Reminiscences of Old-Timers — Progress of Radio Sets — Radio in the Future
Most Famous Circuits in Radio History — A Chronological History of Radio
For this Broadcasting Receiver thousands have been waiting

Ever since broadcasting became the vogue there has been a demand for a receiver which would fill a whole room with music of perfect tone quality but which would be so simple that anyone could tune in by moving a single lever.

This ideal has at last been realized in the Aeriola Grand—the supreme achievement of present-day radio.

When you hear the voice and the music that come from the Aeriola Grand it is as if the lecturer or singer at the broadcasting station were in your presence. The whole family listens and marvels.

The Aeriola Grand stands unrivaled not only as a radio receiver but as a piece of cabinet work.

Prices

Complete with mahogany stand, storage battery, battery charger, antenna equipment and all accessories $409.50
Without stand, storage battery, charger and receiving antenna equipment $325.00
With stand, but without storage battery, charger and antenna $350.00
Mahogany stand only $35.00

See the Aeriola Grand at your nearest dealer

Before you buy any receiver, secure a copy of the book “Radio Enters the Home.” It tells the real story of radio and will help you to get the most out of this new art. 128 pages—over 200 illustrations—35c a copy. At your dealer or write direct to

Radio Corporation of America

What the guests heard at the Jacksons’ Aeriola Grand Party

Baseball scores Chamber music
Dance music by a noted string quartet
Songs by a great ballad singer Lecture on the “Wedding Ring, Past and Present”
A story by a famous author
The whole opera “Cavalleria Rusticana” with explanations
Weather forecast for the following day

Reprinted by Vestal Press Ltd. in 1987 from an original in the collection of Jules Shaffer

THIS ADVERTISEMENT WAS PUBLISHED IN 1922

What a difference in VALUE a few years make!

NOW... for only $89.95*

RCA Victor ELECTRIC TUNING!

Compare the value! The advertisement on the opposite page tells about the Acriola Grand selling for $409.50. That was in 1922.

And now—look at present-day radio value! A beautiful 7-tube RCA Victor Radio with Electric Tuning—for only $89.95*. In all radio history, few developments have captured the public fancy as quickly and completely as has RCA Victor Electric Tuning! Just imagine the thrill of getting any one of your six favorite stations with the simple push of a button! That's all there is to it! Just push a button—there's your station, and it comes in tuned "right on the nose."

Visit your nearest RCA Victor dealer today or tomorrow. See this amazing instrument that can be yours for so little. Notice its many other fine features. Every one of them is proof that RCA Victor offers great radio value—and that this set is one of the greatest values of all time!

When buying radio tubes, say "RCA". First in Metal—Foremost in Glass—Finest in Tone.

RCA presents the Magic Key every Sunday, 2 to 3 P.M., E.S.T., on NBC Blue Network.

*Price f.o.b. Camden, New Jersey, subject to change without notice.

RCA Victor
A SERVICE OF THE RADIO CORPORATION OF AMERICA

Please Say That You Saw It in Radio-Craft
At home with the world's greatest artists

Enjoying the exquisite interpretations of the most famous singers and musicians is a pleasure which only the Victrola can afford you.

Only the Victrola. For the world's greatest artists make records for the Victrola exclusively.

Any Victor dealer will gladly show you the complete line of Victors and Victrolas—$10 to $400—and play the music you know and like best.

New Victor Records demonstrated at all dealers on the 28th of each month.

Important warning. Victor Records cannot be safely played on machines with Jeweled or other reproducing points.
HEAR THE MUSIC YOU WANT

WITH AN RCA VICTOR
PHONOGRAPh-RADIO

Bring more happiness into your home with an RCA Victor Phonograph-Radio! Then the whole family can listen to Victor Records... then the heart songs that stir you most... the symphony you love... your favorite opera... the dance bands that please you... all are ready to be heard when you want them...

A SERVICE OF THE RADIO CORPORATION OF AMERICA

performances by the world's greatest artists.

Never before could you hear such a miracle of tone fidelity and beauty in recorded music as you can hear this year with the new RCA Victor Higher Fidelity Phonograph-Radios. Many different models to choose from, and the prices begin under $80!

RCA Victor Phonograph-Radio U-109


All prices f.o.b., Cleveland, O. J., subject to change without notice. RCA presents the "Music Key" Band, 3:15 P.M., E.S.T., on NBC Blue Network. When buying radio tubes, say RCA—First in Metal—For more in Glass—For more in Tone.

Above—This and your radio play Victor Records. RCA Victor Record Player 249-95, transforms any radio into an electric phonograph. Plays with full tone of the radio.

RCA Victor

Please Say That You Saw It in RADIO-CRAFT
Announcing the National Broadcasting Company, Inc.

National radio broadcasting with better programs permanently assured by this important action of the Radio Corporation of America in the interest of the listening public.

The Radio Corporation of America is the largest distributor of radio receiving sets in the world. It has handled the entire output in this field of the Westinghouse and General Electric factories.

It does not say this boastfully. It does not say it with apology. It says it for the purpose of making clear the fact that it is more largely interested, more selflessly interested, if you please, in the best possible broadcasting in the United States than anyone else.

Radio for 26,000,000 Homes

The market for receiving sets in the future will be determined largely by the quantity and quality of the programs broadcast.

We say quantity because they must be diversified enough so that some of them will appeal to all possible listeners.

We say quality because each program must be the best of its kind. If that ideal were to be reached, no home in the United States could afford to be without a radio receiving set.

Today the best available statistics indicate that 3,000,000 homes are equipped, and 21,000,000 homes remain to be supplied.

Radio receiving sets of the best reproductiveness and quality should be made available for all, and we hope to make them cheap enough so that all may buy.

The day has gone by when the radio receiving set is a luxury. It must now be an instrument of service to all.

WEAF Purchased for $1,000,000

The Radio Corporation of America, therefore, is interested, just as the public is, in having the most adequate programs broadcast. It is interested, as the public is, in having them comprehensive and free from discrimination.

Any use of radio transmission which causes the public to feel that the quality of the programs is not the highest, that the use of radio is not the broadest and best use in the public interest, that it is used for political advantage or for selfish ends, will be detrimental to the public interest in radio, and therefore to the Radio Corporation of America.

To insure, therefore, the development of this great service, the Radio Corporation of America has purchased for one million dollars station WEAF from the American Telephone and Telegraph Company, that company having decided to retire from the broadcasting business.

The Radio Corporation of America will assume active control of that station on November 15.

National Broadcasting Company Organized

The Radio Corporation of America has decided to incorporate that station, which has achieved such a deservedly high reputation for the quality and character of its programs, under the name of the National Broadcasting Company, Inc.

The Purpose of the New Company

The purpose of that company will be to provide the best programs available for broadcasting in the United States.

The National Broadcasting Company will not only broadcast these programs through station WEAF, but it will make them available to other broadcasting stations throughout the country so far as it may be practicable to do so, and they may desire to take them.

It is hoped that arrangements may be made so that every event of national importance may be broadcast widely throughout the United States.

No Monopoly of the Air

The Radio Corporation of America is not in any sense seeking a monopoly of the air. That would be a liability rather than an asset. It is seeking, however, to provide machinery which will assure a national distribution of national programs, and a wider distribution of programs of the highest quality.

If others will engage in this business the Radio Corporation of America will welcome their action, whether it be competitive or cooperative.

If other radio manufacturing companies, competitors of the Radio Corporation of America, wish to use the facilities of the National Broadcasting Company for the purpose of making known to the public their receiving sets, they may do so under the same terms as accorded to other clients.

The necessity of providing adequate broadcasting is apparent. The problem of finding the best means of doing it is yet experimental. The Radio Corporation of America is making this experiment in the interest of the art and the furtherance of the industry.

A Public Advisory Council

In order that the National Broadcasting Company may be advised as to the best type of program, that discrimination may be avoided, that the public may be assured that the broadcasting is being done in the fairest and best way, always allowing for human frailties and human performance, it has created an Advisory Council, composed of twelve members, to be chosen as representative of various shades of public opinion, which will from time to time give its benefit of its judgment and suggestion.

The members of this Council will be announced as soon as their acceptance shall have been obtained.

M. H. Aylesworth to be President

The President of the new National Broadcasting Company will be M. H. Aylesworth, for many years Managing Director of the National Electric Light Association. He will perform the executive and administrative duties of the corporation.

Mr. Aylesworth, while not a radio specialist, is well informed in the radio industry and broadcasting, having had public experience as Chairman of the Colorado Public Utilities Commission, and, through his work with the association which represents the electrical industry, has a broad understanding of the technical problems which make the peace of broadcasting.

One of his major responsibilities will be to see that the operations of the National Broadcasting Company are conducted in the public interest, which expression itself no promptly the morning after any error of taste or judgment or departure from public play.

We have no hesitation in recommending the National Broadcasting Company to the people of the United States. It will need the help of all listeners. It will make mistakes. If the public will make known its views to the officials of the company in time, we are confident that the new broadcasting company will be an instrument of great public service.

RADIO CORPORATION OF AMERICA

Owen D. Young, Chairman of the Board

James G. Harbold, President

This advertisement appeared in 1926
In every sense of the word

**NBC is**

"Broadcasting Headquarters"

**Take PROGRAMS...** NBC's Red and Blue Networks sent out over 51,000 programs during 1937. 35 hours a day of the world's most popular programs available to 21,500,000 radio families.

**Take STATIONS...** Completing its eleventh year, there are 142 affiliated stations broadcasting Blue and Red Network programs. Ten NBC associated short-wave stations make NBC the leader in international broadcasts.

**Take PROGRAM BUILDING...** For every one of these eleven years, NBC has set the style in programs. These styles, numbering many "Famous Firsts" in radio, have since become radio patterns.

**Take TRANSCRIPTIONS...** The NBC Recorded Program Service offers complete facilities for the creation, casting, production and recording of programs for National Spot and Local Advertising. NBC Thesaurus is used by no less than 220 station subscribers!

Whether you Write it...Wire it...Phone it...Cable or Radio it...

"**RADIO CITY NEW YORK**

is the World's best known Radio Address"

**Take SPOT and LOCAL ADVERTISING...** NBC's Managed Stations are, everywhere, "Tops in Spot!" Super-power transmitters on clear channels cover major markets, making an economical lineup for spot advertisers who want to cover broad territories with a few stations. Fifteen fine stations in ten key markets.

**Take ARTISTS SERVICE...** NBC Artists Service is the largest talent sales organization in the world. It offers both personal management and valuable guidance to artists. To radio advertisers and their agencies, it offers not only specific talent to answer advertisers' sales problems, but sound program ideas as well, and complete casts.

...These advantages, plus NBC's known primary concern that "the listener be served", first, have caused NBC to be known, wherever radio is mentioned, as "BROADCASTING HEADQUARTERS"
WORLD WIDE WIRELESS

In addition to the complete line of Radio Transmitting and Receiving sets sold by the RADIO CORPORATION OF AMERICA, for Ship to Ship and Ship to Shore Communication, the Corporation is in a position to quote upon:

PORTABLE MULE PACK AND CART RADIO SETS.

SPECIAL TYPES OF SPARK TRANSMITTERS FROM 1 TO 30 KILOWATTS, FOR MOBILE AND FIXED STATIONS FOR COMMERCIAL AND GOVERNMENT USE.

MILITARY TRACTOR SETS OF THE VACUUM-TUBE TYPE.

SPECIAL CONTINUOUS WAVE TRANSMITTERS FOR SUBMARINES, DESTROYERS, SEAPLANES AND FOR NAVAL BASES.

SPECIAL INTER-FLEET RADIO TELEPHONE SYSTEMS FOR BATTLESHIPS AND OTHER NAVAL CRAFT.

The Corporation has in development a new series of Continuous Wave Tube Transmitters for the various fields of commercial usage. This apparatus bears the stamp of The General Electric Co., (U.S.A.) one of the world’s largest electrical manufacturers.

TRANS-OCEANIC RADIO

Two hundred kilowatt radio frequency alternators are now in daily use in the Corporation’s high-power trans-oceanic stations. The Corporation is in a position to bid on similar equipment for international communication.

SHIP - WIRELESS may be bought outright, may be leased, and may be bought or leased in addition to our service of inspection, maintenance and operation. We provide licensed, skillful and trustworthy operators. Also our service and inspection depots are located at all important seaports of the world.

Our Nearest Office Will Give You All Details and Information

RADIO CORPORATION OF AMERICA
EDWARD J. NALLY, President
WOOLWORTH BUILDING NEW YORK CITY

BRANCH OFFICES IN THE U. S. A.

BOSTON NEW ORLEANS SEATTLE

PHILADELPHIA GALVESTON PORTLAND

BALTIMORE PORT ARTHUR SAN FRANCISCO

NORFOLK CLEVELAND SAN PEDRO

SAVANNAH CHICAGO HONOLULU

THIS ADVERTISEMENT APPEARED IN 1920
Send your messages

"Via RCA"

Direct communication with 43 foreign countries and among 11 cities in the United States

RCA Communications offers every type of radio telegraph service to and from 43 foreign countries, as well as between 11 leading cities in the United States. To send your message "Via RCA" is to insure fast, efficient handling of your communication with any part of the world.

RCA Communications maintains offices in principal cities in the United States, and in addition, every office of the Western Union Telegraph Company is at your service in handling international radio telegrams. The cities reached by RCA’s domestic service are Baltimore, Boston, Chicago, Detroit, Los Angeles, New Orleans, New York, Philadelphia, San Francisco, Seattle, Washington, D.C.

RCA COMMUNICATIONS, INC.
A RADIO CORPORATION OF AMERICA SERVICE
Candidates for the Promised Land

“The Promised Land” is the name professional operators have given to the New York Radio Central Station, on Long Island. When completed, this station will be the largest and most powerful radio station in the world. It will be equipped to work simultaneously with five other stations in widely separated and distant parts of the world, and will be epoch-making in the field of international communication.

Enrollments are coming in by every mail. Why aren't you one of the wireless men who have seen the new and greater opportunity opened to them by this fascinating field? NOW—not some later day—is the time to act!

A position at this station is the height of every operator's ambition, for it means unlimited opportunity to succeed and progress to higher, more responsible and better paying positions in the radio industry. So far as opportunity goes the successful future of these men is assured.

How about you?

The Radio Institute of America has been an established and successful institution for over fifteen years. The year round average attendance in its classrooms is now 298 students per month. It has trained over 6,000 men, 95% of whom have successfully engaged in this new branch of science and industry.

You, too, can be successful in this new field if you properly train yourself. Radio offers an unlimited opportunity for future advancement—why not take advantage of it.

Write for our booklet and further details—now.

Radio Institute of America
(formerly Marconi Institute)
326 Broadway, New York

This new course of radio training, which has been developed for the benefit of those who cannot attend the Institute personally, is the same course used at the Institute. It includes everything from basic principles of electricity and magnetism, to actual operation of commercial radio equipment. It also includes the same textbooks used in the Institute classes, as well as a buzzer set of greatly improved design, with a variable automatic transmitter, for code practice.

The graduates of the Radio Institute of America enjoy a great and exclusive advantage in the close connection existing between the Institute and the Radio Corporation of America, world’s largest radio manufacturing and commercial radio company.

Prominent executives in the radio field are former students of the Institute. The Radio Corporation employs thousands of men, in its executive departments, on ships and at shore stations and in factories and laboratories. A large percentage of these men are graduates of the Institute.

This advertisement appeared in 1928.
...serving ships on every sea—in all Branches of Radio

RIGHT NOW, as you read this, there are on every sea hundreds of ships for which RCA is performing a service. These ships include small pleasure yachts, tankers, freighters, large passenger liners. And the radio service RCA is rendering is greatly diversified. Some of these ships are being guided through fog and storm with the RCA Radio Direction Finder. Others are in direct radio communication with shore or with other ships, through the medium of their RCA Transmitting and Receiving Equipment. Still others are guarding against tragedy at sea with the RCA Automatic Radio Alarm.

RCA's radio service to ships at sea is complete. No matter what you want for your ship—if it's in connection with radio—Radiomarine can supply it! RCA's vast wealth of experience in every phase of radio, its long association with the problems of marine radio, make equipment bearing the RCA trademark your logical choice. More and more each day smart marine operations men are seeing the wisdom of going "RCA All the Way." It means more dependable radio for their ships.
at last—
the portable super-heterodyne

PERFECTED
by McMurdo Silver. It surpasses your fondest hopes.

AUTHORITIES

on Radio have declared it to be an "ELECTRICAL MASTERPIECE." It secures results you never hoped to obtain outside of a Laboratory, and is so simple that you can construct it with a pair of Pliers, a Screw Driver and a Soldering Iron.

THE PARTS

recommended by Mr. Silver include a drilled and engraved Panel, and everything necessary to build the set. Price $58.00 Parcel Post prepaid, East of Rockies. (Accessories not included: Tubes, Batteries, Cabinet, Loop, Loud Speaker).

SILVER SPECIALS

Oscillator Coupler, No. 101 ......................$2.50
30 KC Tuned Output Transformer, No. 201........... 3.50
.0005 Low Loss Condenser, No. 201 ................. 4.50
50 KC R.F. Transformer Unit, No. 401 ................ 4.00
5-Gang 100-Socket, No. 501 ..........................3.00

Write for Descriptive Circulars

All S.M Products are backed by Silver-Marshall's Unconditional Guarantee of Satisfaction or Your Money Back.

EASTERN DISTRIBUTOR

Twentieth Century Radio Corp., 102 Flatbush Avenue
Brooklyn, N. Y.

Silver-Marshall, inc.

105 S. Wabash Avenue, Chicago, Ill.

THIS ADVERTISEMENT APPEARED IN 1924
Still Years Ahead
RADIO BY McMURDO SILVER

STARTLING radio engineering achievements have characterized the work of McMurdo Silver for a quarter of a century. Year after year his radio receivers have won the acclaim of technical schools, engineering laboratories, radio distance receiving champions, leaders of scientific expeditions, and internationally famous musicians...have made widely accessible results previously considered unobtainable outside of a laboratory. This leadership in radio engineering is strikingly demonstrated by current models. It is no exaggeration to say that no real conception of what radio offers today is possible until you have tested the 1938 masterpieces of this master engineer. Here is radio which, with uncanny "reach" goes to the earth's four corners to snare unique and unusual programs...music, sports, news, ships' messages. Thirty-six distinctive technical features are responsible for the "Years Ahead" performance of tomorrow's radio by McMurdo Silver. Send for details.

The 14-15—Super-sharp communication receiver of 14 tubes (15 with larger speakers) with fused and stabilized regeneration r.f. amplification on all wave bands.


The 15-17—Advanced 15 tube super-heterodyne circuit delivering the power of 12 tubes. Every coil and circuit individually shielded and chassis chrome plated throughout.

New Selective-Directional Antenna
The SELECTIVE-DIRECTIONAL 9 gives nine different choices of directional double, single wire and V-antennas. One may select at the turn of the knob an East-West or North-South double, an East, West, or South single wire "L" antenna, or a South-East, West-South, North-West or North-East "V" antenna.
All are coupled to the receiver through a noise rejecting transmission line and performed automatically self-selecting long and short wave antennas and set couplers. All soldered and ready to put up, erection requires only two cross-arms. Kit includes 4 antenna and insulators, 4 stand-off insulators, 1 insulated insulator tube and 50-ft. of weather-proof lead-in cable.

NEW and Sensitive Dynamic Microphone
In America's best and most highly developed broadcasting stations, the dynamic microphone reigns practically supreme as the source of microphone quality. So, in offering a microphone comparable in quality to McMurdo Silver receivers, we naturally selected the dynamic principle as the sound basis upon which to start development. We are proud to offer at one and the same time not only a microphone directly comparable in quality to the costly units used in the finest broadcasts, but to provide through recent research greatly increased sensitivity, a combination of directional or non-directional characteristics in one single unit—and to be able to establish what is an extraordinarily low price for such a remarkable instrument.

The new McMurdo Silver 4A Dynamic Microphone is shown mounted upon its 7½" high, non-tip over steel deck stand, together with the shielded plug which terminates at the microphone, the 25-foot rubber-covered shielded microphone cable with which it is equipped. Both stand and cable plug unscrew for convenience. The stand thread is standard, so that the microphone itself may be quickly transferred to different stands as may be desired.

This super microphone is only 3-13/16" long and 2-1/4" in diameter, and weighing but 1-1/2 lbs. has a frequency characteristic flat to 3 db. from 50 to 10,000 cycles—the full range of the best broadcast stations. Its "level" is unusually high, being only—52 db. and its output impedance is 50,000 ohms and materially reduces a.c. hum pickup by the microphone or its cable and permits quite long microphone-to-amplifier cables—even up to a couple of hundred feet when necessary.

Type 1B Pre-Amplifier Mixer—This pre-amplifier and electronic mixer (self powered, universal a.c.—d.c.) features two triode sections in the two triode sections of a 678, the two capable of being mixed and faked together by individual gain control. The first with a 677 pentode yields 9 db. voltage gain with an input of 2 megohms permitting use of crystal or other low level microphone plugged in directly through standard shielded jack and plug. The second channel serves for high-level microphone and phone-pick-up or radio receiver input and gives a voltage gain of 20 db. Operation is from any 105 to 125 volt, 25 to 60 cycle a.c. or d.c. power line. Hum is unmeasurable and the 1B may be used to drive following power amplifiers with no trouble on this score, with 20 to 50 foot separation through single conductor shielded microphone cable. Substantial steel shielding cases is 7" long, 6" high and 3-1/2" deep. Shipped complete with 1 each tested Raytheon 695 and 615 it will turn any good receiver into a complete F. A. System.

McMURDO SILVER
2900-G SOUTH MICHIGAN AVENUE, CHICAGO, ILLINOIS

Please Say That You Saw It In Radio-Craft
Wireless Equipment Revolutionised.

Over a year ago we began applying our Condensers for Wireless Work, and we have now supplied a large number for voltages up to 30,000. They have been subjected to very severe tests, and we are receiving repeat orders from British, Colonial and Foreign Governments, and from other large users in all parts of the world.

We claim, and tests have proved, that Dubilier Condensers are more efficient than any others; that they occupy not more than one-tenth of the space and are about one-tenth the weight of other high-tension condensers: that they cost no more than other good condensers; that they cannot be surpassed for portability; that they are practically unbreakable: that there are no losses due to brush discharge or leakage; that hysteresis is reduced to a minimum; that desired capacities are supplied true to within 1 per cent; that the efficiency of wireless stations is increased by the installation of Dubilier Condensers, and therefore

The Sending Radius is Greatly Increased.

<table>
<thead>
<tr>
<th>Voltage (kV)</th>
<th>Working Voltage (kV)</th>
<th>Breakdown Voltage (kV)</th>
<th>Capacity (μF)</th>
<th>Dimension (mm)</th>
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<tr>
<td>30,000</td>
<td>15,000</td>
<td>42,000</td>
<td>0.05 M.F.</td>
<td>13.5 x 8.5 x 8.5</td>
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<td>75,000</td>
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<td>0.10 M.F.</td>
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<td>150,000</td>
<td>90,000</td>
<td>200,000</td>
<td>0.15 M.F.</td>
<td>18.5 x 16 x 10</td>
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SEND YOUR ENQUIRIES. All Condensers Guaranteed and are returnable if they do not give entire satisfaction.

THE DUBLILIER ELECTRIC Co., 96 E. 42nd St., NEW YORK.

THIS ADVERTISEMENT APPEARED IN 1910
...MORE THAN 28 YEARS AGO

The name DUBILIER was on engineering tongues in a dozen lands. For it was Dubilier who invented and produced, in those early days, the first mica condenser — with a vision perhaps of things to come. In all the 28 years that intervened — years that saw a strange wireless contraption become one of the world's major industries, Dubilier pioneering never ceased. So it is, in 1938, as in 1910, the world looks to Cornell-Dubilier for condensers.

Now as then — all condensers are fully guaranteed.

CATALOG SENT ON REQUEST
Write to 1014 Hamilton Blvd. So. Plainfield, N. J.

MICA - DYKANOL - PAPER
WET & DRY ELECTROLYTICS
World's largest and oldest exclusive manufacturer of capacitors.

CORNELL DUBILIER
ELECTRIC CORPORATION
South Plainfield, New Jersey

Please Say That You Saw It in RADIO-CRAFT
The Weston Radio Set Tester

will identify YOUR STORE with dependable Service and Products

This advertisement appeared in the Electrical World for March, 1938.

WESTON ELECTRICAL INSTRUMENT CORPORATION
20 Weston Avenue, Newark, N. J.

THESE ADVERTISEMENTS APPEARED IN 1888 AND 1925
No matter what type of test equipment is needed, radio servicemen know that when they buy WESTON they get the sound engineering, the added dependability, which comes from a half-century experience in building better instruments. Send for literature on the complete line.

Weston Electrical Instrument Corp., 599 Frelinghuysen Ave., Newark, N. J.
Do Amateurs Realize the Wireless Opportunities that Await Them?

How the President of the National Radio Institute Answered this Question When It Was Put Up to Him. What Would You Have Said? Is the World's Fastest-Growing Field Actually Going to Slip Away From Those Best Able to Cash In Big On It? These Are Questions Which Will Interest Every Radio Amateur.

THAT was one of the questions recently put up to me by a well-known authority on wireless, in connection with the fact that, in his opinion, "do amateurs realize the wireless opportunities that await them?" For a moment I was stumped. Then I replied, "Yes, with one 'but.' I think that amateurs are well aware of the tremendous expansion of wireless that is daily going on. They realize that wireless is sweeping the world like wildfire, but I do not think that they realize what this means to them—they do not realize that they can easily get the blanks that the field offers. They 'have the jump' on everyone else, and they should realize now that the fastest-growing field in the world besides being a fascinating hobby is a wonderful, opportunity-filled field offering splendid present and future advantages so rapidly that the future is beyond estimation."

I wonder if many amateurs have ever considered the fact that it is a fascinating hobby is also a fascinating profession, filled with opportunities that they can easily share whenever they are ready to do so. It's only a short step for them now to a splendid field that they can put their hearts into—and offering a bigger future than old businesses which are overcrowded.

Big Opportunities Are Knocking—Are Some of Us Saying "Please Go Way and Let Me Sleep?"

After the caller who started me thinking about this matter had left, I jotted down on my pad some of the items which I had recently noted regarding wireless expansion. On land and sea big opportunities are opening, and even greater uses for wireless are being found every day. No doubt you too have read these items, but I am writing to have them printed here because I want to impress upon you what this tremendous expansion means to man.

When I read every day how wireless expansion is sweeping over the world, I think too often of my youth. The opportunities are knocking—I wonder if amateurs realize that they can cash in big on this growing field. While opportunities knock, I wonder if anyone isn't saying: "Please go away and let me sleep."

Of course, there is sleeping to be done, but I want all of us to know that new methods should be fully qualified for a field which is unhesitatingly filled with greater advantages than most other work in the world today.

Easy to Qualify

In Spare Time—at Home

I want to tell you—without obligation to yourself—in just a few words about wireless opportunities and how you can take advantage of them. I would like to tell you about our Institute. This National Radio Institute is the oldest and largest school in America teaching wireless—mail. The government allows our students five ten-point credits when taking First Grade Government Examinations. We have graduated enough of the world who have quickly qualified through the special method through which we make Wireless easily, efficiently, and quickly.

Write Me For Booklet

A little booklet is being put here so that you can save yourself trouble in writing for this illustrated booklet. "Wireless, the Opportunity of Today." By mailing this booklet you will not be obligated to yourself in any way and no solicitor will call upon you. But this booklet will bring you some mighty interesting facts about Wireless Opportunities and about how you can qualify and easily get them at home and in your spare time.

Would you mail this little booklet at once? Whether you are a junior Radio Amateur and want to learn about Wireless or whether you are anxious to fully qualify so as to enter the wireless profession now in one of the fine opportunities open on land or sea—I will send you this booklet. All that I ask is that you write us soon as possible. And since there is no obligation why not write me today?

MAIL THIS COUPON TODAY

Mr. James E. Smith, President, National Radio Institute, Dept. 16, Washington, D.C.

I want to learn the Wireless, the Opportunity of Today. Tell me about your Institute and your special advantages.

Name

Address

City State

What I Jotted Down

Here are the items I jotted down on my pad following how Wireless is opening by leaps and bounds all over the world. Let me tell you what this worldwide story of wireless expansion means to you and to your future.

A glowing American commission has been formed to establish wireless stations in every part of the globe. The L.S. Meredith Maritime wireless division of cables, Wireless, is in a hurry on ships.

The Chicago Tribune recently published a long history on wireless, calling Wireless wireless stations are springing up all over the world. Wireless, Foreign Institute, Wireless, Foreign Institute, wireless, and the like are a few.

Half tableaux are taking up wireless to display land and early on communication. The looks upon the Lynneville & Nashville, the Canadian Pacific, the Nashville-Detroit, St. Louis, are coming...

Wireless is being interfered with wireless through the Post Office Department. The New York, Cleveland, Chicago and Detroit are supported by a few cities, wireless stations.

Citizens are being interfered with wireless through the Post Office Department. The New York, Cleveland, Chicago and Detroit are supported by a few cities, wireless stations.

Booths, Boarders, Merchants, Manufacturers and others, business, Everywhere are calling upon wireless. John, handset, handset, handset, handset, handset, handset, handset, handset, handset, handset, handset, handset, handset, handset, handset, handset, handset, handset, handset, handset, handset, handset, handset, handset, handset, handset.

The Naval Staff Service of the Post Office Department... Wireless, Wireless, Wireless.

The Japanese are constructing a powerful station in Japan.

A big wireless center is to be established between England and France. The German, Telegraph Co., is starting a powerful station in England, 1,000 miles from the coast.

Messages are sent to wireless stations in all parts of the country. Wireless wireless stations are springing up everywhere in part of the globe. Wireless, Foreign Institute, Wireless, Foreign Institute, wireless, and the like are a few.

The Naval Staff Service of the Post Office Department... Wireless, Wireless, Wireless.

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The Naval Staff Service of the Post Office Department... Wireless, Wireless, Wireless.
I used to Play with Radio
NOW IT PAYS ME GOOD MONEY

J.E. Smith showed me HOW TO
START A RADIO SERVICE BUSINESS
WITHOUT CAPITAL

C. N. S. (NAME AND ADDRESS UPON REQUEST)

I will train you to CASH IN ON RADIO’S
spare time and full time OPPORTUNITIES

MANY RADIO EXPERTS MAKE
$30, $50, $75 A WEEK

For many years I have been earning 
my weekly pay by working on 
Radio. There are many opportunities 
for men to earn good money by 
working on this business. There are 
many different types of Radio 
work that you can do. Here are 
some of the things you can do:

1. Repairing Radios
2. Installing Radios
3. Teaching Radios
4. Selling Radios
5. Buying Radios

Many Make $5, $10, $15 a Week Extra
in Spare Time While Learning

Almost everyone who makes a good wage 
from Radio work has learned how to 
operate a radio. Many of them have 
learned how to do this through self-teaching. 
I sent you plans and ideas that have made 
me a good money from home. I know how to 
earn a good income from home. I send you 
special Radio equipment and show you how to 
control your radio circuits and build 
equipment which will enable you to 
earn money from home. My training gives 
YOU PRACTICAL EXPERIENCE while

I Give You a Professional Servicing Instrument
Here is the instrument 
every Radio expert 
will need in 
All-Wave Milling 
Servicing. It contains ever 
thing necessary to 
operate a 
year. Radio operators 
are needed everywhere. DJ-Radio, 
F.C., X-F, 
appliances, Consumer Radio, and local 
Radio stations are now 
looking for Radio experts. Send me 
the coupon for the 
free catalog today.

MAIL FOR 64-PAGE BOOK FREE

J. E. SMITH, President
National Radio Institute
Dept. 581-C
Washington, D. C.

Dear Mr. Smith: Without obligation, send me free the Sample Lesson and your 64-page Book "Rich Rewards in Radio," telling about spare and full time Radio opportunities, and how I can train for them at home in spare time. (Please write plainly.)

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ADDRESS ____________________________________________

CITY ____________________________________________ STATE ___________ 2293-

Please Say That You Saw It in RADIO-CRAFT
SAY FELLOWS
GET INTO
RADIO-TELEVISION
AND TALKING PICTURES

Let me tell you how I can quickly train you, not by book study, but by actual shop training on real radio, television, and talking picture equipment in 12 weeks in the great shops of COYNE in Chicago. Here at COYNE you don't need advanced education or experience and many of my students earn while learning. After graduation I give them lifetime employment service. Here at COYNE too you get individual instruction, and you can start anytime.

Radio offers jobs as designer, inspector and tester, salesmen, and in installation work, operator of a broadcasting station, wireless operators, or a ship, with television Laboratories and studios. Television alone will soon be calling for thousands of trained men. Come to COYNE here in Chicago and prepare for one of these jobs the quick and practical way BY ACTUAL SHOP WORK.

It is a shame for any fellow to go thru life as an untrained man working at small pay, and never being sure of a steady job, and when he does work working at any old price they want to pay him.

You can avoid this. You can be a leader, and have a real future. Mail the coupon today, and I'll send you my big Free Radio and Television Book, and tell you how you can be a success just as hundreds of my graduates are today.

H. C. LEWIS, President
Radio Division, COYNE ELECTRICAL SCHOOL
500 S. Paulina St., Dept. 30-70, Chicago, Ill.
Send me your Big Free Radio and Television Book, and tell me how I too can make a success in Radio.

Name
Address
City, State

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MANY OPPORTUNITIES FOR THE
COYNE TRAINED
RADIO MAN

Are You Ready for a Better Job—More Pay?

Don’t be an untrained man. Let me show you how to get your start in Radio—a fast growing, live money-making industry.

Prepare for jobs as Assembler, Inspector and Tester—Radio Sales or Service and Installation Work—Broadcasting Station Operator—Wireless Operator on a Ship or Airplane or Sound Work—HUNDREDS OF OPPORTUNITIES for a real future in radio!

12 Weeks of Shop Training

We don’t teach by book study. We train you on a great outlay of Radio, Television and Sound equipment—on scores of modern Radio Receivers, actual Broadcasting equipment, Television apparatus and Sound Reproduction equipment, Code and Telegraph equipment, etc. You don’t need advanced education or previous experience. We give you—RIGHT HERE IN THE COYNE SHOPS—the actual practice and experience you’ll need for your start in this great field. And because we cut out all useless theory and only give that which is necessary you get a practical training in 12 weeks. Mail coupon for all facts about my school and training methods.

TELEVISION and PUBLIC ADDRESS

Television is sure to come as a commercial industry. Rapid progress is now being made in developing this new field. It will offer opportunities to the man who is trained in Radio. Here at Coyne you learn Television principles, and work on actual Television equipment. Public Address Systems offer opportunities to the Trained Radio Man. Here is a great new Radio field which is rapidly expanding. Prepare NOW for these wonderful opportunities! Learn Radio Sound Work at COYNE on actual Sound Reproduction equipment. Not a home study course.

SEND FOR DETAILS OF MY
“PAY AFTER GRADUATION” PLAN

Mail the Coupon below and I’ll tell you about my “Pay After Graduation” Plan which has enabled hundreds of others to get Coyne training with very little money. On this plan you can get your training first, then take 18 months to complete your small monthly tuition payments starting 5 months after you begin training. Not a home study course.

Mail the coupon for all details of this “Tuition Payment Plan.”

PRACTICAL WORK
at COYNE in Chicago

ACTUAL, PRACTICAL WORK. You build and service radio sets. You get training on real Broadcasting equipment. You construct Television Receiving Sets and actually transmit your own Television images over our Television equipment. You work on real Sound equipment. You learn Wireless Operating on Actual Code Practice apparatus. We don’t waste time on useless theory. We give you the practical training you’ll need for your start in Radio—in 12 short weeks. If you desire code, this requires additional time for which there is no extra charge.

Mail Coupon Today For All the Facts

H. C. LEWIS, Pres.  RADIO DIVISION  Founded 1899
Coyne Electrical School 500 S. Paulina St., Dept. 38-8H, Chicago, Ill.

ELECTRIC REFRIGERATION
AIR CONDITIONING
AUTOMOBILE ELECTRICAL WORK

Instruction now included at no extra cost. Here is your opportunity to learn these valuable allied lines without extra tuition charge.

PART TIME EMPLOYMENT TO HELP YOU “EARN WHILE LEARNING”

If you are short of money and need part time employment to help pay for your room and board while training, my Employment Department will help you get a part time job.

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Radio Division, Coyne Electrical School
500 S. Paulina St., Dept. 38-8H, Chicago, Ill.

Dear Mr. Lewis—I sent your Big Free Radio Book, and all details of your “Pay After Graduation” Plan including valuable instruction in Electric Refrigeration, Air Conditioning and Automobile Electrical Work.

Name: ________________________________ Address: ________________________________

City: ________________________________ State: ________________________________

Please say that you saw it in Radio-Craft.
Again Acclaimed "SUPREME"

Another RMA Show—Another Triumph

Standing the acid test of daily actual use in the hands of thousands of radio engineers and service men the country over, meeting every service requirement in a constantly changing field, the SUPREME Radio Diagnometer remains UNAPPROACHED! UNCHALLENGED!

UNCHANGED! except for the addition of Pentode Testing to its almost limitless servicing functions!

Again the SUPREME DIAGNOMETER MODEL 400-B at the RMA Show was readily conceded by engineers from all parts of the globe to be the unrivaled leader in the field of radio service instruments. Radio dealers, manufacturers, technicians and service men, in ever-increasing numbers are demanding the SUPREME DIAGNOMETER because:

1. Its unique design is outstanding, a guarantee against obsolescence.
2. Its rugged construction prevents break-down, insuring accurate operation at all times.
3. It is the one service instrument capable of making every necessary test—none other so complete.
4. It pays for itself in a few months—faster and more accurate servicing means greater profits.
5. It provides maximum efficiency with utmost simplicity—pictorial diagrams of every test supplied with each instrument.
6. It creates satisfied customers—provides a laboratory method for the solution of every service problem.
7. It provides the greatest amount of test equipment in the least possible space at the lowest cost per service unit. The service units contained in the Supreme Diagnometer, if purchased separately, would cost many times its price.

Make your Service Department outstanding Modernize with the SUPREME DIAGNOMETER and watch your profits grow.

SUPREME INSTRUMENTS CORPORATION
GREENWOOD, MISS.
Distributors in All Principal Cities

Dealer's Net Price, F. O. B. Greenwood, Miss. Size 7½ x 12½ x 16½.
$139.50

Also available in smaller case for the radio man who does not care to carry spare parts, tubes, etc., in same unit.

And Now! A Revolutionary Set Analyzer

25 Testing Instruments in 1

All Readings on One Meter—Only One Meter to Read

SUPREME SET ANALYZER MODEL 90

Dealer's Net Price, F. O. B. Greenwood, Miss. Size 4½ x 9½ x 11½. Shipping weight 8 pounds.
$78.50

Responding to demand for a simple, yet more flexible and complete set analyzer, the "Supreme" Model 90 SET ANALYZER is offered to the Radio service world. Simplified to only one meter of unique design never before available in any but the most expensive laboratory equipment, it measures both A. C. and D. C. voltages up to 900 volts, and currents up to 300 milliamperes, and provides many readings and tests never before attempted with any other similar instrument. You owe it to yourself to compare "Supreme" advantages with any other set analyzer you may be considering!

Most good distributors carry the complete line of Supreme products in stock, including the Model 50 Tube Tester, Model 19 Ohmmeter, Model 17 Tube Checker, as well as the Diagnometer and Set Analyzer. If yours cannot supply you, use order coupon to the right.

Supreme Instruments Corp.
311 Supreme Bldg.,
Greenwood, Mississippi
Please ship Supreme Test Instrument as checked below:

Model 400-B Diagnometer
Net Cash $139.50

Time Payment Plan—$33.50 Cash and 8 monthly payments of $15.00 each

Model 90 Set Analyzer
Net Cash only $78.50

All prices are F. O. B. Greenwood, Miss. No Dealer's discount.

Date Shipment desired

Signed

Firm Name

Street Address

City

State

Please give three or more bank or trade references and names of distributors from whom most purchases are made.

THIS ADVERTISEMENT APPEARED IN 1930
SOME of America's finest radio engineers . . . men who work daily with test instruments costing thousands of dollars . . . certainly know fine instruments. They recognize superiority in accuracy . . . in quality. That's why these same men who use the best laboratory instruments available acclaim Supreme instruments—the instruments for your service laboratory.

Too, Supreme instruments are easy to own. Your parts jobbers sell them for only a few dollars down—balance in monthly payments—on S. I. C. terms, the world's easiest installment terms!

JUST OFF THE PRESS!
FREE Illustrated 1938 Catalog. Write for It!

FREE "Adequately Equipped Shop" Certificate
Send for the free booklet explaining how you can qualify for a Supreme "Adequately Equipped Shop" Certificate.

"I am particularly glad to see SUPREME introduce so efficient and reliable an instrument as the Model 541 Sc: Tester—and so extremely efficient for all types of service work."

Karl W. Miles
Chief Engineer
THE HALLICRAFTERS, INC.

"I was really amazed at the excellence and flexibility of Model 551 Analyzer, considering its very low price. A serviceman entering a home with it should certainly present all the earmarks of competence and ability."

McMordu Milw.
President
McMURDO SILVER CORP.

"I have found Model 570 Signal Generator meets all requirements to an excellent degree, and I can well recommend it to those contemplating the purchase of such an instrument."

Arthur E. Moehaupt
Directing Engineer
RADIO TRAINING ASS'N. OF AMERICA

Please Say That You Saw It in RADIO-CRAFT
SYLVANIA tubes are not made simply to sell but, first of all, to perform. If you have had experience with tubes of questionable quality, this simple statement of a fact will go far in accounting to you for the big difference in quality of tone, sensitivity and volume that you will notice immediately you install Sylvania in your receiving set.

The fundamental reason for the extra measure of performance that Sylvania tubes deliver is easily understood when you consider the attitude of the makers to their product. They know beyond any question of doubt that the future of radio depends on how good its equipment is made—not how cheap.

Sylvania tubes are made by a close knit organization that has been identified with the manufacture of superior quality electrical products for many years. You are invited to investigate its responsibility through any of the commercial agencies.

To demonstrate to yourself how good a radio tube really can be made, compare Sylvania performance with that of any other tube you may hold in high esteem. Both the manufacturers and the dealers guarantee of complete satisfaction is an obligation that will be upheld under any and all conditions.

We Invite Dealers
— who recognize the relationship of quality to profits to ask us about the Sylvania franchise and the better business building plan. It will be worth your while to investigate regardless of your present connections.

Types: S01-A, S99 Large Base, S99 Small Base

SYLVANIA PRODUCTS CO.
Emporium, Pa.

THIS ADVERTISEMENT APPEARED IN 1925
When the name is Sylvania, the answer—now and always—is quality

Radio since its birth has seen many changes—improvements that have raised the industry to its present high standing in the world of business.

But the quality of Sylvania radio tubes has never changed. For ever since the first Sylvania tube was made—back in the days when radio first became commercially important—Sylvania engineers have insisted on perfection by "set-testing" each tube before it is okayed for shipment.

This consistent quality has shown itself in the sales recognition which the public has accorded Sylvania. That's why the name Sylvania means profits for you! Hygrade Sylvania Corporation, Emporium, Pa.

FREE OFFER: Send to Dept. RCJ, Hygrade Sylvania Corp., Emporium, Pa., for a free three-month subscription to Sylvania News. Don't miss this offer—every issue of Sylvania News is full of helpful radio information!

Please Say That You Saw It in RADIO-CRAFT
The New CROSLEY Variable Condenser

"Better — Costs Less"

MODEL "C"

The principle of this instrument needs no introduction. Thousands of the Crosley Model "A" Condensers have been sold with uniform satisfaction. The Model "A" is conservatively rated at 0.005 Mf. The new Model "C" is conservatively rated at 0.012 Mf.

The CROSLEY VARIABLE CONDENSER consists of ground porcelain plates with die cast frame. It is as efficient a piece of apparatus as you could desire. For tuning C.W. and for power transmission it cannot be equaled. It is tested on one thousand volts before shipment. No body or hand capacity. Low resistance due to absence of spring contacts, copper posts, etc.

The CROSLEY VARIABLE CONDENSER is now made in three styles:

Model "A" with wood frame and laminated wood plates.
Model "B" with wood plates and die cast frame.
Model "C" as illustrated — capacity .001 — porcelain plates, die cast frame, etc.

Prices as follows:

Without knob and dial
With knob and dial
With knob and dial mounted in cabinet

Model "A" $1.25
Model "B" $2.25
Model "C" $3.50

Every CROSLEY VARIABLE CONDENSER is GUARANTEED to give absolute satisfaction or money refunded.

The CROSLEY VARIABLE CONDENSER is now made in three styles:

Crosley Detector Units

Furnished completely wired and mounted as shown in illustration or in knocked down form. Price completely assembled $7.50. Price of all parts including formica or other panel of high grade dielectric composition, not drilled .

Crosley Two Step Amplifier

Complete with knob, pointers, etc., as shown in illustration.

Model "A"—overall diameter 3/4", Resistance 7 ohms, three amperes without heating. Price $2.60
Model "B"—Resistance 4 ohms, three amperes without heating. Price $1.50

Every article guaranteed to give absolute satisfaction or money refunded. If your dealer can't supply you, send us his name and order direct.

Dealers and Distributors. Every item shown above should be in your stock. Write for proposition.

CROSLEY MFG. CO. Radio Dept. R-7 CINCINNATI, 0.
CROSLEY Scores again!

AS EASY TO TUNE AS SOUNDING YOUR HORN...

New! CROSLEY SAFETY-TUNE FIVER ROAMIO

24.95

The lowest priced push-button tuning automobile radio

FIVER ROAMIO

The famous Crosley Fiver Roamio with exceptional tuning is also available at $19.99

(Prices slightly higher in South and West)

1. Highest signal to noise ratio in any 5 tube radio.
2. Full size, full wave, vibration transformer for long life.
3. 5 Octal base tubes in standard circuit.
4. Antenna system designed to compensate for any type antenna.
5. Fully equipped with distributor compressor and generator condenser.
6. Easy to read, edge-lit, slide rule type dial.
7. Fully equipped with distributor and generator condenser.
8. Full automatic volume control.
9. Low battery drain.
10. Sufficient volume to be heard at any speed.
11. Single unit, easily and quickly installed in any car.

Last year Crosley startled the radio world with the most sensational value in the automobile radio field—a set selling for less than $20... and car radio sales skyrocketed to a new high. Now Crosley again scoops the industry with another record-breaking sales-leader—the Safety-Tune Fiver Roamio with automatic push-button tuning for only $24.95! Your favorite stations can be pre-selected and the push-buttons set in a few minutes... and the safety-tuning mechanism is instantaneous. Here is the best in car radio reception and tuning at a price that every car owner can afford to pay. See and hear The Crosley Safety-Tune Fiver Roamio at your nearest Crosley dealer today. Have him install it in your car while you wait.

THE CROSLEY RADIO CORPORATION - CINCINNATI

YOU'RE THERE WITH A CROSLEY

Please Say That You Saw It in Radio-Craft
Buy Reliable Radio Apparatus

ORDER DIRECT FROM THIS PAGE

Combined Detector and Two Stage Amplifier

This instrument with the proper accessory instruments has the broadcast potential range of my watt power, a directional receiver is it even with an indoor aerial such as our keyless automatic NO. 6000 makes clear, speaker from stations hundreds of miles distant. Combined with our Regenerative set and two variable condensers and the proper accessory receiver is the panacea. Gesan power, its range is increased to equal the best commercial stations. Has one detector and one amplifier circuit. Standard tube sockets, grid condenser in detector circuit, two amplification transformers, three jacks and one plug so that any desired circuit may be used. Durable pink, 5 in. wide. High grade weathered oak finish cabinet with hinged top making interior easily accessible. Bounding post-black oxidized finish. No tubes, batteries or phones included. Shipping weight, 18 lbs.

63161—Price……………………. $13.10

Commercial Type Oscillation Transformer

Price………………………………….

Double Action Wireless Key

631535—Double action which gives wide range both above and below meter range. Solid copper windings. For

6305352—Design to give range both above and below meter range. Solid copper windings. For

Art. No. K. V. A. or Volts. Pipeline. Price

7048—10,000 5 lbs. 10.00 7048A—10,000 25 lbs. 19.90

263155—Designed to give wave range both above and below meter range. Solid copper windings. For

Spark Gap Electrodes

6315335—Raw bamboo, 5 in. diam. of the natural rod. Has all the properties of the original. May be

Improved Model Rotary Spark Gap

631155—Fits all spark coil adapters. Good for use with either high or low pressure. Has all the properties of the original. May be

Art. No. K. V. A. or Volts. Pipeline. Price

6315351—Fits all spark coil adapters. Good for use with either high or low pressure. Has all the properties of the original. May be

Ground Switch

63161—From ground rod, length, 8 ft. Heavily galvanized. A ground rod necessary with every set. Includes a small ground rod, 8 ft. long, 1/4 in. dia. and 43¢

63161R—Price, per dozen…………………………. $4.30

American Ignitor Dry Cell

We guarantee that these batteries will remain fresh and will give 100% service. No other power plant can equal the efficiency of these new batteries. For ignition work on gas engines, automotive or traction service. May be used as a generator.

63161A—100 watts. Ship. wt. 15 lbs. Price……………………….

63161B—200 watts. Ship. wt. 25 lbs. Price……………………….

63161C—500 watts. Ship. wt. 40 lbs. Price……………………….

63161D—1000 watts. Ship. wt. 50 lbs. Price……………………….

63161E—2500 watts. Ship. wt. 75 lbs. Price……………………….
AMERICA'S OLDEST RADIO MAIL ORDER HOUSE STILL BRINGS YOU THE MOST RELIABLE RADIO EQUIPMENT

For more than 20 years we have offered only the most reliable radio apparatus—our old advertisement proves it! We believe we have made an important contribution to radio's progress by making the latest and finest equipment available to amateurs and experimenters everywhere through our complete lines, world-wide distribution, low prices, and liberal credit terms. Today, backed by radio's greatest names, we continue the service that has enabled us to become America's oldest radio mail order house.

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CHICAGO • BALTIMORE • ALBANY • KANSAS CITY • ST. PAUL
DENVER • FORT WORTH • PORTLAND • OAKLAND • JACKSONVILLE

EVERYTHING SOLD ON TIME PAYMENTS

The newest and best radio equipment at rock-bottom prices! Use it while you're paying for it in convenient monthly payments—terms as low as $2 Down, $2 a Month. Send for Ward's new 1938 Radio Catalog—the finest ever printed. Check the equipment you're most interested in and mail the coupon AT ONCE for your FREE copy. MONTGOMERY WARD, DEPT. R2-7, CHICAGO, ILL.

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APRIL RADIO-CRAFT

The annual SPECIAL ELECTRONICS NUMBER will contain not only many articles of exceptional interest to experimenters and practitioners in the electronics field but also numerous articles on other allied fields of radio; and of course, as usual, the various monthly departments. This issue will tell you about new developments in electronic music, test equipment, sound apparatus, and radio in general. Also in April "R.-C." will appear an unusually informative article for the Service Man; and another on a 10-tube all-wave receiver for the set builder; a third on an "expressor" for Public Address specialists; and, finally, several departments which due to lack of space do not appear in this March issue. All these and much more will be found in the forthcoming April issue of Radio-Craft.
An Editorial by HUGO GERNSBACK

WHEN Heinrich Hertz performed his epoch-making experiments during the years 1887-88 in Frankfurt, Germany, he little dreamed what a tremendous force he was about to lose upon humanity.

It is unfortunate that this illustrious scientist has had so little recognition, and, indeed, the proverbial man in the street does not even know his name. Most people think that Marconi is the man responsible for radio. Of course, Marconi is responsible for the practical application of radio, but it was Hertz who laid the ground work; and it is a fact that he did all the research work upon which modern radio is based. As time goes on, we must marvel more and more at the tremendous insight which Hertz had into radio physics, for many of the principles which he discovered are being used only of late.

Thus, for instance, short waves were first used by Hertz only to be discarded when radio got under way, and but lately "rediscovered." The art of radio advanced along orthodox lines the same as any other art, and the process was just as painful, but as regular, as in other arts. It is always an easy matter to look back upon what has gone before, and laugh at the mistakes which were made when we were still groping in the dark. From our elevated height in looking backwards over 50 years of radio, it would be easy to point out the mistakes, the fallacies and the blunders which were committed during the entire development stage of the first half-century of radio.

The pity of it is that the hard work which went into the art of radio, and which contributed so largely to its present state of development, is not recognized by most of us in this latter day. Many are the heroes of radio who are buried in darkness, and who have had little recognition, if any. Indeed, it perhaps would be pointless to give a list of the men whose illustrious work made radio what it is today, in an article of this type. Ours is an impatient world which is not concerned with names and personalities, but which wishes only to see the results of their labors. This is most unfortunate, but it has ever been thus with pioneers, and those who have slaved and given their best to make a new art possible.

As a small monument to those who gave their effort and best years to the development of radio, this issue of Radio-Craft has been dedicated.

Radio would not be what it is today without those valiant souls who stayed up nights, and often wrecked their health, but who gave us and posterity present-day radio.

It is to these unsung, uncrowned men, who deserve some recognition (even if it is only in reading their name for the first time), that we are offering this Jubilee Souvenir Number of Radio-Craft that this issue is dedicated.

While it has not been possible to give as much space as we had hoped to all radio pioneers, we believe the issues of Radio-Craft almost every radio personality whose work has gone into modern radio.

And I, for one, believe and sincerely hope that you, who are interested in radio, will find time to peruse the entire issue, if for no other purpose than to etch these names of radio men, without whose radio would not have developed into the miraculous art which has become so tremendous a part of our lives.

And is to those men, to their tireless efforts, and to their work, to whom I dedicate this, the Jubilee Souvenir Number of Radio-Craft.
HOW modern broadcasting grew from the experiments of a Pennsylvania amateur, conducted shortly after the World War, to a mammoth industry is told in the following article.

**N. H. LESSEM**

In order to trace broadcasting's growth, one must first arrive at a definition of the term. Do we include the experiments of Hertz and Loomis? Did broadcasting commence with Marconi, de Forest or with Conrad's transmissions? For the purposes of this article, a rather definite distinction must be drawn between bona-fide broadcasting and the mere transmission of signals (be they voice, music or Morse) by wireless means.

**A DEFINITION**

In its exact sense, the term "broadcasting" includes only such signals as are sent out by means of radio waves for general reception. A signal directed from one point to another in code, so that it is unintelligible except to a certain or restricted few, is certainly not "broadcast" as the average individual or listener-in would define it.

His conception of "broadcasting" would refer more specifically to speech or music sent out for the information, entertainment or education of the general public,—consequently, broadcasting as America knows it today may be said to have had its true birth early in 1907,—when de Forest constructed the first means of modulating an arc transmitter with voice impulses and began sound broadcasting from atop the 12-story Terminal Building at 42nd St. and Park Ave., in New York City.

So successful were the results that de Forest's company soon received an order for an installation on a private de luxe yacht, which was quickly followed by the sale of 24 complete radiophone stations to the U. S. Navy for installation on battleships. It is interesting to note that the latter units were sold with a positive guarantee of 5 miles reliable range, although actual operating tests showed them to be consistently good over a distance of 26 miles.

In 1908, de Forest went to France and installed his radiophone transmitter atop the Eiffel Tower, from where he broadcast phonograph music. Reports of this test showed that he was heard as far as 500 miles,—a feat which a few more modern stations could not duplicate today.

In January 1910, the De Forest Radio Telephone Company began a series of broadcasts, employing actual singers and grand opera stars to provide the programs. The first grand opera broadcast was a "double-feature", Pagliacci and Cavalleria Rusticana, and Caruso...
The major steps in the transformation of "wireless" to "radio", ethereal chaos to orderly regulation with side excursions into studio technique are here chronicled.

sang in the latter. These efforts and the talent were wasted, however, for it was too soon for broadcasting. Only amateur wireless operators had receiving sets and they were very few in number at that time.

And so for a while broadcasting lay dormant, until the day when it would catch the public's imagination like wildfire and create an insatiable demand for receivers and parts. In the interim, during the early part of the World War to be exact, the A. T. & T. Company was conducting a series of tests and making developments in wireless telephone transmissions, for the purpose of providing facilities for long-distance telephone communication without wires. They had purchased the sole rights to de Forest's audion tube, perfected modulation systems (the vacuum tube as an oscillator was already discovered by both de Forest and Armstrong), and were finally successful in broadcasting telephone speech clearly and reliably over long distances. By the latter part of 1915, telephone conversations were broadcast across the Atlantic, to illustrate how far their progress had gone. These early researches were destined to be the basis for future broadcast station design,—without them, broadcasting would have certainly been later in coming to the fore.

AN INTRODUCTION—KDKA

In 1919, Dr. Frank Conrad—amateur and Westinghouse engineer—began to broadcast programs from his station which was located in the garage at the rear of his house in Pittsburgh. The programs consisted mainly of phonograph records, but by this time so many amateurs were in existence and so many were their friends who would come over to listen to the music, that Conrad began to receive avalanches of mail. Even newspapers began to publicize Conrad's stunt, listing at times the hours of broadcast. So great became the enthusiasm of nearby radio amateurs that the advertising department of a leading Pittsburgh department store got a bright idea for selling some Army surplus apparatus which it had on hand. "Buy one of these World War sets," the ads proclaimed, "and you will be able to hear Dr. Frank Conrad."

Ideas breed more ideas, and when Westinghouse officials saw the advertisement, a startling idea struck them: "Why not build a transmitter right at the factory?" they thought, and proceeded to do so. By the middle of 1920,
It had been assigned call letters, and the little shack perched atop the 9-story factory was known as KDKA.

Then station officials got in touch with the executives of the Pittsburgh Post and Sun, making arrangements for the returns of the Presidential election to be broadcast. On November 2, 1920, the station broadcast the bulletins and finally the news that Warren G. Harding was the country's newly-chosen chief executive.

Not recognizing a competitor which was later to cause them untold worry, various newspapers hailed this achievement. Some 2,000 of them, in fact, were so impressed by the performance that they commenced printing KDKA's programs, as a matter of reader interest. In doing so, they gave broadcasting its first foothold, which it has consistently enlarged.

Once started, broadcasting continued to spread like living flame, but before turning to contributions made to the art by other stations, let us tip our hats a few more times to KDKA. This station broadcast the first radio church service—and think of that when you get an airful next Sunday.

When you tune-in the speeches at a banquet, recall that KDKA was the first station to handle a broadcast of that sort. The same also holds true for the first remote pick-up, the first presidential inauguration, sporting event, baseball scores, time signals, market reports, etc.

THE "A" AND "B" RANGES OF 360 AND 400 METERS, RESPECTIVELY

In broadcasting's early days, stations were licensed indiscriminately, without regard for the kilocycles and the interference that many stations would create when crowded together in a narrow channel. The operating frequency was at first 360 meters or (A) range, but soon broadcasting mushroomed from one station in 1920 to 600 stations in 1922, and the Department of Commerce was forced to include a 400-meter channel, or (B) range for the higher-power (and quality) stations.

At that there was considerable interference (even though
this number of stations was spread out over the country),—so that at that time we find the broadcasters themselves drifting slightly away from their assigned frequencies to minimize or prevent the interference which they were creating. By 1923, the broadcasting range had changed to 200 to 550 meters, and none too soon, for by 1924 a total of 1,400 broadcasting stations were in existence.

IMPORTANT CONTRIBUTIONS TO BROADCASTING

From the standpoint of reception, a contribution of WLW's is of almost equal importance, and though other developments antedate it, it merits consideration here. It was the first remote control transmitter.

One early broadcasting peculiarity was that the transmitter and studios of any station were housed in the same building—the closer together the better. While convenient, it was not sound practice from the viewpoint of either the engineering or the program departments, for if the station were located in the heart of a city, the large neighboring buildings absorbed much of the radiated energy; if it were located anywhere else, it was hard to persuade top-notch artists to journey to it.

Performers were unpaid in the early '20's, and there was scarcely a more diverting sight than a taxi-load of hilarious and high-salaried opera stars bound for a station, elated over the free ride. The microphone into which they sang upon their arrival looked like an antique phonograph horn.

Returning from this digression, one must bow to the telephone company rather than to the broadcasting stations themselves for a step which may be considered to rank at least third in importance: the development of radio program transmission lines and, subsequently, high-frequency lines.

Standard telephone lines were at first the sole means of carrying programs from or to remote points. As such lines were designed to transmit only the human voice, they carried only a comparatively narrow band of audio frequencies,

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few, if any, receivers were sold complete, even in the crystal models. You bought the set, the headphones or "phones" (there were no loudspeakers—they're modern) and the antenna kit separately, and hooked them together as dictated by the instruction sheet and your own conscience, with the latter predominating. The combination cost you more than a 2-hand A.C.-D.C. midget does today, for you paid from $12.00 to $25.00 for the set, $2.00 to $5.00 for the antenna outfit and spent whatever you had left for the phones—and walked home. Phones might even cost you more than the set itself, if you wanted "DX".

Having a factory-built receiver was a mark of distinction, for most people of radio's 'teens and early 'twenties were graduating into radio via the oatmeal-box route. And then when sets which really used tubes came out—!

The early single-tube sets were, in effect, a diode rectifier replacing the crystal, which had been a marked advance over the coherer. Though technologically "radio," they were not what one generally has in mind when considering early sets. The first sets used by the average listener of today were the rather highly-developed crystal sets, and the sets using such early 3-element tubes as the WD11 and the UV201.

Early tube sets were only slightly more expensive than crystal sets and but little better. Some of the crystal outfits contained a buzzer (which, plus its usual clearly audible buzz, produces—like a local radio station—strong radio signals or buzzes), a battery and a button, to enable the user to find a sensitive spot on the crystal. He pressed the button and listened for the buzzes (unless you had muffled the audible buzz, you sometimes couldn't hear the radio buzz!) in his phones, while he felt around on the surface of the galena crystal with the metal "cat-whisker" (whisker-like wire) contact until he had located a sensitive spot. If some one then walked across the room, the contact often jarred out of position, making a new search necessary. There was quite a lot of advertising on crystal detectors with cat-whiskers which would stay in position. Iron pyrite detectors were also favored for that characteristic—and fixed crystals, in which a sensitive spot was located and the cat-whisker permanently attached in position, sold for $1.00 to $2.50 each. Carborundum detectors, energized by flashlight batteries, had the same appeal.

No jarring out of position bothered the users of the early tube sets, but they did have to ask the family please to sit still while a distant station was being received. Tubes were "microphonic," and a footstep in a different part of the house often came through the phones with a sound much like Major Bowes' gong, only duller. To overcome microphonics, lead caps were often placed on the tubes.
EICHBERG

The first tube sets were neither sensitive nor selective. They were, for the most part, single-circuit sets—merely a condenser-tuned coil connected between antenna and ground, with its antenna end connected to the grid of the tube through a grid-leak and condenser; its ground connected to the negative side of the filament. The phones were simply hooked between the tube’s plate and the "B" battery's positive terminal.

Then came regeneration, bringing joyous chaos in its wake. All that was done was to introduce a "tickler" coil in series with the tube plate. This effectively reduced the operating resistance of the grid circuit, permitting the tube to operate at far higher efficiency. However, it often caused circuit oscillation.

As a result, each set became a miniature transmitter, sending its howls for blocks. Radio listeners did this quite deliberately, for they soon learned the "dead beat" method of tuning, through making the set howl, then tuning the receiver; the pitch of the howl changed as a carrier wave was approached and the stations came in with a sound much like "bloop" and ergo, the sets became known as "bloopers."

Even with these regenerative sets, headphones were the customary adjunct, though on powerful local stations, one might lay the phones on the table and hear the program, such as it was. Myriad numbers of crushed and aching ears rose up and demanded a means of listening to more remote stations with the phones on the table—so audio amplifiers and loudspeakers began to creep timidly toward the market place. Soon you could buy, for about the cost of your set, a 2-stage amplifier to add to it. Then you could put your phones in a cut-glass fruit bowl and "let the whole family listen-in," as the ads put it. Incidentally, there were two schools of thought during this period. One claimed that a wooden chopping bowl gave best results; the other, that cut-glass was more brilliant.

Soon the bowl no longer cheered, and people demanded something better. It was offered to them in the form of a cast-aluminum horn with a pair of arms over which the phones could be clamped. The horns sold for $12.50 when they first appeared, but soon cheaper ones, made of papier mâché, came out, claiming that they were better because they did not resonate so freely.

About this time there were also phonograph adapters. These did not permit you to play your phonograph through your radio set; conversely they permitted you to play your radio set through your phonograph. All the élite owned phonographs in those days, and these instruments had well-engineered tone-arms and horns. The adapters permitted the sound from the radio set's phone unit to come through the phonograph's horn. It sounded almost as well as a record, that was fine, for the early sets were not all that might have been desired from the standpoint of fidelity. Bass notes were almost lacking as were, of course, harmonics of treble frequencies. Speech came through harshly; music with tinny tone. The way one judged a set was to tune-in a piano selection and if all the notes were...
heard with approximately equal volume, the set was eminently satisfactory.

Other means of regeneration were also developed, some replacing the tickler tuning with capacity feed-back or a resistance control. Another system put a variometer in the detector plate circuit so that it might be tuned to high impedance, causing the feedback to occur capacitatively between the elements of the tube.

None the less, the Armstrong regeneration patents were good, and while every manufacturer was eager to produce a regenerative set, not all were legally entitled to do so. A few resorted to clever methods of trying to beat the patent. One, to cite an example, incorporated a tickler coil in his set, but had it short-circuited with a heavy wire to which was attached a large red tag cautioning the purchaser not to remove the wire under any conditions, because it would make the set infringe. However, it added the information that the set would give much better reception if the wire were removed. Some purchasers, it is said, were able to wait until they got home before cutting the wire loose.

It was about that time—early in the 1920’s—that the first all-wave sets became popular. These were honeycomb-coil outfits, a popular make being the Federal. This was a handsome 3-tube job in a cabinet approximately 2 feet long. The coils were on the outside, at the left, below them were 2 variable condenser controls and a series-parallel switch for putting the coils and condensers in series or parallel. The set had a variable grid-leak that varied with the weather, for it was merely a pencil mark between 2 contacts; a neat nickeled cap hid it from the public gaze when it was not being varied manually. If changing the switch did not extend the set’s wavelength enough, one could always pull out the coils and plug in a fresh set—if one could afford them.

Another early type of multi-range set was the so-called Navy model. There really were some genuine Navy sets, left over from the World War, and these were readily distinguishable by their
dials—large metal affairs with movable pointers indicating the calibrations on their faces. The pointers were controlled by the same knobs which operated tap-switches, moving to inner or outer arcs on the dials as the switches were turned. Similar systems are used to indicate the band on present multi-range receivers.

Although sets which contained their detectors and amplifiers in a single cabinet were on sale, those which came as separate units persisted for some years. As late as 1926 such dual-unit sets were on sale, though they were being retailed through outlet stores at bargain prices.

All during this early period, receivers were battery-operated. The batteries were identified as filament or “A” batteries and plate or “B” batteries. Separate batteries to provide grid potential were not yet in use; such “C” batteries made their appearance during the middle 1920’s and promptly won the public heart, not so much because they decreased distortion in the audio stages, but because they cut down plate current, making the “B” batteries last longer.

Costly as tubes were (some standard receiving tubes were $6.50 each; others, $9.00, and scarce to boot—during “the war” you paid a premium, besides, and liked it!), batteries were by no means the smallest expense which the set owner had to undergo.

Two types of filament or “A” batteries were in general use; standard No. 6 dryells for the 1.5-volt tubes of the WD11 type, 6-volt storage batteries for the type 201 tubes. Such storage batteries cost from $15.00 to $40.00, depending upon their quality and ampere-hour capacity. While many listeners used regular automobile batteries, which were somewhat cheaper, a good dealer could usually sell a special radio “A” battery instead, as it had thinner, more numerous plates. This was said to give it longer life and more even current flow.

While the larger ampere-hour-capacity batteries cost more than the lesser ones, they were an economy in the long run, as they required less frequent charging—and charging cost a dollar a shot.
in most localities, with an additional 25c (per day) sometimes added for a rental battery for use during the charging period. Many listeners bought their own chargers at prices averaging around $18.50 and considered this an economy.

There were also trickle chargers, so called because of their low current output. These were connected through an ingenious switching system so that the battery was always on charge while the set was switched off. They were really the beginning of the "A" eliminator, which in its first form consisted merely of a battery across a reduced-voltage line, to act as a high-capacity electrolytic filter condenser.

Later the highly-filtered "A" eliminator came into being, but the "B" eliminator, as such, was made available first. "B" batteries were, as many still are, composed of a number of flashlight cells connected together and contained in a sealed cardboard box. Their prices ranged from about $1.00 upward, depending principally upon size. Larger batteries lasted longer — save when some gyp manufacturer placed a small battery in a large box, filled the spaces with old newspaper or sawdust and sealed it up (or held a lamp or cheap meter on the terminals too long while demonstrating that the battery was up to par — which it probably was, before the start of the test!).

Eventually storage "B" batteries were produced. These (Continued on page 614)
ORIGIN AND GROWTH OF RADIO SERVICING

It is to be supposed that radio servicing started with the inception of "wireless"—back in the early Marconi days, since even the very earliest of apparatus which was in use must have required repairing at some time or other. In the strict sense of the word, however, the "Service Man" did not come into existence until 1923-'24, although radio technicians who performed repair work were an established unit with the United States' forces during the World War.

This condition was probably due to two factors: (1) receiving apparatus was so designed and constructed that it seldom, if ever, required servicing (especially in the case of crystal detector receivers) or, if it did, it was either a case of replacing tubes or batteries (in the earliest regenerative receivers) which was so simple a job that either storekeeper or consumer did it; (2) real technical equipment, such as transmitters (spark or tube), was installed and maintained by factory technicians who were usually the engineering representatives of the manufacturers.

SERVICING IN 1923-'24

It wasn't really until 1923-'24 that the commercial broadcast receiver began to take on a technical aspect, which accounts for shopkeepers or their "helpers" ceasing to replace the set's batteries (with the aid of a 0.50 volt pocket voltmeter and a hydrometer for checking storage batteries), and a sudden demand created for men with a knowledge of radio to perform whatever repairs were found necessary. From simple regenerative sets with 1- or 2-stage audio amplifiers manufacturers suddenly began to make receivers with reflex circuits, stabilized T.R.F. stages, superheterodynes, etc.—although all these receivers were still battery operated. A good many of these sets were of the custom-built variety, especially those with superheterodyne circuits. However, set manufacturers began at that time to use the complex circuits, as well as compact and elaborate construction, all of which necessitated skilled or trained men to service them.

The De Forest Radio Tel. and Tel. Co., one of the earliest pioneers in the field, was manufacturing the famous D-7 all self-contained loop receiver in 1923, which used 1 tubes, or stages, of which were reflexed so that 7 stages of amplification were obtained, plus a crystal detector. In 1924, this company followed up this trend in design with another 4-tube reflex, the D-12, a really handsome leathertette semi-console cabinet job with inner compartments for the "A" and "B" batteries; speaker within cabinet with adjustable speaker unit; folding-type loop with calibrated compass plate on top cover (through which the loop would go into a jack receptacle) with plug tip end so that it could be removed and an aerial and ground substituted; 2-gang condenser to tune 2 circuits, and many other novel refinements.

THE RCA "PORTABLE"(1)

That same year (1924) RCA came out with their "portable" superheterodyne using 199-type tubes, with all batteries and loop self-contained within the case,—a rather gigantic affair (over 36 ins. in length) and very heavy but intended also for home use.

Within a short time of their introduction both the De Forest and RCA sets required servicing; in the former the A.F. transformers would burn out and the speaker unit developed mechanical troubles due to the adjusting feature. In the RCA sets the well known "catcounes" were giving trouble, although as a rule most of the troubles were due to the 199's which always were extremely fragile tubes. At any rate, this servicing work was beyond the scope of the dealer and a demand for Service Men was created. Strangely, despite the great number of constructors that

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A CHRONOLOGICAL

Since the dawn of civilization man has ever tried to improve the art of communication. Delving into the history of mankind, we find the smokefire and seme-

J. T. BERSLEY


ey history would be considered incomplete if it did not include all events from the beginning. Hence, while radio is based on electricity, our chronology must begin with the ancient days, with the “discovery” of the peculiar, spark-producing properties of amber when this material was rubbed on a piece of cloth or fur. Similarly, knowledge of magnetic attraction in lodestone, which also dates back to the days of the ancients, was an epochal event; inasmuch as both of these “accidents” were responsible for the later discovery and refinement of electrical laws and principles, which served as the foundation upon which “wireless” was built.

While no exact dates are available, the earliest histories mention the phenomena surrounding amber and the lodestone, as far back as 600 B.C. In that era, it is chronicled, Thales discovered the mysterious sparks which resulted when rubbing the mineral amber, and which we now know to be “static electricity.” Since the Greek word for amber is “electrum,” when the experiment was repeated many centuries later, so that move might be known regarding its cause and effect, it served as the root for a new word—electricity.

During the long interim, strange and fantastic superstitions were conceived concerning static electricity and magnetism. The philosophers of the early days theorized quite a bit, but did very little experimenting; and what was known was handed down from generation to generation with elaboration and no attempt at justification by, at least, trial-and-error experiments. Consequently, we find such theories, based more on hearsay, as “garlic odor destroys the magnetic potency of the lodestone or the compass.” This myth lasted through the early centuries clear up to 1544, when the famous treatise on Physics by Philip Melancthon included mention of it. After that time, numerous controversies sprang up, and many, until 1658, when it received its death blow by Sir Thomas Browne. This astute physician-scientist refused to take anybody’s word for it, and actually performed experiments with magnetized iron and “garlick juice”—thus definitely disproving the centuries-old superstition.

Similarly, numerous theories were created concerning amber and diamonds; among them the most notable being that iron rubbed with a diamond became a magnet, and that diamonds when rubbed would attract bits of paper and particles of dust. Another English scientist, Dr. William Gilbert, outraged at what he termed “chattering of barbers,” undertook to disprove these theories by actual experiment. To his discomfiture, he found that rubbing diamonds did cause them to attract bits of paper; but he discovered also that practically everything he rubbed, except metals, became thus “electrified.”

This led Gilbert to compile a huge list of materials which could be “electrified,” including such items as “true jewels and paste imitations, sulphur, sealing wax, rock salt, alum, resin,” etc. It was this gentleman who gave the name “electric” to this effect, and later on, in 1676, Robert Boyle, in his “Mechanical Production of Electricity” coined or derived the word “electricity” from it. More important, however, is Gilbert’s invention of the “electroscope,” which he probably used to test the various materials enumerated in his lengthy compendium. Also, he too set a precedent by conducting actual experiments before publishing scientific information, refusing to accept hearsay as fact.

With the beginnings of magnetism, came a new era in scientific research; from then on, scientists have resorted to trial and tests to confirm their theories. Back into the darkness were dispelled the mysteries and superstitions of the ancients. Electricity was born, and new fields were open to conquest. Perhaps that is why some chroniclers refer to Gilbert as the “Father of Electricity.” At any rate, since this period marks the inception of scientific electricity, because of the gradual elimination of rumors, guesswork and superstition, our chronology begins with the date of 1600. Without question, scientific work of importance in this field was reported earlier than this period, and this fact is now acknowledged to avoid confusion, discussion and unnecessary arguments.

1600

Dr. WILLIAM GILBERT, physician to Queen Elizabeth, and scientist. Invented the “electroscope,” consisting of a straw which was pivoted like a compass needle, and which indicated the approach of a charged body. Disproved many myths, and compiled a list of materials which could be electrified by rubbing. Coined the word “Electric,” from the Greek root for amber—“Electrum.” Conceived the earth as a huge magnet, with magnetic poles and a field of magnetic force about it—thus laying a positive foundation for many scientific discoveries to come later.

1646

Sir Thomas Browne, English physician and author. Performed many experiments with the lodestone and magnetism, refuting many idle superstitions by actual experiment. Actually tried to make the first “wireless” by employing two compasses with the alphabet written upon them (although credit for the idea must be given to a predecessor, one John Baptist Porta). He imagined that if the two needles were magnetized together, then separated, the turning of one to indicate some letter of the alphabet would cause the indicator on the second dial to move to a similar position; thus envisioning a means of communication without any intervening medium. The second compass indicator, however, did not budge from its North-pointing position, remaining as he said “like the pillars of Hercules.” Nevertheless, the thought of communicating between persons over a distance, hitherto more or less a figment of the imagination that inspired very few people in the centuries before, became an intriguing thought in the minds of many scientists of that time.

1672

OTTO VON GUERICKE, German burgomaster of Magdeburg. Famous for the “Magdeburg experiment” with which he proved atmospheric pressure and entertaining principle. Built an “electric” generating device of a globe of sulphur mounted on an axle and turned by a crank. The globe was rubbed by the dry palm of the hand, as it rotated and, after some little friction, the globe was sufficiently electrified to attract particles. This machine was, of course, a generator only of static electricity, not current electricity which we now use. While experimenting with this device, he discovered that the particles after they had been attracted, would in a

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short while be repelled. At this time we know that the particles assumed a like charge to that of the sulphur ball and, when this condition occurred, the particles were repelled because "like charges repel each other." But the poor burgomaster was laying the foundation for our knowledge by chasing a repelled feather around the room with a heavy globe of sulphur in his arms. In his pursuit of the feather, he noticed that the feather was repelled by a lit candle on the table, and then "felt back to a sulphur globe as a sort of a guard." Von Guericke attributed human attributes to a feather when, in reality, he had observed the fact of electronic emission without knowing it; nearly three more centuries elapsed before anyone knew more about this phenomenon. What really had happened to the feather was that its charge was disturbed and then changed by the electron stream from the candle and, consequently, was now attracted to the globe which had repelled it before. His experiments resulted in further discoveries but, as with all pioneering work performed with little or no background, satisfactory explanations for some of the phenomena he encountered were not available. He heard and saw the tiny discharges which resulted when he generated static electricity with his globe, but he didn't associate it with lightning and thunder. That discovery was to wait until Franklin's experiment with the kite.

1729

Stephen Gray, Englishman. By experimenting with charged bodies, Gray discovered the effect and the differences of what we now know to be conductors and insulators. As regards conveying or transmitting charged impulses. About this same time, Dufay, a Frenchman, conducted similar experiments but along more elaborate lines. He, evidently, was versed in Gray's accomplishments because his work seemed to be in the nature of proving or disproving Gray's discoveries. In the course of his experiments he found that metal wires or wet objects were the best conductors, though the most difficult to electrify, while those easiest to electrify were the best supporters or insulators of the charged impulse. In fact, he built a line, a quarter-mile long, which consisted of a wet thread held up on glass tubes and determined that it was an excellent means of conveying a charged impulse from one end to the other. This was probably the first transmission or electric line, and consequently an important discovery.

1745

Pieter van Musschenbroek, of Leyden, Holland. Invented the Leyden jar, after discovering it in an accidental but most interesting manner. It must be remembered that the scientists of this period were still playing around with friction apparatus, since no other means for generating electricity had been discovered. Musschenbroek had the thought that electricity could be bottled or, rather, confined within a bottle so that it could be used at some later time. Whether the idea was original with him is hard to determine; since histories vary. At any rate, the idea was that, if water were placed within a bottle and then charged by means of a frictional-electric producing machine, the charge would remain in the corked or stoppered bottle because glass is a good insulating material. Pale took a hand the day Musschenbroek was conducting the experiment. He was turning the crank of the electric-producing machine, while his assistant, Cunaeus, was holding the jar with one hand and with the other trying to draw off sparks from a gun barrel. The circuit consisted of the gun barrel connected to the friction machine and also to a brass wire which entered the jar, partly filled with water. Had Cunaeus placed the jar on a table, nothing would have happened, and the condenser might have been heard of today. As it was, his hand formed one plate, the liquid in the jar the other plate and, while Musschenbroek cranked the machine, the improvised condenser eventually became charged up—and then Cunaeus must have thought the world had come to an end! The tremendous spark which resulted caused the entire charge to pass through his body—and the records have it that Cunaeus was incapacitated for two full days. Another scientist of that period, Nollet by name, heard of the experiment and, unwilling to be a subject for experiment himself, got together approximately two hundred soldiers, had them all join hands in a large circle, and then, in much the same manner as Musschenbroek and Cunaeus had done, sent a severe charge through them. The fact that they all jumped instantly and strenuously pleased him immensely, and gave him much to marvel at. Naturally both Musschenbroek and Nollet tried to figure out what had caused the effect, and it wasn't for some time that a definite conclusion was arrived at. They found that, when they placed the jar of water on a table, it would refuse to be electrified (since the other plate of the condenser was (air) and that, only when the hand was placed around the jar, could the phenomenon be repeated. But volunteers for the experiment were probably lacking; so eventually it was discovered that placing the jar over a metal plate seemed to do as well. Later on, an outside tinfoil covering was substituted with improved results, and for many years this was the actual construction of Leyden jars—the granddaddy of all condensers.

1751

Benjamin Franklin, American statesman, philosopher and, last but no means least, scientist. Practically everyone is familiar with Franklin's kite and lightning experiment—but perhaps too familiar with this phase of his work and not so well versed in his other scientific endeavors. Some of his deductions have played an important role in the development of electricity since he employed the same methodical precision and calm logic which made him famous as a statesman and philosopher. Franklin established the law of conservation of the electric charge; that there are a Positive and Negative kind of electricity; that lightning and thunder are related to the crashings and sparks obtained when electrically-charged bodies became discharged. He invented the lightning rod, to prevent the great damage done to property by lightning, and sent the suggestion to the Royal Society in London—but was ridiculed for it. His theories led to his followers' discovery that air may be substituted as the dielectric in place of glass in the construction of a Leyden jar, as well as that "like charges repel and unlike charges attract"—which is now axiomatic.
1780  **Aloisius Galvani**, Italian professor of anatomy. Up to his time, only two means for obtaining electricity were known: one by means of the frictional machine, the other from the clouds, as discovered by Franklin. Galvani (by accident, it is reported) noticed that an electrical charge applied to a dead frog's nerve would make it kick and struggle as if it were very much alive. Continuing his experiments along this line, he found that a number of frogs he had prepared and suspended on his balcony would respond to lightning flashes in similar manner and that, even before a storm, if a frog's legs happened to touch the iron part of the balcony, the twitching muscular movement would occur. Later on he determined that any two metals joined together, so that one touched a leg muscle and the other a leg nerve, would cause the muscular twitching. Galvani then reasoned that the muscle was akin to a Leyden jar, and that the electricity was a fluid which made a circuit from the muscle to the nerve, then through the metallic conductors back to the muscle again. He called the "fluid" animal electricity; but true galvanic electricity, as caused by two dissimilar metals in contact, was not recognized by Galvani who theorized that the electricity originated in the frog's leg.

1790  **Alessandro Volta**, Italian professor. Shortly after Galvani's experiments, Volta devised what we now know as the "voltaic pile," consisting of a pile of alternate zinc and copper discs (each pair of discs being separated by a moistened pasteboard disc and termed a "couple"); so that, by using quite an aggregation or large pile of discs, a distinct shock was obtained when the finger tips were placed on each end of the pile. The disadvantage of this arrangement was that, when the pasteboard discs dried out, the voltage diminished. Consequently Volta devised copper and zinc strips, joined at the ends and placed in separate jars containing a weak acid solution. Now we have the first real battery—a unit destined to be of great help to future inventors and scientists in their explorations into the realm of electricity. In honor of this discovery, Volta's name was immortalized when, later on, the volt was the name given to the unit of electrical force.

1800  **Nicholson and Carlisle**, English experimenters. Set up a voltaic pile and showed that water could be decomposed into its elements, hydrogen and oxygen, by passing an electric current through it. Known now as the electrolysis of water.

1820  **Hans Christian Oersted**, Dane. Professor at Copenhagen. For thirteen years Professor Oersted had experimented with electricity and its effects on a compass needle, having read in Benj. Franklin's reports that there was some effect and relation between the two. While lecturing to a class, Oersted had his attention called to the vibrating of a compass needle, whenever a switch was thrown which connected to a voltaic pile. After the classroom students had departed, he investigated the phenomenon—finally ascertaining that, when the compass needle was placed along the wire, there was a deflection, with the compass needle coming to a stationary position when it was across the wire. When the compass was placed above the wire, the needle turned one way, when placed under the wire it turned the other way. This was the basis for determining magnetic lines of force, and without doubt the foundation for measuring or indicating electrical instruments. In this same year, the chronicles have it, one week after Oersted made the aforementioned discovery, Andre Marie Ampere, French scientist, made the important discovery that two parallel wires carrying an electric current but free to move, attract each other if the currents travel in the same direction, and repel each other if they travel in opposite directions. Also, he determined not only that a wire carrying an electric current would attract a magnetized needle, but that the needle would also attract the wire. Today we find the unit of current, the ampere, named in his honor.

1826  **George Simon Ohm**, Bavaria. His outstanding accomplishment is the law which now bears his name: "A current flowing in any closed circuit is proportional to the force or voltage and inversely proportional to the resistance of the wire." Today we express Ohm's law simply by mathematical means, viz., \( I = \frac{V}{R} \).

1831  **Joseph Henry**, American physicist, improved the electromagnet (developed by Arago in 1820) by using silk-covered wire, which allowed the use of many layers of turns. First to employ insulated wire, which permitted him to make coil-magnets large enough to lift several pounds. The unit of inductance, the henry, is named after him.

1832-1837  **Samuel F. B. Morse**, American artist, created the electric telegraph system and conceived a "code" which permitted transmission and reception of messages. This Morse code—still used in wired telegraphy—was soon adopted for use in the earlier transmission and reception of wireless messages.

1825-1867  **Michael Faraday**, English. Since it is very difficult to assign accurately the various dates for Faraday's numerous inventions and discoveries, we herewith list the period of his activity. In 1824 Faraday became a Fellow of the Royal Institute, but his fame as a scientist had preceded this date. He died in 1867; and in the interim his discoveries were the most complete, numerous and productive of any contemporary scientist. They deal with every phase of the sciences, physics, chemistry, mechanics, electricity, and chemistry. His first explorations in the field of electricity resulted in the basic principle of the electric motor. Faraday reasoned that, if an electric current in a wire causes a magnetized needle to rotate, then a magnet should cause a wire carrying current to do likewise. He proved his reasoning by suspending a conductor, so that it could rotate between magnetic poles. He formulated the laws of magnetic induction, which finally led him to invent the first electric generator; as a matter of fact, he built many models, each time improving them. He invented the induction coil which was later improved by Ruhrkorff, a Frenchman; and also the transformer, which operated from alternating current and, consequently, did not need the
interrupter device for starting and stopping the current. In fact, Faraday discovered alternating current; and the experiment now shown in high schools, for producing electricity by plunging a bar magnet into a coil of wire, was conceived by this most brilliant of all inventors. He made a study of condensers, discovered different dielectrics that may be employed, and analyzed the relative merits of each—finally tabulating this data so that today we have the “dielectric constant” for each insulating material and can be guided accordingly. He coined many electrical terms now in use.

1865  
JAMES CLERK MAXWELL, Scottish. Elaborated mathematically what is known as the “electromagnetic theory of light”, although the thought was conceived by Faraday. This theory says that light, electric waves and magnetic waves, of varying frequency, travel in the same medium, namely—ether. Since ether permeates all matter, a current may exist in and about a conductor, but is essentially guided by it.

1865  
DR. MAHLON LOOMIS, American dentist. The inventions of the previous years in the field of electricity had brought about the electric generator, batteries, the telegraph, are lights, a trans-Atlantic cable and many other devices which were a great boon to humanity. But man is always continuously striving to improve as well as explore, and so we find Loomis, a Washington dentist, conducting experiments and applying for a patent on a method for transmitting and receiving messages whereby the earth’s atmosphere is used as one conductor. Strangely, he not only wanted to send messages as aforementioned, but also to do away with batteries or generators, since he was acquainted with the fact that the atmosphere is continuously charged with electricity. Operating on the theory that the higher the level, the greater the charge would be, Loomis sent up kites 18 miles apart, from two high mountains in West Virginia. The kites, covered with large squares of copper screen or gauge, were connected to the ground by strings within which the copper wires were enclosed. The wire from each kite string was connected to one side of a galvanometer, the other side of which Loomis held in readiness, so that he could establish a connection to a coil buried in the earth. The receiving station connection, between meter and earth coil, was always closed; and, whenever the circuit was closed at the transmitting end—wonder of all wonders—the galvanometer at the receiving station actually dipped! This and other numerous similar tests were conducted in the presence of reputable witnesses; and Loomis almost got an appropriation of $50,000 from Congress, to develop his invention.

1875  
In 1875 the microphone (or magnetic transducer, which functions optionally as an earphone) was invented by Alexander Graham Bell. About 2 years later D. E. Hughes invented the carbon microphone.

1879  
DAVID EDWARD HUGHES, English. Discovered an arrangement which consisted of a stick of wood covered with powdered copper; when placed in an electrical circuit the copper particles would cohere when a spark was made.

1885  
SIR WM. H. Preece and A. W. HEAVISIDE, Englishmen. These two gentlemen sent signals to each other over a distance of 1,000 yards. The means employed consisted of two telegraph lines parallelizing each other, with a telephone receiver in the receiving side. The telegraph signals could be clearly heard in the phone receiver, without actual connection between the two, due to what is known as induction or, in common telephone parlance, “cross-talk”.

1887-1888  
HEINRICH HERZ, German. It will be noted that the dedication of this issue of Radio-Craft to old-time radio begins for the next issue date since, in reality, Hertz’ experiments paved the way for Mareoni’s work in this field. Some prefer to call Hertz the “Father of Radio”; and that he deserves more than ordinary recognition, for his work in this field is indicated by the fact that radio waves are commonly referred to as “Hertzian waves”. Hertz first became intrigued with this problem when he studied Maxwell’s theories concerning light, magnetism and electrical waves. In an attempt to gain further data on this theory, Hertz actually set up the first spark transmitter and receiver. The transmitter consisted of a Leyden jar and a coil of wire, the ends of which were left open so that a small gap was formed. For the receiver he employed a similar coil, with gap arrangement, located in the opposite end of the room. When the Leyden jar was charged sufficiently, it discharged through the gap in the wire coil; and the oscillating waves thus generated were launched into the ether of the room, and swept across the receiving coil causing sparks to fly across the gap in the receiving coil. Hertz measured the velocity of these waves and found that they were the same as that of light, 186,000 miles per second; also measured their length and, subsequently, substantiated Maxwell’s theories.

1892  
EDOUARD BRANLY, French. Inventor of the coherer, which was later destined to play so large a part in the practical reception of wireless waves by Marconi. The coherer was not named as such until later, nor was it basically conceived by Branly, since Hughes had employed a similar device as mentioned previously. Branly, however, made the device as Marconi was to use it, consisting of a tube containing loose zinc and silver filings, and plugs to make contact to each end. Since the filings would cohere (stick together) after the first spark was received, a means of separating them for the next signal was necessary. Popoff (Russian) conceived the idea of employing the vibrator and hammer of an ordinary electric bell in the circuit of the coherer so that, almost the instant the filings cohered, the hammer would strike the tube and cause them to “decohere”.

1893  
NIKOLA TESLA, Serbian. Suggested a means of wireless communication which utilized the earth as a conductor and created stationary electrical waves on it. Invented the Tesla coil, which, in effect, created high-frequency oscillations of a broad nature (hence was in reality a broad wireless transmitter) but, since he made no effort to detect (Continued on page 642)
Pause for a few minutes and pass back over the years with a few of the famous old-timers who made radio history. Radio-Craft is proud and deeply honored to record for posterity this glowing record of hard-fought achievement.

Dr. LEE de FOREST—
Lee de Forest Laboratories

RENOVED for his discovery of the Audion,—the first 3-element tube! One of the first of American radio pioneers and manufacturers. Designed and sold many early radio stations, including radiophone types, some of them to the U.S. Navy. His pioneering work in the development of "flying" talks and other researches are also well known to many.

FIFTY years of Radio! My memories do not go back quite that far. Thank heaven, because otherwise I fear my future efforts would be too briefly curtailed—and it's a great game, this Radio, which I don't want to abandon, not for many years yet to come.

No, 37 years is all I can lay claim to—first in wireless, then in Radio experimentation, invention, and manufacturing.

My recollections of the earliest beginnings are still vivid—my first tests from the flagpole of Armour Institute to the Lakato Hotel—a half-mile; and the ecstasy of jubilation I thrilled to when those first purring signals from my single headphone entered my ear. No triumph since that day has ever excited me as did that first, primitive success.

Next the tests to the tower of the Auditorium Hotel, then to a yacht on Lake Michigan, actually sailing the horizon, and I heard the signals—"amazing, incredible"! Then came the battles in Manhattan, to persuade men of wealth that wireless telegraphy was (1) possible, (2) profitable. None, old J. P. Morgan, Geo. Westinghouse included, could be persuaded that wireless possessed potential earning powers. Believe it or not!

Came the 1903 International Yacht Races. "Sir Thomas Lipton installs de Forest Wireless on his yacht Erins." The A.P. transmitted thousands of words to my Cony Island station, and American business began slowly to realize that perhaps "we had something there". The demonstrations at the St. Louis World Exposition convinced the public—commercial wireless messages to Springfield, then Chicago—300 miles overland, an unheard-of world record! And then the U.S. Navy began to install "modern" American wireless on battleship and cruiser. T. R.'s famous trip to the Canal on the West Virginia, in constant touch with shore, even exchanging messages with Ohio's Governor Herrick, from mid-Gulf to my Cleveland station; then the Navy's 5 world-beater, 25-kw. (1) stations in the Caribbean and Porto Rico, resulting in rapid installations on most of our Atlantic coast marine.

But O.M. static in 1906 caused collapse of financiers' over-ambitious plans for overland networks; the wireless stock bubbles burst, and when the smoke subsided American wireless was owned and controlled by London.

So I began over, this time with "Radio", for words and music, not merely dots and dashes. Solely salvaged from that wireless wreck was a small glass bulb, a "wireless detector", fortunately (for me) deemed commercially worthless in comparison with the slightly less sensitive, more rugged crystals.

Using a small carbon arc in alcohol flame as my undamped-wave generator, with double or triple pancake tuner and the grid Audion detector, I was soon broadcasting phonograph music for 10 miles from a small laboratory, atop the old Parker Building—14th Avenue at 19th Street. There the 3-electrode amplifier for telephone currents was invented, destined later to twine voice networks around the globe.

November, 1907, saw Bob Evans' Fleet start around the world, every vessel carrying a radio telephone. The uncertainties of performance of the arc-transmitter, with husky carbon mike in the antenna-earth lead, rendered these early broadcast efforts abortive.

So again I retired to a laboratory for new studies, further discoveries; this time in far-off Palo Alto. There in the summer of 1912, while constructing the original Cascade Audion amplifier, for later demonstration to the Bell engineers in New York, the first "feed-back," or regenerative circuit was accidentally discovered.

One year later and Charley Logwood and I were telephoning across my Highbridge Laboratory using a small audion bulb for transmitter, another as detector, a third for amplifier to headphones. Thence grew quickly "oscillation" tubes, of 25, 50, 100 watts—grid modulated; and actual broadcasting—with Election Returns in November, 1916—4 years before WWJ and KDKA, and nightly or thrice-weekly programs, until the War stopped everything.

The post-war growth, from 1919 to today, is history familiar to most of your readers. But those earlier struggles, disappointments, defeats, ultimate triumphs—their memories are cherished by but a few veterans and pioneers, in numbers steadily, sadly diminishing—annals which now make pleasant recollection.

DAVID SARNOFF—
Pres., Radio Corporation of America

WHO, in the radio industry, has not at some time heard of David Sarnoff and the "Horatio Alger"-like story of his success? From lonely wireless operator in 1915, to president of the Radio Corporation of America; that interlude has been full of successful incidents that now make this man an outstanding figure in radio, and in the business world.

In 1888 an American author, Edward Bellamy, published a novel entitled "Looking Backward." It became a best-seller, was published in many editions and translated into many languages. The author pictured a Utopian world of the year 2000, where, among other miraculous advantages, one might summon beautiful music into one's home merely by turning an electric switch.
Of Old-Timers

Albeit many of these lines are whimsical, none-the-less, reading between them we see years of disappointment and disillusion that only the indomitable spirit of the pioneer was able to surmount. Radio’s spirit of yesteryear carries on!

In 1888 Heinrich Hertz was probably too busy experimenting with an electric spark and a loop of wire to read “Looking Backward.” In any case it may never have occurred to him that there could be any association between his experiments and the early fulfillment of Bellamy’s dream. Nor could he have believed that the work he was doing would make possible instant communication between all nations, would promote human safety on land, at sea, and in the air; and would help bring not only music but news, education, drama, and comedy into the home.

Although radio as we know it today has been a half-century in the making, its most spectacular progress has occurred only within the past 15 years. As radio has gained momentum its forward speed has been constantly accelerated.

Prominent among the accomplishments of the recent past are the automatic SOS radio alarm, which insures reception of distress calls at sea; the improved application of radio technique to recorded music, and to motion picture films; the widespread development of automatic tuning; the development of shortwave technique to permit broadcast programs of all nations to be heard around the world.

Radio, the pioneer, continues to scan far horizons. Television is steadily progressing toward the ultimate goal of a useful public service. Recent outstanding television advances have included the development of more sensitive iconsopes, and of larger kinescopes, presenting black-and-white instead of tinted pictures; the projection of television pictures onto a 3 x 4 ft. screen; the successful transition from 344- to 411-line scanning; and the development of a mobile truck-unit for outside program pick-ups.

There is only one thing certain about the future of radio, and that is the certainty of fresh surprises. If, in 1938, another Bellamy should write another “Looking Backward” his imagination would be unequal to the task of predicting the ultimate results of the simple findings of Hertz and their application by Marconi. They are beyond human calculation. Radio has only started.

Dr. FRANK CONRAD—
Assistant Chief Engineer, Westinghouse Elec. & Mfg. Co.

Among the many incidents associated with radio broadcast I recall, none remains clearer in mind than a demonstration of short-wave transmission between our station at East Pittsburgh, Pa., and London, England, made before delegates to an International Radio Conference held in 1922.

Misconception as to the efficacy of the short-wave band for distance transmission was wide-spread at the time due to the well-known skip-distance phenomenon of ultra-high-frequency, whereby they tended to fade out a short distance from the station only to come in strong again at points far removed.

For several years, those with whom I associated had been conducting tests with short waves and were familiar with the characteristics of such transmission, finally concluding that it would be an excellent medium for trans-oceanic operations.

In 1922, I carried a short-wave set with me to London, keeping in touch with our Pittsburgh radio station while on board ship.

At the conference, the question of short waves was discussed and some questions were raised as to their ever being of any value in radio.

One night, we invited a number of delegates to my hotel room and using the short-wave receiver, with a brief length of wire tossed out the window, listened to Pittsburgh. By cable, I had arranged for a complete program to be sent from our Station W8XX. The announcer in Pittsburgh, probably thinking to bring us up to date with the news, read not only the entire front page of a Pittsburgh newspaper but also several other columns inside.

The listening radio delegates heard not only their first trans-Atlantic short-wave transmission but also the greatest number of words sent over the ocean by radio up to that time.

The incident was widely discussed at the conference and the short-wave band given due importance in the consideration of future radio requirements. Now, of course, the short-wave band is used widely in radio transmissions and will continue to be the part of the radio spectrum from which new channels for radio use will be drawn.

POWEL CROSLEY, JR.—
Pres., The Crosley Radio Corp.

Pioneer manufacturer of radio receivers and parts, and now President of one of the largest radio set companies and largest radio broadcast station in the world. His vision and faith in the future of radio are well illustrated by the progress and success of his company, since the days when he first made the “Pup” I-tube set, and tube-type condenser.

Y ou ask me to reminisce a bit about radio. So here goes. Perhaps you have heard how my son, then 2 years old, came to me back in 1929, wanting me to buy him a wireless outfit. I did—a little crystal detector affair. That is how the whole thing started. Now, son is Vice-President in direct charge of our radio division. In the meantime, we have built several million radio sets.

Then again I look back to our first broadcasting station...
- a little 20-watter — upstairs in a room housing a billiard table that I used as a laboratory in the early days of radio. The call letters were SCR. It was an amateur radio television transmitter. At odd times I used to put phonograph records on. One day with the wind blowing in the right direction I received an acknowledgement card from Lima, Ohio, 100 miles away. Marvelous!

I remember when a radio club in Cincinnati got after us pretty hard for using super-power — 50 watts. There have been similar repercussions down through the years in pioneering 5,000, 50,000, and 500,000 watts. But I still say that a lot of people have been able to enjoy better radio reception in remote parts of the country as a result of such pioneering.

I look back upon the day when we first carried on 2-way communication with WLW hook-in with an airplane in the sky, directing its course to the location of our transmitter then at Harrison, Ohio. I remember the chap who came into my office with the idea of buying a “Jenny” plane. He wanted to paint our trade-name on the lower side of the wings. I thought I had a better idea — load the ship with a receiving set and powerful loudspeaker; transmit by radio to the plane and let it talk back to the ground. So we tried it and it worked. That was a long time ago as time goes in radio.

I could go on enumerating hundreds of little incidents throughout the past 16 or 17 years, but one series of incidents that stands out very pleasantly in my mind has been the meetings from time to time with you, Hugo Gernsback. While our paths have not crossed frequently recently, I read your stuff regularly and admire the inventive vision of your brain. How many things have come true that you have predicted?

Dr. ALFRED N. GOLDSMITH —
Consulting Industrial Engineer

ONE-THIRD of a century is not much in the life of nations but it is a long time in the history of radio. At the beginning of the 20th century the “other” was practically undisturbed. Except for lightning storms and occasional X-ray outfits all was quiet on the electrical front.

The radio amateur or professional of those days needed a lot of patience. To build apparatus that would work, he required infinite tenacity together with outstanding detective ability. People who knew anything about radio (or "wireless" as it was then called) kept their dark secrets to themselves. Accordingly it was necessary to extract the facts by force or guile.

I can recall building a portable coherer receiving outfit in those days. It was carried to the homes of my friends, and aerial wires were lowered out of windows or thrown across roofs. Then began a long vigil in each case. After anything from 10 minutes to several hours, the radio telegraph signals from some ship in the harbor would gladden expectant ears. The reaction of my hosts varied, but was generally either amazement, incredulity, or else a slight doubt as to the genuineness of the actual reception. Messages were few and far between and tuning, as we now know it, played little part in those days of “high-decrement waves”.

Later, radio telephony began to be of interest. One of my friends, an eminent radio engineer since deceased, had a small arc telephone transmitter installed in lower Manhattan. He visited my laboratory to pick up the signals on a simple crystal receiving set, vacuum-tube amplifiers being unavailable in those days. The tests were carried out in the silence of night in a quiet neighborhood. The headset telephones were closely clamped to the ears of the expectant listener. Then the telephone cords were held away from the table and equipment by his companion, because even the slightest scratching sound of a telephone cord rubbing against any obstacle would have been sufficient to drown out the excessively feeble telephone signals which could then be received over even a few miles distance!! Such was radio telephony before power output tubes and efficient loudspeakers.

Less than 10 years later it was possible to put many hundreds of watts of speech-modulated energy on the air. A radio telephone transmitter which I had in operation more than 20 years ago, working around 1,700 meters, was received in the mid-West on midnight tests by an eminent university professor who was also a radio expert. This gentleman later became one of the leaders in the field and a high officer in the communication service of the United States. At midnight he would send me, after each test, a wire telegram telling me of the results — after which I would go to the local telephone office near my laboratory and wait for the telegram to arrive (there having been no messenger boys available at 1 o’clock in the morning in outlying districts in those days).

Altogether, radio was a rough and ready field one-third of a century ago but it was full of interest, new things happened frequently, and all radio men were enthusiasts. Indeed they had to be enthusiasts to stay in a field which most sober business people regarded as related to mesmerism, hypnotism, or some other exotic "ism". Now radio is respectable and occasionally even solid. But fortunately the new arts of radio centering about the ultra-high-frequency waves, facsimile, and television will provide both the headaches and the stimulations which will make radio interesting and worth-while as a career in the future.

ELLERY W. STONE —
Vice-President, All America Cables, Inc.

PROMINENT radio engineer and consultant in the old days when radio was booming. Some of the Pacific coast radio amateurs and wireless "ops" will remember him as their inspector (San Francisco district) between 1914 and 1917. His book, "Elements of Radio Telegraphy", served as the text for many student operators and amateurs of those early days.

I REMEMBER when Modern Electrics was my engineering guide and its companion enterprise — the Electro Importing Company, generally known as the E. I. Co. to
the "aficionados"—was my only source of radio equipment other than that which Modern Electrics taught me to build.

As a boy in high school, radio was my first hobby. After 30 years of it, it is still as fascinating. In the old days, the hobby end of it was as a "ham" operator. Today, the telephone end of it is my daily job and the hobby end of my radio interest has drifted over into high-fidelity reproduction of music—radio and phonograph. But once a radio man—always a radio man.

So I remember when my first detector was a carbon and needle. Then I went to a crystal and graduated through carborundum, silicon and galena to reach finally in 1913 the dizzy heights of the de Forest audion—the low-vacuum type with the grid wire and the red plate wire, and the candelabra-base connection for the filament.

But in the course of my detector experiments, I should not omit reference to one experiment in the field of the electrolytic—and finance. Wollaston wire in San Francisco was only obtainable at a dealer's on lower Market Street—a six-inch length. Shipments were received irregularly from the East. So one day, some of the local hams pulled a "Black Friday" on the rest of the fraternity and cornered the local Wollaston market. It probably cost us all of $3.75 but the pool sold out at 100% profit.

One of our number was really fired with genius. When the de Forest audions first made their appearance on the Coast, along about 1913, he noticed that in the cold morning hours, his detector was never as sensitive as it was when he had gotten his "shack" heated. He discovered that his audion was a little on the hard side and the warming of the surrounding air cooled enough gas molecules from the inner side of the glass envelope, or perhaps the metal electrodes, to lower the vacuum to the optimum point for maximum sensitivity. Therefore, a local glass blower pumped each of our audions just past the critical stage, and we operated them suspended downward inside bulbs of oil, and with a Bunsen burner brought them to—maintained them at—a degree of sensitivity which made our DX records the envy of the less erudite hams of our acquaintance.

Next I followed the use of a U-shaped magnet around the outside of the audion for so directing the ionic (or electronic?) stream within the electrode field as to secure still greater sensitivity. I think I contributed a monograph in this field of "research" to Modern Electrics in 1914. I know that when the War came, and I packed up to join the Navy, the old magnet went with me and saw active duty at NPL to the astonishment of some hard-boiled sailors who wouldn't believe what it could do for a weak signal until I showed them.

Those were the days before amplifiers we had to extract the last ounce out of the incoming signal—when poor or careless engineering couldn't be compensated for by just adding another tube. Litz wire in receivers and high-impedance Brandes "cans" helped, but many were the schemes we tried, to get out that "last drop."

Now we fight for straight-line performance, ±0.5-db. from 30 to 16,000 cycles. The thrill of music of the great masters has replaced the thrill of the faint whisper of a 240-cycle note in the 'phones. Today, we fight acoustics and control line cut-off and long-line phase distortion, when formerly we fought static and interference from a "rock-crusher" a few miles away. It's still the same old game but perhaps just a little less selfish; for in the old days only the ham of the family got the thrill; today, the entire family can respond to Wagner or to Beethoven—to both under the incomparable Toscanini.

Of Old-Cimers

ROBERT H. MARRIOTT—
Consulting Engineer

FORTY years ago, Robert H. Marriott became interested in "wireless," studied it, and experimented with Hertz equipment. In order to send and receive, he developed automatic recording apparatus. He recalls the first commercial receiver, early news transmissions and police alarms. Mr. Marriott was the first President of the I.R.E.; is now a consulting engineer.

AMONG the many who are entitled to credit for radio, Heinrich Hertz seemingly has not received enough. Hertz was the first to take up the Maxwell theory and from that theory to set about designing, building and operating the devices that would demonstrate radio transmission, reception, waves, wavelengths, frequencies, tuning, reflection and refraction.

Following the publicity about Marconi in the Spring of 1897, I asked Ohio State University how I could study wireless. They advised me to take the General Science Course—majoring in Physics and specializing in wireless—which is what I did from 1897 to 1901. The Hertz radio equipment was what I used first and I understood it had been there for several years. I presume that there were copies and modified copies of the Hertz radio equipment in many colleges, in increasing numbers, after the Hertz 1887 disclosures.

Hertz transmitters and receivers were made small enough to be used in either the horizontal or vertical position with reflectors and lenses on lecture tables before classes, with the transmitter and receiver on the same table. The radio frequencies with Hertz apparatus, between 1887 and 1887, probably averaged around 350 megacycles.

From 1897 on, radio expanded beyond the walls of college physics laboratories. The antennas became higher, the frequency of the powers increased; home reception was made possible; detectors became more sensitive and the communication distances became longer. Maxwell-Hertz radio that had been academic for several years was trying to become commercial with Marconi and others. However the publicity about Marconi did not cause a general stampede to the radio field. No fellow student would take up radio with me, therefore, when I passed from operating the apparatus where both the key and detector were within reach to longer ranges, I had to arrange the transmitter to be keyed by a clock and include a tape recorder in the portable receiver!

The X-ray also began to be a commercial product in about 1897. Induction coils (later to be popularly referred to as "spark-coils") that were made for X-ray were also used for radio. The first factory-made radio receiver for experimental and private use, that I saw, was purchased during the academic year 1899-1900 by Ohio State University from the J. H. Bunnell Company and was made by the United States Electrical Supply Company, both of New York.

Disbelief in radio was common and persistent. In 1902 newspapers published test messages which they had sent over the Catalina Island to the California mainland radio circuit, a famous physician was obtained quickly by radio for an Avalon guest and the result of the Jeffries-Fitz-
McMURDO SILVER—
Pres., McMurdor Silver Corp.

IN this, the 50-year JUBILEE NUMBER of Radio-Craft, the writer is somewhat amazed to realize that he can actually look back over an active 26 out of this total of 50 years.

Very well does he recall his introduction to wireless in 1912; his first and fruitless attempts to build a spark coil, and his final reasonably successful attempts to build a single-slide tuning coil and crystal detector.

"Much water has flowed under the bridge" and it is almost impossible to project oneself back a quarter of a century and then try and look forward at radio. It seems equally difficult to attempt today to look forward another quarter- or half-century.

The writer distinctively recalls his first thrill at finally hearing POZ with a "1-lung" (only one filament still burning) audion bulb, flanked by a Bunsen burner and an old telephone magnet to increase its sensitivity; and the difficulty he had in keeping untangled from what seemed endless lengths of cardboard carpet-tubing, for the winding of which the local electric shop had given its last inch of No. 36 S.C.C. copper wire.

Equally thrilling was the occasion in the fall of 1914 when Hobart College played against Cornell's football team at Ithaca, actually won and no one in Geneva, New York, knew this because a storm had cut off telephone and telegraph communication. For the first time the villagers appreciated amateur wireless activities, for despite the elements, news of the triumphal victory was brought in over a Colby tuner and the same 1-lung audion bulb.

The memory of almost any engineer will yield innumerable anecdotes and one man's reminiscences would almost fill this whole magazine, so the writer will sign off with only one more.

In either 1920 or 1921, the Aurora Borealis was visible early one evening in New York City. On that evening, he had gone to help a brother amateur get his VT-2 tube to oscillating in one of the new fangled tube transmitters, on Broad Street, Newark. Arriving before dinner was over, the writer fired up the rig alone and was delighted indeed to see the old G.R. "hot-wire" ammeter climbing slowly from the hoped for 1/10-ampere to all of 1 1/4 amperes. Looking over the rig and out of the window, he saw the Northern Lights in the sky over the Hudson. Promptly shutting off the power, he was amazed to notice the ammeter slowly climbing to an ampere-and-a-half, and even more slowly drop to zero. Needless to say, experiments were discontinued that evening.

What will come in the next 50 years—maybe television?

ISIDOR GOLDBERG—
Pres., Pilot Radio Corp.

WHEN I received your letter of recent date informing me of your JUBILEE SOUVENIR NUMBER, it carried me back to the days when you and I became associated in 1908 in the manufacture of wireless apparatus.

Those were the days of the sliding tube condenser, ball-bearing tuning coil, coherer detectors, electrolytic detectors and the inevitable cat's-whiskers. Well do I remember the 1-, 2-, 3- and 6-inch spark coils, each weighing it seemed to me about a ton apiece, being sold as rapidly to the experimenters of that time as tubes are now being sold to Service Men. Every inch of spark coil power meant 5 miles of transmission and how desperately anxious all the boys were to accumulate enough to get larger and larger spark coils. Now you know why Pilot Radio claims 29 years' experience in the Radio Art.

I want to go on record as saying that I don't think credit enough has been given you by the radio industry for the pioneering work you have done in the Art. You are responsible for the vast number of experimenters in the wireless field and without them, we wouldn't have the radio developments which we have today.

May you continue your good work for many years to come; I wish you continued success.

ARTHUR A. HEBERT, WIES—
Treasurer, The American Relay League

THE treasurer of the American Relay League, Arthur H. Hebert, has been an amateur since 1902. His first real transmitter was built at the old E. I. Co., and operated under the call AH before Federal licensing provisions went into effect. Mr. Hebert has operated 22H and 3MP in addition to his present WIES. As an amateur, he is a firm believer in "ham" communications.

IT is just 35 years ago that I, as a young railroad telegrapher, in Providence, Rhode Island, became infected with the "wireless bug" while trying to make a coherer...
"decohere" and enable one to receive wireless signals from the Massie Wireless station in that city.—and the bug has never left me.

Shortly thereafter, I accepted a position in New York City, and our four-leafed spirits, but the business of making a living put a damper on much activity, but enabled one, nonetheless, to browse about steamship piers, "DF" at Manhattan Beach, "WA" at Waldorf-Astoria Hotel (the famous Col. Wilson's stock station) and other commercial stations, becoming acquainted with the "wireless operators", which kept the interest alive until 1908 when a momentous decision was made of acquiring a real transmitter.

What a thrill while walking through Fulton St. during the noon hour in picking up a little magazine named Modern Electrics to discover after reading a few pages that there actually was a store in New York City where "wireless" parts could be bought. The desire to see the place that same noon could not be resisted and on we walked through Fulton, Greenwich and West Broadway, and there on the 2nd floor of an old building we met for the first time, the Father of Amateur Radio, Hugo Gernsback, the publisher of Modern Electrics and the owner, if memory fails not, of the famous E. I. Co.; and at the same time it was my pleasure of meeting Victor Laughter, author of a book on wireless. The amateur spirit was there as we have it today and what a "talkfest" we had—it resulted in my parting with a $20 bill and leaving the place 2 hours later with a 1-inch spark coil, a 1-slide "tuner" guaranteed to receive 1,000 miles—it had 1,000 turns of black and white wound wire on it—, and a pair of headphones which we still have.

During the next 3 years we find ourselves "puttering" and feeling very much discouraged because the "Molybdenum" detector would not bring in signals; the "Electrolytic" detector "ate up" the "Wollaston" wire at the rate of almost 1 inch per hour and as this wire cost us $1 per inch, it became too much of a luxury. But when we discovered a source of supply where we could buy Galena at 25 cents per pound, there was a silver lining in our radio world.

The detectors made with galena were so good and sensitive we found ourselves in the position of being able to copy the Navy Yards all along the Atlantic Coast and, many times, have intercepted messages which Navy and commercial operators had difficulty in receiving. In that manner our circle of friends amongst the wireless operators grew, but once in a while irritation would develop, particularly when our 1-kw. spark transmitter caused interference and we were asked to "stand-by", but it had to be done politely; otherwise the poor Navy, ship or land station operators were in hard luck as our signals were stronger than theirs.

When the laws of 1912 were passed by Congress, and the administration placed with the Bureau of Navigation, Dept. of Commerce, station and operator licenses became obligations. The old "TH" call changed to "2HH", after the way to "2MH" and as such was as well known as WIES has been since 1923 when we moved to the first call area.

With the advent of government supervision rapid changes took place and Amateur Radio—through the efforts of the American Radio Relay League, founded in Hartford in early 1911, by the famous inventor and amateur, the late Hiram Percy Maxim—made astounding progress in the field of communication and experiment.

Whom do we find prominently connected with the radio industry today but the men who were radio amateurs 20 or more years ago? Amateur radio is still the great training school. The memory of today is the prophecy of tomorrow.

The story of amateur radio is one of service to the government and to communities in time of disasters.

The early pioneers deserve great credit for developing a "hobby" which is the admiration of the world, and where it may lead to, with television just around the corner, I shall leave to the prophecy of Mr. Hugo Gernsback, whose many editorials have been so far ahead of the times.

WILLIAM H. PRIESS—
Pro., International Television Radio Corp.

PRIESS' work on the development of reflex receivers, while with Kolster and when manufacturing sets under his own name, is well known to many old-timers. His more recent work in television, described in recent issues of Radio-Craft magazine, is receiving outstanding and popular. His reminiscence has exceptional value. (Photo is from a painting by M. Kuskel.)

The summer of 1911 found me working in the electrical and blackface gang at the old Waldorf-Astoria. A job requiring a strong back.

Tesla, the Montezuma genius of Mephistophelian get-up lived on the 11th floor. This man with his induction motor created the alternating current industry, and dreamed of the Earth as you and I would of an apple, which he would activate from a central point to drive ships and trains, give light and heat everywhere without wires. He played with millions of volts and made property cheap in the vicinity of his laboratory. He gave us the multiple spark-gap, and Tesla transformer. His roast was generally avoided by us all, and we tip-toed by it as a youngster by a graveyard at night. On the roof of the Waldorf, a wireless station crackled messages to the ships at sea.

Marriott, of the old United Wireless, the grand-daddy of the Federal Communications Commission field service. I recall my pride in carrying his wavemeter, Braun hot-wire ammeter and voltmeter, in 1912 on ship inspections. Can you remember the racket and the roar of the early commercial wireless sets doing their job at an efficiency of one-half of one per cent? Do you remember the Fleming Cyclometer?

Bucher, teaching the Marconi School, in a dismal loft at this time. We two aimed at writing a correspondence school course on wireless, with directions for using the keen stuff Electro Importing Co. was offering. The talented Bucher became the first sales manager for the RCA and later its Vice-President.

Shoemaker, with the largest cud of tobacco ever carried in the mouth of a white man, performing tricks with link circuits. The old-Timers remember how he planned a reserve flag wig-wag system to make sure there would be no slip in the advertised first wireless reporting of the America's Cup Yacht Races.

Austin, his mastery of meter and buzzer, and his range data established by the cruise of the Salem and the Birmingham.

Pickard, the cultured, the foremost scholar of the business and a veritable walking engineering encyclopedia, also an aspirant for wireless cup-race honors. He is of the crystal detector and L.P.76 receiver fame. Have him show you the repellant picture, taken 50 years ago, he has of himself, loitering in a box on his reporting tug, bearded and as condescending in appearance as a tramp on a hand-out line.

Sarnoff, pounding brass in a two-by-four station on top of Wanamakers. Now President of RCA.

Goldsmith, teaching radio and hanging out the Proceedings.
In times of stress, when all other means of communications fail through the action of fire, flood or storm, the radio amateurs come through! Everyone knows of their sensational achievements in recent years. Yet hardly a person.

It was in 1908," says Clinton B. De Soto, in a book published by the A.R.R.L., "that Hugo Gernsback, a clever Belgian promoter, manufacturer and shopkeeper on Fulton Street in New York City... began the publication of the magazine Modern Electrics... The contents... soon became predominantly radio in character."

A little farther on, Mr. De Soto continues, "The Wireless Association of America was a child of Hugo Gernsback, publisher of Modern Electrics. In early 1910 the first Wireless Blue Book of the Association appeared, dated 1909. It listed 96 U.S. amateur stations... together with the call letters used, wavelength in meters and spark-length of the induction coil..."

To Mr. Gernsback, thus, may be attributed the development and organization of amateur radio, in a great degree. Without his foresight and friendly interest, it is highly doubtful that the "hams," as the amateurs call themselves, would ever have reached their present high degree of development. His early publication of a magazine devoted to wireless and scientific amateurs stimulated and encouraged the youths to interest themselves in fascinating and intellectual pastimes; later his fostering of the "amateur association" movement resulted in an organization destined to play no small part in the growth of amateur radio.

Amateur radio may be said to have received its first impetus when the late Guglielmo Marconi, then a young Italian experimenter, received 3 dots sent across the Atlantic Ocean on December 12, 1901. The apparatus he used was crude, and amateur scientists, inspired by his achievement, built similar set-ups and proceeded to try their hands at sending and receiving.

There were no licenses required in those early days. The sole requirement for amateur radio activities was the equipment. If one could afford to buy the parts and had the skill to use them, he could go on the air, using any frequency or power his heart desired. Sometimes his heart desired a frequency adjacent to one used by the Navy, or commercial wireless companies, after these had come into existence. If so, it was just too bad, for the amateur was under no obligation to shut down his service or shift his wavelength if he was interfering with other communications; it was a matter left to his own discretion. This condition held from the beginnings of radio until August 17, 1912, when President Taft signed an act to regulate radio.

Although 28 bills to regulate radio had been introduced in Congress during the preceding 10 years, this was the first to affect the amateurs—and affect them it did! It made licensing mandatory.

*Mr. Gernsback is a native of the Grand Duchy of Luxembourg, not Belgium. He is now editor and publisher of Radio-Craft and other magazines.
AMATEUR RADIO

knows of the amateurs' less spectacular but equally important contributions to radio. The annual Paley Amateur Award (shown at right) is presented to the amateur who "has contributed most usefully to the American people".

for all operators, including the amateurs, whom it banished to the limbo of the lower wavelengths, then considered useless for long-distance transmission. It regulated their transmission to 200 meters or less, their transformer input to a maximum of 1 kilowatt.

Amateurs immediately began applying for licenses, and by the end of the year approximately a thousand had secured theirs. Another year saw another thousand licensed amateurs, and by the middle of 1914, more than 5,000 were licensed. It is estimated that an equal number of stations were operating without licenses, on the old theory that "to err is human; to get caught is crime." Even the licensed hams did not permit their activities to be circumscribed by the law. If they felt like operating on 300 or 350 meters, they did so, and if the signals did not get out well enough with 1 kilowatt input, they doubled or trebled the power.

Still the amateurs craved distance communications, and in 1912 Edwin H. Armstrong, 22-year-old ham, played around with a de Forest audion and made regeneration work. De Forest had discovered regeneration a year before, but had not as yet put in a patent claim for it. To this principle, many trace the use of oscillating tube circuits for both transmission and reception.

In March the following year, the amateurs established the tradition that hams have carried on ever since—that they can be depended upon to "come through" in times of emergency. Amateur stations throughout the country, and especially those at the University of Michigan and Ohio State University, carried on communications for a large section of the mid-West when all other forms of communication were rendered inoperative by severe storms.

During all these years there had been many radio clubs throughout the country, and in 1914 Hiram Percy Maxim, president of a Hartford (Conn.) radio club, wanted to send a message to another amateur who was beyond the range of his transmitter. So he called another amateur who was nearer and had him relay the message. Though message relays had often been conducted before, this was the first time that they had given anyone a really new idea. The idea was for the establishment of the American Radio Relay League, the first steps toward which were taken on April 6, 1914. By September it had 237 member stations in 32 states and Canada, paying no dues save in enthusiasm. In early 1915, the League—the A.R.R.L.—separated from the Hartford club and was legally incorporated as a separate organization. The first official A.R.R.L. magazine was published in December of that year.

The war had broken out in Europe, in the meantime, and the

(Continued on page 618)
If you want to go back for a survey of the earliest radio parts, you will have to refer to the work of a Washington, D.C., dentist, Dr. Mahlon Loomis, who used such items as kites, copper-screen antennas and galvanometers to send signals a distance of 18 miles—in 1899! Later he turned his thoughts to a buzzer and a spark-gap, which were to be actuated by the difference in potential between the earth and the higher atmosphere, where the kite held the antenna aloft. There is no record that he ever performed this latter experiment.

The open rings used by Heinrich Hertz in 1887-88—a low-value inductance in series with an air gap—to demonstrate the transference of energy from a circuit in which a spark was produced, might be termed another form of early radio part. But that likewise antedates broadcasting, as we know it, by so much that it may be considered the Stone Age of Radio.

EARLY TYPES OF RADIO COMPONENTS

More recent are the electrolytic detector and the coherer. Although the latter has been traced back as far as 1835, it was not usable until the de-coherer (a tapper similar to an electric bell) was invented to jar the filings in the tube, apart after they had been caused to cohere (stick together) by the incoming signal. Marconi patented the coherer, which Sir Oliver Lodge had suggested as a possible radio device a few years earlier, in 1894. The de-coherer in its usable form was introduced in '96. These devices co-existed for

some time with the electrolytic detector, until 1907, although the electrolytic detector was the more popular of the two because of its greater stability and efficiency. The Fleming 2-element rectifier, invented in 1904, which we call the Fleming valve, while a revolutionary improvement and destined to be the basis for a still more remarkable achievement in radio, was never popularly used for the reason that the "diode" was too insensitive to weak impulses.

Pickard’s invention of the crystal detector, in 1907, was a great step forward in this direction, since it provided a very simple and economical detector which was the most efficient of all until the "triode" was made commercially available. The crystal detector was popular from the year it was discovered until 1924, for it permitted the construction of simple, practical and economical receivers. Many various metal ores were employed in this type of detector, some of which were carbonadium, galena, silicon, iron pyrites, copper pyrites and zincite. The coarser the grain of the crystal, the better it was supposed to act as a detector. Some manufacturers went so far as to produce a detector with a multiple number of crystal cups, so that any one might be rotated into position and the cat whisker placed in contact thereto in quick order.

About that time, primitive inductances were made. These were simply long coils of wire, with two sets of taps. The first 10 turns were each tapped; every 10th turn from there on was also tapped. In this way, the experimenter could tune by cutting any number of turns into the circuit. These were still in use in the late 'teens and early 'twenties, when many listeners were still
Leyden jars. The first fixed condensers and bypass condensers, as they were classed, were heavy paper and tinfoil affairs, very bulky and crudely made as compared to present-day standards.

The method of winding them resulted in building up an inductance as well as a capacity—although the condenser manufacturer of that day would neglect this factor when specifying the condenser's value.

**Improved Parts**

Then the variocoupler began to enter the field, obsoleting the loose coupler.

This new part had the familiar tapped primary, but its secondary was mounted on a shaft and could be rotated, thus changing its coupling. A dial could be attached to the shaft, and an accurate record kept of the setting. There was quite a controversy between set builders as to whether pig-tail connections to the secondary were superior to wiping contacts. The former were favored as affording positive, noiseless connection, the latter for avoiding any stray inductance which might exist in the pig-tail itself!

The variocoupler brought in its wake the variometer—simply one coil inside the other, the two coils being connected in series. Rotating the inner coil made the combined inductance increase or decrease—and sets could be tuned without recourse to variable condensers over a limited range of frequencies. It was about 1925 when the variometer was brought to its peak as the "Phasing formers", a trade name for a device of this class using pancake (i.e., flat, spiral-wound) coils.

Coils, for that matter, were being made and sold in almost every conceivable shape. There were the solenoid coils of standard design, pancake coils, spider-web coils (wound on a form like the spokes of a wheel), honeycomb coils, toroidal coils (sometimes referred to as "doughnut" coils), binocular coils—made famous by Grebe when he used them in his commercial receivers, bank-wound coils, random-wound winding their own inductances.

Of a comparable period were the clock-spring variable condensers. These were made by mounting two strips of metal, insulated from each other, on a frame, with their other ends fastened to a shaft. Turning the shaft brought the strips closer together over a greater portion of their length, thus raising the circuit's capacity.

Another early form of variable condenser made use of mercury for its "stationary" plate, the liquid metal being sealed inside a flattened cylinder and brought into capacitative relation with a movable plate. This condenser, while novel, had the distinct disadvantage of being highly sensitive to vibration which would affect the mercury and hence the capacity which it created.

Gradually, condensers and coils were improved. The loose coupler, having a primary winding sliding within the secondary, so that coupling between the two could be varied, became popular. For certain types of sets, sliders replaced the tap switches, which were retained, however, when panels were used.

Book-type condensers, in which the angular relation of a hinged plate and a stationary plate, replaced the clock-spring condensers and the still earlier coupler.
coils and a year or two later, laminaeite coils, wound in the form of the figure 8.

THE "LOW-LOSS" ERA

Early in 1925, the industry became "loss conscious", electrically speaking. Constructors and engineers began to worry about the R.F. resistance in coils and condensers, and then on everything had to be low-loss to be acceptable. Dielectric end-plates which had supported the bearing in variable condensers were discarded, the insulation being moved to the side, where it supported the stator plates. The substitution of metal end-plates was of even further advantage, for it enabled the set builder to reduce the effects of body capacity to a minimum while tuning. One manufacturer of condensers held out to the end, advertising, "Don't be fooled by 'Low Loss' BUNK!" but the public would not heed, and condensers of the "low-loss" type are in use to this very day.

Coils, too, came in for their share of attention from the efficiency experts. The spider-web coils, stuck in position with cement, had a spell of popularity. The solenoid coils were liberally coated with similar "dope" and slipped from their winding forms, of which only vestiges were permitted to remain as terminal and mounting supports.

One manufacturer even went so far as to silver plate the primary of his 9-circuit tuner (in this case, a variocoupler with additional fixed winding to act as antenna coil!) on the assumption that the greater conductivity of this metal would improve reception. Some users reported that it did!

Shortly after the "low-loss" era, began the period of condenser plate curvature improvement. Variable condensers of the inter-meshing type as first designed were of the "straight-line capacity" variety. With the ever increasing number of broadcast stations, it was found that on the lower wavelengths many stations were crowded into a narrow range of the tuning dial and spread too far out on the higher wavelengths.

To correct this the straight-line wavelength condensers were brought out, this curve being obtained by elongating the shape of the plates a bit. While the new condenser somewhat corrected the condition of crowded tuning on the low-wavelength end of the dial, it wasn't completely satisfactory for the reason that broadcast stations were being assigned wavelengths on a 10 kc-separation frequency basis.

Hence, to get equal frequency changes over the entire tuning range of the dial, the tuning condenser had to have a straight-line frequency curve—which resulted in an era of almost elliptically-shaped condensers, known as straight-line frequency condensers. One of the first and most ingenious of these was the "square law" condenser designed by Clyde J. Fitch; its triangular plates were meshed, point first, by means of an ingenious screw-thread gear system and 360° dial.

However, some manufacturers saw an opportunity to cash-
in on the fact that many thousands of variable condensers of
the older style were already in use, or else available at
such low prices, and figured that some device was necessary
to give straight-line frequency tuning with old-type variable
condensers,—and so was born the straight-line frequency
dial. It consisted of nothing more than an eccentric-shape
disc driven by a smaller disc by friction, so that slow vernier
tuning was accomplished on the lower wavelengths and
practically normal direct-drive tuning on the higher wave-
lengths.

MISCELLANEOUS PARTS

Variable resistors, too, found a ready market. Each tube,
of course, was supposed to have its own rheostat for most
efficient operation. Then vernier rheostats, some with ex-
tremely ingenious design for varying the resistance a frac-
tion of an ohm at a time, were sold. These were supplanted,
in the higher-price ranges, by compression-type rheostats,
which used piles of carbon discs or conductive powder, the
resistance being varied as a knob was screwed tighter or
looser. Subsequently it was learned that filament voltage
was not so critical, especially on the audio amplifier tubes,
and fixed, self-adjusting filament resistors, such as the
Amperite, came into general use as an effective means of
compensating the change in battery voltage between charge
and discharge.

Potentiometers were sold separately or combined in one
instrument with a rheostat,—and even grid leaks were made
variable. One of the latter, sold at a high price, was actually
hand-calibrated in megohms and fractions thereof, but was
highly hygroscopic, and its actual readings varied with
changes in weather.

All during the set-building boom, which ran from about
1922 to 1931, kits were available. Some of the earliest were
reflex kits. Later the neutrodyne was sold in kit form, the
basic essentials being matched neutroformers (coils) and
neutrodes (neutralizing condensers).

The condenser manufacturers were quick to take advan-
tage of this, and at least one was soon advertising sets of
2 and 3 individual, matched tuning condensers, the use of
which was said to make the dials "log" perfectly.

At about the same time, gauged condensers swung into
favor. Some of these used a common shaft, as at present,
but others used gearing and belts to tie together several separate
units. One popular model had plates of approximately square
shape, which were pivoted at the corners, both sets of plates
moving. In the early gaug condensers, variable trimmers
were nearly always added to afford finer tuning.

Vernier dials were another part that was popular to
achieve the same end. Geared drives, and friction drives of
various sorts were employed to secure positive action and
freedom from backlash. (One prominent make of dials even
had a sort of gearshift lever for varying the ratio.) Re-

(Continued on page 612)
Development of

Practical transmission of sound began with the inception of the telephone, hence it was within this industry that the first Microphone was developed. Credit for much of the improvement of this device, however, belongs to radio, as is told in this story. Loudspeakers, Amplifiers and Phonograph.

The first telephone was invented by an English genius in 1667, who based his work on the “bull-roarer,” an instrument still used by African witches-doctors and American sideshowmen. It consists of a can, one end of which is covered by a tightly-stretched membrane, with a cord fastened in the center. This is the device used by Robert Hooke in 1667 when he transmitted voice between two distant points. Hooke linked two of these instruments together with a goodly length of string, which, when stretched taut, permitted the vibrations of a voice striking one diaphragm to be transmitted along the cord to the other. (Sound waves are transmitted much farther through denser mediums such as cord and other solid materials than through air which is a comparatively low-density medium.)

Nearly 200 years went by before our present devices were approached. It was, in fact, 1854 when Charles Bourseul suggested that a disc, vibrated by the voice, could be used to make and break an electrical circuit to cause similar vibrations in a second diaphragm. This idea was tried by Reiss, of Frankfort, in 1860.

Another 16 years passed and in 1876 Elisha Gray, an American, invented a system which caused variations in the strength of a steady current. In the same year, Alexander Graham Bell connected two “receivers” together, so that the diaphragm of one, actuated by the human voice, generated in the pole windings a current which was adequate to cause the other receiver to operate, reproducing the vibrations.

However, the currents generated in Bell’s magnetic transmitter were too weak for use over appreciable distances, so it was supplanted by a means of modulating a constant current, thus paving the way for the microphone.

DEVELOPMENT OF THE MICROPHONE

Early laboratory models of the microphone were simply a light base, sup-
Sound Equipment

Pickups are exclusively products of the radio laboratories. Without vacuum tubes we would have had no amplifiers,—no loudspeaker reception. The crude apparatus depicted should amaze all those who are familiar with present-day developments in high-fidelity radio and sound equipment.

porting two or more carbons in light contact with each other, and in series with an electrical circuit. Thus when the base was jarred, the contact and hence the electrical resistance between the carbons varied, causing similar variations in the current flow.

Crude and insensitive as this device was, it formed the basis of the modern carbon-type microphone, which merely affords multiple instead of one or two carbon-to-carbon contacts. The single-button type consisted of a fixed carbon disc, with a diaphragm-impelled carbon disc suspended a slight fraction of an inch away from it, the space between them being filled with loosely-packed carbon granules. This microphone is sensitive, but does not cover a sufficiently wide range of audio frequencies. It was largely supplanted by the double-button “mike”, which has the diaphragm supported between two such buttons. This, while affording better tone quality, still retained many earlier defects, such as variation in its characteristics caused by changes in humidity, noisy operation (carbon noise), carbon “packing”, etc.

Soon the condenser microphone, of low power output but wide frequency response, was developed. This was a 2-plate condenser, the diaphragm composing one of the plates. It was popular in the late 1920’s. A preamplifier (usually built-in), connected between the regular amplifier and the condenser microphone, was soon added to boost the weak output. The ribbon-type or velocity microphone became popular about 1931, employing principles similar to the “magneto” microphone which Bell had used in his early experiments. Shortly after, the crystal mike made its appearance and at this time is the greatest favorite because of its relative higher output when compared with other types—excepting the carbon microphone. The dynamic mike was used many years ago, then dropped, and lately has reappeared to compete with today’s velocity and crystal units. Each have their special features and following, and are individually adaptable for special work.

A connecting link between microphones and loudspeakers (or reproducers) appeared in the June, 1912, issue of Hugo Gernsback’s Modern Electrics magazine. The output of a crystal-detector wireless receiver was fed into a single phone. On the diaphragm of this phone, and connected to a separate battery, was a small cup of mercury, touching the surface of which was a carbon rod, connected to one side of a low-impedance phone unit, the other side of which completed the battery circuit. A horn was positioned on this phone unit, to act as a loudspeaker.

DEVELOPMENT OF LOUDSPEAKERS

The first reproducers, then, were simply horns positioned correctly in relation to simple magnetic telephone units. Such horns were rather costly and for this reason radio fans were inclined to improvise sounding cham-
bers, using bowls of various sorts, to reflect and “amplify” the sound.

The main idea of a speaker was to enable a large number of persons to listen to a message or broadcast simultaneously, and simple gadgets were invented to do this without the need for speakers, as amplification was still inadequate. Among these devices were phone caps attached to a multiplicity of stethoscope tubes; plugs with terminals to permit the attachment of two or more pairs of phones; plugs incorporating switches so that phones might be connected in series or parallel; multiple binding posts (one type of which was simply a short length of coil spring), etc. However, though these served their primary purpose, they did nothing to relieve ears crushed by headphones. Therefore the search for a loudspeaker continued.

One of the earliest commercial types was merely a horn, with a place provided for attaching a headphone unit at its apex. Then came one that was “twice as good”—it had arms to hold 2 headphones. Made of aluminum, such horns sold for $10 and upward. Another manufacturer made a similar horn of papier mâché and advertised it as having “less resonance”, and sold it more cheaply. Prices gradually declined until the components were on sale in the “10-cent” stores. Numerous variations were also produced, one of which was a bowl with an arm to hold a unit at its “focal point”. Still another type attached a phone unit in place of a phonograph sound head to the tone arm of a phonograph.

But there were also deluxe speakers, two of which merit particular mention. The first, the Magnavox, because it employed the dynamic (moving coil in a magnetic field) principle upon which almost all present speakers are based. The second, the Western Electric magnetic (moving iron in a magnetic field) speaker, because it was generally sold in connection with a 2-stage audio amplifier, the basis of present-day public-address systems. In fact, it was the invention of multi-stage cascade amplifiers that made loudspeaker radio possible.

But there were other innovations in the early art of reproducers. Some of these flourished for a time, but only the dynamic speaker had a lasting influence.

There came the horn with phone unit built-in—the first real loudspeaker. Then followed the phone unit with movable pole-pieces, to adjust the air-gap between diaphragm and magnetic poles so that maximum volume and sensitivity could be obtained without diaphragm rattle on loud reproduction. There were also mica diaphragms with iron discs riveted to their centers, to improve sensitivity and tonal quality.

Then came the era of cone speakers, at first actuated by magnetic units. Cones of different sizes and shapes were in turn popular; for a time the belief existed that true fidelity could not be attained unless the cone was 3 feet in diameter. When this was proven fallacious, the field was explored further—resulting in balsa-wood, airplane-cloth and condenser-type speakers. All were based on the cone-type principle,—i. e., a large, light mass driven by a magnetic unit. The mechanisms of these cones were of the armature type, similar to those used in Baldwin phones.

Later, the cone, smaller in size, was combined with the dynamic driver—a combination which has retained its popularity ever since. Adequate response over most of the audio range is possible with this type of speaker when correctly-designed baffling is employed.

With the inception of high fidelity, however, there was a surge of interest toward crystal speakers, to be used in conjunction with reproducers of the ordinary type. Known as “tweeters”, the crystal speakers are made with small cone areas, designed to emphasize the higher end of the audio
spectrum. Many persons still believe their use essential for optimum tone.

Today, the dynamic speaker of high-fidelity design is seldom larger than 18 inches in diameter. The electromagnetic field is eliminated in many cases, especially magnetized alloy metal having been found to create a magnetic flux (or magnetomagnetic field) about as high as that obtained by electromagnetic means.

**DEVELOPMENT OF AUDIO AMPLIFIER**

The link between the detected signal and the loudspeaker is the amplifier. At first the output of the detector was fed directly into the reproducer. A little later, mechanical amplification was designed, but this was highly unsatisfactory, as judged by present standards.

Then, in the early part of 1912, de Forest with his associates Logwood and Van Ethen discovered the tremendous amplifying properties of the audion tube especially when used in 2- and 3-stage cascade (one stage after the other) amplifiers. They determined the amount of amplification (or the "amplification constant") that took place in each tube and explored the field of amplifying transformer design so as to increase this amplification. It was this work and his discoveries in this field that later interested the Bell System A.T.&T. Co., in the audition and resulted in the sale of the audion to this company.

After A.F. transformers were further improved, and radiotelephony and broadcasting started, early set builders had a problem on their hands—whether to use high-ratio audio-frequency transformers for high gain, or low-ratio ones for better tone and greater stability. Audio stages oscillated and the amplification became distorted if the much gain was sought, and a compromise had to be effected. In fact, at least one manufacturer brought out a transformer with tapped primary and secondary, so that the step-up ratio might be varied at will.

The invention of the "C" (or grid) battery circuit did much to improve amplifiers, for the use of this potential kept the grids of the audio tubes from swinging positive and causing distortion on loud signals. As mentioned in the article on old-time tubes in this issue of Radio-Craft, power tubes were another important factor in the amplifier field, but even before they came out, push-pull amplification was in use, to serve a not dissimilar end. For those who wished greater output than was possible with a single last-stage tube, yet who did not wish to incur the expense of push-pull transformers, paralleling of output tubes was employed.

Perhaps one of the greatest inventions during battery days was that of Latour, who patented the use of a single "B" or "C" battery on several stages. The more antique diagrams show a separate battery for the plate supply of each tube in a set. This patent was of particular value when eliminators and power packs came along, for it made it unnecessary to use a large number of eliminators for a multistage set.

Nor can this article conclude without mention of the Loftin-White direct-coupled amplifier, which was highly efficient when properly constructed. In it, the plate of one tube connected directly to the grid of the following tube, biasing being such that each grid was negative, each plate positive, in respect to its own filament.

Today, we have amplifiers that employ a minimum of tubes, have straight-line amplification from 20 to 15,000 cycles, extremely high power output and tremendous voltage gain, without the instability or other inefficiencies that were predominant in old-time amplifiers.

Thus has been the progress of audio reproduction. What the next step will be, only time will tell. Most recent developments have been in cabinet and (Continued on page 608)
Old-timers, who became responsible for the amazing growth of the radio set industry, took much of their inspiration and experience from the catalogs and apparatus of the famous E. I. Company which, founded in 1904, was the earliest in the field to supply wireless amateurs with their

HUGO GERNSBACK

The history of the E. I. Company really had its beginning when I was exactly 6 years old.

The entire course of my future life had its direction, probably, when my father's caretaker presented me with an electric bell, a roll of lead-covered copper wire, and an old French Léclanché wet battery. I remember quite distinctly now that the thing which captured my imagination was not so much the mysterious-looking wet battery, nor the French-made, walnut-boxed electric bell, but rather the mysterious green spark which I observed at the platinum contact points of the bell.

I also remember that this, my first introduction into the mystery of electricity, did not end there; but for many days I hooked and unhooked the battery from the bell, and later on a pushbutton was added which had been procured somewhere. From this beginning I was soon installing electric bells for friends; as, indeed, in the town where I was born—Luxembourg—there was only one electrician at the time.

(For the record, let me digress here for a moment, and state that I am neither German, French nor Belgian; though these various nationalities have been attributed to me in various newspaper and magazine articles for many years.

(The Grand Duchy of Luxembourg is a small, independent country of some 330,000 souls, sandwiched in a triangle between Germany, France and Belgium. At one time, Luxembourg was an impregnable fortress, second only to Gibraltar; in 1807 various powers [including England, France and Germany] guaranteed the neutrality of the little country if Luxembourg would raise its fortifications. This it promptly did, and this neutrality was not violated until 1914, when Germany invaded Luxembourg just before its invasion of Belgium. Luxembourg, by the way, is a bilingual country, its inhabitants speaking French and German with equal ease.)

To get back to the bells, it wasn't long before I was making quite a good deal of money by installing bells and house telephones for friends and others and, since my expenses were practically nil, everything was in profit—a condition which I have never been able to duplicate since that time.

My parents, who were well-to-do, looked upon this entire electrician business with sad misgivings, and my mother watched the proceedings with the same enthusiasm which a hen feels when she sees a duckling which she has hatched, take to the water.

Opposition, however, ever since childhood has never deterred me, and I kept on importing my electric supplies, from either Germany or France, until I acquired something of a reputation in my city.

My activity soon became known to the Mother Superior of the Carmelite Convent, a large institution occupying,

(The illustrations on this page are identified, by number, at the end of the article.)
apparatus and literature. In commemoration of 50 YEARS OF RADIO, the founder of that well-known company here gives a comprehensive story of its history which will prove of interest to old- and new-timers alike, telling as it does of the birth of a major American industry.

with my father's estate, a high plateau on the outskirts of the city of Luxembourg. I was a frequent visitor to this convent, and Mother Bodewing, the Superior, took a liking to me which was manifested by her presentation to me of various holy pictures, which I treasured highly. One day I was asked if I could provide an intercommunication system for the Carmelite nuns, from one cell to the other, so that the nuns could speak to each other when resting. The order of the Carmelites is quite rigorous; the nuns, for instance, use their coffins as beds, and wear very rough homespun sackcloth for their uniforms.

After a few consultations, a price was agreed upon, and a number of telephones and bells were to be installed in the convent. When the material arrived it was found, however, that although I was yet only 13 years old, I was still considered a man, and as such could not enter the premises of the convent. Indeed, Mother Bodewing had to get a special dispensation from Pope Leo XIII for me in order that I might enter the convent. In due time this permission arrived, and the telephone and bell system was installed. Upon the completion of the work, the Mother Superior presented me with a beautiful illuminated parchment in gold and many colors, testifying to the fact that I had, at the age of 13, installed a telephone and bell system to the satisfaction of the convent.

With the proceeds of the profits made from such telephone and bell installations I soon had assembled a creditable electrical laboratory. Since my parents did not encourage this sort of thing, I found it necessary to buy all supplies for the laboratory out of my own funds.

Not long afterwards, I learned about the "wireless" research of Marconi and, in a few days of hard work, had performed his experiments. With crude apparatus, I was able to send signals across the room with ease.

These wireless experiments, however, did not hold any great significance to me at that time, because I was much more interested in the mysteries of batteries. Indeed, most of my money was expended in making all sorts of primary batteries, and the designing of batteries which could be used for lighting homes. This was a necessity in those days, because, while the city already had an electric power plant, the district where we lived was not provided with service and, consequently, we had to be satisfied with smelly oil lamps.

It wasn't long, however, before I had electric light of my own, and had equipped our house with a number of lights also—all supplied by batteries of my own design. The stunt in those days was to find a good copper sulphate battery, a type known to give a steady stream of current without weakening, and with it charge a storage battery during the daytime; then by throwing a switch at night, light was provided. Of course, these lamps were of the miniature variety, and each gave about
1 or 2 candlepower when the storage battery was freshly charged.

All this work was, of course, done after school, and the work continued during my studies in Brussels (Belgium), as well as in a technical college in-Geill as.

After the turn of the century—at the end of 1903—while still in my teens, I decided I wanted to come to America to exploit a battery invention, because I felt that there was no opportunity in Europe for this sort of thing. The battery which I had invented was a dry-cell fashioned like a storage battery, with alternating carbon and zinc plates in parallel. The trouble with the invention was that the thin carbon plates had to be surrounded by a depolarizer and the arrangement was somewhat too fragile. This battery, which measured about 4 ins. square, and about 6 ins. high, nevertheless gave over 125 amperes on short-circuit and, under normal current consumption, ¾ volts. It was, however, found impractical in my rounds through American battery shops, because of its exceedingly high cost.

I modified the idea of my battery somewhat, and soon found a partner; so we started to manufacture ignition batteries for automobiles. This business succeeded, and would have been a success except that the depression of 1907 came along. A dry storage battery of my design which we were manufacturing at that time, although successful, could no longer be marketed during the slump, as most automobile plants had closed down. So, for the time being, the battery business ceased, and other activities took its place.

I had become acquainted with a young man named Louis A. Coggeshall, who had been a telegraph operator with the Erie Railroad Company, and I used to tell him about the wireless experiments I had made while still in knee breeches. He was much impressed with them; so, one day, I showed him a small wireless set, and he became rather enthusiastic about it. That evening we decided, right then and there, to go into business. We wrote down a number of names; but I was somewhat skeptical that we could succeed by selling just a wireless set, and suggested that it would be better to get out a small catalog and list in it a variety of electrical supplies—a number of which we could procure in Germany and France, from supply houses which I well knew from my former connections with them.

I suggested the name of the Electro Importing Company, which was later on to become famous as the first wireless company in the world. We took quarters in a small office in the top of No. 32 Park Place, in downtown New York, just a block from where the Woolworth building now stands. No. 32 Park Place still remains as it was in those days—the building stands unaltered.

One of our first investments was in a small 1 inch advertisement which we inserted in the January 13, 1906, issue of the Scientific American. A similar ad was inserted in an issue of Youth’s Companion at about that time. We were blissfully ignorant of the fact that these were, later on, to become historical as the first radio advertisements, whereby a radio set was offered for sale to the public for the first time in history.

The little set which we marketed was, of course, crude, but it worked! I had gone Marconi one better, and invented a new circuit, whereby only a single battery was used in a single circuit. Marconi always used a separate battery for the coherer circuit, and another for the decoherer circuit. I combined both circuits into one, thereby saving a battery. We applied for a patent on this circuit, but made the mistake of not employing a regular patent attorney since Mr. Coggeshall, my partner, did the regular application work himself. Many irregularities were found by the Patent Office, as to form and procedure and the application had to be sent back and forth so often that Mr. Coggeshall got discouraged, and we forgot about the whole thing.

(The illustrations on this page are identified, by number, at the end of the article.)
This wireless set which was called the Telimaco (a coined name made up from the words The Electro Importing Company) was priced at $7.50. Orders began to come in pretty rapidly, and our only trouble was that we could not fill them fast enough. One of the difficulties was in the coherer filings, a mixture of silver and iron. Mr. Coggeshall had under him the "filings department," so-called, and it was his duty to take good U. S. dimes and file them with a coarse file, catching the filings in a small cardboard box. These were then put into a glass bottle and kept there until we mixed them with iron filings in the proper proportion.

As manufacturers of the first complete wireless set, we early had a brush with the law. It seemed that some skeptical readers of the Scientific American and the Youth's Companion thought that a working $7.50 wireless set must, of necessity, be a fake; so they wrote letters to the Mayor's office in New York City demanding that we be investigated; the advertisements on their face were apparently a fraud. So, one morning, we were astonished to have a burly Irish policeman descend upon us, demanding in a bellowing gruff voice, "To be held just what sort of business was going on. Naturally, we assured him we were making a wireless set. The stalwart minion of the law bellowed in unmistakable terms that it was impossible that we could do such a thing for $7.50, and that, as a matter of fact, wireless was the most expensive thing going, and no set could be produced for less than $10,000!!

As our demonstration set was always hooked up, we asked him to take into his own hands the receiving part, which consisted of a board, not quite a foot square, on which there was a battery, coherer, decoherer and relay. The coherer was equipped with 2 mysterious looking antenna wires bent in the form of an "L". All the connecting wires were done, in the then-prevailing fashion, in beautiful spiral curlicues without which no electric apparatus was complete.

So there the cop stood in the middle of the room, balancing the receiving set in his ham-like hands. I betook myself to the end of the room where the transmitter (in the shape of a 1-in. spark coil, transmitting oscillator balls with their antenna, four dry cells and a transmitting key) was located.

I then asked the policeman to state how many times he wanted me to ring the bell of the receiver which he had in his hand.

"Four!" he growled. I depressed the key 4 times and, the bell rang 4 times in the best wireless manner of the day. The cop was nonplussed, but still couldn't believe his senses. He then asked me to vary the signals to 3; then to 6; and finally to 12. Fortunately for us, that day the receiver performed miraculously well. (It did not do so on all occasions, due to some electrical disturbances in the building; usually the elevator motor when starting, set off our receiver.)

The policeman put down the receiving set. He was plainly astonished. Yet he had had his first real wireless demonstration—the bell had rung in his own hands without any connecting wires between the transmitter and the receiver!

Let it be stated here that a New York cop is not defeated so easily. His parting words, while he backed through the door, must be recorded here for history. They may not be grammatical, but they were to the point:

"I still think youse guys is a bunch of fakers. This ad here says that you are selling a wireless machine. Well, if you do, what are all them wires for?"

The wires to which the policeman referred were, of course, the antenna wires and the connecting wires; and, technically, we must bow to his superior judgment. He was right. Our wireless set did have wires, and all radio sets continue to have them to this day.

After the first furor which our set had created, there came the inevitable slump. With the coming of summer, (Continued on page 630)

(The illustrations on this page are identified, by number, at the end of the article.)

RADIO-CRAFT for MARCH, 1938 575
Ever since the invention of communications, man's mind has played with the possibility of sending pictures—moving, living pictures—winging their way through space. Even before science had solved the basic problems of dividing each image.

ELVISION dates back far more than 50 years, although the first practical demonstration was not given until January 27, 1926, when John Logie Baird showed members of the Royal Institute in London his system reproducing images in black, white, and tones lying between.

As early as 1880, however, Nipkow of Germany, Carey of the United States, and Swnlec, of France, were working out the first theories of this new art. The former, indeed, devised the perforated disc which bears his name, and which was the accepted means of television pick-up until about 1932, when the Zworykin iconoscope, an electronic pick-up, was proven to be much more efficient. This, however, did not solve the complete problem; that of reception remained.

FIRST PRINCIPLES

The art of sending moving images through the air also owes a debt to Lumiére. Edison and other early developers of the motion picture, and to the numerous workers who devised half-tone engraving, for it makes use of the principles which they took advantage. Television makes use of the limitations of the human eye; i.e., the eye's failure to separate a number of small, closely-spaced dots at a distance from it (as in half-tone engravings) and its tendency to "see" an image as a fraction of a second after the image has gone (as in motion pictures). Television takes advantage of such "resolving power" and "persistence of vision." It breaks (in modern 441-line scanning) an image into nearly 200,000 dots or "picture elements", only one of which is upon the screen at any given instant—the eye blends them into a complete image.

Even the younger television engineers can easily recall the days when television images were composed of no more than 512, 2,304 or 3,000 picture (or more correctly, "image") elements (constituting 24-, 48- and 60-line scanning, respectively). Comparatively crude, they yet permitted the presentation of recognizable images and clearly foreshadowed the possibilities of television as a means of public and home entertainment.

Oddly enough, a successful television experiment was described in the public press only 7 years after the discovery of the properties of selenium—and 4 years before the simplest scanning disc.
into a series of electrical impulses, human brains conceived, in a hazy way, some idea of how the end might be achieved. This article traces the progress of the art from its inception onward to its present state of high development.

was invented! Calling the system "dia-

photograph", one H. E. Licks hoaxed the press of the United States by describing an imaginary experiment in which a selenium pick-up was used. It was not until 1884 that Paul Nipkow, of Germany, invented the scanning disc, using a spiral of pinholes to cover the objects at the transmitter and the image at the receiver in the process now known to the television world as "scanning."

THE NIPKOW DISC—BASIC SCANNING MEANS

For many years the Nipkow disc, or modifications thereof, was the basis of television experiment. C. Francis Jenkins placed his apertures in the surface of a cylinder, for example, while others retained the disc form, but substituted lenses for the pinholes, to pass more light. The spiral form was still retained in the early lens discs, however, and the spot of light, having to be large enough to cover both the first and last lenses in the series, was largely blocked by the uncut portions of the disc.

Using a unique form of reflecting lenses, angularly displaced, William Hoyt Peck was able to arrange these in a circle instead of a spiral, and so was enabled to concentrate his light beam to a small spot, all of which was reflected (save for the usual reflection and refraction losses) to the screen. This produced images of considerable size and brilliance. He put this apparatus into commercial use for bulletin transmission over wires late in 1937.

But the Nipkow disc was by no means the sole basis for television development, though it did mold thought in the art for many years. Other early ideas which must receive their meed of mention include the mirror screen, the revolving prism and the cathode-ray tube.

ENTERS THE CATHODE-RAY TUBE

Startling, isn't it, to think of the cathode-ray tube as an early system, when it has won almost universal adoption by the leading television laboratories of today? Yet Boris Rosing, a Russian professor, was conducting television experiments with cathode-ray tubes as early as 1907. Rosing used a mirror-drum scanner at the transmitting end, and had upon it a number of rolls to generate synchronizing currents to cause electrical scanning in the cathode-ray tube at the receiving end. He was not the first, however, to make use of mirrors, for vibrating reflectors
had been used by Jan Van Szczepanik—a principle later developed along far more efficient lines by Priess.

While scanning has occupied the attention of television engineers to a great degree, there has ever been the coexistent problem of light-beam modulation. Szczepanik used a method which was widely employed for a time—namely, directing the beam (at the receiver) through a small aperture, from which it was deflected for the more shaded picture elements. It was not until some years later that the Kerr (or Karolus) cell was used for the same purpose, but far more effectively, in connection with polarized light.

OUTSTANDING TELEVISION TRANSMISSIONS

Television broadcasts have been on and off the air at intervals since the late '20's. The first of any major importance were the broadcasts of television over WRNY, under the direction of Hugo Gernsback, who sent out signals on a broadcast wave, in 1928, using Pilot equipment. The next step was taken by Jenkins, who radiated televised "sight and sound" programs in connection with broadcasts originating at WGBS. Next, the Columbia Broadcasting System, through an ingenious system of dual modulation, sent sight and sound on a single wave.

The New York Telephone Company engineers, under the guidance of Dr. Ives, sent natural-color images during this period, but the images were so small and the cost of transmitting and receiving equipment so large that the experiments had little immediate practical value. Of greater interest to the average radio fan were the rather dim, pinkish images seen when peering through pinholes at the neon-tube plate.

THE NEON TUBE

In the late 1920's and early '30's, the neon tube gave the amateur television experimenter a means of conducting his work at a moderate cost. For a few dollars, he was enabled to buy a neon tube with an inch-square plate, to produce an image of similar size, scanned by a pinhole disc, which he viewed through a magnifying lens. Receivers of this sort were actually marketed to the public by the Jenkins and "American Baird" companies during that period.
TELEVISION

Reception was considerably improved when the near "crater" tube was produced. This had a tiny "crater" of brilliantly-glowing ionized gas, bright enough to project a picture a few inches square when used with a scanner in which lenses replaced the pinholes, to pass more light. Peck, using this principle, showed images about 2 by 3 feet.

SCREEN-SIZE TELEVISION

John Logie Baird, of England, E. F. W. Alexanderson and Ulysses A. Sanabria, of the United States, were early successes with large-image television. Sanabria used lens discs with a "neon arc" light and "interlaced scanning"; Baird a mirror drum, with a Kerr cell and arc light. The same sort of light source and modulator were used by Alexanderson.

Interlacing was an invention of no mean merit, as it decreased to a considerable degree, the flicker that was present in straight scanning. In simplified language, it consisted of scanning the odd-numbered lines completely, then the even-numbered lines completely to form a single image, thus reducing the "carry over" which the eye previously had to make as the dot leaped from the end of the last line of frame No. 1 to the start of the first line of frame No. 2.

A similar principle is used in the cathode-ray systems developed by RCA and Farnsworth.

CATHODE-RAY PICK-UP "CAMERAS"

Dr. Vladimir Zworykin and Philo T. Farnsworth, working independently, arrived at similar ends in the middle 1930's; these were the Zworykin iconoscope and the Farnsworth image dissector. Both provide electronic means of scanning an object, and translating into high-frequency electrical impulses the picture elements which result. The number of lines per image is 441 (roughly 200,000 picture elements per picture). In a 5 x 7 inch image (this is the equivalent of about an 85-screen halftone—almost as much detail as the cuts in this magazine which uses 100-screen). The images are scanned at the rate of 30 complete pictures or frames per second, using interlacing. (As we go to press we learn that Allyn E. Dumont has developed a new television system. Read about it in the April, annual Electronics Number, of Radio-Craft.—Editor)

(Continued on page 607)
HE "glow lamp oscillation detector" is the heart of your radio set—for that is what Dr. J. A. Fleming, of London, christened the vacuum tube when he adapted it to radio use.

Generally considered the pioneer in the tube field, Fleming in reality was merely one of a long succession of experimenters. It was his good fortune that thought was being devoted to wireless communication when he achieved his laboratory triumph.

1725 TO 1905

The basis of the vacuum tube was laid down in 1725, when Dufay discovered that if one of two spheres was heated, a current-carrying path was formed between them. About 150 years later, Guthrie proved that if an iron ball, insulated, was brought to a red heat, it would still retain a negative electrical charge, but not a positive one, and 7 years afterward, in 1890, Elster and Geitel added a plate to an incandescent lamp. They noticed the valve effect by 1891.

Approximately half-way between the two latter dates (or in 1883), the Edison Effect—flow of current from heated filament to positively-charged electrode in a partially-evacuated tube—had been noted. Sir William Crookes had also conducted his experiments and shown that "corpuscles" (small particles of electricity, now called electrons) could be made to flow between 2 electrodes connected to a source of electricity (such as a Wimshurst machine), when the air between the electrodes was evacuated. The electrodes were sealed in either end of an elongated glass tube, now called a "Crookes' tube".

In 1883, as a result of his association with the Edison Electric Company of America, Fleming began his experiments; in 1897 Thompson published the results of a research into the conductivity of gases; and in 1905 Fleming (by that time with the Marconi Co., in England) patented his "glow lamp oscillation detector or oscillation valve", for he had found its valve (i.e., one-way) effect, and knew that it would function as a rectifier.

INTRODUCING "MR. GRID"

For a time, due to their insensitivity to weak impulses, these tubes or "valves" met with scientific interest but public apathy. Even when, in 1907, de Forest added the 3rd element, or grid, there was not much commercial activity in producing the audion for two reasons. The Marconi Company of England, which owned the Fleming valve patent, claimed an infringement since they asserted the de Forest tube to be a Fleming valve with a grid interposed. The basic patent was, therefore, Marconi's and de Forest could not make the tubes.

Also, since de Forest owned the audion patent, Marconi could not make the audion, and hence the audion situation reached a stalemate! The second reason was that the crystal detectors developed in the same year were far cheaper, and the results nearly as good as the audion.

The reason for the old audion's efficiency not exceeding the crystal detector by proportions comparative to later years, was because so little was known of the precise phenomena which took place and the attendant need for very special precautions in manufacturing the tube. The early audion was very "soft" or gassy, and any plate voltage above (about) 30 volts would cause it to turn blue (gas ionization) and make the tube inoperative. Further additional plate voltage would result in complete destruction of the tube. With such low plate voltage plus the interference offered to the electron flow by the gas molecules, it was no wonder that the audion was only a mite better than the crystal detector. Hugo Gernsback's E. I. Co. was the first to sell audions to the public in 1911.

By this time the diode (2-element) and triode (3-element) tubes had undergone considerable analysis, and out of the analyses had come—and gone, thank goodness—many weird and fearsome designs. One of the most intriguing of these was the "external element"—either the plate, or the grid, as the case might be; numerous variations were tried and, in the final analysis, discarded, by many experimenters, including, Hugo Gernsback.
The general idea was to effect operation even through the glass wall of the tube; it worked, too, as real "old-timers" well recall.

HIGH-VACUUM TUBES

All these defects were eventually overcome as a result of Langmuir's researches into high-vacuum lamps (1912-1913) at the G. E. laboratories, and (almost simultaneously) Arnold's work in the same field for the Western Electric Company, a subsidiary of the American Telephone and Telegraph Company. While Langmuir's work was a result of incandescent lamp problems (although his discoveries affected the whole field of vacuum tubes), Arnold's research was more directly centered about the audion—since de Forest had offered the tube to the A. T. & T. Co. in 1912, and they undertook to improve it for repeater (amplifier) operation for long-distance telephone communication.

In 1914, as a result of the A. T. & T. Co.'s work, the de Forest triodes were first used successfully in sending telephone messages from one side of the continent to the other; and in the following year, in telephony from Arlington, Va., to both Paris and Honolulu.

The World War, of course, spurred activity in communications as well as in other fields, and while only gaseous or "soft" tubes had been available before, so-called "hard" tubes made especially for the Navy somehow got out to the public towards the end of and just after the war. Their superior operation and efficiency as compared to the old audion, resulted in a great demand, by amateurs, for good "hard" vacuum tubes.

As a result of this demand for tubes by amateurs, we find numerous manufacturers entering this field in 1916-1919 and marketing their products—patents or no patents! Those first tubes will remain indelibly impressed on the memory of every old-timer. The "Moorhead", the "Electron-Relay", and the "Audiontron"—first with its double filament (in case one burned out), then later with a single filament, the various types of de Forest tubes—long-tube-shaped (type T) and spherical, as well as the Western Electric-made VT-1, VT-21 and VT-2. When used in regenerative circuits with about 22½ volts for the plate—nothing that was ever made before for detection could touch them. Then, one day in 1920, the newly-formed Radio Corp. of America, with patent privileges retained from the old Marconi Company of America, began to make the Marconi VT tube and warn all other companies that it was infringing on its Fleming patent.

THE "UV" SERIES

In 1921, RCA released the UV 200 (detector) and UV 201 (amplifier), both triodes with brass shells known as the UV base, and incorporating a filament that required one anode at 5 volts for operation. Previously, during July, 1920, the General Electric Company (which was manufacturing the tubes for RCA) made arrangements with the American Telephone and Telegraph Company, owners of the de Forest 5-element audion patent, so that by an exchange of radio patent privileges each was allowed to make tubes without fear of litigation. Shortly afterwards, the UV 201A thoriated filament tube was developed and released, a far better tube than the old 201 in many respects, especially since the filament only consumed one-fourth of an anode and hence materially reduced the drain on the "A" battery.

Many of the early tubes had oxide-coated tungsten filaments, and operated at low brilliancy—such were, for example, the WD11's, the 200 and 201. Meanwhile the laboratories had been experimenting with thorium, and found it to be an efficient emitter of electrons. Consequently, in 1922, tubes with filaments both coated and impregnated with thorium (200A and 201A) came into general use.

CONTEMPORARY DEVELOPMENTS

A digression here may not be amiss. These early tubes were high in cost as compared with tubes of today; they were not especially durable, and were easily damaged by being operated at too great a filament potential. Also, despite the ever-expanding facilities for tube

Dedicated to the memory of many old-timers
manufacturing by the G. E. Company and Westinghouse (which were also manufacturing the tubes for RCA by this time), the supply could not keep up with the tremendous demand which was caused by amazing sales of receivers and parts as a result of the growth of broadcasting. Therefore, there sprang into being a new industry—the rebuilding of radio tubes: new filaments inserted for a dollar or two. Usually the repaired tubes had imperfect vacuum, but no one seemed to mind. At the same time, tube reactivators were put on sale for public use. These devices served to “boil” the new thorium out of the wire at a high filament temperature, then “bake” it fast to the surface of the filament at a temperature only slightly higher than that used for normal operation. No plate potential was applied during this process.

The next advance was the low-current tube—the 199 (1922), which used only 60 milliamperes of filament current. This was important to fans who had to buy dry-cell “A” batteries or have storage “A’s” recharged. After that, we find the trend going back to “soft” or gassy tubes for detection purposes. The 209A is an example, as well as the Donle sodium-vapor detector tube made by Connecticut Tel. & Tel. Co.

1926—POWER TUBES AND RECTIFIERS

In 1926, the early power tubes, such as the 120, the 112 and the 171 came into use. These afforded greater undistorted output and hence better reproduction than was formerly possible. The 210 and 250, usually used with a lighting-line filament and plate supply, soon followed. The “B”-eliminator became popular in 1926, and as a rectifier the 80-type (filament) tube and Raytheon BH (helium-flameless) or “cold” tube shared honors, although the latter tube is now practically unheard-of. All these types up to this date were known as direct-heater tubes.

1927—CATHODE-TYPE “INDIRECT-HEATER” TUBES

Then came 1927, with increased interest in A.C. all-electric sets, and we find the 226 and 227 tubes released by the tube manufacturers. The 226 is a tube whose filament is slow to respond to the cyclic changes of alternating current, and, therefore, could be connected across an A.C. supply of 1.5 volts without causing hum. The 227 employs a cathode, and is known as an indirectly-heated tube and for that reason was perfect for A.C. heater operation. Soon other A.C. tube models were produced, and the battery-operated tubes were pushed out of the radio picture, save for use in locations where electric mains were not available.

1928—SCREEN-GRID TUBES

In 1928, the screen-grid tube was released, type 221 for A.C. sets and 222 for D.C. sets. These tubes had tremendous amplifying power (as compared to old triodes) as well as inherently lower internal tube capacity.

The screen-grid tube did away with the necessity for neutralizing R.F. stages, and resulted in a more stable and sensitive receiver. In fact the amplification of this screen-grid tube was so great that local stations were tuned-in sometimes interfering with each other, sometimes so that they could not be “turned-down” soft enough. Special dual volume control circuits were necessary, as well as local-distance switches to reduce the antenna signal to the set on local stations.

The defect was known as “cross-modulation” and worried engineers no little, until 1931 when variable-mu tubes such as the 95 and 51 (by this time it had become the custom to use an apostrophe [’]) later dropped, in place of the first of a tube’s 3 code numbers) were released along with a power pentode—the 47 tube.

PENTODES

The new power tube was more sensitive and could be satisfactorily driven by the output of an average detector stage and still give higher power output. In 1933, multi-purpose tubes were released such as the 2A7, 58, 2B7, 55, etc., to be followed shortly by similar tubes but with heaters re-
quired 6.3 volts instead of 2.5 volts. The 6A7, 78, 6H7, etc., are examples. Also, in this year, the acorn tubes were developed as a result of research in the ultra-highfrequency field.

1935—METAL TUBES

The final stage in the development of tubes, to date, is the now famous metal tubes, and the secondary emission tubes. In theory, the metal tubes are a marked improvement over the glass tubes, since they are smaller, entirely shielded and, therefore, better for efficient, stable circuit operation. The “secondary emission” type of tube, in its most advanced design, is perhaps best represented by the electron multiplier introduced in the winter of 1935-36 (See Radio-Craft, Jan. 1936, pg. 301); its design makes possible a gain of several millions (i.e., amplification about equivalent to that of 6 or more ordinary tubes). The “electron multiplier” tube makes possible heretofore unattainable results in the field of television. All in all, the vacuum tube development from Fleming’s early diode has been more than satisfactory, and in no small measure responsible for the great improvement in the operation of present-day radio receivers.

CONTEMPORARY DEVELOPMENTS

All vacuum tube developments, however, were not along “receiving tube” lines only. In the early part of the 1930’s we find tube manufacturers considerably interested in various other applications of “electronics”, as a consequence of which numerous strange types and special-purpose tubes have been developed. Their continuous research into the problems relating to tube operation and production made the evolution of special tubes designed for a specific though relatively foreign application, comparatively simple.

Specific types, with which we are now all familiar, are the various types of photocells—including the cesium and the miniature RCA types 922-923; the cathode-ray, of which we now have various sizes ranging from a 1-inch in diameter screen to 10 inches; the electron-ray tuning indicator tube; the “iconoscope”, a special tube for television pick-up purposes; the beam-power tube, used essentially in high-power amplifiers for obtaining tremendous power outputs; improved-efficiency transmitting tubes, by using graphite or carbon anodes for reducing plate losses due to the tremendous heating of this element when operated at maximum ratings. Also, concerning transmitting tubes, the improved construction of present types enables more stable and improved operation on higher frequencies.

Apace with these developments, we find improvements made in rectifier tubes—in some, the inclusion of mercury vapor which ionizes when the filament becomes heated and thus aids the conduction or flow of electrons between plate and filament. In addition, special types of thyratrons have been developed for inverter equipment, the release of which has done much towards solving many special problems in industrial fields.

It is perhaps best that mention be made here of special tubes still in the laboratory and in the process of being developed, the release of these tubes pending the solution of some problems which retard their efficiency and hence application in the radio and electronic fields. These tubes are of the “cold-cathode” variety, no filament or heater being employed although, it must be emphasized that no immediate promise for their future release to the public is in sight.

Due to lack of space we have not been able to discuss transmitter-tube developments. In general, though, they have paralleled the development of receiving tubes; and, in fact, almost all the low-power transmitting tubes, for many years, were taken from the field of receiving-type tubes. Public address and electronics, two newer application fields, tell the same story; only within the last 3 or 4 years has there been any evidence of other than regular radio receiving tubes being applied to these fields. But the march is on! Today, it is estimated that there is an approximate total (radio receiving and transmitting, public address, and electronics general and special-service) of about 500 types of tubes; tomorrow—!
The circuit or "hook-up" was the all-important thing in the old-days, since with few stations and relatively inefficient equipment this was the factor to which was attributed the sensitivity or "DX" ability of the set.

Here's not only a "new school" but also the "old school" in radio, today, but we know that the members of both fraternities will pause here to pay deserved tribute to the famous old circuits reprinted on these pages. The new members will recognize them as being milestones in radio progress, and perhaps also as basic principles which served as a strong structure or foundation upon which radio was built. The older members will see in them intriguing days, when radio was anybody's oyster, and fame and fortune were heaped upon him who helped accelerate radio's march forward.

Today, almost all commercial receivers employ the superheterodyne-type circuit, some with engineering refinements such as automatic volume and frequency control, yet, basically, still the superheterodyne. Considering present conditions and equipment this circuit is acknowledged to be the best, since it results in the most selectivity and sensitivity for a given number of tubes with a minimum of parts. However, in the old days—with very few transmitting stations in operation (and most of them low-powered at that), and these spread all over the globe, plus relatively inefficient equipment such as coherers, and electrolytic and crystal detectors which required triggering adjustment—the experimenter or operator was continuously devising new circuits to increase his receiving efficiency. It must be remembered that vacuum tubes, or the audion—as it was first known—were relatively unknown or too expensive in the very early days. Later on, when they were first released commercially they were rather emotional in their operation (due to imperfect construction and evacuation), and far less efficient than later models when production methods and equipment were improved. Consequently, the "circuit" of the receiver was the thing that made it "tick" satisfactorily or unsatisfactorily, and the dream of every experimenter, in those days, was to build a receiver with a circuit that would outdistance any ever built before.

The old single-, double- and triple-slide tuner and loose-coupler crystal set circuits, as well as the ghosts of other old-timers, are shown here in the border. Marconi's first coherer and decoherer receiving circuit, as well as the auto-coherer by Solari, head the list since they were the first practical receiving circuits. The Fleming Valve and outside-grid vacuum tube circuits...
Those which had the greatest appeal, and hence gained everlasting fame, are herewith reprinted. Incidentally, many still form the basic groundwork upon which the more complicated, modern radio receivers are designed.

...
selective receivers ever developed, because of the superhet circuit and with this circuit are combined many new, novel refinements, comparatively recently discovered. Specifically, these refinements are "automatic volume control" (A.V.C.), "noise suppression control" (N.S.C.), "automatic frequency control" (A.F.C.)—which permits a circuit to adjust itself to proper resonance when the operator tunes a set too casually—and, finally, "automatic tone control" in quite a few of the better receivers. These circuits are not shown in these pages for the very obvious reason that they have been discussed and shown very frequently and in very recent issues of this magazine. Perhaps some day they, too, will be considered obsolete, useless, in much the same light that we look upon the circuits of "old".

While none of the circuits are given here for the trickle chargers and "A" and "B" eliminators of that era, despite their role of importance in the progress of radio receivers, it is perhaps best that they are omitted for the simple reason that they were more infamous than famous. Undoubtedly, most of the
readers of these pages will remember
them more for the nuisance which they
created than for their historical role
in radio. Concerning the first really
"A.C." (alternating current) electric
sets which came out shortly afterwards
(1927), those employing the types 226
"(28) and 227 "(27) tubes, their era
was so short and the circuits so easily
available in various manuals that it is
considered unwise to reprint them.
After all, the real old-timers—such as
the aforementioned—are the ones which
made history, and which gave
the experimenter of those days the real thrill.

Of course, the story would be incom-
plete if we were to leave out the circuit
of the newest modern receiver, with all
refinements such as A.V.C., A.F.C.,
pushbutton tuning, visual tuning indi-
cator, etc., etc. Radio circuits have
traveled a long way in 50 years, and the
final diagram (the RCA model 811K,
shown below) tells the story better with
one illustration than could mere words.

Here they are,—all On Parade! How
many of them do you remember, and
how many have you tried out in your
time? What fond reminiscences they
bring back as we look them over!
THE wireless stations recalled in this article will undoubtedly bring up fond memories to every old-time operator. The names of the "ops" who operated these stations in the old days may no longer be remembered but the service they

BEFORE wireless came about, when a ship left land it was never heard from again until the day it returned to the same port, unless some other ship brought in news or tidings, or perhaps even some mail exchanged in mid-ocean. When wireless came along that picture was changed, since its first adaptation was for ship-to-shore communication although some of the first stations were intended to replace the telegraph and trans-Atlantic cable in the art of communication.

The first commercial wireless station was, naturally, Marconi's, and was erected in November, 1897, at Alum Bay on the Isle of Wight, England. The station employed an antenna consisting of wires stretched between masts that were 120 feet high, and many messages were sent from this station to an experimental station located on a steamer. These tests were designed to show the feasibility of ship-to-shore communication, and the first record of a paid-for message by wireless was made in June, 1898, when Lord Kelvin came to this station and sent a message, for which he paid, to another station at Bournemouth, approximately 14 miles away.

From then on, ship and shore stations were installed rapidly, and we find Marconi's company interested in spanning the Atlantic. With this in mind, he had already installed (in 1901) a powerful station at Poldhu, Cornwall, England. It employed for an antenna system 20 masts, each 200 feet tall, arranged in a circle 200 feet in diameter. After it had already proven that it could reach ships far out at sea, Marconi then traveled to St. Johns, Newfoundland, and after some experimental work was able to hear the letter "S" (3 dots: "..." transmitted by Poldhu. Other difficulties arose, and it wasn't until 1902 that Marconi was able to return to the North American continent to erect his station for trans-Atlantic communication. When he did, he selected Glace Bay, Cape Breton, Nova Scotia, and on December the 17th of that year the Governor-General of Canada and the King of England exchanged greetings through the facilities of these two stations.

These were the forerunners of commercial ship and shore stations to which wireless operators were destined to listen eagerly for communications, press, instructions, weather reports, etc. In the United States, between 1904 and 1908, the United Fruit Company found it advisable to erect a number of shore stations so that its fleet of steamers traveling to southern climes
rendered and the role that these stations played in the days when they constituted the single meagre ethereal thread which permitted contact between ships and distant shores will always remain alive and vivid to all seagoing operators.

could be contacted at will. These early United Fruit stations were located at Limon, Costa Rica and Bocas del Toro, Panama. Before 1908 this company had added more shore stations located at Nicaragua, Cuba, Guatemala, Louisiana, and Swan Island in the Caribbean Sea. In 1904, de Forest installed 5 large Navy shore stations at the following locations: Pensacola, Key West, Guantanamo, Colon (Canal Zone) and San Juan (Porto Rico).

Arlington (NAA) didn’t go on the air until February, 1913, although the installation was started in 1909. Its first signals were made by a 100 kw. spark transmitter of Fessenden design, but this was replaced shortly afterwards by a 30 kw. “arc” transmitter which was much more efficient. From then on, arc transmitters were preferred by the Navy, and Arlington results were the criterion. The Eiffel Tower station (old "FL"), in Paris, began its transmissions in the latter part of 1912, and Time Signals from this station were transmitted regularly.

LONG-WAVE STATIONS

An interesting point, with which only real old-timers would be familiar, is that many of these aforementioned stations operated on extremely low frequencies or very high wave-lengths, although the best results are obtained today in the opposite direction, i.e., ultra-highfrequencies or low wave-lengths.

Arlington, or NAA as the veteran wireless operator would refer to this station, for instance, operated on a wavelength of 6,000 meters. Eiffel Tower, or FL, operated on a wavelength of 10,000 meters; Nauen (Germany), or POZ, operated on 12,000 meters; and NSS (Annapolis, Md.) operated on a wavelength of 16,900 meters or approximately 18 kilocycles—a frequency now considered on the fringe of the audio

(Continued on page 619)
Much has been written about the supposed future of radio that forecasting often becomes a commonplace gesture, and frequently the predictions are no longer taken seriously either by the radio industry or by the public.

I have never taken any particular pride in all the many predictions which I have made in the past (many of which have come true) because, after all, others could have done the same thing if they had thought long enough about the subject, and logically plotted a curve of the future. Such predictions are not as difficult as it might appear, nor are they particularly miraculous either. Any industry, and science in particular, always follows a well-planned path which can be predicted with fair accuracy by almost anyone who takes the trouble to do so.

Radio is no different, and what predictions I have made in the past were always based upon actual needs of the industry; that is the only reason why I have lived to see the fulfillment of many of my predictions.

What I have to say in the following paragraphs follows along the same plan, and while some of the ideas may sound impractical at the present time, remember that many of the other predictions which I made sounded equally foolish and preposterous when I made them.

As I have stated before on many occasions, radio is still in its earliest infancy. As a matter of fact, the entire art remains extremely crude. Perhaps in 100 years or so, radio will really become a great art, which it certainly is not today.

Many problems remain to be solved because most of the instrumentalities which we use in radio today are exceedingly infantile. In other words, I deliberately make the statement that radio still is in the cradle, and the lusty young infant has not as yet started to crawl, let alone walk. To be sure, we have advanced a great deal in the art, but not more so than a six-months-old infant has progressed along the road toward manhood.

While we have made some progress with interference between stations, and those that overlap, much remains to be done. While we think that today's sets, particularly those of the superheterodyne variety, tune sharply, the next two decades will show a complete revolution in this phase alone. Radio will not be satisfactory until the day when there will be no cross-talk between stations themselves, and even no heterodynes from distant stations operating on almost the same frequency.

It is quite likely that our entire ideas as to tuning will be thrown overboard twenty years hence, and that we will use entirely different means to accomplish tuning. The day may come when we will use neither the present type of tuning inductance nor today's type of condenser. Indeed, we may not use inductances or condensers at all in the present accepted sense of the word.

While we have made headway in the elimination of man-made, as well as natural, static, we have done so at the expense of power. In other words, we have increased the watts output of our radio stations in the firm belief that by having great enough power, the emitted signal from the station will be sufficiently strong to override and blot out whatever static there is. This is akin to shouting at the top of our voice in order to make a partly deaf man hear us, when it might be much better to otherwise devote our energies to improving a man's hearing, and then converse in a normal tone of voice.

In other words, the power of the broadcast stations has lulled our radio engineers and designers into a mental state wherein many think that the problem is really solved when, indeed, experience shows that real engineering work has to be done in the radio set itself by means of filters or other devices. The very fact that our radio sets are becoming more sensitive all the time makes a crying need for noise elimination not only out in space, but within the set itself, because we have not only noises from static but from within the tubes. All of these problems deserve much more attention than they get today.

Our broadcasters are spending untold fortunes on the very best of programs, and the finest music that was ever heard on this planet. So when we listen to a Toscanini concert it is the height of absurdity to have such a program

Learn while you sleep, in your radio receptor bed!
his former achievements by stating along what lines the ramified art of radio will develop in the not-so-distant future of the industry.

GERNSBACK

marred with all sorts of noises which, believe it or not, will no longer be heard in a radio set 25 years hence. It means that new principles and new discoveries will be made to slay the monster—Noise, and I have the firm belief that the time an annoying pest which again threatens radio because not everybody wishes to listen to a radio set going at full blast. As civilization advances our nerves are getting more and more jangled and what we really want is a "silent" radio receiver. In other words, we want a radio set which we can enjoy personally without arousing the entire household. Then too, we may wish to listen to programs in bed when we are ill, or otherwise without annoying others in the room. While it may be said that some progress has been made along these lines, still it goes right back to the earphone, which does not solve the problem. Thus we may have a telephone receiver in our pillow and we listen to the music in this manner, although this is old stuff because it was done long before the advent of the loudspeaker.

There are, however, other ways of getting the music and sounds to our inner consciousness without taking advantage of loudspeakers and telephone receivers. There is such a thing known as molecular vibration. I can see in the future, furniture such as chairs or beds wired with a special apparatus or instrument which will give off sonorous sounds the instant one touches the chair or the bed merely with the fingertips. The idea here is to recreate sound in the bony structure of the human skeleton in such a manner that no one except the person making contact will hear the sounds. Anyone standing even one foot away from him will hear nothing. The method which I have in mind is not an electromagnetic sound reproducer working on the principle of the osophone which I patented years ago, which again is nothing but a special telephone receiver. Rather the method which I have in mind is purely molecular. Years ago I witnessed some experiments where I saw an electric motor speak and talk by molecular vibration. There were no diaphragms, no vibrating armatures of any kind, but the sound was produced by means of molecular vibration.

When radio manufacturers adapt this principle, we will be able to enjoy radio as we have never been able to enjoy it before, and at the same time we will not annoy others when they wish quiet.

Many years ago I imagined an instrument which I termed the Hypnobioscope. This fanciful instrument was supposed to teach the student while he slept. Much to my surprise this idea is already being utilized to teach students the code when asleep, even though they could not learn it when awake. (See article entitled "Predictions and Fulfilments" in this issue.) The time is not far away when this will actually come into universal use, and again by means of the above-mentioned molecular radio sound transmitter. By that time broadcast stations will give special programs at night, and stations will vie with one another to give important instruction, whether it be languages, mathematics or history, during the hours from 12 M. to 5 in the morning.

We will not need to wear head receivers or, in fact, anything at all, yet the radio program "connected" to our beds will be transmitted to our inner consciousness with sufficient volume—but not too much volume—to avoid awakening us. As I pointed out before in connection with the Hypnobioscope, the human mind is unusually recep-
An editor who takes his occupation seriously is in position to dispense to his readers largesse in the form of prophecies upon which foresighted persons may capitalize. By observing world-wide technical trends and noting public reaction to

ROBERT EICHBURG

In his writings over a period of more than 30 years, Hugo Gernsback, editor of Radio-Craft, has foretold a number of important trends in various scientific fields. Not all of his predictions, of course, have come to pass, but an astonishingly large number have—particularly in the radio industry. In fact, one may examine almost any phase of broadcasting as we now know it, and trace it back to some prognostication made by Hugo Gernsback in the days before "wireless" had become known as radio.

Perhaps the earliest editorial record of an important Gernsback prediction appeared in the February, 1912, edition of his magazine, Modern Electrics, which he published and edited at that time. In it he foretold, with incredible accuracy, the provisions of the First Radio Act, a law which was not passed by the Senate until May 7 of the same year. In fact, the bill included all the major recommendations made by Mr. Gernsback in the previously-mentioned article. That is either a remarkable coincidence, or an uncanny ability to foreshadow the future, or Mr. Gernsback virtually dictated the bill. Compare his words with those of the Wireless Act:

Mr. Gernsback suggested:

"There should be a bill passed re-staining the amateur from using too much power, say anything above 1 K.W."

Section 15 of the Wireless Act of 1912 states:

"No private or commercial station not engaged in the transaction of bona fide commercial business by radio communication shall use a transmitting wave length exceeding two hundred meters or a transformer input exceeding one kilowatt except by special authority of the Secretary of Commerce and Labor contained in the license which shall be granted by the Secretary of Commerce and Labor for the use of the wireless station.

Save for the use of the waves in excess of 1,000 meters, the bill included all the provisions prescribed by Gernsback.

But while that gentleman looks upon this as his outstanding achievement in the field of radio prognostication, it is by no means his earliest nor, to the minds of some others, his most astonishing.

His predictions, which he arranged back to as early a date as May, 1909, when, in Modern Electrics, he foretold the possibility of chain station operation—and that was in the days before broadcasting existed as such, let alone chains.

Nor, for that matter, were the prognostications of Hugo Gernsback confined to the austere editorial. In a serial science-fiction story which commenced in the April, 1911, issue of Modern Electrics, he narrated the adventures of a character—"Ralph 124C41++"—who was imagined to be living in the year 2660 A.D. The instalment in the June issue of that year carried the following:

"He soon went to bed, but before he fell asleep he attached to his head a double leather head-band with metal temple plates. He then called for his faithful butler and told him to put on Homer's Odyssey for the night...

The butler, . . . took down . . . a narrow box... From
existing facilities he is able to offer tangible and workable suggestions by which everyone may profit. Hugo Gernsback, whose liberality in suggesting worthwhile improvements in the radio field is unequaled, is one such editor.

This he extracted a large but thin reel on which was wound a long, narrow film. This film was entirely black but for a white transparent wavy line running in the center of it. ... He introduced the end of the film into the Hypnobioscope ..., which transmits words direct to the sleeping brain in such a manner that everything can be remembered in detail the next morning."

Mr. Gernsback's sketch was published in his fictional story. He repeated this prediction, somewhat more seriously, in an article which was featured in the December, 1921, issue of Science and Invention.

Then, in October, 1920, Radio News carried the startling information that Gernsback's prediction had come true, for it printed an article by J. N. Phinney, Chief Radioman, U.S.N., in which the practical application of the idea was described. Mr. Phinney had acquired rapidity in code by sleeping next to a telephone sounder. In 1922, he had conducted tests, sending code to 12 sleeping students who wished to learn radio. The students wore, while they slept, aviation-type helmets containing headphones. The tests were conducted for some period and all reported improvement. The "Hypnobioscope", which Mr. Gernsback had conceived, had become an actuality—without waiting for the year 2660 either!

In the Electrical Expositor of December, 1918, he predicted that wireless signals would be heard around the world, and in July, 1919, inaugurating his Radio Amateur News, Mr. Gernsback asserted his faith in the future of radio in America; then in the last issue of that publication, before it became Radio News, he brought up three extremely interesting points, for in the May, 1920, issue, he wrote editorially:

(1) "There is a tremendous market existing for a small (send-receive outfit that can be put into a suitcase and which works on 6 dry-cells. Why does not someone invent it?!"; (2) "Then there are our good old telephone receivers. Year after year, we have been using them, whereas it has often been pointed out that we really do not want them because they tire our heads and ears, and are unsightly and very inefficient."; (3) "Why must we receive by ear? Why not, for instance, by sight? It can be done, and at least as efficiently as by ear." The proof that these predictions were well founded is borne out by (1) the portable transceivers of today, (2) the loudspeaker, and (3) the oscilloscope or "Tuning Eye" indicator.

In June of 1920, this magazine became Radio News, the publication from which the following predictions are taken, unless otherwise noted.

The July, 1920, issue contained more than one such suggestion. For example, Mr. Gernsback wrote, "Twenty-five years from now our long-distance stations will be operating with comparatively small power .... It should be possible in 1945 to telegraph 12,000 miles .... with a power which does not exceed ½ k.w." This is borne out in the results achieved by numerous amateur short-wave stations. He also wrote, "And one of these days, we will wake up and find that some genius has made it possible for us to see actual radio waves." The present-day cathode-ray oscilloscope has done that. He also said, "One of the coming wonders without doubt is radio movies." Although Mr. Gernsback had spoken of television many years earlier (indeed, he is credited with having coined the word in 1909) when he said it would be possible to transmit images "without using numerous wires", this seems to be the first
suggestion to be made of televised movies.

In the September, 1920, issue, after having discussed radio concerts, Gernsback went on to say, "Why cannot someone go after the Presidential candidates and invite them to make a speech via radio thru a powerful telephone apparatus in the near future. With proper advertising and with the proper enterprise behind such a scheme, it certainly should not cost a great deal to do. The people of the United States . . . would get a chance to listen to our candidates in a very novel manner." This was a follow-through on an earlier idea, which Gernsback had expressed in Modern Electrics as early as September, 1916, when he suggested that it would be a fine thing if President Wilson would use the radio to address all the United States simultaneously. The collator wonders if Mr. Gernsback, around election time, ever regrets his suggestion of 1920.

When midget sets and loudspeakers were virtually unknown, in February of 1921, Mr. Gernsback predicted that by 1931 there would be compact radio receivers which would include one or two stages of audio and said that "... the sounds will come right from a horn similar to our phonograph today, only built along miniature lines . . . . The small outfit is the thing and we cannot urge manufacturers (too strongly) to pay attention to this phase."

The following month he foretold the end of spark transmission for amateur operation, saying, "Have you ever stopped to think how clear the nightly ether would be if all the amateurs were using radiofone equipment instead of wireless telegraphy . . . . The writer believes that the radiofone, as far as the amateur is concerned, is the right way out." While amateurs still use I.C.W. as well as C.W., they have discontinued spark transmission, which was what Mr. Gernsback had reference to.

In May he clarified the point somewhat in an article which concluded: "Sooner or later we will be forced to give up our spark stations and operate on C.W., and this is as it should be. The sooner we amateurs realise this, the better it will be for us . . . ."

The condenser-type loudspeaker, which flourished for a brief while, was prognosticated by Gernsback in October, 1921, and the following month the transmission of newspapers by facsimile was suggested. Eight years later the present collator actually did this for the New York Evening World, sending "the printed page, type, pictures and all, in less than a half-hour," just as Mr. Gernsback had predicted would be done.

One prediction, made in an editorial written for December 1921, seems particularly important. Mr. Gernsback said, "We can not expect the future wireless radio enthusiast to buy the parts of an outfit and put it up himself . . . . What he wants is a sort of 'radiofone' that is all connected up for him and, with a few intelligible instructions, can be used as easily by the young hopeful as by granddad . . . . All we require is a nice cabinet which contains all the instruments ready put up. In front there should be a knob that could be turned for any desired entertainment, such as jazz, lectures, good-night stories for children, grand opera, etc . . . ." Remember, we had no complete radio sets or consoles in 1921.

Mr. Gernsback opened 1922 with a prediction in the January issue of Radio News, saying, "In 1922, we may safely predict that millions of homes will have their radio receiving sets right in their parlors . . . . The 'radiofone' of which we spoke last month will come into its own. The latter for the time being will eclipse, or put into the shade, its predecessor, the Victrola and the . . . ."

(Continued on page 610)
NEW CIRCUITS IN MODERN RADIO RECEIVERS

The details of the modern radio receiver circuits that make them "different" from previous designs are illustrated and described each month by a well-known technician.

F. L. SPRAYBERRY

(1) NEW INPUT DISCRIMINATOR CIRCUIT

General Electric Model F-135. An I.F. signal voltage is developed across the circuit tuned by C30, Fig. 1A, from the plates of the last I.F. amplifier. This voltage level is applied to both diode plates of the discriminator detector "in-phase", from the electrical center of the coil each end of which attaches to one diode plate. With the I.F. trimmer C31, an I.F. tuned circuit is formed between the plates. The diode loads, however, do not have similar impedance values as one (the A.V.C. and signal load) is practically a pure resistance while the other (the A.F.C. load) is largely capacity reactance due to C57. This latter impedance being lower than the former one, more current tends to flow in the upper-half of the coil than in the lower-half. Thus, the upper diode plate voltage changes more with the signal than the lower one. This difference in diode plate potential gives rise to a series resonant current in the diode input tuned circuit, which results in a voltage of resonant frequency being fed to the plates out-of-phase. The shift in phase, of the "in-phase" signal voltage to that of the "out-of-phase" voltages as the signal frequency varies, creates the A.F.C. voltage in the customary fashion.

(2) SET USES A.C. OR BATTERY SUPPLY

RCA Model 85BT6. Use this set as a 110-volt, A.C.-operated home receiver or simply plug it into a vibrator power supply operating from a 6-volt storage battery. Plug into the conventional A.C. power unit are brought leads as in Fig. 1B, to a 7-hole socket mounted on the left-rear of the chassis. The vibrator power supply unit is separate and is provided with a cord and plug which plugs into the socket for battery operation. Its plug pins are identified in Fig. 1B by numbers corresponding to those in the receiver socket mounted on the receiver chassis. It will be observed that the same controls are used for either power supply.

(3) FEEDBACK-TYPE TONE CONTROL

Philco Model S-1526 (Automotive). Control of the amplitude characteristics of the A.F. amplifier within the audio spectrum for voice and music, is accomplished without the sacrifice of an overall signal reduction by the means shown in Fig. 1C. In position 1 of the tone control switch TW, the audio response is essentially "flat" and extended appreciably at each end (low and high frequencies). It is actually rising slightly at either end. In position 2, the low frequencies are attenuated to a satisfactory extent and in position 3, the high frequencies in addition are attenuated. The average center part of the spectrum (around 400 cycles), however, remains at the same level throughout. A low-pass filter L-C is used in the speaker voice coil circuit so that extremely high frequencies beyond the control range will not be reproduced.

(4) NEW PHONOGRAPH CHANGEOVER

Stewart-Warner Models 1821 to 1829. To insure that the radio signal is completely eliminated when set for phonograph reproduction this circuit (see Fig. 1D) disconnects the I.F-detector and I.F. screen-grids, and the signal-diode plate return. In this way, the input section of the receiver

*Continued on page 609*

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Fig. 1. The heavy lines in the circuits are the points discussed in the text.
THE RADIO MONTH

RADIOOFFICIAL REGULATIONS

MEETING in Nice (France) last month (it's a nice place to meet in) the Union Internationale de Radiodiffusion, which deals with European broadcasting, voiced the difficulties of continual interference on that crowded continent of none too amicable independent nationalities. As to unwanted interference, directional antennas are helping to reduce that. It was recommended that a program of exchanging broadcasts of chimes for New Year's, 1938-9, be extended to further interchange of records. And it was voted unanimously that the European public would not be satisfied with the idea of advertising-sponsored programs, instead of making payment for their programs in the form of set licenses. (Two American broadcast networks were represented at the meeting.)

The Federal Trade Commission, laying down regulations against mis-representation in radio sales, allows a 540-18,000 kc. set to be advertised and sold as "Limited All-Wave." It also clamped down last month on a "radio metal locator," and required the advertiser to cease representing that it could "distinguish between metals such as gold and silver."

The F.C.C. issued an order requiring owners of airplane radio equipment to have station licenses, and to have the frequency checked periodically at authorized laboratories. Further, after a long hearing, it last month suspended from practice an attorney for filing before it the applications of "dummy corporations" seeking station licenses. A similar position was taken by the Federal Court of Appeals, D.C., disapproving incorporation to hide ownership of licenses. At a meeting in Chicago of those interested in "educational broadcasting" last month, F.C. Commissioner Payne observed that "program standards must be raised," and that this would be impossible if left to broadcasters, appealing to the masses. Rebuttal by Merrill Denison said that radio cannot "inflict again a high school and college course on listeners." (Many groans are heard from British listeners about educational programs of B.B.C.—and none from listeners in other European states where they take what the government thinks is good for them, and like it.) Controversy will undoubtedly continue far into the century.

Regulations reported last month by U.S. foreign trade bureau include: Cuba prohibits radio sets in busses, public or private; Turkey requires purchaser of set to be given "prospectus" and diagram, copy of which is filed with government. Sydney, Australia, lighting service equips 42 service vehicles with 2-way telephone service. Each carries also emergency signal device on transmitter to acknowledge message, or request repetition, when voice cannot be heard at central or receiving relay stations.

The competition of foreign language broadcasts by different powers seeking to spread propaganda to colonies and partisans in other nations was admitted by the British Empire when the B.B.C. announced, last month, it will broadcast in Spanish and Portuguese to South America and in Arabic to the Near East. "Not in German and Italian as yet." And in this country, two stations in a large city, which had been keeping on different languages at the same hour, severed diplomatic relations and concentrated on Yiddish from 8 to 9 p.m.

Japanese government installed amplifiers on electric trains, with loud-speakers to inform passengers of station stops, etc. Novel feature of an-
IN REVIEW

Rumors last month of television licensing caused inquiry, and the following definite statement from the office of the F.C.C. was received by Radio-Craft: "So long as there are no radiations or violations of the experimental and non-commercial status of co-axial cables and television broadcast stations, the Commission has no jurisdiction. Though future activity cannot be predicted at the present time, it would appear that commercial television will not be practical until some form of standardization is adopted. No applications have been filed for a commercial television authorization; and no action will be forthcoming (from the Commission) until there is a satisfactory showing that television is ready to be presented to the public."

Something like the general idea of television—direct sight of impulses—is provided in a patent (No. 2,101,139) issued last month to Clarence W. Hansell and assigned to RCA. It provides a viewing screen covered with copper sulphate, in a moist atmosphere; which turns white when ultra-short radio waves impinge upon it, either by reflection or direct from a transmitter. Thus, it is proposed, a ship or plane may be seen through fog or darkness! It does not appear how practical the device is, in its present state of development.

Ship reception of television signals, considered in the light of present medical service by radio from shore to ship, caused proposal last month by Reynolds (London) that it may yet be possible to enable a doctor to see a patient at sea, and (even more practicable) to illustrate by action the operation or treatment which he recommends a shipman's companions to administer in an emergency. Even appendicitis operations have been performed on radio advice; but how much better if they could be first illustrated to the amateur surgeons.

Television news service appeared commercially last month, when Peck Television installed a receiver in Jack Dempsey's (popular N. Y. restaurant) demonstrating mirror-scanning of signals transmitted over leased lines. Letters 4 inches high run across a screen, giving about 60 words a minute, and can be read 75 feet away. Plan is to install receivers where news bulletins, etc., are wanted in public places. Master tape is typed at transmitter (Continued on page 618)
HOW TO MAKE THE RADIO-CRAFT SUPER-DELUXE 30-TUBE SET

Here, at last, is the concluding chapter on this superlative receiver, dealing with the loud-speaker system and the construction of the framework of the complete 4-chassis assembly. *Radio-Craft* will be pleased to receive reports from readers who built this receiver in easy stages as described.

\[\text{Fig. 17. Constructional data for the infinite-baffle cabinet housing the 2 speakers.}\]

**PART VI**

In this, the concluding installment of the series of articles, we will describe the construction of the rack frame which houses the 4 chassis. At the time of going to press, the special infinite-baffle cabinet was not completed. Inasmuch as the speaker, or speakers used, will vary with the requirements of the builder, we give in Fig. 17 the dimensions of the loudspeaker cabinet (which is separate from the receiver cabinet) which we believe to be the best. The dimensions can be scaled down to suit the size which the builder requires.

In any event, the cabinet will be better, acoustically, than a flat baffle of equivalent front area.

The rack frame was built open all around (see Figs. K and L) in order to show the construction and placement of the shelves. Veneer panels may be affixed to the front and sides, if an enclosed type of rack is desired.

The first job is to prepare the base platform. See Fig. 18A in which the dimensions are given. It is desirable to use a solid board at least 1 inch thick. Before chamfering the edges it is advisable to locate the area which the aluminum rectangle will occupy on the baseboard. The aluminum rectangle must be assembled according to Fig. 18B and screwed to the base platform. The upright angle girders should next be prepared and mounted, one in each corner of the rectangle.

Within the area of the rectangle is mounted the spacer board. The dimensions are given in Fig. 18C. The reason for using this board is so that the level of the aluminum rectangle is even with the spacer, so that the Heavy-Duty Power Supply Chassis may be slid in and out easily, without having to lift this heavy chassis over the edge of the rectangle. After the spacer board has been screwed down, the shelves are ready for mounting.

The 4 shelves are all alike, the dimensions are given in Fig. 18D. The spacing between shelves is 15 inches between base rectangle and 1st shelf; between 1st and 2nd shelf, 15 inches; between 3rd shelf and top shelf, 14½ inches. Holes should be drilled and countersunk in the angle uprights to accommodate the small woodscrews which hold the shelves to the uprights.

The ornamental strips shown in Fig. 18H are screwed to the top shelf. They may be spaced close or far apart as the builder desires. The shelf brackets, shown in Fig. 18G, are mounted next, by means of 2 small wood screws and one self-tapping screw, which should be placed on the inside of the upright for each bracket. The platform and upright brackets are next prepared according to Fig. 18I.

These brackets are mounted on the base rectangle and to the uprights with self-tapping screws. This completes the
The main construction of the rack frame. The A.C. line switch should be mounted on the special bracket shown in Fig. 18F; this bracket is then screwed to the edge of the 1st shelf, on the right hand side of the framework. The final touch is to prepare and mount the aluminum ornament, shown in Fig. 18J. As can be seen, it consists of 3 pieces of angle aluminum screwed together and to the center of the top shelf.

THE LOUDSPEAKER SYSTEM

The dimensions of the baffle cabinet are given in Fig. 17. The front and rear panels are each one piece of plywood. The rear panel may be 3/4-inch thick, while the front panel must be at least 5/8-inch thick.

The top, bottom and two side panels must also be 3/4-inch thick. The sound track within the cabinet may be of celotex or plain pine boards. If a wooden sound track is used each board should be covered with some sound absorbing material such as felt, hair wool, kapok or cotton. If celotex is used, the various pieces should all be at least 1 inch thick to obtain overall uniformity.

Two different types of external field supply are shown, which will take care of practically any combination of speakers which the builder may desire to use, in the event that permanent magnet types of dynamic loudspeakers are considered too expensive. A small field supply which is inexpensive and yet very good is shown in Fig. 19A. Here a 25Z5 rectifier is used and is capable of supplying 100 volts at 100 ma., or 10 watts of field power. Two of these small supplies may be used in parallel, thus operating two fields, each of 1,000 ohms.

If it is desired to actuate a 2,500-ohm field from the same supply, only 40 ma. can flow, producing only 3 watts of field power. This is not really sufficient, so the other type of supply should be used. This is the high-voltage transformer type shown in Fig. 19B and is capable of supplying 300 volts at 200 ma., or a total of 60 watts, which is enough for 3 or 4 large speakers. The speakers which are being used to try out the laboratory model of the 35 tube receiver are two Utah (The Utah Radio Products Co.) 12-inch speakers, model II-12-25 (see Fig. 19C) with a field resistance (each) of 2,500 ohms.

The 9-ohm voice coils are paralleled and hooked into the 4-ohm tap on Chassis No. 3. The field coils are also paralleled, giving a total resistance of 1,500 ohms, and they are connected across a field supply of 200 volts at 150 ma., giving a field strength of 30 watts. This gives each field 15 watts.

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Fig. 17. Recommended speaker and optional power supplies.

Fig. 18. Here are the steps necessary to construct the rack for the 4 chassis. These specifications must be followed exactly if the chassis are to fit.
NEW TUBES
INTRODUCED TO RADIO MEN
— IN 1937-'38

From infra-midget to ultra-giant, the 13 types presented this month cover a size and power gamut never before encompassed in one crop of new tubes. The intermediate types are of equal interest to many technicians.

R. D. WASHBURN

NEW demands upon the electronic field by various services have resulted in the development and production of several unusual tubes which we have described; more orthodox but equally persistent requests from radio set makers for improved types also have been met by tube manufacturers whose latest designs are considered in this article.

XPD "Peanut" (2 V.) Diode-Triode. This tube—last in a line of peanut-size types previously described in Radio-Craft—operates in conjunction with the type XVS tube; A.V.C. being fed back to the control-grid from the diode of the XPD (shown pictorially in Fig. A). The XVS being a variable-mu screen-grid tube it is thus possible to produce a deaf-aid having A.V.C. and capable of maintaining a constant-volume output level. This arrangement completely avoids blasting on loud transients. Curves are available from the English manufacturer. (*)

Characteristics data on this tube appear at the end of this article in Table I. Tube terminals are shown in Fig. 1. Note that either of 2 base types is available.

XVS "Peanut" (2 V.) Variable-Mu Screen-Grid. Although especially designed for use in deaf-aid apparatus this tube, also shown in Fig. A, due to its variable-mu characteristic may be recommended for use in small-space radio receivers in which it is desirable to have a variable-mu type in order to reduce cross-modulation. (*)

Characteristics data on this tube are given in Table II. The pin connections are shown in Fig. 1.

814 Transmitter Beam-type R.F. Power Amplifier, Multiplier, and Oscillator. This is a filament type of ceramic-base transmitter tube incorporating new design principles involving the use of directed electron beams. See Fig. B.

Features resulting from the use of these principles in the 814 are that the screen-grid absorbs little power and that efficient suppressor action is supplied by space-charge effects produced between the screen-grid and the plate; full power may be developed at 30 megacycles. The resultant high power-sensitivity makes this tube especially suited for use as an R.F. amplifier, frequency multiplier, oscillator and plate-modulated amplifier.

Tentative characteristics and ratings, and maximum ratings and typical operating conditions as an R.F. power amplifier in class B telephony, are given in Table III. Further characteristics for class C telephony together with considerable operational data and curves are available from the manufacturer.

Tube terminals are shown in Fig. 1. (Data courtesy RCA Manufacturing Co., Inc.)

313A Cold-Cathode Gas-Filled (1) Relay, (2) Voltage Regulator, or (3) Rectifier Tube. The overall appearance of the 313A tube is shown in Fig. C. (In finished tubes the bulb is opaque to render the glow invisible.) Due to lack of space Radio-Craft until now has been unable to present this most important contribution to the electronic field. However, and although not strictly a new type in comparison with the other tubes described in this article, it merits special attention in view of its application in the article "Radio Waves Used to Completely Control Remote Receiver," which is appearing in April Radio-Craft.

As a circuit element, the 313A tube may be used to perform as a relay, as a voltage regulator, or as a rectifier. Within the tube there are two conduction paths, one between the 2 control electrodes, known as the control gap; and the other between one of the control electrodes and the anode, known as the anode gap.

The 2 control electrodes are coated with an activated surface of barium and the envelope is filled to a pressure of several centimeters of mercury with a mixture of the rare gases, neon being the principal constituent. The physical properties of the barium surface together with the nature of the gas-filling combine to produce a discharge device that operates on an unusually low voltage.

Each gap is characterized by a breakdown voltage and a sustaining voltage. This difference in breakdown voltage of the 2 gaps enables the tube to act as a relay.

*Most Radio mail order houses can supply this tube if properly identified as to type, title of article, issue (month) of Radio-Craft and year.
Two features of the 313A in a suitable circuit arrangement are of particular importance. One is the flatness of the voltage curve for positive currents, which makes the tube suitable for voltage regulation, and the other is the lack of symmetry in voltage for positive and negative currents, which allows the tube to act as a rectifier.

Characteristics data for various operational circuits and conditions, and of performance curves, are available from the manufacturer; general characteristics data are given in Table IV. Terminal connections are shown in Fig. 1. This tube has been developed by Bell Telephone Laboratories.

Super-Power Transmitter Tube. Something quite unusual in transmitter tubes and one which is mentioned here to illustrate the tremendous advance in transmitter tubes is the 250-kilowatt giant-size tube illustrated in Fig. D. Heretofore high-power tubes have only been "man-sized" but the new job now undergoing test at the Whippany, N. J. laboratory of Bell Telephone Co. is almost double the height of preceding types.

Inlet and outlet pipes feeding the outer jacket of this water-cooled vacuum tube may be seen leading leftward. The upper or outlet portion of this cooling jacket is mounted in a suspension cradle that helps support the entire tube; the lower end of the tube is supported by a ring-mounting plate which protrude the various connecting leads. Not shown in this view are the insulators which isolate the water-cooling system; and a foot-high corrugated insulator which holds the insulators and supports the weight of this tube. Vacuum tubes of this sort cost thousands of dollars.

6J8G Triode-Heptode Converter. This new converter tube (Fig. E) consists of a triode and a heptode unit having a common cathode and assembled in the same envelope. It combines a triode oscillator element with a heptode converter section, so designed as to avoid oscillator frequency drift with change in applied A.C. voltages.

Although the basing arrangement of this tube is such that in some applications it may be substituted for type 6A8G, with slight realigning, it is not primarily intended for use in this manner. As compared with 6A8G, the reduction of some of the interelectrode capacities is an important advantage in type 6J8G. High conversion gain is maintained at frequencies of 18 mc. and above, and the ratio of signal to noise is materially improved. The exceptionally high plate resistance of 4.5 mcg makes it possible to use a high-quality I.F. transformer with marked advantage in gain. The selectivity of a high-Q tuned circuit is not appreciably impaired by shunting the plate resistance of this tube across it. High input impedance is maintained under all normal operating conditions.

Characteristics data are given in Table V. Terminal connections are shown in Fig. 1.

(Continued on page 621)
**Wholesale Prices**

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Emission type perfected tube tester for any and all type receiver tubes, including metal and metal-glass. Tests shorts and leaks, etc. Accurate, simple, sturdy, direct — English — reading $10.00 (Bad-Good) .............. Operates on 110 volts, 60 cycle, A.C.

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Please Say That You Saw It in RADIO-CRAFT
The Growth of Broadcasting
(Continued from page 515)

scarcely going below 200 or over 2,500 cycles. This resulted in loss of "highs" and "lows" in the transmission of music and lack of natural quality in speech; the only reason it was acceptable is that early receivers were incapable of reproducing much more. As receiver design improved, the telephone companies kept step, offering radio lines of ever-increasing fidelity. Today almost every line for program transmission covers at least 100 to 5,000 cycles.

Came Super-Power—and High Fidelity

Of approximately equal importance was the development of super-power for radio broadcasting. Early stations had radiated low power, in most instances 100 to 500 watts. Considering the larger figure, one is immediately struck by the fact that this power, being dissipated in all directions, is slightly less than that consumed in the average 1-slice electric toaster.

With so little energy being radiated, the ratio of static to signal was extremely high; therefore static disturbances drowned out received signals very often during reception. But station engineers battled against interference, both natural and man-made, the fight culminating on May 2, 1934, when Povel Crosley, Jr. (who had begun broadcasting in 1921) increased WLW's power to half a million watts (in the antenna system), the first station of that power in the United States (or, for that matter, in the world).

High fidelity, about the same time, was receiving attention and it was found that carrier waves could be modulated to carry audio frequencies from 30 to 14,000 cycles, representing the upper and lower limits of average hearing. It was found also that stations could transmit such programs without incommensurate expenditures, and experimental high-fidelity transmission was begun. Only a few of the better receivers were able to take advantage of this improvement, however, until the manufacturing branch of the industry took cognizance of the better transmissions and began producing receivers capable of reproducing the extreme highs and lows. WOR claims to be the first regular commercial station to have adopted high-fidelity transmission as standard practice.

Importance of Short Waves in Broadcasting

Many consider the short-wave link as being next in importance. It has made possible not only the "stunt" broadcasts from airplanes, submarines, golf links, and similar points impossible to "hook-up" otherwise, but also the more important foreign penetrations. It antedates the previously mentioned steps by more than a decade, N.B.C. having used it in the mid-twenties for the presentation.
of European programs in America, at
not infrequent intervals.

Other advances are, for the most part, somewhat less revolutionary. For ex-
ample, WENR-WMAQ claims a "first" on the broadcast of football and base-
ball games, and on the presentation of
school and college classes by radio.

Other stations have originated other
programs of similarly great importance,
but immeasurably as much attention to
programming has benefited radio, there
is insufficient space to pay to each ad-
vent the tribute it merits.

MILE POSTS IN TELEVISION
(Continued from page 579)

The images, reproduced by cathode-
ray tubes are clear, with good detail
and adequate brilliancy. Size is still un-
satisfactory for general use, although
the newer tubes, which produce 8 x 10
inch images, are more nearly adequate,
though there is some loss of definition,
which is more apparent than real.

It must be stressed that the compari-
son of number of lines per television
image with number of dots per inch in
a printer's half-tone cut is unfair to tele-
vision. While the imperfections of the
human eye are such that it corrects for
a certain amount of lack of detail in
either still or moving images, it does
so in a much greater degree when image
motion is present.

Intermediate-film and projection-type
television have been aided by new high-
intensity illuminants; and, as recently
pointed out in Radio-Craft, high-defini-
tion video transmissions may soon
utilize up to 1,000 lines/frame.

Already in acceptable form for pub-
lic presentation, the release of television
may now be expected almost from month
to month. There are a number of sta-
tions throughout the United States
broadcasting television programs on an
experimental basis; television is well es-

tablished in England (where it is sub-
sidized by the government) and upon
the European continent. The major net-
works are ready for television—they
have studios and mobile (truck) pick-
ups constructed—and are in truth
straining at the leash.

With sufficient business upturn, to
make mass purchases of television
receivers in the $200 class probable,
broadcasting will commence. As to who
will bear the cost of programs—spon-
sors will, despite the comparatively few
sets which will comprise the early audi-
ence, for there will be publicity and
prestige for the first advertisers in
the new art.

The contention that the Federal Com-
munications Commission does not per-
mit televised advertising will no longer
exist, for it is safe to say that this im-
portant government bureau will do noth-
ing to hamper a budding industry, but
will cooperate and try to aid it in every
way.

Thus, with television, an old catch-
word will gain new meaning. It is:
"I'll be seeing you!"

WHEREVER TUBES
PLAY A VITAL PART
YOU'LL FIND
RAYTHEON
ON THE JOB!

It is just as important for you to use top quality
tubes as it is for the United States Navy. They use Raytheon
because it is the tube that can be depended on to work
smoothly in any circuit...and stand up under the roughest
usage and thundering vibration of a battleship under
fire. The Navy can't stop in the middle of a battle to find
which tube has blown!

Leading licensed set manufacturers, too, prefer
Raytheon because of their sturdiness and uniformity. And
when you make a replacement in a receiver you must be
just as confident. That is why thousands of Servicemen
and Dealers depend on Raytheon.

Order Raytheon for greater permanent tube profits.

RAYTHEON
CHICAGO • ATLANTA • NEW YORK • SAN FRANCISCO

"WORLD'S LARGEST EXCLUSIVE RADIO TUBE MANUFACTURERS"

Please Say That You Saw It in Radio-Craft
DEVELOPMENT OF SOUND EQUIPMENT

(Continued from page 571)

baffle design, such as the Stromberg-Carlson "labyrinth", the RCA "acoustic chamber", the Philco "inclined sounding board" and the Emerson mantle set "sonic chamber".

As there is an increasing tendency to combine radio receivers and phonographs in a single cabinet, there must be special mention of radio's debt to the phonograph, and vice versa. At first the debt was all in the phonograph's favor. The needle of an Edison ("hill-and-dale")-type soundbox, resting on the diaphragm of a headphone, "amplified" the sound by means of the phonograph horn. Later, as has been described, an adapter was made to couple the phone directly to the phonograph tone-arm, and still later special speaker units were made, to replace the soundbox. Rhamstine, years ago, brought out a diaphragmless unit with a vibrating armature; the needle in the soundbox of a phonograph of the Victor ("wavy groove") type was then rested in a groove in the armature. (Incidentally, other vibrating-reed reproducers, including Clyde Fitch's "Ensco" unit, were made to utilize all sorts of things—from a piano sounding board to a door-panel—as their diaphragms.)

The phonograph had undergone a far longer period of development than the loudspeaker, hence the trend was to make use of the acoustic advantages of its reproducer system.

But radio developed apace. Soon the amplifiers and loudspeakers equalled the tone of the phonograph—then surpassed it. Magnetic pickups, essentially reed-type speaker units with a needle holder on the reed, came into use. An early pickup put out by Pacent had no arm of its own, but clamped to the tone-arm of the phonograph which nearly every family then possessed.

Pickup design has had many variations, but has never abandoned the early basis, though a collateral branch has come into being. There have been, and still are, magnetic pickups with the armatures damped by oil or rubber, but they still adhere to the same principle that an armature moving in a magnetic field generates an alternating current of frequencies corresponding to its vibrations.

The other type in general use is the crystal pickup, utilizing the current-generating properties of the piezoelectric crystal when subjected to mechanical stress.

Any of the pickups, when connected to the detector or first-audio stage of a receiver, either directly or through an impedance-matching transformer, permit the reproduction of disc-recorded music through the loudspeaker.

Many are sold in conjunction with electric phonograph motors and turntables, but those are a separate field and save for mention that the combination of radio and phonograph was probably responsible for the replacement of the spring motor by the electric motor; they need not be considered here.
Sound-on-film is also a distinctly related industry, not included although directly attributable to radio which developed the necessary amplifiers and speakers. Most interesting is a reference in Motion Electronics dated May, 1919, for in that issue there is described the first sound-on-film talking motion picture apparatus. Though the light-beam method had not then been devised, the rudiments of the idea were there. But in no case it was proposed for a "hill-and-dale" sound track on the edge of the film.

Hence, we can see that the present highly-developed art of sound equipment and reproduction owes much to radio. Its fostering of an appreciation of music and good reproduction, then development of apparatus to satisfy the demand for more and better programs, has done as much for the public as has the public done for radio. By no means are the sound engineers of today content to rest on present laurels,—as is indicated by the almost daily release of new developments from the sound laboratories. Even 3-dimensional sound has been developed and is being perfected in the laboratories,—to produce realism along with high-fidelity reproduction. Some day in the near future we shall be "seeing" as well as listening, and the sounds will be related to the motion that takes place so that in every detail we will get an exact impression of being "Johnny on the spot" instead of alongside a radio receiver.

NEW CIRCUITS IN MODERN RADIO RECEIVERS

(Continued from page 505)

to the 2nd-detector has no gain and by disconnecting the diode there is no distortion of the signal from the pic-up due to rectification of it by the diode.

[S] SPLIT-LOAD PHASE INVERTER

Fada Model 916. A very practical application of the split-load type of phase inverter feeding 4 tubes in push-pull-parallel is shown in Fig. 1E. The plate load of the 6C5 A.F. amplifier is divided into two equal sections, one being placed in the cathode side of the plate circuit and the other in the plate side in the conventional manner. In this way, instead of all of the signal voltage variation appearing at the plate, half of it appears at the plate and half at the cathode. The signal voltage drops in the two loads are of opposite phase and of equal value so that the voltages may be appropriately coupled to these points. Resistor (6) is the usual grid bias resistor and the total of this with resistor (20) makes up the cathode lead resistance. One pair of power amplifier grids is fed from the plate of this phase inverter and the other from the cathode.

Radio-Craft considers this department to be an especially useful addition to practical radio literature. Comments from Radio-Craft readers will be appreciated.—Editor
The Best Step-up Transformer on the Market

The Thordarson Flexible Step-up Transformer surpasses every other make in all respects save price. Cheapest because it lasts longest. Extremely powerful. Design and construction embody highest type of mechanical and electrical perfection. May be used for Wireless Work, Generation of Ozone, Testing Insulation, Electro-Static, Separation, etc. For alternating current only.

Write for circular giving full information and prices.

THORDARSON ELECTRIC MFG. CO.
224 SO. JEFFERSON ST., CHICAGO

THIS ADVERTISEMENT APPEARED IN 1912

PREDICTIONS AND FULFILLMENTS

(Continued from page 594)

Horn attachments were used with our radio sets in 1922, and Mr. Gernsback in the October issue, suggested using larger diaphragms than the 2-inch ones then prevalent, stressing the need for greater area in the reproduction of music. He also deplored the use of metallic horns. The paper-cono speakers which followed a few years later were the answer.

In November, 1922, he raised the question of adequate instruction sheets to be supplied with all receivers as, at that time, most of them were sold without such printed information. Today every set carries data covering its installation and operation. That is an important prediction, for the wider use of instruction sheets has greatly increased public satisfaction with radio by virtue of improved performance when correctly operated.

In February of 1923, Mr. Gernsback wrote, “We predict . . . that radio frequency amplification will be used much more generally . . . . In 1923 we shall, no doubt, see the single-control outfit . . . . The next great improvement needed . . . . is the outfit . . . . that will do away with interference . . . . Only an expert can tune out the unwanted station . . . . The next improvement . . . . is the loud talker . . . . We predict that it will not be of the horn type at all . . . .” These predictions were followed by the neotrodyne which afforded more selectivity and soon was followed by ganged condensers. The cone speaker came somewhat later.

Wider use of educational programs was predicted in the April edition, and today such programs constitute an essential part of many daily broadcasts.

The year’s final issue carried a Gernsback editorial which again mentioned the need for simplified tuning, and went into considerable detail about what should be done. The point about the undesirability of the horn was made again, but this time Mr. Gernsback added a radically new idea, “That loud speaker, by the way, will be built into the future radio cabinet, and why shouldn’t it be?” It has been, as well you know.

It was in March of the following year, 1924, that he first predicted automatic tuning. It was similar to present push-button sets, except that Mr. Gernsback thought of jacks rather than buttons, and did not contemplate the addition of manual tuning in the same model.

June, 1924, saw a Gernsback prediction of radio installations in road houses and country inns. He asked editorially, “If city restaurants install radio loudspeakers, is there any reason why those
in the country cannot do likewise? A loud speaker in a store or inn will surely attract people by the hundreds.” Now we know who originated the idea which has made soothing silence a lost boon in America!

“The television,” wrote Mr. Gernsback in January, 1925, “will come to the front during the next three years.” And this statement was promptly followed by the booms of Jenkins, Baird and others. And a little over a year later, in February, 1926, he predicted a television and servicing instrument, the cathode-ray tube (used in an oscilloscope), saying, “Some day some one is going to invent a new sort of lens by which it will be possible to look into a radio set and actually see the radio frequency currents . . .”

Another tube, the screen-grid, then made in Europe though not commercially available in the United States, was predicted in August, 1926. Through their use, he wrote, “it should be possible to produce amplifiers of power far exceeding anything we have hitherto seen.” Today’s R.F. and I.F. amplifiers are proof that again he was right.

Shaper tuning was called-for in a March, 1927, editorial, and soon was made available by the manufacturers, who apparently watch Mr. Gernsback’s every utterance with an eagle eye.

June saw another Gernsback editorial on television. In this he told of the need for motors which would stay in synchronism. A year or so later, synchronous motors appeared on the market, not only for television, but in midget form for clocks as well.

He continued his discussion of television needs in the December, 1927, edition, saying, “I personally foresee the final television receiver, which will have incorporated into it some sort of vacuum tube, such as the Braun. The Braun tube, instead of using discs, or wheels, employs a cathode discharge. This latter, having no inertia, throws upon the screen a moving beam of light which responds to magnetic impulses. There should not be any difficulty in getting this beam to work at any required speed.” In view of present trends in television, all that one may comment is—!!!!

In May of the following year, he pursued the subject farther, prognosticating that early television sets would replace not only the loudspeaker, but would use the rest of the equipment, and that subsequently they would be built into the sound radio console, operating from house current. This, too, has happened.

The same editorial predicted the smaller console and the midget table model as a distinct trend. This, similarly, came about.

September, 1928, brought forth another bull’s-eye prediction when Mr. Gernsback wrote, “It would not surprise me at all if, during the next five years, the broadcasting of both sight and sound will be done completely on short waves . . . .” This was borne out by fact. The Columbia Broadcasting System accomplished it first, early in 1932.

Turning to some other of the writings of Hugo Gernsback, we find an editorial in the October-November, 1931, issue of Short Wave Craft. In this, Mr. Gernsback discusses the use of police radio and the possibility that criminals might listen-in to the alarms dealing with them. To obviate this possibility, he suggests that code words be used so that even if unauthorized persons do listen, they can learn nothing. Since that was written such code signals have won very nearly universal adoption throughout the United States.

In the March, 1933, issue of the same publication, Gernsback stresses the need for better band-spread in short-wave tuning, and for “noise-free” antennas. It was only a little later that the wave of enthusiasm for “split-second” tuning and for doublet antennas with twisted-pair lead-ins was manifested.

The need for work on the waves lying below 10 meters was considered in an editorial in the same publication for December, 1933, and the comparative freedom from static on such waves was pointed out.—As you know, television in the United States has turned entirely to these ultra-high frequencies.

Turning to Science & Invention, another Gernsback publication, we find more about television, at an even earlier date, for in the August, 1921, edition, Mr. Gernsback editorialized: “Within a comparatively short time . . . . we will be able to witness the future Dempsey—

(Continued on following page)
Again 
by Sprague

Since the first electric car in 1888—a Sprague invention—many electrical engineering advancements have been given industry—by Sprague.

No wonder that the latest—the SPRAGUE MIDGET fixed condenser—is attracting such widespread set-builder interest.

For the MIDGETS are factory tested at 1500 volts—have higher uniform breakdowns—constant capacities—insulated casings—quarter the weight—half the size; in short, they are midgets with electrical hearts of giants. Their new flexible lugs—presoldered—short-cut assembling expenses; saving screws, nuts, bolts, drillings and wire, too.

Just your address will bring you samples and all the reasons why Sprague Midgets will improve and economize in your set construction.

SPRAGUE SPECIALTIES COMPANY
Dept R.
QUINCY, MASS.

BOOK REVIEW


This book offers even more comprehensive treatment of the amateur short-wave field than the 14 previous editions. It contains about 600 illustrations, 290,000 words, 72 charts and tables, and 111 practical equations and formulas.

It is, perhaps, the largest volume of technical information to be sold at so low a cost, and represents 4 months’ work by 12 specialists in amateur radio.

Among the new chapters are ones on workshop practice, another on portable and emergency equipment, and another on fundamental principles. The latter is written for the complete novice.

All other chapters have been completely rewritten and modernized. Every radio man should have this reference work available.

PREDICTIONS AND FULFILLMENTS

(Continued from preceding page)

Carpentier fighter a thousand miles away with our own eyes, by radio, while out at sea. In other words, television by radio will be an accomplished fact. The truth of that statement is apparent, in the light of progress which has already been made.

The same publication, in March, 1924, ran another typical Gernsback prediction. He wrote, “At the present time there is a slow swing from the telephone loud set to the loud speaker. Local dealers will tell you that the proportion of headsets sold to loud speakers is 3 to 4. But in another year or two, the proportion of the loud speakers will probably be larger than that of the telephone receivers.”

An odd branch of radio, still little known to the layman though familiar to physicians, was predicted in the October, 1924, issue, when Mr. Gernsback editorially discussed possible effects of radio waves on the human body, expressing the belief that they would be beneficial. It was not until nearly a decade later that short-wave therapy came into use, however.

In September, 1927, Mr. Gernsback made a double prediction. He wrote of the coming of television, stating that within 20 years it would have won general adoption. This prediction is cited, although the period has not elapsed, to show that Mr. Gernsback was not one of the crowd who, each year, confidently predicted television “next season”.

His other prediction forecast air conditioning—an industry of no little interest to many radio manufacturers, distributors and Service Men.

He turned his attention to wired pictures and the trans-Atlantic telephone in the November, 1927, issue, stating that “... when the rates are reduced sufficiently to make it attractive, people will use the service. And, incidentally, the inventions will go begging no longer, but will coin handsome dividends.” The telephone rate from New York to London was $25 a minute in those days; it is now $21 for 3 minutes during business hours and $15 on Sundays. Traffic has increased tremendously. Similarly, the wire-photo service is in daily use by newspaper syndicates.

Lack of space prevents more complete discussion of the forecasts of Hugo Gernsback, but the collaborator wishes to add that there is hardly an issue of any technical or popular scientific publication which Mr. Gernsback has owned or edited that does not contain one or more predictions. A large percentage of such predictions have come true. The fact that not all of the Gernsback statements have as yet been proven in no way casts doubt upon their accuracy. The mere transmission of power, interplanetary communication, and telemechanics are well within the bounds of possibility. Work has already been commenced in these fields.

Today’s dream becomes tomorrow’s fact.
RADIO IN THE FUTURE
(Continued from page 591)

school children would find this a much more pleasant method of doing much of their homework.

The physical size of radio sets, particularly when it comes to portables, is undergoing radical change even now. Already it is no trick for the short-wave enthusiast to build a radio set that will bring programs from other hemispheres, which can conveniently be placed in one's coat pocket. Future radio is going much further than this.

Radio tubes are continually being improved. They are also getting smaller and smaller. We already have radio tubes with a diameter no larger than the little finger. The day is not far distant when an efficient radio tube will have shrunk to the size of a rubber eraser at the end of a lead pencil. The future tube will probably be "cold"; that is, instead of having a glowing filament, electrons will be supplied by some chemical or other means. That means, of course, that the power which we require of a radio set will be infinitesimal. I foresee the time when the pocket set will not require any batteries at all; whatever electricity is required in order to operate the set will be supplied by a tiny electric generator housed in a case no larger than your watch. Indeed, the generator will be driven by means of a large watchspring, and will run for a considerable period. At present there is already manufactured a small flashlight and-operated by means of a tiny dynamo, but the bulb consumes a comparatively large amount of power.

So the watchspring-driven electric generator becomes a certainty in the not too distant future. In fact, the entire radio set will be small enough so that the watchspring generator, molecular speaker and whatever tubes are necessary will go easily into the vest pocket. Indeed, the set will be small enough so that it can be concealed in the hand. You will say, as a toy this might be interesting, but what practical use is there for sets of such type? The answer to this is that as civilization progresses, instant communication is of paramount importance. Twenty years ago you probably would have laughed at the idea of ear-radio, but in the future no one will wish to be without his vest-pocket set because of its efficiency. He has not only within reach of the more efficient, large radio sets. We may be in the street, we may be on a train, we may be in a theatre, in a restaurant or any of hundreds of other places, and may wish to be in touch with the outside world.

By that time, of course, the radio set will not only be equipped for broadcasting but for personal messages as well. Physicians, contractors, business men, and others find it necessary to be in touch with their offices many hours of the day. Special broadcast stations will be erected whereby special messages to certain individuals will be broadcast. This is particularly important for physicians. Such broadcast stations probably will operate at special frequencies. In other words, this will be a glorified paging system, but not limited to the confines of a hotel; it will be possible to page individuals within a radius of 100 miles.

By this time every radio set, whether pocket or otherwise, will be television equipped, but this is no longer news. You may ask, how will I be able to see a television program by means of a vest-pocket set? The answer to this is found in another prediction, not as yet realized, which I made in the October, 1936, issue of Short Wave Craft. This has to do with an instrument which I term television "spectacles." In other words, you wear a pair of "spectacles" which have a twin television receiver built right on the eye-glass frame. This means, of course, that the television images received are small, but they need not be large, because they are right up close to your eye; indeed they will be sharper in this manner. Therefore, all you require is to put on "television eyeglasses" and you will see and hear at the same time, because the frame of the television set on the bony part of your nose will also, by molecular vibration, transmit the sound to your ear-drums in a most realistic fashion.

And let no one think that this exhausts the list of future radio developments. As I have said many times before, the really big radio inventions are still in the future.
ELECTRIFY your Radio without "revolutionary" rebuilding of set

All power from light socket automatically controlled from "A" unit "on" and "off" switch. Webster B and BC units give minute regulation up to 180 volts (plus) for quality reception.

**Price $23.00 to $38.00**

Raytheon Tube $4.50 extra

Those who bought Webster last year are our best boosters—they are satisfied. Any set owner examining the working parts inside the case can see at once the Webster is dependable for years to come. A try-out convinces any owner of a good radio that the Webster unit gives amazingly improved reception.

Webster "Bone-Dri" A with Elkon Rectifier

$39.50

For any set requiring up to 2 1/2 amp. Equipped with control switch and line voltage control. With the Webster A-10 Elkon equipped and B or BC units Raytheon equipped, you can completely electrify any battery receiver without "revolutionary" rewiring of set. If your dealer will not supply Webster units, don't take a substitute. It will pay you to write us for address of distributor nearest you and complete booklet.

THE WEBSTER COMPANY

860 Blackhawk Street

Chicago, Ill.

SUPER-REGENERATION—IN 1922

Here is an illustration of Major Edwin H. Armstrong's super-regenerative loop receiver—about 1922. The original caption speaks for itself: "An invention that amplifies an ordinary radio receiving set 100,000 times and eliminates the use of outside aerials is the latest work of Major Edwin H. Armstrong, formerly in charge of Uncle Sam's radio service in France. This super-regenerative circuit with 3 vacuum tubes gives the same result as an ordinary receiving set would give with 9 vacuum tubes. Another feature of Major Armstrong's invention is its simplicity—it having but 3 adjustments. The essential super-audible or squelching frequency was obtained from an oscillatory circuit that included the 1,250-turn honeycomb coil which appears so prominently (alongside the box under Andrew Halbran's left hand) in the photo. The photo-shy major couldn't be induced to pose with his achievements of "making 3 tubes do the work of 9," but he did snap this picture.

Please Say That You Saw It in Radio-Craft
done with interstage shielding—and put the shields in the fields of the R.F. coils to introduce loss in that way.

Then came the Neutrodyne! They were the sensation of radio. If you didn’t have a Neutrodyne, you were such a social outcast that your very dog hid under the bed at your approach and looked at you reprovingly, because the dogs of Neutrodyne owners wouldn’t associate with him.

The Neutrodyne used a low-capacity trimmer condenser of unique design between the grid and plate of each tube in the R.F. to neutralize the internal capacity between these elements. The Hazeltine corporation, which owned the patents, formed its licensees into an organization that advertised as a group and protected its patents mutually.

Besides its high efficiency and freedom from oscillation, the Neutrodyne had a novel and valuable feature—you could actually “lock” it! That is, a station often would come in at the same place on the dial (there were 3 of them) twice in succession. “Daddy,” said the little boy in the advertisement, “get Los Angeles.” “Just turn the dial to 32 and there it is,” the father replied—and there it was indeed, especially if the set was in Hollywood.

The 3-circuit regenerative sets were of about the same period. These were the old “bloopers” with an untuned primary antenna winding loosely coupled to the grid coil. They bloomed, but the oscillations did not radiate, and a degree of peace came to the kilocycles. These sets, too, could be logged after a fashion.

Then came the “supers”—the super-heterodyne. There had been a few super-regeneratives, but they were mostly home-made; the supernets, were factory produced. RCA put out some really good ones, with the I.F. stages sealed in a mysterious can (known as the catacomb) to prevent tampering.

One of their best sets at that time used a new and wonderfully economical tuning, the U.P. 60—six one-hundredths of an ampere filament current, and had a remarkably low plate current as well. It could be operated from small batteries, which could be housed in the cabinet, and neatness of installation took a large stride forward.

One of these sets, put out in the middle 20’s, had a sloping panel, much like many present sets, and operated on a loop antenna which projected from its lid. The cabinet could be had provided with legs—and console models could then be seen dimly in the offing. There was also a portable super, which had its loop concealed in the cover, much like several of the portable T.R.F. and reflex sets. This one, the model 26, was a really first-rate job.

It was about then that “A,” “B” and “C” eliminators came into use, and electric sets were foreshadowed. Indeed, some sets which used special tubes that would operate with A.C. on their filaments made their appearance, but they met with considerable skepticism. Fans,

(Continued on following page)
who had been given a separate rheostat for each tube, felt that there simply would be enough hum to interfere with DX reception, and the sets did not meet with the popularity they merited.

Late in the '20's another new tube arrived on the radio scene—the screen-grid tube—an entirely new device than the power output tubes of some years before. The latter had made it possible to increase the bass response of the set; the former simplified R.F. amplification, for they were efficient, yet could not oscillate. With their advent, the neodyne circuit began to wane in popularity, as sets using '22's became the fashion.

A short time afterward, the '27's again revolutionized radio. These were the first tubes that the public could be convinced would work well on A.C.—with no "A" eliminator needed. They heralded the birth of the "all-electric" set—radio as we know it today—for while the 210's and other A.C. power tubes had been used, people had still been rather dubious as to the wisdom of trying A.C. in the earlier stages. Soon thereafter the '24's—A.C. screen-grid tubes—were out, and radio went to town. The fashion was A.C. tubing.

Superhet's had not enjoyed the fullest possible popularity because, in most of them, not only did the dials fail to "track," or read the same for a given station, but in many instances the same station could be tuned-in at two points on the dial—and listeners had learned to demand "accurate logging." It was not until the early 1930's that single-control "one-spot" supers, (A.C. operated, of course) began winning the lead which they have never since lost.

Tone control was the next real achievement, and while it has since won universal acceptance, it met with a mixed welcome at first, as some set users held that it merely added another knob to turn. These people, who now thought 3 controls too many, were probably the same people who had happily twirled the 17 knobs and dials which tuned the 3-tube sets of a decade before.

Tuning meters, so that the stations could be brought in "on the nose" were another useful adjunct of the same date. These were, at first, simply milliammeters in the screen-grid circuits of the I.F. tubes, when automatic volume control was used. This A.V.C. was, by the way, a distinct advance, for it eliminated the blasting which had formerly shattered the ear drums when a powerful station was tuned-in after a weaker one. The tuning meters were, with one or two notable exceptions, merely meters, the popular "shadow" type simply substituting a pane in the path of a light beam for the familiar needle. The cathode-ray type, popularly called by the copyrighted (RCA) name "Magic Eye," did not come into general use until the middle '30's.

Quiet automatic volume control, "Q.A.V.C.," which smothered inter-station background noises by cutting sensitivity when no carrier was being received, began attracting notice about 1934 and
has since won general acceptance, and the following year, all-wave tuning became something that every set had to have, save in the lowest-priced models. The folks who previously had the honeycomb-coil sets sat around with bored fond recollection on their faces. But the new sets were far simpler to operate; band switches (remember the "Navy" sets?) made shifting from one range to another merely a matter of turning a switch, to cut one group of coils out of the circuit and another group in.

Then came high fidelity. Early sets had reproduced audio frequencies from about 200 to 3,000 cycles, then had improved to handle 100 to 3,500 cycles. For a while it was believed that 100 was about the lower limit, and that 60-cycle hum would come through if the set went much lower. But as filtering was improved, some de luxe models of the early '50's handled 20 to 4,500 cycles with no trouble. By 1953, high-fidelity sets reproduced from 10 to, in some instances, 14,000 cycles, resulting in far more natural speech and music.

Automatic frequency control, which moved mysteriously to make the set tune perfectly when tuned approximately by hand, came next. This resulted in the re-birth of automatic tuning, which had been tried and virtually abandoned some 10 years earlier.

Oil-time sets had used both mechanical and motor-driven automatic tuners, but the difficulty of compensating for minor tuning variations had rendered such systems somewhat less than 100% satisfactory. Now A.F.C., as well as automatic temperature compensation (obtained through the use of thermostatic trimmers), have made automatic tuning practical.

Radio has become respectable. Sets are complete units, with self-contained speakers, as Hugo Gernsback prophesied when such perfection was undreamed of. But is the radio listener of today as happy as the fan of yesteryear? I doubt it, for though programs have improved along with equipment, the old thrill is largely gone. No more does one wonder, every time the set is switched on, whether it will actually work! Perfection has replaced chance in radio reception.

BOOK REVIEWS

OLD WIRES AND NEW WAVES, by Alvin F. Harlow. Published by D. Appleton-Century Co. Size, 6 x 9 ins., cloth covers, 548 pages, over 70 illustrations. Price, $5.00.

Here is a zest for chronology of communications dating from the days spoken of in Homer's *Hind* down the years to the present day. Throughout the book is the note of optimism that spurred on the indefatigable workers of yesteryear.

Every effort has been made to maintain authenticity; and where the author found historical statements confusing, he presented, to the best of his ability, both sides of the story and allowed the reader to judge.

The average radio man may feel that this book is incomplete in not treating extensively with the subjects of broadcasting and television, and other phases of radio, however, it must be remembered that the book is intended only to present the historical background of communications. In this connection the book is quite complete in discussing point-to-point telegraphy and telephony by wire and radio. The undeniable important part that amateur radio played in communications development, however, is not mentioned; and, too-great emphasis is placed upon the telephone. Taken all-in-all, though, the volume makes interesting reading; and is an excellent reference to historical dates in communication. It will be a valuable addition to any library.

Please Say That You Saw It in RADIO-CRAFT

MICROPHONE MEMOIRS, by Credo Fitch Harris. Published by The Bobbs-Merrill Company. Size, 5½ x 8¼ ins., cloth covers. 281 pages. Price, $1.75.

This book is light reading of the most entertaining sort. It is dated for the period subsequent to 1922; its reading tempo is tuned to suit the dilettante who wants to really enjoy an extensive reminiscent period. Although the locale revolves around WHAS, Louisville, Ky., the retrospect is quite representative of the more glamorous days of radio's infancy—or to quote the author, "the Horse and Buggy Days of Radio."

The charming informalities of Radio's early period are gone forever, and the odd and amusing customs of the past can be found only in such works as this.
The Story of Amateur Radio

(Continued from page 563)

United States was trying to maintain its neutrality. Government officials had reason to suspect the Telefunken station, WSL, at Sayville, L. I., and asked amateur C. E. Appgar, 2MN, whose work was known to them, to help check. He recorded the German station's transmissions and turned them over to the Secret Service. The transmissions proved to be reports on allied shipping, sent to German submarines, and WSL was closed and confiscated.

The United States and Germany were drifting closer to war, and in the autumn of 1915, the A.R.R.L. told the government its members would cooperate if the occasion arose, and was cordially thanked. Then in April, 1917, all amateur stations were ordered closed by the United States government.

Shortly after our entry into the war, the Navy called upon the A.R.R.L. for 500 capable operators and any good radio equipment that might be available. The request was complied with inside of 10 days, and by the end of the war, more than 3,500 A.R.R.L. members were in the service as operators.

The amateurs were allowed to recommence operation of their receivers on April 12, 1919. On September 26 of the same year all bans were called off, transmission was permitted again, and before the end of the year, amateur radio was re-established.

With experience gained in the war-torn years, the amateurs began replacing their spark transmitters with tube oscillators (C.W.), and a few of them then started to send out voice and music in addition to code. One such amateur was 8XK; you can read more about him in the article "The Growth of Broadcasting" (in this issue), for he was Frank Conrad, whose pioneering in radio transmission of music gave birth to the present billion-dollar radio entertainment industry.*

In the latter part of 1921, Paul F. Godley was sent to Scotland to erect an amateur listening post, so that trans-Atlantic tests might be conducted. So many were the American amateur stations that he heard, and preponderantly C-W. stations, too, that the prestige of the amateur rose immeasurably as a result of that test. The fact that the amateur could do so much with so little power and on wavelengths that were previously held in contempt was a revelation to both the public and the giants of the industry.

The amateurs—all 60,000 of them now operating in America today—are more than a mere part of the radio picture. They are a part of life in the United States. An important part, too, for they continue, year after year, to serve the nation faithfully, whatever be its needs.

*Dr. Lee de Forest, Frank King, and George Eltz, as well as the Detroit News had staged earlier musical broadcasts, without important result.
Some Old-Time Radio Stations (Continued from page 589)

spectrum. No small wonder that these stations had to use tremendous power and extremely large and lengthy antenna systems. The tuning coils on the receivers, for receiving these wavelengths, were also very large—sometimes resembling huge Tesla induction coils. In general, though, commercial wireless seemed to favor the 600- to 1,000-meter range.

The first attempt at legislation of commercial wireless was made at the International Radiotelegraphic Convention, held at Berlin in 1906, which provided that the wavelengths of 300 and 600 meters be assigned for commercial wireless work. The wavelength of 1,600 meters (or band from 600 to 1,600 meters) was reserved for governmental coast stations. However, these provisions did not at that time apply to wireless in the United States, since this country sent no representative to the Convention. The U. S. had no real laws governing wireless until The Wireless Law of 1910 was signed by President Taft, and which only became effective on July 1st, 1911. The tenets of the International Convention were not ratified by the Senate until January 22nd, 1912.

From this period on, and until the United States entered the World War, commercial wireless grew by leaps and bounds, and when finally this country did enter the War, the shore stations that were established by this time proved to be an invaluable asset. When the War started there were 35 Navy coastal stations (privately-owned commercial stations were much more numerous), and 45 Marconi stations for ship-to-shore service. These the U. S. Navy took over, and in 1918 purchased them outright. Their calls were heard by innumerable wireless operators of those days, and amateurs as well, since listening-in to commercial news, press, etc.—especially, the NAA press reports after the 9:56-10:00 P.M. time signals—was a favorite pastime that provided good practice to attain "copying speed."

Today, the number of shore stations in the United States is difficult to estimate, since wireless (radio) is no longer confined to ship service. Aviation, Police, Paeifico, Press, Communication (radiograms), Wireless Telephone, Broadcast, Military (Army and Navy), Experimental (television, etc.), all tend to make the number run into many thousands.

Meanwhile the ghosts of old stations still linger in the background. Arlington still sends out Time Signals; Nauen, Germany, still transmits on the upper wavelengths where now, if one were to listen-in, an almost graveyard silence prevails in contrast to the old-time busy chatter. The Eiffel Tower is somewhat more modern, having included facilities for radiophone and, we understand, television transmission, but the call letters are the same . . . probably to serve as a reminder of its past glories.
of the Institute of Radio Engineers on his typewriter. The Institute of Radio Engineers was young and broke, so Doc carried on. Later Vice-President in charge of Engineering for RCA. An inspiring force—with a mind loaded with engineering data seasoned with a priceless sense of humor—to the younger.

Curtis, back from erecting the wireless station at Manoa, the modern city now buried in the jungle. What a yarn he spun.

Armstrong, new on the horizon with his mystery black box, filled the phones with signals. Armstrong later, over a flying field in France, changing a ballast lamp on a wind-driven generator far out on the wing. Fessenden, the burly giant, whose genius produced steel antenna towers, the heterodyne, the radio-frequency alternator, and the Arlington Station. Fessenden was an addict to the smoking of his own special brand of poisonous, black, skinny, long and particularly vile stogies. No survivor ever thereafter accepted another offering of them. Fessenden delegated Bill Beakes to press the key, for the first time, at the opening of Arlington. Bill tied 2 broomsticks together—for distance seemed desirable—and gave it a tap. A deafening crash. Bill dropped the stick and made a World's record 50-meter sprint. Fessenden has passed on, and today Beakes heads-up the United Fruit Co. radio system.

Hazeltine, starting in radio by giving our crowd in Navy Radio a much needed lesson in tube mathematics, and winding up as one of the great names in the field.

Coffin, laddling out stiff doses of B-kernels in German as part of his job, and creating for his own amusement, his vector analysis, and the formulas we all use for calculating inductance.

Clark, over at the Navy, sticking pins into turn and measuring inductance for his coil-curve library. An atheist who refused to believe the Bureau of Standards' "Inductance Bills."

Wiegant and Ferrand, battling at the Institute over the static eliminator.

Simon, sparkling with enthusiasm, surrounded by assorted genius, producing exotic masterpiece of design, and pioneering in aircraft radio, and radio intercity communication networks.

Eaton, keying high powers, and bringing sanity by his modesty and clear thinking to the Washington Navy Yard madhouse.

Lofitin, running around in France with 8 Eiffel towers under one arm and a 1,000-kilowatt arc job under the other, later to erect Lafayette, for many years the most powerful station in the world. Afterwards he was to tackle the job of studying and evaluating every patent in the radio art for Uncle Sam.

Alexander, of the agile sliderule and contempt for mere size. He gave us Gargantuan antenna systems, and transmitters. From paper-thickness steel he evolved ponderous machinery that safely whirls at the edge of destruction, spaced by microscopic clearances maintained by one of his brain children.

Fuller and Beal, provided the arcs that proved that Navy operators can drink the food of the generators of their design, namely, alcohol mixed with benzine; and live, and come back for more.

Jack Binns, and he makes me think of the lonely memorial in Battery Park, inscribed with the names of the heroes of wireless, true men who maintained the traditions of the sea.

The transmitter room. The architect team of Stone, Stove and Roos. The famous Cutting and Washington team. Craft and his Army mule test, Logwood the inspired. The logical Ballantine. Squires with his waves on wires. White, his tubes and his common sense. Godley and Maxum, egging-on the "hams" with their distance work. Cooper-Hewitt in the Madison Square Tower. Davis the empire builder. Lowenstein the perfect engineer, and later on, the KDKA group.

De Forest, the master magician, I have saved for the piece de resistance. The creator of 5 billions of dollars of American industries. His inventions are the essential starting point of much of the present-day discoveries. Thus far we can credit him with the invention of the vacuum tube, broadcasting, the long-distance telephone, the commercial radio telephone, motion pictures with sound-on-film, the radio knife, high-frequency therapeutic fever equipment, and a host of elements of these. Television would be impossible, the photoelectric cell would be still a laboratory curiosity, the concentric cable undreamed-of without his inventions. You who have prospered from his inventions, or those whose lives have been saved by his radio knife, or who have had death-dealing germs removed from their bodies by his fever equipment, as well as the uncounted millions whose spirits have been lifted and strengthened by the influence of his radio broadcasting and talking motion pictures owe this man an incalculable debt. Fortunately this brave soul is with us today, a tireless worker and unsoured by the fact that his magnificent contributions have not lined his pocketbook. (America has produced only one other giant of his measure, the beloved Edison.) Gentleman, our hats off to the greatest member of our craft!

**William Dubilier**

Vice-Pres., Cornell-Dubilier Electric Corp.

**Pioneer in radio and specialist in condenser design and manufacture.** His activities in this field are responsible for the development and manufacture of condensers since the era of the Leyden jar. Holds innumerable radio patents pertaining to telegraphy, telephony, high-frequency apparatus, and a system for detecting submarines which he devised during the World War.

I first became interested in radio when I read in the local papers that Marconi was coming to this country to lecture on his wireless telegraphy apparatus in 1903. In 1904 and 1905 I assisted in giving lectures for some of Marconi's associates who remained here and then began to build some of the early coherers and open spark coil transmitters, using medical induction coils.

In 1906 I was associated with the Continental Wireless Telegraph and Telephone Company. It is not generally known that I operated the equivalent of a broadcasting station as early as 1909. The novelty of receiving music through the air appealed to the owner of an amusement park in Seattle. He fitted up a set and erected a sign "Listen to the Wireless for 10c." Strangely enough, every time that I visited the amusement park and attempted to listen-in, I was told that the apparatus was out of order. The receiver was working, but there was no music to pick up—for the simple reason that I was not at the transmitter to operate it!

In 1908 I formed my own company—the Commercial Wireless Telegraph & Telephone Co. I remember buying equipment in 1908 or '09 from the Electro Importing Co., run by a young man named Hugo Gernsback who had a room upstairs on West Broadway and who was selling wireless apparatus, Branley coaxes, spark coils and other equipment.

In 1907 and 1908 I exhibited radio, telephones and telegraph apparatus at the electrical show at Madison Square Garden, then at Madison Avenue and 23rd Street, for the Collins Wireless & Telephone Company. About the same time, I also organized one of the first amateur societies with a membership approximating 550. The first meeting was held in Montclair, New Jersey. During those early days of radio and radiograms, it is strange to recall how the industry started with patent litigation and seems to have continued so up to the present time. I definitely recall the constant patent fights between the Marconi Company and the United Wireless Telegraph Company. Mr. Samuel Darby, father of the (Continued on page 522)
NEW TUBES INTRODUCED TO RADIO MEN
—IN 1937-38

(Continued from page 601)

to advantage in home-type battery sets where low heater consumption is desired; with the same plate voltage it has about 4 times the power sensitivity of the 38, which requires twice the heater current.

The 6G6G is a pentode-type power amplifier tube designed for service in the output stage of receivers where maximum over-all efficiency is required.

Characteristics data are given in Table VIII. Terminal connections are shown in Fig. 1.

(Data courtesy Raytheon Production Corp.)

310A Pentode Voltage Amplifier for Carrier Systems. Increasing use of wired radio makes it necessary that the progressive technician keep himself posted on new developments in this field.

It is of interest therefore to note the features of several new tubes especially designed for use in such carrier-current service. The 310A indirect-heater tube for instance, shown in Fig. E, has the following operating conditions.

The control-grid normally operates at 3 V. negative with respect to the cathode. The screen-grid of the tube provides electrostatic shielding between the control-grid and the plate. This is accomplished by externally tying the screen-grid to the cathode through a condenser, thereby effectively grounding this grid at voice and carrier frequencies. The 310 has about 3 times the voltage gain of the type 102F tube previously used in this carrier service.

Partial characteristics data are given in Table IX; terminal connections are shown in Fig. 1. Bell Telephone Laboratories developed this tube.

328A. Except for its filament characteristics this tube is a counterpart of the type 310A described above. Filament rating: 0.425-A. at 7.5 V.

311A Pentode Power Amplifier for Carrier Systems. The power output of the 311A (Fig. E) is about 9 times greater than that of the older, type 104D tube which is the power tube used in existing carrier systems.

The 3rd-harmonic is about 35 db. greater in the new tube but this is permissible since the new carrier systems use feedback and the 3rd-harmonic is thereby reduced to an acceptable value.

Unlike tubes of this general type commonly available for radio receiver use these new tubes are designed to meet the much more severe demands of carrier "telephone" service. For instance, the insulators are supplied with ceramic material to further improve the insulation, and the small metal plates used for electrostatic shielding are formed to act as baffles to prevent metal, sprayed from the surface of the cathode, from being deposited on the insulators and causing leaks.

(Continued on page 623)
present Mr. Darby, was the then famous patent attorney. (No wonder the present Samuel Darby knows his onions.) The Wireless Telegraph Company sued the Marconi Wireless Company and Fessenden sued them all. I recall being present at the various cases when textbooks and ordinary fiction were read into the testimony, one side trying to air out the other by making the suit expensive. It is strange to relate that some of the litigation relating to patents of that date were only recently settled by the Court of Claims—the Marconi patents claim against the Government.

During those old days, it was a constant sales struggle among the various companies to see who could sell more stock. Marconi Company started with a small office of 2 rooms in the Lords Court Building on William Street. The original stock of this company skyrocketed from $5 to $125 before they had a station going. The various companies started by de Forest sold many millions of stock to the public, all the companies subsequently folding up.

The amateurs of that time were the only ones making constructive advances in the industry. The commercial organizations and the governments engaged in making the world radio conscious by selling stock. The financiers used the radio companies as a means for hooking the public. The engineers had a hard time to build apparatus badly needed for the ships. I recall at one time when the United Wireless Company installed wireless equipment on military ships and the manager informed me that his company sold millions of dollars worth of stock, he couldn’t get enough money from the main office to buy transformers to fill orders. However, in order to fill these old orders, he gathered together all the old brass and junk in the plant which he sold to a junk man to get sufficient money to buy the necessary transformers. Rules, no regulations, no government interference.

De Forest finally moved to a little place on Sedgwick Ave., the Bronx, where with the assistance of Charles Gilbert he made little coils, crystals, and audions. The 3-stage amplifiers then weighed about 80 lbs. and sold for $500. When the United Wireless Company purchased the patents from de Forest and presented them to the British and French governments, They were the first 3-stage amplifiers seen in France and the radio department of the French Navy was astonished to find amplification of 10,000 times in the 3-stage amplifier. These were built by de Forest in America.

Very few realized at that time the importance that the radio tube or received audion would play in the development of electronic science. It was the foresight of Mr. Folk of the American Telephone & Telegraph Co. who paid de Forest $250,000 for his radio tube inventions which enabled de Forest to do further work with this tube. It was no doubt the greatest contribution made to the A. T. & T. and a great deal of credit should be given to Mr. Folk in acquiring this valuable invention which later proved to be of inestimable value to the A. T. & T. I recall how everybody was surprised at the amount paid but it was the biggest bargain that A. T. & T. ever received.

From the angle of non-cooperation, cut-throat patent litigation, the industry has never grown up. It is only in recent years that we have learned how to cooperate as radio companies in various European countries have, so here we find a radio set selling for less than the cost of the tubes in any other country. The famous American institution of profitability business is part of the radio history.

JOHN L. REINARTZ—
Consultant, RCA Mfg. Co., Inc.

WHAT early amateur or constructor hasn’t heard of the famous “Reinartz” circuit, or Reinartz’s activities in furthering amateur radio? His leadership and fine work while with the American Radio Relay League is recognized by many of its members, especially his efforts to help make the first amateur trans-Atlantic tests a success. A real old-timer and radio pioneer!

Pierre Boucheron—
Remington Arms Co.

One of the earliest amateurs in the New York area, Pierre Boucheron waged some of the first battles for radio’s rights in the United States. He later became editor of Radio News (then a Gernsback publication) and subsequently went to a high position with the Radio Corporation of America. Mr. Boucheron, though no longer active in radio, has earned a niche in its history.

No dubious claim to radio fame, if any, dates back 30 years when I was one of New York’s pioneer wireless amateurs. Early in 1908, I came to the Big Town with a 1-inch spark coil purchased from the original E. I. Co., some dry cells, a regular telegraph key; I soon set up a 100-foot aerial atop a walk-up apartment on East 45th Street. With this outfit I proceeded to make life miserable for the night crews of the two nearby wireless stations who had to pound brass for a living, namely, the United Wireless, “NY” and the Brooklyn Navy Yard stations.

There was but a handful of local amateurs, of which there still live and thrive Major E. H. Armstrong of superhet fame, George Elitz, Ernest Amy, Louis Pacent, Joe Fried and several others whose present whereabouts and state of health are unknown to me. Oh yes, there was a millionaire playboy in the Bronx who owned, believe it or not, a 5 kw. etheric-power plant, and when he was “sending,” every commercial, Naval and other operator on the entire Atlantic seaboard just stood by, groaned and waited for the din to cease and desist—which might be from an hour to a day. No rules, no regulations, no Government supervision. Just a lot of free-for-all, healthy fun, packed with a thrill a minute. Of course, we all knew who was who, and where. The professionals would telephone the boys (affluent ones who had ‘em) and beg “please, old man, won’t you PLEASE stand by for a few minutes; there’s a ship

(Continued on page 624)
NEW TUBES INTRODUCED TO RADIO MEN — IN 1937-38

(Continued from page 621)

Of special interest are the low inter-electrode capacities which in carrier service constitute an element of unusual importance. It is also of interest to note that the heater voltages chosen, for the types 310A and 311A tubes were based on the connection of 2 type 310A heaters in parallel and this combination operated in series with the heater of 1 type 311A tube. This arrangement results in high-efficiency operation in "regulated" offices where the battery voltage is held close to 24 V.

The characteristics data are available in Table X. Tube terminal connections are shown in Fig. 1.

(Data courtesy Bell Telephone Laboratories.)

329 A. Except for its filament characteristics this tube is a counterpart of the type 311A. Filament rating: 0.85-A. at 7.5 V.

WL-706 Voltage Regulator Tube. There are 2 general types of regulator tubes, in one make, of which the WL-706 type is representative. These are voltage-regulator and current-regulator tubes. As both types are different in construction and principle as well as in application, they are described separately. Both types were illustrated in the article, "Keeping Your Radio Alive" in August, 1937 Radio-Craft; they are included in this later article for completeness of data-reference.

The WL-706 tube is a cold-cathode gaseous type. It, therefore, has a tendency to maintain its voltage drop at a constant value regardless of ordinary fluctuations in the supply line voltage. Thus it may be used to regulate the D.C. plate voltage applied to amplifier tubes and many other electronic circuits. As the operation is entirely electronic the regulation action is practically instantaneous. Incorporated in the WL-706 is an auxiliary electrode which by special circuit connections initiates the ionization, thereby permitting the tube to break down and be used on lower voltage lines than would otherwise be the case.

Characteristics are given in Table XI. Terminal connections are shown in Fig. 1.

(Continued from page 625)

...for
AMBITIOUS MEn ONLY!
F. L. SPRAYBERRY
Associate Professor, Radio Engineering, University of Illinois

THE MOST IMPORTANT COUPON YOU'LL EVER CLIP

I OFFER A NEW Home Training COURSE THAT WILL SUPPLY THE RADIO EXPERTS of TOMORROW!

Fellows! Radio is proving up. Every week, thousands of homes throughout America are being equipped with Radio receivers. Vast strides are being taken in commercial Radio. Every trend, activity in the Radio Industry is bristling. Good paying jobs by the hundred are springing up in all branches of the Industry for properly trained men. Why not prepare yourself now, for the bright, easy future that's yours?

Don't Wait 'Til It's Too Late

The fellows who get Plenty will be the ones who remained the big salaries at tomorrow. My Training will give you a thoroughly sound training in every branch of Radio. I've simple and easily understood are the lessons that you need have prepared you for the work you will be doing. It will give you the tools to handle them efficiently.

Already A Big Demand for Servicemen

Today, but, the days of home owners alone will provide employment and need for the services of servicemen. If you are a do-ityourselfer, I will train you for a home service man. I'll show you how to handle them yourself.

"Yes, Joe's Going Into Radio"

Only a few weeks ago, the wife of one of my students wrote in and said: "I tell you, Joe's going into radio. He has first been interested as a 'weekend' hobby. His income was fair, but three days work in the very month increased his Radio Training, and in the short space of the time, he was able to take his first paying position, with some spare time jobs that you showed him how to get. In fact, he has a chance opportunity ahead of him, and your Training is just what he needs."

Remember, fellows, you don't have to be a 필요한 수준으로의 새로운 서비스 엔지니어의 주관적 주제 in your studies to be interested as a "weekend" hobby. With ambition and good judgment one can do very well in Radio. Why not study Radio with us? Let me show you where the money is to be made and how to make it.

USE COUPON AT TOP TO GET COMPLETE FREE FACTS!

...for
AMBITIOUS MEn ONLY!
F. L. SPRAYBERRY
Associate Professor, Radio Engineering, University of Illinois

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USE COUPON AT TOP TO GET COMPLETE FREE FACTS!
sinking off Hatteras and we're trying to get her position
from 'HA' (Cape Hatteras)."

Wireless in some sweet, irresponsible days of our youth
(I don't believe that the word "radio" was even coined then)
was just a free, unbridled, bucking bronco, and wireless
operators, commercial and Naval as well as amateurs, were
a select crowd of swashbuckling young braggarts, of a
doo-doo-doo breed, comparable, I suppose, to the later-day crack-
heads who flew Jennies with "OX-5" grinders over the French
lines during the "teens of the War. Ah me, those were the
days!

Later, we New York amateurs became more numerous
and troublesome, and as a consequence, there began to creep
up some resentment from certain quarters about our noise-
making on the air, so we formed a <i>protective</i> association
headed by young W. E. D. Stokes, Jr., whose father was a
power. We met and denounced this interference with our
inalienable rights as free Americans. A clipping in my
yellowing Scrap Book, dated November 30, 1910, reports an
attendance of 20 ardent souls at the first and only meeting
ever held to denounce the Depew bill "which proposes to
require a Federal license for all wireless stations" and a
resolution was passed to send young Stokes to Washington
to see Congressman Whosoit about it. Ah me, again!

Codes? Could we read, rapidly, what was going on in
the air? Certainly. Some of us were land wire operators,
and since the American Morse Code was then the more
or less official wireless code of the U. S., it was easy to copy
and gossip about everything that went on whether sacred or
otherwise. What few foreign ships were equipped used the
Continental Code. This was a cinch, too, for many of us
had learned to read that Code as well as American Morse
via the nightly broadcasts of "CC" (Cape Cod), a powerful
Marconi station of the day that sent Marconigrams and
press items to ships at sea, over and over again the whole
night long. So missed one word (speed was 12 w.p.m.)
you got it on the next round.

And there was the now long-forgotten Navy Code, the
first letter of the alphabet which I recall was 2 dashes,
instead of a dot and a dash. Unlike the Continental and Amer-
ican Morse Codes which have many letters in common, there
was no Navy character the same as any one of the other
two codes. I suppose the master minds who originated this
Navy Code sought extreme secrecy. They got it, too. For
it isn't on record that any operator ever got beyond the speed
of 5 words per minute with it, which of course soon meant
complete oblivion for the Navy Code.

Finally, there came a day when it began to look as if the
commercial and Naval authorities were going to have the
last word about the right-of-the-way of the ether. Gloomy talk
was heard about regulations, examinations and licenses, and
the fines and even imprisonment for the willful boys bold
enough to break the impending new laws. Then came that
fateful International Conference of 1912. It looked bad
for those unhampered, damped amateur waves. So those
liberty-loving spirits among us amateurs of 1910-12 who
could not bear the thought of being muzzled sought Escape
to the Tropics where we could pound away brass to our
hearts' content amid the roar of the thunderous static that
prevails there most of the year 'round.

We individually did this by casting aside drab land ties,
such as school, job, or even sweetheart, and signing-on in
the role of "Sparks" on board passenger, freight or tramp
ships of the then scant American merchant marine. And
what glorious years those were! Adventure, glamour, trans-
sient love—all mixed with the proper amount of storms,
hurricane, wrecks, murderous captains, and other hazards
of land and sea, of course. I fell in easily with this motley
crew and there still hangs, in fact, Certificate of Skill
No. 50, which was the very first attempt by the Government
to license these sea-going radio rovers.

But that is another story, and since my old friend and
one-time editorial chief, Hugo Gernsback, has confined me
to a few hundred words, I leave you, oh, gentlest of readers,
with a sigh for the past and a salute to the future of our
beloved radio.

LOUIS GERARD PACENT—

WHEN, more than 20 years
ago, amateur radio was
being born, one of the leading
spirits in the new field was
Louis Gerard Pacent, who had
started his activities in 1906.
He is a Fellow of the A.I.E.E.,
I.R.E., S.M.P.E., and Radio
Club of America, where he
held the office of President.
Noted as a radio and sound
engineer, he has contributed
much to radio's progress.

In the year 1865, Professor James C. Maxwell of the
University of Edinburgh, Scotland, by a series of brilli-
ant mathematical processes, attempted to show that such
things as electromagnetic or radio waves must exist. Pro-essor Maxwell predicted that electric oscillations in a circuit
would produce electric waves in the ether and that these
waves would travel with the velocity of light.

A few years later, Professor Heinrich Hertz, of Karlsruhe,
performed experiments that proved definitely the existence
of the radiations that were predicted by the Scottish
mathematician. Later, at the University of Bonn, Professor Hertz
performed a number of classical experiments along these
same lines. Most of these experiments were on wavelengths
which even today are considered "short." He not only
propagated these radio waves, but he detected them, yet he
did not realize the tremendous possibilities of his achieve-
ments.

The man who had the vision necessary to see the possi-
bilities in the then fairly well established theory of electric
er waves was Guglielmo Marconi. Marconi, at a very
early age, began experimenting with radio apparatus and
developing it along the lines which were to make it a com-
mercial success. In June, 1896, he filed a patent with the
Patent Office of Great Britain, covering "Improvements in
Transmitting Electrical Impulses and Signals and an
Apparatus Therefor." From this time on, Marconi was the
leader in the new art, and due to the perfection of the
apparatus so far developed it seemed to Marconi that the
long wavelengths held the greatest promise for transmission
over great distances. The other great minds of early radio
concurred with Marconi in this belief, and the rapid
commercial development of radio on the longer waves was a
result. Accomplishment is also a strong argument, and per-
haps for the reason that long-range communication on the
longer wavelengths was already established, it was grad-
ually assumed that such communication could not take
place on the short wavelengths. As a matter of fact, this belief
was so firmly established that when the Government assumed
authority over the various agencies using the ether to
transmit intelligence and allotted to the amateurs wave-
lengths of 200 meters and lower, it was at first thought to
be a death blow to amateur radio. The amateurs, however,
did not give up and soon proved that long-range communica-
tion on shorter and shorter wavelengths was not only pos-
sible, but possible with infinitely less power than that used
on the long waves.

Many will recall the first signals on 200 meters, trans-
mited by radio station WBCG at Greenwich, Conn., and
received in England by Mr. P. F. Godley, under the auspices
of the Radio Club of America in 1920. (See Proc., Radio
Club of America, Vol. 2, No. 2, February, 1922.) The idea
of transmitting amateur signals across the Atlantic originated
with the writer before the World War, when it was pre-
sented to the Board of Direction of the Radio Club of Amer-

(Continued on page 628)
NEW TUBES
INTRODUCED TO RADIO MEN
—IN 1937-38
(Continued from page 623)

important when those filaments are of the thoriated or oxide-coated type. This requisite constant filament voltage may be obtained either by connecting the WL-896 in series with the tube filaments as a ballast tube, or in series with the filament transformer primary, with secondaries delivering their requisite filament voltages. The tube also may be used to maintain constant voltage from storage batteries, particularly those in aircraft, or wind-electric or gasoline-generator service. Technical data are given in Table XII; tube terminals are shown in Fig. 1.

(Name of manufacturer will be supplied upon receipt of a stamped and self-addressed envelope.)

WL-788. This tube except for variations in its characteristics is a counterpart of the WL-896. Characteristics data are given in Table XIV. Tube terminals are the same as shown, in Fig. 1, for the WL-896.

CHARACTERISTICS DATA

\[ \text{XPD—Table I} \]

**Average Characteristics**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filament voltage</td>
<td>2 V.</td>
</tr>
<tr>
<td>Filament current</td>
<td>75 ma.</td>
</tr>
<tr>
<td>Amplification factor</td>
<td>6.7</td>
</tr>
<tr>
<td>Impedance</td>
<td>7,400 ohms</td>
</tr>
<tr>
<td>Mutual conductance</td>
<td>0.2 ma./V.</td>
</tr>
<tr>
<td>Av. diode current</td>
<td>200 microamps.</td>
</tr>
<tr>
<td>* Taken at Ea=6 V. *</td>
<td></td>
</tr>
</tbody>
</table>

\[ \text{XVII—Table II} \]

**Average Characteristics**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filament voltage</td>
<td>2 V.</td>
</tr>
<tr>
<td>Filament current</td>
<td>75 ma.</td>
</tr>
<tr>
<td>Amplification factor</td>
<td>6.7</td>
</tr>
<tr>
<td>Impedance</td>
<td>1.3 microamps.</td>
</tr>
<tr>
<td>Mutual conductance</td>
<td>0.5 ma./V.</td>
</tr>
<tr>
<td>Mutual conductance</td>
<td>75 ma./V.</td>
</tr>
</tbody>
</table>

\[ \text{XI—Table III} \]

**Tentative Characteristics and Ratings**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filament voltage (A.C. or D.C.)</td>
<td>10.6 V.</td>
</tr>
<tr>
<td>Filament current</td>
<td>0.25 A.</td>
</tr>
<tr>
<td>Transconductance, for plate</td>
<td>3,300 microamps.</td>
</tr>
<tr>
<td>Direct interelectrode capacities:</td>
<td></td>
</tr>
<tr>
<td>Grid-Plate (with external shielding)</td>
<td>0.1 mil. max.</td>
</tr>
<tr>
<td>Input</td>
<td>15.5 mil. max.</td>
</tr>
<tr>
<td>Output</td>
<td>13.5 mil. max.</td>
</tr>
</tbody>
</table>

**Maximum Ratings and Typical Operating Conditions**

As R.F. Power Amplifier—Class B Telephony

\[ \text{Carrier conditions per tube for use with a max. modulation factor of 0.9} \]

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>D.C. plate voltage</td>
<td>1,250 V. (max.)</td>
</tr>
<tr>
<td>D.C. screen-grid voltage</td>
<td>300 V. (max.)</td>
</tr>
<tr>
<td>D.C. plate current</td>
<td>60 ma. (max.)</td>
</tr>
<tr>
<td>Plate input</td>
<td>75 ma. (max.)</td>
</tr>
<tr>
<td>Screen-grid input</td>
<td>8.7 W. (max.)</td>
</tr>
<tr>
<td>Plate dissipation</td>
<td>50 W. (max.)</td>
</tr>
</tbody>
</table>

Typical operation:

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>D.C. plate voltage</td>
<td>1,000 V.</td>
</tr>
<tr>
<td>D.C. screen-grid voltage</td>
<td>200 V.</td>
</tr>
<tr>
<td>D.C. grid voltage (grid No. 11)*</td>
<td>-28 V.</td>
</tr>
<tr>
<td>Peak R.F. grid voltage</td>
<td>50 V.</td>
</tr>
<tr>
<td>Beam-forming-plate voltage</td>
<td>0 V.</td>
</tr>
</tbody>
</table>

(Continued on page 627)
ica for consideration. The War prevented their carrying out these experiments at the time, but after the War, successful experiments were made and the results obtained aroused the radio world.

This brings to mind that in 1915 or thereabouts 100 to 200 meters were considered short waves and the general engineer- ing opinion at that time was that these waves would not travel long distances. In recent years short waves of the order of 10 meters were also considered that they would not travel the curvature of the earth and only travel short distances. Now both of these theories have been disproved and waves of 10 meters and less have covered half the world. Everyone has now awakened to the possibilities of the short waves, and we now see radio once more attempting to return to the short wavelengths used by Hertz, so long ago.

IRVING VERMILYA, WIZE—
Radio Station WNEH, Standard-Times, Mercury

It certainly gives me great pleasure to look back over the long years, and to recall some of the incidents and happenings of those years gone by. Certainly, a lot of "radio water" has passed under the bridge since I first became interested in radio in 1901 (and thus earned the sobriquet of "Amateur No. 1"—Editor). At that time I lived in Mt. Vernon, N. Y., and can well remember making trips to New York City in an effort to buy radio material, and I can also well remember that there was almost an impossibility to buy anything connected with radio in that day. Having been keenly interested in wire telegraphy, I naturally made the strongest effort to obtain wireless material at the J. H. Bunnell Co., which was located in Park Place, N. Y. C. As those years pass by, I have fond recollections of being able to buy radio equipment from Hugo Gernsback's Electro Importing Co. I can also well remember that Mr. Gernshaw launched probably what was then the first radio amateur call book in the world, and I was duly registered in this book under the call letters of "VN". This was many, many years before the Government even issued any license to any types of wireless stations and the wavelengths that we boys used in those days were anything from 200 to 900 meters. I recall with great pleasure having worked the following stations back in those dark dim years.

FW—Frank King; DR—Dr. Hudson; CC—C. Cannon; DX—Mr. Meyers; HB—A doctor in N. Y. C.; FH—Arthur Boeder; and WA—C. Runyon, Yonkers, N. Y.; and many others whose call letters I cannot now recall. Today under the call letters of WZE which I have now held for 22 years, I am still operating with a kilowatt on 5, 20, 80 and 160 meters both phone and C.W. and I would be very glad to contact any of my old friends.

Incidentally, some of the "newer-timers" may be interested to learn how I acquired the appellation of "Amateur No. 1." This was the title of an article I wrote, and which appeared some years ago in QST, in which I recounted how I had visited Marconi at Goat Hill and watched him fly his kites, and how, when I returned home, I then set up a coherer-decoherer and Ruhmkorff-coil amateur radio station—in 1901. I was 11 years of age. A year later I was presented with one of two coherers Mr. Marconi had given Dr. Tyndall.
NEW TUBES INTRODUCED TO RADIO MEN
IN 1937-38

(Continued from page 625)

*Grid voltages are given with respect to the mid-point of filament circuit operated on A.C.
if D.C. is used, each stipulated value of grid voltage
should be decreased by 7 volts and the circuit
returns made to the negative end of the filament.
*Beam-forming plates should be connected to the
mid-point of filament circuit operated on A.C., or
to the negative end of the filament when
a D.C. filament supply is used.

<table>
<thead>
<tr>
<th>313A—TABLE IV</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ratings</strong></td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td>Max. peak control-electrode current</td>
</tr>
<tr>
<td>Max. average control-electrode current (avg. over 1 sec.)</td>
</tr>
<tr>
<td>Max. peak reverse current in main gap</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Characteristics</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal control-gap breakdown voltage</td>
</tr>
<tr>
<td>Nominal control-gap sustaining voltage</td>
</tr>
<tr>
<td>Nominal main-gap breakdown voltage</td>
</tr>
<tr>
<td>Nominal main-gap sustaining voltage</td>
</tr>
<tr>
<td>Transfer current</td>
</tr>
<tr>
<td>Nominal deionization time</td>
</tr>
<tr>
<td>Control gap</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>6J4G—TABLE V</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Triode-Heptode Converter Characteristics</strong></td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td>Heater voltage, A.C. or D.C.</td>
</tr>
<tr>
<td>Heater current</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Operating Conditions and Characteristics</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Heater voltage</td>
</tr>
<tr>
<td>Plate voltage (heptode)</td>
</tr>
<tr>
<td>Control-grid voltage (heptode)</td>
</tr>
<tr>
<td>Screen-grid voltage (heptode)</td>
</tr>
<tr>
<td>Oscillator plate voltage (triode)</td>
</tr>
<tr>
<td>Oscillator grid resistor (triode)</td>
</tr>
<tr>
<td>Plate current (heptode)</td>
</tr>
<tr>
<td>Screen-grid current (heptode)</td>
</tr>
<tr>
<td>Oscillator plate current (triode)</td>
</tr>
<tr>
<td>Oscillator grid current (triode)</td>
</tr>
<tr>
<td>Plate resistance (heptode)</td>
</tr>
<tr>
<td>Conversion conductance</td>
</tr>
<tr>
<td>Control-grid voltage (heptode)</td>
</tr>
<tr>
<td>Control-grid plate current (heptode)</td>
</tr>
</tbody>
</table>

*Applied through 20,000-ohm dropping resistor.

<table>
<thead>
<tr>
<th>6ZY5-G—TABLE VI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tentative Data</strong></td>
</tr>
<tr>
<td>-------------------</td>
</tr>
<tr>
<td>Heater voltage</td>
</tr>
<tr>
<td>Heater current</td>
</tr>
</tbody>
</table>

As Full-Wave Rectifier

<table>
<thead>
<tr>
<th>Operating Conditions: Condenser Input to Filter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heater voltage*</td>
</tr>
<tr>
<td>A.C. plate voltage per plate (r.m.s.)</td>
</tr>
<tr>
<td>Peak inverse voltage</td>
</tr>
<tr>
<td>Peak plate current per plate</td>
</tr>
<tr>
<td>D.C. output current</td>
</tr>
</tbody>
</table>

When the D.C. resistance of each half of the secondary of the power transformer is less than 625 ohms, sufficient resistance should be added in series with each plate to provide this minimum of resistance.

*The D.C. potential between heater and cathode
should be limited to 400 volts.

Under no condition of operation should
the normal operating heater voltage of 6.3-volt ever fluctuate to exceed a maximum of 15 volts.

(Continued on page 629)
REMINISCENCES OF OLD-TIMERS

(Continued from page 626)

Just at the end of this First Decade, as I have placed it, I was happily given the position of laboratory assistant to Dr. Lee de Forest. He was then carrying forward his work on the audion, which up to that time had been principally a modified Fleming valve sensitized by the addition of a plate-circuit battery. During my time with de Forest, the very first "grid audion" (or 3-electrode vacuum tube) was built; the fact that I ran and took notes on the first plate-voltage—plate-current characteristic of this veritable but tiny grand-daddy of all radio amplifiers is perhaps one of the fondest of my early wireless memories. That particular little job was so significant, so prophetic of what afterward came to dominate radio, that I often wonder whether we are today doing anything that will be equally the basis of a great part of the radio practice that will exist 30 years from now. Perhaps we are; and if I were asked to put my finger on a single item of today's work that might contain the germ of an important radio service likely to flame into significance within the next 3 decades, I think that for that position of honor I would select point-to-point, and broadcast Parsimone.

J. R. POPPELE
Chief-Engineer, radio station WOR

TONS of expensive equipment, complicated apparatus, connected together by numerous heavy cables from studio to transmitters, to power plant room. Such is the picture of broadcast station WOR, of which Poppele is chief-engineer. It sends 50,000 watts into the ether whenever the station is "on", and Poppele and his staff see to it that WOR functions smoothly and efficiently.

DESPITE the efficient, nation-wide industry which broadcasting has become today, there are few old-timers who cannot look back upon the early days before the war without a smile.

A personal recollection of my first encounter with radiotelephony is that it was a baffling experience. At the age of 13 or 14, like many of the other radio pioneers, I built an amateur wireless transmitter, operating under the call letters 2AEY at my home in Newark. It was a customary quenched-gap spark rig of the era, with a simple galena crystal detector as receiver—one of those patience-exacting outfits where one spent interminable minutes adjusting the all-important cat's-whisker to find the point of greatest sensitivity. My first wireless contact, I recall, was with another amateur across the Passaic River from my home.

Then one day in March, 1912, something new came into the headphones. Instead of the customary raucous spark, raspy as a file, I heard music—the strains of Tipperary.

Somehow, I felt this was impossible. So I searched the house for a phonograph, threw open the window and listened to see if the phenomenon were coming from a neighbor's house. But only in the harmonium was there music.

A worried note to old Modern Electrics solved the mystery. There actually was a station accomplishing this seemingly impossible miracle of broadcasting music and voices by wireless and I had heard it.

These days of national networks and voices from the remotest cities of the globe are a far cry from March, 1912. And there are other recollections which crowd back upon us when we start remembering.

The wonderful Geissler tube, forerunner of the neon bulb, which I won for selling subscriptions to Modern Electrics, has not been forgotten. Nor have the halcyon days of the Great War when wireless altered the pattern and speeded the tempo of modern warfare. Then again, as a ship's operator in the North Atlantic during 1919, I copied a message to watch for Alcock and Brown, the pioneer trans-Atlantic flyers. Imagine the thrill when I saw their frail plane pass us 10 miles off on the horizon and reported its progress to an anxious world.

And today, when such memories seem amusing, when such wonders have become commonplace, I am still proud to have been both a witness and a participant in the progress which has made radio a foremost factor in the web of modern communication and culture.

This concludes Radio-Craft's presentation of reminiscences of old-timers in radio. Although space limitations preclude the inclusion of the many more pioneers who helped lay the foundation of modern radio, we salute you, one and all.

A $750, KC.-CALIBRATED TUNER—IN 1927!

A DECADE AGO, when custom set building was in its heyday, your Managing Editor—who's interest in radio is hereditary (Mr. Washburne, pere, having built his first spark coil and coherer-detector set in 1897)—joined Radio Construction Labs. and now presents the first published account of what was probably the finest engineering feat of that period. "I was de Forest's son," he avowed, "and knew whereof I speak. Rudolph Siemens, in collaboration with Paul Levy and business associates Howard Smith and John Murray, was producing a custom-built tuning unit that sold, sans audio system, for $750, and that could be guaranteed to pick up (even at West End Ave., locations in New York City) programs originating in California.

The final design of the tuner incorporated 5 stages of radio-frequency amplification, (4 stages— as shown in photo and figure—were used in early designs) in an improved Wheatstone-bridge version of the Rice neutrodine circuit. A single, cast-metal dial, with accurate calibrations in kilocycles printed on the arch (1), was used (the other type—as shown in photo—used 2 dials). Each stage employed a type 201A tube, and was completely and individually shielded and bypassed; and could be individually cut into an out of circuit at the flick of a switch. All 5 stages resulted in "California" sensitivity and somewhat better than 10 kc. selectivity straight across the band; a letter number of stages were used for local (less sensitive and general) reception. Two Hammerslund straight-line-frequency variable condensers were required in each stage; a tool-steel shaft turned all 10 condensers, without backlash, merely by blowing on the periphery of the tuning dial. A heavy, cast-metal base was found essential to maintain alignment,
NEW TUBES INTRODUCED TO RADIO MEN—IN 1937-38

(Continued from page 627)

884—Tubas VII

Tentative Data

<table>
<thead>
<tr>
<th>Heat voltage</th>
<th>6.3 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat current</td>
<td>0.6 A</td>
</tr>
</tbody>
</table>

Direct Interelectrode Capacities:

| Grid to plate | 3.2 mmf. |
| Grid to cathode | 3.5 mmf. |
| Plate to cathode | 2.5 mmf. |

Tube voltage drop: 15 V. approx.

As Sweep-Circuit Oscillator

| Plate voltage (instantaneous) | 300 V. (max.) |
| Peak voltage between any two electrodes | 350 V. (max.) |
| Peak plate current | 300 ma. (max.) |

Average Plate Current:

| For frequencies below 200 cycles/sec. | 3 ma. (max.) |
| For frequencies above 200 cycles/sec. | 2 ma. (max.) |

Grid Resistor—The resistance of the grid resistor should not be less than 1,000 ohms per maximum instantaneous volt applied to the grid. Resistance values in excess of 0.5 meg. may cause circuit instability.

As Grid-Controlled Rectifier

| For frequencies below 55 cycles per sec. | Peak voltage between any two electrodes | 300 ma. |
| Average plate current | 350 V. (max.) |
| Average over period of not more than 30 sec. | 75 ma. (max.) |
| Grid Resistor—The resistance of the grid resistor should not be less than 1,000 ohms per maximum instantaneous volt applied to the grid. Resistance values in excess of 0.5-meg. may cause circuit instability. |

Heater voltage should be applied for 30 seconds before drawing plate-load current.

The cathode should preferably be connected directly to the midpoint of the heater winding. In circuits where the cathode is not connected directly to the heater, the heater may be made negative with respect to the cathode by a potential difference not to exceed 100 volts provided the peak voltage between any electrode and the heater does not exceed 350 volts.

625—Table VIII

<table>
<thead>
<tr>
<th>Ratings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heater voltage (A.C. or D.C.)</td>
</tr>
<tr>
<td>Heater current</td>
</tr>
<tr>
<td>Maximum plate voltage</td>
</tr>
<tr>
<td>Maximum screen-grid voltage</td>
</tr>
</tbody>
</table>

Amplifier—Class A

| Plate voltage | 135 | 190 V. |
| Screen-grid voltage | 135 | 190 V. |
| Grid bias | -6 | -6 V. |
| Self-bias resistor | 449 | 510 ohms |
| Amplification factor | 600 | 400 |
| Plate resistance | 0.12 | 0.15-meg. |
| Transconductance | 2.100 | 2.900 |
| Plate current | 11.5 | 15 ma. |
| Screen-grid current | 2 | 25 ma. |
| Load resistance | 12,000 | 10,000 ohms |
| Total harmonic distortion | 7.5 | 10 P.C. |
| Power output | 0.3 | 1 W. |

The voltage between heater and cathode should be kept as low as possible where they are not directly connected.

Transformer or impedance input systems are recommended. If resistance coupling is used the B.C. resistance in the grid circuit should not exceed 0.5-meg. with self-bias. With fixed-bias the B.C. grid circuit resistance should not exceed 0.5-meg. under the 190 volt operating condition or 0.05-meg. under the "150 volt" condition.

(Continued on page 611)
orders fell off—as they have done every summer since that day. Coggeshall, my partner, thought that the wireless business was gone for good, and he offered to sell the apparatus and leave. I bought out the stock for a low figure, he and I parted company, and he departed for Chicago, leaving me as sole owner of the E. I. Co.

By that time we had moved to 87 Warren Street, a few blocks northwest from No. 32 Park Place where our first office had been. The new work reproduced in its pages was done by Mr. Coggeshall, who was also an artist with a flair for beautiful women as exemplified on the cover of the first E. I. Co. catalog.

Several issues of this green-covered catalog were sent out thereafter, and soon trade was brisk again, and more and more people climbed up the 5 flights of stairs at 87 Warren Street to become initiated into the mysteries of radio. Soon I brought out another catalog, on the cover of which I displayed the words “Modern Electrics”; and this, a few months later, became my first magazine.

“MODERN ELECTRICS”

Indeed, this was the first wireless or radio magazine in the world, and immediately started to make history. While the magazine was always operated separately from the E. I. Co., nevertheless the two were contemporary, and their fortunes were woven inextricably into each other. Neither the E. I. Co., nor the magazine made sufficient money to support me; but both of them together could support the organization, and gave the wireless amateurs of the day something that they could not have had otherwise. And it must be said in praise of those early amateurs that they responded nobly and supported my enterprise, much better than could have been expected.

The service was not always of the best; the apparatus was still crude, and Modern Electrics in its first few issues had not achieved any great journalistic or literary efforts. But these were the pioneer radio days where anything went, as is usually the case when explorers sail uncharted waters. It soon became necessary to move from 87 Warren Street to 84 West Broadway, because the former quarters proved too small. It was really on the 4th floor of 84 West Broadway (which still remains today as it was in those days) that the E. I. Co. and Modern Electrics found their stride. The sinking of the Republic, with the heroic exploits of her wireless operator, Jack Binns, caught the imagination of the public, and a small boom for wireless immediately began. People flocked for wireless and we were there to give it to them. By that time it had improved somewhat, and we started to manufacture wireless apparatus in earnest.

Indeed, forthwith I designed no less than 7 pieces of radio apparatus which became famous in their days. They comprised the Universal Crystal Detector Stand, the Double-Slide Electro Tuner, the Adjustable Transmitting Condenser, a sending Helix Inductance, the Electro Variable Sliding Plate Condenser, the Zig Zag Sliding Plate Condenser, and the Electro Variable Potentiometer, all of which are reproduced in these pages. These were all original designs and were, later on, copied by practically every wireless manufacturer of note. I still remember the day when I took my first flying woodwork-plant, and had them fashion the samples for all of the apparatus which was afterward issued.

The only troublesome item was the potentiometer. Here I used the lead of a pencil as a resistor; and we used to buy pencils by the thousands, then soak them in hot water until the leads fell out. I originally had gotten hold of a number of Dixon pencils, and had a local laboratory test the resistance of various leads. I found one—a carpenter’s flat pencil with a rectangular lead—of 300 ohms and another of 500 ohms. So we adopted these pencils and proudly announced the fact, that with each potentiometer, we furnished 2 rods, one of 300 and one of 500 ohms. We were blissfully ignorant of the fact that not all pencils would test alike; so that soon we began to get complaints that our 500 ohms were, maybe, 600 or 700, and our 300 ohms were either double that, or perhaps, only 50 ohms! How could we have known that pencil manufacturers were so careless in their “ohmage” when making pencils?

So I went to see the manager of the Dixon Crucible Company, makers of the pencils, and told him our requirements. Thereafter, they actually manufactured for us resistance rods which were accurate and dependable, so far as the ohmic resistance was concerned.

In lead-up to the first issues of Modern Electrics, I came across an article written by me in the May 1907 issue of that magazine entitled “The Dynamophone.” This now came to have a second first in a remote-control radio apparatus. As the article shows, I energized the transmitter by a microphone, whose impulses were superimposed on the spark and ensuing radio waves. At the receiving end, this operated the coherer and detector and an electric motor. It makes it thus the first remote-control wireless or radio apparatus on record. (See Fig. 45.)

RADIO “FIRSTS”

There were, however, other “firsts.” For instance, in 1910, across the street at 69 West Broadway, I opened what was to become the first radio store the world had ever seen. This became the mecca for radio experimenters and amateurs of the day, and we really did a very huge business for the small compass of that store.

The only trouble was that we could not supply the material as fast as it was demanded. I had some rather famous customers at that store, too. Thus, we recorded, one of the sons of President Theodore Roosevelt, one of the grandsons of John D. Rockefeller, and many others.

I must not forget another important “first” and that is the vacuum tube and the thing we called it was offered to the public through the E. I. Co. catalog in 1911. It was also advertised in the July 1911 issue of Modern Electrics by the E. I. Company. No vacuum tubes for radio purposes had previously been offered to the public.

The E. I. Company also sold parts for vacuum-tube amplifiers as early as 1913, mostly to jewelers all over the country. Many of them wrote in to us that with 1200 audions hooked up with an E. I. Co. coupling impedance, they were able to pick up Arlington time signals (NAA) on 2500 meters and amplify the signals with such volume that they could be heard a block away from the store. This was excellent advertising for the jewelers in those days.

It was also the E. I. Co. which sold probably one of the first, if not the very first, wireless telephone sets. This included a hand-fed French transmission set, sold by H. W. Secor, were sold by the E. I. Company to a number of colleges and governments, including a 2-kw. set which was bought by the Brazilian government.

There was another important “first”; in the January 1909 issue of Modern Electrics, I announced the formation of the Wireless Association of America. It was actually the first national association anywhere, and it is believed that it was also the first wireless club in existence.

It is true that, in January, 1909, another radio organization was formed—the Junior Wireless Club of New York City. But inasmuch as the January issue of the magazine came out in December, and the arrangements for the Association had been made in November and December of 1908, it is most likely that the honors of “first” should go to the Wireless Association of America.

In any event, it was the first national organization to bring amateurs from all over the country together under one head. Let me quote from that excellent book, Two Hundred Meters and Down, the story of Amateur, by Clinton B. De Soto, Assistant Secretary of the American Radio Relay League:

“The Wireless Association of America was a child of Hugo Gernsback, publisher of Modern Electrics. After the first few months of its existence, Gernsback announced a membership totaling 3,200. By November 1910, he claimed...”
A Wonderful "NEW VOICE" for Radio

The New
QUAM
CONE SPEAKER

Retail at
$17.50

The Quam Loud Speaker introduces a new and startling improvement in Loud Speaker construction. Instead of a floating reed secured at one end, the Quam Speaker has a Stretched Reed—like the human vocal cords. The result is amazingly superior to any you have heard before.

Directors of the Wireless Association of America were as follows:

Dr. Lee de Forest, President
John Stone Stone, Vice-President
Wm. Mavor, Jr., Secretary
Hugo Gernsback, Chairman and Business Manager

In the January 1909 issue of Modern Electrics I said, editorially:

"It affords the Editor genuine pleasure to offer to the thousands of wireless enthusiasts an appropriate New Year's present in the form of the Wireless Association of America. Every reader pursuing the announcement of the Association, found elsewhere in this issue, will agree that such an organization has been needed for a long time.

"Wireless Telegraphy may now be said to have left the experimental stage. It has become an everyday necessity, and already rivals the wire and cable telegraph. Between sea and land, wireless is of the utmost importance and today forms not merely an adjunct to every up-to-date vessel, as its coast and lifeboats."

"Only a few days ago Wireless demonstrated anew its utility. Several Italian warships were at sea, when the disaster occurred in Southern Italy, necessitating prompt assistance by outside help. The warships were at once recalled by means of wireless, and through it, saved the lives of hundreds of sufferers and brought the much needed relief.

"Not alone on sea, or between land and sea, but on the mainland also, Wireless is of high importance. Only a few weeks ago, two young Wireless experimenters saved several hundred lives in southern France in a dramatic manner. One of the young men, living on a hill near a dam, discovered that it was giving away, which meant the destruction of a small village in the valley below and the drowning of hundreds. He promptly called his friend, living in the village below, who gave the alarm. Over two hundred people reached the mountain in safety, just in time to avoid the flood. Without Wireless they would have been surely drowned, as telephone and telegraph are not known in that locality."

In announcing the Wireless Association of America in that issue of Modern Electrics, I said:

"The Wireless Association of America has been (Continued on following page)"
founded with the sole object of furthering the interests of wireless telegraphy and aeropony in America. We are now on the threshold of the wireless era, and just beginning to rub our intellectual eyes, as it were. Sometimes we look over the wall of our knowledge with wonderment, wondering what lies beyond the wall, as yet covered with a dense haze.

However, younger America, up to the occasion, is wide awake as usual. "Even Dr. Lee de Forest, America’s foremost wireless authority, confessed himself surprised that so many young men in this country should be in the possession of such well-constructed and wireless listening stations, which is only another proof that the clear-headed young men of this country are unusually advanced in the youngest branch of electrical science."

"So far America has led in the race. The next thing is to stay in the front, and let the others follow. In fact he would be a bold prophet who would even dare hint at the wonders to come during the next decade."

"The boy experimenting in an attic today may be an authority tomorrow. However, not even the cleverest inventors or experimenters always have the opportunity of making themselves known to the world, and it is right here that we are confronted with a mystery, a mystery unsolved."

"As was stated before, the new Wireless Association’s sole aim is to further the interests of experimental wireless telegraphy and aeropony in this country."

"Headed by America’s foremost wireless men, it is not a money-making institution. There are no memberships, no subscription, no contributions required to become a member."

"There are two conditions only. Each member of the Association must be an American citizen and must own a wireless station, either for sending or for receiving, or both."

"The Board of Directors of this Association earnestly request every wireless experimenter and owner of a station to apply for membership in this Association, by submitting his call sign, dates, location, instruments used, etc., to the Board of Directors. There is no charge or fee whatever connected with this."

"Each member will be recorded and all members will be classified by town and state."

The first emblem of the Wireless Association, a button, is also reproduced here as a record of record.

About this time, and even previous to that, I had started to print a number of radio handbooks, which were the first of their type to appear in print. Notable among them were:


These were all 80- to 96-page radio handbooks.

"The Wireless Telephone," the first book on radio telephony to appear anywhere, was published by me in February, 1910, and contains a rather astonishing preface, which I reprint here, merely to show the trend of thought at that time:

"The present little volume is intended for the experimenter doing research work in wireless telephony, for the student who wishes to keep abreast with the youngest branch of the wireless art."

"The author realizes that the future use of the wireless telephone will be confined to the lower powers; and that the present instruments, necessitating 220 and 550 volts for their successful operation, are not desirable nor practicable for such use."

"The wireless telephone of the future must be as flexible as the wire telephone of today."

"Every farmer will be able to operate his wireless telephone, when the sending and receiving instruments will be housed in a box a foot square, with nothing depending on the lighting current for its operation."

"The author predicts that, in less than 10 years, this telephone will be reached; as it is bound to come sooner or later.""

Remember, in those days we had only spark coils and crystal detectors, the vacuum tube as yet being an unknown factor—Lee de Forest just having constructed his first audion which, by the way, is illustrated on page 69 of the book mentioned above.

But the radio telephone—which was to become broadcasting later on—had not as yet been invented. Radio, or rather wireless, in those days was inarticulate. We could only send and receive dots and dashes; the transmission of the human voice was still in the future.

We dimly suspected that, sometime or other, it would come about. In the meanwhile, we valiantly experimented with our spark coils, and often substituted a tropical Stock Market key, only to hear hashed-up voices or hashed sounds over our electrolytic detectors (or crystal detectors) and our earphones.

Once in a while, if we were lucky, we could hear part of a word, but usually it was broken up badly. I knew what the requirements of the final radio telephone were; and the diagram which I reproduce herewith from page 13 of my book, "The Wireless Telephone," shows a capital "L" with a question mark in a box. This, then, was the "missing link." The question mark later became the vacuum tube and, if this is now inserted in the circuit at "L," it will be seen that this fits closely with the elementary requirements of our present-day radio telephone.

About 1908, I had begun to expand my activities by the attempt to introduce wireless instruments to the rest of the country. I started traveling a good deal, and began to introduce my wireless instruments and apparatus to the different radio stores as far west as St. Louis.

Naturally, this new amateur wireless industry attracted many boys of talent, and indeed it has been said that I have employed more people who later became famous in the radio industry, than perhaps any other man. This may or may not be true; but here is a partial list of those who worked with me in the old E. I. Company days, and who have helped to make radio what it is today:

**Employees of Yesteryear**

There was, first of all, Austin C. Lescarboua, who became the first managing editor of Short Wave, and later managing editor of a number of other publications.

Victor H. Laughter was another importation of mine. I brought him all the way from Mississippi after I had seen some of his handiwork. He was an excellent radio man and is today a manufacturer of radio testing equipment.

Isidor Goldberg, like Lescarboua, came to me in knee pants, and was active in our factory in various capacities. This early radio training never left him, and he is, today, the president of the Pilot Radio Corporation.

About this time also, Harry W. Secor came with me in an editorial capacity; this veteran radio man has never since been with me, and is today managing editor of Short Wave & Television.

A little later, E. R. Weedon became the general manager of the E. I. Company; he is today advertising manager of Schlucker Publications. It was he also who, in 1911, induced me to put out the E. I. Company's first Spanish catalog, as he had been in South America and was well acquainted with the Spanish language. Over 100,000 catalogs in Spanish were circulated in South America thereafter, and the venture proved profitable. As far as is known, this was the first radio catalog in Spanish.

There was Milton B. Sleeper, who first came with me in the capacity of associate editor of the Electrical Experimenter.

This well-known radio engineer is now domestic sales manager for F. A. D. Armstrong radio receiver manufacturers.

Next on the list is H. G. Cisin, who started with us and is well-known as a technical radio writer. Incidentally, it was he who invented the first A.C.-D.C. radio set, and his patent was recently upheld.

From Down East I imported a 100% Yankee of the taciturn type of Calvin Coolidge. His name is Clyde Fitch, who was with us for a number of years in various capacities, in the radio labora-

tory designing radio circuits and radio instruments, and also associate editor of the Experimenter magazine, as well as Everyday Mechanics. He became somewhat famous for his superheterodyne circuits, especially the Tropodyne, which was in high vogue during the late twenties.

Then there was Robert Hertzberg, who was on the staff of several of our magazines including Television News (later merged with my present Short Wave & Television magazine). Mr. Hertzberg is now editor of Modern Mechanix magazine.

Later on, through the E. I. Co. or through my various magazines, other names which since have become famous were added to the list of those who started with me. Among them are such well-known radio names, as Samuel...
Cohen, now president of the General Instrument Corporation. He still manufactures enormous quantities of radio condensers, for practically every radio set made in the United States today.

W. G. Maney, now with Aerovox Company:

A. P. Peck, now associate editor of Scientific American:

Maurice L. Muhleman, editor of a number of radio magazines, and now of All Wave Radio;

Leon L. Adelman, now sales manager of Cornell-Dubilier;

John F. Rider, now publisher of "Rider's Radio Manuals";

Alfred P. Morgan, who later on became a radio manufacturer in his own right;

E. J. Quinby, as well as C. W. Palmer, both of whom are now with the Western Electric Company;

Then there was E. T. Jones, one of my first editors on Radio News, now in the manufacturing division of RCA at Camden, N.J.;

Pierre Boucheron, also one of my first editors on Radio News, who later became well-known as an official of the RCA Radio Mfg. Corp., now general merchandising manager of Remington Arms Manufacturing Co.

And I must not forget Robert E. Lacaut, who came to me, fresh from France, after the war, to become one of my best editors on Radio News. Mr. Lacaut, inventor of the Ultradyne circuit, was one of the outstanding designers of superheterodynes. He later on became a manufacturer of radio sets, and a brilliant future was predicted for him, but an untimely death cut his career short.

There were many others who, if they did not become so prominent, are still connected with the radio industry in one way or another.

Before the World War, the E. I. Company became known through every part of the world, and there are few countries today which can not boast of some early E. I. Co. sets. Many of these articles, by the way, were patented by me and, at the height of the E. I. Co.'s career, I had a string of patents, all pertaining to wireless apparatus of one sort or another.

One of the best known patents, no doubt, was that of the Gernbach Slider, used in all E. I. Co. tuning coils. This was made of red and black composition and was made to slide on a square rod, the contact being made by a ball, attached by a spring to the slider.

Another familiar patent of the E. I. Co. was an electrolytic interrupter, which consumed a terrific amount of current and merrily burned out fuses all over the land.

Then there was the well-known Electro Rotary Potentiometer, also patented by me. Also, I had a compression chuck handwheel with which most of the later E. I. Co. headsets were equipped. In addition to these, minor other patents helped to give the E. I. Co. its reputation.

There was also the famous Rheostat (Continued on following page)
THE OLD E. I. Co. DAYS
(Continued from preceding page)

Regulator, which was built with an open coil spring resistance for better cooling. Almost every experimenter in the country had one of these rheostats.

I must not forget another E. I. Co. piece of apparatus which became famous—the Radisson sealed-in electrolytic detector, also reproduced in this article. This had been developed by me, and it certainly was (and still is, to my mind) the most sensitive detector except for the vacuum tube.

I developed a method whereby a special type of Wollaston wire was fused into the detector part proper and then drawn out into a sealed tube. This was then broken in half, and the sealed half ground on a very fine stone, and then highly polished. Each point was then viewed, through a high-power microscope, by several operators before the detector part proper was sealed in a glass tube containing diluted sulphuric acid.

While these detectors were satisfactory, the trouble was that strong static tended to burn them out insuch as the fine platinum Wollaston wire was less than 1/10,000 of an inch in diameter.

One of the things which helped to disseminate wireless in the early days was the E. I. Co.'s famous “Wireless Course in 20 Lessons,” by S. Gernaback, H. W. Secor and A. C. Lescarboura. This “Wireless Course” went through more than 20 editions, totaling some 500,000 copies, and was given away free through the E. I. Co. catalog in a rather novel manner. Bound in the middle of the catalog were 20 coupons; if you needed wireless supplies, you tore out one of the coupons which entitled you to one lesson, provided your order was for $1.00 or more; if you ordered merchandising totaling $20, you, therefore, received the 20 lessons free.

The E. I. Co. proclaimed proudly that the “Wireless Course in 20 Lessons” was “in use on every battleship of the U.S. Navy.” Indeed, the course was used to teach newly recruited Army and Navy operators during the World War.

RADIO (“WIRELESS”) LEGISLATION

The part played by me in the enactment of wireless legislation has been printed many times by others. I give herefrom a reprint from one of the later catalogs of the E. I. Co., which makes the case conclusively. It must be remembered that there were then no radio laws, nor restrictions, and any one could set up a transmitter and raise a rumpus in the so-called “ether,” to the annoyance of amateurs and government stations as well. This state of affairs could not, of course, go on. I clearly foresaw that, sooner or later, the government would put a halt to all amateur radio activities, and in Modern Electrics I sounded many warnings to this effect. The catalog reprint follows:

The very first talk about Wireless Legislation in the country started in 1908. The writer in his Editorial in the November, 1914, issue of Modern Electrics pointed out that a wireless law...
WIRING
DIAGRAMS

package number 1 supplement to John F. Rider's "Trouble Shooter's Manual" is now ready for distribution. Here is an opportunity to secure wiring diagrams of the modern screen grid receivers at a ridiculously low price. 115 wiring diagrams, size 8½ x 11 in. punched three holes suitable for loose leaf binding, covering screen grid receivers produced by such manufacturers as Grebe, Crosley, Stromberg-Carlson, Fada, Stewart-Warner, Edison, Eveready, Silver-Marshall and others . . . Price $2.50 postpaid . . . Write for list of diagrams and books.

was sure to be passed in a very short while. In order to guard against unfair legislation as far as the wireless amateur was concerned the writer, in January, 1910, organized the "Wireless Association of America." This was done to bring all wireless amateurs together and to protest against unfair laws. Previous to this time there was no wireless club or association in the country. In January, 1913, there were over 230 clubs in existence, all of which owe their origin to the "Wireless Association of America."

The association had no sooner become a national body than the first wireless bill made its appearance. It was the famous Roberts Bill, put up by the then defunct wireless "trust." The writer, single-handed, fought this bill, tooth and nail. He had representatives in Washington, and was the direct cause of having some 8,000 wireless amateurs send protesting letters and telegrams to their congressmen in Washington. The writer's Editorial which inspired the thousands of amateurs, appeared in the January, 1910, issue of Modern Electrics. It was the only Editorial during this time that fought the Roberts Bill. No other editorial periodical seemed to care a whoop whether the amateur should be muzzled or not. If the Roberts Bill had become a law there would be no wireless amateurs today.

That Editorial quickly found its way into the press and hundreds of newspapers praised the writer's stand. During January, 1910, the New York American, the New York Independent, the New York World, the New York Times, the Boston Transcript, etc., all lauded and commended the writer's views. (See Editorial article February, 1911, Modern Electrics.) Public sentiment quickly turned against the Roberts Bill and it was dropped.

Later, the Alexander Bill made its appearance, on December 11, 1911. This bill as far as the amateur was concerned was not quite as acceptable to the writer, who had the amateurs' rights at heart, and steps were immediately taken to bring about an amendment as the writer, perhaps more than anyone else, realized that this bill, in some form or other, would become a law sooner or later. This is clearly stated in his Editorial in the February, 1912, issue of Modern Electrics. In that Editorial is to be found also the first and now historical recommendation that if a wireless law was to be framed it should restrict the amateur from using a higher power than 1 kw. and its wavelength should be kept below 200 meters. No one else had thought of it before and it is to be noted that when Congress finally passed the present wireless law, it acceded the writer's recommendation in full, thus paying him the greatest compliment, while at the same time acknowledge the fact that he acted as the then sole spokesman for and in behalf of the wireless amateur.

In March, 1912, the writer in a letter to the New York Times (See page 24, April, 1912, issue Modern Electrics.) pointed out the shortcomings of the Alexander Bill, and protested against unfair legislation.

The Times, as well as a host of other newspapers, took up the cry and published broadcast the shortcomings of the Alexander Bill. All this attention had the desired effect and Mr. Alexander for the first time realized that the amateur could not be mistimed, especially when there was such a possibility as Modern Electrics to champion his cause. Promptly in April the Alexander Wireless Bill, amended, appeared and here for the first time in history the amateur and his rights are introduced in any wireless bill.

Mr. Alexander and his advisers accepted the writer's recommendation to set forth in his Editorial in the February, 1912, issue of Modern Electrics. It will be noted that it copied the writer's recommendations word for word. The amateur had at last come into his own. This is all the more remarkable as this is the only country that recognizes the wireless amateur. On May 7, 1912, the Alexander Bill, amended, known as S.4112, passed the United States Senate and on May 8th was sent to the House of Representatives and referred to the Committee on the Merchant Marine and Fisheries. The bill was signed on August 13th by President Taft, thus making it a law.

This terminated the fight which the writer had waged single-handedly for almost five years in behalf of the American amateur.

With wireless having become more specialized under government regimen (Continued on following page)
THE OLD E. I. Co. DAYS
(Continued from preceding page)

lations, radio began to expand rapidly and, while the E. I. Co. had its ups and downs, still it continued to make progress. Came the World War and, with the entrance of the U. S. into the war in 1917, the official edict that all radio activities must cease immediately. No further radio instruments could be sold; so the puzzle for the E. I. Co. became "What to Do?"

For the time being, it was necessary to change the entire business around from wireless to non-wireless. This I did by utilizing many of the parts which we had in stock, turning them into telegraph instruments and other electrical instruments and devices. But the best remedy proved to be a large quantity of radio parts made into a sort of kit which I called "The Boy's Electric Toys."

This set, with an instruction book, showed how to conduct some 100 electrical experiments, and practically all the material that went into the kit had originally been parts used in our wireless instruments.

Before this, however, I had already sold Modern Electrics to a former partner of mine, and this magazine was later merged with Popular Electricity and became known under the name of World'sAbbey.

This later became what is today Popular Science. After that I started the magazine Electrical Experimenter, which also made history. Like Modern Electrics, the Electrical Experimenter was also closely connected with the E. I. Co. It was destined to become a great radio magazine, as it carried more radio text and more radio advertising than any other magazine of its time.

When the World War had gone into its second year, many Americans, myself included, began to think that it would be only a matter of time until the United States, too, would enter the war. With the passing of the Wireless Act of 1912, the usefulness of the Wireless Association of America had come to an end, and, though up to late 1912 there had been enrolled not less than 22,300 members, the Wireless Association had no political significance of any kind. Late in 1915, however, I took it upon myself to form the Radio League of America, because I felt that the U. S. needed a body of radio recruits who would be needed when we finally did enter the war.

As the first move I called up Capt. W. H. G. Bullard of the U. S. Navy and asked him whether he would help me in forming the Radio League of America. This he did, early in November, 1915, by accepting honorary membership in the League. The board comprised the following illustrious members:

Capt. W. H. G. Bullard; Prof. Reginald Fessenden, of radio fame; Nikola Tesla, that indefatigable electrical genius who is today possibly the greatest living electrical scientist; Dr. Lee de Forest, Father of American Radio; I myself became manager. I give here a
few excerpts from the prospectus of the Radio League of America, reprinted from the December, 1915, issue of the Electrical Engineer:

"The advent of the great European war in 1914 found the U. S. in an unprepared condition as regards its defenses and vigorous steps were promptly taken to wake us from our lethargy. Free, Wilson's recommendations to the country for a vast increase of our Army and Navy has been so much discussed of late that no further reference to his valuable advice is required here. It suffices to say that probably a vast majority of citizens endorse the President's defensive military program.

"But there exists today a formidable defense weapon, which up to now has not been exploited by Uncle Sam. We refer to the thousands of amateur radio stations scattered broadcast through the entire length and breadth of this fair land. There is hardly a hamlet today which does not boast of several amateur wireless stations, and their number is increasing by many hundreds each day.

"If Uncle Sam wants the amateur the free use of the ether, it is certainly up to the amateur to give something in return for the privilege. It was with this thought uppermost in his mind that Mr. Gernsback in July, 1914, first conceived the idea of organizing the Radio League of America.

"By referring to the 1914 Government book, 'Radio Stations of the United States,' it will be seen that only 5,723 amateurs have been licensed since 1913. The reason for this surprisingly small registration is found in the fact that the law does not require receiving stations to be licensed, nor small sending stations located in the interior of large states, where the effect of a weak spark coil would not extend over the state borders. Such stations are exceedingly numerous and have been estimated to run above $3,000,000. Now, then, there appears no reason for doubt that, sooner or later, the Government would pass a new law requiring the registration and licensing of such stations in order to have such stations available in case of national stress.

"No one can foretell what surprise such a new law will bring the amateurs, and for that reason it cannot be denied that it is far better and more patriotic to give this necessary information voluntarily to the Government, instead of waiting till a new law is passed which might perhaps be detrimental from the viewpoint of the amateur."

Membership in the League was free: there were no dues or fees of any kind. The radio amateur had merely to sign the blank on which was stated, among other things: "I, the undersigned, a radio amateur, am the owner of a Wireless Station described in full on the back of this application. My station has been in use since ... and I hereby, with desire to apply for membership in the Radio League of America, I have read all the rules of the League and I hereby give my word of honor to abide by all the rules, and I particularly pledge my station to the U. S. Government in the event of war, if such occasion should arise.

"I understand that this blank with my signature will be sent to the U. S. Government officials at Washington who will make a record of my station."

Certificates of membership in the League were also made, wherein the amateur pledged himself to abide by all the rules. The League also issued an official insignia or button. The U. S. Government found the idea valuable and, indeed, I was in receipt of many letters from high officials endorsing the movement. Late in November, 1915, Capt. Ballard wrote to me as follows:

"I beg leave to acknowledge the receipt of your letter of November 4, 1915, submitting information concerning the Radio League of America (Continued on following page)
THE OLD E. I. Co. DAYS
(Continued from preceding page)
America, together with a copy of the Certificate of Membership.
"It seems to me that you have undertaken to carry through a very patriotic motive in banding together the great number of amateur wireless operators in the U. S. which you state, now number probably over 200,000 of which only about 10,000 are licensed; it is presumed that the remainder operate receiving stations only, and under the law are not required to have licenses.
"The Naval Radio Service is particularly anxious to increase its operating personnel in time of public peril, to furnish many private stations, ship and shore, would probably be taken over by the general government, and the thought has arisen that through cooperation with the Radio League many of its members would like to enroll themselves for active service under the Navy Department as their services might be required.
"You can readily understand that any information shared by the Radio League will be of the greatest value to this service, and this office will be glad to avail itself of your kind offer to furnish such free of all cost, this to contain the names, locations, etc., of all amateurs in the U. S.
"I should like further to take advantage of this opportunity to ask your cooperation in enrolling members of the Radio League (Navy Dept.) operation in time of war, and take this opportunity to encircle a circular prepared in this office which we have sent out to operating wireless companies in the U. S. who in turn have distributed them to their operators, with the result that many civilian operators have engaged themselves to enlist in the Navy in time of war. Could we do something similar to enlist members of your League, and would you lend your efforts to cooperate along these lines for the good of the country? From the monthly list you propose to furnish us we can get the names and addresses of many amateurs, among whom we might find many who would wish to enroll themselves. Of course, the forwarding letter accompanying the circular would have to be modified, but that could easily be done to call the attention of amateurs to how they can really serve their country in time of need.
"Please accept my thanks for thus being allowed to bring to your attention certain views in connection with the Radio League, an organization which can be made to be of the utmost help to the government and by focusing the attention on existing laws bring home to every amateur the desirability of cooperation all along the line to correct the great question of interference with proper government, commercial and other legitimate correspondence handled by means of wireless art."
(Signed) "W. H. G. Bellard,
"Captain, U. S. Navy,
"Navy Radio Service."

From then on, the Radio League of America functioned smoothly and enrollments grew at a rapid rate. This was fortunate for when in April, 1917, the U. S. finally did enter the War, the radio amateurs at least were ready and prepared. I was in receipt of many communications from the government during the War seeking to recruit radio operators for the service.

This, for instance, was the date of June 16, 1917, Adjutant General C. J. Martin of Kansas wired me as follows:

"Radio Company, Kansas National Guard, needs ten commercial radio operators. Please furnish names of radio operators in your district."

Adjutant General Martin was furnished the names promptly, and acknowledged receipt of them in his letter of June 25, 1917, as follows:

"Kindly accept my thanks for your kind notice and in furnishing you names of radio operators in this section of the country.
"Capt. Elmer J. Stahl, Topeka, Kansas, is commanding officer of the Radio Co. and it is probable that Capt. Stahl and the members of his
This advertisement appeared in 1928

RADIO-CRAFT for MARCH, 1938

The product of 4 years' experience making the highest type precision instruments

HAMMARLUND VERNIER and PLAIN CONDENSER'S
For Greater Distance, Less Interference and Better Toneal Quality

Buy A Hammarlund At Your Dealer's
Write for Descriptive Folder
HAMMARLUND MFG. CO.
414-146 W. 31st Street, New York
Circular Representatives:
RANG, LIMITED, Montreal

96% Perfect
HIGHEST AWARD GIVEN ANY CONDENSER BY Radio News Laboratory

HAMMARLUND VERNIER VARIABLE CONDENSER
Awards highest accuracy-product for long distance reception.
Eliminates annoying "out-lar" from undesired stations.
Base, Alloy.
List for Panel Mfg.
He. Ern. No.

At your dealers or write for terms and price and you will be supplied postpaid.

HAMMARLUND MFG. CO.
144-146 W. 10th St.
New York City

'HAMMARLUND' is a registered trademark

Hammarlund Vernier Variable Condenser

Pat. Applied For

.001 Mfd. $7.00
.0005 Mfd. $6.00
3-1/2 in. Bakelite Dial, $1.00

For Super-Accurate Tuning

The Radio News Laboratories rate this condenser 96% perfect, the highest rating given any condenser. Tested and approved by the Tribune Institute.

Write for descriptive circular.

HAMMARLUND MFG. CO., Inc.
144-146 West 18th Street
New York

THIS ADVERTISEMENT APPEARED IN 1928

organization would be interested in the electrical and radio publications published by your company. It might be well to send them a list of such publications and possibly a catalog of apparatus.

"Yours very truly,
C. J. MARTIN, Assistant General"

On August 15th, 1917, Lieut. C. H. McCam, of the Navy, wrote me as follows:

"The U. S. Navy Department has instructed this recruiting office to make every effort to enlist men for service in the radio branch of the Navy.

"These men are wanted immediately for active service.

"We are unable to find a complete list of all radio operators in the St. Louis district, which comprises the entire state of Missouri, with the exception of Jackson and Buchanan counties, in addition to two Illinois counties, Madison and St. Clair.

"One of your subscribers to the Electrical Experimenter suggested to me that you would be in a position to furnish us with a complete list of all licensed radio operators in this district, and in addition, those who are amateurs, but who have not as yet been licensed.

"You may be sure that any information given us will be highly appreciated.

(Signed) "C. H. McCAN, "Lieutenant, U. S. Navy."

The lists of names were promptly supplied. About that time, I decided it was necessary to do something for those radio amateurs who had enrolled in the government service, and I started to publish their names under the caption, "Radio Roll of Honor." Each month in the Electrical Experimenter we listed the names of those who had enrolled. I continued to urge amateurs to enlist as radio operators for the government throughout 1917. I exhorted the sometimes flogging spirit of the young men who did not respond as fast as I thought they should.

At the end of the War, there being no further necessity for keeping the Radio League of America alive, it was disbanded.

Several years before this, however—in 1910—the E. I. Co. had moved to 233 Fulton Street after 84 West Broadway had become too small, and expansion was necessary; so the 5-story building at the famous address was rented. This address indeed became the first radio center, and in its immediate wake followed the present "Radio Row" adjacent to 233 Fulton St., in Greenwich and Cortlandt Sts. Of course, the great activity of Radio Row did not begin until the broadcast boom in 1921, but still 233 Fulton St. was the dazzy of them all and, when the boom started, there bloomed on each side of 233 Fulton Street, as well as across the street and on the other side, one radio store after another, until the overflow ran into Greenwich and later into Cortlandt Sts.

Foreseeing the ultimate growth of radio, particularly after the war, while still on the premises of the E. I. Co. at 233 Fulton Street, I started Radio News, which was to become the world's greatest radio magazine in its day. This was in 1918.

During the radio boom our publishing ventures assumed huge proportions, so much in fact, that the E. I. Company became less and less important and, as thousands of others

(Continued on following page)
THE OLD E. I. CO. DAYS
(Continued from preceding page)
jumped into the making of radio instruments, it was thought best to concentrate our efforts on publishing. Consequently, the E. I. Company stopped its radio and catalog activities and turned publisher, and in this, the E. I. Co. was highly successful.
Between 1 and 1½ million books were sold subsequently, during the radio boom, by the E. I. Co. to Woolworth's and other outlets.
These little books sold for from 10c to 25c, and many of them are still to be found in the libraries of radio enthusiasts.
In the latter 20's the E. I. Co. book business was merged with that of the Experimenter Publishing Company, thereby closing the long and varied existence of a pioneer company that made history in its day.

IDENTIFICATION OF ILLUSTRATIONS IN THIS ARTICLE
(1) One of the first E. I. Co. catalogs in 1906.
(3) Earliest adjustable zinc spark-gap for amateur use.
(5) Auto-coherer of 1905.
(6) E. I. Co. coherer and decoherer of 1905.
(7) First potentiometer for amateurs, by E. I. Co. About 1908.
(8) Transmitting helix (inductance). 1908.
(9) Variable transmitting condenser. 1909.
(10) E. I. Co. rheostat regulator. 1907.
(12) Adjustable zinc spark gap, for amateurs. 1908.
(13) Earliest crystal detector stand. About 1908.
(14) E. I. Co. patent ball-bearing slider.
(15) Cover of E. I. Co. catalog in 1907.
(16) E. I. Co. 1-inch spark coil.
(17) Gernsback rotary variable condenser. 1911.
(18) Adjustable E. I. Co. transmitting inductance.
(19) E. I. Co. bare-point electrolytic detector. 1908.
(20) E. I. Co. sealed-in electrolytic detector.
(21) E. I. Co. 1-inch spark coil.
(22) Large tuning coil with ball-bearing sliders.
(25) E. I. Co. adjustable transmitting inductance with pilot lamp.
(27) E. I. Co. transmitting key.
(28) Cover of one of the earliest issues of Modern Electrics.
(30) First E. I. Co. loose coupler with variable secondary.
(31) E. I. Co. loose coupler—perfect model.
(32) Loose coupler with crystal detector and loading inductance.
(33) E. I. Co. rotary variable condenser.
(34) E. I. Co. air-cooled ½-kw. transmitting transformer.
(35) The first vacuum tube sold by E. I. Co. 1911.
(36) Headquarters of E. I. Co. at 233 Fulton St., N. Y. 1919.
(37) First portable radio transmitter used for advertising purposes by E. I. Co. 1908.
(38) E. I. Co. rotary zinc spark gap.
(39) First complete receiving unit comprising tuning coil, telephone receiver and variable crystal detector made by E. I. Co. 1919.
(40) E. I. variable loading inductance.
(42) E. I. Co. complete receiving set with tuning variable condenser, detector, potentiometer, loading inductance and phone, assembled on board. 1915.
(43) E. I. Co. deluxe receiving outfit. 1915.
(44) E. I. Co. receiving inductance.
(45) Circuit of Gernsback radio remote control.
RADIO-CRAFT

RCA OSCILLOGRAPH

Prices Reduced!

Overwhelming sales of these instruments greatly increase production—bring prices down! Buy now—and save!

WAS $84.50
NOW $63.95

Stock No. 545 RCA 3-inch Cathode Ray Oscillograph

Thousands have been sold during the three short years since this splendid instrument was introduced. It's sensitivity is 0.7 volts R.M.S./per inch...linear saw-tooth sweep oscillograph 10 to 18,000 cycles...2 wide range amplifiers, 10 cycles to 90 kilocycles. Gain 40...Complete with Tubes.

WAS $47.50
NOW $39.95

Stock No. 551 RCA 1-inch Cathode Ray Oscillograph

This Oscillograph will give you "big time" performance. Its sensitivity is 1.77 volts R.M.S./per inch...amplifier range—40-10,000 cycles. Gain 40. Linear sweep at functional sweep—50-10,000 cycles...All controls on front panel...Gray wrinkled lacquer finish with nickel trimming. Complete with Tubes. Over 500 million RCA Tubes have been bought by radio users. In tubes as in test equipment, it pays to go RCA ALL THE WAY!

Listen to the Magic Key of RCA every Sunday 2 to 3 P.M., E.S.T. on NBC Blue Network.

NEW TUBES

INTRODUCED TO RADIO MEN

— IN 1937-38

(Continued from page 629)

<table>
<thead>
<tr>
<th>Type</th>
<th>Heater</th>
<th>Heater Voltage (A.C. or D.C.)</th>
<th>Nominal Heater Current</th>
<th>Typical Characteristics</th>
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</thead>
<tbody>
<tr>
<td>310A</td>
<td>H-TARLE</td>
<td>10.0 V. (exact)</td>
<td>0.32-A.</td>
<td>Plate 105, C.G. 95, C.S. 75</td>
</tr>
</tbody>
</table>

**WELL-TOUCH**

**TABLE XI**

Technical Data and Ratings

<table>
<thead>
<tr>
<th>Type</th>
<th>Voltage range</th>
<th>Current range</th>
<th>Max. allowable ambient temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>310A</td>
<td>5-16 V.</td>
<td>225-270 ma.</td>
<td>150° F.</td>
</tr>
</tbody>
</table>

Use MODEL 666

For Both A.C. and D.C. Testing

**Pocket Volt-Ohm Milliammeter**

Has 3" Sq. Triplett Improved Rectifier Type Instrument.

AC-DC Voltage Scales Read: 10-50-250-500-1000 at 1000 Ohms per Volt.

D.C. Milliamperes Scale Reads: 1-10-50-250.

Ohms Scales Read: Low ½-300; High 250,000.

Size—3-1/16" x 5-3/4" x 2-¼".

Black Molded Case and Panel.

Low Loss Selector Switch.

Complete with Alligator Clips, Battery and Test Leads.

**DEALER PRICE** . . . . . . $15.00

A complete instrument for all servicing and other needs. Can be used for all A.C. and D.C. voltage, current and resistance analyses. Resistance range can be increased by adding external batteries.

Attractive, Heavy Black Leather Carrying Case with Finished Edges and Strap, Model 669, supplied extra.

**DEALER PRICE** . . . . . . $3.67

WRITE FOR CATALOG

The Triplett Electrical Instrument Co.
163 Harmon Drive, Bluffton, Ohio

— Please send me more information on Model 666...I am also interested in...

Name

Address

City State
TRY - MO Specials for This Month!

TRY-MO RADIO carries the largest and most complete stock of speakers, pick-ups and speaker accessories. Specialists in speaker repairs, we can repair any speaker, whether for our estimation. We can build power amplifiers and public address systems to any specifications. We can supply anything in radio. Write us for our price.

LOFTIN-WHITE AMPLIFIER

AMPLION HAND MICROPHONE

HAMMELRUND VAR. CONDENSER

BEST DELUXE THEATRE PICK-UP

$4.95

$95c

For all high quality reproductions, try the BEST stand far above any other pick up. Volume control is built in conveniently on the base ...... $7.25.

BARGAIN LISTING OF LAST-MINUTE SPECIALS!

Cortlandt Street

85 Cortlandt Street

New York City

Sealed Model 1-224

Sealed Model 1-293

$12.50

$15.95

5c

35c

5c

Unexcelled for tone quality reproduction, the BARGAIN LISTING of Last-Minute Specials are prepared to meet any emergency. Volume control is built in, conveniently on the base.

AMPLIFIERS Designed To Specifications

TRY-MO RADIO CORPORATION

No Magnetic Material Used in its Construction

CRL

No. 100

Filament Rheostat

for Panel Mounting

This new Rheostat consists of a resistor of special non-corrodable alloy inserted in a molded base of high insulating and heat resisting properties—genuine Thermoflex. Each turn of the resistor is anchored firmly in place so that there is no chance for noisy or scratchy operation. All metal parts are nickelized.

If you cannot obtain CRL Rheostats from your local dealer, send $1.00 plus 10c. for carriage.

List Price (East of Rocky Mountains) $1.00

Dealers and Manufacturers of Radio Equipment are invited to communicate with us. We are prepared to make immediate shipments.

CENTRAL RADIO LABORATORIES

303 Sixteenth Street

MILWAUKEE WISCONSIN

A CHRONOLOGICAL HISTORY OF RADIO

(Continued from page 555)

(Continued from page 567)

Radio parts of Yesteryear

duced-speed tuning controls are another of the early parts which have survived. They are used in virtually every set today, except in the lowest price ranges. Many parts which have existed from almost the first days of radio, have persisted until the present, often in but slightly modified form. Others have outlived their usefulness and vanished from the scene forever.

It is interesting to note, in concluding this necessarily sketchy account, that many commercial radio parts had their genesis in a passing comment, or published account of how some thrifty or imaginative radio experimenter found an inexpensive, simple solution to a problem. It is unfortunate that these unsung "heroes" of radio's swaddling-clothes stage have become lost in the shuffle; but with the passing of the years to which we dedicate this issue of Radio-Craft the increasingly abundant fruits of their labor bear undying witness to the ingenuity of these indefatigable pioneers.

them, allowed the golden opportunity of being the first to discover wireless slip by. By 1905, he had devised a means of wireless communication from his earlier experiments, but the Marconi system was well established by that time. In 1899, Marconi was successful in covering distances up to 74 miles with his instruments, and ship and shore stations began to install his equipment. His activities and progress with wireless filtered through to America, and in 1899 he was invited to this country by the New York Herald which engaged him to report the international yacht races held in October of that year. Marconi accepted for another reason, he wanted to interest the United States Navy in his equipment in the hope that it would make large purchases and thus help commercially exploit wireless. To facilitate matters, representatives of the British company financed and incorporated the Wireless Telegraph Company of America, to take care of the Marconi interests in this country. Marconi then went ahead with the transmission and reception of the yacht race results, and an amazed American public obtained the news as to who had won, long before the ships had returned to port. From this angle, Marconi's efforts were thoroughly successful, but not so with the Navy. In demonstrations, the official witnesses were considerably impressed by the efficiency of his equipment, although in their reports mention was made of the interference obtained when two transmitters were operating. Marconi, with the success of his experiments with Lodge's
syntony or tuning still fresh in his mind, specified that this defect could be overcome. The deciding factor, however, against Marconi's equipment was the terms of his proposed contract, which the Navy definitely rejected. Thus, for a while, no further real progress was made in wireless in this country. Marconi, in the meantime, had gone back to England to continue with his experiments and make further rapid advances in the art of wireless communication. His famous trans-Atlantic transmission of the letter “S” is described elsewhere in this issue.

1900-1905—REINALD A. FESSENDEN, LEE DE FOREST, Americans. These two gentlemen were the outstanding American contributors to the art of wireless in its earlier days, and to each has been applied the appellation of “father of American radio.”

Fessenden, while fully acquainted with Marconi's wireless equipment—having experimented with these devices—was more interested in radiotelephony. He knew that Marconi's system was adapted only to damped-wave transmission and that, as such, would not tolerate super-imposing on it voice or further irregular waves. Consequently, he began to experiment with continuous wave transmissions (now known as C.W.), which led to his perfecting an arc transmitter. However, the coherer would not receive the voice impulses modulated on the oscillating wave produced by the arc, so, remembering his electricity and chemistry, Fessenden created the "electrolytic detector," which allowed current to flow in only one direction. It consisted of a small aluminum cup, filled with a solution of silver in water into which a fine silver wire dipped, which was a tremendous improvement over the coherer, and increased the receiver's efficiency considerably. Later on, Fessenden conceived the idea of employing an alternator, similar to a regular A.C. generator—but with a frequency much higher than 120 cycles—to an antenna (similar to the arc transmitter's) and thus eliminating the spark gaps and arcs which wasted so much power. While at the time he was laughed at, his idea was in the future to play a very important part in the progress of radio.

Meanwhile, de Forest was experimenting with wireless, and in 1901 built an outfit less cumbersome and more efficient than Marconi's. He, too, employed the electrolytic detector, which existed between him and Fessenden considerable legal conflict which later was determined in Fessenden's favor. De Forest secured some financial backing and formed the American De Forest Wireless Telegraph Company. With this company he commenced manufacturing equipment, some of which he sold to the Army. Unfortunately, the company depended upon stock promotion for capital to finance its development work, and soon it was in financial difficulties that prevented it from getting into the commercial communications field. In this same period, 1901 to be exact, J. AMBROSE FLEMING, English, developed his 2-element (diode) "valve" while employed by Marconi. He remembered Edison's experiments and the so-called "Edison effect"—since he had been a scientific advisor to the Edison Electric Light Company of America—and hence it occurred to him that the phenomenon could be employed to advantage as a detector of radio waves. This invention was to enjoy only a short life, inasmuch as De Forest's discovery of the 3-element (triole) or audion tube was soon to follow.

1906—DE FOREST'S AUdion. Here is the mightiest radio invention of all! It consisted only of the insertion of a grid between the filament and plate of Fleming's "valve," yet this addition of a third element so revolutionized radio that today we must be grateful for its invention. While the power or the ability of the audion tube as an amplifier or generator of oscillations had not as yet been recognized, its merit as a detector was soon proven. Despite this invention, and other meritorious work in the wireless field, de Forest's finances were in extremely poor shape. To obtain the necessary capital, he was forced to sell stock in his company, but somehow an unwilling public could not be interested. Later on, in 1912, to obtain funds for himself and his company, de Forest sold the rights to the Audion amplifier to the American Telephone and Telegraph Company. (Continued on following page)

Please Say That You Saw It in Radio-Craft
A CHRONOLOGICAL HISTORY OF RADIO

(Continued from preceding page)

Co., for a paltry sum compared to its actual worth.

1907 First Crystal Detector, by G. W. Pickard. Up to this time, the most popular detector was the electrolytic type; the coherer, while still somewhat used, had been found unstable and insensitive. The Fleming valve was never really popularized, because of its insensitivity to weak impulses. Consequently, the development of the crystal detector marks another great stride in the development of radio. While the first employed silicon as the mineral, it was later determined that galena, iron pyrites, and many other minerals (even carbonurandum) also are efficient. It was extremely effective as a detector of feeble irregular impulses (modulated C.W., damped waves) although somewhat critical in the adjustment of the "catwhisker". Because of its inexpensiveness, it was the most popular detector until the advent of cheap commercial audions, and was to a great extent responsible for increased activity and interest in wireless or radio (these terms are synonymous).

1909 S. S. Republic and Jack Binns. By this year, practically all large ocean-going vessels had been equipped with wireless apparatus, since it served as a means of contact with land. Fortunately so, for on January 23rd of this year the White Star liner Republic rammed the Florida off Nantucket Island, and commenced immediately to sink. Binns, the wireless operator on the Republic, broadcast his famous "CQD" (now "SOS") which brought rescue ships that saved all but 6 of the entire crew and passengers. This drama, so tense and poignant, was reported to the entire world, and created such a favorable impression on the public's mind that wireless was definitely established for ship communication.

1911 Ships Require Wireless. As a result of the Republic episode, Congress passed an act (signed June 24th, 1910) which made it unlawful for any ship, whether foreign or American, plying between United States ports at least 200 miles apart, to leave or attempt to leave these ports without wireless equipment in good working order. Such apparatus was also required on all American ships clearing for foreign ports.

1912 Titanic Disaster. When this great liner struck an iceberg in mid-Atlantic on its maiden voyage, its wireless calls for help (the first "SOS") were received and picked up by the Carpathia which managed to arrive in time.
to pick up many survivors. An unfortunate incident was brought out later, when it was discovered that one ship had been much nearer, and could have saved many more people—if it had not been that only one wireless operator was employed on that ship and that he was "off-watch" at the time. It resulted in an amendment to the Radio Act of 1910, requiring that two operators be employed on a ship, so that a constant watch could be maintained. Out of this story emerges a new figure in radio—David Sarnoff, now president of the Radio Corp. of America. At the time he was stationed at the Wanamaker Radio Station in New York City, and received the signals between the distressed ship and its rescuers, the reports concerning the rescue work and, finally, a list of the survivors, so that an anxious world could be advised of the consequences of this tragedy.

1913 **Armstrong and Regeneration.** The increase in sensitivity, which results when regeneration is introduced into a receiver, is known to all who have experimented with radio circuits. Small wonder, then, that that great litigation resulted between Edwin H. Armstrong, a Columbia student at that time, and de Forest as to who was the rightful inventor. Armstrong sought a patent in 1913, whereas de Forest claimed to have discovered it with an assistant (Van Etten) in 1912, although they did not bring it out at the time. De Forest produced notebooks to prove that he discovered feedback and the oscillating properties of a tube; and, after much partisanship in the various courts, and, various court decisions, he was finally awarded the patent by the Supreme Court in 1934. Also in 1913, Irving D. Langmuir, prominent physicist with the G.E. laboratories, discovered his process for creating high vacuums. (Arnold of Western Electric developed a high-vacuum process that assumed importance in telephone work.)

1914-19 **Alexander Anderson's Alternator—World War.** Ernst F. W. Alexander, Swedish-American, had helped Fessenden build some of his earlier alternators. Due to this experience, Anderson was able to improve this unit so that "smooth" continuous waves with a frequency of 50,000 to 100,000 cycles per second could be generated. So great were the possibilities of his device that Marconi himself came to the G.E. laboratories in Schenectady to see a demonstration of it. As a result, the British Marconi Company began negotiating for the machine, but no immediate sale was made. A stalemate in the negotiations was reached when the United States entered the World War, and seized or closed down all private wireless stations. Throughout the war wireless was of substantial aid to (Continued on following page)

**The Royal**

*is the typewriter with the rapid-fire action and adjustable personal touch—the machine that fires letters as an automatic gun spits bullets!*

**Built for the Expert Typist—Better for the Ordinary Operator**

The new Royal way of sending direct force from the fingertips to the type takes the "grind" out of typing and increases the daily output of any stenographer.

**Get the Facts!**

Send for the "Royal man" and ask for a DEMONSTRATION. Or write us direct for our new brochure, "Better Service," and a beautiful Color-Photograph of the New Royal Master-Model 10.

**ROYAL TYPEWRITER CO., Inc.**

2 Park Ave., Royal Typewriter Building

NEW YORK

**THIS ADVERTISEMENT APPEARED IN 1915**

---

**Your Free Trial got me a BIG RAISE!**

"I had a lot of ideas but I didn't know what to do with them.

The boss said no idea is good until you put it on paper.

I saw your offer of a free trial—and only a few cents a day thereafter for a Royal Portable.

I tried it out with your free typing course...sent my ideas into the boss and got a raise!"

**ACT NOW...Own a ROYAL PORTABLE ON YOUR OWN TERMS!**

Free Home Trial...get busy and send in the coupon today!

Here's the opportunity of a lifetime to own a lifetime portable, a genuine Royal. And what a buy it is too! Full-sized, swiveling keyboard throughout—complete with numerous office typewriter features which only Royal can give you! And you practically write your own ticket! a free home trial—you don't risk a penny...then make your own terms—cash or as little as only a few cents a day. Take advantage of this offer at our expense. Mail the coupon today for full details.

**FREE**

With every Royal Portable comes a handsome all-weather Carrying Case; also Instant Typing Chart which shows you how to type right.

---

**CLIP THE COUPON!**

[Blank space for signature and details]

---

**NEW YORK**

**ROYAL TYPEWRITER COMPANY, Inc.**

2 Park Ave., New York, N.Y.

Please tell me how I can win...for only a few cents more—a latest improved Royal Portable—complete with free Carrying Case and Instant Typing Chart.

---

**Please Say That You Saw It in RADIO-CRAFT**
A CHRONOLOGICAL HISTORY OF RADIO

(Continued from preceding page)

both sides as a means of constant contact, and community tests were also run as an aid to espionage. In the United States, the Bell System (A.T.&T. Co.) was hard at work perfecting the vacuum tube which it purchased from de Forest. Its ability to function as an "oscillator", or generator of high frequencies, was established by that time, and by virtue of de Forest's and Armstrong's feedback circuits. A means for modulating voice impulses on the carrier wave which was produced, also by using vacuum tubes, was developed in 1914-15 in the G.E. labs. by Alexander and by Colpitts in the W. E. labs. The Hartley (W. E. Co.) oscillator circuit was developed in 1916.

These inventions resulted in experiments in radio telephony, for the purpose of facilitating and improving long-distance transmission of speech. The first test made by Bell Telephone engineers was in 1915. A low-powered transmitter was installed at Montauk, L. I., and an apparatus at Wilmington, Del. Wave lengths of from 800 to 1,800 meters were employed, and the results obtained were satisfactory enough to warrant further tests with higher power.

While the initial waves were made with transmitting tubes which totaled a maximum of 15 watts power output, before the end of 1915 several hundred such tubes in parallel (some times as many as 500) were employed to achieve higher power. Larger transmitting tubes, of the order of 100 and 500 watts and 1 kw., were not to be developed until some time afterwards. As a result of all these researches, in 1915 the first trans-Atlantic (and, incidentally, trans-Pacific to Honolulu) radio telephone conversations were successfully held between Arlington, Va., and the Eiffel Tower in Paris, France. The U. S. Navy, W. E. Co., and A. T. & T. Co. co-operated.

All of this was the forerunner of broadcasting, which, commercially, didn't make its appearance until 1920. The developments in speech transmission without wires made in this period were the forerunners of the equipment for the broadcasting station which was soon to come.

In 1919, Frank Conrad of Pittsburgh, Pa., an amateur and Westinghouse engineer, began broadcasting record programs from his amateur radio phone station located in a garage at the rear of his house. They were received with such great enthusiasm by other amateurs in the vicinity, who incidentally invited their friends and neighbors over to hear the "wireless music", that in a short time much newspaper publicity was given to his broadcasts. As a result Westinghouse officials, in 1920, decided to build a large station to conduct broadcasting...
Complete Details for Building the
NEW YORK EVENING JOURNAL'S
GOLD MEDAL FILTER TUNER

Gold medals awarded to Paul McGinnis, RA.
for the publicity and prestige that it would give the company. The station was rushed and launched in time for the broadcasting of the Harding-Cox presidential election returns—with Frank Conrad's little station standing just in case of an emergency. The large station later on became KHKA, now known to practically everybody with a radio receiving set. From one station in 1920, to 400 in 1922 and over 1,400 stations by 1924 was the record set by broadcasting. Further details concerning this phase of the radio industry are given elsewhere in this issue.

1919-1921 Formation of the Radio Corp. of America. Heretofore, the British Marconi Company had dominated in all activities of the wireless field. Their early start and strong finances permitted them to buy in and control all major patents and activities so that even here in America, their dominance was felt. After the World War, the Marconi Company resigned its negotiations for the Alexanderson alternator. At this stage, the United States government intervened since it was felt, at that time, that the sale of this American equipment might result in world domination of wireless communication by foreign interests. After conference with the Navy, another meeting was held at the General Electric offices, when it was decided to retain the alternator in the interests of this country. It was probably at this latter conference that the plans were formulated for a strictly American-owned radio company, since we find such men as Admiral Bullard, Owen D. Young and C. W. Stone of General Electric attending it. At any rate, on October 17th, 1919, the Radio Corp. of America was organized and a patent pool of heretofore competing patent interests was effected. On November 20th of that year, the assets and business of the Marconi Wireless Telegraph Company of America were taken over by RCA, and from then on American wireless was "on its own."

The story of broadcasting, how and when it first began, is told in other pages of this issue. So, too, are the stories of the advance of the vacuum tube, circuits, parts and receivers, and so on. Wherever possible, dates are included—consequently, to repeat such information in this chronicle would be superfluous.

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6 Eighth Street, Varsavka, N. Y.
 Published 1874

THE RADIO MONTH IN REVIEW
(Continued from page 597)

When Mount Vernon, N. Y., headquarters W2XKE called 3 police for photoelectric scanning, but no record at receiver, Radio-Craft understands that such "commercial television" does not come under F.C.C. control so long as it remains intra-state.

Two large-screen television demonstrations in London, last month, of the Baird and Scopitone systems, indicated that theaters will introduce feature, provided postmaster general, who also controls telegraph and telephone lines, permits. The Baird system showed pictures in color on 6 x 8 foot screen; but sharpness is lost as compared with black and white.

RADIOOPS HEARD ACROSS OCEAN

When Mount Vernon, N. Y., headquarters W2XKE called 3 police men to extinguish a brush fire one morning last month, it was not exactly private. Shortly arrived a request verification from George Garvey, Liverpool, England, fan—who heard it on a 2-tube and an 8-foot indoor aerial. And other police cars, here and there, are having problems when messages are picked up, sometimes from the next state! The Havana radio conference last month voted in favor of a radio police network to cover the American continent. Recently Commissioner Valentine, of New York, sent a test message to Chief Martines, of Mexico City, over an all-police communication hookup, which it is proposed in the near future to make routine.

BROADCASTING RATTIDDDITIES

Record chimes, used with a P.A. system for sales promotion, finished the holiday task at Plainfield, N. J., last month when they joined with the city's church bells in an intoxicating chorus. (See photo.) Chimes were also thus broadcast 3 times daily during Xmas.

Yule carols blanketed Plainfield, N. J., via the four 6-ft. loudspeakers here shown being installed (for 4th year) by Verne M. Wintemuth (left) and James P. McCarty, The Chamber of Commerce and First National Bank collaborated.
In a close-of-season game between Richmond and William and Mary U.S. last month, Station WRVA broadcast the battle of the Richmond team at the opening of the final quarter. But W. & M., not having sets and phones, put no tip-off from the proceeding. Forewarned is forearmed; an encore might be risky.

The mike was crashed at WHBL, Sheboygan (Wisc.), by an outsider last month. A great snow-owl flew into the power wires, and put the station off the air for 35 minutes. (He is off the air permanently, himself.)

Standard R.F. transmissions have been known for years, and occasionally standard A.P. pitches. C.B.S. last month announced that, from now on, time signals will be the standard international A (140 cycles) for the use of musicians.

Debate by phonograph record will be carried on between the College of the Pacific and the University of Redlands, says an announcement received last month. Both institutions have Universal recording machines; and first the pro and con, and then the rebuttal and surrebuttal will be "diced" for radio use.

While educators last month were running radio programs at Chicago, Radio Supervisor Blanche Young of Indianapolis suggested that important current-event broadcasts, as well as air historical pageants, be canned and made available for classroom reproduction.

**RADIOODDS AND ENDS**

A RE they "sidelbands"? Some light may be thrown on that bitterly-argued question by experiments announced last month by Prof. R. R. Ramsey, well-known radio textbook. Recalling previously conflicting experiments, he showed that, when 2 distinct notes are sounded, the ear hears a "beat-note"; but a resonator does not receive it. If a single source of sound gives off 2 notes at once, on the other hand, the beat-note can be physically demonstrated. The conclusion is that the ear creates "beat-notes," and supplies missing sum- and difference-frequencies.

The French radio industry celebrated Une Grande Quinzaine (15-year anniversary) of broadcasting last month with the slogan: "Un foyer sans T.S.F. est un foyer sans joie." (A home without radio is a home without happiness.)

The American Medical Association, setting up standards for ear-testing apparatus (audiometers) last month ruled that they shall have a range from 250 to 8,192 cycles, or higher, with a frequency tolerance of 5%; he calculated in decibels with steps of 5 or less; have pure tone (harmonics down at least 40 db.) and that manufacturers should assure servicing. But a test chart must wait on more definite consensus of medical opinion for approved standardization.

(Continued on following page)
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THE RADIO MONTH IN REVIEW

(Continued from preceding page)

New York radio dealers last month issued an appeal for the organization of a national association of retailers to improve conditions and develop a better selling way, including that of trade-in and resale.

"Videotron" for cathode-ray tubes is now claimed as a trade name, accurately descriptive, for "video" or sight work, by National Union Radio Tube Co.

A test of listener interest in showmanship was made last month on a well-known Sunday evening program — or, to be exact, of showmanship. The reaction was one of the strongest recorded in the history of radio. One particular broadcast was heard by an operator who said that there was nothing objectionable in the mum-mery unless the listener supplied it by exercising his own imagination" — which said imagination brings us forward to the approaching day of television, and the question of how a "script" can be submitted in advance for station or official censorship?

Ground was broken, last month, for the erection of the A.R.R.L. station W1AW, designed specifically for the league’s founder, the late Hiram Percy Maxim, at West Hartford, Conn. When it is completed, it will have 5 transmitters, each 1 kw., for voice and code.

Ten years ago a benevolent New Yorker fitted radio dials with Braille numbers for blind friends; 2 years ago, Radio-Craft described the construction of such a set, but more modern. Last month, G.E. brought out a commercial-type set with this feature; and the first page was devoted to a How-To-Do-It article for the American Foundation for the Blind, New York! It has keys, with raised numerals, for touch tuning.

More of the early history of short waves will, perhaps, find its way to light during the trial of the content of a lawsuit, begun last month, by the estate of the late R. A. Pessenden, S. W. pioneer, against RCA on patent claims whose validity the defendant contests.

N.B.C. announced, last month, that it closed the year 1937 with 143 stations in its network, a net gain of 38. In power, the addition is less striking — 112,900 watts or 6.27% (daytime).

The tuning pulley bleb is the weakest

(Continued on page 654)

Here’s 18-year-old Lillian Sutter trying out the new "Videotron" Electric "Tooth"—an electric tube set, specially equipped with Braille (raised) symbols, recently presented by Miss Helen Keller (right) to the American Foundation for the Blind.
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This Advertisement Appeared in 1926

The Radio Experimenter's Handbook
By M. B. Sleeper

Throughout the preparation of this book, one purpose was kept in mind—answer the Practical Questions of the "Novice," of the "Beginner," and the more advanced "Student." This book will help in the selection or construction of simple apparatus for the transmission and reception of radio telegraph and telephone signals. In the chapters on radio receiving, the fundamental circuits, the simple audition, and the regenerative type are described in full, with detail. The complete circuits for both, both transmission, and complete receiving, are taken up. A few novel helpful suggestions are also made. The book is a complete one in the expeditor. 16 chapters. Fully illustrated. Price $1.00

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Arithmetic of Electricity
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RELIABLE RADIO CO.
1493 Broadway  New York City

This Advertisement Appeared in 1923

ORIGIN AND GROWTH
OF RADIO SERVICING
(Continued from page 651)

were in this field, Service Men were few, although some of the constructors began to dabble in it. Today, we find too many Service Men in the profession, and, too, too many constructors dabbling with servicing.

INTRODUCING TUBE TESTERS
About this time we also find testing equipment being developed and manufactured, especially tube testers. Previously, if a dealer sold a tube all he would do for the consumer was connect a battery across the filament prongs and show him that the tube would light. Since the construction of earlier tubes was such that the filament seldom outlasted its emitting properties, this method of proving to the customer that a tube was considered satisfactory until tubes were made better and then the fact that its lighting had relatively slight bearing on its efficiency was well established. It is entirely possible that the need for tube-testing equipment was another factor which made it necessary to obtain a Service Man-technician.

From this period on, and in step with the ever-increasing technical advance in receiver design, the servicing profession or industry grew. To some extent this phase of the industry was encouraged by the manufacturers themselves, many of them going so far as to have a special department staffed with factory-trained men who could travel over the country teaching and instructing the jobber's and dealer's service personnel in the art of servicing their particular models. But for no altruistic reason did the manufacturer do this. An insatiable demand for sets on the part of the public made it necessary for them to rush these sets out, often poorly produced and with insufficient engineering behind them. In the field, transformers would open, poorly-soldered joints would develop noise, sets became inoperative due to mistakes in the wiring (proving that some were never even air-tested), and other typical factory blemishes developed.

A.C.-SET SERVICING
By the early part of 1926 almost every Tom, Dick and Harry could fix a radio receiver. Even when battery sets began to be "electrified," salesman and tinkers could replace "B"-eliminator rectifier tubes or the copper-oxide rectifier in the "A" supply, or even make the installation when these units were sold to replace the batteries. Then along came the all-electric set, using type 235 tubes in the R.F. and A.F. stages, a 227 in the detector stage, and a 71A in the power stage, with a power-pack containing an 80-type tube rectifier, power transformer, chokes, filtering condensers, voltage divider system for power distribution to the various stages,—when the tinkers began to feel his tent and silently steal away. So many different types of tubes, not to mention the other compli- (Continued on page 654)
Official Radio Service Manual

and Complete Directory of all Commercial Wiring Diagrams of Receivers

PREPARED ESPECIALLY FOR THE RADIO SERVICE MAN

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A tremendous amount of material has been collected, not only for the Service Man, but for everyone interested in radio. A complete directory of every radio circuit of commercial receivers is now possible, and not only do you get every circuit of every set manufactured, of which there is any record, but in addition, an entirely new idea makes it possible to keep the manual up-to-date.

The OFFICIAL RADIO SERVICE MANUAL is made in loose-leaf form—handsomely made of flexible leatherette—the entire book can be folded and slipped easily into your pocket or put in your bag.

Rarely do manufacturers supply information about receivers made before 1927—even 1930 service data are not always available because many manufacturers do not supply independent Service Men with such data. And, when you can get the material from some of the manufacturers, it is of little use to you because it is not uniform, and it is scattered in different places; difficult to get at.

Additional service data, for new receivers as they appear on the market will be published and supplied at trifling cost so that the MANUAL may be kept up-to-date at all times.

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**ORIGIN AND GROWTH OF RADIO SERVICING**

(Continued from page 651)

ns, were a bit too confusing for him. Besides, the need for test equipment was more obviously necessary now; and that investment as compared to an ordinary pocket voltmeter and screwdriver was too much for one who just dabbled in repairing.

In the years that followed, receivers became increasingly complicated and each year would cause new expenditures in instruments, manuals (since circuits became too varied and involved for the average Service Man), and for text books, so that new engineering developments could be better understood. And each year would see some of the old-timers, who couldn't keep pace with the changing technique of servicing, drop out only to be replaced by new men—many of whom were not even as efficient. To this day that situation exists.

Perhaps, as in 1926, the even more complicated receiver to come (in the very near future) will cause a further thinning of the now overswelling ranks of Service Men, and be another salvation for the profession.

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**THE RADIO MONTH IN REVIEW**

(Continued from page 650)

part of a radio set: many Service Men had suspected as much, but last month President Hoffman of Midwest Radio Corp. said it had been proved by a wear-testing machine. (This is the kind of robot that tells your radio's fortune, by giving it continuous action till something breaks. In 1 day, it will make a 4-year forecast.) Anyway, a 10-year cable was made of long-staple cotton with silk threads; while even a wire cable will go phutt in 2.

General Electric received authority last month to go ahead with an S-W. broadcast station for South American and Far Eastern transistors, at Belmont, Calif. It will be completed this year, and work on 9,530 and 15,330 kc. Directional antennas will concentrate the beam, and give a better aural path to Asia than that from Schenectady, which passes over the magnetic and geographical poles, and suffers much from atmospheric variations.

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D.—Allen B. DuMont
D.C.—The Davis Company
DeF.—Lee de Forest Laboratories
"G.C."—George Clark, RCA Historian
G.E.—General Electric Company
G.I.—General Instrument Company
G.I.C.—General Instrument Corp.
H.—Andrew Halban
H.R.D.—Havana Radio Devices
J.T.R.—J. Thos. Rhamstine
"K & H"—Andrew Halban
L.F.—Lee de Forest
L.F.—Leo Friel
L.G.P.—Louis Gerard Parent
M.—Robert H. Marriot
M.C.G.—Martin Company, Great Britain
"M.C.H."—Milwaukee, Cleveland
M.C.M.—McMurdo Spark Industry
M.E.—Modern Electrics
"M.H."—Modern Helenics
M.V.—Magnavox Company, Ltd.
M.W.—Marconi's Wireless Telegraph Co., Ltd.
M.W.B.—National Broadcasting Co., Inc.
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O.T.—O. T. Telefunken, Electronic Products
P.—Pawtucket Engineering Corp.
"P.C."—Popular C. Radio
P.R.C.—Philco Radio and Television Corp.
P.R.K.—Philco Radio and Television Corp.
R.C.A.—RCA Manufacturing Company, Inc.
R.D.W.—R. D. Washburne
"R.P.A."—Radio For All
R.M.W.—Rudolph Master Works
S.H.—Shure Brothers Company
S.I.—Supreme Instruments Corp.
S.P.E.—Spearpoint Photo Service
T.A.—Thomas A. Edison, Inc.
T.C.—Transducer Corp.
W.E.—Westinghouse Electric & Mfg. Co. (pages 413, 445, 446)
W.E.—Western Electric Co. (pages 565, 566)
W.M.C.—Workrite Manufacturing Company
W.S.—Wholesale Radio Service
W.T.—Western Television Corp.
X.L.R.—X-L Radio Laboratories

CREDIT CORRECTIONS

Radio-Craft takes this opportunity to express appreciation to several individuals and organizations whose exceptional cooperation helped make possible this JUBILEE SOUVENIR NUMBER.

Mr. George H. Clark, RCA historian, made available to Radio-Craft many photographs in his personal file of old-time radio equipment. Mr. M. Raber, who collaborated with Mr. Clark in furnishing these photos, also contributed numerous photos from the historical archives of the Radio Corp. of America. Mr. L. O. Parent made available the following photographs by Radio-Craft actual equipment in his private museum of old-time radio apparatus. Mr. R. H. Marriot, supplied many of the exceptionally old views, some of which date prior to 1900. Mr. Joseph D'Agostino, N.D.C. engineer, contributed generously of data and photographs of tubes in his internationally famous collection (on display in Radio City) that supplied considerable material (data and photos) from the historical files of the Western Electric Co. Bell Telephone Labs. furnished photographs of equipment in their museum. Westinghouse Elec. & Mfr. Co. contributed many of the photos and much of the information concerning the early days of broadcasting.

Space limitations preclude giving full credit to the many hundreds of individuals and organizations which so wholeheartedly cooperated in making the JUBILEE SOUVENIR NUMBER a success.

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VELVET Vernier and Dials

Grounded Rotor
Shielded Stator
Heavy Aluminum Plate
Radion Hard Rubber

Low Loss
Used by Browning and Drake before the American Inst. of Electrical Engineers

PRICES
DX Condenser including 3" Vernier Dial.

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Velvet Vernier Dial Only

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PERFECT RESONANCE CONTROL
That is the way that a user of a NATIONAL VELVET VERNIER DIAL and CONDENSER describes the liquid smoothness and flexibility of this Perfect Slow Motion Dial and Low Loss Condenser. Perfect because of perfect design and skilled craftsmanship. No gears—no grating—no backlash. Every part in perfect accord.

A Perfect Control For the Whole Dyne Family
Made by

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The RCA Manufacturing Co., an RCA service, makes everything in radio—radio sets for home, farm and automobile ... phonograph-radios ... record players ... Victrolas and Electrolas ... Victor Records ... Transmitters and associated apparatus for broadcasting stations ... radio equipment for aircraft and airport—for the amateur, the experimenter, the radio service man. No matter what product millions may need—if it's in connection with radio or sound—RCA has it!

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