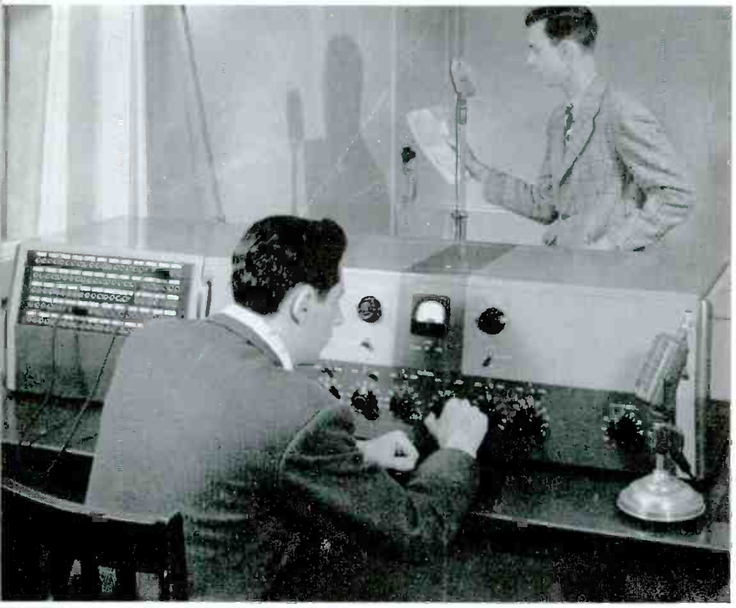
The pulse of any institution is that of the men and women who guide it. Naturally, we are specially proud of our faculty heads and instruction staff. We recognize them to be not only good educators, but also practical men and women with years of experience in the radio-engineering and allied fields. As a result, they are familiar with the practical problems that men like you encounter daily in the field.

You will find throughout your training at CREI a personal interest in your progress on the part of the instruction staff. Many of our students and graduates who have had previous home study training remark on this very important factor. This is one of the many *plusses* which make CREI training unique when compared to ordinary home study courses.

At CREI we work *with* the student. Each section of each lesson must be thoroughly understood before the student is allowed to proceed to the next section. Careful, explicit notes of explanation are made on examination lessons; frequently an instructor will write a special letter covering a particular problem that needs clarification in the student's mind. We develop an interest in each student which is invariably maintained years after he has completed his course.

An engineer needs a thorough knowledge of fundamental principles, plus reasoning ability and judgment developed through experience. He must be able to apply his knowledge to practical engineering problems; he must get practical results in a minimum of time. Our training methods keep these goals always in view.

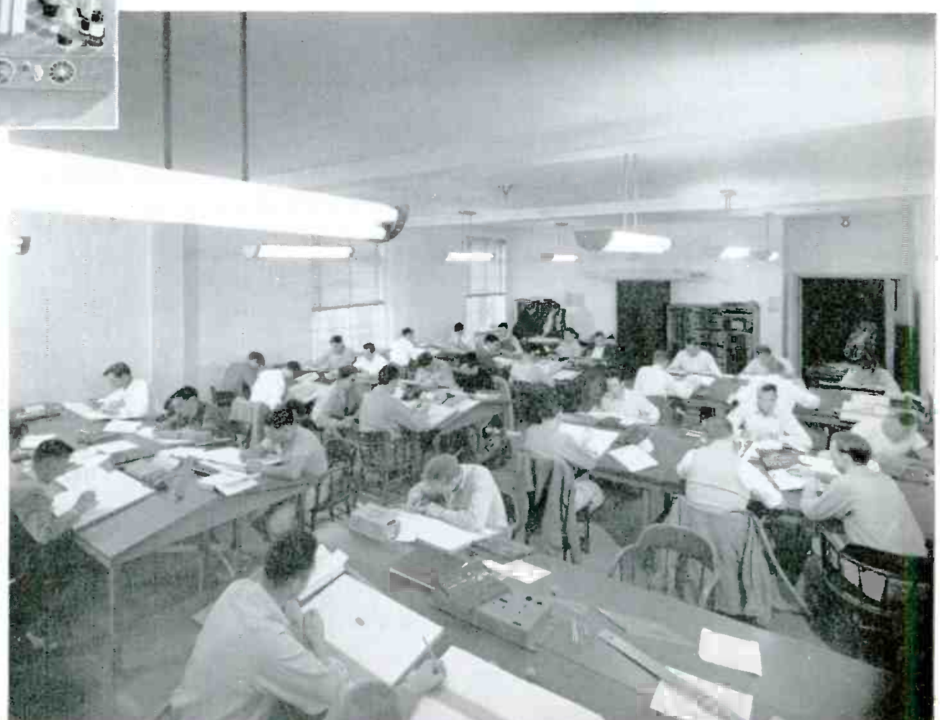
CREI home study courses are practical and comprehensive



THE CREI LESSON TEXTS YOU WILL BE USING ARE THE SAME AS USED IN THE RESIDENCE SCHOOL. The excellence of the CREI home study text material has been proved by thousands of students over a period of twenty-four years. The U. S. Navy during World War II purchased more than 300,000 CREI home study lessons.

Because of the wide recognition accorded these texts it was logical in modernizing the CREI residence course following the war, to make these lesson texts the backbone of the theoretical instruction. This material now replaces the older lecture systems. The same CREI lessons you will receive are used in both the home study and residence courses. Every lesson you receive is clear, practical and understandable.

CREI WORKS WITH WELL-KNOWN AUTHORITIES. In order to make your home study lessons accurate, up-to-date and readily understandable, CREI refers specialized subjects to engineers in industry who have engaged in the actual development of them. Their criticisms, comments and suggestions are invaluable in gaining a complete, correct interpretation to pass on to you. Typical of such cases were lessons on the Doherty Amplifier used in broadcast transmitting, the Collins Autotune used in aircraft radio transmitters, the blind landing systems as developed by the CAA and industry, broadcast studio



(Top) Scene in section of CREI broadcasting studios. Student is shown in control room No. 2, looking into one of two studios handled by this control room.

(Above) Microwave experiment being made by CREI student using the Klystron and reflector. This beam can be directed from point to point like a searchlight.

(Right) Engineering drawing class at CREI is interesting and popular with all students.

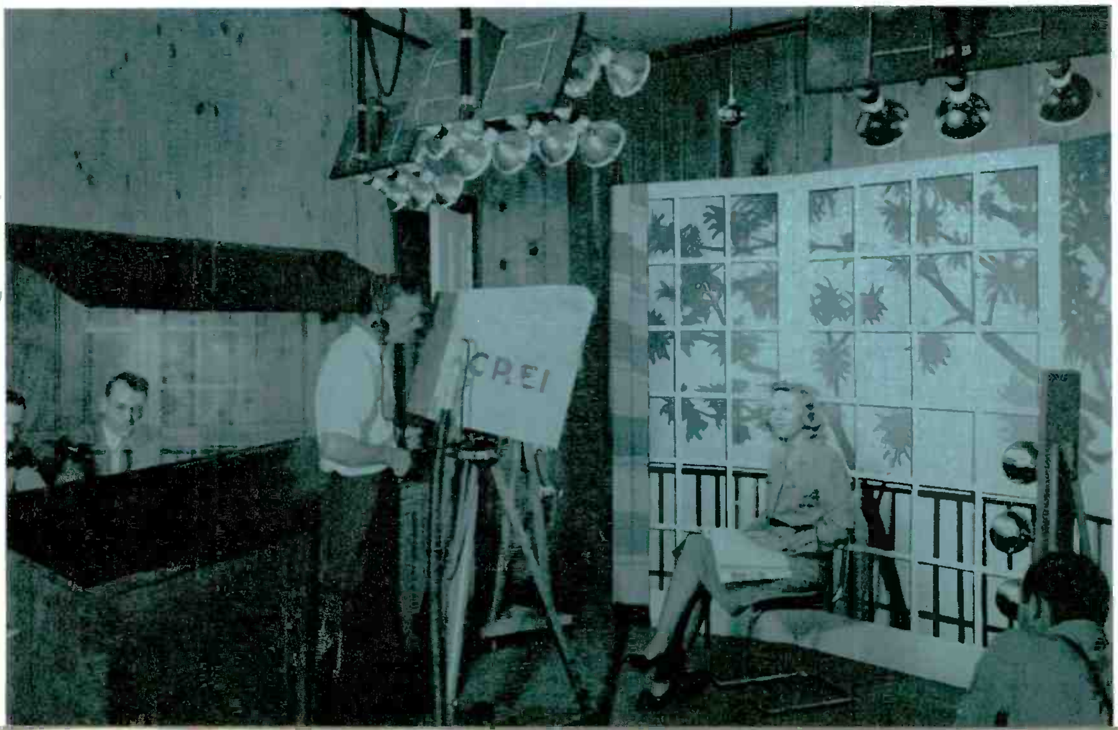
CREI main experimental laboratory. In this room are over 125 feet of laboratory table space wired for power and equipped for all types of experimental work.

designs, and others. A number of the aeronautical lessons were written with the close cooperation of several airline radio engineers. RCA and DuMont were particularly helpful in the development of CREI television material. A leading engineer in the Naval Research Laboratory specializing in U.H.F. work has carefully checked our U.H.F. lessons for accuracy and modern techniques.

CREI MAINTAINS FULLY EQUIPPED LABORATORIES. The CREI residence school is well equipped with modern radio and television apparatus, with a large variety of laboratory measuring and testing equipment and with parts and supplies for the construction of experimental devices and apparatus. CREI maintains a fully equipped Television Studio and laboratories for experimentation in this important electronic art. In our Ultra-High Frequency laboratory, experimental set-ups are used operating over a wide range of frequencies and circuits to 3000 megacycles.

This extensive laboratory equipment is at the disposal of our technical staff and writers in preparing the courses —and directing your study.

CREI METHODS PROVED SUCCESSFUL. Of the thousands of professional radiomen who have enrolled for CREI home study courses, many have at one time or another expressed their high regard for the teaching methods and the thoroughness with which they have mastered the CREI lesson material. CREI home study courses truly cover practical Radio-Electronics and Television engineering. They help professional radiomen absorb the new techniques, theories and methods that are essential to *success* in the field of Radio-Electronics. They provide basic knowledge, throughout the entire course, that can be applied every day in practical radio engineering work.



(Left) Section of the fully equipped CREI Television Studio showing part of lighting system, overhead microphone and camera. In back of the camerman can be seen part of the Television control room.

Here Are the Streamlined CREI Home Study Courses

ALL CREI courses (except Practical Television Engineering, Television and FM Servicing and Section M) are composed of Section 2 . . . and one or more of the additional sections. A study of the various sections, as set forth below, will enable you to select the course best suited to your needs.

SECTION 1. Introduction to Practical Radio Engineering.
20 lessons
20 examinations

This section is specifically prepared for the student who has not had previous radio training of at least two years practical experience in the care and upkeep of radio equipment, and for those who desire to review the more elementary fundamentals and to re-form study habits. Unless you have made a habit of regular study since leaving school and *unless you have had considerable practical experience such as the installation and maintenance of receiving and transmitting radio equipment, you will be well advised to include this section in your course.*

SECTION 2. Advanced Practical Radio Engineering.
56 lessons
57 examinations, including final

This section is the basic course covering the fundamentals of practical radio engineering. *All CREI courses are built around this section.*

The introductory Section 1 leads up to this section, and the specialized sections, as their names imply, carry the student beyond the scope of this section into the specialized application of the fundamental principles as covered in this section. The radioman who has had at least two years of professional experience in the installation and upkeep of a wide variety of radio equipment, who has kept up his knowledge of elementary fundamentals, and who has made a habit of regular study can exclude Section 1 and start with this section.

SECTION 3. Specialized Broadcast Radio Engineering.
15 lessons
15 examinations

This is a specialized course in broadcast engineering wherein the principles of radio engineering as covered in Section 2 are enlarged and their special application to broadcast use are covered. All students engaged in or planning to be engaged in technical broadcast work should include this section in their selection of a CREI course.

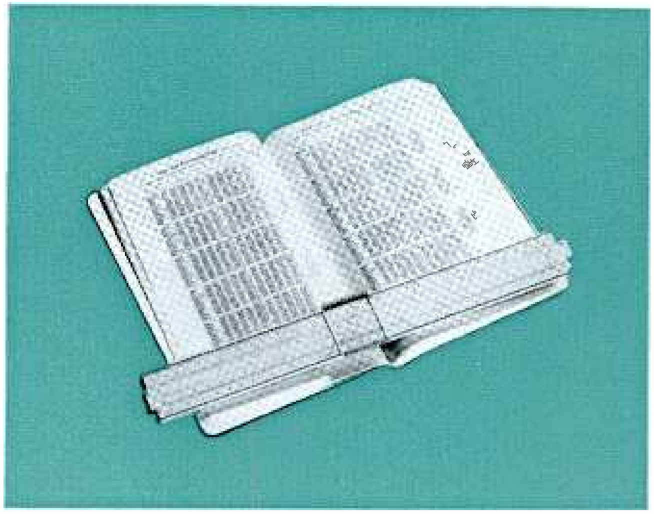
SECTION 4. Specialized Aeronautical Radio Engineering.
15 lessons
15 examinations

This is a specialized section extending and enlarging the principles of radio engineering of Section 2 as applied to the use of radio in aircraft, airways, and in air radio navigation. All students engaged in airways, airline, or Armed Forces aircraft radio work will find this section most useful in enlarging their knowledge of such subjects.

SECTION 5. Specialized Television Engineering.
15 lessons
15 examinations

This section is prepared for the graduate of Section 2 who has acquired the necessary broad radio engineering background and who further wishes to specialize in television engineering. The lesson material is up-to-date, practical in its application, and prepared from a background of wide experience in the CREI television laboratories and extensive contacts with the television industry.

In addition to the regular lesson material, illustrated on the opposite page, each student receives a book of mathematical tables and a slide rule with instruction book when he begins the study of mathematics.



SECTION M. Specialized Advanced Mathematics.

5 lessons
5 examinations

This section has been especially prepared for those students who desire to pursue the study of mathematics as applied to radio engineering. Its completion should enable the student more readily to absorb and understand (after completing the study of Section 2) advanced technical reference works and publications.

Section M is now available separately, at $25 with complete instruction service. It can be studied at any time, but it is recommended after completion of basic Section 2.

PRACTICAL TELEVISION ENGINEERING.

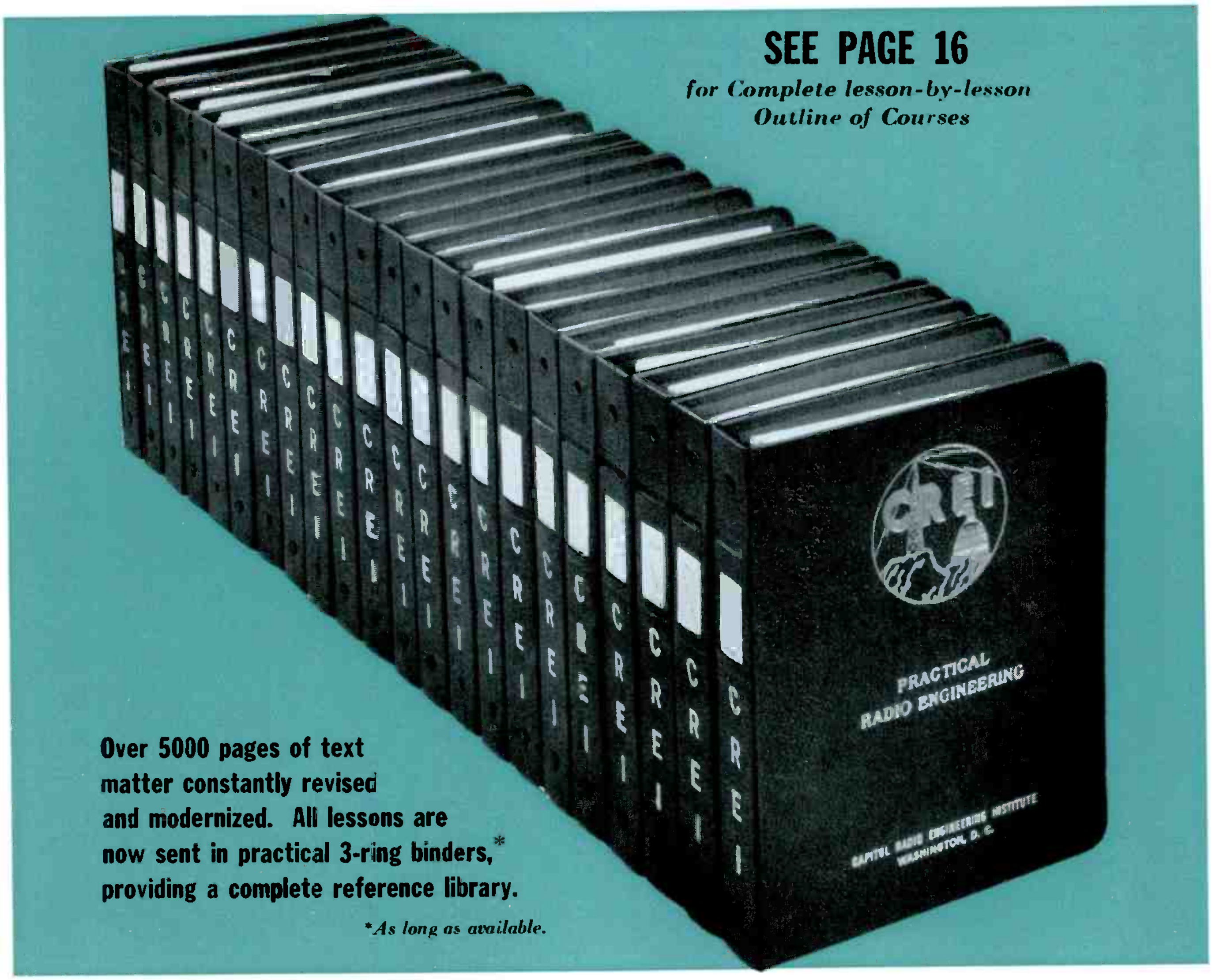
71 lessons
72 examinations, including final

This course is very complete in its coverage. It has been prepared for the professional radioman who wishes specifically to make a career of television engineering and who is willing to devote the necessary time to acquiring sound technical education which is essential to the specialist. Television is the subject from the very first lesson; even in the study of basic mathematics and electrical theory, and applications to television are brought out in the examinations and elsewhere.

TELEVISION AND FM SERVICING.

51 lessons
52 examinations, including final

To meet the demand of qualified service technicians, CREI offers this streamlined, practical course. It provides the more advanced technical education needed by the experienced man. It is not "over the head" of the man having limited experience, if he has real ambition and inherent ability. This is practical, on-the-job servicing course backed by all the facilities of CREI. *(Complete lesson outline, costs and terms will be gladly sent on request.)*



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**As long as available.*

Complete Outline of CREI Home Study Courses in PRACTICAL RADIO-ELECTRONICS ENGINEERING

These assignments are under constant revision to conform with new technical developments and therefore subject to change.

Introduction to Practical Radio Engineering. Sec. 1.

(Not available separately)

101. INTRODUCTION TO RADIO COMMUNICATION: Need for broad understanding of the field of radio communication by every radioman; survey of past development and present scope of radio industry; characteristics of low, intermediate, and high frequencies; allocation of radio spectrum to various services: radiotelegraphy, radiotelephony and broadcasting: aeronautical radio; television and facsimile.

102. ARITHMETIC: How to study mathematics; multiplication, division, fractions, decimals, percentage: weights and measures, the metric system; temperature conversion; measurement of time; ratio and proportion; positive and negative number; powers and root: methods of checking results; exercise problems and answers.

103. MENSURATION: Fundamental operations with algebraic quantities; removal of parentheses; procedure for solving simple equations; elements of geometry, plane figures, equilateral and right triangles, determination of areas, sides, and angles of right triangles by methods of geometry and trigonometry; the circle, diameter, radius, sector, chord; circular areas, circular and square mil measure; cylindrical and spherical volumes; exercise problems and answers.

104. ELECTRONICS: Electronics in modern life; the structure of matter; molecules, atoms, electrons; velocity of particles, evaporation; electrostatic charge, current flow; conductors and insulators, effects of high frequency; sources of electromotive force; magnesium, magnetic circuits.

105. CURRENT, VOLTAGE AND POWER: Types of current flow: the ampere and coulomb; electromotive force and difference of potential: power, the watt, relationship between mechanical and electrical power; sources of power frequently employed.

106. CONDUCTORS AND INSULATORS: Conception of these terms from the electronic point of view; displacement and leakage currents, effects of length, area of cross-section, specific resistivity, and temperature upon the resistance of conductors; circular and area; insulators, breakdown voltage, other considerations; commercial resistors, wire-wound and carbon types, power ratings, color code; exercise problems and answers.

107. OHM'S LAW: Statement of the law and its significance: equation forms of the law; series circuits, parallel circuits, current and voltage relations; series-parallel combinations; internal resistance of power supplies; conditions for maximum power output; solutions of practical problems.

108. ALTERNATING CURRENTS: Importance of knowledge of A.C. theory in radio work, cycles and alternations; study of the wave form; peak, R.M.S., average, and instantaneous voltages and currents; determination of polarity and amplitude of induced voltage; basic principles and construction of the alternator; the inductor alternator; principle of the alternating current transformer.

109. PRIMARY AND SECONDARY CELLS: Meaning of the terms; uses of each type in modern radio practice; theory of the wet cell, polarization, local action; the Weston cell; the standard "dry" cell; construction and operating characteristics of modern high voltage dry batteries; grid bias cells; Air Cell battery advantages and disadvantages; storage batteries, construction and care of lead-acid and Edison types; internal resistance, battery grouping, methods of charging, wind chargers.

110. DIRECT CURRENT MOTORS AND GENERATORS: Fundamental theory; introduction; generator action; magnitude of induced e. m. f.; motor action; magnitude of force; simultaneous motor and generator actions; practical construction; conversion into rotary motion; actual mechanical arrangements; commutator action-generator; commutator action-motor; armature windings; machine components; multiple pole machines. Operating characteristics; shunt type machine; series type machine; compound-wound machine; motor reactions; c.e.m.f. in a motor; motor regulation; adjustable speed motors; series motors; compound motor, interpoles; starting boxes; motor-generator sets; converters and inverters; dynamotors; care and maintenance; summary.

111. INDUCTANCE AND CAPACITY: Ideas of inertia and rate of change; effects of inductance in a circuit; Lenz's law: calculation of inductive reactance: inductance and resistance in series, impedance and angle of lag; mutual inductance, iron core transformers; reactors; distributed inductance. Meaning of capacity, storage of energy in condenser, definition of units; calculation of capacity; effects of capacity in a circuit, calculation of capacitive reactance; breakdown voltage rating, series and parallel connection of condensers; types of condensers for radio purposes.

112. RADIO CIRCUITS: General considerations; capacity, inductance, and resistance in series: power losses; frequency, wavelength; series and parallel resonant circuits: identification of series and parallel circuits: LC product, L/C ratio; circuit Q; values of circuit constants commonly encountered in transmitters and receivers.

113. VACUUM TUBES AND VACUUM TUBE CIRCUITS: General discussion; construction and uses of diodes, triodes, tetrodes, pentodes and beam power amplifier tubes; power sources, anode cooling methods; types of vacuum tube circuits; audio frequency amplifiers; the video amplifier; R.F. amplifiers; detector circuits, oscillators: rectifiers and filters.

114. RADIO RECEIVERS: Simple detectors; A.F. amplification, autodyne detection, R.F. amplification, the superheterodyne circuit; mixer circuit, I.F. amplifier: analysis of circuits of typical broadcast receivers.

115. PUBLIC ADDRESS SYSTEMS: General considerations; carbon, condenser, dynamic, ribbon, and crystal microphones, phonograph pickups, crystal electromagnetic, beam of light types: scratch filters; study of circuit of modern P.A. system; the decibel; determination of gain and power output requirements to obtain adequate P.A. coverage; reproducers, baffles, horns.

116. RADIO TRANSMITTERS: Transmitting tubes, construction features, operating adjustments: tank circuits, antenna coupling, adjustment for maximum output: power supplies; telegraph transmitters; broadcast transmitters: high and low level modulation; study of typical circuit arrangements: control circuits.

117. TRANSMITTING AND RECEIVING ANTENNAS, TYPES OF RADIO TRANSMISSION: Radiation of energy from transmitting antenna; transmission at low and high radio frequencies; directional transmission and reception; receiving antennas, types of radio transmission, FCC designations; percentage of modulation, sideband interference, harmonic suppressions; frequency modulation, transmission and reception.

118. METERS AND MEASURING INSTRUMENTS: Types of meters, basic principles; the A.C. vane meter; the D'Arsonval meter, principle of operation; meter sensitivity, use of shunts and multipliers; ohmmeters, series and shunt types; rectifier meters;

capacity meters; output meters, wattmeter, principle of operation; R.F. meters, thermocouple construction and operation; correction data for ultra-high frequency; protection and care of instruments.

119. RADIO DIRECTION FINDERS: General considerations; the loop antenna, bilateral directivity, factors determining signal strength at RDF receiver; deviation; antenna effect, pickup error, quadrature effect, displacement current error, polarization error; unilateral directivity, Bellini-Tosi and Adcock RDF systems; aircraft applications.

120. TOOLS AND SHOP WORKS: Construction of soldering iron, control of temperature, tinning and general care of iron; soldering procedure; splicing conductors; terminal strips, soldering to notched terminals; use of blow torch, screw drivers, chisels, types of files, pliers, backsaws; twist drills, drill grinding, drill speed and feed; drill sizes, drill gauge, drilling aids; screw threads, dies, and taps; machine screws, types and sizes; micrometers; pulley-belt and gear drives.

Advanced Practical Radio Engineering. Sec. 2.

201. ELECTRON PHYSICS AND ELECTRON THEORY: Composition of matter; electrons and protons; Coulomb's law, neutrons; composition of the atom, the nucleus; chemical reactions, valence, atomic number; isotopes and isobars; matter and energy, Einstein's law, atomic energy, heat energy; application to radio engineering; free electrons, metals, crystalline structure of solids; electrical conductivity, thermal noise; the volt, coulomb, and the ampere potential, charge current, direction of current flow; factors determining resistance, specific resistance, temperature coefficient; insulators; thermionic emission; photoelectric emission; ionization, electric fields.

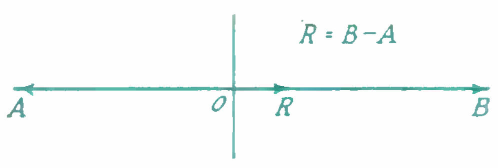
202. POSITIVE AND NEGATIVE NUMBERS; EXPONENTS: SQUARE ROOT: Addition and subtraction, multiplication and division of positive and negative numbers; exponents, use of powers of ten; powers and roots; conversion factors for electrical units; square root; problems and answers.

203. LOGARITHMS: Theory of logarithms, use of tables, determination of logarithms and antilogarithms; multiplication and division, roots and powers by use of logarithms; interpolation in tables; use of logarithms in radio problems; Napierian logarithms; cologarithms; use of the slide rule, problems and answers.

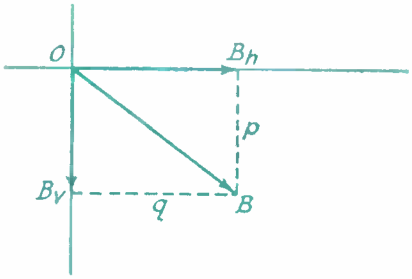
204. ALGEBRA: Fundamental ideas, algebraic symbols; addition, subtraction, multiplication, and division of algebraic quantities; rules for operation upon equations; solution of equations, simultaneous equations; quadratic equations; equations involving logarithmic terms, problems and answers.

205. OHM'S AND KIRCHHOFF'S LAWS; BRIDGE CIRCUITS: Voltage and current relations in series and parallel circuits; series-parallel combinations; application to radio work, shunts, multipliers; ohmmeters; multirange meters; voltage divider circuits; Kirchoff's Laws and applications to the solution of network problems; star and delta network transformation equations, bridge circuits for measuring resistance, illustrating the theory and use of a slide wire bridge.

206. GEOMETRY; TRIGONOMETRY: Use of geometry in radio problems; addition of forces along a line and at various angles; determination of components of resultant force; addition of multiple forces; trigonometric functions; use of trig tables; solution of right triangles by use of trigonometry; law of cosines; law of sines.



Algebraic addition.



Finding components of force B.

207. VECTOR ANALYSIS: Definition of a vector, simple vector relations, development of a sine curve, addition of vector quantities; radian measure; signs of functions in various quadrants.

208. GRAPHICAL ANALYSIS: Importance of curves in radio work; rectangular coordinates; construction of a graph, selection of scales; plotting curves; logarithmic scales; plotting polar curves; rates of change; inclination and slope; relations between curves and equations; power laws; exponential functions and equations.

209. MAGNETIC CIRCUITS: General theory; electromagnetism; properties of magnetic lines of force, relation to current flow; reactions between electrical circuits; solenoids; interaction between solenoids; permanent magnets; magnetic units; magnetomotive force; factors determining reluctance; magnetic circuits; flux density, B; magnetizing force, H; the B-H curve; permeability; hysteresis; hysteresis loss; total core losses; permanent magnet design; stabilization of permanent magnets.

210. ALTERNATING CURRENTS: EMF and difference of potential, generation of an EMF; mechanical and electrical degrees; the sine curve, method of plotting, instantaneous values, sine values of electrical angles; average and maximum E and I; effective or R.M.S. values; meter scale to read R.M.S. values; radio frequency ammeters, hot wire and thermo-element, calibration, construction and operation.

211. PHASE ANGLE, SINGLE AND POLYPHASE AC SYSTEMS: Ohm's Law for alternating currents; leading, lagging and in-phase currents; calculation of phase angles; angle in radians; Polyphase AC Systems; alternator and transformer connections; vector analysis for voltage, current and power relations for delta and wye connections; transformer connections.

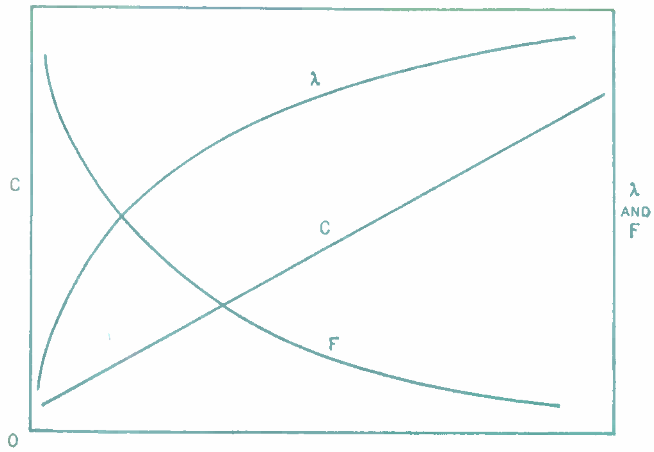
212. INDUCTANCE: Induced currents, Lenz's Law; theory of mutual- and self-induction; inductance formulas for air core coils; calculations for inductance, turns, wire size, etc.; inductance in series and in parallel.

213. INDUCTIVE REACTANCE, IMPEDANCE, Q OF COILS: Angle of lag; effect of current change on C.E.M.F.; reactance, definition and reason for; effect of variations of f and L on X_L; and angle of lag; calculations in practical load circuits; Q of coils; factors affecting radio frequency resistance of coils; comparison of RF/DC resistance of coils; practical considerations in coil design.

214. INDUCTIVE COUPLING: Methods used; mutual inductance; transformer action; requirements of coupling circuits; reflected impedance reactance and resistance relations for coupled circuits; coefficient of coupling; optimum coupling at radio frequencies; mutual reactance; calculations.

215. CAPACITY: Electro-static field; mechanical analogy; capacity of capacitor; charge and discharge; instantaneous comparative values of voltage and current in a capacitor; capacity reactance; capacitors in series and in parallel.

216. CAPACITORS USED IN RADIO: Effect of capacity on amount of charge; spacing of capacitor plates; dielectric permeability and break down voltage; capacitor construction; losses in condenser and power dissipation; how to select condensers. Calculations of phase angle, power losses, break-down voltages; electrolytic capacitors.



Dial Settings

217. THE SERIES LCR CIRCUIT: Calculation of impedance; angle of lead or lag; effects of frequency variation on impedance; series resonance, impedance, current, voltage and phase angle; L/C ratio; circuit Q, calculations involving Q.

218. THE PARALLEL LCR CIRCUIT: Impedance in circuit containing L, C and R; phase relation; parallel resonance; effect of resistance in resonant circuits; L/C ratio; plate output circuits; calculations using Z=L/CR formula; shunting effect of grid input circuits, complex numbers and complex algebra.

219. SERIES-PARALLEL CIRCUITS: Mathematical analysis of complex circuits; impedance, currents, voltages, phase relations, power; the LC Table, example of use.

220. PRACTICAL APPLICATIONS OF SERIES AND PARALLEL CIRCUITS: Tuned antenna circuits; tuned grid and plate circuits; selectivity; series by-pass circuits; parallel trap circuits; transmitter tank circuits, band pass filters; low pass filters.

221. RADIO AND AUDIO FREQUENCY CHOKES: Reason for using distributed capacity of choke; desirable ratio of inductance to capacity; frequency of operation; standing wave effect; types of chokes; modern design for maximum inductance to capacity ratio; arrangements for minimum capacity with maximum inductance; universal winding; design for very high frequency operation.

222. POWER CONSUMPTION IN ELECTRICAL CIRCUITS: Expenditure and calculation of power; RF resistance, method of measuring; power calculation in circuits not operated at resonance, power calculations in high frequency tube circuits; R.F. losses in transmitter circuits.

223. THERMIONIC EMISSION: Thermionic emission, work function vs. melting point; evacuation, residual gas, types of filaments, advantages and disadvantages of each; indirectly heated cathodes; grid and plate materials; radiation emissivity; mechanical considerations; secondary emission; two element tubes; space charge; A. C. filament operation.

224. POWER SUPPLIES: Rectifier circuits, high vacuum and mercury vapor rectifier tubes; neutralization of space charge; operating voltage and inverse peak voltage; single phase bridge rectifier, three phase full wave and half wave rectifiers; filter design, input and output ripple; lowest ripple frequency, cut-off frequency; design of a transmitter plate supply; transformer ratings; study of complex resistance network in broadcast receiver.

225. POWER TRANSFORMERS: Transformer theory relations shown vectorally; leakage reactance; current and voltage relations; types of transformers, core and shell; core construction: windings; power relations; tables for current density terminal voltage; volts-per-turn rating and transformer space factor; transformer design.

226. THEORY OF THE TRIODE TUBE: Voltage drop between plate and cathode; effects of grid voltage on space charge, plate current, internal resistance and grid current; grid construction; factors determining *u* and plate resistance; Static and dynamic Eg-Ip curves; A.C. components in plate and grid circuits; determination of *u*; mutual conductance, (transconductance), derivation and use; tube input impedance.

227. VACUUM TUBE AMPLIFIERS: Voltage amplification; fundamental considerations; resistance coupled amplifiers; grid-coupling circuits; methods of obtaining grid bias; bias battery, cathode resistors; power supply resistor graphical constructions; tube characteristic curves; load line; second and third harmonic distortion and their reduction; graphical determination of voltage gain and power output.

228. THE SCREEN GRID TUBE: Advantages over triode; Inter-element capacities; Eg-Ip characteristic; Interstage coupling both broad and sharply peaked; Shielding requirements; Use in receivers. The Pentode: Element arrangement; Load line and power output; Power sensitivity comparison; R.F. and power pentodes.

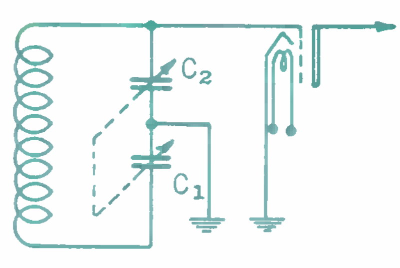
229. DESIGN OF OUTPUT CIRCUITS FOR TRANSMITTER POWER AMPLIFIERS: The linear amplifier; controlling audio distortion; radio frequency harmonics and how controlled by plate tank circuit design; calculation of tube efficiency, KVA/KW ratio limits; calculation of second and third harmonic components in harmonic radiation, effect of modulation frequency range and R.F. operating frequency on permissible KVA/KW ratios, calculations of power output, efficiency, tank circuit design, antenna design and tube voltage requirements; push pull operation and circuit calculations; coupling to the antenna, calculations; adjustments for linear output, class c amplifier design.

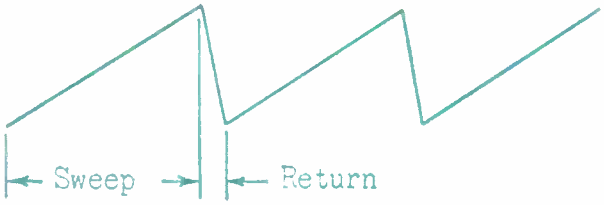
230. FREQUENCY MULTIPLYING; THE VACUUM TUBE AS A DETECTOR: Natural and forced harmonics; the crystal calibrator; frequency multipliers for power operation, doublers and triplers; Detector Action (Demodulation), small signal plate detection, grid leak and condenser detectors; first detector of a superheterodyne; Power and linear detectors, plate detection; Grid leak power detectors; practical ratios and values of grid leak and condenser; Diode detection.

231. MULTI-ELEMENT TUBES; SPECIAL TUBES: Special tube requirements; automatic volume control, superheterodyne mixer; Class B audio amplification, diode detection, push-pull amplification; advantages of using special tubes; Variable *u* tubes; Pentagrid converter; Class B and audio amplifiers; Duplex-Diode Triode and Duplex-Diode Pentode; metal tubes, characteristics operation, advantages, tube types.

232. COMPLEX NOTATION; PART I; OPERATOR J: Introduction; the real number; the imaginary number; the complex number; application of operator j to vector analysis; impedance in the complex form; addition, subtraction, multiplication, division of complex numbers; use of operator j in analysis of transmission line terminating networks.

233. COMPLEX NOTATION; PART II: Polar form of complex numbers, transformations between polar and rectangular forms; multiplication, division, powers and roots of complex numbers in polar form; methods for determining net impedance of parallel circuits; design of T and Pi impedance matching networks for use with antennas and transmission lines.





234. THE CATHODE RAY TUBE AND ITS APPLICATIONS TO RADIO: Cathode ray tube development; theory of operation; deflection of ray, electro-static and magnetic; the fluorescent screen; deflection voltages; sweep voltage and the sweep circuit; uses of the cathode ray oscillograph, voltage and current measurement, wave-form analysis, checking distortion, measuring percentage of modulation; construction of tube, methods of focusing, deflection mechanism and deflection sensitivity; practical circuits.

235. OSCILLATOR AND NEUTRALIZING CIRCUITS: Production of oscillations, zero and negative circuit resistance; Armstrong, Hartley, Colpitts oscillator; calculations of circuit constants, feed-back adjustments; Electron Coupled oscillator, advantages, modifications; oscillator tank circuit design and coupling; excitation and bias voltages; tube capacity neutralizing circuits, Hazeltine, Rice, Miller, push-pull circuits.

236. CRYSTAL CONTROL OF RADIO FREQUENCIES: Operation of crystal in controlling frequency; piezo-electric effect; types of crystals having piezo-electric properties; axes of crystals; methods of cutting crystal; relation between frequency and dimensions of crystal; circuit to be controlled by crystal; adjustments of circuits; methods of keying a crystal controlled transmitter; crystal current and effects of excessive current; care of crystal; crystal holder; effects of temperature on the frequency of crystals; special cut crystals.

237. RECEIVERS; RADIO-FREQUENCY AMPLIFICATION: Theory and design of receivers for the standard broadcast band. Design of r. f. amplifier stages, with emphasis on image rejection; oscillator and mixed design; a particular noteworthy analysis of i. f. amplifier design; the effect of the diode detector loading upon an i. f. amplifier stage; and a study and analysis of actual commercial receivers. Analysis of tuning capacitor and tracking problems; alignment of such receivers.

238. F. M. RECEIVERS: Principles of f. m., including both the generation and reception of frequency-modulated waves. Their significance is analyzed from a physical viewpoint. Analysis of thermal noise, impulse noise, co-channel and adjacent-channel interference, and the ability of an f. m. system to reduce such interference. Preemphasis and deemphasis circuits. Their implication in interference reduction. Receiver design, r. f. amplifiers, i. f. amplifiers, limiters, balanced discriminators, ratio-detectors, and lock-oscillator detectors. Receiver adjustments and design considerations.

239. AUDIO FREQUENCY AMPLIFICATION; PART I: DB calculations; Frequency response characteristics; Wave analysis; R-C amplifier; amplifier impedance; input and interstage transformers; low, intermediate and high frequency response transformer-coupled amplifiers.

240. AUDIO FREQUENCY AMPLIFICATION; PART II: McIntosh Amplifier; inverse feedback; practical feed back circuits; current feedback; phase inverters; tone controls; bass boost; treble boost; push-pull design.

241. DESIGN FEATURES AND ADJUSTMENTS OF TRANSMITTER CIRCUITS: Coupling to the antenna; minimizing harmonic transfer to antenna; transformer and tank circuit methods of antenna coupling; use of high and low resistance antennas; use of transmission line, balanced two wire and coaxial lines, calculation of impedance; coupling transmission line to transmitter and to antenna, harmonic suppression; push-pull operation of power tubes; power tubes in parallel; factors in excitation, calculation and adjustment; over and under excitation; circuit design to prevent excessive selectivity.

242. MODULATION: The theory and practice of both amplitude and frequency modulation analyzed and discussed. A. M. in theory and design procedure is given for plate and grid modulation, and miscellaneous other forms of modulation. F. M.: three representative methods are described in detail, the original Armstrong system of phase modulation, the G. E. phasitron-tube type of phase modulation, and the Western Electric type of f. m. A comprehensive text on modulation: what it means, and how it is accomplished.

243. PULSE TECHNIQUES: Introduction; survey of applications: radar, television, pulse time modulation; basic circuits; mixing, clipping, differentiating circuits, integrating circuits, keying; multi-vibrators; counter circuits; blocking oscillators; deflection circuits; special circuits.

244. LINE TERMINAL AND INPUT EQUIPMENT: Transmission Unit power, voltage and current ratios; impedance matching; attenuation pads, design, and use; H and T type pads; line equalizers; the mixing panel; volume control, design, use, calibration in transmission units.

245. RADIATION AND RADIATORS: Fundamental concepts of radiation, electric and magnetic field lines, relations of accelerated fields, variation of field with distance, and frequency; configurations of open fields, wavelength, radiation resistance; polarization and reflection; electrical characteristics of antennas.

246. RADIATING SYSTEMS: Transmission lines, traveling waves, standing waves; open and short-circuited lines; antenna characteristics, effect of ground; Hertz and Marconi antennas; methods of feeding antennas, tuned and untuned lines, construction of lines; line termination. Radiation characteristics antenna system losses, field strength. Vertical radiators, directional and turnstile antennas.

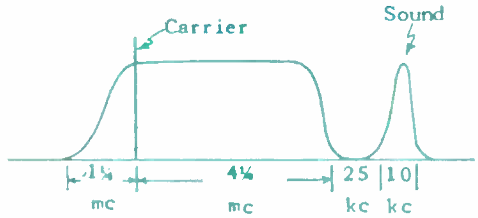
247. RADIO WAVE PROPAGATION—RECEIVING ANTENNAS—PART I: The ground wave and space wave; the ionosphere; critical frequency, skip distance; echo signals. Types of receiving antennas, loop and Beverage antennas, broadside and diversity arrays.

248. RADIO WAVE PROPAGATION—RECEIVING ANTENNAS—PART II: The Rhombic antenna, analysis; rhombic antenna design, alignment of pattern, electrical characteristics. Non-directional antennas, noise pick-up considerations; short wave antennas, doublets, folded dipoles; all-wave antennas; automobile antennas.

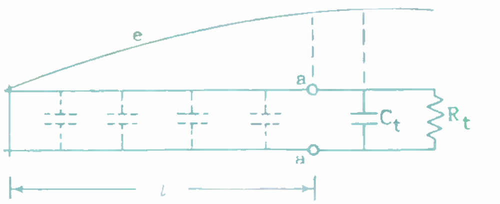
249. RADIO FREQUENCY MEASUREMENTS—PART I: Circuit residuals; condensers as impedance standards; stray capacity and shielding; connections and grounds. Frequency measurements drivers and wavemeters. Distributed capacity of coils, true and apparent inductance; theory and use of the Q meter.

250. RADIO FREQUENCY MEASUREMENTS—PART II: The heterodyne frequency meter, linear interpolation and direct-heating methods of measurement. The signal generator, component elements, attenuator construction, description of typical instruments, antenna measurements, fundamental frequency, antenna impedance, use of R. F. bridge. Measurements on transmission lines, balanced and unbalanced types.

251. PROPAGATION AND TRANSMISSION LINES AT ULTRA HIGH FREQUENCIES: Propagation of U. H. F. space waves, optimum antenna height for maximum signals and for maximum line-of-sight transmission. Transmission lines as circuit elements, properties; oscillator tank circuit have desired Q, antenna receiving system having desired selectivity or band width.



Band of frequencies for a television channel.



The voltage varies along a resonant line, so that each element of capacitance has voltage across it.

252. WAVE GUIDES AND CAVITY RESONATORS AT ULTRA HIGH FREQUENCIES: Theory of wave guides, cut-off frequency, wave modes, attenuation, impedance matching diaphragms, cavity resonators, coupling methods, design of receiving system.

253. RADIATING SYSTEMS AT ULTRA HIGH FREQUENCY: Types of radiating systems, antenna arrays, radiation from a pipe, sectoral horn, biconical horn, parabolic reflector design for desired directional effects, methods of coupling.

254. TUBES AND ASSOCIATED CIRCUITS: Grounded-Grid Amplifier; impedance matching, capacitances, gain, examples, practical circuits; input loading; gain, cathode-lead inductance; resistance and tube noise, input loading, amplifier stage, illustrative typical example, noise factors; mixers and converters, characteristics, gain, noise; typical receiver noise calculations.

255. NEGATIVE-GRID TUBES AT ULTRA HIGH FREQUENCIES: Negative-grid tubes; transit-time effects factors; acorn and U. H. F. midget tubes; light-house tube; pulse operation; circuit limitations; resonant lines; reduction of lead inductance; glass seals; general power tube considerations; advantages of push-pull circuit; comparison of water-cooled and air-cooled tubes; neutralization; air and water cooling.

256. SPECIAL ULTRA HIGH FREQUENCY TUBES: Inductive-output tube, fundamental theory; construction, operating features; the klystron tube, fundamental action; klystron amplifier; klystron frequency multiplication; methods of modulation; the magnetron; original development; motion in a magnetic field; action of a combined electric and magnetic field; split-plate magnetron, magnetrons with cavity resonators; performance of four-cavity magnetron.

FINAL EXAMINATION.

Specialized Broadcast Radio Engineering. Sec. 3.

(Not available separately)

301. GENERAL DISCUSSION: General problems in broadcast transmission, frequency modulation; high fidelity; frequency stability; percentage of modulation; high and low level modulation; power trend and transmitter location; radiating systems, primary service area; radiator efficiency; vertical towers; transmitter circuit arrangements; speech control equipment.

302. AUDIO FREQUENCY VOLTAGE AMPLIFIERS: Classification of amplifiers; types of distortion; analysis of vacuum tube as an amplifier; resistance coupled amplifiers, gain at low, intermediate, and high audio frequencies; design of resistance coupled amplifier, response curves; impedance coupled amplifier design, response curve; transformer coupled amplifier, calculation of response curve.

303. AUDIO POWER AMPLIFIERS: Voltage and power amplifier tubes; correct bias, power output, operating efficiency: Class AB operation; bias and excitation adjustments; pentode power amplifiers, power output and distortion calculations, beam power amplifier tube, circuit, inverse feed-back; operation of tubes in parallel; matching tube to load; Class B audio amplifiers; tubes and drivers; Class B modulator output circuit; inverse feedback in broadcast transmitters, phase shift consideration.

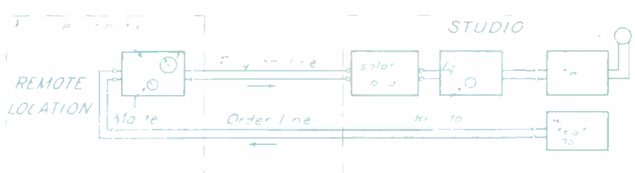
304. LOUDSPEAKERS: Sound waves; structure and characteristics of the human ear; audibility curves; loudness contours; loudspeaker requirements; driving units, moving iron and moving coil types; electrodynamic speaker; wide range speakers, curvilinear cones, mass reactance and compliance; response curves; speaker baffles; exponential horns and baffles; tweeters; choice of number, selection of types, placement of speakers for adequate coverage; impedance matching considerations with multiple speakers.

305. MICROPHONES: Types of microphones; acoustical considerations; directional characteristics, phase difference; frequency-output and polar diagrams, reduction in reverberation and noise pickup; electrical consideration; output characteristics and level; effect of input transformer; microphone ratings; noise pickup; mass friction, compliance; example; representative types of microphones; electrical and acoustical characteristics of double-button carbon, condenser and velocity microphone; the unidirectional microphone directional response, applications; non-directional dynamic microphone, constructional features, acoustical and electrical characteristics; crystal microphone, bimorph unit, the direct-actuated, multicell and diaphragm type crystal microphones, physical characteristics.

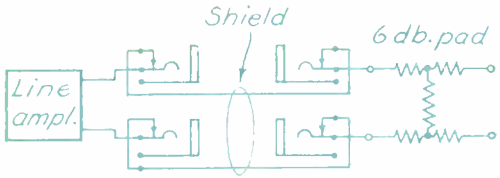
306. STUDIO AND AUDITORIUM ACOUSTICS: Theory of reverberation, reduction of articulation, effect on music; reverberation time, optimum reverberation time-frequency curve; high-frequency absorption; diffusion of sound; irregularities in reverberation curve, coupled rooms, effect of balconies, etc.; echoes and wall flutter focusing effects, parallel wall reflection; methods of diffusing sound, use of vee serrations and circular arcs; measurement of reverberation time; representative and special sound absorption materials; practical behavior of sound-absorptive materials; table of sound-absorptive materials; sound insulation; permissible noise levels, isolation of machine and building vibration; construction of doors, windows, vestibules and ventilating systems; studio design; location and layout, dimensions, examples of studio design; sample design, determination of dimensions and reverberation time, design of diffusing surfaces.

307. SPEECH EQUIPMENT: Typical studio layout, general description, essential components, master control room; speech equipment; microphone pre-amplifiers; mixers, general design consideration, practical parallel mixers, series mixers, series-parallel mixer, bridge type mixer, modified series-parallel type, balanced and unbalanced circuits, cross talk in a mixer; attenuation pads; electronic mixing; program amplifier; line amplifier, monitoring amplifier; remote pickup equipment.

308. AUDIO CONTROL EQUIPMENT: Control components, channel connections, jacks and plugs, patching procedure, multiple connection; types of switches, interlocking push buttons; relays; control circuits; set-up locking circuit, released relay, other types of relays; interlocking circuits; interlocking of several studios, mechanical interlocking; pre-setting, master control key switch; talk-back system, control-room announce connections; care and maintenance; relay contacts; relay adjustments; fader controls; frequency run, distortion and noise measurements; operational technique, monitoring, limiting amplifiers, line equalization.



Setup for equalizing a telephone line.



Schematic representation of normalled connection.

309. RECORDING SYSTEMS: General recording processes, magnetic recording; high fidelity systems, modern processing methods; constant-velocity and constant-amplitude recording; high-frequency limitation, importance of eliminating surface noise; effect of needle size; orthacoustic recording; lateral-cut and vertical-cut, comparison of two types of recording; playing time; recording and reproducing systems; general layout; recording amplifier; turntable design, friction and other types of drive; feed screws and accessories; recording heads, high-frequency and low-frequency response, electrical compensation; representative recorders; examples of pickup design; tone arms, resonance, tracking error; vertical pivot; technique of recording.

310. HIGH POWER BROADCAST TRANSMITTERS: Methods of developing high power modulated R.F.; theory of the Doherty high efficiency amplifier; detailed explanation; practical circuits, circuit adjustment; adjustment of feed-back; R.C.A. Class BC power amplifier; theory of operation; tuning procedure, grid and plate circuit adjustments, final tuning adjustment; feed-back circuit; operation at lower power.

311. POWER AND CONTROL CIRCUITS FOR BROADCAST TRANSMITTERS: General discussion; high voltage plate supply rectifiers; grid bias rectifiers; power supply for oscillator and intermediate power amplifiers; power distribution system of typical transmitter; control circuit, control power sources; detailed explanation of operation of control circuits in typical transmitter; protection of apparatus and personnel; starting procedure, sequence of operation; switches, circuit breakers, contractors, power relays, time delay relays; adjustments and maintenance.

312. FREQUENCY-MODULATED TRANSMITTERS: A comprehensive analysis of the new Armstrong dual-channel f. m. system, (as built by REL) the RCA system, the cascade type of modulator built by Raytheon, the frequamatic system of Federal, and the Westinghouse equipment, with its unusual method of stabilizing the center frequency. The principles and practice employed in f. m. transmitters.

313. TRANSMISSION SYSTEMS FOR U.H.F. BROADCASTING: Special applications of transmission lines and calculations for stubs, impedance matching, etc., of importance in broadcast practice.

314. BROADCAST ANTENNA SYSTEMS, PART I: Choice of antenna site; types of broadcast radiators, factors involved in antenna height; the ground system; coupling to tower; shunt excited antennas; antenna efficiency; attenuation, conductivity and inductivity, e.m.u., e.s.u.; and practical units; determination of ground conductivity and inductivity, and inverse field, by comparison of measured and calculated curves; field intensity contours; field strength measurement for location of proposed transmitter.

315. BROADCAST ANTENNA SYSTEMS, PART II: The directional antenna, advantages in broadcast transmission; principles of operation of directional arrays; effects of spacing, current amplitudes and phase relations; transmission lines and phase shifting networks; phase measurements, the phase meter; calculation of array performance; field intensity measurements, circuit and operation of field intensity meter.

Specialized Aeronautical Radio Engineering — Sec. 4.

(Not available separately)

401. INTRODUCTION—GENERAL AERONAUTICAL PRINCIPLES: Functions of radio in aviation; classification of aircraft, principles of flight; construction features of aircraft; aircraft instruments; engine guages; flight instruments; navigation instruments; aircraft radio instruments; airports, the Federal airways system.

402. RADIO DIRECTION FINDERS; PART I: Propagation of electromagnetic waves, application of loop antennas to direction finders; loop errors, antenna effects, pickup errors, etc.; correction circuits, night effect, description of typical radio compass equipment, special antennas.

403. RADIO DIRECTION FINDERS; PART II: Analysis of the functions of ADF equipment; discussion of power supplies, block diagram of typical unit, description of components. Analysis of theory of operation of the modulation system, r.f. amplifier; i.f. amplifier, a.v.c. circuit; tuning meter; audio and loop-motor circuits. Discussion of a second type of A.D.F. equipment, including study of special electrical features; noise-limiting circuit, and C-W oscillator.

404. THE RADIO RANGE: Analysis of operation of the low-frequency radio range, including the visual range, loop goniometer, method of rotating, squeezing and bending of courses, method of coupling vertical antenna to loops, sharpening of courses; the R.A. Range, antenna adjustments and artificial line calculations, measurement of phase; practical circuits, including transmitter, sideband, carrier, and tube sections, final adjustments and checking of line terminations, course rotation, and phase stability.

405. THE OMNIDIRECTIONAL RANGE: General description of the various proposed services, including the omnidirectional range (ODR), distance-measuring equipment (DME), the off-set course computer (OCC), and the instrument landing system (ILS); theory of the omni-directional range, including the antenna system and the rotating goniometer, the octantal error, action of the non-directional antenna; analysis of the ODR, including transmitter, sideband circuits, reference generator, modulation eliminator, and other miscellaneous items; the ODR receiver including the radial converter-indicator, the r.f. unit, the frequency control system, the i.f. amplifier, and the navigation circuits unit.

406. DISTANCE MEASURING EQUIPMENT: Theory of the distance-measuring equipment, frequency channels and duty cycle limitations, transponder systems; Hazeltine FTR, and proposed systems; transponder components, including r.f. lead, tuning system, i.f. amplifier, decoder and coder circuits, modulator and AFC circuits; Interrogator circuits, including sanaphant delay and gate circuits, tracking circuits, search and memory circuits, and indicator units.

407. THE OFF-SET COURSE COMPUTER: DME, interference considerations and analysis; OCC geometrical considerations, one form of computing circuit, proposed electronic computer, method of multiplying variables, linear time base operations and circuit, and linear sweep circuit.

408. INSTRUMENT LANDING SYSTEMS, PART I: Fundamental requirements, the localizer radiating system, Alford loop, antenna patterns, course sharpness; Localizer equipment including keyer unit, modulation circuits, hybrid unit and sideband generator, and carrier transmitter; ILS monitor and control equipment and the localizer receiver.

409. INSTRUMENT LANDING SYSTEMS, PART II: Glide path considerations, including offset and modified glide paths, antenna systems, spurious courses, clearance and course sharpness; the transmitter—electrical and mechanical features including the r.f. unit and mechanical modulator, circuit details and adjustments.

410. INSTRUMENT LANDING SYSTEMS, PART III: Electrical and mechanical features of the monitor unit, including circuit details; the control unit; the receiver; proposed glide path systems—advantages over older system; optical landing aids—inclined lamp banks.

411. FAN AND MARKER BEACONS: Low frequency and UHF marker beacons, radiating systems for fan and cone markers; description of the UHF Type TZG fan marker, transmitter, including r.f., modulation, keying and output circuits; the monitor unit; the various adjustments of the equipment.

412. MAINTENANCE OF AIRCRAFT RADIO EQUIPMENT: Equipment required, testing, necessity for periodic checks, vibration tests, installation notes, adjustment of transmitters, receivers, aligning.

413. AIRCRAFT RECEIVERS: Functions of receivers in aircraft communication and navigation; factors in aircraft receiver design; sensitivity, selectivity, A.F. range, frequency stability, ruggedness; dependability, accessibility, shock mounting, weight, remote control; typical aircraft receivers, beacon-weather and general communication types; schematic diagrams and discussion of circuit features; description of a typical 75 MC/s marker signal receiver.

414. AIRCRAFT AND RADIO TRANSMITTERS: General discussion, types of aircraft transmitters, factors in transmitter design; phone operation, circuit simplicity, mechanical and motor driven frequency-change systems, weight reduction, ruggedness; schematic diagrams, illustrations, explanations of circuit operation of three types of modern aircraft transmitters; pi coupling networks, frequency selectors, location of units in aircraft; detailed description of operation of motor-driven "Autotune" system.

415. POWER SUPPLIES; NOISE SUPPRESSION; SHOCK MOUNTING: Dynamotors vibrators power control circuits; filtering, shielding, bonding, vibration control, all types.

Specialized Advanced Mathematics — Sec. M.

M-1. ADVANCED ALGEBRA, PART 1: Circuits, meshes and branches; mesh equations and solutions with examples; theory of determinants; Cramer's rule—inconsistency of equation; Determinants of the third and higher orders, properties of determinants, exercise problems.

M-2. ADVANCED ALGEBRA, PART 2: Further discussion of simultaneous equations, application of determinants to analysis of cathode coupling, and of oscillator frequency stability (Llewellyn's method).

M-3. DIFFERENTIAL CALCULUS: An introduction to the study of the practical use of analytic geometry and differential calculus, development of formulas and examples of their use in electrical problems.

M-4. APPLICATIONS OF THE DIFFERENTIAL CALCULUS: Derivative of a function of a function; text for maximum and minimum and inflection points; successive differentiation, application to maximum and minimum values; differentiation of trigonometric functions; derivative of sine and cosine functions; other trigonometric functions; differentiation of logarithmic and exponential functions; physical significance of the exponential function; differentials; geometrical and general examples; use of mathematical tables, explicit and implicit functions; derivative of an implicit function; applications; inductive and capacitive reactance; maximum power output, maximum volumes of a chassis; parabolic reflector, maximum dielectric strength—coaxial cable; inductive and capacitive reactance, physical interpretation; sawtooth waves; a differentiating circuit; panoramic receiver; precision of measurements; vibrator power supplies; conclusion.

M-5. INTEGRAL CALCULUS AND ELEMENTARY DIFFERENTIAL EQUATIONS: Introduction; the indefinite integral; the power rule; trigonometric, logarithmic and exponential functions; exact differentials; use of integral tables; the definite integral; the integral as an area; application; current and charge, sinusodial current wave, capacitive circuit, determination of d.c. component; calculation of power; integrating circuit; differential equations; characteristics, initial and boundary conditions, solution; types of differential equations; separation of variables, lineal differential equations; linear equations, constant coefficients; homogeneous equations; illustrative examples; the general linear differential equation with constant coefficients; resume.

SECTION M IS NOW AVAILABLE SEPARATELY, AT $25 WITH COMPLETE INSTRUCTION SERVICE. IT CAN BE STUDIED AT ANY TIME, BUT IT IS RECOMMENDED AFTER COMPLETION OF BASIC SECTION 2.

CREI courses are continually under revision. The above schedule is subject to change as revisions, additions or deletions are made necessary by the advancement of the radio-electronics art.

Specialized Television Engineering — Sec. 5.

(Not available separately)

501. FUNDAMENTAL IDEAS: Practical and fundamental television principles as adapted to everyday operation. Possibilities and methods of transmission. Good picture requirements.

502. THE MECHANISM OF THE EYE: The characteristics of the eye and the manner in which these characteristics influence the design of a television system.

503. ANALYSIS OF A TELEVISION SYSTEM: The components of a complete television system and their relation to the complex job of making a high fidelity picture.

504. OPTICS: Lenses, mirrors, screens and other optical equipment are fundamental components of a television system and must be understood for a thorough knowledge of the system.

505. ELECTRON OPTICS: Since the sharpness of the television picture is largely determined by the sharpness of focus of an electron beam, this is a most important subject.

506. CATHODE RAY PICTURE TUBES: A technical discussion of the direct-viewing type of picture tube, its design factors and operation.

507. PICKUP TUBES — ICONOSCOPE AND IMAGE DISSECTOR TUBES: These are the fundamental pickup tubes of a television camera.

508. STUDIO LIGHTING: One of the most important problems of the television engineer. The various types of lights, their particular uses and lighting calculations are discussed.

509. THE SYNCHRONIZING GENERATOR; TIMING CIRCUITS: The method and apparatus used to secure exact timing which is so important in television broadcasting.

510. SHAPING CIRCUITS; DEFLECTION GENERATORS: The circuits employed to shape the special voltage and current pulses used in synchronizing and electron beam deflection.

511. VIDEO AMPLIFIERS: A television picture's fidelity is determined to a large extent by the design of the several video amplifiers as explained in this assignment.

512. TELEVISION RECEIVERS—PART I: The general considerations influencing the design of television receivers which are vastly more complex than the finest broadcast receiver.

513. TELEVISION RECEIVERS—PART II: The operation, maintenance and alignment of television receivers and methods of checking and correcting trouble.

514. TELEVISION TRANSMITTERS: A discussion of the design factors involved with UHF operation, wide band modulation, DC insertion, partial sideband suppression, large power output requirements.

515. TELEVISION ANTENNAS: Type, characteristics and performance; problems of coupling and impedance matching.

Complete Outline of CREI Home Study Course in
PRACTICAL TELEVISION ENGINEERING

These assignments are under constant revision to conform with new technical developments, and therefore subject to change.

701. FUNDAMENTAL IDEAS: Practical and fundamental television principles as adapted to everyday operation. Possibilities and methods of transmission. Good picture requirements.

702. ARITHMETIC: The basic mathematics of radio is not difficult but must be thoroughly understood if you are to be able to progress and master the subject of television.

703. MENSURATION: A continuation in a very fundamental manner, of the study or the basic mathematics used in the solution of television problems.

704. THE MECHANISM OF THE EYE: The characteristics of the eye and the manner in which these characteristics influence the design of a television system.

705. POSITIVE AND NEGATIVE NUMBERS; EXPONENTS; SQUARE ROOTS: An inspiring study to show how an engineer solves for answers in such problems as conversion factors of electrical units and other radio problems.

706. LOGARITHMS: How to use log tables and their importance as timesavers in calculations. The basis of the slide rule operation and of all decibel calculations.

707. ALGEBRA: A practical lesson in applied algebra of radio; symbols, rules and their uses.

708. ELECTRON PHYSICS AND ELECTRON THEORY: An interesting assignment dealing with the composition of matter. The atom and the interactions of atoms; electrons and protons; neutrons; chemical reactions; isotopes and isobars; matter and energy and their applications to radio engineering.

709. OHM'S AND KIRCHOFF'S LAW; BRIDGE CIRCUITS: The fundamental relationships between current, voltage and impedance. Very interesting and a MUST.

710. METERS AND MEASURING INSTRUMENTS: Tools every radio engineer uses to his great advantage, their particular and appropriate uses and their care.

711. GEOMETRY; TRIGONOMETRY: Problems involving curves, angles, and triangles in radio and television can be analyzed quickly and readily by your having a good knowledge of these two subjects as furnished by this lesson.

712. OPTICS: Lenses, mirrors, screens and other optical equipment are fundamental components of a television system and must be understood for a thorough knowledge of the system.

713. VECTOR ANALYSIS: Simple vector relations, development of a sine curve and signs of functions in various quadrants.

714. GRAPHICAL ANALYSIS: Curves in radio work, construction of a graph, plotting curves, curve inclination and slope, all of great importance to a television engineer.

715. MAGNETIC CIRCUITS: Properties of magnetic lines of force, magnet design and application to the operation and maintenance of radio and television apparatus.

716. ALTERNATING CURRENTS: The basic rules of AC theory must never be forgotten or minimized. This is an interesting and important lesson.

717. PHASE ANGLES, SINGLE AND POLYPHASE AC SYSTEMS: Phase relations of currents and voltages; their effect on a television picture and the problems involved in transmission to the receiver.

718. INDUCTANCE: Radio and television are greatly affected by this component (one of three) present in every electrical and radio circuit.

719. INDUCTIVE REACTANCE, IMPEDANCE Q OF COILS: An intensely practical assignment dealing with further study of the Q of coils and their important use in radio.

720. INDUCTIVE COUPLING: One of the most extensively employed methods of transferring electrical power from one circuit or device to another.

721. CAPACITY: A component (one of three) present in every electrical and radio circuit. Every radio and television engineer must understand its peculiarities in order to control it.

722. CAPACITORS USED IN RADIO: Types of capacitors and their various uses, how to select condensers and how and where to place them.

723. THE SERIES LCR CIRCUIT: The approach to the applications of L, C and R in tuned circuits and to the phenomena associated with circuit "resonance."

724. THE PARALLEL LCR CIRCUIT: This assignment explains the effects of "resonance" but with parallel LCR circuits which will be opposite in meaning to a Series LCR Circuit.

725. SERIES PARALLEL CIRCUITS: This assignment will show you how easily the most complex circuit is broken down for analysis into simple component circuits. Such complex circuits are used as filters in many television applications.

726. PRACTICAL APPLICATIONS OF SERIES AND PARALLEL CIRCUITS: The study of tuned antenna circuits, tuned grid and plate circuits, effects of frequency, tank circuits, band pass filters, etc.

727. POWER CONSUMPTION IN ELECTRICAL CIRCUITS: An explanation of the calculation and expenditure of power. The power consumption by television will be large as it will include studio lights, transmitters and multi-tube receivers.

728. STUDIO LIGHTING: One of the most important problems of the television engineer. The various types of lights, their particular uses and lighting calculations are discussed.

729. THERMIONIC EMISSION: This lesson is primarily concerned with thermionic emission, characteristics of different types of filaments, grid and plate materials, etc.

730. POWER SUPPLIES: A preliminary discussion of rectifier circuits, effects of gas pressure and temperature, filter design, etc.

731. THEORY OF THE TRIODE TUBE: This is the basic tube of radio and the predominant high power amplifier tube.

732. VACUUM TUBE AMPLIFIERS: This discussion is on the basic relations of vacuum tubes and their grid and plate load circuits, and the calculations involved.

733. THE SCREEN GRID TUBE: High gain, wide range television amplifiers are made possible by the use of screen grid tubes. A discussion of the various types of tubes and associated circuits.

734. DESIGN OF OUTPUT CIRCUITS FOR TRANSMITTER POWER AMPLIFIERS: A high power tube is useless without a properly designed plate load circuit. This assignment covers the complete design of such a circuit.

735. FREQUENCY MULTIPLYING: THE VACUUM TUBE AS A DETECTOR: The high output frequency of a television transmitter is obtained by frequency multiplying. Proper design of the detector is a most important factor in receiver operation.

736. AUDIO FREQUENCY AMPLIFICATION; PART I: Frequency response, wave analysis, amplifier design and circuit discussions.

737. COMPLEX NOTATION—PART I: OPERATOR J: Numbers—real, imaginary and complex. The mathematics of radio engineering.

738. COMPLEX NOTATION—PART II: Polar form of complex numbers. The application of advanced mathematics to circuit calculations.

739. AUDIO FREQUENCY AMPLIFICATION; PART II: McIntosh Amplifier: inverse feedback, phase inverters, tone controls and boost circuits.

740. RECEIVERS-RADIO FREQUENCY AMPLIFICATION: This assignment covers important factors in design of radio and television receivers.

741. FM RECEIVERS: Principles of FM including noise and interference problems. Design of typical FM receiver circuits and alignment.

742. OSCILLATOR AND NEUTRALIZING CIRCUITS: Two fundamental problems in transmitter and receiver design at all frequencies.

743. CRYSTAL CONTROL OF RADIO FREQUENCIES: The advantages of crystal control and the theory involved, adaptability and uses.

744. ELECTRON OPTICS: Since the sharpness of the television picture is largely determined by the sharpness of focus of an electron beam, this is a most important subject.

745. CATHODE RAY PICTURE TUBES: A technical discussion of the direct-viewing type of picture tube, its design factors and operation.

746. PROJECTION PICTURE TUBES: These high voltage tubes are employed where optical projection is used to produce a larger picture than can be obtained with the direct-viewing type.

747. PULSE TECHNIQUES: A survey of applications in television, radar, and pulse time modulation. The methods by which pulses are properly shaped and phased.

748. MODULATION: The methods of modulation, characteristics and control; a special problem in television because of the wide band required.

749. RADIATION AND RADIATORS: The principles and fundamental concepts of radiation, electric and magnetic field lines, wavelength and radiation resistance.

750. RADIATING SYSTEMS: Transmission lines, antenna characteristics and effect of ground; directional and turnstile antennas; a television transmitter can be no better than its radiating system.

751. RADIO WAVE PROPAGATION—RECEIVING ANTENNAS: Types of antennas, their advantages and special adaptations. The best television receiver is useless unless properly installed.

752. PROPAGATION AND TRANSMISSION LINES AT ULTRA HIGH FREQUENCIES: Propagation of U. H. F. space waves, optimum antenna height for maximum signals and for maximum line-of-sight transmission. Transmission lines as circuit elements, properties; oscillator tank circuit having desired Q, antenna receiving system having desired selectivity or band width.

753. WAVE GUIDES AND CAVITY RESONATORS AT ULTRA HIGH FREQUENCIES: Theory of wave guides, cut-off frequency, wave modes, attenuation, impedance matching diaphragms, cavity resonators, coupling methods, design of receiving system.

754. RADIATING SYSTEMS AT ULTRA HIGH FREQUENCY: Types of radiating systems, antenna arrays, radiation from a pipe, sectoral horn, biconical horn, parabolic reflector design for desired directional effects, methods of coupling.

755. TUBES AND ASSOCIATED CIRCUITS: Grounded-Grid Amplifier; impedance matching, capacitances, gain, examples, practical circuits; input loading; gain, cathode-lead inductance; resistance and tube noise, input loading, amplifier stage, illustrative typical example, noise factors; mixers and converters, characteristics, gain, noise; typical receiver noise calculations.

756. NEGATIVE-GRID TUBES AT ULTRA HIGH FREQUENCIES: Negative-grid tubes; transit time effects factors; acorn and U. H. F. midget tubes; light-house tube; pulse operation; circuit limitations; resonant lines; reduction of lead inductance; glass seals; general power tube considerations; advantages of push-pull circuit; comparison of water-cooled and air-cooled tubes; neutralization; air and water cooling.

757. SPECIAL ULTRA HIGH FREQUENCY TUBES: Inductive-output tube, fundamental theory; construction, operating features; the klystron tube, fundamental action; klystron amplifier; klystron frequency multiplication; methods of modulation; the magnetron; original development; motion in a magnetic field; action of a combined electric and magnetic field; split-plate magnetron, magnetrons with cavity resonators; performance of four-cavity magnetron.

758. ANALYSIS OF A TELEVISION SYSTEM: The components of a complete television system and their relation to the complex job of making a high fidelity picture.

759. PICKUP TUBES—ICONOSCOPE AND IMAGE DISSECTOR TUBES: These are the fundamental pickup tubes of a television camera.

760. THE ORTHICON AND IMAGE ORTHICON: These are the latest types of camera pickup tubes which make television less dependent on special lighting.

761. FILM PICKUP CAMERA: An important adjunct to every television studio. Much television program material will be motion picture film.

762. THE SYNCHRONIZING GENERATOR; TIMING CIRCUITS: The method of apparatus used to secure exact timing which is so important in television broadcasting.

763. SHAPING CIRCUITS; DEFLECTION GENERATORS: The circuits employed to shape the special voltage and current pulses used in synchronizing and electron beam deflection.

764. VIDEO AMPLIFIERS: A television picture's fidelity is determined to a large extent by the design of the several video amplifiers as explained in this assignment.

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767. TELEVISION TRANSMITTERS: A discussion of the design factors involved with UHF operation, wide band modulation, DC insertion, partial sideband suppression, large power output requirements.

768. TELEVISION ANTENNAS: Type, characteristics and performance; problems of coupling and impedance matching.

769. TELEVISION TEST EQUIPMENT—PART I: Transmitters, studios, receivers—all require adequate test equipment in order to continue functioning properly. This assignment deals with general test setups—such as in a service shop, and test equipment for general use.

770. TELEVISION TEST EQUIPMENT—PART II: In this assignment the more specialized receiver test equipment is taken up, such as sweep and marker generators. A "must" for servicemen.

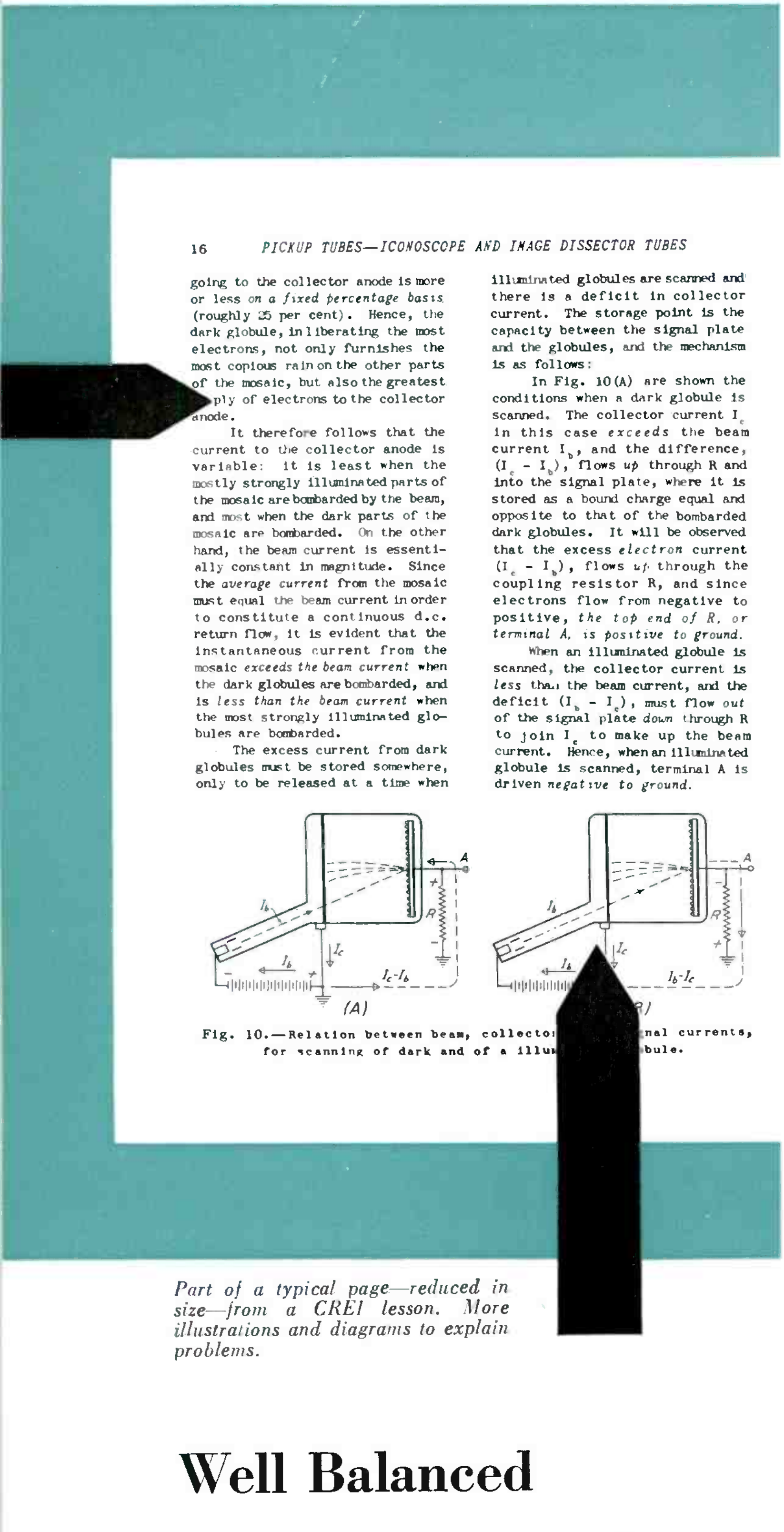
771. TELEVISION AND FM TROUBLE SHOOTING: Owing to the greater complexity of FM and particularly television receivers, trouble-shooting procedures must be systematized if service work is to be profitable. This assignment deals with such procedures and is therefore of utmost importance.

Personalized Instruction Service Gives You Individual Attention

CREI *planned* home study is an individual method of instruction. Each student receives continuous attention and assistance to meet his special needs throughout the course. Upon enrollment, you receive your first set of lessons—each with its own examination, which is sent in for correction and comment. As you complete and are examined on the first group of lessons, you receive the next set. Thus, you always have a sufficient number of lessons at hand to allow you to proceed as quickly as you like.

But, most important of all is CREI's plan of "personalized" instruction. As a student you will be assigned to competent instructors. These instructors will guide you through your studies and offer prompt additional explanations when necessary. They will recommend methods and means which will contribute to a more complete understanding of the subject matter and will personally correct and explain errors in examinations. This is truly "personalized" instruction, and it is one of the most valuable features of CREI home study education.

On page 27 is reproduced an actual corrected examination returned to a student. Note the detail of instruction and advice. Each paper is carefully examined. On complex problems, frequently a personal letter with a detailed explanation is written to the student to help clarify the problem at hand. Your instructors quickly get to know you through this "personalized" contact. They can then correct any weaknesses that exist, emphasize factors that require further clarification and help you to a clear-cut understanding of any doubtful points. By carefully examining these "personalized" instructions and corrections the student can proceed through his studies with the confidence and assurance that erroneous ideas are corrected.


16 *PICKUP TUBES—ICONOSCOPE AND IMAGE DISSECTOR TUBES*

going to the collector anode is more or less *on a fixed percentage basis* (roughly 25 per cent). Hence, the dark globule, in liberating the most electrons, not only furnishes the most copious rain on the other parts of the mosaic, but also the greatest ply of electrons to the collector anode.

It therefore follows that the current to the collector anode is variable: it is least when the mostly strongly illuminated parts of the mosaic are bombarded by the beam, and most when the dark parts of the mosaic are bombarded. On the other hand, the beam current is essentially constant in magnitude. Since the *average current* from the mosaic must equal the beam current in order to constitute a continuous d.c. return flow, it is evident that the instantaneous current from the mosaic *exceeds the beam current* when the dark globules are bombarded, and is *less than the beam current* when the most strongly illuminated globules are bombarded.

The excess current from dark globules must be stored somewhere, only to be released at a time when illuminated globules are scanned and there is a deficit in collector current. The storage point is the capacity between the signal plate and the globules, and the mechanism is as follows:

In Fig. 10(A) are shown the conditions when a dark globule is scanned. The collector current I_c in this case *exceeds* the beam current I_b, and the difference, $(I_c - I_b)$, flows *up* through R and into the signal plate, where it is stored as a bound charge equal and opposite to that of the bombarded dark globules. It will be observed that the excess *electron* current $(I_c - I_b)$, flows *up* through the coupling resistor R, and since electrons flow from negative to positive, *the top end of R, or terminal A, is positive to ground.*

When an illuminated globule is scanned, the collector current is *less* than the beam current, and the deficit $(I_b - I_c)$, must flow *out* of the signal plate *down* through R to join I_c to make up the beam current. Hence, when an illuminated globule is scanned, terminal A is driven *negative to ground.*

Fig. 10.—Relation between beam, collecto… …nal currents, for scanning of dark and of a illu… …bule.

Part of a typical page—reduced in size—from a CREI lesson. More illustrations and diagrams to explain problems.

Well Balanced Courses Presented in Modern Style

ONE of the greatest and most important tasks of the CREI engineering department is to maintain CREI courses at an up-to-the-minute level of modern engineering. As major engineering developments are accepted in the Radio-Electronics field they are incorporated in CREI courses. This includes new circuits, new applications of older principles and new equipment. CREI courses are kept strictly up to date. Additional lesson material is being constantly added as commercial radio, television, FM and the many new developments in Radio-Electronics are tried and proved.

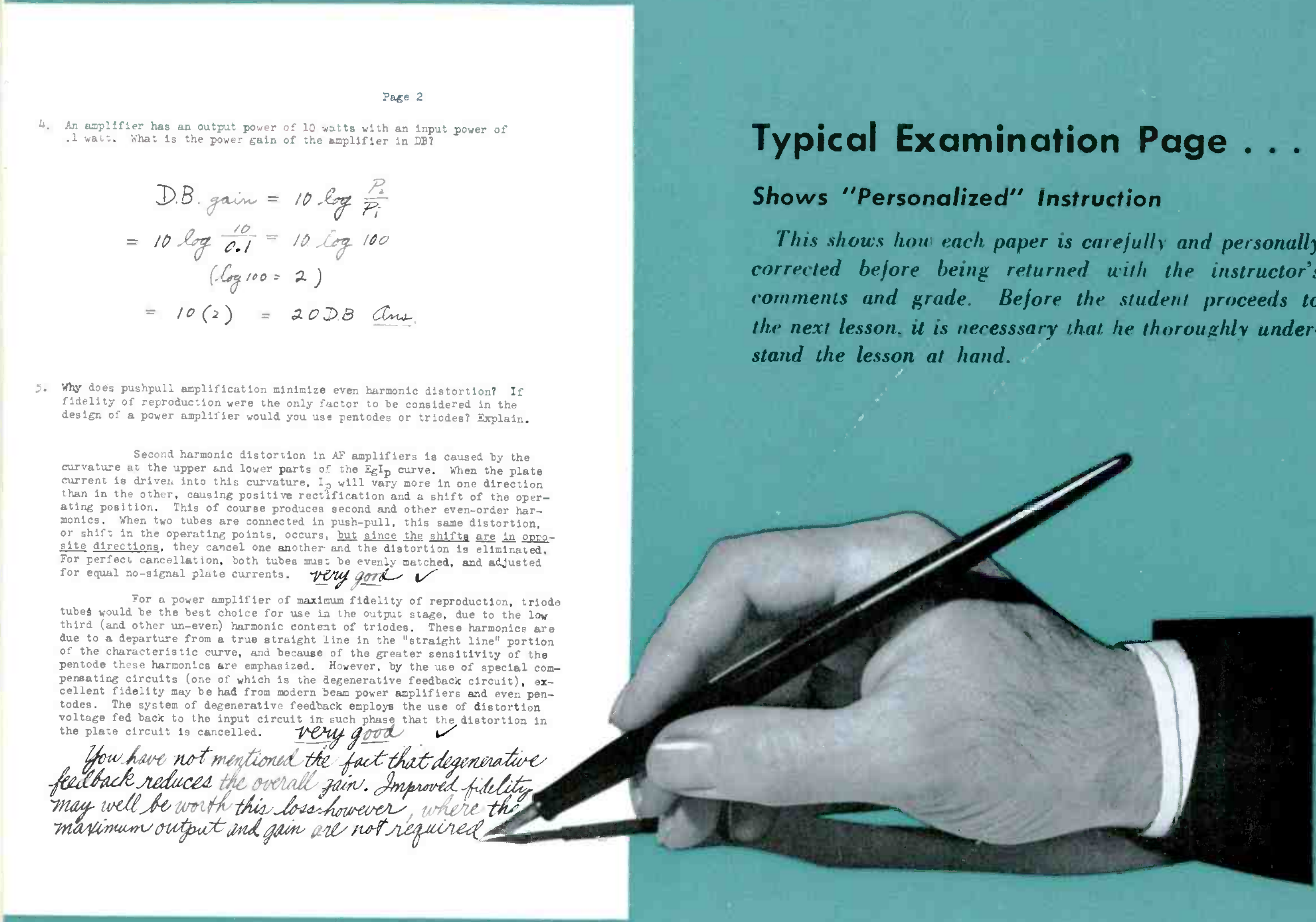
CREI courses are designed from a strictly practical viewpoint. They are first of all *easy to read* and written for quick, thorough understanding. They put over their subject matter expertly, thoroughly and clearly. Modernized printing and binding increase their functional usability. All lessons are made up in binders of standard size, and indexed for quick reference purposes. The complete course of more than 5000 pages of text, illustrations and detailed diagrams becomes a most valuable reference library to graduates.

As a further service, graduates are allowed at any time to replace their old lessons with the latest revised editions at a nominal cost to cover production and mailing. Thus, the CREI graduate can always keep his reference lesson material strictly up-to-date. In addition to the regular lesson material, each student is provided with a book of mathematical tables and a student's slide rule when he starts the study of mathematics.

Typical Examination Page . . .

Shows "Personalized" Instruction

This shows how each paper is carefully and personally corrected before being returned with the instructor's comments and grade. Before the student proceeds to the next lesson, it is necessary that he thoroughly understand the lesson at hand.



Page 2

4. An amplifier has an output power of 10 watts with an input power of .1 watt. What is the power gain of the amplifier in DB?

$$\text{D.B. gain} = 10 \log \frac{P_2}{P_1}$$
$$= 10 \log \frac{10}{0.1} = 10 \log 100$$
$$(\log 100 = 2)$$
$$= 10(2) = 20\text{DB Ans.}$$

5. Why does pushpull amplification minimize even harmonic distortion? If fidelity of reproduction were the only factor to be considered in the design of a power amplifier would you use pentodes or triodes? Explain.

Second harmonic distortion in AF amplifiers is caused by the curvature at the upper and lower parts of the E_gI_p curve. When the plate current is driven into this curvature, I_p will vary more in one direction than in the other, causing positive rectification and a shift of the operating position. This of course produces second and other even-order harmonics. When two tubes are connected in push-pull, this same distortion, or shift in the operating points, occurs, but since the shifts are in opposite directions, they cancel one another and the distortion is eliminated. For perfect cancellation, both tubes must be evenly matched, and adjusted for equal no-signal plate currents. very good ✓

For a power amplifier of maximum fidelity of reproduction, triode tubes would be the best choice for use in the output stage, due to the low third (and other un-even) harmonic content of triodes. These harmonics are due to a departure from a true straight line in the "straight line" portion of the characteristic curve, and because of the greater sensitivity of the pentode these harmonics are emphasized. However, by the use of special compensating circuits (one of which is the degenerative feedback circuit), excellent fidelity may be had from modern beam power amplifiers and even pentodes. The system of degenerative feedback employs the use of distortion voltage fed back to the input circuit in such phase that the distortion in the plate circuit is cancelled. very good ✓

You have not mentioned the fact that degenerative feedback reduces the overall gain. Improved fidelity may well be worth this loss; however, where the maximum output and gain are not required

MATHEMATICS is presented in an easy-to-understand manner. Most CREI students have had no more than regular high school mathematics. This is kept in mind in presenting the subject to those who need a good basic "brush-up." The CREI simple, step-by-step instruction method will successfully lead you to a good, practical working knowledge of the necessary mathematics needed in Radio-Electronics engineering. The average student can capably handle mathematics as presented in this simplified CREI method.

The CREI Diploma—Your Best Reference for a Better Job

A large, attractive diploma, suitable for framing, is awarded to each student who successfully completes Section 2, or the Practical Television Engineering Course. Certificates are awarded to all students upon successful completion of Sections 3, 4 and 5. Your CREI diploma commands respect throughout the industry. Employers, when seeking men to fill important technical positions of responsibility, give more than ordinary attention to the man with a CREI diploma.

Here are CREI's five great services

—endorsed by thousands of satisfied, enthusiastic professional radiomen.

1. PROGRESSIVE AND LOGICAL ARRANGEMENT OF LESSONS AND EXAMINATIONS COMPLETELY COVERING PRACTICAL RADIO-ELECTRONICS AND TELEVISION ENGINEERING. CREI provides a clear-cut, well defined path of study for the student to follow. Lessons proceed in logical sequence. All superfluous subject matter is eliminated. Confusion, waste time and repetition are avoided. From the very first lesson the student starts his studies with practical every-day problems and practices. The course is kept up-to-date and complete. Revised lessons, including new and advanced engineering data, automatically become a part of the course, if such lessons are in advance of the student's progress. Our own engineering and text writing department works continually on revision and addition of text material so that new engineering principles are included in the course as they become accepted by the industry.

2. PERSONAL SUPERVISION GUIDANCE AND CONSULTATION OF AN EXPERIENCED CREI STAFF INSTRUCTOR. Each student's work is handled by competent instructors. These instructors, carefully trained in the subject the student is studying, will personally advise and clarify problems the student may encounter.

After completing each lesson the student submits his written examination to the school. Errors are corrected by letter, or on the back of the examination paper. The correct method of solving a problem, or applying a principle, may be actually illustrated. This close cooperation between instructors and student assures good understanding of every lesson throughout the entire course.

If the student becomes perplexed over portions of the text (and in spite of over twenty-three years of writing, revising and re-writing, some students will stumble occasionally), he is urged to ask his instructor to clear up the misunderstanding. This service is his, as often as he requests it.

3. CONSULTATION REGARDING ENGINEERING PROBLEMS ENCOUNTERED IN PROFESSIONAL DUTIES. If the student has completed that part of the course relating to a problem that arises in his daily work, he may call on CREI for consultation or advice. Many graduate students use this service and consult with the

CREI staff for constructive advice and assistance in connection with their professional problems and work.

4. LESSON RENEWAL SERVICE KEEPS GRADUATES CONTINUOUSLY UP-TO-DATE. Graduates find their lesson texts and completed examinations a valuable reference library. To keep this reference material current and up-to-date the graduate may purchase at nominal cost all new and revised lessons he has completed in his course as they are produced. CREI lesson revisions are announced periodically in the bi-monthly edition of the CREI NEWS which is mailed free to all students and graduates.

5. THE CREI NEWS COMES TO YOU REGULARLY WITHOUT COST. Every student and graduate receives the CREI NEWS. This interesting publication, released bi-monthly, serves as a permanent tie between the student, the graduate, and the Institute.

Important technical articles appear in every issue on subjects that are of practical value to every man in Radio-Electronics. These articles become an essential part of your reference library. Up-to-the-minute *news* covering new trends, new developments, and new inventions are included. Personal notes of students and graduates from all over the world provide you with a human interest picture of what other CREI men are doing in the Radio world.

These "5 Great Services" outlined here, are yours to use and benefit from . . . they comprise a proven system of training endorsed by satisfied enthusiastic students since 1927.

CREI PLACEMENT BUREAU

is at your service!

CREI maintains a Placement Bureau—available to all students—that enables employers and students to get together in the interest of placing the student in the right job.

CREI students usually are employed in Radio-Electronics at the time of their enrollment, and, in common with other ethical technical schools, CREI does not promise or guarantee jobs to its students. But most students are capable of moving ahead to better jobs after completing their CREI course. It has always been the policy of CREI to cooperate with students and graduates in every way possible.

"In following up your suggestion regarding American Airlines, I succeeded in obtaining a position in Radio Maintenance. . . . I really can't thank you enough for your helpful advice. It means so much to my wife and me."

—Edwin J. Williamson

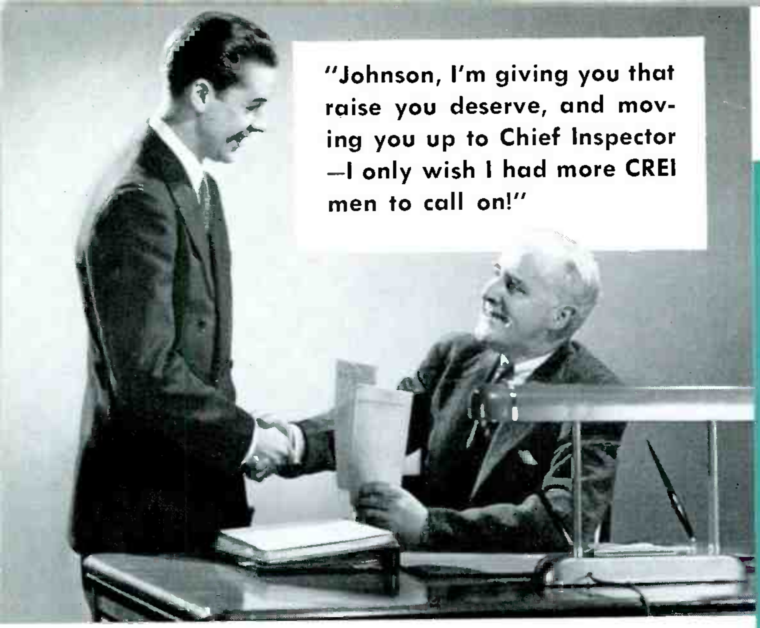
"About six weeks ago I started working here at WTMA and want to take this opportunity to thank you for your help in making this position available to me."

—LeRoy S. Wenger

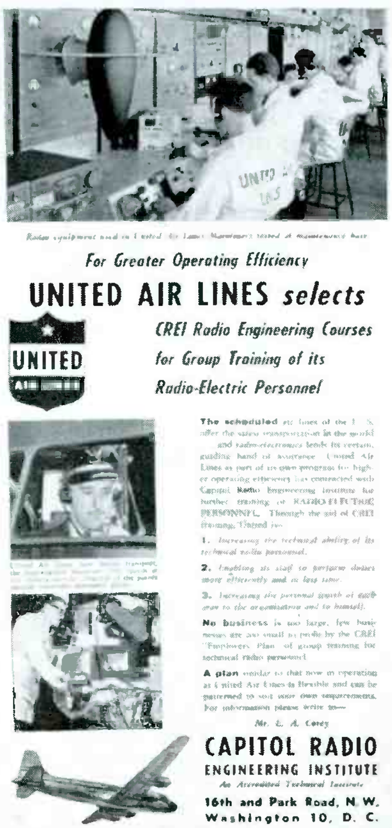
CREI ALUMNI ASSOCIATION

offers continuing contacts

The Alumni Association is open to all CREI graduates. It offers a means of continuing your CREI relationship, plus enjoyable fellowship and a means for exchanging ideas and experiences. Headquarters are maintained in Washington, D. C., with chapters located throughout the country. A national convention is held annually and officers are elected from and by the membership.



EMPLOYERS APPROVE AND ENCOURAGE CREI HOME STUDY



Employers recognize the initiative displayed by an employee when he signs up for advanced technical education to improve his ability and worth to his company on his own time and at his own expense. Employers regard CREI graduates and students with high favor and often give them preference in selecting applicants for preferred positions. Promotions come quickly to men who are alert and who prepare themselves. At your request, CREI will inform your employer of the progress you are making with your studies, upon completion of certain sections of the course. Below are quotations from typical letters received in reply. Only the names have been deleted.

From Chief Engineer of large manufacturer: "Your letter concerning Mr. ——— who is at present enrolled with your school has been brought to my attention. We greatly appreciate having this information and arrangements are being made to talk to Mr. ——— with the thought that we might be able to employ him to greater advantage in our electronics section. Your interest in this matter is greatly appreciated and we trust it will result in mutual advantage to Mr. ——— and ourselves."

From Supt. of Communications of large airlines company: "It is certainly gratifying to know that our boys are sufficiently interested in their work to expend time and effort to equip themselves for further advancement. We feel sure that the course offered by your school will prove beneficial to both Mr. ——— and the Company."

From Vice-President of a major broadcasting corporation: "I am certainly delighted to know that Mr. ——— has satisfactorily completed your advanced extension course in Practical Radio Engineering. Mr. ——— to my mind, is one of the best engineers we have at this station, and it is a source of great gratification to me to have any member of our staff improve his knowledge regarding technical information . . . and for that reason your report on Mr. ——— was most encouraging to me."

CREI files contain similar letters from all over the world . . . from big companies and from small companies . . . from Government Departments and private organizations. The man who requests CREI reports of study progress to be forwarded to his employer enjoys the unusual advantage of having his name brought in a favorable light frequently to his employer's attention. Employers, when seeking men qualified to fill the better jobs, give more than ordinary attention to the man who spends his spare time in professional self-improvement.

"I would like to take this opportunity to express my satisfaction with the excellent training I have received from your Home Study Course. I wish you would extend my thanks to Mr. Rietzke and all his associates for their careful preparation of material and systematic progression of lessons, and application to practical problems. Being employed in the radio industry at the time of enrollment, I had constant opportunities to apply my training to my daily work, with gratifying results both to myself and my employer."

—H. B. Seabrook,
Chief Engineer, CJOR, Ltd.

"I have gone to work as a Testing Equipment Engineer for Bendix Aviation Radio Corporation, at an excellent salary and in the most desirable of jobs, development engineering. I wish to express my gratitude and thanks to C.R.E.I.'s Placement Bureau for the tremendous help you have given me in obtaining this position."

—Vincent F. Lopresti

"I have always maintained that to my knowledge, there is no better home study course in radio engineering than the 'Practical Radio Engineering' course pioneered by Capitol. The course has been an invaluable aid to me in my work as Radio Electrician, Maintenance Supervisor, and finally Communication Supervisor, with the Civil Aeronautics Authority, and I can state without exaggeration that it would still be a bargain at twice its present cost. I still refer to my CREI texts when confronted with a knotty problem."

—George L. Rand,
Communication Supervisor,
Civil Aeronautics Authority,
Fort Worth, Texas

"I shall once again try and express to you the value that CREI training has been to me. As a matter of fact, I suppose I shall be writing this type of letter to you many times through the coming years, for CREI training has been a 'lifesaver' to me.

"Recently, the Army conducted a competitive examination for the grade of Warrant Officer. I applied for the examination in 'Communications, Air Corps.' I took the examination in March of this year. Last May, I was notified that I had passed the examination and received my appointment as a Warrant Officer.

"I can truthfully say that my CREI training was the outstanding factor that enabled me to pass the examination.

"As a matter of reminiscence, I am now making five times the money that I was when you enrolled me as a student of CREI. That enrollment was the BEST investment that I ever made in my life."

—James L. Weeks,
Warrant Officer,
Army Air Forces

"I have passed the examination for F.C.C. monitoring officer, which as you know is a pretty good job. I attribute a large part of my success to Capitol training."

—Harold M. Gander,
Chief Engineer, KORE,
Eugene, Oregon

"I am highly satisfied with the course, my weak point is mathematics so I intend reviewing lessons 2 and 3 at intervals. Being a high school graduate I should know the mathematics in these two lessons but I seem to have forgotten it all. This is the first time I have had a thorough understanding of trigonometry, that is, the basic principles."

—Charles D. Vaughn, RM2c.

"You may be interested to know that I have been advanced to the rate of ARM1c (Aircraft Radioman) effective June 1st last. This rate was made 18 months after my coming on active duty. As you know I started in this man's service as apprentice seaman, thanks to your aid I have made, what I think, fair strides."

—J. V. Coleman, ARM1c.

CREI TECHNICAL EDUCATION LEADS TO BETTER JOBS MORE MONEY SECURITY

"A few days ago I was officially notified of the fact that I had successfully passed the examination for Radio Inspector, with the Federal Communications Commission. I attribute this to the complete basic training I had received from your engineering course, so you see I have complete confidence in it and I do not fail to speak very highly of it at any opportune moment."

—Charles J. Leipert,
Santa Ana, California

"I have been a student of your CREI Home Study Course for little over a year, and I feel that your course so far has helped me a great deal, and is greatly responsible for my advancement in ratings."

—John Liska,
US-10 c/o PM,
San Francisco, California

"I am writing this letter to tell you that again CREI has been a tremendous help, since I was studying the lesson on CR tubes and had received the Television lessons. I really obtained the information I needed about wide band amplifiers from Lesson 10 of the Television Course. That lesson is certainly crammed chuck full of information on peaking circuits of which amplifiers of the 305 Scope has several. It really makes one appreciate the CREI course when it falls in so rapidly with everyday work."

—Oscar Carlson,
RCA Corp.

"There are many times where what I am studying in the course works right in with the immediate problems of my job. This helps me on my job a great deal."

—C. I. Carpenter,
C.A.A., Fort Worth, Texas

"This transfer also brought about a promotion with a noticeable increase in salary. While I have been studying with you for but a short while, I can honestly say that the material I have studied has greatly aided me in absorbing more advanced theory."

—C. O. Wilkinson,
Ass't. General Foreman,
Radio Repair Section,
U. S. Signal Corps

"Yesterday I passed the F.C.C. exams for Commercial Radio telephone first-class and I attribute my ability to do so, largely and almost entirely to CREI. Without CREI I surely would not have passed. I am employed now at WTAR, a 5 kw station using RCA equipment, and everything I studied seems to come into immediate use. Also many things I do every day become more clear as to reasons and theory."

—Howard W. Baker,
Norfolk, Virginia

"I think it will interest you to know that I am now working for the General Electric Company. I certainly was lucky to have taken the CREI course in time to take advantage of the opportunities now open, and I am grateful to you for your part in the matter."

—W. J. Gralewski,
Brooklyn, New York

"On February 6 I was employed by the Vega Aircraft Corp. in the electrical precision assembly department on the strength that I was enrolled with your school."

—Charles F. Hampton

"The fact that I'm studying with CREI impressed my new boss very favorably and I feel it only fair to give CREI a good deal of credit for my securing this position."

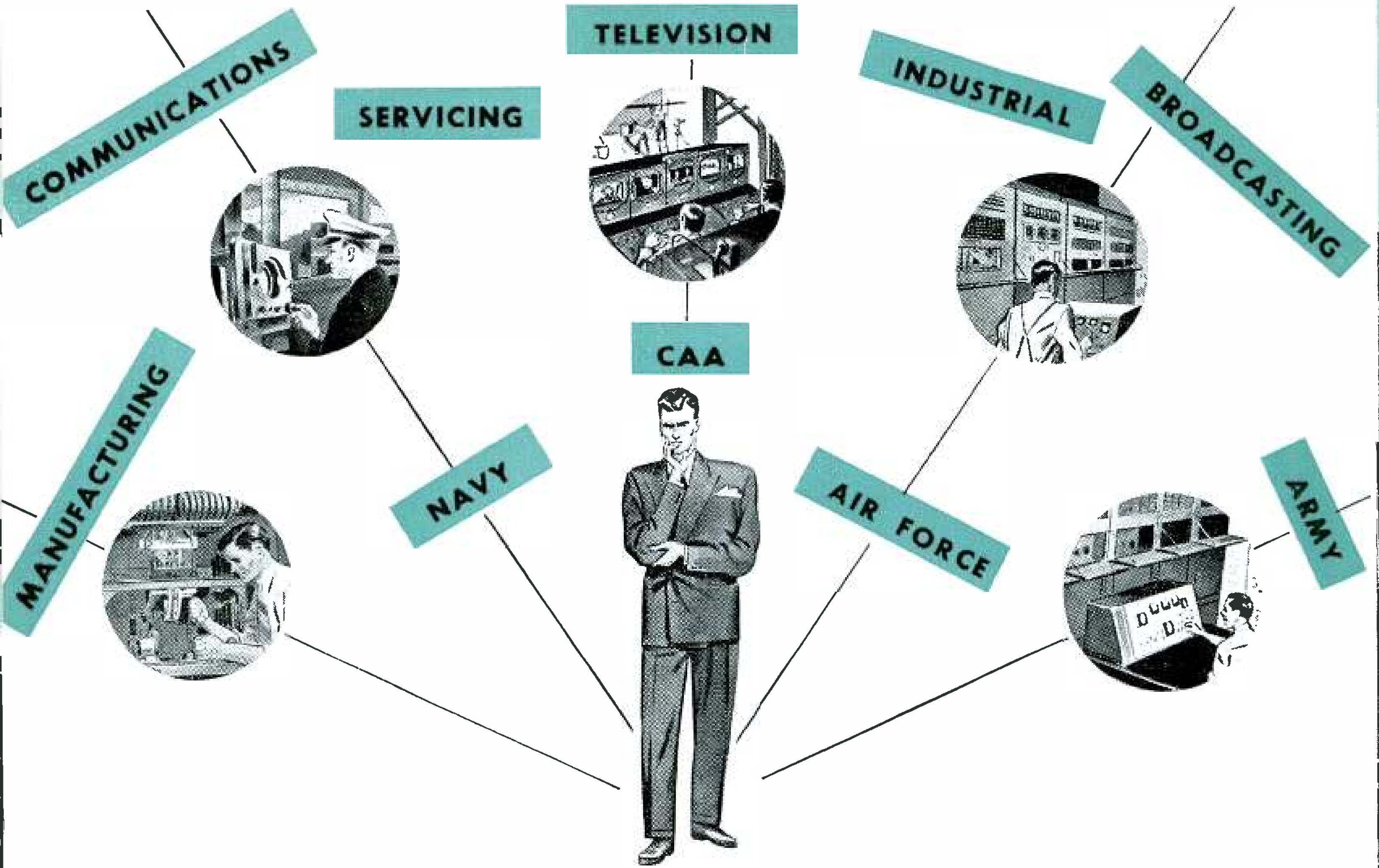
—Alex N. Steinberg,
Radio Station KIUP

"I wish to say that I believe CREI has been instrumental in making my promotion possible, as considerable background in radio is necessary before an operator can be transferred from the Communication Section to the Maintenance Section."

—Don W. Lowrey,
Senior Radio Electrician, CAA

"I have been promoted to Radio Electrician and am now practically living along side of and working on modern transmitters. I can truthfully say that I believe the fact that I had completed a certain portion of the CREI course has had considerable bearing on my being selected for my present position."

—Benjamin A. Calamore, CAA,
Radio Electrician
(Maintenance)



Where do YOU go from here?

CREI Streamlined, Spare-time Technical Education is the DIRECT COURSE to that Secure, GOOD-PAYING JOB You Want

NEVER was there such widespread opportunity as exists today in every field of Radio-Electronics. Not only are there countless new jobs . . . but *more* jobs with good salaries than ever before. The demand for good men extends far beyond the number of radiomen *qualified* to fill these positions. In the Armed Services, too, there is a great demand for trained technicians. CREI technical training can help qualify you for promotion or higher rating in any branch of the service.

You may have "gotten by" up to this point. But if you want to progress with the industry . . . if you want an important, good-paying position and the security that goes with it . . . you must acquire an up-to-date technical education.

If your interest lies in broadcasting, aviation, manufacturing, television, servicing or in any one of the scores of positions in the many phases of radio-electronics . . . you can enroll with CREI, confident that this high-caliber, professional, practical Radio-Electronics technical education will give you proper and sound qualifications for the field of your choice.

Decide today "where YOU will go from here." You can assure your future security and happiness . . . end the threat of competition challenging you for your job. You have that opportunity . . . if you act now! Fill out and mail the enrollment form enclosed and start your technical education for that better job you want.

QUESTIONS AND ANSWERS

1. Q. ***When is a CREI diploma awarded?***

   A. Upon completion of Section 2 and the final examinations. Certificates are awarded upon completion of Section 3 or 4 or 5 or M. Graduates of Practical Television Engineering Course receive diploma after final examinations.

2. Q. ***Will the completion of Section 2 enable me to pass the FCC examination?***

   A. An advanced student or graduate should easily pass the FCC examination.

3. Q. ***What kind of positions will a CREI advanced student or graduate be qualified to accept?***

   A. CREI students and graduates are employed in practically every phase of the radio-electronics industry and from technicians to engineers.

4. Q. ***May the student enroll for the Practical Television Engineering Course and Sections 3 or 4?***

   A. Yes. A student may enroll for Sections 3 or 4 to be studied after completion of the Practical Television Engineering Course.

5. Q. ***How may a foreign student pay his tuition?***

   A. The regulations of the country in which a student resides determines the procedure to follow in obtaining United States funds for educational training. Students residing in Canada will be notified of the procedure to follow at the time the catalog is sent.

6. Q. ***Can a foreign student expect to be kept supplied with student material?***

   A. Yes. Distances and mailing conditions determine the quantity and rate of shipment.

State Rehabilitation Students. Capitol Radio Engineering Institute cooperates with various state agencies directing vocational rehabilitation. We invite inquiries for details of enrollment procedures from authorized state agencies.

CAPITOL RADIO ENGINEERING INSTITUTE
16th and Park Road, N.W. Washington 10, D.C.

Branch Office:
760 Market Street, San Francisco 2, California

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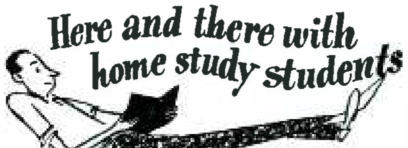
CREI

CREI NEWS

"The Man Who Knows HOW Will Always Have a Job: But the Man Who Knows WHY Will Be His Boss!"

Vol. 9, No. 3 | WASHINGTON 10, D. C. | May-June, 1951



VERN E. HENSLEY, Endicott, N. Y., is now employed as Customer Engineer with the International Business Machines Corporation.

JACK D. DURHAM is confined to the Oak Knoll Naval Hospital with a compound fracture of the right wrist and will be in a cast for three months.

CHARLES TRENHOLM writes that he has transferred from a 250 w to KTPS (10 kw) in Shreveport, La., and that he is busy studying their layouts and making new acquaintances.

THOMAS F. MOORE, JR., of Oklahoma City, Okla., writes that he received an appointment as Maintenance Technician with the Civil Aeronautics Administration. He is attending the C.A.A. Indoctrination School at the Aeronautical Center in Oklahoma City and when he completes his studies he will report to Augusta, Ga., for duty. He says that his CREI course "has been a great deal of help" to him in his present studies.

G. HARMAN, West Palm Beach, Fla., has received his First Class Phone License.

PHILIP A. BROWN, British West Africa, advises that his government plans to build a number of broadcasting stations to serve the main African language speaking regions. He also writes that he feels the field of radio-electronics is progressing rapidly in his country.

MARTIN L. GREINER, West Chester, Pa., is now Chief Aircraft Communicator at Moses Point, Alaska.

GEORGE GRIST, Kingston, Canada, has completed his basic training in the Army and is stationed at the RCEME School studying Radar.

ERNEST H. PLETCHER, Seattle, Wash., has been working for the Army since last July as a Radio and Radar Technician.

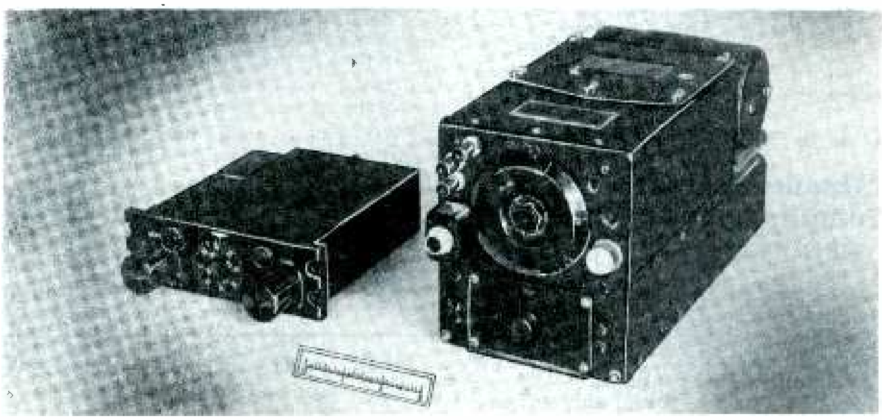
WILLIAM R. E. JONES, Skowhegan, Maine, has opened his own appliance and flooring store. He sells and services all types of appliances and floor coverings.

RHODIN A. CHRISTIANSEN, Salt Lake City, Utah, is now employed by R.C.A.

TEDDY BAKER, Dayton, Ohio, is employed by Dayton Airadio, Incorporated. He designs custom-built equipment for private companies.

(Continued on Page 2, Col. 2)

B. OF S. CUTS AIRCRAFT RADIO SIZE OVER 80 PER CENT



Before and after: Unit on the left shows the new B. of S. aircraft design, less than 1/5 size of World War II unit.

A 12-tube subminiature radio receiver for aircraft use, continuously tunable from 190 to 550 kilocycles and utilizing a 135-kilocycle intermediate-frequency amplifier, has been developed by the National Bureau of Standards. This assembly is the functional equivalent of a World War II unit more than five times as large.

With the use of more and more electronic equipment within the limited space of military planes and tanks, reduction of size has become increasingly important. The Bureau of Aeronautics of the Department of the Navy has therefore initiated at the National Bureau of Standards a broad program for subminiaturization of airborne equipment. Designed and constructed as part of this program, the new low-frequency receiver, in conjunction with a previous high-frequency project (a 60-megacycle, 11-tube intermediate-frequency amplifier assembly), effectively brackets the communication spectrum.

The new equipment, a "radio range" receiver used to keep aircraft on course, occupies about 55 cubic inches, whereas the volume of the original version was approximately 300 cubic inches. Characteristics of the receiver include continuous tuning from 190 to 550 kilocycles, intermediate frequency of 135 kilocycles, a sensitivity of 5 microvolts for 6 decibels signal-to-noise ratio, and a power output of 100 milliwatts. The 12 tubes provide two tuned radio-frequency lator, two 135-kilocycle intermediate-frequency amplifier stages with a bandwidth of about 2 kilocycles, a diode detector, an a-v-c diode, a beat-frequency oscillator, an audio amplifier stage, and a push-pull-parallel power output stage. All stages operate with 26 volts direct-current on heaters, screens, and plates. Under these conditions of operation, four subminiature audio power output tubes are required for adequate power output.

Unusual design problems were presented by the need for hermetic sealing and the high operating temperatures resulting from the very compact construction.

THE "NEWS" TAKES A HOLIDAY

Following this issue of the CREI "News" we're taking a "vacation," and will resume publication with the September issue, after which we will publish quarterly.

Here's wishing a happy vacation to our readers . . . with this reminder: don't let the good old summertime keep you from your appointments with the books and slide rule!

★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

★ CREI NEWS

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In the interest of its students by
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"The Man Who Has The WILL to Study, Has The Ability To Learn"
—E. H. RIETZKE.
May-June, 1951
Volume 9 Number 3
Printed in U. S. A.

★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

"Thanks for the Compliment . . ."

JOHN W. JONES, Bangor, Maine, writes:

. . . passed the exams for 1st cl. Radiotelephone License and received it with ship radar and loran indorsement, on February 21, 1951. The CREI course was almost solely responsible for my being able to pass the exams.

"I visited WHDH (Boston) and the engineers told me practically all of them were taking the CREI course and were very well pleased with the course and thought it was very complete in scope. Made me proud to know what people thought of CREI and to be enrolled there."

JOHN R. RICHARD, Hialeah, Fla., writes:

"Once again it gives me pleasure to tell you how much I enjoy studying the Capitol course. Its simplified approach to all phases of radio is very helpful as well as its anticipation and answering of almost every question which might arise in the mind of a student."

D. D. LAFFERTY, Quincy, Ill., writes:

"I would also like to add in this short letter that I am most happy I chose CREI for the course of instruction and education I am undertaking. I have had a chance to look over some of the lessons of other correspondence courses but CREI has them all beat. The instruction, lesson material and grading is one of the best and most just of any I have seen."

WILLIAM H. BLAND, JR., Chief Engineer, Radio Station KLFY, Lafayette, La., writes:

"First, I want to thank you for your interest and consideration in my course of study.

"Second, I would like to give you something in the way of a partial explanation of the long lapse in the completed lessons. Near the close of 1949 I started the design and construction of Radio Station KLFY in Lafayette, La. As you can well understand, several months were required for the construction and the usual cleaning up process. Hardly was this finished when I began the engineering and construction of Radio Station KVIM in New Iberia, La., which I put on the air on the first of this month. There is some cleaning up work to be done on it yet, of course, but now the pressure is about off, and I will be able to devote time to my CREI work once again.

"I want you and the other members of your staff to know that I realize the immeasurable value of the radio training that CREI offers, and I have not the least intention of failing to complete it. Also, when this time comes I intend to go into your television work, with an eye to the future."

HELP *YOURSELF* TO LIFE'S OPPORTUNITIES

Ask a man of fifty about opportunities he has missed and you will hear an intriguing story. "I just missed the boat," he will tell you. And he will relate some incident which might have changed his whole life.

A celebrated English clergyman watched the death march of a criminal. "There, but for the grace of God, go I," he said. And it is true. A small everyday incident may be the determining factor in the kind of life led thereafter.

Many of the accidental discoveries of science were not accidents at all but a succession of circumstances under the right conditions, observed by the right person. The astronomer, Herschel, discovered a discrepancy in the time of an eclipse and from this "error" discovered that the speed of light was not instantaneous. A German chemist threw some chemicals, the results of an unsuccessful experiment, into the small creek flowing at the rear door of his laboratory. Upon contact with the water an explosion occurred. It was the first acetylene ever made by man.

Looking backward, we all see some lost opportunities resulting from unfortunate choices. Maybe we got started in the wrong vocation. Maybe our present job has led us up a blind alley. Possibly our work is boring and not worthy of our mentality. Perhaps we depended on friendships to make our lives successful . . . but discovered later that friendship is a great ally only if we ourselves possess the skill, knowledge and training demanded for success.

Friends may be willing, even eager, to help, yet one person only can qualify us for advancement. Influential friends would cease to be influential if they made poor choices of men for promotion. Loyalty and friendship work both ways. If you would merit the support of those in top management you must have every qualification for the job up the line. A wise man will take inventory of his qualifications and fill in any missing gaps in his training.

HERE AND THERE WITH HOME STUDY STUDENTS

(Continued From Page 1)

EDWARD BAILEY recently was appointed Major in the U.S.A.F. and is stationed at Selfridge Air Force Base, Mich.

ROBERT ROPES of Kokomo, Ind., is laid up in bed with a severe back injury caused by falling down the basement stairs.

M. H. GROSS, Fort Worth, Texas, is Supervisor of electronic and radio maintenance for the U. S. Naval Air Station, Dallas, Texas.

LEO ST. DENIS, Nashua, N. H., recently obtained a position with the Raytheon Company in Waltham, Mass.

VICTOR O. SERVISS, Denver, Colo., has just completed one year of general engineering and two years radio technician's course at Denver University. He obtained his first class phone license last June and started working at Station KTLN, Denver, Colo.

GEORGE N. DALIANA, Hollywood, Fla., was recently recalled to active duty in the Naval Air Reserve.

VICTOR J. MCKNIGHT, New Bern, N. C., is employed as traveling salesman with the largest radio and TV parts distributor in North Carolina.

CAPTAIN HENRY W. GREENAWALT, USAF, St. Louis, Mo., is Department Operations Officer for the Department of Radio Mechanics at Scott Air Force Base. He recently passed the AF Warrant Officer Exam in radio maintenance and repair and the FCC first class Radiotelephone license.

L. MICHAELIS, Dallas, Texas, is now working as an inspector of electronic materials for the Navy Department.

L. W. DANENBERG, Santa Monica, Calif., is now Development Engineer for Benson Lebner Corporation, in charge of the development laboratory. His department studies both mechanical and electronic problems.

JOSEPH L. BRIGGS, Hamilton, Ohio, was recently appointed Chief Engineer at Radio Station WMOH. He is busy with his new duties but writes that he has "CREI to thank for the advancement."

FRANK F. LEHMAN, Lantana, Fla., is in the Southeast Florida State Sanitorium but writes that he is feeling much better now.

EUGENE T. HAWKINSON of Tucson, Ariz., has been on the sick list but is now improving.

C. EDWARD MORTLOCK, JR., of Wilmington, Del., has been transferred to Fort Riley, Kans.

WILLIAM R. ALLEN, JR., Salt Lake City, Utah, recently received his F.C.C. First Class License.

HOWARD BECKMAN of Rosetown, Canada, is still with Graham Brothers in charge of the radio department. This past summer and fall Mr. Beckman installed F.M. two-way radio and serviced fourteen units which were used by Bechtel Mannix, the pipeline contractors. The service work was done within a radius of 100 miles of Rosetown and amounted to nearly

(Continued on Page 8)

Electronics Engineering
CONSULTATION AND ADVICE

By ALBERT PREISMAN

RECTIFIER INTERNAL RESISTANCE

A student writes in to ask how the internal resistance of a rectifier tube can be found for use in calculations for determining its performance in a choke input filter circuit. What curves furnished by the manufacturer are pertinent to such an analysis, and how are they used?

Specifically, the curves usually furnished by the manufacturer are the regulation curves; that is, the way in which the d-c output voltage varies with the d-c current. One set of curves, for different applied a-c voltages, is furnished for a choke input filter, and another set for a condenser input filter. The latter droop more, and would tend to indicate a higher internal resistance. Yet it would seem that the internal resistance of a rectifier tube should be the same regardless of what kind of a filter is employed. Hence which set of curves are relevant to the analysis?

The answer is, "The set referring to the choke input filter." The other set shows a greater droop not because of the internal resistance of the rectifier tube, but because of the time constant involving the condenser input filter and the load resistance. The lower this time constant is relative to the supply frequency, the lower will be the d-c output voltage, because the load resistor will discharge the filter condenser to a greater degree.

The only effect of the rectifier internal (forward) resistance is in the recharging of the filter condenser during the interval in the cycle when the a-c voltage exceeds the d-c voltage. This is illustrated in Fig. 1, where A

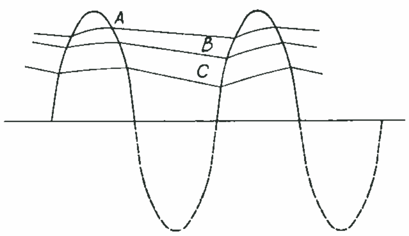


Fig. 1.—Charge and discharge phenomena for three values of rectifier resistance.

represents the lowest internal resistance, and C represents the highest internal resistance of the rectifier tube. The part of each curve that indicates the internal resistance is that within the positive half cycle of the sine wave; in the case of C, the capacitor can not charge anywhere near to the peak of the sine wave because the internal resistance is so high, whereas in the case of A, it can do so because the internal resistance is low.

The portion of the curve between the positive half cycles represents the discharging of the input condenser C_F through the load resistor R_L. Its downward slope to the right is greater, the smaller the time constant $C_F R_L$. For reasonable values of rectifier resistance, the curves within the positive half cycles are closer to A than to C, and hence are fairly near the positive peak of the sine wave. It is then mainly the downward slope during the negative half cycles that determines the average d-c output voltage, rather than the internal resistance of the rectifier.

Fig. 2 shows a regulation curve for a choke input filter to a 5Y3-GT full wave rectifier for 300 volts r.m.s. applied to each plate. Similar curves are obtained for other applied d-c

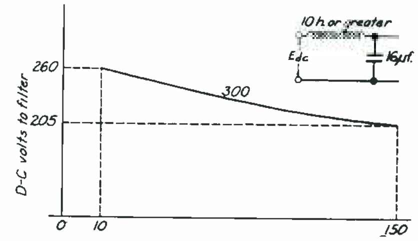


Fig. 2.—Regulation curve for 5Y3-GT rectifier tube.

MR. GEORGE WUEST, a former graduate, is now working at WKRC, Cincinnati, Ohio. He recently married JEAN MCAFEE. Cincinnati is the home town of both Mr. and Mrs. Wuest. MR. EDWARD JOHNSON, who graduated from CREI at the same time that Mr. Wuest did, is also working at Station WKRC. Mr. Johnson and Mr. Wuest were the best of friends while attending school. CREI wishes them the best of luck.

The Television Service Meeting was conducted by the Factory Engineer at General Electric Supply Corp. on Tuesday, February 13th. Refreshments were served and door prizes were given away.

The Sylvania Service Meeting sponsored by Rucker Radio Wholesalers was held in the CREI Study Hall February 15th.

On January 29, 1951, the "Stork" visited MODELLE and ANTHONY VIVIANI and delivered to them a daughter, DEBORAH MARIE VIVIANI. Congratulations to the proud parents.

MR. and MRS. KEVEN RAFFERTY are the proud parents of a baby boy.

MR. THOMAS V. POTTER and MISS BETTY KIT HAMLIN were married in Milo, Maine, on February 10, 1951. CREI wishes them the best of luck and happiness.

The CREI Staff and the student body extend their deepest sympathy to MR. and MRS. RUSSELL MERRY in the loss of their son, and to MR. SAMUEL WHITE in the loss of his father.

The CREI Spring Dance was held in the Theory Room April 6, 1951. The room was beautifully decorated in spring colors, and the dance was well attended by the students and their ladies. The Student Council did their usual good job of making the the dance a success. Refreshments were served and a door prize given away.

MR. JOHN COOLEY has accepted a position with WMAR-TV, Baltimore, Md.

MR. CHARLEY J. CAMPBELL is now employed at the Kellex Electronics Research, Washington, D. C.

MR. GEORGE A. KERESTON accepted a position with Standard Radio Co., Atlantic City, N. J.

MR. WILLIAM R. HENRY, JR., accepted a position with Philco Radio Corp., Philadelphia, Pa.

Recent Residence School Graduates

John Reed Dull, Jr.	Robert H. McIntire
Russell J. Boteilho	William E. Karches
Henry G. Magarian	Jack T. Waynick
George A. Kereston	Shigeo Motoike
Victor H. DeLorenzo	Benjamin Czarnawski
Rodney D. Via	

New Residence School Students

Nader, R.	Alexander, L.
Newcomb, D.	Allen, W.
O'Rourke, T.	Berntsen, W.
Rice, R.	Buck, E.
Rodriquez, S.	Chapman, G.
Ryan, J.	Crabtree, P.
Segars, J.	David, L.
Shellock, J.	Denyer, E.
Stone, D.	Graham, J.
Tessari, D.	Hill, R.
Timmons, C.	Hirt, A.
Tomek, A.	Hubley, R.
Trammell, J.	Hunter, R.
Weimer, E.	Jackson, C.
Wettengel, E.	Kapsch, J.

CREI Student Council Members

Arthur Adkins	Schneeman, Orman
Brown, Howard	Steele, William
Carlson, Robert	Watts, William
Denton, William	Wilson, Walter
Donaldson, John	White, Sam
Hum, Bing	Sherr, Joseph
Murray, William	

OFFICERS

President	William C. Watts
Vice President	William Steele
Secretary	Robert Carlson
Treasurer	William Murray

COMMITTEE CHAIRMEN

Student Relations	Orman Schneeman John Donaldson
Hospital	William Denton Arthur Adkins
Sports	William Watts Sam White
Entertainment	William Murray
Rings and Pins	William Steele
Newspaper	Howard Brown

Wedding Bells For:

Edgar C. Weber, British Columbia, Canada.

Louis D. Goss, Manheim, Pa.

Congratulations To:

Mr. and Mrs. David Rubin and new son, Alan Howard, Bronx, N. Y.

Mr. and Mrs. Carl A. Merrills and new daughter, Westport, Mass.

Mr. and Mrs. William E. Elliott and new arrival, Dothan, Ala.

Mr. and Mrs. J. G. Mayhalls and new arrival, Rockledge, Fla.

Mr. and Mrs. Edward L. Brannen and new arrival, Key West, Fla.

A CREI Orchid goes to honor graduates: Donald W. Brusch, c/o Fleet Post Office, San Francisco, Calif.; Herman A. Seeba, Point Mugu, Calif.; John W. Keegan, Biloxi, Miss.; Merlin G. Morasch, Portland, Oreg.; William E. Wallace, Winston-Salem, N. C.; Charles A. Miller, Hyde Park, N. Y.; Paul W. Jones, San Francisco, Calif.; William Henry Gaeckle, Haddonfield, N. J.; Harry R. Long, Norfolk, Va.

HONORABLE MENTION for fine scholastic work goes to graduates: Tony Symanovich, East Rockaway, Long Island, N. Y.; William S. Bradford, Durham, N. C.; Gasper Tassielle, Oakland, Calif.; Lucien Ascencio, Caracas, Venezuela, South America; Daniel Bienstock, Pittsburgh, Pa.; Raymond A. Colvin, Moorestown, N. J.; Louis J. Hauber, Teaneck, N. J.; Stanley Cahill, May's Landing, N. J.; Marvin A. Kramer, Junction City, Kans.; Arthur P. Johnson, St. Paul, Minn.; Wilma C. Hughes, Pedro Miguel, Canal Zone; Manuel Serra, Jr., San Juan, Puerto Rico; Ralph W. Ripsom, Oconomowoc, Wis.

CONGRATULATIONS should also be sent to Mr. Claude O. Mains of San Jose, Calif., who has completed the Introductory Course with the outstanding average of 100%.

Rectifier Resistance

(Continued From Page 3)

voltages. With reference to the one shown, the d-c voltage drops from 260 to 205 volts, when the d-c- load current drawn is increased from 10 to 150 ma.

This means that the internal resistance of the rectifier tube is equal to

$$R_r = R_r \frac{260 - 205}{.105 - .01} = \frac{55}{.41} = 393 \text{ ohms.}$$

Actually the resistance varies from a somewhat higher value at low d-c currents to a somewhat lower value at high d-c currents, but the above magnitude represents a suitable average value that can be employed in subsequent calculations.

GORDON WEBSTER VE2BB Lachine, Quebec, Canada	M. H. GROSS W5OVU Fort Worth, Texas
	M. L. PHILLIPS W5PZL Monroe, La.
GLENN HARMAN W4IUJ West Palm Beach, Fla.	C. B. KELLEY W8-XLU-WSAI Cincinnati, Ohio

NEW IDEAS IN COLOR T.V.

By Albert Preisman, *Vice-President in Charge of Engineering*

INTRODUCTION

The recent (March) IRE Convention featured among other things a symposium on color television. A significant fact brought out here was that many different firms, employing old ideas on color and new ideas on communication techniques, were approaching a common viewpoint on the transmission of color within the present band width, that was also compatible with the present monochrome (black-and-white) receivers. Let us see what is happening.

COLOR FUNDAMENTALS

As has been mentioned many times previously in these columns, any color can be reproduced by a suitable mixture of three fundamental single colors, called primary colors. There are an infinite number of trios of primary colors that can be used; the usual three are red, green, and blue of certain frequencies whose specific values are not of interest to us here.

The various colors can be described in terms of these three primaries: this is an objective or impersonal method of description. Another method, more subjective in nature, is to rate a color in terms of its hue, brightness, and saturation. All colors can be regarded as being composed of a predominant frequency or color, more or less diluted bv other frequencies that altogether make up a white addition to the color. The hue refers to the predominant color; the dilution, or rather the lack of it, is a measure of the saturation; i.e., the less white dilution, the more saturated the hue is.

Thus an actual color mav have 75 per cent of a given hue or frequency, and 25 per cent of white diluting it. This is a relative matter between the components. However, there is also such a thing as an absolute level or brightness; the above color may be of a certain strength or brightness. or it may be twice as bright, or half as bright.

If therefore we wish to reproduce a given color, we can cause the three primary sources of light (the red, blue, and green picture tubes) to emit the proper brightness of each primary color, and the desired color will be obtained.

Suppose we have a red light of exactly the color emitted by the red tube. Then only this tube will light up. Suppose we wish a red light having also a good deal of white light mixed with it, such as a shade of pink. Then all three picture tubes should light up to the proper proportions to produce the white light, and in addition the red picture tube should light up even more brightly to produce the predominant hue of red.

We therefore have a hue of red that is not saturated, but is diluted by white light. There is, however, the additional question of brightness. If the tubes are assumed, for simplicity, to be linear between electrical input and light output then, if all inputs are doubled, the same hue and saturation will be obtained, but the brightness will be doubled. In short, the relative levels of the signals determine the hue and saturation; their absolute level, the brightness.

Note one further fact. In the above example, the hue was assumed to be that of the red picture tube. However, the hue can be any other color, such as a yellow requiring a certain proportion of red and a certain proportion of green, in addition to the required amounts of red, blue, and green to give the proper amount of white light dilution. In this case the picture tubes all light up to give the white dilution; superimposed on this is an additional amount of red and green light from the respective picture tubes to give the particular unsaturated shade of yellow.

Let us now return to the previous example of the unsaturated shade of red. We can get this shade in one of two ways:

1). We can feed the proper amplitudes of signal to the grids of the red. green, and blue picture tubes to get the white component, plus an additional signal to the grid of the red picture tube to get the predominant red hue. In short, the signal to the grid of the red tube is in the proper excess to give the hue.

2). We can feed the proper amplitudes of signal to the GRIDS of the three tubes to get white light, but then we can feed in addition a NEGATIVE signal to the CATHODE of the red tube to increase its output.

The latter method, in conjunction with other important features, has been suggested by the Hazeltine Corporation, and has been adopted by RCA. The various features to be described eliminate the dot structure of a 2-mc coarseness previously present in the RCA pictures, yet permit the conservation of band width and also provide the feature of compatibility inherent in the dot-sampling process.

The reason is that the colors are used to reproduce the large areas, and represent a definition no greater than that provided by a 2-mc band width. But superimposed on this is a full 0-4 mc monochrome signal, that gives a dot or element structure corresponding to 4 mc. To get the broad expanses of color, such as for example red, an additional red signal of the appropriate polarity is applied to the cathode of the red picture tube, brightening it over and above the amount necessary to give the white diluting signal coming in on the grid.

From 2-4 mc, however, all tubes get the same signal and the finer detail is thus an overlay on the color expanses. Only where the colors come in very fine stripes (like an awning) is there any loss in COLOR resolution. The stripes can still be seen, but their hue is not as saturated.

Let us see how the system works, and how band conservation is obtained. Although no actual circuits will be shown, circuit methods will be discussed.

THE TRANSMITTER

We note first that three independent cameras are employed: one for the red, one for the blue, and one for the green component in the scene. As shown in Fig. 1, each camera feeds its signal into two channels: one direct to the program transmitter, and retaining its 0-4 mc band width, and the other through a 0-2 mc low-pass filter to the sampler. The 0-4 mc signal will furnish the high-definition monochrome system; the 0-2 mc. signals will furnish the color to broad expanses.

The term even refers to the fact that the video signal consists essentially of components that are harmonics (multiples) of the line-scanning frequency, and are therefore EVEN harmonics of HALF the line frequency, since doubling any number results in an even number. As was brought out in the previous issue of the CREI News with regard to the proposed GE high-definition monochrome systems, an even harmonic of half the line frequency always repeats its position on the screen from one field to the next, and therefore produces an additive or integrated effect on the eye, whereas an odd harmonic of half the line frequency alters its position on the screen by half a cycle from one field to the next, and therefore cancels its effect on the eye over a pair of field scans.

The sampler is essentially a modu-

(Continued on Page 6)

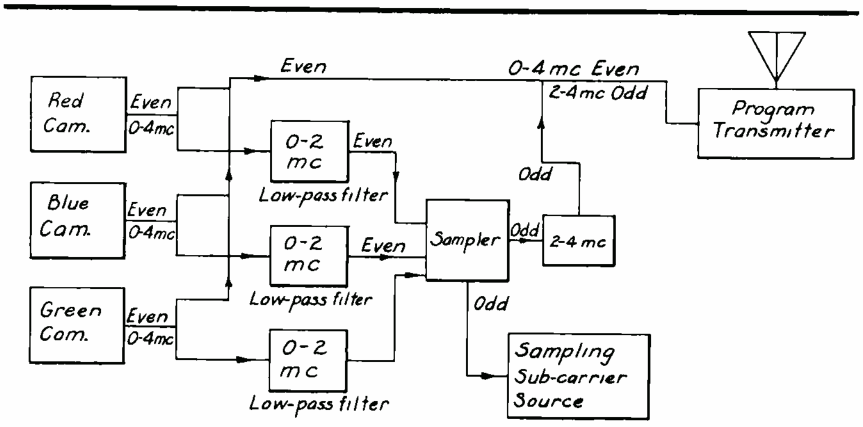


Fig. 1.—Block diagram of the transmitter.

New Ideas in Color T.V.

(Continued From Page 5)

lator. A suggested form is shown in Fig. 2. The subcarrier source gen-

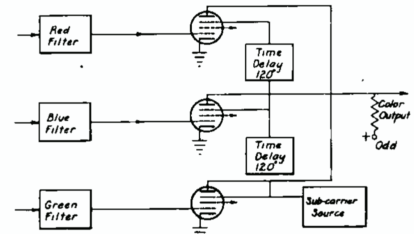


Fig. 2.—Possible modulator circuit for the sampler.

erates a frequency that is an ODD harmonic of one-half the line frequency, such as $271 \times \frac{15750}{2} = 2,134,125$ c.p.s. This beats with the 0-2 mc components to produce side bands that are all ODD harmonics of half the line frequency. The reason that the output consists of ODD harmonics is that the odd harmonic subcarrier combines with the even harmonic video components to give summation terms (upper sidebands) that are the sums of an even and odd numbers, and an odd plus an even number is always an odd number.

Notice also that the summation terms range from 2-4 mc. When these are added to the 0-4 mc monochrome signal, the complete video signal is obtained; it contains both the monochrome and color information.

The action of the sampler is interesting. Note that the subcarrier is delayed or shifted in phase by 120° from one tube to the next. It is shown injected on the suppressor grid; it could be injected on the screen grid, instead. The amplitude of the carrier in the plate circuit is determined by the magnitude of the color signal coming in on the control grid.

If all three colors are of equal intensity (white light), all three color signals are presumably of equal amplitude, and the three carrier amplitudes are therefore of equal magnitude, but of course 120° out of phase. It is a property of three such voltages that their vector sum is ZERO; it is this fact that permits the neutral in a three-phase system to be dispensed with.

Hence the output of the sampler for white light is zero. But if the red hue, for example, predominates, then the excess of this vector will appear in the output. Its phase position or timing will indicate that it is red which predominates; its amplitude will indicate to what degree it predominates.

Should the hue in the scene be intermediate between say, blue and red, then both the blue and red vectors will predominate, and a resultant vector will appear in the output of the three tubes whose phase is intermediate between that of the blue and red components, and whose amplitude is the vector sum of the excess of the blue and red vectors.

At the receiver the desampler can separate these two vectors on the basis that where two are passing instantaneously through zero, the third is at its crest value. This has been discussed in a previous issue of the CREI News anent the original RCA dot-interlace system.

RECEIVER CONSIDERATIONS

Consider the effect of the complete signal on an ordinary black-and-white receiver. The 0-4 mc monochrome signal, consisting of even multiples of half the line frequency, produces a cumulative effect over any pair of consecutive field scans, and therefore registers on the observer. The color components, being odd multiples of half the line frequency, tend to cancel out over any pair of consecutive field scans, and do not therefore appreciably register on the observer. This is fortunate, because the black-and-white picture is not marred by useless color signals (useless to a black-and-white receiver).

Now consider the effect of the composite signal on a color receiver. Fig. 3 shows a block design of such a unit.

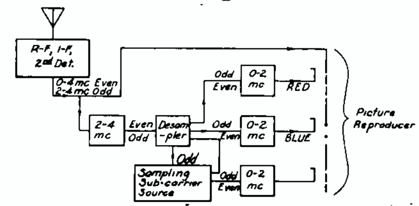


Fig. 3.—Block diagram of a TV color receiver.

The monochrome 0-4 mc signal is fed to the grids of the three guns, causing them to light up equally. The result is white light, of an intensity depending upon the strength of the signal, and the effect is a monochrome picture of high definition. There is also present in this signal the 2-4 mc color component, but since this consists of odd harmonics of half the line frequency, it cancels out so far as the grids are concerned.

The 2-4 mc, odd color component, as well as the 2-4 mc portion of the monochrome signal (of even harmonics of the half-line-frequency) are passed through a 2-4 mc bandpass filter to a desampler. Here those signals are mixed with a subcarrier which is the same odd harmonic of half the line frequency as the one at the transmitter.

It is obtained at the receiver from short "bursts" of this frequency located on the "back porch" of the horizontal pedestals (after the horizontal sync pulse). These bursts can be used to actuate an oscillator, or a tuned circuit, or other suitable means to provide a continuous subcarrier.

The ODD subcarrier beats with the ODD color signal to produce difference-frequency components ranging from 0-2 mc that are EVEN. But the 2-4 mc EVEN monochrome components beat to form ODD components. This is because the sum of two odd numbers is an even number; but the sum of an odd and even number is an odd number.

When these output components of the desampler are impressed on the cathodes of the picture tubes, the now ODD monochrome components cancel out, and the now EVEN color components add up. The desampler also sorts out the signal for each color in a manner similar to that described for the RCA dot-interlace system in a previous issue, so that if for example red predominates, the red signal lights up the red picture tube more strongly via its cathode, and causes this hue to predominate.

An alternative method would be to feed this red signal in opposite polarity to the cathodes of the blue and green tubes, causing them to get darker, and thereby permitting the red tube to predominate in output. This arrangement tends to maintain the total brightness and saturation more nearly correct.

CONCLUSIONS

This system, as stated previously, eliminates the coarse 2-mc structure of the color picture, and gives it the fine grain of a 0-4 mc band. It suffers (very slightly) from lack of color definition in small areas, but this effect is not particularly noticeable nor objectionable.

At the same time the signal can actuate a black-and-white receiver to give 0-4 mc band width monochrome pictures, without appreciable interference from the color component. This is because of the ODD and EVEN nature of the color and monochrome signals.

The later characteristic also explains how the color signal can be added to the monochrome signal without extending the band width beyond 4 mc. The even monochrome signal occupies points in the spectrum that are both odd and even multiples of the horizontal scanning frequency. and hence always even multiples of half the horizontal scanning frequency.

The color signal is always odd multiples of half the horizontal scanning frequency. It therefore occupies points in the spectrum HALF WAY between those points where the monochrome signal exist. As such it fills in what would otherwise be holes in the spectrum, and therefore utilizes the band width more efficiently. A complete receiver requires forty-three tubes, which is not very much more complicated than the thirty-tube monochrome receiver of a few years ago.

Recent School Visitors

HOWARD AUGER stopped to visit with us but had little time to spare. He is attending radio school in Georgia at Camp Gordon for twenty-one weeks.

CAPTAIN JOHN F. MORIN was a recent visitor. He has been called back into active duty in the Air Force.

DAVID H. HAND of Hayward, Calif., also visited us while on Navy duty in this vicinity.

EVERITT ARTHUR PEAVEY, Great Lakes, Ill., visited us to discuss his home study course.

MR. and MRS. WINFIELD S. GREENLEAF and MR. and MR. MIKE ROMANYCZYN recently visited CREI, as well as MR. DAVID HILL, who is a Philco Technical Representative.

ROBERT E. HOPPER of 4327 Santa Cruz St., San Diego, Calif., a Residence School Graduate, visited the school recently. Mr. Hopper is now Electronic Technician at the Naval Electronics Laboratory. He would like to hear from old classmates, so jot down that address above!

ALUMNI SCANNER

SPECIAL SECTION

Alumni Scanner Special Section
Published bi-monthly for the CREI Alumni Association, 3224 16th Street, N.W., Washington 10, D. C.
Editor.......W. R. WALKER
President.......DAN O. HUNTER
Vice President.......A. E. TEACHMAN
Executive Secretary.......E. G. BOND

★ ★ ★ ★ ★ ★ ★

Field PATTERNS

Mr. Joseph V. Kapp, formerly of the Transmitter Lab, left recently to accept a position with Bendix. Mr. Walker of the Broadcast Lab is now instructor in the Transmitter Lab, and Mr. Radabaugh and Mr. Howard of the Television Labs are assisting with the Broadcast Lab.

Correction

Mr. N. R. Olding, Operations Engineer, Canadian Broadcasting Corporation, reports an error in "Field Patterns" in our March-April issue.

Charles Frenette, '35, whom we incorrectly reported as Technical Supervisor for CBS, is TV Technical Director for CBC, Montreal. He will be responsible for the technical operation of CBC's new TV station in Montreal when it goes on the air in 1952.

Labs Open Evenings

Since the last issue of the "Scanner" went to press the Broadcast Labs have been opened for Evening School students of the Television course. Incidentally, the evening classes are enjoying the largest enrollment in their history. Mr. Arthur J. Freynick is in charge.

Meet Some New Alumni Members

Frank A. Lounsbery
927 Cheyene
Leavenworth, Kans.

John Wilson Jones
W1QEQ
258 Elizabeth Ave.
Bangor, Maine

William A. Dennis, Jr.
W1RFC
330 Cook Ave.
Meridian, Conn.

William R. Henry, Jr.
W3RGV
15033 W St. S.E.
Washington 20, D. C.

Edmund A. Parsons
W7KHW
Senior High School
Great Falls, Mont.

George C. Wuest, Jr.
3602 Edwards St.
Cincinnati 8, Ohio

Victor DeLorenzo
3610 Wabash Ave.
Cincinnati 7, Ohio

Donald K. Hawkins
Box 236
Mt. Rainier, Md.

Lowndes Y. Sellers
W4LWO
152 Emogene Pl.
Mobile, Ala.

Stanley C. Maciejko
W1GVV
3366 Cedar St.
Dedham, Mass.

Jack T. Waynick
709 Mayflower Dr.
Greensboro, N. C.

Leland A. Greene
6636 Rhode Island Ave.
Riverdale, Md.

George J. Kunetz
12 Main St.
Beaver Brook, Penn.

William E. Karches
2760 Jessup Rd.
Cincinnati 24, Ohio

Henry G. Magarian
33400 Montrose Ave.
Richmond 22, Va.

Russell W. Merry
W3PXQ
23 W. Center St.
Florence, Mass.

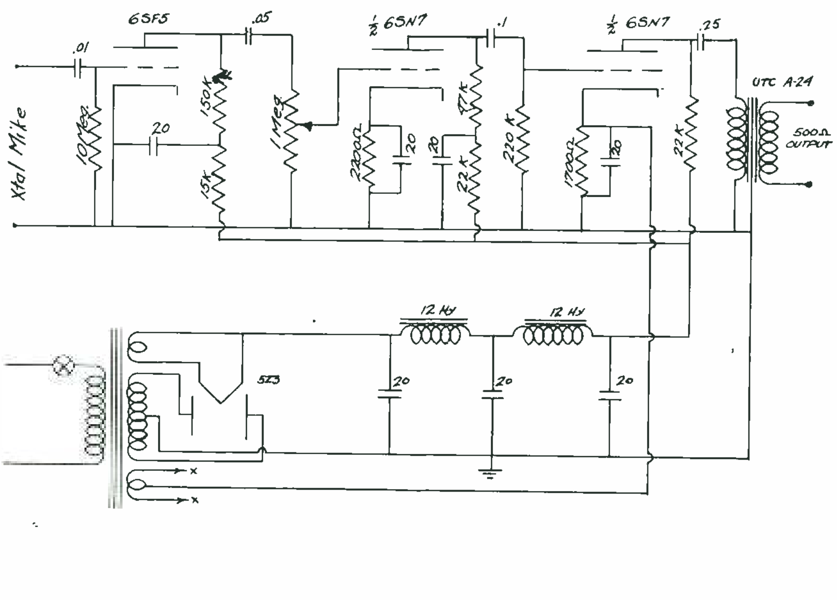
Student Designs Remote Amplifier (Shown Below)

We are including in this issue of the "Scanner" the diagram and description of a remote amplifier built recently by Mr. Walter Pietka, a student in the CREI Broadcast Labs. This amplifier is part of a plan to extend the Broadcast training facilities to include more remote operation.

This information is included in the hope that it will serve as a guide to those who may be interested in such a unit.

The amplifier, with its self-contained power supply, is built on a 7x11x2 black crackle chassis. All resistors shown in the diagram are 1 watt composition units, and all condensers are rated at 600 volts.

Maximum output of the amplifier, when used with an average crystal microphone, is +18 VU. Distortion at + 8 VU output is .7%. Frequency response ± 2 DB from 50 to 20000 cps.



Know Your Fellow Alumni

Set yourself a study schedule and stick to it, says CREI graduate Charles A. Miller, of East Market St., Hyde Park, N. Y. Here's what a steady two-hour-a-day schedule did for him: when he completed the FM and TV course in February, 1951, his work had averaged 97! By working at it seven days a week, Mr. Miller completed the course in one and a half years.

Now operating his own radio service business in Hyde Park, he's looking forward to adding television servicing.

Mr. Miller's technical training, in addition to CREI, includes the RCA Institute and the U. S. Army Radio School at Camp Hood, Texas. After returning from World War II service, he did considerable wiring and testing of electronic equipment for the Navy and the Air Force. In some cases, his skill was used for the assembly of important top secret equipment. In the plant where he was working, he and a Navy inspector were the only ones to see and work on certain complete electronic units.

Mr. Miller first heard of CREI through an advertisement. He says that a regular, self-imposed home study schedule "may be hard at first, but within a short time it becomes easy."

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Thanks a lot for all the favorable comments we have received on the first of the series of "Know Your Fellow Alumni" articles. Many have expressed a desire to know more of the members through this series; and it is our intention to fulfill their wishes.

SWAP SHOP

C. B. KELLEY, 7204 Clovernook Avenue, Cincinnati 13, Ohio (Call W8-ZLU-WSAI):

"New PE103-A Dynamotor with spare brushes and power output plug. Need one-half HP Motor, 110V-AC Capacitor type preferred."

HAL MARGARGLE, 7237 Hilltop Road, Upper Darby, Pa.:

"RCA AVT-112A 2500-6500 KC Portable Fone Xmitter complete with 6v input power supply, brand new. Two JAN 813 xmitter tubes, brand new. Need FM or AM-FM tuner, or for cash AVT 22.00, tubes both for 10.00."

Here and There

(Continued From Page 2)

two hundred hours, about half being in traveling time. Equipment was 30 watt Motorola dispatcher units 152 mc. and made in Canada by Rogers Majestic-Canada, Ltd. Each "spread" or camp had six units in trucks and one base station in the office. There were three spreads between Regina and Edmonton, each building 165 miles of line.

E. DANN REED of San Diego, Calif., has received a promotion to the Engineering Department of Consolidated-Vultee Aircraft Company.

CARLTON E. KENNARD, Keesler Air Force Base, Miss., has passed "the Radio Telephone Operators" Test (Second Class).

THEODORE R. LANGE, Baldwin, Long Island, N. Y., is employed as a Field Engineer for Western Electric Company, Radio Division, and is assigned to headquarters technical staff in New York.

VICTOR KRUGER, Jackson Heights, N. Y., has been undergoing an intensive course in government policies and procedures for the past two months due to a recent change in positions from Colonial Airlines to the Air Force Procurement Inspection Service.

ERNEST L. RANSOM, Denver, Colo., writes that he is working at KLMO, Longmont, Calif., and that his brother, STANLEY T. RANSOM, also a Home Study student, left for the U. S. Army in October of 1950.

ROBERT L. HESS, Pocatello, Idaho, is taking a course in Television at the Idaho State College in Pocatello. He is also working as Staff Engineer at Station KSEI. His TV Class has built two complete camera chains on the order of the RCA models. A lot of this has been necessarily built with surplus materials as much as possible with the image orthicon tubes and the associated sweep and focus coils being about the only ready made items purchased. These camera chains have been made complete with communications channels between all units such as the camera man, video man and the directors. Included in each chain is, of course, the timing and synchronizing generators, both studio type and field type. The pulse formers and shapers put out the required RMA standard sync and blanking signals. The cameras are controlled by control amplifiers, and monitors along with the "A" scope to keep close check on video and pedestal levels. A flying spot system is being built up now and is about ready for testing so that they may have a good means of applying test patterns. At present this is all piped via coaxial lines to various receivers in the TV building and a line to various other buildings on the campus is being put in so that their own programs may be piped into various viewing points for the students and the public. All of this equipment was built by the students under the supervision of the instructors. In addition to this, Mr. Hess has been able to obtain his Class "A" amateur license so that W7KEA will soon be on 75 meters mobile phone.

CLYDE J. BURDETTE, Chief Engineer for Station WORD, Spartanburg, S. C., advises us that WORD is in the midst of an expansion program. They already have an F.C.C. construction permit to increase their WORD (Ampliture Modulated) from 250 watts to 1000 watts and move both the AM and FM transmitters to a new site. Television for Spartanburg is also being provided for along with these moves.

M. L. PHILLIPS, Monroe, La., has been working on his amateur license and just passed Class A exam.

JAMIL N. NAHHAS, Beirut, Lebanon, has been employed with the American Oil Co., "ARAMCO Overseas."

LOYD G. PETERSEN, JR., Millington, Tenn., is helping establish a new Navy Helicopter Maintenance School in Memphis.

JAMES H. CHAPMAN, Seattle, Wash., is currently employed as Staff Engineer for Station KOL. They recently installed an RCA BTA 5F transmitter with which they are very pleased. If anyone residing nearby would be interested in seeing it, contact Mr. Chapman.

F. PHILLIP TURVEY, JR., Charlotte, N. C., is attending the North Carolina State College in Raleigh. He is a student in Electrical Engineering.

S/SGT. DONALD C. LEE is enroute overseas.

FRANCIS A. CICCARICCO, Rochester, N. Y., is employed at the University of Rochester AEC Research Project as cyclotron technician.

N. R. MIRANDA, Sol 20, Apto. 203, Havana, Cuba, would like to know of any CREI Home Study students who live in or around Havana, so he could study with them.

TOM W. WELCH, Belleview, Ill., has been advanced from Staff Sergeant to Technical Sergeant.

EDGAR C. WEBER, British Columbia, Canada, is now employed with Station CKOV, where they are working on the installation of a new 1-KW transmitter.