MAY, 1919
20cts.

ELECTRICAL EXPERIMENTER

SCIENCE AND INVENTION

OVER 175 ILLUST.

REG US PAT OFF.

THE THOUGHT RECORDER

See Page 12

Learn Electricity

In the Great Shops of COYNE IN 3½ MONTHS

Thousands of Electrical experts are needed to help rebuild the world. Come to Chicago to the great shops of Coyne and let us train you quickly by our sure, practical way, backed by twenty years of success. Hundreds of our graduates have become experts in less than four months. *You* can do the same. *Now* is your big opportunity. Come—no previous education necessary.

Earn $125 to $300 a Month

In the Electrical business. Come here where you will be trained in these great $100,000 shops. Experts show you everything and you learn right on the actual apparatus. You work on everything from the simple bell to the mighty motors, generators, electric locomotives, dynamos, switchboards, power plants, everything to make you a master electrician. We have thousands of successful graduates. Just as soon as you have finished we assist you to a good position.

Become an Expert in 3½ Months

No need of taking from 1 to 4 years to become an expert, we have proved this in thousands of cases. The Coyne method of practical training eliminates all books, useless theory and other non-essentials and trains you in just what you need to know to become an expert.

Earn Your Way

Don't tell yourself you haven't got the money to come to Coyne. If you have ambition and the nerve of a real man, that's all you need. Dozens of our students every year work in their spare time and earn their living expenses. Dozens of others work in the day time, earn all their expense and attend our evening school. Our employment department will help you without charge.

Day or Evening Courses

Don't worry about the money. Anyone with ambition can learn here. Our tuition is low with small easy payments if desired. All tools and equipment is furnished free. Our students live in comfortable homes in the best section in Chicago—on the lake—just a few minutes' walk from our school.

Electricity, Drafting Motion Picture Operating Plumbing

We teach all these trades and professions quickly and in such a thorough, practical way that when finished you are ready to step right into a position of responsibility and big pay.

Send Today for Big Free Book

Write today, *now*, for the book. It tells what Coyne graduates have done. What you can do. Fill in the coupon, check the trade you are most interested in or send a postal card, do it *now*.

Learn Drafting

The country is crying for skilled draftsmen in all lines. Thousands of positions open with princely salaries. We give you the advantage of our big shops. No other school can do this. Now is the time to get into this big field. Experts train you under practical working conditions, no books and theory go here. Check drafting on the coupon below and mail it *at once* for full particulars.

BENNETT W. COOKE, *Director*

COYNE TRADE AND ENGINEERING SCHOOLS

Dept. 25 39-51 E. Illinois Street, Chicago, Ill.

MAIL COUPON FOR FREE BOOK NOW!

COYNE TRADE AND ENGINEERING SCHOOLS
Bennett W. Cooke, Director
Dept. 25, 39-51 E. Illinois St.
Chicago, Ill.

Please send at once your big Free Book—I am interested in

[ ] Electricity [ ] Drafting [ ] Plumbing
[ ] Motion Picture Operating
(*Check trade interested in*)

Name.....

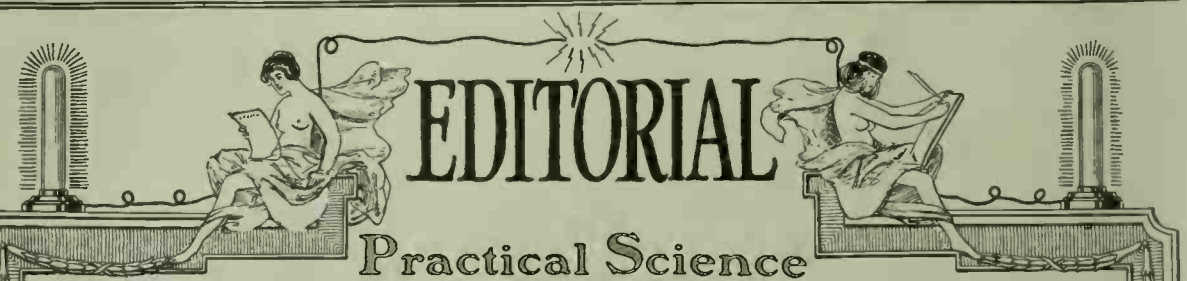
Address.....

Electrical Experimenter

233 FULTON STREET, NEW YORK

Publisht by Experimenter Publishing Company, Inc. (H. Gernsback, President; S. Gernsback, Treasurer;) 233 Fulton Street, New York.

Vol. VII. Whole No. 73 **MAY, 1919** **No. 1**



EDITORIAL

Practical Science

THE wonderful age in which we are living has never been paralleled in history. We have more comforts, more conveniences, more of everything than human beings ever had, since the creation of the world. Nevertheless, our lives become more and more complex, as time rolls on, while the average human being becomes more perplexed at the strange surroundings in which he finds himself.

Our electro-mechanical age brings forth new surprises constantly, and he who does not know the rudimentaries of mechanics, electricity and general physics is like a blind man in a circus. He hears what is going on, but all is meaningless to him—he cannot get the full benefit of the performance.

Where humanity now finds itself surrounded by machines, and by electrical wires at every hand, it behooves every man to know something about them. Thousands of lives are lost every year because laymen refuse to learn a little about science in general. They get killed because they fight short-circuits with water, when ten minutes of study would have told them that water is a conductor, and that a few handfuls of dry sand—which is a non-conductor—would have saved the life, *and* the house which burnt down due to the short-circuit. If the father had told his boy that a wet rope is a good conductor for electricity that boy would be alive today. Instead, the boy threw the wet rope over the high tension line, while holding it in his hand, and was killed.

If the six hundred auto owners who were asphyxiated last year—the casualties become larger each year—had known a bit of chemistry, they, too, would be living today. But they insisted upon running their engines in a garage with closed doors, and unfortunately, you can't smell carbon monoxid, even if it is deadly.

Then, too, hundreds of people perish in snow storms every year quite unnecessarily. Usually they freeze to death. The white man runs about in a frenzy when he knows himself lost. He becomes overheated, and the perspiration soaks his clothing. Finally he sinks down into the snow, exhausted, and if it is cold enough he is soon frozen stiff. Now Eskimos, who have learned a bit of science by hard experience, prefer to live pleasantly thru the worst snowstorm, with the temperature below zero. If the Eskimo becomes lost in the wilderness he knows better than to run about aimlessly. He promptly digs a cave into the snow, with the entrance away from the wind, using only his hands for tools. Inside of ten minutes he is safely ensconced in a comparatively warm shelter. He then closes up the entrance almost entirely, sits down, drops his head on his knees, and has a refreshing sleep. The next morning he digs himself out, and is on his way.

If the writer had not known something about electricity, he, too, might not be here to write these lines. As a boy he went down into an unoccupied cellar. The wind blew the wooden door shut, locking him in, as the iron latch was outside. The only other exit was an open window hole barricaded with stout iron rods, thru which the wind roared. The temperature was below zero. The cellar was empty, save for a few wooden crates, the object of the visit. The cellar being distant from the house and other habitations, the parents away, and the caretaker off for the night, there was every possibility of his freezing to death. No tools to break down the door, no matches to make a fire. But there was a portable light, with two large electric dry cells in a wooden box, which the writer had brought along to light his way.

He unraveled the stranded electric cord and extracted a single thin copper strand an inch long. With this he short-circuited the dry cells. The wire became white hot. A piece of paper was touched to it, which burst into flame; a broken piece of crate wood was ignited by the flame, and a fire soon roared. A burning crate set the cellar door on fire, and in ten minutes the adventure had come to a close.

H. GERNSBACK.

The ELECTRICAL EXPERIMENTER is publisht on the 15th of each month at 233 Fulton Street, New York. There are 12 numbers per year. Subscription price is $2.00 a year in U. S. and possessions, Canada and foreign countries, $2.50 a year. U. S. coin as well as U. S. stamps accepted (no foreign coins or stamps). Single copies, 20 cents each. A sample copy will be sent gratis on request. Checks and money orders should be drawn to order of EXPERIMENTER PUBLISHING CO., INC. If you change your address notify us promptly, in order that copies are not miscarried or lost. A green wrapper indicates expiration. No copies sent after expiration.

All communications and contributions to this journal should be address to: Editor, ELECTRICAL EXPERIMENTER, 233 Fulton Street, New York. Unaccepted contributions cannot be returned unless full postage has been included. ALL accepted contributions are paid for on publication. A special rate is paid for novel experiments; good photographs accompanying them are highly desirable.

ELECTRICAL EXPERIMENTER. Monthly. Entered as second-class matter at the New York Post Office under Act of Congress of March 3, 1879. Title registered U. S. Patent Office.

The ELECTRICAL EXPERIMENTER is for sale at all newsstands in the United States and Canada; also at Brentano's, 37 Avenue de l'Opera, Paris.

Member of the Audit Bureau of Circulation.

The Secret of Being a Convincing Talker

How I Learned It in One Evening

By GEORGE RAYMOND

"HAVE you heard the news about Frank Jordan?"

This question quickly brought me to the little group which had gathered in the center of the office. Jordan and I had started with the Great Eastern Machinery Co., within a month of each other, four years ago. A year ago Jordan was taken into the accounting division and I was sent out as salesman. Neither of us was blessed with an unusual amount of brilliancy, but we got by in our new jobs well enough to hold them.

Imagine my amazement, then, when I heard:

"Jordan's just been made Treasurer of the Company!"

I could hardly believe my ears. But there was the "Notice to Employees" on the bulletin board, telling about Jordan's good fortune.

Now I knew that Jordan was a capable fellow, quiet, and unassuming, but I never would have picked him for any such sudden rise. I knew, too, that the Treasurer of the Great Eastern had to be a big man, and I wondered how in the world Jordan landed the place.

The first chance I got, I walked into Jordan's new office and after congratulating him warmly, I asked him to let me "in" on the details of how he jumped ahead so quickly. His story is so intensely interesting that I am going to repeat it as closely as I remember.

FREDERICK HOUK LAW

As educator, lecturer, executive, traveler and author few men are so well equipped by experience and training as Dr. Law to teach the art of effective speaking. His "Mastery of Speech" is the fruit of 20 years' active lecturing and instruction in Eastern schools and colleges preceded by an education at Oxford Academy, Amherst College, Columbia University, The Teachers College, Brown University, and New York University. He holds the degrees of A.B., A.M., and Ph.D.

Dr. Law is the author of two novels, two books of poetry, and editor of six school text-books. At present he is lecturer in English in New York University, Lecturer in Pedagogy in the Extension Work of the College of the City of New York, Head of the Dept. of English in the Stuyvesant H. S. and writer of the Weekly Lesson Plans for The Independent.

"I'll tell you just how it happened, George, because you may pick up a pointer or two that will help *you*.

"You remember how scared I used to be whenever I had to talk to the chief? You remember how you used to tell me that every time I opened my mouth I put my foot into it, meaning of course that every time I spoke I got into trouble? You remember when Ralph Sinton left to take charge of the Western office and I was asked to present him with the loving cup the boys gave him, how flustered I was and how I couldn't say a word because there were people around? You remember how confused I used to be every time I met new people? I couldn't say what I wanted to say when I wanted to say it; and I determined that if there was any possible chance to learn how to talk I was going to do it.

"The first thing I did was to buy a number of books on public speaking, but they seemed to be meant for those who wanted to become orators, whereas what I wanted to learn was not only how to speak in public but how to speak to individuals under various conditions in business and social life.

"A few weeks later, just as I was about to give up hope of ever learning how to talk interestingly, I read an announcement stating that Dr. Frederick Houk Law of New York University had just completed a new course in business talking and public speaking entitled 'Mastery of Speech.' The course was offered on approval without money in advance, so since I had nothing whatever to lose by examining the lessons, I sent for them and in a few days they arrived. I glanced through the entire eight lessons, reading the headings and a few paragraphs here and there, and in about an hour the whole secret of effective speaking was opened to me.

"For example, I learned why I had always lacked confidence, why talking had always seemed something to be dreaded whereas it is really the simplest thing in the world to 'get up and talk.' I learned how to secure complete attention to what I was saying and how to make everything I said interesting, forceful and convincing. I learned the art of listening, the value of silence, and the power of brevity. Instead of being funny at the wrong time, I learned how and when to use humor with telling effect.

"But perhaps the most wonderful thing about the lessons were the actual examples of what things to say and when to say them to meet every condition. I found that there was a knack in making oral reports to my superiors. I found that there was a right way and a wrong way to present complaints, to give estimates, and to issue orders.

"I picked up some wonderful pointers about how to give my opinions, about how to answer complaints, about how to ask the bank for a loan, about how to ask for extensions. Another thing that struck me forcibly was that, instead of antagonizing people when I didn't agree with them, I learned how to bring them around to my way of thinking in the most pleasant sort of way. Then, of course, along with those lessons there were chapters on speaking before large audiences, how to find material for talking and speaking, how to talk to friends, how to talk to servants, and how to talk to children.

"Why, I got the secret the very first evening and it was only a short time before I was able to apply all of the principles and found that my words were beginning to have an almost magical effect upon everybody to whom I spoke. It seemed that I got things done instantly, where formerly, as you know, what I said 'went in one ear and out the other.' I began to acquire an executive ability that surprised me. I smoothed out difficulties like a true diplomat. In my talks with the chief I spoke clearly, simply, convincingly. Then came my first promotion since I entered the accounting department. I was given the job of answering complaints, and I made good. From that I was given the job of making collections. When Mr. Buckley joined the Officers' Training Camp, I was made Treasurer. Between you and me, George, my salary is now $7,500 a year, and I expect it will be more from the first of the year.

"And I want to tell you sincerely, that I attribute my success solely to the fact that I learned how to talk to people."

****

When Jordan finished, I asked him for the address of the publishers of Dr. Law's Course and he gave it to me. I sent for it and found it to be exactly as he had stated. After studying the eight simple lessons I began to sell to people who had previously refused to listen to me at all. After four months of record breaking sales during the dullest season of the year, I received a wire from the chief asking me to return to the home office. We had quite a long talk in which I explained how I was able to break sales records—and I was appointed Sales Manager at almost twice my former salary. I know that there was nothing in me that had changed except that I had acquired the ability to talk where formerly I simply used "words without reason." I can never thank Jordan enough for telling me about Dr. Law's Course in Business Talking and Public Speaking. Jordan and I are both spending all our spare time making public speeches on war subjects, and Jordan is being talked about now as Mayor of our little town.

So confident is the Independent Corporation, publishers of "Mastery of Speech," Dr. Law's Course in Business Talking and Public Speaking, that once you have an opportunity to see in your own home how you can, in one hour, learn the secret of speaking and how you can apply the principles of effective speech under all conditions, that they are willing to send you the Course on free examination.

Don't send any money. Merely mail the coupon or write a letter and the complete Course will be sent, all charges prepaid, at once. If you are not entirely satisfied send it back any time within five days after you receive it and you will owe nothing.

On the other hand, if you are as pleased as are the thousands of other men and women who have used the Course, send only $5 in full payment. You take no risk and you have everything to gain, so mail the coupon now before this remarkable offer is withdrawn.

FREE EXAMINATION COUPON

Independent Corporation

Publishers of The Independent Weekly

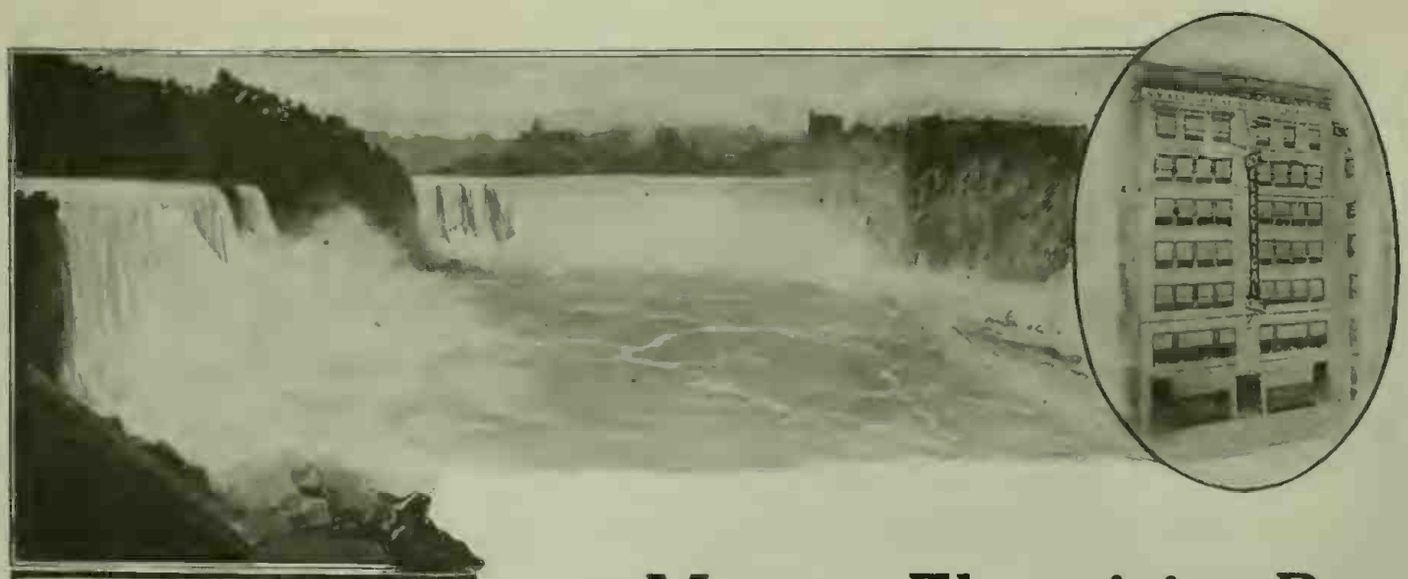
Dept. L-1105 119 West 40th Street, New York

Please send me Dr. Frederick Houk Law's "Mastery of Speech," a Course in Business Talking and Public Speaking in eight lessons. I will either remail the Course to you within five days after its receipt, or send you $5.

Name .....

Address .....

..... Elect. Exp. 5-19



Master Electricity By Actual Practice

The only way you can become an expert is by doing the very work under competent instructors, which you will be called upon to do later on. In other words, *learn by doing.* That is the method of the New York Electrical School.

Five minutes of actual practice properly directed is worth more to a man than years and years of book study. Indeed, Actual Practice is the only training of value, and graduates of New York Electrical School have proved themselves to be the only men that are fully qualified to satisfy EVERY demand of the Electrical Profession.

The Only Institution of the Kind in America

At this "Learn by Doing" School a man acquires the art of Electrical Drafting; the best business method and experience in Electrical Contracting, together with the skill to install, operate and maintain all systems for producing, transmitting and using electricity. A school for Old and Young. Individual instruction.

Over 5,500 Graduates are Successful Men in the Electrical World

No previous knowledge of electricity, mechanics or mathematics is necessary to take this electrical course. You can begin the course now and by steady application prepare yourself in a short time. You will be taught by practical electrical experts with actual apparatus, under actual conditions.

Let us explain this course to you in person. If you can't call, send now for 64-page book—it's FREE to you

New York Electrical School

29 West 17th Street, New York

New York Electrical School
29 W. 17th St., New York, N. Y.

Please send FREE and without obligation to me your 64-page book.

.....(NAME)

.....(ADDRESS)

ELECTRICAL EXPERIMENTER

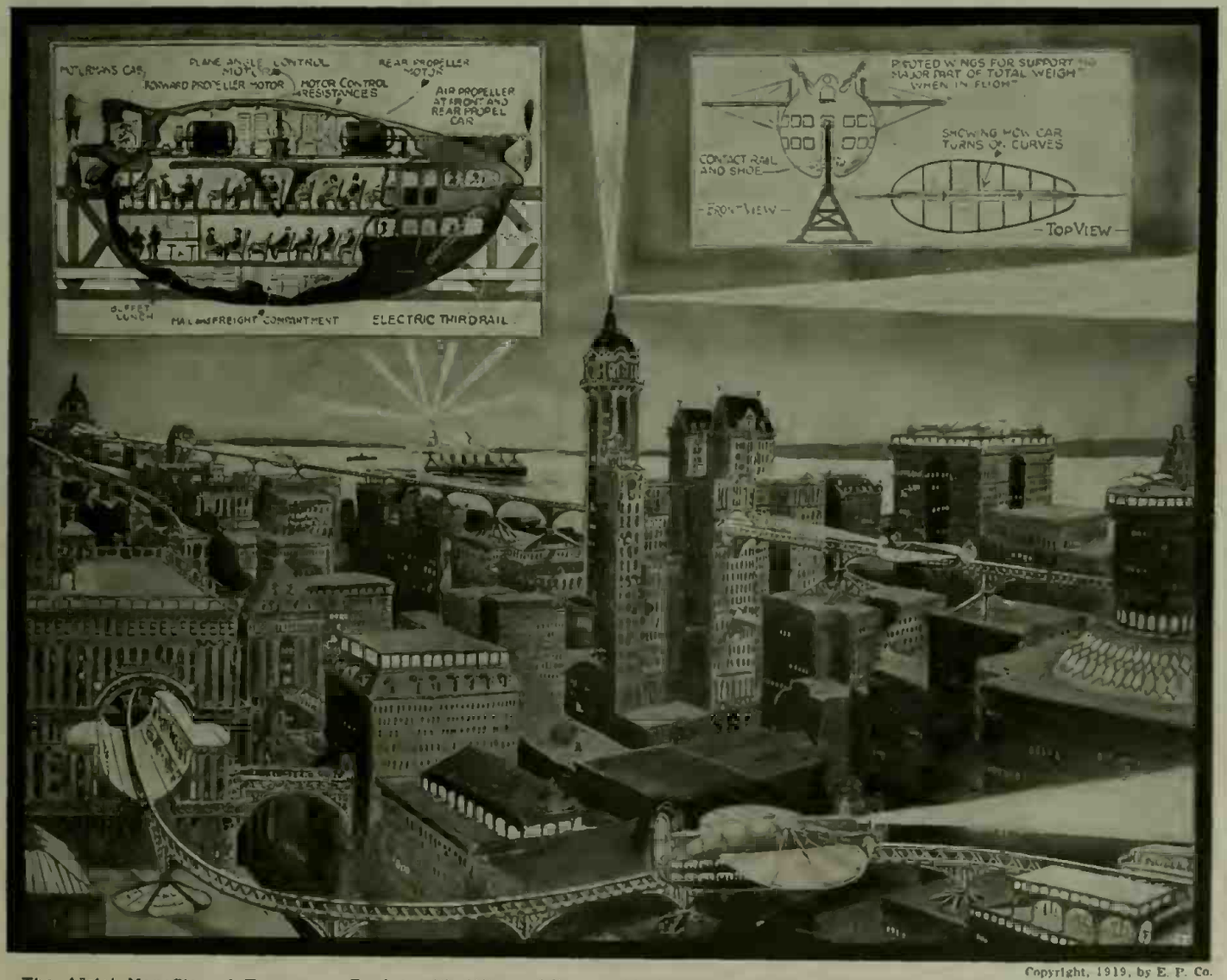
H. GERNSBACK – EDITOR
H. W. SECOR – ASSOCIATE EDITOR

Vol. VII. Whole No. 73 MAY, 1919 No. 1

Future Rapid Transit

PEOPLE who have traveled abroad will remember having seen the remarkable suspended aërial railway of Elberfeld (Germany), the cars having wheels on the roof instead of underneath, and but one rail being used. This form of construction gives, among other considerations, much greater flexibility to the speeding cars or trains, as for example when they wish to turn sharp curves at comparatively high speed. Possibly many will remember having seen this interesting suspended railway in the motion picture travelogues given by Burton Holmes. It has always seemed to us, however, that these cars have a little too much freedom of movement to make the ride as comfortable as it might be to the passengers, owing to the constant swinging or sidewise rolling motion produced by this cradle suspension arrangement. Apparently there are other people who have entertained similar ideas, for in the accompanying illustration there is shown a new development of a monorail car, which might be termed an "Aërial Monoflier," and which has been recently invented and patented by the celebrated French engineer, M. Francis Laur of Paris. As M. Laur points out in his description of the invention, his scheme relates to an improvement in a vehicle for use in high speed locomotion in connection with a monorail or single track. A very novel idea of the project is a passenger-carrying vehicle somewhat in the form of

(*Continued on page* 66)



The Aërial Monoflier of Tomorrow—Equipt with Wings, Like an Airplane, It Will Skim Along Thru the Air, Guided by the Monorail. The Cars Are Propelled by Motor-Driven Propellers, Which Derive Their Power from Third Rails, as the Car Glides Along at Speeds of 200 to 300 Miles Per Hour. When In Motion the Entire Weight Is Practically Carried by the Wings, the Same as In an Airplane.

Will Man Freeze the Earth to Death?

By E. T. BRONDSDON

"TO RENT: Ten-room suburban home. Three baths. Sun, sleeping and breakfast porches. Radium heating system (20 pounds) . . ." To find this advertisement, look in the classified columns of any metropolitan newspaper five or six centuries hence. Our great-great-grandchildren fifteen times removed will be worrying about paying the rent on some such dwelling. Have you paid your "Radium Rent" will be a common slogan then.

Radium power, light and heat for apartment and home will seem as much of a commonplace to them as soft coal furnaces seem to us. In tomes of ancient history they will read stories of how their ancestors struggled thru the smoky winter of 1918, and they will marvel at our lack of understanding. Soft coal then will have a place only in museums.

Twenty pounds of radium gives off an amount of heat in six months equivalent to that secured by burning four and one-half tons of the best Pocahontas or anthracite coal. The ten-room house mentioned above would be adequately heated, however, on twenty pounds, because a radium heating plant would be *one hundred per cent efficient*. Even with hot water and hard coal from eighty to ninety per cent of the heat our plants generate goes up the chimney. A radium system would have no chimney. Every single heat unit would be conserved for the interior of the house and distributed by any ordinary medium, such as register, radiator or the like.

In addition to this, the radium system would have the splendid recommendation that there would be no flues, traps or pipes to be cleaned, and no ashes would accumulate to make the householder angry on Saturday afternoon. Then there would be the greatest point of all. Once installed, this radium system *never would have to be replaced!* When one house began to disintegrate from old age, the mysterious metal could be taken out and installed in the system of a new house, and so on forever, unless some careless janitor took it out to clean and left it in the subway Coal men and ash carters would pass into that same merciful oblivion which shelters stage-coach bandits and Indians on the warpath.

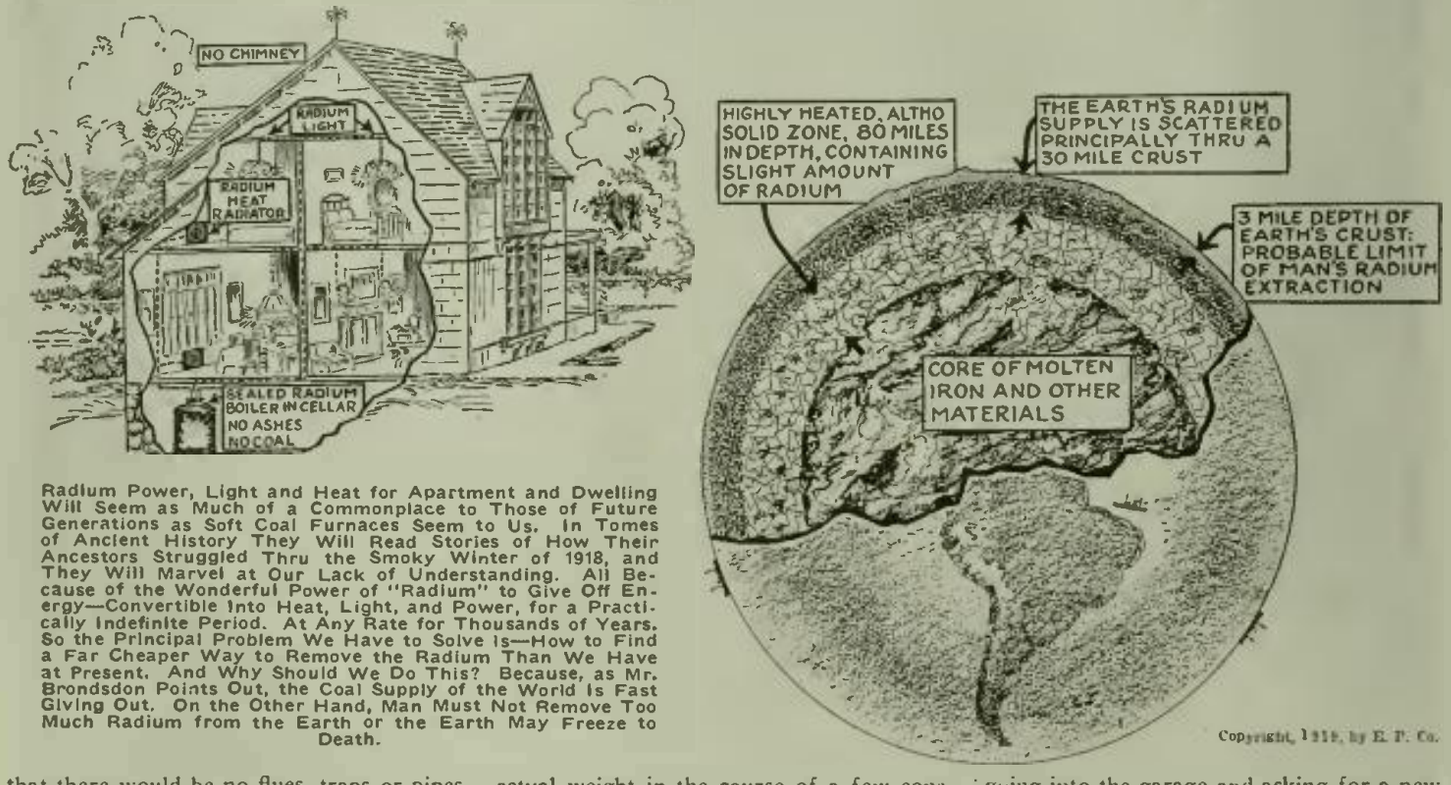
The reason why such a radium system would never have to be replaced is that radium is the one and only close approach to perpetual motion to be found on our globe. Look at a piece of radium one-thousandth the size of a pin point thru a *spinthariscope*. This is an instrument consisting of a high-magnifying lens and an aluminum disc covered with zinc sulfid. When viewed in this manner millions of tiny arrows of fire are seen to be flying from the radium and impinging on the zinc sulfid with an explosion like that of a fire ball from a Roman candle.

Tho each of the exploding projectiles of helium—radium somehow transforms itself into active atoms of this other element—looks nearly as large as the original divot of radium, you may glue your eye to the spinthariscope for hours—centuries, if you live that long—and you never will see any diminution in the discharge or in the size of the radium piece.* Scientists who have given the matter intensive study over long months and years say that they suspect radium of losing an infinitesimal part of its actual weight in the course of a few eons, but that human beings are going to have trouble gathering accurate data on the subject unless a dynasty of scientific Methuselahs is established.

The one big obvious objection at present to the use of radium for heating plants lies in the scarcity and tremendous cost of the metal. One ounce only would cost, at the present market price, approximately $40,000. The twenty pounds necessary for heating the ten-room house mentioned would retail at $12,800,000, were such a quantity procurable. Figuring interest at six per cent, the cost of that radium heating system for a year—excluding the original investment, which would not appreciably deteriorate—would be in the neighborhood of $768,000, or about 4,000 times the cost of coal heating today.

The only logical reason in the world for even allowing imagination to roam on this subject lies in the terrible and undisputed fact that *somewhere we are going to have to get heat if we are to live!*

So much space has been given in the last decade to learned dissertations on our rapidly decreasing supplies of coal and petroleum that it is useless to dwell on this. Suffice it to say that the last reports of competent authorities state baldly that we will surely be out of both *forever* at the conclusion of the present century, provided our present rate of consumption is neither raised or lowered. Since we have no assurance that the rate of increase of consumption will not keep on, we may bet safely that the year 1975 will see coal and oil so scarce that only millionaires can afford them. Coal then may be $500 a ton, and crude oil $25 a gallon. Alas for the "flivvers"! Imagine Mr. Autoist of that day going into the garage and asking for a new "can" of Radium for his "Radiobile." It can happen. (*Continued on page* 59)



Radium Power, Light and Heat for Apartment and Dwelling Will Seem as Much of a Commonplace to Those of Future Generations as Soft Coal Furnaces Seem to Us. In Tomes of Ancient History They Will Read Stories of How Their Ancestors Struggled Thru the Smoky Winter of 1918, and They Will Marvel at Our Lack of Understanding. All Because of the Wonderful Power of "Radium" to Give Off Energy—Convertible Into Heat, Light, and Power, for a Practically Indefinite Period. At Any Rate for Thousands of Years. So the Principal Problem We Have to Solve Is—How to Find a Far Cheaper Way to Remove the Radium Than We Have at Present. And Why Should We Do This? Because, as Mr. Brondsdon Points Out, the Coal Supply of the World Is Fast Giving Out. On the Other Hand, Man Must Not Remove Too Much Radium from the Earth or the Earth May Freeze to Death.

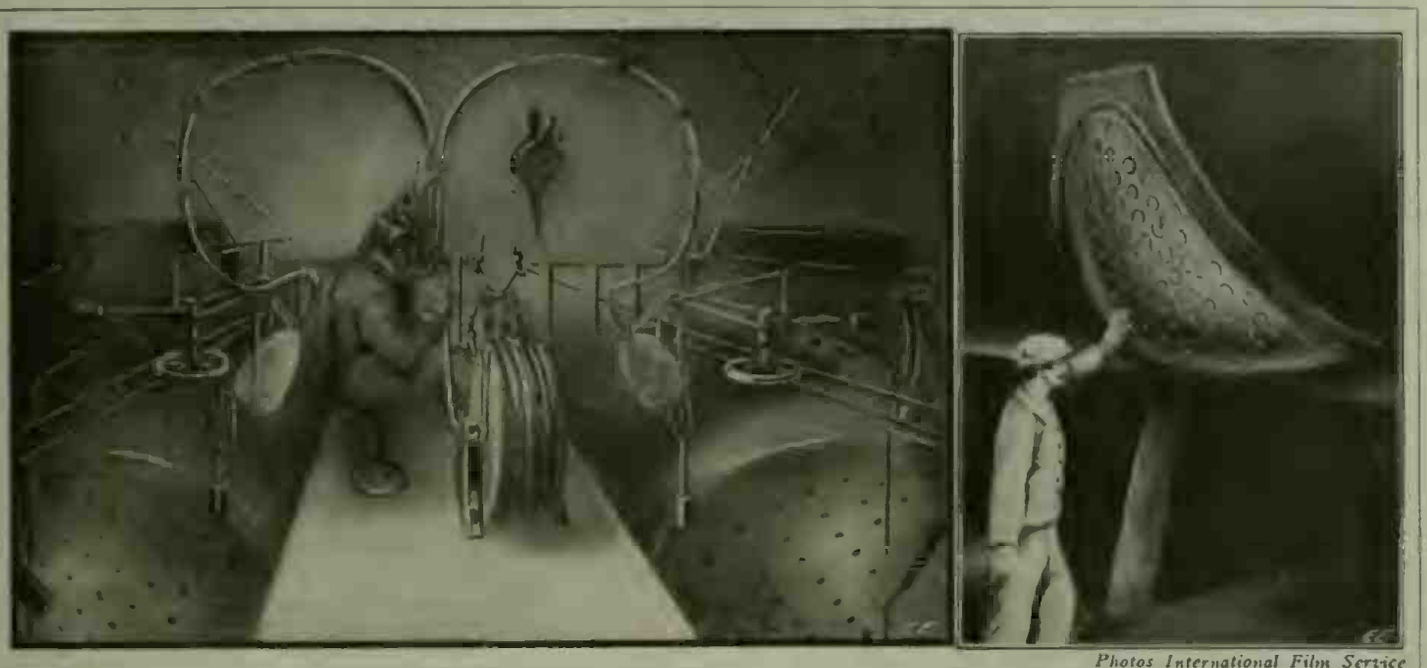
*This is not strictly the case, for the zinc sulfid spinthariscope we have to-day, for while the radium will last for thousands of years, the zinc sulfid will give out in a relatively short time. However, there are undoubtedly other substances which would last much longer than zinc sulfid. Another variable factor, variable in the sense that we have not lived long enough with radium yet to tell exactly how long it will last before losing its power, is the total life of this marvelous substance. Scientists tell us that in 1,800 years radium loses one-half of its activity. In another 1,800 years one-half of the remainder will have disintegrated, etc., etc. So that on this assumption the radium will have totally disintegrated in 22,000 years.—Editor.

How the French Located Submarines

ONE by one the multitudinous scientific secrets of the great World War are finding their way to the public press, so that the student of science may at last have his appetite appeased in his quest of descriptive matter on some of the master problems which have been worked out and solved by engineers and scientific workers connected with army and navy developments. Probably no one problem in the whole war drew more attention from laymen and scientists alike than did the one of accurately discovering and locating the whereabouts of the Kaiser's U-Boats. The United States Naval Advisory Board received thousands upon thousands of suggestions, all telling how very simple it was to ferret out and locate the position of an enemy submarine, just by placing a microphone or set of microphones in the hull of a vessel and connecting these up with a set of telephone receivers, so that the sound produced by the submarine propeller and motor would be picked up by the microphones and thus heard in the receivers. Various methods were described for taking certain definite and very precise measurements along these lines, so as to work out mathematically or otherwise the position of the lurking sub-sea fighter. Considerable success was obtained with similar arrangements by the navies of the different countries participating in the World War, but the Walser gear—a special type of hydrophone used particularly for listening to submarines under water was developed and successfully used by the French Navy and other allied vessels for accurately locating enemy submarines at distances of one mile to three miles or more, depending upon the operating conditions and the size of the submarine.

The Walser Gear, whose construction has been kept secret during the war, is a directional apparatus for detecting and recording sounds heard thru water and thus locating the presence or approach of enemy ships. Many different devices for "listening" for enemy ships have been disclosed, but this apparatus, the invention of Lieut. Georges Walser, of the French Navy, is recognized as the most improved type and most practicable.

The sounds are received thru a number of vibrating diaframs fitted into holes pierced in a boss, or "blister" of sheet steel, which replaces a corresponding section of a ship's hull. The observer works in a sound-proof cabin stretching across the whole width of the ship, and wears a listening helmet attached to two trumpets. Into these trumpets the sounds are focust by the vibrating diaframs attached to the the "blister."



Photos International Film Service

The Walser Gear—a Type of Hydrophone Used for Submarine Listening. The Walser Gear, Whose Construction Had Been Kept Secret During the War, Is a Directional Apparatus for Detecting and Recording Sounds Thru Water and Thus Locating the Presence or Approach of Enemy Ships. This Apparatus is the Invention of Lieut. Georges Walser, of the French Navy, and is Recognized as the Most Improved Type and Most Practicable. The Sounds are Received Thru a Number of Vibrating Plates Fitted Into Holes Pierced In a Boss, or "Blister" of Sheet Iron, Which Replaces a Corresponding Section of a Ship's Hull. The Observer Works In a Sound Proof Cabin Stretching Across the Whole Width of the Ship, and Wears a Listening-helmet, Attached to Two Trumpets. Into These Trumpets the Sounds are Focused By the Vibrating Plates Attached to the "Blister." Left:—Detecting the Presence of Enemy Ships On or Under the Surface of the Sea. An Observer Using the Walser Gear in a Special Cabin Fitted Up as a Listening Post. Right:—On the Hull of the "Henriette II", a French Warship Which is Using the Apparatus, Showing the Exterior of the Sound—Collecting Boss or "Blister".

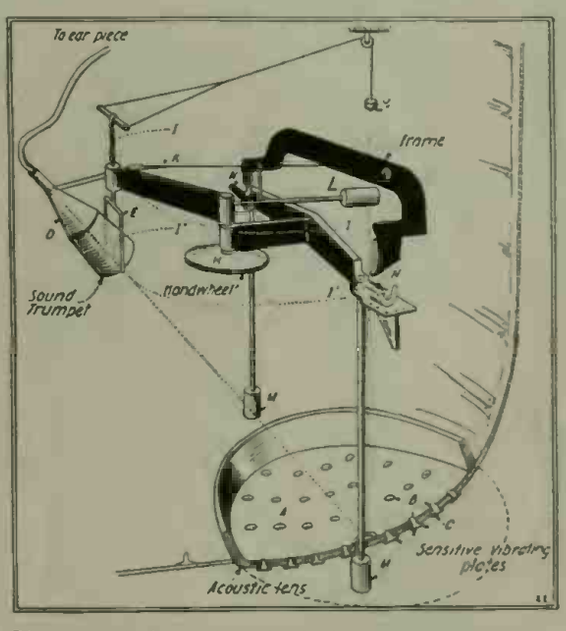
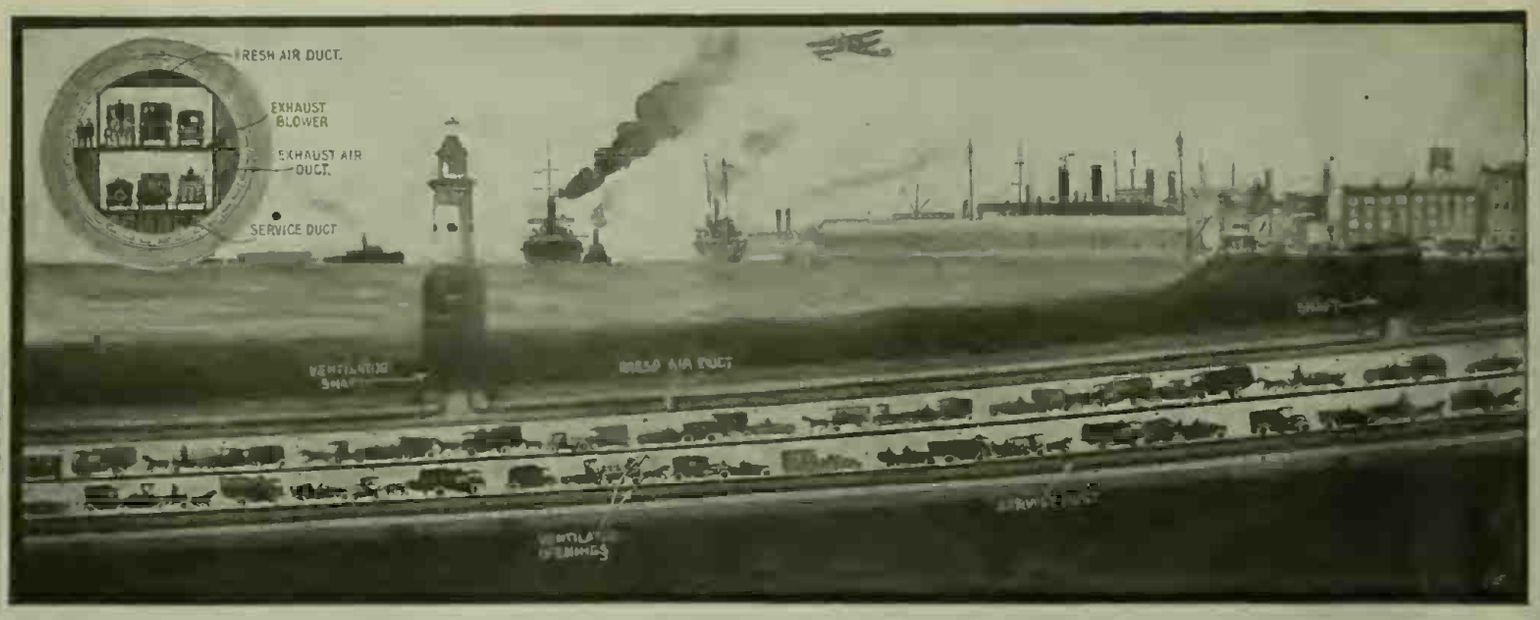


Diagram of One "Lens" of the Walser Submarine Detector and Locater, Showing the Carefully Worked Out Balancing Scheme for Supporting the Movable Sound Trumpet Over the Various Sound Focal Points.

Some of the disadvantages of the ordinary listening microphone arrangement for the detection of submarines are the following: Invariably the vessel on which they are mounted has to be stopt momentarily while a listening test is being made, in order that the ship's engines shall not drown out the sounds which the listening operator is endeavoring to pick up from the sea. It is interesting to mention in this connection, that some of the American listening devices of this type were so remarkably sensitive that even a small dynamotor used on the regular wireless apparatus on the vessel had to be mounted on springs, so that the extremely slight mechanical vibration set up by it would not interfere with the sounds picked up from the water on the submerged microphones fastened to the hull of the boat. Another fault found with the ordinary "hydrophone" is that the different sounds received simultaneously could not be distinguished very readily from one another, and even if but one sound was picked up, the direction from which the sound emanated was not very perfectly indicated.

Practically speaking then, one of the

(*Continued on page 82*)



The Accompanying Sectional View Shows Vividly How the New Vehicular Tunnel Under the Hudson River at New York City Will Look When Finished. There Seems to be No Question at Present as to the Possibility of Building This Tunnel, and the Only Remaining Details Are Engineering Considerations Such as Ventilation, Etc., Which Are Being Rapidly Solved by Some of the Crack Engineers of America, Including No Less a Personage Than General George W. Goethals, Builder of the Panama Canal, and Now Holding the Position of Consulting Engineer to the Interstate Bridge and Tunnel Commissions of New York and of New Jersey. Several Other Proposals Have Been Brought Forward for the Building of This Tunnel Under the Hudson River, But the Goethals Plan Seems to be the Most Feasible, and the One Most Likely to be Adopted. The Length of This Vehicular Tunnel Will be About 9,400 Feet from Portal to Portal, with a Distance of 5,500 Feet, or More Than a Mile Separating the Bulkhead Lines, If These Are Placed Back of the Shore Line. In View of the Fact that the Ventilation Problem Is at Present One of the Most Important, and the One Responsible for the Most Discussion Among Tunnel Experts, We Have Several Suggestions In the Present Article and Illustrations Which Might, If Adopted, Help to Bring About the Early Adoption

Hudson River

By H. WINFIELD
Associate Member American

THE bridging of the Hudson River, commonly known as the North River in New York City, is an engineering problem that has been before the people of the states of New York and New Jersey for probably more than thirty years. A bridge across this great water highway would no doubt have been constructed many years ago, if it had been found possible to raise sufficient funds to render this dream a living reality. Engineering experts have recently bestirred themselves with the thought of crossing the Hudson either by bridge or else by means of a tunnel, particularly a vehicular tunnel suitable for horse-drawn, electric and gasoline propelled vehicles. The bridge question seems to have been discarded practically altogether now, owing to its tremendous initial cost, which would be about $72,000,000 at least, compared to the initial cost of $12,000,000 for constructing a large tunnel under the Hudson on the newly revised plan proposed by General George W. Goethals, the well-known American engineer and builder of the Panama Canal. General Goethals has been appointed consulting engineer to the Interstate Bridge and Tunnel Commissions of New York and of New Jersey. There are many reasons why New York should have means of communication such as this, as its sister state supplies, either directly or indirectly, a very large portion of the food and other commodities for greater New York's population of 7,000,000, which is brought to the piers on the west side of the Hudson by numerous railroads. Right here there is a constant and prohibitive wastage of perishable food products, owing to the highly congested and inadequate terminal facilities afforded for their movement.

At the present time there is more or less agitation in the legislatures of both states between those friendly and unfriendly to the Hudson River project. So far the one great problem, according to some of the testimony being given, and which has seemed almost insurmountable, is the proper ventilation of this tube, especially where gasoline driven vehicles are to be permitted to exhaust devitiating gases into the air of the tunnel. But according to a very able engineering report on this project, given in the Journal of the Franklin Institute and prepared by Martin Schreiber, Chief Engineer of the Public Service Railway Company of New Jersey, the ventilating problem of such a tunnel as proposed by General Goethals and other engineers can be readily taken care of, as actual laboratory tests have proven, and which have provided a satisfactory basis for calculating the results of such a long tunnel as that under the Hudson. Also to back up the argument for building the tunnel, there is precedence afforded by the fact that London, England, has built two vehicular tunnels under the Thames River, one 6,200 feet long, and the other 6,883 feet long.

The editors make several new tunnel suggestions, which are shown in the illustration accompanying this article, whereby the gigantic ventilating problem could be overcome to a large extent by controlling the kinds of traffic that should be allowed to pass thru the tube. First, the writer would suggest that the engineers contemplating the building of this tunnel consider a cable-way, one of which would be provided on each roadway, east and west, for the purpose of hauling *gasoline operated* vehicles thru the tunnel, *without their engines being operated*, thus doing away with the production of the objectionable carbon monoxid and other poisonous gases emanating from their exhaust. It would not be an impossible, or even impracticable matter, if such an electric motor-operated cable-way, similar to the old cable-car systems, were used to haul the gasoline vehicles thru the tunnel to Jersey or to New York. It could be arranged to have the owners purchase a standard cable grip, which could be fitted on to any gasoline vehicle at nominal cost.

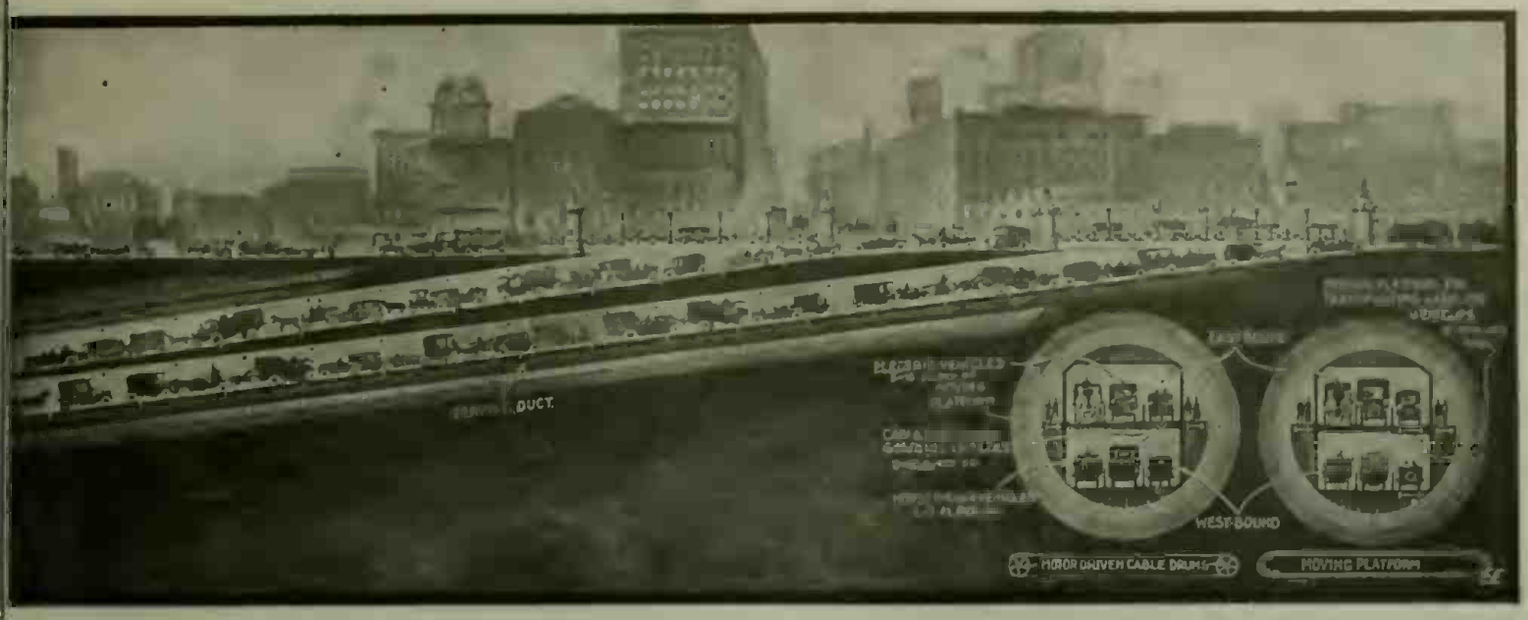
Another proposal, made by Mr. H. Gernsback, is one employing a *moving roadway* of sufficient width to accommodate gasoline auto trucks, the roadway being operated by electric motors spaced at suitable intervals along its length.

Another proposal suggested by the writer would be to utilize a trolley wire over the one line of traffic apportioned to gasoline vehicles on each roadway, and having the owners of these vehicles equip them with a trolley pole, but by the time the owners had installed an electric motor under the gasoline vehicles for use with it, it would probably be just as well for the tunnel operating engineers to ask the owners of such vehicles to invest in electric trucks for that particular traffic intended to go via the tunnel.

All of the tunnel proposals now under consideration agree on the location, which extends from Twelfth Street, Jersey City, to Canal Street, New York. The termini of the tunnel at both ends are located in the center of the trucking and freight districts. The New Jersey terminus is also happily located adjacent to the great freight yards of the principal railroads, and close to the main ferry lines, thus providing every chance for close co-operation. Besides, the great Lincoln and other much used vehicular highways lead to the location proposed for the Jersey City terminus.

The Hudson tubes as well as the Pennsylvania tunnels under the Hudson River, which are used for railway traffic exclusively, were driven by the well-known shield method. General Goethals, in his proposal for the new Hudson vehicular tunnel, has advocated the shield-driven double-deck single tube, as shown in the accompanying illustration. This tube is to have an internal diameter of 36 feet, with two 18-foot roadways, one super-imposed above the other, and a concrete floor between them. This proposal for the tunnel would permit of four lines of vehicles, two on each roadway, two of the faster moving type such as pleasure automobiles on the upper floor, and two of the slower moving vehicles, such as auto-trucks, on the lower floor.

Most of these under-river tubes have been constructed with cast-iron blocks built of segmental form, which were bolted together after being put in place, and which thus tended to resist any external hydrostatic



of the Tunnel Project. Among These Features Are the Following:—First, That a Ventilator Shaft be Placed a Comparatively Short Ways Out in the River at Either Approach, So as to Simplify the Ventilating Problem by Reducing the Length Between the Bulkheads. Second, That Gasoline Vehicles be "Hauled" Thru the Tunnels So as to Eliminate the Fouling of the Air by Obnoxious Exhaust Gases, Particularly Carbon Monoxid, by Means of a Moving Platform. Third, Haul Gasoline Vehicles Thru the Tunnel by a Cableway Similar to the Well-Known Cable Car System. Fourth, Cause the Gasoline Vehicles to be Fitted with a Trolley Pole and Electric Motor for the Purpose of passing Thru the Tunnel Without Discharging Obnoxious Gases. The Goethals Proposal Calls for a Concrete Block Tunnel, 42 Feet In Outside Diameter, with Two Road Levels, as Here Shown. One Roadway Will be for East-Bound Traffic, and the Other for West-Bound Traffic. Actual Laboratory Tests On a Short Length of Tunnel Have Shown That 750 H.P. Would be Required to Operate the Fresh Air and Exhaust Fans, with a Maximum Capacity of 360,000 Cubic Feet of Fresh Air Per Minute.

Vehicular Tunnel

SECOR

Institute Electrical Engineers

pressure with great power, much in the same way that the stones of an archway tend to support the arch. The outside of these segmental steel tubes is covered over with a fairly thick coating of concrete. Here is where the Goethals proposal differs radically from former practise, and there is considerable discussion now taking place as to the feasibility and practicability of his proposed design, which is as follows:

General Goethals' proposition is that the tunnel be constructed of O'Rourke concrete blocks in segmental form. Outside of this tube a gravel packing is to be placed. Some experts seem to doubt whether such a tube would be thoroly water-proof, and also what would happen in case of an earthquake or other severe concussion, as when a powder boat or supply of explosives might happen to blow up in the harbor, as has occurred several times during the war, when the concrete tube might crack with an appalling loss of life.

Detailed plans have been drawn up by the New York State Bridge and Tunnel Commission, under the direction of Major General George W. Goethals and John F. O'Rourke, which provide for the driving of the tunnel by the use of a shield forty-two feet in diameter—the method most usual when dealing with soft material. The material under the Hudson River is a soft silt and sand overlaid by still softer material of sewage origin, which is almost fluid. These conditions are complicated by the presence of ledge rock which is occasionally encountered. In a shield having a diameter of twenty-five feet, there is a difference in pressure between the top and bottom of ten pounds per square foot. This makes it difficult to guard against blow-outs and other accidents caused by the difference in pressure at the top and bottom of the shield, tunnel experts consulted by the state commissions have pointed out.

The diameter of the shield used in driving the Hudson tunnel was 17 feet; that of the Pennsylvania tunnel shields 23 feet 6 inches. The latter were the largest ever used under either the Hudson or the East rivers. The Rotherhithe tunnel, under the Thames River in England, was driven with a shield 30 feet in diameter thru clay mixt with shells, pebbles, loam, a much firmer material than that under the Hudson.

Of course, the traffic would have to be handled so that approximately half of the vehicles would move *eastward* and the other half *westward*. Once the tunnel is built, however, this becomes a problem for the traffic engineers of that year to solve. According to the Goethals plan, the fresh air duct is at the top of the tunnel, and fresh air is constantly pumped along this duct by means of powerful electrically-driven blowers and fans, while the foul air, including exhaust from the gasoline vehicles, is drawn out thru ducts at the bottom of the roadway. Besides, there are additional ventilating and foul air ducts at either side of the tunnel, walled off from the roadways.

To find out exactly what would happen in a section of such a tunnel with a number of gasoline vehicles operating their engines therein, a test building, corresponding in cross-section to the proposed tunnels and measuring 125 feet in length, was constructed at Newark, N. J. Eight automobiles were operated in this building, which could be shut off air-tight and fresh air pumped in at the top and the exhaust pumped out at the bottom, or vice versa. A number of elaborate tests of various kinds were carefully made by experts, including Professor Gellert Alleman, of Swarthmore, Pa., and Dr. H. Jermain Creighton, of Swarthmore College. From a very elaborate and convincing analysis on the various gases present in the tube after the automobiles had been operated for a period of forty minutes, Prof. Alleman reported that when all doors were closed and the ventilators opened, after the engines of eight cars had been *running light* for forty minutes, the condition of the atmosphere was almost normal, so far as physiological action was concerned, and the amount of carbon monoxide content not dangerous This calculation was further supported by the fact that eighteen persons who remained in the tunnel during the test for a continuous period of forty minutes experienced no unpleasant sensations from breathing the air. The contaminated air in this particular test showed .075 per cent. carbon monoxid, and 6 per cent. carbon dioxid, which proved that the per cent. of carbon monoxid was so small as to be negligible. With the data thus obtained, it was calculated that air supply fans with a maximum capacity of 360,000 cubic feet of fresh air per minute, and exhaust fans having 20 per cent. more capacity, would be required to ventilate the tunnel. The total amount of horse-power computed for operating these fans was 750 H.P. The length of the proposed tunnel under the Hudson, from portal to portal, would be approximately 9,400 feet, with a distance of about one mile, or somewhat over 5,000 feet between the bulkhead lines.

As aforementioned, London has built two vehicular tunnels under the Thames, one 6,200 feet long, the other 6,883 feet. Public interest in tunnels for New York was aroused about thirty years ago by Austin Corbin, who proposed tubes under both the Hudson and East Rivers. Scientists charted the bottoms of the two rivers and reported that tunnel construction was feasible. Perhaps it might have been undertaken at that time but for Mr. Corbin's death. Twenty years later William G. McAdoo undertook this work. President Cassatt, of the Pennsylvania, persuaded his directors to authorize the construction of tubes under the Hudson, also under Manhattan Island, extending under the East River to Long Island.

The total underwater section of the tube will be about 1 3/5 miles, and it is conservatively estimated that it will have a daily capacity of approximately 100,000 vehicles. Statistics compiled from data of 1917 show that during that year 4,800 vehicles crost over the five ferry lines between New York and New Jersey in the vicinity of the proposed tunnel every day. The material thru which the trench must be dug is soft silt and mud.

COMING INVENTIONS 2

THE THOUGHT RECORDER

By H. GERNSBACK

When the writer first conceived the idea of the thought recorder, he asked three prominent scientists regarding their views on recording thoughts electricolly. The letters are reproduced herewith excerpted. It will be noted that Nikola Tesla disagrees with the writer as to thought transmission at all, but his letter nevertheless will give considerable food for thought to many readers.

Dr. Lee de Forest, inventor of the audion, is not too sure about thought transmission.

Dr. Greenleaf Whittier Pickard, the inventor of the silicon and pericon detector, as well as many other wireless specialties, has several interesting ideas, and his letter will certainly prove a revelation, particularly to those interested in radio.

IN studying the evolution of the human specie we must go back to the time when man proper, as we know him, had not as yet arrived on this planet. Our great biologists have irrefutable evidence that everything in Nature works on a slow, laborious plan, one specie being developed slowly into another from the smallest animalculae up to present man. When man was still in the what we may call animal stage, i.e., when he was not "thinking," as that term is understood, he was wholly guided by instinct. His "thoughts," if so they may be called, were probably on a much lower plane than thoughts of the average dog. The chances are that the present day dog probably "thinks" much better than prehistoric man. We also find that thought and language go hand in hand. Crudely speaking, prehistoric man had no better language than any highly developed animal, such as a dog, cat or a horse.

Thru thousands of years of evolution, however, instinct developed into crude thought, and finally there came a time when prehistoric man really began to think, as we know the term. That was the time when he began to utter his thoughts by means of his voice. At first only a few crude words were formulated, and probably consisted of not much more than the gibberish of a chimpanzee. Little by little organized thought arrived, and words, translated into speech kept pace with the advancing thought of man. As the human race kept advancing at a slow pace, its thinking qualities increased little by little, and the senses correspondingly became more sharpened.

This is especially true of the human thinking machinery which perhaps has advanced more rapidly than the senses. Thus we find that certain senses have even been retarded, such as, for instance, sight, smell and hearing. When man lived his wild life it was very necessary for these senses to be much sharper than they are at present; hence our poor hearing, bad sight and very much poorer smell. On the other hand, as the battle for existence becomes more and more acute, and as moreover the battle is not as much physical as mental, it follows that the mind and its thinking machinery should naturally become more and more developed, which, in fact, it does. We may safely say that within the next hundred thousand years—which is only a small span of time in man's evolution—the human mind will be an entirely different sort of apparatus than it is today. Man's mental power will be infinitely greater than what it is at present. Already we have indications that man's thoughts, or the effects therefrom, do not necessarily have to remain *within* his skull, but that they actually radiate from the latter in a very imperfect manner. As the human race advances, there is no doubt that thought transference proper will become an accomplished fact. It has already been shown experimentally by Di Brazza, as well as Charpentier, that concentrated thinking will produce certain external effects, as for instance, a slight fluorescence on a zinc sulfid screen, or a suitably excited X-ray screen. This would tend to prove that thoughts are of an electrical nature, having probably a very short wave length. As most electrical effects in space are depend-

(*Continued on page 84*)

THREE FAMOUS SCIENTISTS' VIEWS ON THOUGHT TRANSMISSION

Altho I am clinging to ideals, my conception of the universe is, I fear, grossly materialistic. As stated in some of my published articles, I have satisfied myself thoroly thru careful observation carried on for many years that we are simply automata acting in obedience to external influences, without power or initiative. The brain is not an accumulator as commonly held in philosophy, and contains no records whatever of a phonographic or photographic kind. In other words, there is no stored knowledge or memory as usually conceived, our minds are blanks. The brain has merely the quality to respond, becoming more and more susceptible as the impressions are often repeated, this resulting in memory.

There is a possibility, however, which I have indicated years ago, that we may finally succeed in not only reading thoughts accurately, but reproducing faithfully every mental image. It can be done thru the analysis of the retina, which is instrumental in conveying impressions to the nerve centers and, in my opinion, is also capable of serving as an indicator of the mental processes taking place within. Evidently, when an object is seen, consciousness of the external form can only be due to the fact that those cones and rods of the retina which are covered by the image are affected differently from the rest, and it is a speculation not too hazardous to assume that visualization is accompanied by a reflex action on the retina which might be detected by suitable instruments. In this way it might also be possible to project the reflex image on a screen, and with further refinement, resorting to the principle involved in moving pictures, the continuous play of thoughts might be rendered visible, recorded and at will reproduced.

Nikola Tesla.

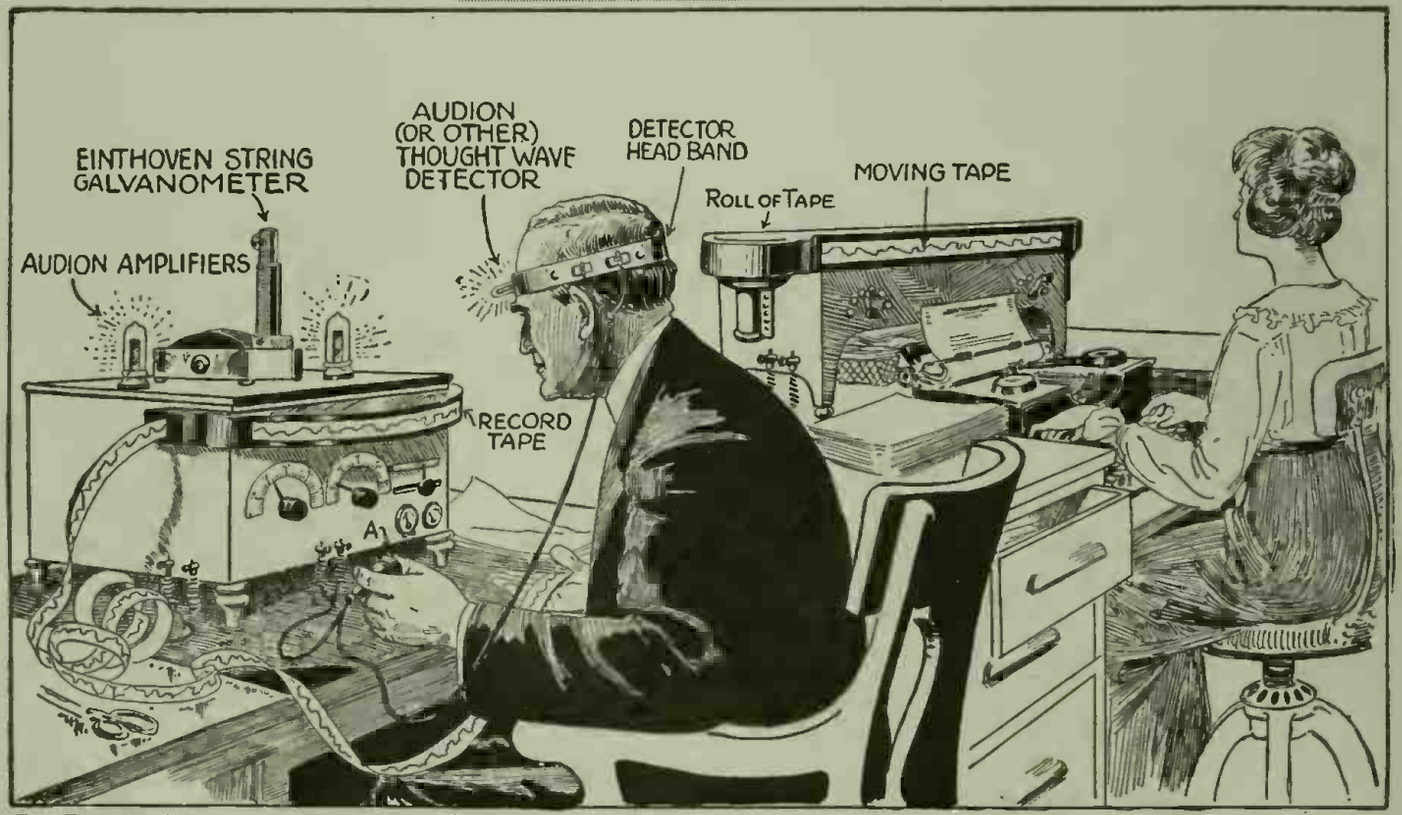
Your article should be an interesting one, particularly as to the audion suggestion. The audion, however, seems to have a certain wavelength limitation, so that unless the waves to be recorded lie between about 3×10^{10} cm. and 3×10^{2} cm., they are not apt to be "picked up."

A more likely range to search would be from 3×10^{2} cm. down to 3×10^{10} cm., that is, down to the harder Gamma rays, or to even shorter wavelengths, starting with the shorter Hertzian waves. Here the audion would be useless, save as a second stage in the detection, i.e., as an amplifier for some other form of detector.

Greenleaf W. Pickard.

While I have little doubt that there is such a thing in nature as transference of thought from one brain to another, I am not aware that sufficient data has ever been gathered on such a highly abstruse subject to permit forming any definite opinion.

Lee De Forest.



The Thought Recorder is an Instrument Recording Thoughts Directly by Electrical Means, On a Moving Paper Tape. Our Illustration Shows What a Future Business Office Will Look Like When the Invention, Which as Yet Only Exists In the Imagination, Has Been Perfected. By Pushing the Button A, the Tape is Started and Stopt Automatically So That Only Thoughts That Are Wanted Are Recorded.

Paris Letter

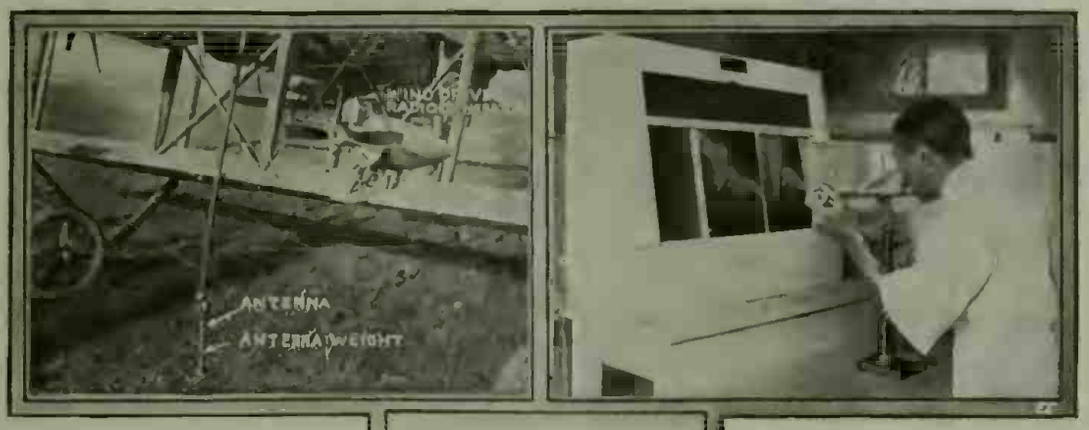
By JACQUES BOYER

Paris Correspondent of the ELECTRICAL EXPERIMENTER

Airplane-Radio.

Paris, February, 1919.

THE war having ended thru the conclusion of the armistice, the military censor now allows the publication of information concerning various technical matters of the French Army. In this and in the following monthly letters, we will unfold thru the ELECTRICAL EXPERIMENTER the latest European technical developments as they come to our attention.



French airplane radio generator of the wind driven type and antenna employed. The dynamo is fitted with a small air blade which spins it rapidly. The antenna and weight are lowered from a reel on the cockpit. Similar schemes are in use on American Airplanes. Fig. 1.

The "Radio-stereoscope" is the latest in French X-ray apparatus. By its means it now becomes possible to rapidly locate bullets or fractures — owing to the perspective of vision thus afforded. The X-ray plates are illuminated from behind, while the physician views them thru the special coördinating instrument shown. Fig. 3.

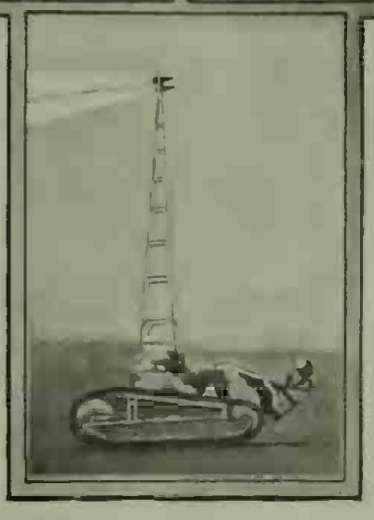
Particularly during the war, the censorship has been so rigid that many important inventions have never been even mentioned in the technical press. We shall be glad to describe these monthly for the benefit of EXPERIMENTER readers.

The accompanying photographs show the latest system of radio-telegraphy installed on French Airplanes during the war. Fig. 1 shows what is called the "radio-telegraph dynamo" on a Farman airplane.

All the French combat machines were equipt with this or similar apparatus. Between 25 and 150 kilometers could be covered by means of this apparatus weighing some thirty odd kilograms. For receiving the wireless waves the aviators of course used the audion, and by use of sound-proof helmets, it was possible to receive the orders clearly, notwithstanding the terrific noise of the airplane motor. The small dynamo shown in Fig. 1 is operated by means of a small air propeller, and this motor works entirely independent from the power plant of the airplane. As long as the airplane is in motion the propeller will turn due to the rush of the air, and thus even if the engine becomes stalled, the aviator can still use his wireless, for the 'plane while volplaning down furnishes enough energy to drive the small auxiliary dynamo. The wireless antenna trails behind the airplane thru the steel tube as seen in Fig. 1, at the end of which there is a small pulley. At the free end of the antenna wire there is a weight of two or three kilograms (4 to 6 pounds) which tends to keep the antenna more or less taut. The wire stays of the airplane themselves form the "ground" for the wireless system. All aviators in the air were constantly in touch with each other, and in order that one airplane should not be mistaken for another one, different wave lengths were used for each. Not only this, but other tricks as for instance, sending at a different intensity, was often resorted to by certain aviators in order that the ground station would know from which 'plane the signals emanated.

Signaling Tanks.

The "baby" Renault tanks now well known in the United States, played an important rôle in pushing back the Huns. They had not a little to do with the Allied victory and were constructed by the French engineer, Louis Renault. This well-known French technician created many different models, some of which carried cannon and machine guns, while others merely carried ammunition. One of the strangest ones constructed by him is the "*tank projecteur*" (signaling tank). It is shown in the accompanying photograph, Fig. 2. This tank is built along the lines of the "baby" tank,



The "Baby" Renault Tanks Played an Important Rôle in Pushing Back the Huns. Some of These Tanks Carried Cannon and Machine Guns. The "Tank Projecteur" Here Shown Was Effectively Used for Signaling Purposes. Fig. 2.

> The war has brought forth a great many surprises, many of which for military reasons having remained secret, and many will continue a secret for some time to come. Our readers no doubt are very much interested in many of the war devices brought out during the war by our European Allies. We have therefore made arrangements with our Paris correspondent, Mr. Jacques Boyer to send us an article each month on hitherto unpublished information. The first article of the series appears on this page.—*Editor.*

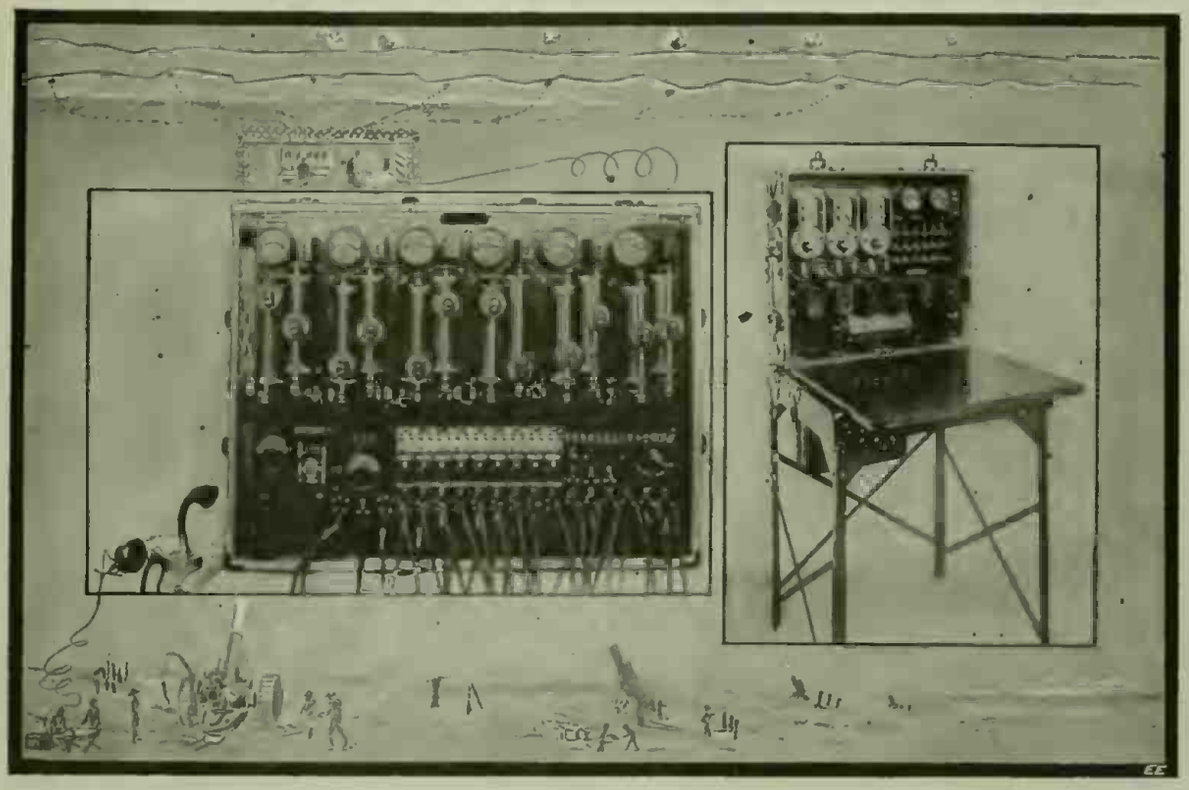
but in the back we find on an inclined steel truss a little dynamo driven by the machinery of the tank. Two "signaling projectors" are mounted at the top of a light metallic mast, the four lower legs of which are mounted on a revolving cupola which makes it possible for the mast to be immediately revolved in any direction. The top of the mast is 7½ meters from the ground. The two searchlights are arranged in such a manner that they can send out two independent light shafts, or the two shafts can be converted into a single shaft of light. In the inside of the tank we find our usual Morse telegraphers, operating a key which controls the light shafts. By means of this arrangement, the ordinary Morse or Continental Code can be sent out by breaking up the light shaft into "dots and dashes" the same as is done in the usual method of signaling with lights. Mr. Renault has incorporated several refinements into the search lights, one of which is an iris obturator whereby the volume of the light can be increased or decreased at will.

Radio-stereoscope.

This apparatus has been developed by the French engineer, M. Nemirovsky, the X-ray specialist of Paris. It has given wonderful results to the French military physicians, and it now becomes possible to locate metallic or other foreign pieces in the human body in a manner not possible before. The ordinary X-ray photograph shows only the foreign body, but it is impossible to tell how deep the penetration is, and often the physician cannot tell if a bullet is in front or in back of a certain organ. In other words, he does not know just how deep the bullet is embodied. Everyone who has looked thru the ordinary stereoscope will readily understand how objects "stand out" and how they reveal their exact location to the human eye.

It is this principle which is made use of by M. Nemirovsky, who has also greatly simplified the radio-stereoscope technique. Our illustration, Fig. 3, shows the method. Two X-ray pictures taken at one time by super-imposing two plates and afterward developing them are placed side by side in an arrangement termed a "*negatoscope.*" The plates are illuminated from behind by means of an electric lamp. The physician then regulates the radio-stereoscope by means of a thumb screw as shown, until he sees the bones, and all other parts as well. The foreign body then stands out in plain relief. The physician now examines the plates carefully and he obtains a clear mental picture which subsequently gives him an exact idea as to just how deep the foreign body is emplaced. If necessary during the operation, he can frequently inspect the negatives stereoscopically in order to guide himself should this be necessary.

Locating Enemy Guns by Flash and Sound



Switchboards Used for Flash or Sound Spotting of Enemy Artillery. Photo at Left Shows a Type B-T Sound Ranging Set Such as Used By the United States Army Signal Corps During the War. Many of These Switchboards Were Successfully Used At the Front. It Is Slightly Larger Than the Smaller Model and Requires a Little More Time to Set Up, But On the Other Hand It Combines Many More Telephone Circuits. A Single Section Has Located as High as 117 Guns of Enemy Batteries In 24 Hours. The Right Hand Photo Shows a Small Portable Switchboard, Known as a Flash Ranging Set. This Signal Board Is Used in Conjunction With an Observation Telescope for Locating the Flash of Enemy Guns and General Activities At the Extreme Front, and is Suitable for Night or Day Service.

THE accompanying photographs show respectively two of the war's newer developments, which even the veterans of the Spanish-American War were not familiar with. For one thing, of course, "flash ranging" and "sound ranging," as they are called, are really two military developments which were brought about by the fact that vastly greater numbers of guns were used in the great world war than were ever even dreamed of before.

Let us first consider the "flash spotter." The flash spotter usually takes up his location in the vicinity of front line trenches, or in a shell hole from which he can effectively use an observation telescope for minutely observing and locating in what direction the flash of an enemy gun occurs. The electrical switchboard shown herewith forms a part of the communication link with the artillery and general intelligence headquarters, so that the position of the enemy guns can be quickly made known, and either shelled at once by counter-battery fire by the artillerists, or else the location is accurately plotted on large maps for future consideration, depending upon the activity of the enemy gun or guns at the moment.

The flash spotter, if he happens to be located in a listening post or shell hole, or in fact in any other forward location, invariably has with him his trusty portable telephone connected by wire to the nearest communicating depot, where we find one of the small portable switchboards here shown. These switchboards are fitted with the proper regulating instruments for creating the best working conditions on the various circuits, and make provision for connecting and disconnecting a large number of circuits, in some cases, about 30 or 40 lines running out to various flash ranging observation stations, or in other cases as many as 100 or more lines. The work of the flash spotter is finished for any particular case when his observations, as to the angle in which the flash was observed, and a similar or different angle measured by a co-observer somewhere down the line, have reached the engineers. These experts, by means of special slide rules and tables, quickly solve the distance of the enemy gun and its definite location geographically by the information afforded thru the observation data submitted by two or more flash ranging observers. In other words, it is *triangulation*, which mathematical quantity has been raised to the n'th power by Uncle Sam's artillery experts.

The work of the "sound ranging" experts in locating enemy guns, both large and small, is somewhat different from that of the flash ranging corps. One of the switchboards used in connection with the sound ranging of enemy guns is illustrated herewith. Hundreds of these switchboards were successfully used at the front during the progress of the war. A single section of sound-ranging equipment located as high as 117 guns of enemy batteries in 24 hours.

(*Continued on page* 68)

World's Largest Generator

The accompanying illustration shows one of the largest water-wheel type generators ever built, and its gigantic dimensions may be judged by comparison with the figure of the man standing beside it. This is one of several water-wheel generators built for the Keokuk electric generating station of the Mississippi River Power Company. This mastodonic generator has 52 poles and delivers a current at 11,000 volts potential. This is a high voltage for a generator to produce, owing to the strains on the revolving windings, etc. Much higher voltages are frequently used for the transmission line, and voltages of 50,000 to 75,000 are common for such transmission, these extra high potentials being obtained by means of stationary transformers in the power station where the generators are located.

The large field or stator frame here shown forms the stationary part of the generator, and the rotating member which is also of gigantic size and mounted on a steel shaft several feet in diameter, is put in place and lined up with high accuracy when the stator frame of the generator is put in place and bolted to its foundation. These large machines are invariably built in sections which can be bolted together after they have reached the site of their installation.

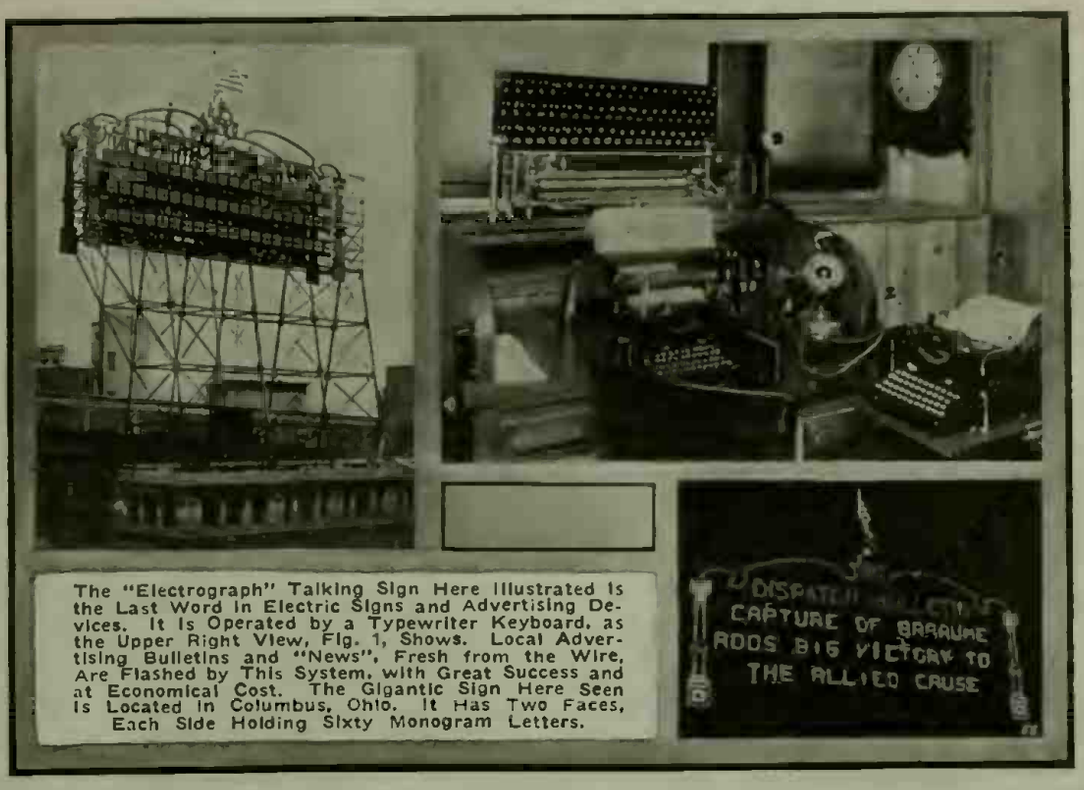
The transformer comprises a laminated sheet iron core on which there are two windings or series of windings, one of which forms a low voltage primary which is connected with the generator, driven by a water-wheel or other source of primary power; while the second set of windings form a high voltage or secondary circuit, in which any desired potential current is induced by induction, the primary and secondary windings being linked magnetically by means of the iron core. Transmission lines are in use at the present day with potentials of 150,000 volts and higher.—*Photo Courtesy G. E. Co.*

Note the Relative Size of the Man Compared to the Huge Stator of the Largest Water-Wheel Type Generator Ever Built. It Develops a Current of 11,000 Volts.

Novel Electric Talking Sign

THE accompanying illustrations, Figs. 1, 2 and 3, show the design, construction and method of operation of an electric bulletin board, operated by a typewriter, which is said to be the latest achievement in the electric sign industry. This new illuminated sign called the *Electrograph* has been erected on the Dispatch Building in Columbus, Ohio, and flashes the latest news, fresh from the press wires, and advertising bulletins for local and national concerns.

It may be stated that this Illuminated Sign has two sides, each side holding sixty monograms, arranged in three rows. Each monogram contains a clever arrangement of twenty-one lights, combinations of which form any letter or numeral and a few other characters, each one measuring two by three feet.



The "Electrograph" Talking Sign Here Illustrated Is the Last Word In Electric Signs and Advertising Devices. It Is Operated by a Typewriter Keyboard, as the Upper Right View, Fig. 1, Shows. Local Advertising Bulletins and "News", Fresh from the Wire, Are Flashed by This System, with Great Success and at Economical Cost. The Gigantic Sign Here Seen Is Located in Columbus, Ohio. It Has Two Faces, Each Side Holding Sixty Monogram Letters.

The photograph Fig. 1 shows the operating room. The typewriter method of operation distinguishes this device from others of similar character. A standard machine is used and contacts are made by striking the keys just as they would be struck in ordinary typing. An extra platen, bearing silver plugs, over which a stylus rides, selects the monograms automatically as the writing proceeds, thus throwing the letters in their proper places on the sign. The letters remain in place until the bulletin is completed and may be held any length of time; it is then released by pressing a single key.

It is of interest to note that a unit releasing device enables the operator to strike any one letter out and replace it with another without interfering with the other letters. Thus, if an error is made, it may be promptly corrected. The operator cannot see the sign as he works and so a pilot board has been provided directly in front of him, consisting of sixty green light bulbs, corresponding to the sixty monograms on either face of the board. When a letter is struck, with the platen set at any given position, the letter appears in the corresponding monogram and automatically lights the corresponding green light.

For illustration, it will be seen that if the platen is set with the stylus on No. 3 plug and the letter "K" is struck, "K" will appear in the monogram and green light No. 3 will burn. If it does not burn, the operator knows that the "K" failed to appear in the monogram and he strikes it again. When the operator writes a bulletin, the typewriter keys write on paper in the usual manner. This gives a complete record of everything that appears on the board. The record is used in checking advertising.

It is claimed that an ordinary bulletin may be written in ten seconds. It usually is left burning ten or more seconds after being completed. This indicates the amount of advertising and news that may be flashed in an evening.

Mr. Alton D. Spencer, of the *Evening Dispatch*, points out that the news feature gives the electrograph an advertising pull not possible with ordinary electric signs. Latest news from the peace table fronts is bound to attract attention, and while the crowds watch for news, they read the advertisements. On election night the electrograph is the center of attraction, as the returns are flashed more promptly than is possible by any other means. This service, of course, increases the value of the sign to the advertisers and gets more results from them than they could get from a sign hanging in front of their places of business and at less cost.—*By Frank C. Perkins.*

Relieving the Car Crush

By Sidney Gernsback

HAVE you ever seen a Subway crowd being herded into a car? Of course you have, if you are living in "little old New York." If not, thank the Lord and turn to the next page. You are not interested! Not at all! And then again you may get a notion to visit that "Burgh" one day; well, read on, it may interest you after all!

Let us go back to that Subway crowd on a rainy Monday morning between 8 and 9 A. M. and let us try to board a car at Times Square. There our train stops, packed brimful with its rain-smelling, sneezing and coughing cargo. You think there is not room for as much as another umbrella in the car you have selected. But behold the convulsory jerking and pushing going on in the middle of the car. Our well trained eye reads these signs, like an Indian would read footprints on the warpath: These spasmodic movements, this pushing, twitching and thrusting can mean only one thing: somebody wants to get off that train! And if somebody wants to get off, a half dozen other bodies want to get on, and usually do, too.

The Cure for the "Subway Crush".—There Are Three Doors on Each Subway Car: Two on Each End and One, About the Same Size as the Front and End Door Combined, in the Center. Let the Outgoing Passengers Use the End Doors Only, and the Incoming Travelers the Center Doors Only, as the Diagram Indicates.

Acting on this well established principle we push and get pushed toward the open car door. A melodious voice from the end of the car sings out: "Let 'em get off! Let 'em get off!" And behind you a gentleman wearing the snug uniform of a Subway gladiator pushes on: "Step lively!"

And right here it is where Kipling is wrong about that east and west business "who never shall meet!" Take it from an old Subway traveler: *they do meet!* They not only meet! They clash and they col-

(*Continued on page* 56)

My Inventions

By Nikola Tesla

IV. The Discovery of the Tesla Coil and Transformer

FOR a while I gave myself up entirely to the intense enjoyment of picturing machines and devising new forms. It was a mental state of happiness about as complete as I have ever known in life. Ideas came in an uninterrupted stream and the only difficulty I had was to hold them fast. The pieces of apparatus I conceived were to me absolutely real and tangible in every detail, even to the minutest marks and signs of wear. I delighted in imagining the motors constantly running, for in this way they presented to the mind's eye a more fascinating sight. When natural inclination develops into a passionate desire, one advances towards his goal in seven-league boots. In less than two months I evolved virtually all the types of motors and modifications of the system which are now identified with my name. It was, perhaps, providential that the necessities of existence commanded a temporary halt to this consuming activity of the mind. I came to Budapest prompted by a premature report concerning the telephone enterprise and, as irony of fate willed it, I had to accept a position as draftsman in the Central Telegraph Office of the Hungarian Government at a salary which I deem it my privilege not to disclose! Fortunately, I soon won the interest of the Inspector-in-Chief and was thereafter employed on calculations, designs and estimates in connection with new installations, until the Telephone Exchange was started, when I took charge of the same. The knowledge and practical experience I gained in the course of this work was most valuable and the employment gave me ample opportunities for the exercise of my inventive faculties. I made several improvements in the Central Station apparatus and perfected a telephone repeater or amplifier which was never patented or publicly described but would be creditable to me even today. In recognition of my efficient assistance the organizer of the undertaking, Mr. Puskas, upon disposing of his business in Budapest, offered me a position in Paris which I gladly accepted.

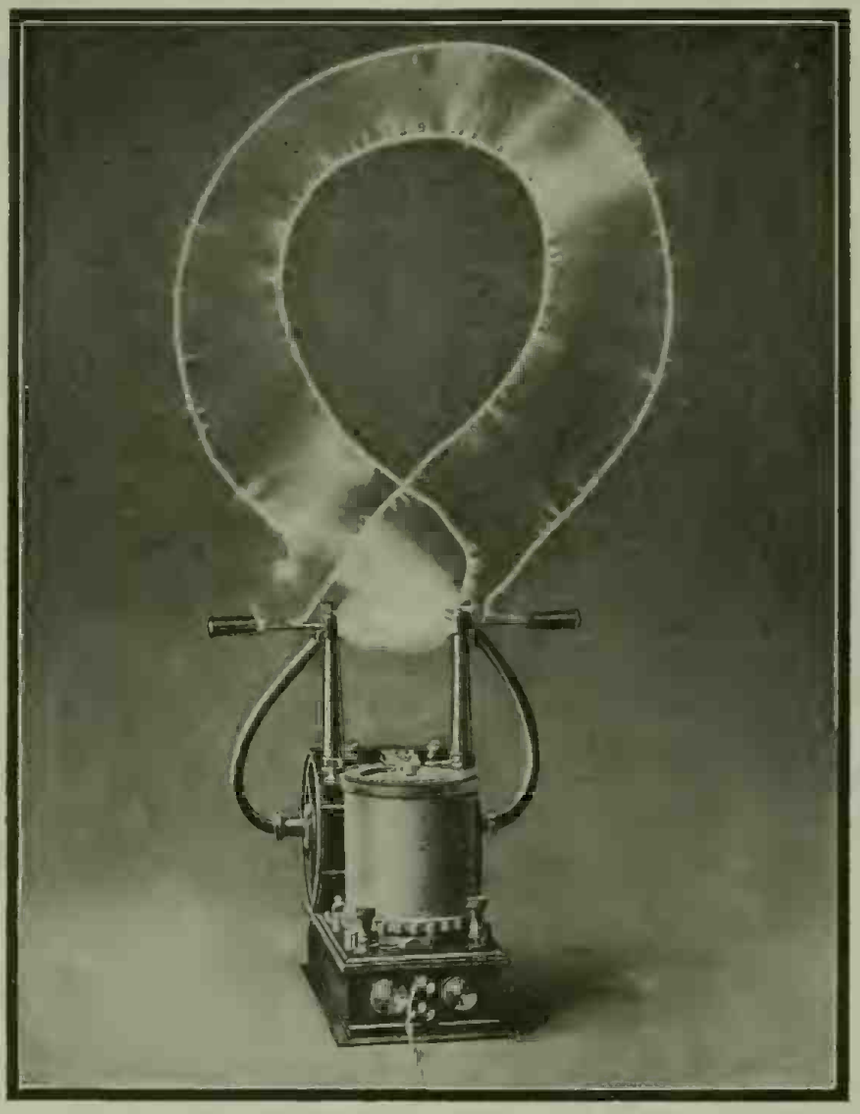


Fig. 1—Tesla Oscillation Transformer (Tesla Coil) Presented by Lord Kelvin Before the British Association in August, 1897. This Small and Compact Instrument, Only 8 Inches High, Developed Two Square Feet of Streamers With Twenty-Five Watts From the 110 Volt D. C. Supply Circuit. The Instrument Contains a Tesla Primary and Secondary, Condenser, and a Circuit Controller.

I never can forget the deep impression that magic city produced on my mind. For several days after my arrival I roamed thru the streets in utter bewilderment of the new spectacle. The attractions were many and irresistible, but, alas, the income was spent as soon as received. When Mr. Puskas asked me how I was getting along in the new sphere, I described the situation accurately in the statement that "the last twenty-nine days of the month are the toughest!" I led a rather strenuous life in what would now be termed "Rooseveltian fashion." Every morning, regardless of weather, I would go from the Boulevard St. Marcel, where I resided, to a bathing house on the Seine, plunge into the water, loop the circuit twenty-seven times and then walk an hour to reach Ivry, where the Company's factory was located. There I would have a woodchopper's breakfast at half-past seven o'clock and then eagerly await the lunch hour, in the meanwhile cracking hard nuts for the Manager of the Works, Mr. Charles Batchellor, who was an intimate friend and assistant of Edison. Here I was thrown in contact with a few Americans who fairly fell in love with me because of my proficiency in—billiards. To these men I explained my invention and one of them, Mr. D. Cunningham, Foreman of the Mechanical Department, offered to form a stock company. The proposal seemed to me comical in the extreme. I did not have the faintest conception of what that meant except that it was an American way of doing things. Nothing came of it, however, and during the next few months I had to travel from one to another place in France and Germany to cure the ills of the power plants. On my return to Paris I submitted to one of the administrators of the Company, Mr. Rau, a plan for improving their dynamos and was given an opportunity. My success was complete and the delighted directors accorded me the privilege of developing automatic regulators which were much desired. Shortly after there was some trouble with the lighting plant which has been installed at the new rail-

Mr. Tesla's articles started in our February issue

road station in Strassburg, Alsace. The wiring was defective and on the occasion of the opening ceremonies a large part of a wall was blown out thru a short-circuit right in the presence of old Emperor William I. The German Government refused to take the plant and the French Company was facing a serious loss. On account of my knowledge of the German language and past experience, I was entrusted with the difficult task of straightening out matters and early in 1883 I went to Strassburg on that mission.

The First Induction Motor Is Built.

Some of the incidents in that city have left an indelible record on my memory. By a curious coincidence, a number of men who subsequently achieved fame, lived there about that time. In later life I used to say, "There were bacteria of greatness in that old town. Others caught the disease but I escaped!" The practical work, correspondence, and conferences with officials kept me preoccupied day and night, but as soon as I was able to manage I undertook the construction of a simple motor in a mechanical shop opposite the railroad station, having brought with me from Paris some material for that purpose. The consummation of the experiment was, however, delayed until the summer of that year when I finally had the satisfaction of *seeing rotation effected by alternating currents of different phase, and without sliding contacts or commutator*, as I had conceived a year before. It was an exquisite pleasure but not to compare with the delirium of joy following the first revelation.

Among my new friends was the former Mayor of the city, Mr. Bauzin, whom I had already in a measure acquainted with this and other inventions of mine and whose support I endeavored to enlist. He was sincerely devoted to me and put my project before several wealthy persons but, to my mortification, found no response. He wanted to help me in every possible way and the approach of the first of July, 1919, happens to remind me of a form of "assistance" I received from that charming man, which was not financial but none the less appreciated. In 1870, when the Germans invaded the country, Mr. Bauzin had buried a good sized allotment of St. Estèphe of 1801 and he came to the conclusion that he knew no worthier person than myself to consume that precious beverage. This, I may say, is one of the unforgettable incidents to which I have referred. My friend urged me to return to Paris as soon as possible and seek support there. This I was anxious to do but my work and negotiations were protracted owing to all sorts of petty obstacles I encountered so that at times the situation seemed hopeless.

Fig. 2—This Illustrates Tests With Spark Discharges From a Ball of Forty Centimeters Radius in Tesla's Wireless Plant Erected at Colorado Springs in 1899. The Ball Is Connected to the Free End of a Grounded Resonant Circuit Seventeen Meters in Diameter. The Disruptive Potential of a Ball, Is, According to Tesla, in Volts Approximatelly V = 75,400 r (r Being in Centimeters), That Is, in This Case 75,400 x 40 = 3,016,000 Volts. The Gigantic Tesla Coil Which Produced These Bolts of Thor Was Capable of Furnishing a Current of 1,100 Amperes in the High Tension Secondary. The Primary Coil Had a Diameter of 51 Feet! This Tesla Coil Produced Discharges Which Were the Nearest Approach to Lightning Ever Made by Man.

German "Efficiency".

Just to give an idea of German thoroness and "efficiency," I may mention here a rather funny experience. An incandescent lamp of 16 c.p. was to be placed in a hallway and upon selecting the proper location I ordered the *monteur* to run the wires. After working for a while he concluded that the engineer had to be consulted and this was done. The latter made several objections but ultimately agreed that the lamp should be placed two inches from the spot I had assigned, whereupon the work proceeded. Then the engineer became worried and told me that Inspector Averdeck should be notified. That important person called, investigated, debated, and decided that the lamp should be shifted back two inches, which was the place I had marked. It was not long, however, before Averdeck got cold feet himself and advised me that he had informed *Ober-Inspector* Hieronimus of the matter and that I should await his decision. It was several days before the *Ober-Inspector* was able to free himself of other pressing duties but at last he arrived and a two-hour debate followed, when he decided to move the lamp two inches farther. My hopes that this was the final act were shattered when the *Ober-Inspector* returned and said to me: "*Regierungsrath* Funke is so particular that I would not dare to give an order for placing this lamp without his explicit approval." Accordingly arrangements for a visit from that great man were made. We started cleaning up and polishing early in the morning. Everybody brushed up, I put on my gloves and when Funke came with his retinue he was ceremoniously received. After two hours' deliberation he suddenly exclaimed: "I must be going," and pointing to a place on the ceiling, he ordered me to put the

(*Continued on page 64*)

THE proverbial trials and tribulations known to every inventor were not spared Tesla, the world's greatest inventor of all times. In this article we see him, arrived at young manhood, struggling along in a cold world. Already his fame has spread far and wide and his genius is recognized. But converting genius and fame into dollars and cents is quite a different matter, and the world is full of unappreciative and unscrupulous men. Tesla, the idealist, cared little for money and thus was promptly taken advantage of. But let Tesla himself tell you in his own inimitable style. It is a wonderful story.

In this month's installment Tesla also tells us how he made one of his most important as well as sensational discoveries—the Tesla Coil. Few inventions have caused such a sensation as this one which culminated in the only man-made lightning ever produced. The Tesla coil has so many uses and has been built in so many styles that it would take a catalog to list them all. From the spectacular high frequency stunts on the stage down to the "violet" ray machine in your home; all are Tesla coils in one form or another.

Wireless without the Tesla Coil would not be possible today. Without an oscillation transformer, spark gap and condenser—which is a Tesla Coil—the sending station would be crippled.

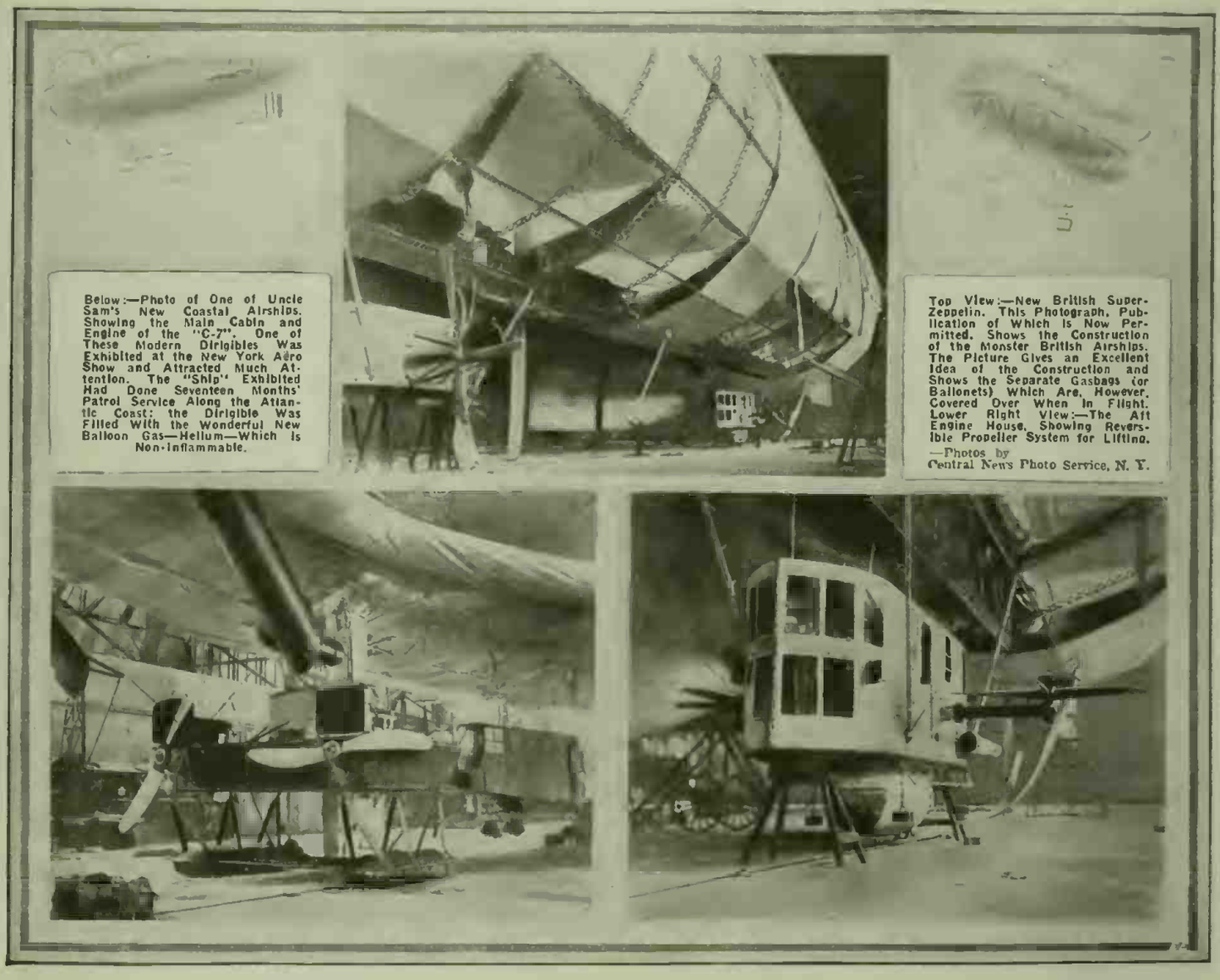
But it is for industrial purposes where the Tesla Coil will shine brightest in the future. The production of Ozone, the extraction of Nitrogen from the air in huge quantities—all are children of Tesla's fertile brain. His coil is the key to them all.

EDITOR.

The New York Aëro Show

THE aëronautical exposition which was held jointly in Madison Square Garden and the 69th Regiment Armory, New York City, March 1st to 15th, was the most successful aëro show and exposition ever held in the United States. Many remarkable exhibits were shown, including large bombing 'planes, small high-speed pleasure and scouting 'planes, besides a gigantic naval sea plane, of the stations at the Madison Square Garden or 69th Regiment Armory could be establisht with the flying 'planes or dirigibles, and in turn wireless telephonic speech was transmitted from the aircraft to the respective land stations. The effect on the public was startling, as while most of them had undoubtedly read of the wireless telephone, they did not have the slightest idea as to what the apparatus used for the purpose wonderful indeed, to stand in the crowd before the radio exhibit, and hear this conversation flitting back and forth between the operator in front of you and a second operator flying thru the air at a speed of 80 to 100 miles an hour.

One day a captive propaganda balloon broke from its moorings over the Sixty-ninth Regiment Armory and shot into the clouds, spilling leaflets, its anchorage dang-



Below:—Photo of One of Uncle Sam's New Coastal Airships, Showing the Main Cabin and Engine of the "C-7". One of These Modern Dirigibles Was Exhibited at the New York Aëro Show and Attracted Much Attention. The "Ship" Exhibited Had Done Seventeen Months' Patrol Service Along the Atlantic Coast; the Dirigible Was Filled With the Wonderful New Balloon Gas—Hellum—Which Is Non-Inflammable.

Top View:—New British Super-Zeppelin. This Photograph, Publication of Which Is Now Permitted, Shows the Construction of the Monster British Airships. The Picture Gives an Excellent Idea of the Construction and Shows the Separate Gasbags (or Ballonets) Which Are, However, Covered Over When In Flight. Lower Right View:—The Aft Engine House, Showing Reversible Propeller System for Lifting. —Photos by Central News Photo Service, N. Y.

and a powerful Caproni tri-plane. A captured German 'plane of the Albatross type was also exhibited. There were also shown a number of gas type, or lighter-than-air aircraft, such as solo balloons, blimps, a naval dirigible which had seen seventeen months' service on coast patrol work, etc. The "gas bags" were filled with the new balloon gas—Helium. The individual exhibits included many interesting auxiliary appurtenances in the flying world, such as rapid-fire photographic cameras, aircraft machine guns, measuring instruments for indicating the velocity of the 'plane thru the air, et cetera, and a host of other new and highly novel devices.

Radio-telephony was demonstrated by the Army Radio Corps of the Air Division in a very popular and interesting way. During the course of the exposition, various types of aircraft flew over the city, equipt with wireless telephone and telegraph installations, so that communication from either looked like, or how it worked, and many of them had a twisted notion that it had something to do with *telegraphy* somehow or other. However, Uncle Sam's radio experts, as soon as they got the sets up and working, soon showed the visitors how the wireless telephone worked. The roof operator, who is stationed at that point so that he could readily observe the approach of aircraft, would start calling the airplane or dirigible as soon as it came to view, somewhat in this fashion: "Hello airplane! Hello airplane! Hello airplane!" After a few moments' pause, and when the operator had manipulated the tuning of the apparatus to the right point and gotten his Audion detector and amplifiers adjusted to the proper strength, the voice of the pilot on the airplane, hovering in the air several hundred feet above the aëro show, could be heard calling, thru a large Audion amplifier—"Hello land station! I get you all right now, land station!" It was really very ling. Up to approximately 3,000 feet it sailed, where it exploded in a burst of brown smoke, falling upon a roof in the neighborhood of Fifth Avenue. Came the wireless comment from an airplane aloft:

"Did you see that? It burst about a thousand feet under us—ought to make good stuff for the reporters. By the way, are any down there?"

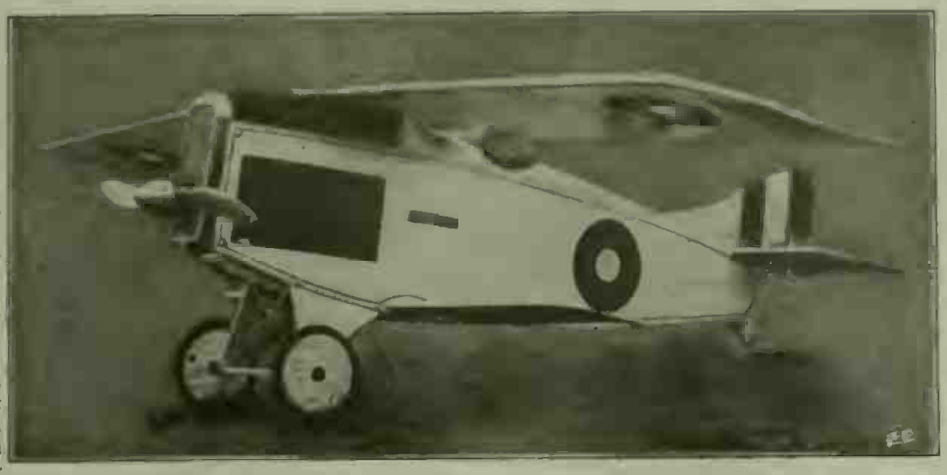
"Yes," broke in a newspaper man standing near the land wireless set, "and will you spell your observer's name for the reporters?"

"Yes—it's Sergeant S-a-u-v-e-g-e-a-u. He had a date to come to New York this afternoon, and altho he's come he can't fill his date very well, unless he comes down and lands on the crankshaft. Anything else?"

"No, thanks," said the reporter as he hung up on the first *interview* by wireless telephony yet recorded.

The radio apparatus exhibited, including that in the exhibit of the United States

Navy, was that of the vacuum bulb or Audion type. The range of the wireless telephone airplane apparatus for transmitting and receiving speech signals varies, of course, with the size of the transmitting set, the length of the aerials used on the airplane and several other factors. It is interesting to note at this point that only recently Secretary of the Navy Daniels carried on a wireless telephone conversation on March 11th with an airplane flying over the Potomac River at a distance of 150 miles. In this two-way wireless telephone conversation with the Secretary of the Navy, who was located at Washington, he used his ordinary desk telephone, which was connected up to the wireless transmitting set in another building. A recent report states that radio-telegraphic communication from earth to 'plane has been carried on over a distance of 200 miles.



The Fastest Airplane Exhibited At the Aëro Show In New York—The "Christmas Bullet" —Rated Speed 200 Miles Per Hour. Test Showed 185 M.P.H. To Be Used as "Taxiplane" to Deliver Dispatches to Vessels One Day Out At Sea.

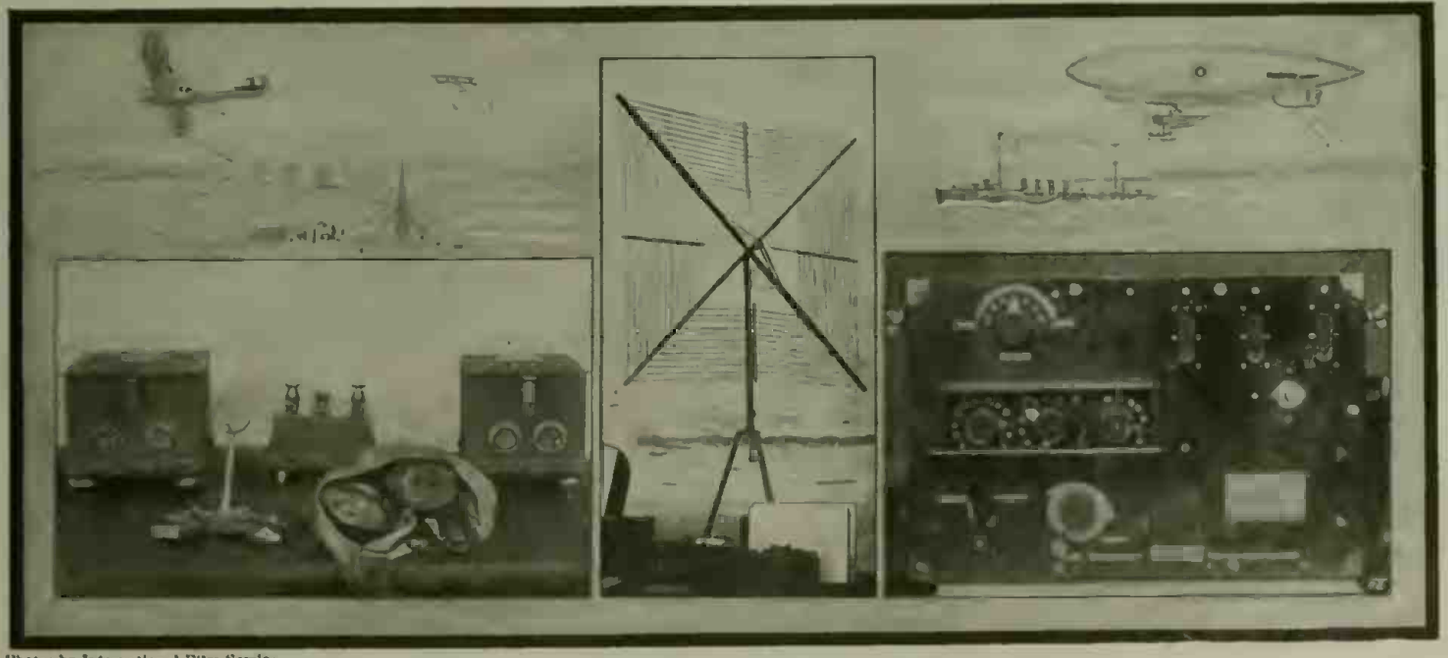
The form of antenna used on aircraft during the war has been invariably that employing a quick-acting reel, on which the phosfor bronze stranded antenna cable was wound upon or released from, according to the desires of the pilot. However, in the newer aërial systems as applied to the airplane, not one, but two aërials are utilized, and no reels are employed. Each wire is about 100 feet long, with a two-pound lead weight at the end, and flies out from either extreme of the wings. These wires, contrary to popular conception, are said not to interfere with the maneuvering of the plane at all. One of the officers at the radio exhibit explained that the 'planes can rise and land with these wires outstretched without any trouble. One of the wires forms the aërial, while the other forms a counterpoise ground capacity. The tuning and detecting apparatus are connected between them in the cockpit.

In looking over the wireless equipment on the various 'planes, one was struck by the wide-spread adoption of the wind-driven wireless dynamo, and even the gigantic foreign bombing planes, including the Handley-Page, were fitted with a wind-driven radio generator. This small dynamo is usually mounted just to one side of the fuselage or cockpit, and is rigidly secured to the wing. As the airplane speeds thru the air, the propeller on the small dynamo is rapidly spun, and the necessary current thus produced for operating the radio telephone or telegraph instruments. Whenever an airplane or dirigible was in radio telephonic communication with the station at the show, the most frequent question heard among the audience was: "Why is it that the terrific noise of the airplane engine is not heard above the comparatively weak voice of the pilot?" The explanation is simple when you know how it is done. The explanation for the non-transmission of the airplane engine exhaust noises is as follows: Many weary weeks were spent in special research on this particular problem by experts of the concerns who developed the radio telephone during the war, under great pressure, but thanks to their keen perception of the principles involved in successfully telephoning by radio from a moving vehicle in the air, in proximity to a terrific noise such as produced by the airplane, these engineers had the forethought to finally devise a special sound detecting instrument or microphone, which is strapt to the aviator's breast, and in the front of which there is a metal plate containing three small holes about the size of a needle. The voice waves of the airplane operator impinge directly against this plate, and readily pass thru the small openings in it, thus vibrating the diafram of the microphone, while the violent swirling noises set up by the airplane engine pass by it without affecting the diafram thus protected.

Here are some of the outstanding electrical and other features which appealed to the visitor of the aero show, in looking over the airplanes of all designs, both large and small. On one of the 'planes one found *red* and *green* signal lights, which were placed respectively on the extreme outer ends of the lower wing. Another novelty was the electric searchlight of small size, mounted over the cockpit so as to be rapidly manipulated by the pilot or his assistant, for the purpose of making landings at night or helping to locate the enemy in a night attack. Many interesting exhibits were on hand of the various magneto ignition systems. A beautiful model was shown of a spark phase-angle indicator, which roused great interest among the spectators, as the sparks staggered around the edge of a rapidly revolving two-foot black disc, which was covered over with sheet glass. Of course, there were electric lights in the aviators' quarters, or cockpit, besides many other electrical and allied features of great interest, such as signaling systems between the pilot and the observer, provision for supplying current to the electrically-heated aviator's clothes, which the aviators always wear on long distance trips, or in night flying when it is particularly cold.

Other exhibits included luminous radium dial measuring instruments and gages, electro-pneumatic and other forms of aerial photographic apparatus, some of which operated at very high speed, as can be read-

(*Continued on page* 60)

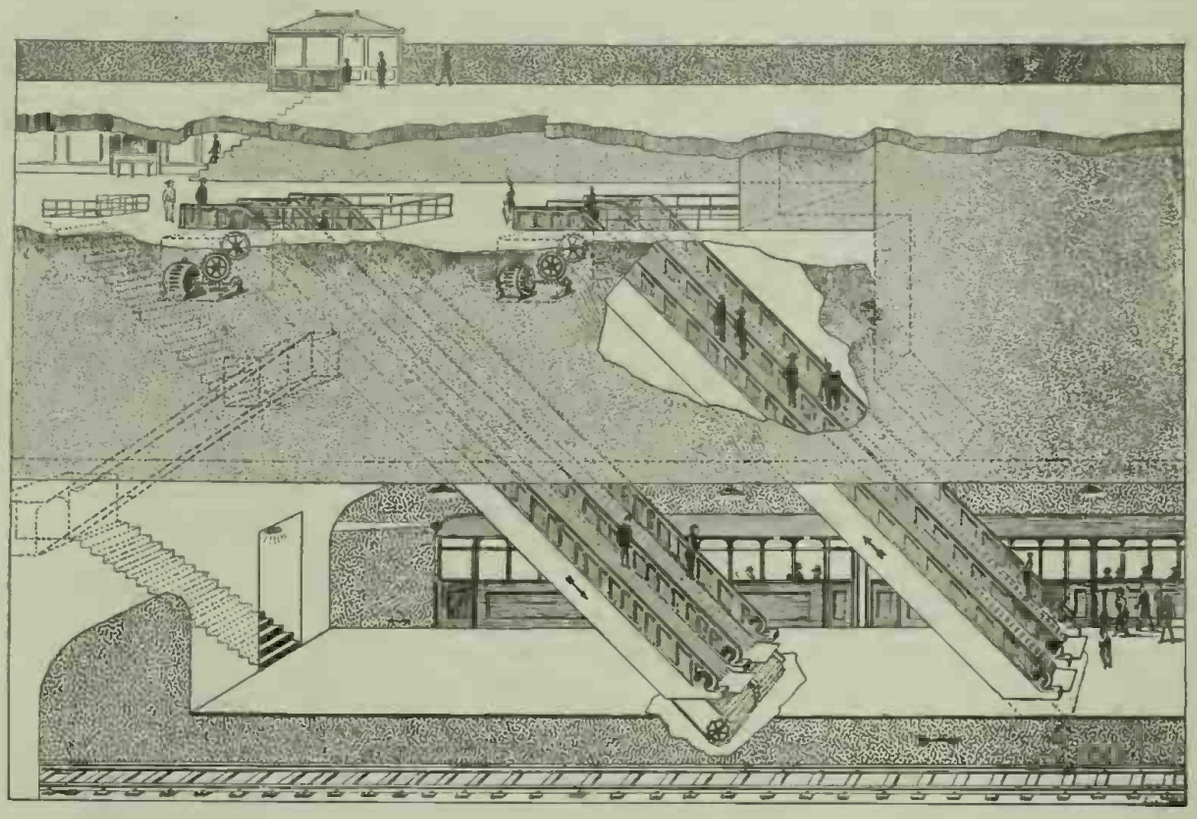


Photos by International Film Service

Airplane Radio at the "Aëro Show." Left:—A Short Range Wireless Telephone Set, Transmitting and Receiving, Used on Airplanes. Center:—A Radio Direction Finder, Used for Locating Direction of Transmitting Stations. Right:—The Airplane "Land Station" Wireless Telephone Set, Transmitting and Receiving. One of the Many Exhibitions of the Special Feature at the Aëro Show Held In New York City. The Management of the Show Arranged for Demonstrations and Exhibitions of the Many Developments of Aërial Communication Recently Adopted by the U. S. Government.

Monster Escalator for New York Subway

THE New York subway system has incorporated in its various ramifications some of the most novel engineering features possest by any similar transportation system in the world. Moving platforms have been suggested and tried in various New York transportation systems, and moving stairways or escalators are not unknown to the metropolis' subway and elevated railroad traveling public by any means. But one of the most interesting and highest lift escalators is now being built at the Park Place and Broadway station of the 7th Avenue Subway, New York City. The accompanying illustration shows a sectional view of this subway innovation, which promises to make this station one of the highest speed stations of its kind in the world.



An Innovation in Escalators is to be Tried Out at the Park Place Station of the Seventh Avenue Subway in New York City. Four Escalators Will be Available, Any Or All of Which May be Operated Either Up Or Down, Depending Upon the Direction of Traffic, Which Is Mostly Eastward in the Morning and Westward at Night.

The four escalators to be finally installed will be *reversible*, and several ways of operating these electric motor-driven moving stairways will be available. In the morning when this downtown station of the great metropolis is flooded with office-bound passengers, then if necessary all four of the escalators may run *upward* to carry the traffic to the street. After about 10 o'clock in the morning when the traffic thins down, until it is about half uptown and half downtown, then two parallel escalators can be upward and the other two downward. If the traffic is quite light, it will be up to the station master to cut out two of the escalators and block them off, running one of the remaining pair upward and the other downward. As the crowd slowly changes and becomes a strong uptown-bound traffic, toward the latter part of the afternoon, then all of the escalators will be run *downward*.

The reason for installing the escalators at this station was because of the fact that the 7th Avenue Subway, which dives under the Interboro Subway, running under Broadway at this point, has to pass under the latter Subway, and as it is located about three levels underground, this renders present climbing to the street up existing stairways a very tedious and laborious exertion, which is almost as bad as climbing the steps of the Washington Monument. Of course, the present staircases will remain in place, as under the condition where north-bound traffic might necessitate operating all of the escalators downward, then passengers arriving on southbound trains would have to gain access up these stairways to the street. It would probably be more expedient to operate three of the escalators downward and one upwards, a problem which the traffic engineers will have to determine by careful check over a considerable period of time, after the escalators have been in operation for a while.

Lightning of All Kinds

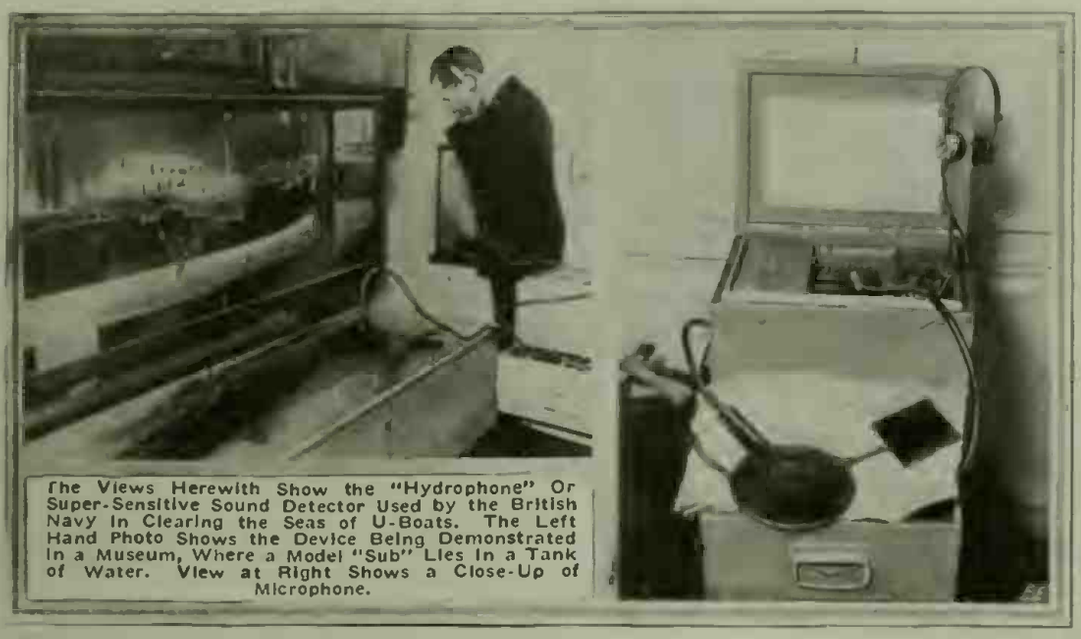
Lightning photos are more or less common, and a great number of them have been publisht in the various issues of this Journal from time to time, but one of the most astonishing lightning pictures ever recorded by the camera, is that shown in the accompanying view, which incorporates every form of lightning, such as bead, forked, chain and ribbon, so-called heat or *flash*, and ball lightning. This picture is extremely interesting to all photographers, who have attempted to obtain good photos of lightning discharges. It is quite a trick to photograph lightning in just the way you would like to have it appear on a finished picture.

In some cases, and as is the usual practise, excellent lightning pictures are obtained by waiting for a dark period just after a flash, and then opening the camera shutter, which has previously been set for a time exposure. As soon as the next flash of lightning occurs, the shutter is at once closed, and the plate then developed. This sounds simple, but as Shakespeare said, "There is many a slip twixt the cup and the lip," and one humorous instance comes to mind of an ambitious lightning photographer, who sud-

(*Continued on page* 56)

In this Remarkable Photo Lightning of Many Kinds—Chain, Bead, Forked and Ribbon Varieties—Are Shown. A Photo Hard to Beat.

British Submarine Detector



The Views Herewith Show the "Hydrophone" Or Super-Sensitive Sound Detector Used by the British Navy In Clearing the Seas of U-Boats. The Left Hand Photo Shows the Device Being Demonstrated In a Museum, Where a Model "Sub" Lies In a Tank of Water. View at Right Shows a Close-Up of Microphone.

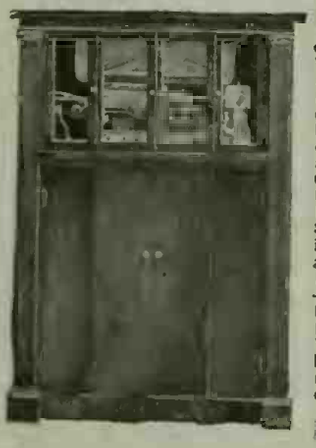
This invention was used extensively and successfully by the British Navy during the war. Wires lead to various stations on the ship, at which listeners are posted. By this means a steady watch is kept and the approach of every undersea craft is heralded. One of the photos shows a model submarine in an experimental tank, showing the hydrophone in the tank, while the man with the receivers listens to the sounds from the propeller which warn of the approaching submarine.

Practically all of the British ships were equipt with the device, and it is acknowledged that many ships were saved by means of the instrument, which is somewhat like a dictagraph, i.e., a super-sensitive telephone transmitter connected with a low resistance telephone receiver. The sound detecting microphone is placed in a submerged part of the hull.

Electric Violin-Virtuoso a Marvel

One of the most wonderful musical instruments ever perfected is the electrically played violin-virtuoso shown herewith. Musicians said it could never be done—but it has been accomplisht at last, with a range of action almost, if not, indeed, actually, miraculous.

The control of both speed and pressure of the bows of the self playing violin is said to be perfect. Regardless of how fast or slow the tempo the proper ratio of pressure is consistently maintained. This is accomplished by means of a small electric motor possessing a speed of from 200 to 6,000 (and any intermediate rate) revolutions per minute, and so constructed that the amount of pressure applied to the bows is automatically and accurately regulated by the speed. Thus even the softest notes are clear and sweet, while the loud are rich and sonorous. Furthermore, one by one, there has been added to the Violano-Virtuoso various devices for producing not only the staccato, but the arpeggio, portamento, pizzicato, shake, trill and all other musical variants peculiar to violin playing.



The Electrically Played Violin Is Truly a Wonder of Modern Science—It Was Long Predicted That Such a Device Could Not Be Built. But It Has—and Sixty Magnetically Operated Fingers Do the Work—and Play Better Than Most Human Violinists. Four Magnets Operate the Bows.

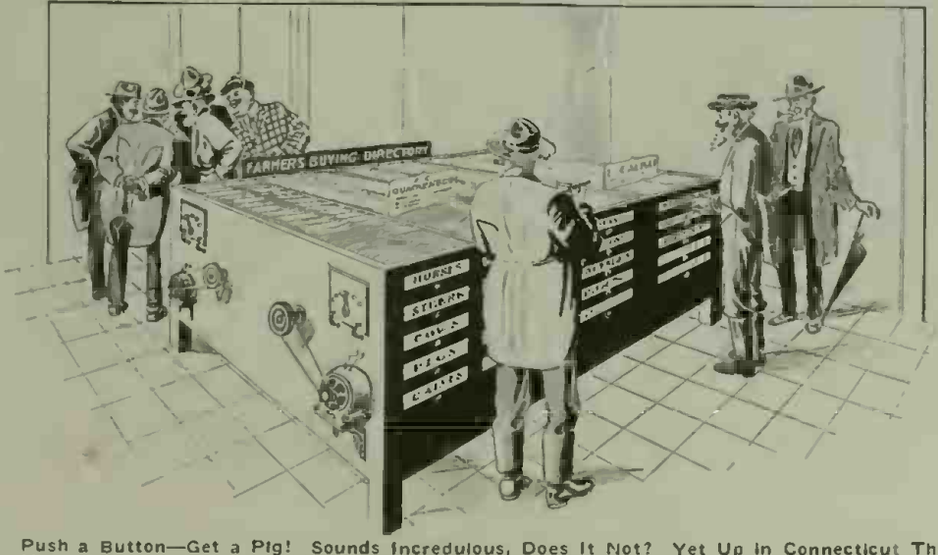
Sixty "fingers" perform the action. As the contact cylinder carrying the paper (fed by a secondary cylinder) revolves, and the perforations in the music roll pass given points, contact is made with one or more of the brushes and an electric current flows to finger magnets resting over the finger board. Each of these magnets attracts an armature connected with a finger operating rod acting upon the violin strings. The same current also acts simultaneously on the bow action magnets. Another magnet produces the "staccato" while the tremolo

(*Continued on page* 56)

Push a Button--Get a Pig

The Federal Agricultural Agent up in Litchfield, Conn., being frequently called upon to help farmers find things they needed and having no definite means of knowing where they were to be had except for gossip heard on his rounds, conceived the idea of an agricultural survey. Now, if you want to locate a supply of seed corn or oats, a grain binder, a pure-bred bull, or some young pigs, in any community in five counties in that State, all you have to do is to walk into the office of the State Librarian at Hartford, run a series of cards thru an electric sorting machine, and, Presto! you have the information.

It may sound a little like the story of Aladdin's lamp, but it is only big business applied to farm affairs under war stress. The Council of Defense took up this plan and offered to back the farm bureaus to the limit in every county in the State. Five of the eight counties began surveys early in March, 1918. Forty questions, under the headings of area, crops harvested in 1917, crops planted to be harvested in 1918, live stock on hand, machinery on hand, and employes, were included in the survey, and a corps of volunteer farmer census enumerators got busy. When the survey was completed the farm bureaus had a stack of cards containing minute information as to the resources and needs of every farm. An electric sorting machine was installed in the State Library, and any fact disclosed by the survey can be made available by throwing on an electric switch. The survey has been invaluable by helping Connecticut to mobilize her agricultural forces for peace needs.



Push a Button—Get a Pig! Sounds Incredulous, Does It Not? Yet Up In Connecticut They Have Such an Electric System In Operation. You Don't Exactly Get the Pig Or Cow by Pushing the Button, But You Do Obtain Data as to Where You Can Buy Them.

Putting It Over on Fritz

By K. K. SAMMERIN

Tricks and Odd Slants of Warfare that Puzzled the Hun

THE immediate ancestor of the "Mills" hand grenade was the "jam tin." This was an awkward and unreliable species of bomb, shaped like a canned soup receptable, with a six- or eight-inch projecting fuse intended to burn four seconds. Sometimes it fulfilled expectations exactly, but more often the fuse was temperamental. It went off before the time was up, or sputtered long enough, after dropping in the German trench, to allow one of the enemy to pick it up and toss it back. Because, early in the fall of 1915 when this crude weapon flourished, bombs of any kind were so scarce that the soldiers often made their own, few opportunities for dosing the enemy with his own pills were overlooked.

The last day upon which Fritz monkeyed with "fizzers" from the Allied trenches with any degree of self-confidence was November 12th, 1915. That occasion taught him that even a "dud" jam tin has its lively moments.

For several weeks preceding the date mentioned a French ordnance engineer had been experimenting with what he termed "instantaneous fuse." This was made up, wound in waxed thread, just like the ordinary fuse used in jam tins. The essential and important difference between the two varieties lay in the fact that while straight fuse fizzed off at the rate of *one and one-half inches a second*, the instantaneous variety burned *twenty-six feet a second!*

Without giving the fact much publicity, several thousand jam tins identical in appearance with the stock variety were made up. In every way but one these were the same; the six-inch fuse was instantaneous, and was made with the end charred a trifle, to look as if the bomb had been lighted and had gone "dud" after being thrown.

Over a sixty-kilometer front in the Verdun sector the bombers were assembled and coached in the use of this new weapon. Simultaneously at seven in the evening "parties" started out for the German wire. Stopping here, each of the four hundred bombers participating delivered himself of four regular "jam tin" grenades and four of the "imitations" before scurrying back.

Fritz noted one striking feature of the engagement. Many of the Allied missiles landed "dud"; this probably was due to the extraordinary *inefficiency* of the French ordnance department, concerning which the German privates had been told so much. All along the line German defenders picked up the imitation duds and lighted their fuses, intending to bomb the bombers with French ammunition.

The havoc that resulted was appalling! Each grenade, of course, exploded the instant it was lighted. Because a raid was in progress, anyway, each individual accident received no attention at the moment. If Fritz saw Heiney go up in smoke while handling a French bomb, he thought simply that Heiney had been too careless—tough luck for Heiney, but *he* would never get caught that way. A second later another trick bomb would send him to join his Hun Comrade.

For several minutes after the bombers reached their sheltered trench the explosions continued across No Man's Land. It was estimated at the time that a full thousand of the grenades exploded in the hands of German soldiers before anyone found out the secret. Since the average bomb exploding in the confined lane of a trench will kill three and wound six soldiers, it is fairly safe to assume that this simple trick cost the Germans at least *five thousand men in killed and wounded!* From that day forward it was official practise in the German lines to let French bombs severely alone.

Another point at which Allied wits bested German scheming was at forecasting retreats by the enemy. To civilians, well-posted with data on the occasional exploits of airplane observers, this does not sound sensational in the least, but doubtless to the Huns themselves the manner in which the Allied forces knew of the last retreat in the Soissons-Reims sector in time to take full advantage of it seemed little less than miraculous. No matter what airmen may say about the photographs they took, or the observations made by telescope from a 'plane, this latter scheme could only tell of a retreat actually under way—too late for much action by the Allies. On the other hand, the method described here not only would tell for certain, two weeks in advance of the first troop or supply train movement, *but would mark off the exact line to be abandoned, and tell the depth to which the Germans intended to relinquish their hold!*

This was done simply by listening in on the unintelligible gibberish of German trench wireless with Allied instruments. Ordinarily, of course, three-fourths of the signaling done in the front trenches is done by means of telephone, orders being sent thru one central station by wire to all parts of the sector.

Towards the end of the war, however, the Germans began to run out of wire and telephone instruments. They could not replace them because of a lack of the materials. Therefore they began to plan on saving every instrument and foot of wire when a retreat was to be made. They took out the stations gradually, and as they removed them they set up trench wireless instead. The Allies, after finding out this plan, simply watched the appearance of wireless sets where 'phone stations had been; when the wireless began to predominate it was certain that ten days or two weeks would

(*Continued on page 77*)

He Thought He Detected Something That Sounded Just a Little Like a Message! He Wound the Phonograph and Turned Its Speed Indicator Down So That the Record Revolved Only a Few Times a Minute. Then He Applied the Needle Again. Aha! There Was Something There!

Cold Light

By ROGERS D. RUSK, M. A.

COLD light is one of the wonders of the modern age. Light without heat seems like a contradiction, nevertheless it is a scientific fact. Since the discovery of the electrical

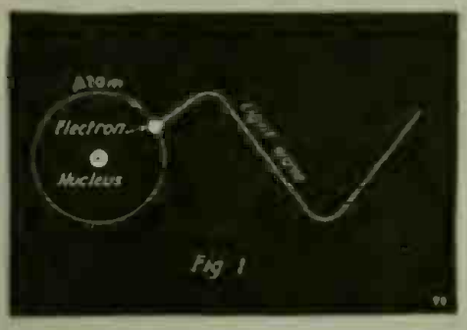


Diagram Illustrating the Old Theory of Light Produced by Electricity. In This Explanation the Electron is Considered as Continuously Producing Light Waves by its Rotation. The Newer Theory of Light and Heat Waves is Shown at Fig. 2.

nature of light, the possibility of transforming electricity directly into light, without the production of heat, has been a tempting goal. For centuries, scientists dreamed of solving the mystery of the *firefly* and the *Aurora Borealis*, but dreamed in vain. They saw light without heat produced in Nature, but could not produce it themselves.

Today the discovery that light may be produced without heat, by means of electrical ionization, seems to be the key to the situation, and we can only wonder where it may lead us. At the present time over 96 per cent of all the energy used in the fifty million incandescent lamps in the United States, instead of being turned into light, *is wasted in the form of heat!* Moreover the astonishing production of light without heat by ionization has given us a new view of the relation between light and electricity and the great problem of the origin of light.

It used to be thought that light could only be produced by incandescence, that is, thru heating of a solid body to white heat. Strange as it may seem, the candle and the kerosene lamp are really incandescent lights. The light they give off is due to white-hot particles of carbon liberated in the combustion process. Even the light from an arc lamp is mainly due to the crater in the positive carbon being heated to incandescence.

The fact that heat is not the only factor which effects the production of light can be easily seen in two ways. First, salts of sodium, potassium and lithium may be thrown in the same flame at exactly the same temperature, but the first gives off a bright yellow light, the second a violet, and the third a deep red. Second, light is produced by an electric spark in a partial vacuum, such as a Geissler tube, *with little or no heat at all.* In both of these cases the light *must* be produced by the breaking up of the molecules, of the solid or gas, into electrically charged particles, or ions, in a manner to be explained later.

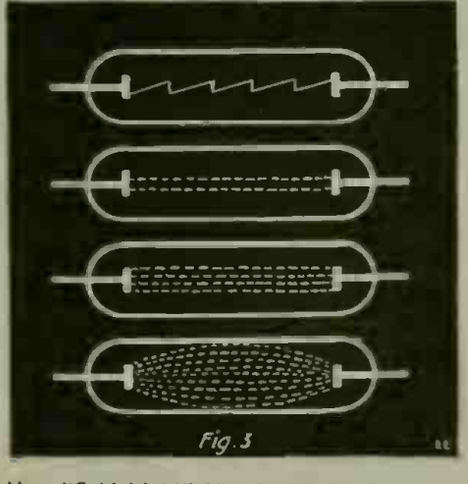
The idea of using cold light for illuminating purposes seems to have first occurred to Nikola Tesla. Very early in his career he suggested that the effects produced in Geissler tubes might be utilized in that way. Not until recent years, however, did his suggestion bear fruit in the shape of the now famous Moore *vacuum tube* light, invented by McFarland Moore, which produces a fine soft light from a glass tube thirty to forty feet long, filled with carbon dioxid. The heat which this light produces is almost negligible.

Cold light is a term used to indicate luminous radiation *without* heat radiation, and that means maximum efficiency, i.e., a colder and a colder source. The old fashioned kerosene lamp wastes 36.4 calories of heat per second for every candle-power of light produced. The gas mantle wastes 11, and the tungsten lamp but from 1. to 2. calories.

Considering electric lights only, the heat loss in tungsten lamps has been reduced by the introduction of gases such as nitrogen into the bulb, but arc lights have made a greater development. The invention of the enclosed arc reduced the heat loss without reducing the illumination. Then the invention of the flaming arc increased the illumination without increasing the temperature of the arc. The latter is the most interesting development because part of the light from the flaming arc is *cold light*, from the chemicals in the flame which are ionized by the electric current. The cold light from these ions plus the light from the incandescent carbons makes the flaming arc nearly *three hundred per cent* more efficient than the ordinary incandescent lamp.

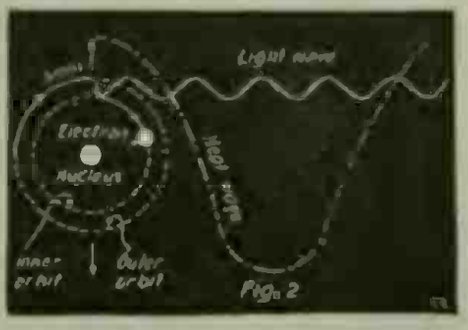
The first flaming arc appeared in 1900, known as the Bremer arc, and using carbons impregnated with several chemical salts. Later Steinmetz and Whitney used the rare metals titanium and chromium in their arcs and produced a still more efficient light. About the same time the *mercury vapor* light was invented, which gave a brilliant bluish white light from the mercury ions in the arc. Later still is the discovery by two scientists, Franck and Hertz, that an electric current of only 4 volts, when past thru *cold iodin vapor*, produces a faint light of definite color. When the voltage is raised to twelve, another color is obtained. This is *true cold light*, produced directly from the molecules as they are ionized by the current. How this is possible, and how light and heat may be produced independently of each other, will now be shown.

What the actual source of a light wave is has been one of the mysteries of science since the beginning of history. The discovery by Maxwell, Hertz and others that light is an electro-magnetic vibration, caused scientists to look for the electric charges which produce these waves. When the electron was discovered it was thought that the solution had been found, but there



How "Cold Light" May be Obtained by Exhausting an Ordinary Glass Tube. When Air is Pumped Out of a Tube in Which There is an Electric Spark Discharge, a Stage is Reached Where the Whole Tube is Filled with a Soft Luminous glow—Cold Light.

was still one great drawback. Scientists said that as the electron revolved about its axis in the molecule it produced light waves just like a paddle wheel in a body of water. But as all molecules of all substances con-



The New Theory of Light and Heat Waves, Which Says that Light is Produced Intermittently. Here Light is Produced by the Electron Jumping from One Orbit to Another, as the Circular Orbital Paths Indicate.

tain electrons which are constantly in motion, then all substances should give off light all the time. This was ridiculous, as everything in the world and the whole universe would be of a dazzling brightness like the sun.

The discoveries of today are changing this idea completely. One of the world's greatest physicists, Planck, says electrons cannot give off light waves continuously, but emit definite quantities at intervals. This theory he calls the *quanta theory*, and another physicist, Bohr, says the time the light is given off is when the motion of the electron is suddenly changed from its normal continuous motion, by its jumping from one atom to another, or from one orbit to another about the same atom. This is a very simple theory, but it is often the simplest theory which best explains the facts. When trillions of trillions of electrons are doing this at the same time, the light is to all purposes continuous. These theories have received added confirmation from work done recently by Prof. Millikan of Chicago University, who gained fame by his original measurements of the electron itself.

The principle of the new theory can be easily explained by an illustration. If a ball is whirled in a circle on the end of a string, the pull on the string is steady and continuous as long as the ball whirls with the same speed. However, if the ball is suddenly stopt or hit by something which makes it change its course, a jerk or a wave will be felt in the string. Now an electron does the same thing, only the jerk or wave is sent out in all directions by the electro-magnetic field about the electron. This jerk or wave is the little quantity which Planck calls a "quanta". The familiar way in which an electron is pictured as continuously producing light waves, by its rotation, is shown in Fig. 1, but this is wrong according to the above theory. What really must happen is shown in Fig. 2, where the two circles represent different orbits and the full line represents the path of the electron jumping from one orbit to another and at the same time emitting a quantity of radiation or *light*. The way in which electricity or some other agency causes this disturbance of the electron is not fully understood.

The most remarkable thing about it all is that heat and light waves may be produced independently. A heat wave is produced by the vibration of the whole molecule or atom as shown by the big arrows and dotted wave line in Fig. 2. And under

(*Continued on page 73*)

Popular Astronomy

Astronomical Distances

By ISABEL M. LEWIS
of the U. S. Naval Observatory

THE immensity and grandeur of the scale upon which the visible universe is fashioned lies almost beyond human comprehension. To visualize the vast extent of our own solar system which is but a single unit in the system of the stars we may have recourse to earthly standards of measurements, such as the mile. But when we desire to express in terms of units that can be grasped by our imagination, the distances of the stars that lie far, far beyond, we find that all ordinary standards of measurement become utterly inadequate for our purpose. For the measurement of celestial distances *within* the solar system the unit employed is either the familiar mile or kilometer or the "astronomical unit," which is the mean distance from the earth to the sun (ninety-two million nine hundred thousand miles in round numbers).

The unit of measurement employed for distances *beyond* the solar system is either the *light year* or more recently the *parsec* which appears to be rapidly replacing the light year among astronomers. A "light year" is the distance that light, with its finite but almost unimaginable velocity of one hundred and eighty-six thousand miles *per second, travels in a year.* It is equal in round numbers to sixty-three thousand times the distance from the earth to the sun or approximately six thousand billions of miles. The parsec is equal to three and twenty-six hundredths (3.26) light years, and it is approximately two hundred thousand times the distance from the earth to the sun. It is "the distance of a star with the *parallax* of a second," a fact which its name conveys to us. In other words, at the distance of one parsec the distance from the earth to the sun, "the astronomical unit," would subtend an angle equal to one second of arc. This angle is spoken of as the parallax of the star. The larger the parallax; that is, the larger the angle that the astronomical unit or radius of the earth's orbit subtends, viewed from the star, the nearer the star is to us. The fact that there is no known star within one parsec, or three and twenty-six hundredths light years, of the sun shows the immensity of the scale of the universe of stars.

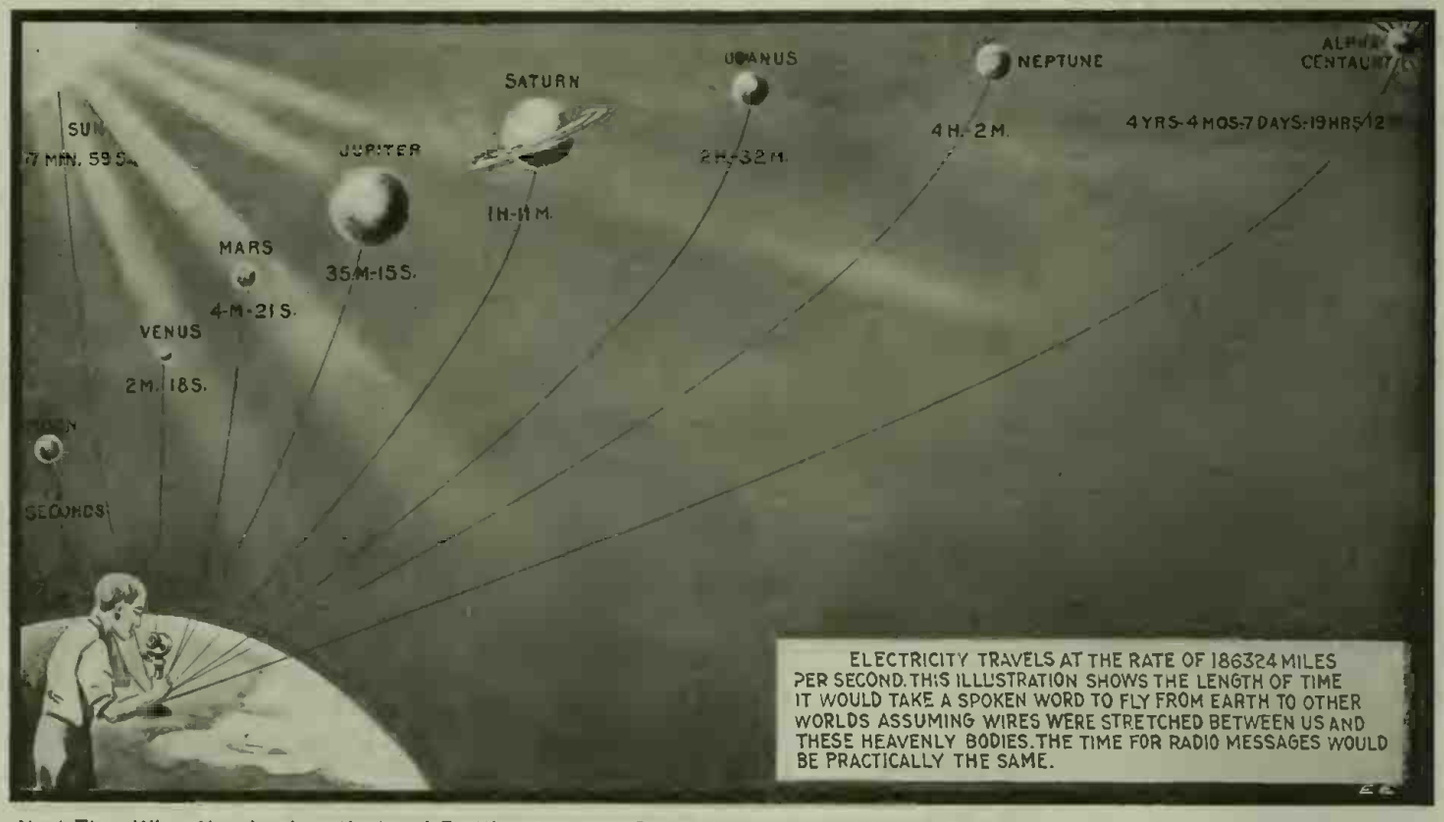
Before considering the distances of the stars and the extent of the sidereal system of which our sun and his satellites form a part, let us undertake to express the distance of the sun, moon and planets from the earth and the extent of the solar system in terms with which we are familiar.

The nearest to the earth of all celestial bodies is its satellite, the moon. So near is the moon that if we should make on some great plain a model of the solar system in which the astronomical unit, the distance from earth to sun, would be four hundred feet, the distance between earth and moon would be only one foot. On the same scale the most distant planet Neptune would be two and one-quarter miles away. In round numbers the moon is distant from us sixty times the distance from the earth's center to its surface or two hundred and forty thousand miles and thru our great telescopes we see it as it would appear at a distance of one hundred miles.

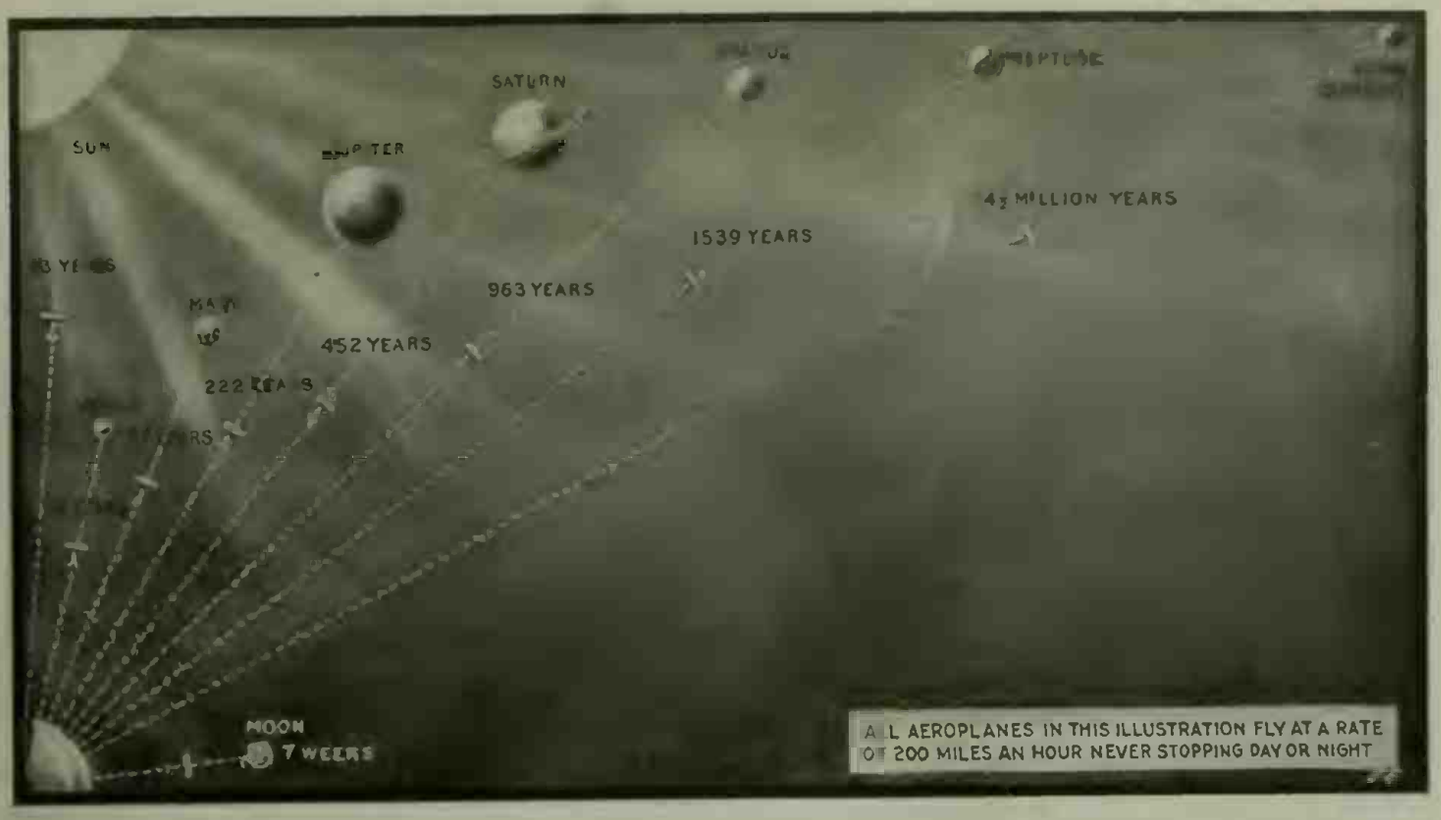
Granted that it were possible to escape the earth's gravitational bonds and to travel by our swiftest means of conveyance, the airplane, thru interplanetary space, let us consider how long it would take us to reach the moon, sun and planets if our speed were unslackened at two hundred miles an hour. An airplane traveling at this rate would circumnavigate the earth in a little over five days and would reach the moon in seven weeks. A trip to the sun, however, would require fifty-three years.

After traveling for fourteen and a fraction years we would pass the orbit of Venus and eighteen years later the orbit of Mercury. If we preferred to travel outward from the earth in the direction of Mars and the outer planets instead of toward the sun, more than twenty-seven years would elapse before the orbit of Mars would be crost. An airplane journey to Jupiter would be a matter of more than two hundred years, to Saturn four hundred and fifty years, to Uranus nearly one thousand years and to Neptune about one thousand five hundred years. To cross the solar system on the diameter of Neptune's orbit would be a journey of more than three thousand years. The sun's attraction reaches far beyond Neptune's orbit, however. There are comets belonging to the solar system compelled by the sun's attraction to accompany him on his travels thru space that return periodically to the immediate vicinity of the sun from regions far beyond the orbit of Neptune and there is also the possibility that one or more undiscovered planets may travel around the sun in orbits exterior to Neptune's orbit.

Measured in terms of familiar units, such as are employed for the measurement of distances on our own planet, the extent of the solar system is tremendously great. Seen from Neptune, the sun presents no appreciable disk. It is in this sense starlike to the Neptunians, but seen from Neptune the stars appear no more brilliant and



Next Time When You Are Impatient and Fretting Because "Central" Keeps You Waiting Ten Seconds for a Connection, Imagine That Your Best Girl Is on Neptune. You say "Hello" and It Takes Exactly 4 Hours and 2 Minutes for "Hello" to Get Up to Neptune, and Then You Have to Wait 4 Hours More to Give Your Sweetheart a Chance to Say "Hello" in Return. While If She Were on Alpha Centauri, It Would Take Your Voice Over Four Years to Get to Her and an Equal Time for Her Voice to Get Back, Altho You Know That Electricity Travels at the Rate of 186,324 Miles a Second.



The Fastest Vehicle Known to Man is the Airplane. Supposing There Was Air Instead of a Vacuum Between the Earth and the Other Heavenly Bodies, It Would Take an Airplane a Very Considerable Time to Reach These Bodies. Even to the Moon, the Nearest of All Heavenly Bodies, Only 236,000 Miles Distant, Seven Weeks Would Be Consumed in Reaching It By Airplane. To Reach Neptune, It Would Take 1359 Years. Such Are the Immense Distances of the Universe.

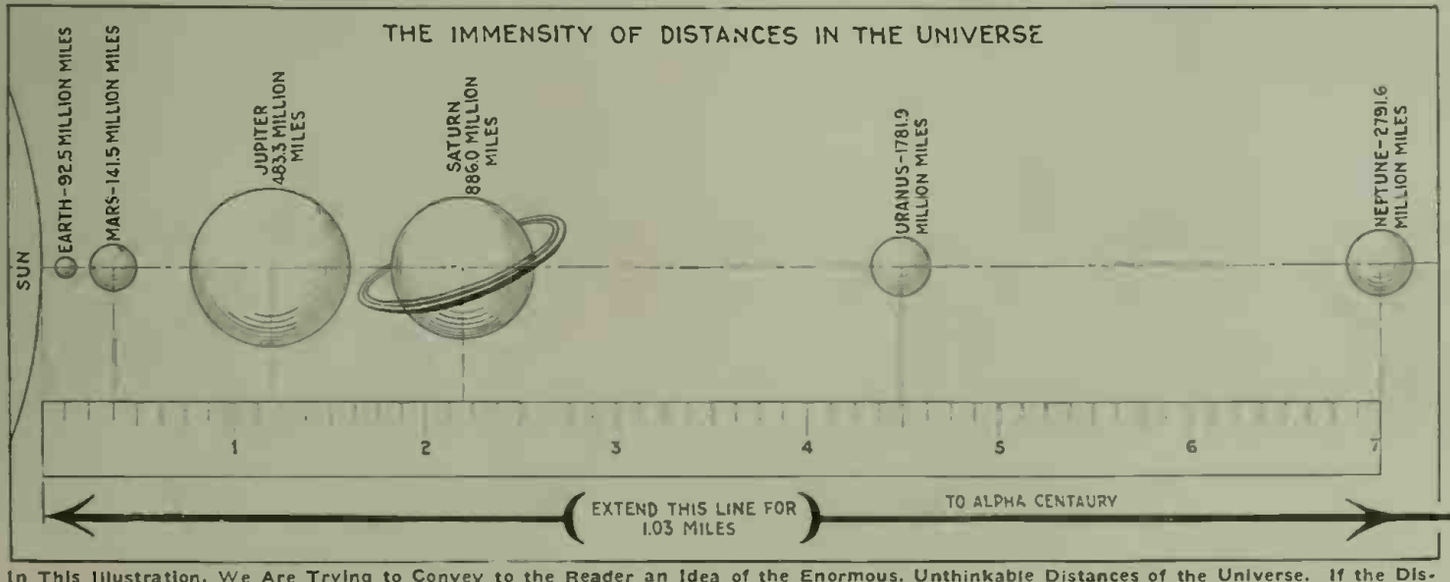
therefore no nearer than they do to us.

To Neptune the sun, tho star-like in form, supplies a very appreciable quantity of light and heat (one nine hundredth of the amount the earth receives) while the amount of light and heat that Neptune receives from the nearest stars is entirely inappreciable. When our airplane reaches Neptune after a journey of one thousand five hundred years, it is, as it were, just clearing the ground for its flight to the stars. To cover the intervening space to the nearest star, traveled by light in four and a third years, an airplane would require *fourteen and a half million years*. In that time the solar system itself would be in some far distant part of the universe, for it is speeding onward thru space at the rate of twelve miles a second or about four astronomical units a year.

Changing now our unit of measurement that we may express interstellar distances in comprehensible numbers, we prepare to travel from the earth to the stars with the velocity of light.

At this speed, one hundred and eighty-six thousand miles per second, we circumnavigate our globe in one-seventh of a second, reach the moon in one and a fourth seconds and the sun in eight minutes. In a little over four hours we pass the orbit of Neptune and are started on our journey to the stars penetrating further and further into interstellar space. For a year we travel and reach not a single star tho we are speeding ever onward with the velocity of light. We have now covered the distance of one light year which means the waves of light from the sun we have left behind must travel for a year before they reach us. We continue our journey and find ourselves next at a distance of one parsec from the sun. We have traveled a distance of approximately three and a quarter light years, and were it possible to see the earth as well as the sun at this distance, the two would appear to be but one second of arc apart, a distance that requires the most careful adjustment and manipulation of the telescope to measure accurately. We are still one light year distant from Alpha Centauri, the nearest of the bright stars. A few of the stars may now appear somewhat brighter than they appear to us on earth, but the majority of the stars appear just as we see them here on earth and the forms of the constellations remain practically unchanged in appearance, for we are only beginning our journey thru the sidereal universe and our position in the universe has only shifted in a slight degree. If we should continue our journey to the immediate vicinity of Alpha Centauri, we would find that it is not like our own sun, a single star, but is a binary star consisting of two suns in revolution around their common center of gravity. The distance of this binary system from the solar system has been meas-

(*Continued on page* 54)



In This Illustration, We Are Trying to Convey to the Reader an Idea of the Enormous, Unthinkable Distances of the Universe. If the Distance from the Sun to Neptune, Which in Reality Is 2,791 Million Miles, is Represented By Seven Inches On This Scale, Then the Distance from the Sun to the Nearest Star, Alpha Centauri, Would Be Slightly Over One Mile. Note How Near the Earth Is to the Sun, Altho 92 Million Miles Away from It. In Order to Show the Earth Without It Touching the Sun, It Was Necessary In This Drawing to Make the Earth Smaller Than Mars. In Reality Mars Is Smaller Than the Earth. The Other Planets Are Shown in Their Correct Proportions.

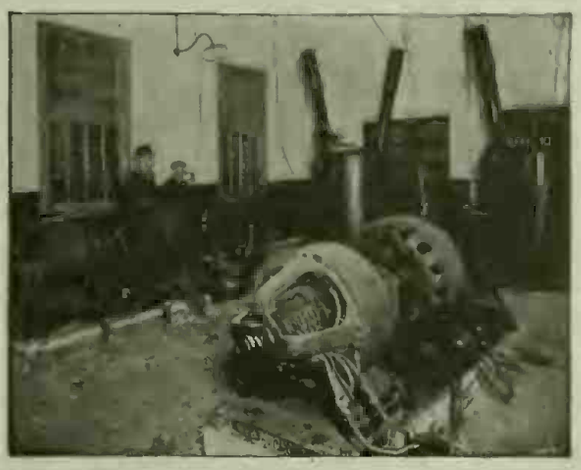
Reclaiming Metal Dust From Flue Gases

IN refineries of different types there is always a possibility of some valuable by-products, waste, etc., being lost by gases ascending the flue. This is particularly true in the metal treating field. Here it has been found possible to save solid and liquid particles from the flue gases by an electrical process. This consists in passing the gases thru tubes in which are suspended insulated chains charged with high voltage direct current. In passing thru the tube the particles carried by the gases become electrified and are projected against the walls to the tubes. These tubes are grounded and thus the particles drop into hoppers below. Mechanical rectifiers convert the low voltage alternating current into direct current.

An interesting application of this process was recently made in a copper refinery. In this particular installation there is another noteworthy fact and that is the size of the generating and transforming unit used.

The treater tubes containing the high tension electrodes and thru which the flu gases pass are arranged in six groups. The electrodes are suspended at the top from a rack which provides ample insulation, and are connected with the high tension direct-current line at the bottom. The gases from the furnaces pass thru pipes 13 feet in diameter, a "Y" with valves being provided so that the gases can be made to go either thru the treater or directly to the stack as desired. See figure herewith.

It is stated that over 90 per cent of the flue dust can be removed and that the value of the copper, zinc and other metals recovered will within a short time pay for the treating equipment.



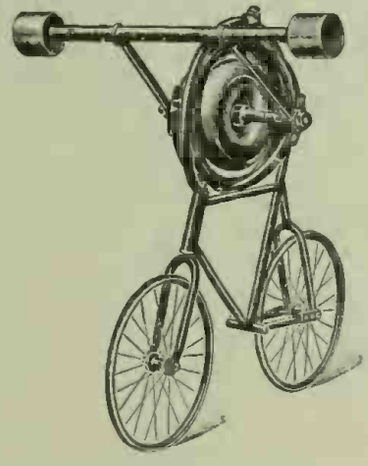
This Power Plant Delivers 100,000 Volts and .5 Ampere, Direct Current, for Precipitating the Solid Particles in Flue Gases, Such as in the Metal Refining Field, Thus Saving as Much as 90 Per Cent of the Flue Dust.

Interior of High Tension, Direct Current, Electrode Chamber Inside of Flue Tube Measuring 13 Feet in Diameter. The Electrodes Are Suspended Chains Which Carry the Charge When in Use.

The transformers are of 40 kva. capacity, 200 volts low tension and 100,000 volts high tension. To the motor-generator shafts are coupled the commutating rectifiers for transforming the high-tension alternating current into direct current.

A Gyrostatic Bicycle

The accompanying illustration shows a novel gyrostatic bicycle model built by a London scientific instrument maker, and this machine will maintain its equilibrium for a considerable period of time. Many of us most probably have seen the street fakir shouting loud and longly about the wonderful possibilities of the toy gyroscope,



The Gyrostatic Bicycle Is Used Extensively in School Laboratories to Demonstrate the Wonderful Stabilizing Power of the Gyroscope.

and the apparatus here shown duplicates the many startling maneuvers that the little twenty-five-cent toy gyro performs. When a gyroscope balance wheel is spun rapidly, and providing the rim of the wheel is sufficiently heavy to give it a good momentum, it will be found very difficult to shift the bicycle, or other device on which the spinning gyro is mounted. To demonstrate the principle of the gyroscope—which is based upon the fact that a spinning or rotating mass tends to preserve its plane of rotation—all one has to do is to jack up the rear wheel of a bicycle, and by turning the pedals, cause this wheel to spin rapidly. Now hold the bicycle off the ground a short distance, and endeavor to turn the complete bicycle sidewise. You will experience a surprisingly strong counter-turning effect, which tends to keep the bicycle in its upright plane as long as the wheel spins at a fair rate of speed. Many of these gyros are electrically driven; also it is well to keep in mind the fact that even an ordinary bicycle exerts some gyrostatic effort, and this has much to do with the success of the rider in maintaing his upright position while spinning along on two wheels mounted in tandem, that is, one behind the other. You have prohably noticed, if you have ever ridden a bicycle that the faster you go, the easier it is to maintain your balance. The increasing gyrostatic effect as the rotational speed of the wheels increased was the reason.

A HARD DRINKER OF SOFT DRINKS.

This little girl is a soft drink demonstrator and she sits in show windows all day long pouring drink after drink of some delicious beverage into the glass and raising it to her lips and draining it with the greatest ease.

She seems to like the beverage, for after each drink she nods her head a couple of times with a happy smile which seems to say, "My, that was good"; then she pours down another one.

The figure is made life size of papier maché and mounted on a tabourette, which contains the electric motor and speed reducing mechanism. The cams and levers which operate the arms and head are thoroly concealed inside the body.

Drink Hearty, Little Girl. It's Only Some of Willie Bryan's Famous Grape Juice. An Electric Motor Solves the Mystery of This Silent and Ever-Drinking Demonstrator.

Try These On Your Auto

ELECTRIC CIGAR LIGHTER FOR THE AUTO

At last—a perfect electric cigar lighter. It should prove a boon to motorists. It is handy and convenient—always within reach. The burner tip is made of heavy wire and will last indefinitely. Burner tip is protected by a cap not shown in cut. This neat and efficient cigar lighter is equipt with 5½ foot cord, which automatically rewinds. The lighter is easily attached to the battery in the car and costs practically nothing to operate.

Ever Try to Light a Cigar While Driving an Auto? This Electric Cigar Lighter Does the Trick Better Than Matches and Does Not "Blow Out".

NEW MAGNETO IMPULSE STARTER.

One of the many reasons why the magneto is so firmly established as the supreme ignition system is the fact that it does not depend upon any other unit or units for its electrical output and distribution of current.

The magneto transforms mechanical energy into electrical energy. The moment the shaft of a magneto-equipt engine revolves, the magneto begins to generate electrical energy for ignition; and, following requirements, the higher the rate at which it is driven the more intense are the sparks.

To facilitate *starting* when necessary, the magneto here shown can be supplied, with an impulse starter, which automatically "speeds up" the magneto armature at the exact moment of firing the *initial* gas charge or charges, thus providing at even low speeds the full electrical capacity of the magneto.

In a word, the impulse starter or coupling is a mechanical device for the purpose of obtaining positive and efficient starting, without the aid of batteries or a battery system of ignition.

The impulse starter is located between the magneto drive and the armature; when the engine is cranked or barred over, the armature is held stationary, while energy is being stored up by the compression of a series of springs. At a predetermined moment the springs are released and the armature is given a partial revolution at high speed. In this way, intense sparks are provided, and the engine given its starting impulse.

As soon as the engine commences its regular operation, or attains a speed of about 120 r.p.m., the impulse starter is automatically disengaged, the "starter" transmitting the driving energy to the magneto as a flexible coupling.

The control of the "starter" is by means of a lever mounted on a shaft projecting from the front of the housing. The lever is so constructed that it can either be operated by hand or thru the medium of a control connection.

The impulse starter is not an attachment, but is provided only as a part of this new magneto.

By Storing Up Energy In a Special Spring Coupling Device, It Becomes Possible to Spin This Magneto at Starting, and Provide a Hot Spark.

HEADLIGHT DIMMER

An Ohio electric concern is offering the public a device known as a headlight dimmer for use on Ford cars to dim the headlights when driving at night. This dimmer, it is claimed by the maker, can be attached to any Ford car by simply clamping it over the steering post and connecting the wires to the lighting circuit. The wires are easily connected, and when in use it is said that the dimmer will not affect the ignition or lighting system in a detrimental way. The control is made possible by means of a push and pull switch and a barrel type resistance. It is pointed out that it makes possible the use of a brighter light than can be secured thru the use of dimming lenses, yet at the same times makes it convenient to dim the lights according to requirements of traffic laws.

Here Is a Simple Electric Headlight Dimmer, Something Every Car Requires by Law. It Answers to the Call of Fords.

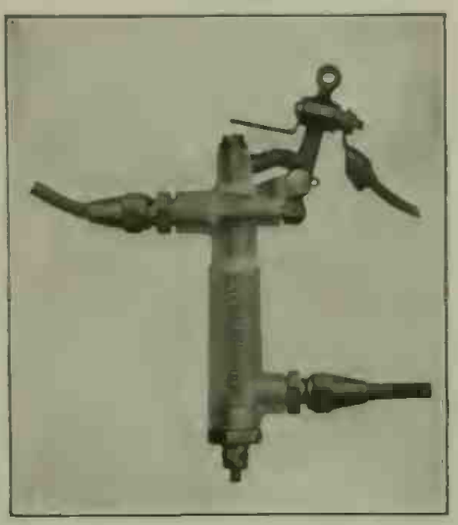
EFFECTIVE AUTO SIGNAL.

In this new electric auto signal there is only one *signal box*, which is placed on the left rear fender (or body or panel in the case of commercial vehicles and trucks). This shows both from the front and rear, and is visible day and night. The left rear fender is the logical place for the signal, as it is seen by all cars following from the rear, or cars approaching from the front, as well as by the traffic policeman, who is always to the left of cars approaching him.

A Logical Design In Electric Auto Signals, Which Can Be Seen from Front or Rear. It Is Controlled from the Driver's Seat by Means of a 3-Way Switch.

The signal is controlled for *left*, *right*, or *stop* by a plainly marked, single handle, three-way switch attached to the steering column immediately below the steering wheel, or in a place most accessible to the person driving. It is easily attached, and there are no moving parts to get out of order. A tell-tale buzzer indicates that the signal is functioning. A very slight amount of current from the lighting system of the car or dry cells is consumed. The signal is easily installed on the car by any mechanic.

ELECTRICALLY HEATED PRIMER FOR QUICK STARTING OF AUTOS.



This Electrically Heated Primer Will Save Much Useless Cussing and Start Your Auto Engine In a Jiffy. The Fuel Is Heated, Mixed With Air and Vaporized. Then Sucked Into the Engine. A Simple and Positive Device.

The autoist usually thinks of a primer as a means of pumping fuel into the cylinders quickly. The master primer here shown is not a pump in any sense of the word. The fuel is first heated boiling hot, vaporized by heat and mixed with air. Then drawn into the cylinders by suction of the motor. The suction draws only the quantity needed. Liquid gasoline will not explode. It must be vaporized. It must have air mixed with it to make it explosive.

Liquid fuel in large quantities carbonizes the engine. With the throttle of the carburetor closed, the master primer acts as an auxiliary carburetor—supplies the motor with what it needs in any kind of weather—heated vapor. The heating coil draws 20 amperes, about the same as the horn. Without it you may turn a balky engine over a hundred times.

To operate the primer all one need do is just pull a button on the dash. The same operation as choking the carburetor. Pulling the button makes electrical contact and opens the outlet valve of the primer. When car starts let go of button; the contact is broken and valve shuts off automatically.

NEW MAGNETIZER FOR REMAGNETIZING FORD MAGNETOS.

The Ford engine will display a great deal more "pep" if the magnets on the magneto are kept charged. We all know these magnets will lose their magnetism, which naturally reduces the energy displayed by the engine. The magnetizer is constructed in such a way that these magnets can be charged without taking the engine apart. All that is necessary is to take off the transmission cover. The magnets can then be charged, requiring only three or four seconds to each magnet. This is done by connecting the magnetizer to a well charged 6 or 12-volt battery or a sufficient number of dry cells in series.

Ford Owners Will Hail With Delight This New Magneto Magnetizer.

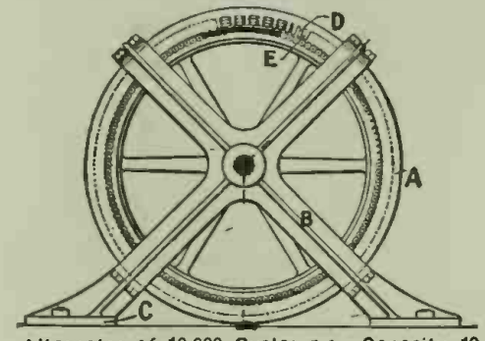
RADIO DEPARTMENT

The True Wireless

By NIKOLA TESLA

Written Exclusively for The Electrical Experimenter

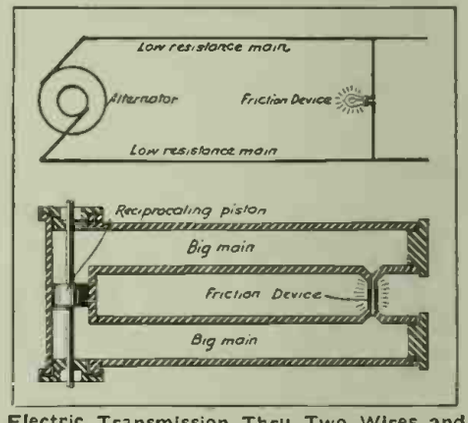
EVER since the announcement of Maxwell's electro-magnetic theory scientific investigators all the world over had been bent on its experimental verification. They were convinced that it would be done and lived in an atmosphere of eager expectancy, unusually favorable to the reception of any evidence to this end. No wonder then that the publication of Dr. Heinrich Hertz's results caused a thrill as had scarcely ever been experienced before. At that time I was in the midst of pressing work in connection with the commercial introduction of my system of power transmission, but, nevertheless, caught the fire of enthusiasm and fairly burned with desire to behold the miracle with my own eyes. Accordingly, as soon as I had freed myself of these imperative duties and resumed research work in my laboratory on Grand Street, New York, I began, parallel with high frequency alternators, the construction of several forms of apparatus with the object of exploring the field opened up by Dr. Hertz. Recognizing the limitations of the devices he had employed, I concentrated my attention on the production of a powerful induction coil but made no notable progress until a happy inspiration led me to the invention of the oscillation transformer. In the latter part of 1891 I was already so far advanced in the development of this new principle that I had at my disposal means vastly superior to those of the German physicist. All my previous efforts with Rhumkorf coils had left me unconvinced, and in order to settle my doubts I went over the whole ground once more, very carefully, with these improved appliances. Similar phenomena were noted, greatly magnified in intensity, but they were susceptible of a different and more plausible explanation. I considered this so important that in 1892 I went to Bonn, Germany, to confer with Dr. Hertz in regard to my observations. He seemed disappointed to such a degree that I regretted my trip and parted from him sorrowfully. During the succeeding years I made numerous experiments with the same object, but the results were uniformly negative. In 1900, however, after I had evolved a wireless transmitter which enabled me to obtain electro-magnetic activities of many millions of horse-power, I made a last desperate attempt to prove that the disturbances emanating from the oscillator were ether vibrations akin to those of light, but met again with utter failure. For more than eighteen years I have been reading treatises, reports of scientific transactions, and articles on Hertz-wave telegraphy, to keep myself informed, but they have always imprest me like works of fiction.



Alternator of 10,000 Cycles p.s., Capacity 10 K.W., Which Was Employed by Tesla in His First Demonstrations of High Frequency Phenomena Before the American Institute of Electrical Engineers at Columbia College, May 20, 1891. Fig. 1.

The history of science shows that theories are perishable. With every new truth that is revealed we get a better understanding of Nature and our conceptions and views are modified. Dr. Hertz did not discover a new principle. He merely gave material support to a hypothesis which had been long ago formulated. It was a perfectly well-established fact that a circuit, traversed by a periodic current, emitted some kind of space waves, but we were in ignorance as to their character. He apparently gave an experimental proof that they were transversal vibrations in the ether. Most people look upon this as his great accomplishment. To my mind it seems that his immortal merit was not so much in this as in the focusing of the investigators' attention on the processes taking place in the ambient medium. The Hertz-wave theory, by its fascinating hold on the imagination, has stifled creative effort in the wireless art and retarded it for twenty-five years. But, on the other hand, it is impossible to over-estimate the beneficial effects of the powerful stimulus it has given in many directions.

As regards signaling without wires, the application of these radiations for the purpose was quite obvious. When Dr. Hertz was asked whether such a system would be of practical value, he did not think so, and he was correct in his forecast. The best that might have been expected was a method of communication similar to the heliographic and subject to the same or even greater limitations.



Electric Transmission Thru Two Wires and Hydraulic Analog. Fig. 3.

In the spring of 1891 I gave my demonstrations with a high frequency machine before the American Institute of Electrical Engineers at Columbia College, which laid the foundation to a new and far more promising departure. Altho the laws of electrical resonance were well known at that time and my lamented friend, Dr. John Hopkinson, had even indicated their specific application to an alternator in the Proceedings of the Institute of Electrical Engineers, London, Nov. 13, 1889, nothing had been done towards the practical use of this knowledge and it is probable that those experiments of mine were the first public exhibition with resonant circuits, more particularly of high frequency. While the spontaneous success of my lecture was due to spectacular features, its chief import was in showing that all kinds of devices could be operated thru a single wire without return. This was the initial step in the evolution of my wireless system. The idea presented itself to me that it might be possible, under ob-

IN this remarkable and complete story of his discovery of the "True Wireless" and the principles upon which transmission and reception, even in the present day systems, are based, Dr. Nikola Tesla shows us that he is indeed the "Father of the Wireless." To him the Hertz wave theory is a delusion; it looks sound from certain angles, but the facts tend to prove that it is hollow and empty. He convinces us that the real Hertz waves are blotted out after they have traveled but a short distance from the sender. It follows, therefore, that the measured antenna current is no indication of the effect, because only a small part of it is effective at a distance. The limited activity of pure Hertz wave transmission and reception is here clearly explained, besides showing definitely that in spite of themselves, the radio engineers of today are employing the original Tesla tuned oscillatory system. He shows by examples with different forms of aërials that the signals picked up by the instruments must actually be induced by earth currents—not etheric space waves. Tesla also disproves the "Heaviside layer" theory from his personal observations and tests.

EDITOR.

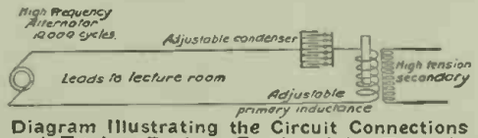
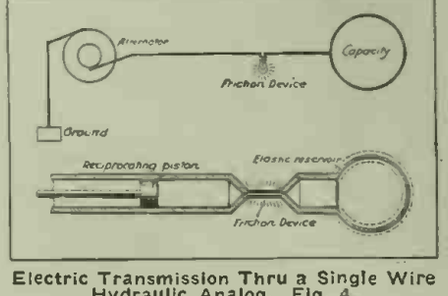
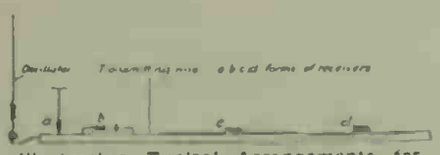


Diagram Illustrating the Circuit Connections and Tuning Devices Employed by Tesla in His Experimental Demonstrations Before the American Institute of Electrical Engineers With the High Frequency Alternator Shown in Fig. 1. Fig. 2.



Electric Transmission Thru a Single Wire Hydraulic Analog. Fig. 4.



Illustrating Typical Arrangements for Collecting Energy in a System of Transmission Thru a Single Wire. Fig. 5.

servance of proper conditions of resonance, to transmit electric energy thru the earth, thus dispensing with all artificial conductors. Anyone who might wish to examine impartially the merit of that early suggestion must not view it in the light of present day science. I only need to say that as late as 1893, when I had prepared an elaborate chapter on my wireless system, dwelling on its various instrumentalities and future prospects, Mr. Joseph Wetzler and other friends of mine emphatically protested against its publication on the ground that such idle and far-fetched speculations would injure me in the opinion of conservative business men. So it came that only a small part of what I had intended to say was embodied in my address of that year before the Franklin Institute and National Electric Light Association under the chapter "On Electrical

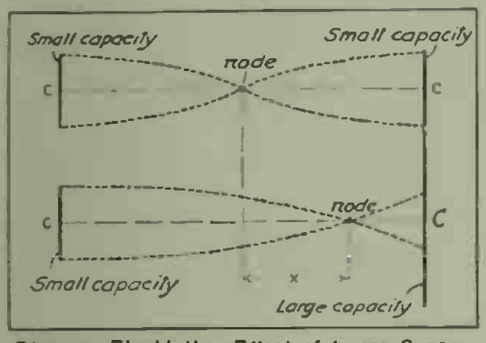
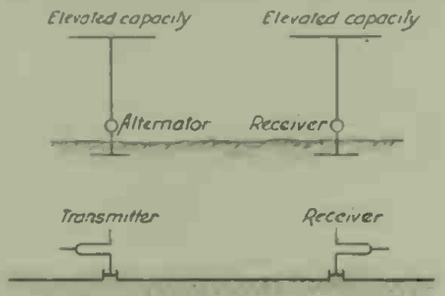


Diagram Elucidating Effect of Large Capacity on One End. Fig. 6.

Resonance." This little salvage from the wreck has earned me the title of "Father of the Wireless" from many well-disposed fellow workers, rather than the invention of scores of appliances which have brought wireless transmission within the reach of every young amateur and which, in a time not distant, will lead to undertakings overshadowing in magnitude and importance all past achievements of the engineer.

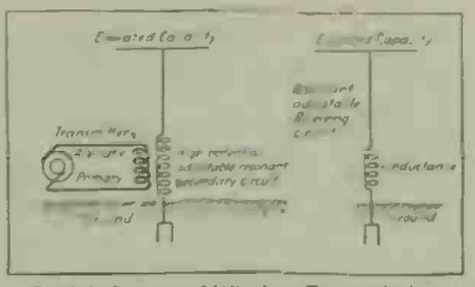
The popular impression is that my wireless work was begun in 1893, but as a matter of fact I spent the two preceding years in investigations, employing forms of apparatus, some of which were almost like those of today. It was clear to me from the very start that the successful consummation could only be brought about by a number of radical improvements. Suitable high frequency generators and electrical oscillators had first to be produced. The energy of these had to be transformed in effective transmitters and collected at a distance in proper receivers. Such a system would be manifestly circumscribed in its usefulness if all extraneous interference were not prevented and exclusiveness secured. In time, however, I recognized that devices of this kind, to be most effective and efficient, should be designed with due regard to the physical properties of this planet and the electrical conditions obtaining on the same. I will briefly touch upon the salient advances as they were made in the gradual development of the system.



Transmission of Electrical Energy Thru the Earth as Illustrated in Tesla's Lectures Before the Franklin Institute and Electric Light Association in February and March, 1893, and Mechanical Analog of the Same. Fig. 7.

The high frequency alternator employed in my first demonstrations is illustrated in Fig. 1. It comprised a field ring, with 384 pole projections and a disc armature with coils wound in one single layer which were connected in various ways according to requirements. It was an excellent machine for experimental purposes, furnishing sinusoidal currents of from 10,000 to 20,000 cycles per second. The output was comparatively large, due to the fact that as much as 30 amperes per square millimeter could be past thru the coils without injury.

The diagram in Fig. 2 shows the circuit arrangements as used in my lecture. Resonant conditions were maintained by means

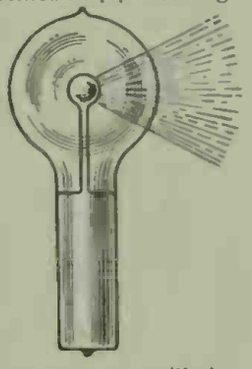


Tesla's System of Wireless Transmission Thru the Earth as Actually Exposed in His Lectures Before the Franklin Institute and Electric Light Association in February and March, 1893. Fig. 8.

of a condenser subdivided into small sections, the finer adjustments being effected by a movable iron core within an inductance coil. Loosely linked with the latter was a high tension secondary which was tuned to the primary.

The operation of devices thru a single wire without return was puzzling at first because of its novelty, but can be readily explained by suitable analogs. For this purpose reference is made to Figs. 3 and 4.

In the former the low resistance electric conductors are represented by pipes of large



The Forerunner of the Audion—the Most Sensitive Wireless Detector Known, as Described by Tesla in His Lecture Before the Institution of Electrical Engineers, London, February, 1892. Fig. 9.

section, the alternator by an oscillating piston and the filament of an incandescent lamp by a minute channel connecting the pipes. It will be clear from a glance at the diagram that very slight excursions of the piston would cause the fluid to rush with high velocity thru the small channel and that virtually all the energy of movement would be transformed into heat by friction, similarly to that of the electric current in the lamp filament.

The second diagram will now be self-explanatory. Corresponding to the terminal capacity of the electric system an elastic reservoir is employed which dispenses with the necessity of a return pipe. As the piston oscillates the bag expands and contracts, and the fluid is made to surge thru the restricted passage with great speed, this

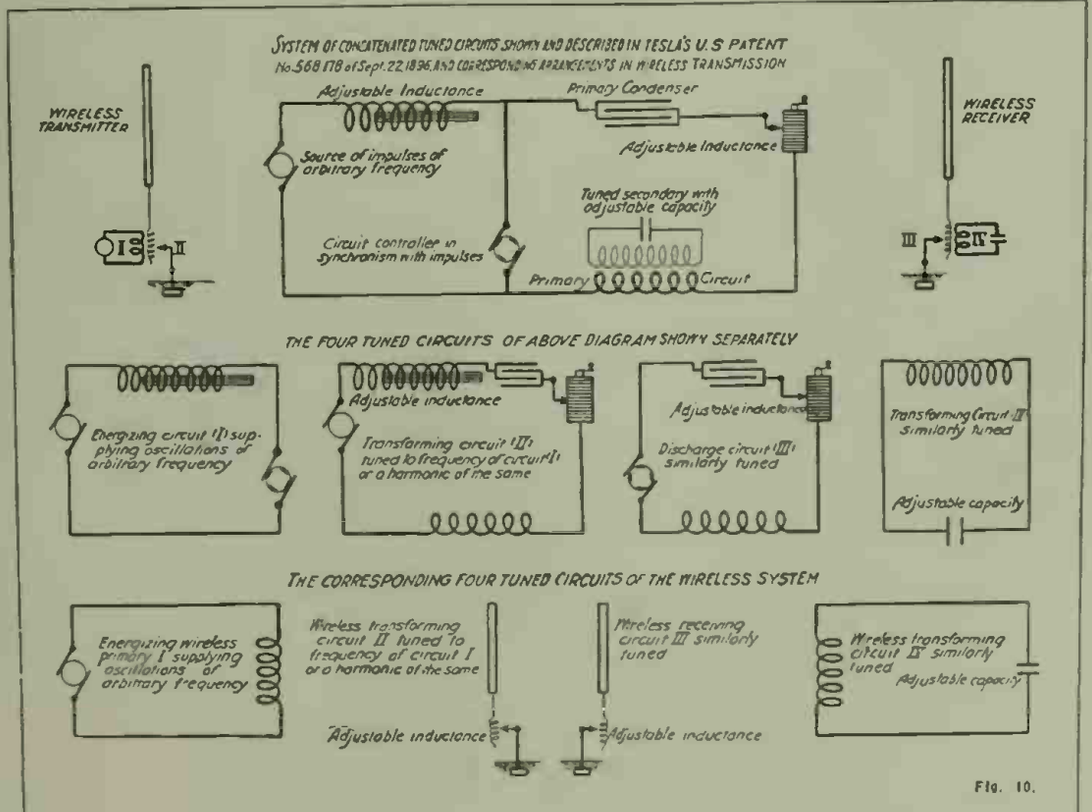
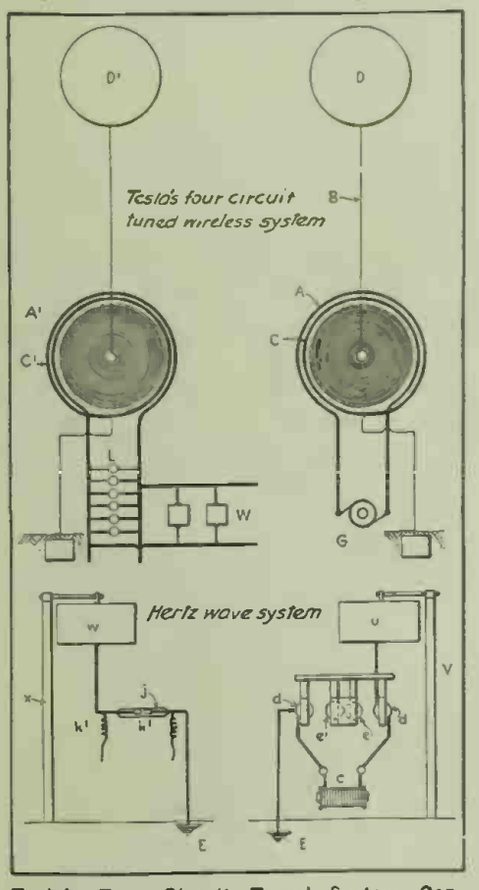


Fig. 10.

Tesla's System of Concatenated Tuned Circuits Shown and Described in U. S. Patent No. 568,178 of September 22, 1896, and Corresponding Arrangements in Wireless Transmission.

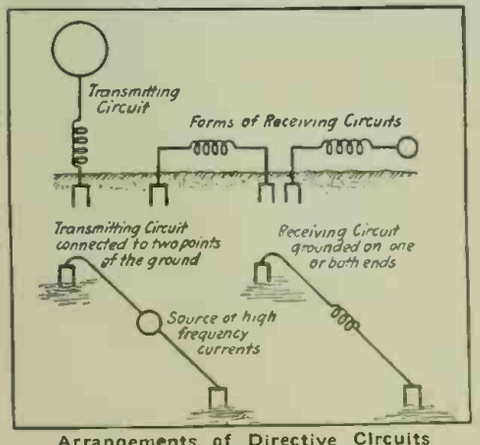
resulting in the generation of heat as in the incandescent lamp. Theoretically considered, the efficiency of conversion of energy should be the same in both cases.

Granted, then, that an economic system of power transmission thru a single wire is



Tesla's Four Circuit Tuned System Contrasted With the Contemporaneous Hertz-wave System. Fig. 11.

practicable, the question arises how to collect the energy in the receivers. With this object attention is called to Fig. 5, in which a conductor is shown excited by an oscillator joined to it at one end. Evidently, as the periodic impulses pass thru the wire, differences of potential will be created along the same as well as at right angles to it in the surrounding medium and either of these may be usefully applied. Thus at *a*, a circuit comprising an inductance and capacity is resonantly excited in the transverse, and at *b*, in the longitudinal sense. At *c*, energy is collected in a circuit parallel to the conductor but not in contact with it, and again at *d*, in a circuit which is partly sunk into the conductor and may be, or not, electrically connected to the same. It is important to keep these typical dispositions in mind, for however the distant ac-



Arrangements of Directive Circuits Described in Tesla's U. S. Patent No. 613,809 of November 8, 1898, on "Method of and Apparatus for Controlling Mechanism of Moving Vessels or Vehicles." Fig. 12.

tions of the oscillator might be modified thru the immense extent of the globe the principles involved are the same.

Consider now the effect of such a conductor of vast dimensions on a circuit exciting it. The upper diagram of Fig. 6 illustrates a familiar oscillating system comprising a straight rod of self-inductance $2L$ with small terminal capacities cc and a node in the center. In the lower diagram of the figure a large capacity C is attached to the rod at one end with the result of shifting the node to the right, thru a distance corresponding to self-inductance X. As both parts of the system on either side of the node vibrate at the same rate, we have evidently, $(L + X)\ c = (L - X)\ C$ from which $X = L\,\frac{C - c}{C + c}$. When the capacity C becomes commensurate to that of the earth, X approximates L, in other words, the node is close to the ground connection. *The exact determination of its position is very important in the calculation of certain terrestrial electrical and geodetic data* and I have devised special means with this purpose in view.

My original plan of transmitting energy without wires is shown in the upper diagram of Fig. 7, while the lower one illustrates its mechanical analog, first publisht in my article in the *Century Magazine* of June, 1900. An alternator, preferably of high tension, has one of its terminals connected to the ground and the other to an elevated capacity and impresses its oscillations upon the earth. At a distant point a receiving circuit, likewise connected to ground and to an elevated capacity, collects some of the energy and actuates a suitable device. I suggested a multiplication of such units in order to intensify the effects, an idea which may yet prove valuable. In the analog two tuning forks are provided, one at the sending and the other at the receiving station, each having attached to its lower prong a piston fitting in a cylinder. The two cylinders communicate with a large elastic reservoir filled with an incom-

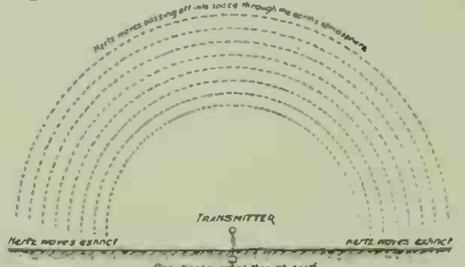


Diagram Exposing the Fallacy of the Gliding Wave Theory as Propounded in Wireless Text Books. Fig. 13.

pressible fluid. The vibrations transmitted to either of the tuning forks excite them by resonance and, thru electrical contacts or otherwise, bring about the desired result. This, I may say, was not a mere mechanical illustration, but a simple representation of my apparatus for submarine signaling, perfected by me in 1892, but not appreciated at that time, altho more efficient than the instruments now in use.

The electric diagram in Fig. 7, which was reproduced from my lecture, was meant only for the exposition of the principle. The arrangement, as I described it in detail, is shown in Fig. 8. In this case an alternator energizes the primary of a transformer, the high tension secondary of which is connected to the ground and an elevated capacity and tuned to the imprest oscillations. The receiving circuit consists of an inductance connected to the ground and to an elevated terminal without break and is resonantly responsive to the transmitted oscillations. A specific form of receiving device was not mentioned, but I had in mind to transform the received currents and thus make their volume and tension suitable for any purpose. This, in substance, is the system of today and I am not aware of a single authenticated instance of successful transmission at considerable distance by different instrumentalities. It might, perhaps, not be clear to

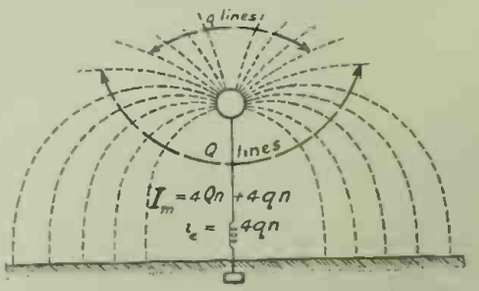


Fig. 14. Diagram Explaining the Relation Between the Effective and the Measured Current in the Antenna.

those who have perused my first description of these improvements that, besides making known new and efficient types of apparatus, I gave to the world a wireless system of potentialities far beyond anything before conceived. I made explicit

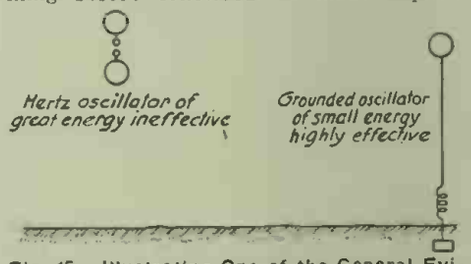


Fig. 15. Illustrating One of the General Evidences Against the Space Wave Transmission.

and repeated statements that I contemplated transmission, absolutely unlimited as to terrestrial distance and amount of energy. But, altho I have overcome all obstacles which seemed in the beginning unsurmountable and found elegant solutions of all the problems which confronted me, yet, even at this very day, the majority of experts are still blind to the possibilities which are within easy attainment.

My confidence that a signal could be easily flashed around the globe was strengthened thru the discovery of the "rotating brush," a wonderful phenomenon which I have fully described in my address before the Institution of Electrical Engineers, London, in 1892, and which is illustrated in Fig. 9. This is undoubtedly the most delicate wireless detector known, but for a long time it was hard to produce and to maintain in the sensitive state. These difficulties do not exist now and I am looking to valuable applications of this device, particularly in connection with the high-speed photographic method, which I suggested, in wireless, as well as in wire, transmission.

Possibly the most important advances during the following three or four years were my system of concatenated tuned circuits

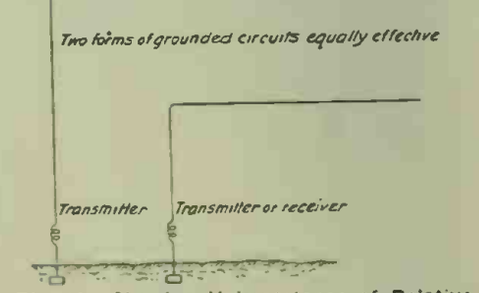


Fig. 16. Showing Unimportance of Relative Position of Transmitting and Receiving Antennae in Disproval of the Hertz-wave Theory.

and methods of regulation, now universally adopted. The intimate bearing of these inventions on the development of the wireless art will appear from Fig. 10, which illus-

(*Continued on page* 61)

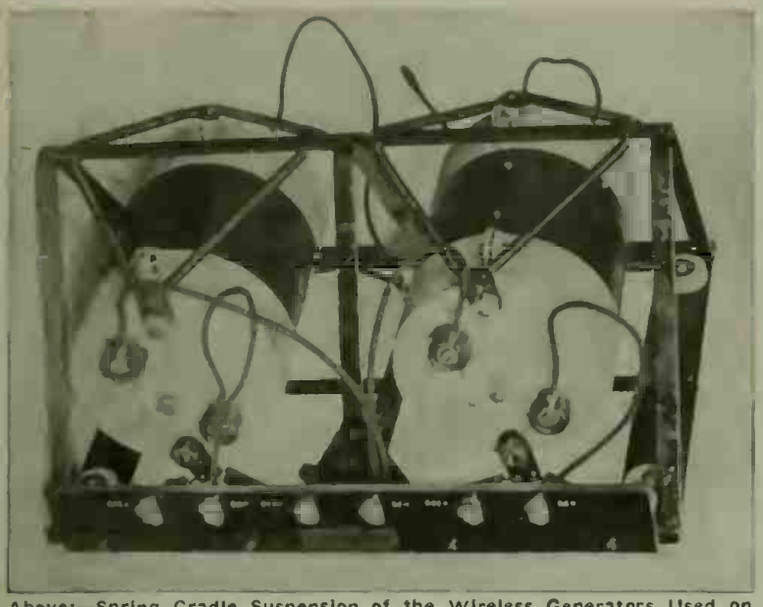
Novel Generators

IMAGINE yourself wearing a set of head receivers and a telephone transmitter and listening to a voice saying, *"I am right over R 7 and your shells are all bursting 'short.' Increase range 50 yards."* That was the experience of American radio operators during the latter part of the war, for radio telephone sets were developed that enabled men on the ground to talk with airplanes flying over the enemy lines and aim the guns according to their directions.

An essential feature of the radio telephone set is a small generator to deliver direct current at from 275 to 350 volts. For airplane use, these generators also delivered current at 25 volts. One is mounted on the landing gear of each 'plane, so that the air "back-wash" of the propeller drives a small two-blade wooden fan on the generator shaft. Thus the generator runs whenever the 'plane is in motion, and also while it is on the ground with the engine running. Constant voltage with variable speed is secured by an ingenious arrangement of differential fields controlled by a two-element vacuum tube mounted in the *stream-line* housing of the generator.

At stations on the ground or on shipboard, power is taken from storage batteries, and here a small dynamotor, driven by 10-volt current, gives the required high voltage. In the field one of these sets was originally mounted on a light metal frame carrying a voltmeter, fuses and terminals. Quite recently an aluminum carrying-case was developed which was watertight when closed. All the switches, fuses, etc., are mounted inside.

A submarine chaser often lies motionless, waiting for a U-boat to stick its nose above the surface. So sensitive are the listening devices on the submarines that even the slight hum of one of these dynamotors, transmitted to the chaser hull, would betray its position. Hence the dynamotors furnished to the Navy are mounted in a cradle of coil springs as here illustrated. *Photos courtesy Westinghouse E. & M. Co.*



Above:—Spring Cradle Suspension of the Wireless Generators Used on U. S. Naval Submarine Chasers and Destroyers, to Eliminate the Transmission of the Humming Sound Produced by Their Operation, to the Steel Hull of the Vessel and Its Subsequent Interception by a Lurking U-boat. The Sub-sea Sound Detector Used by the German Submarines Was so Sensitive That This Precaution Was Necessary.

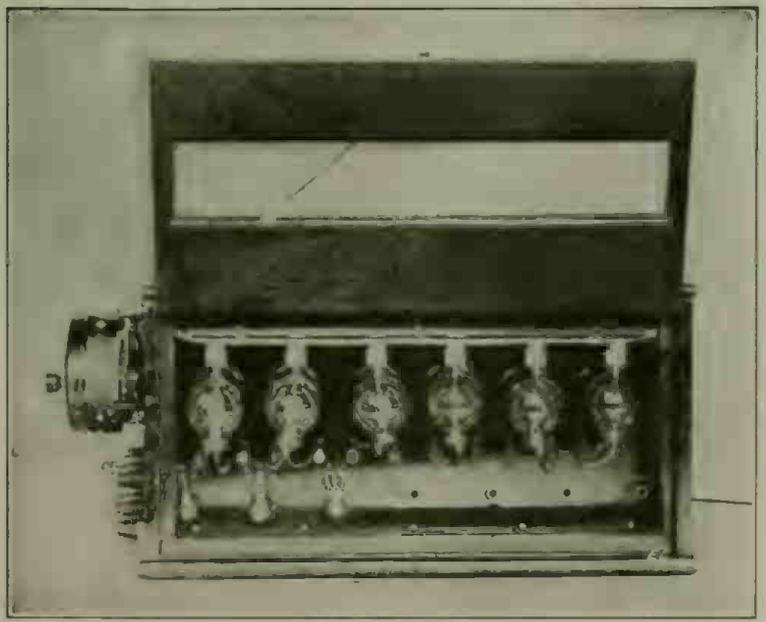
Ground Officers of the U. S. Army Talking to Airplanes In Flight by Means of Wireless Telephone. The Range of Such Communication Has Recently Been Increased to 150 Miles by Official Test.

At Right:—Lower Right-hand View Shows the Wind-driven Airplane Radio Generator Developed During the War. Its Speed, of Course, Varies with the Velocity of the 'Plane and How Its Voltage Is Maintained Constant with Variable Speed Is One of the Interesting Problems That Radio Engineers Had to Solve Before Anything Else Could Be Done.

Boosts Signals 1,000,000 Times

The six-step audion amplifier set here shown represents the latest development in amplifiers, and its intensifying qualities are enormously in excess of any similar apparatus produced heretofore. Under ordinary conditions, this set will *amplify* 1,000,000 *times*, so it is especially well adapted for use in connection with the reception of the very weak signals set up by the small portable transmitters used in modern warfare. As a matter of fact, the set has been designed strictly with an eye towards military field work, and similar purposes, and has already proved its efficiency along such lines. An entirely new departure in design is seen in the fact that only one "A" battery, and one "B" battery are employed. In addition, these batteries are practically free of adjustment, which greatly enhances the value of this set, and is a unique feature in amplifier construction.

In connection with the above apparatus, it may be mentioned that the success of the French armies was in part due to the wonderful results achieved with such amplifiers on the various battle-fronts. Amplifiers using as many as nine steps were employed with marked success in trench communication, aerial communication, and similar work.



The Most Powerful Vacuum Tube Amplifier Now Standardized and Built. It Is a Six-stage Amplifier and Possesses an Amplifying Power of 1,000,000 Times. It Solved Many Knotty Problems During the War.

In the lower left-hand corner of the panel is mounted a simple two-way switch, by means of which the first bulb can be made either a detector for radio signals or the first-step amplifier for audio-frequency currents. When used as a detector, the connections from the tuner are made to the upper pair of external binding posts. When used as an amplifier, the connections from the detector (or the two-ground terminals, in case one is receiving conduction or induction currents thru the earth) are made to the lower pair of external binding posts. To the other pair of binding posts is connected the six-volt storage battery.

The telephone cord terminates in a plug, which can be plugged into the third, fourth, fifth or sixth jack cord to the degree of amplification which is desired.

U. S. Adopts Multiplex Radio

THE recent announcement that the Government had decided to adopt the multiplex system of radio telegraphy and telephony, makes possible some entirely new methods of communication.

The multiplex radio system is a complex one. The multiplex system of ordinary telegraphy permits the sending and receiving of eight different messages on one wire at the same time. Thus it may be seen what a great advantage it holds over the old method of Morse telegraphy.

Radio messages are sent by the same method. The trans-Atlantic Radio Room in the Navy Department illustrated herewith is completely equipt with a multiplex radio outfit. By this new system Secretary Daniels is able to keep in communication with several vessels out at sea at the same time. Likewise, President Wilson, on his voyage to France, was able to keep in immediate communication with Washington.

A Recent Photo Taken of the U. S. Navy Department's Trans-Atlantic Radio Operating Room. Multiplex Radio Signaling Is Now Carried on in Both Directions across the Ocean.

This photograph is the first to be released showing the trans-Atlantic Radio Operating Room of the Navy Department.

This is the receiving room of the radio station in the Navy Department. Four receiving machines constitute, with the four perforating machines, one complete unit of multiplex radio-telegraphy. As a result, four messages may be sent and four received over one antenna at the same time.

RADIO LINKS 3,000 MILES BETWEEN OMSK AND LYONS.

Omsk, in which are centered the hopes for the rebuilding of a new Russia, after months of isolation, is now actively in wireless communication with the outside world. Hourly reports, containing a complete news service, are received in Omsk direct from the French wireless station at Lyons, France. Outgoing communication will be inaugurated soon.

From Omsk to Lyons is 3,000 miles on a direct air line over Bolshevik Russia and Central Europe. Omsk is about midway between the Atlantic and Pacific oceans.

AN OMISSION.

We wish to state that credit for the photographs accompanying the article entitled "The City of Splendid Night" by Amos Stote, publisht in the January, 1919, issue, should have been given to the New York Edison Co.

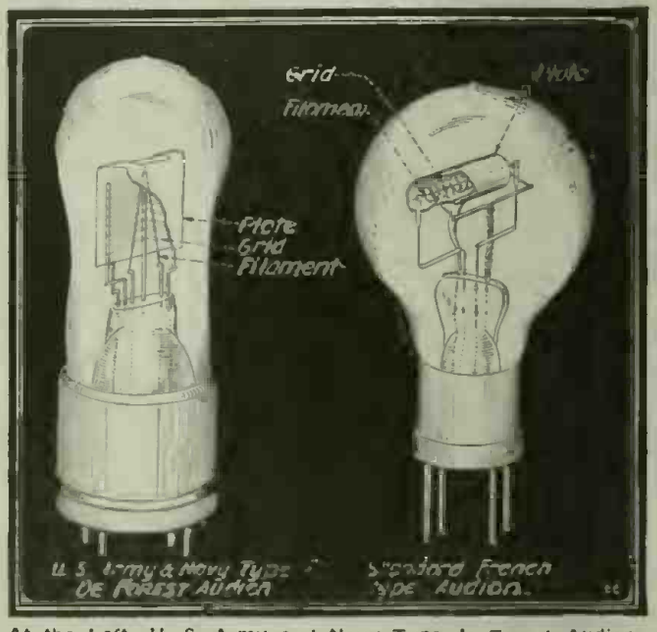
New French and American Audions

UNDOUBTEDLY the radio amateur and experimenter has often wondered what form of audion or vacuum detector and amplifier was being used both by the American and European armies. Thru the courtesy of Dr. Lee de Forest, we are enabled to show herewith the standard form of three-electrode audion in use by the French Army signal corps, as well as by the French Navy, and also the standard form of three-electrode audion in use by the United States Army Signal Corps.

As we have heard but very little concerning the French and other European wireless apparatus for several years, owing to the war conditions existing, we find considerable interest in the French type of vacuum bulb detector and amplifier, and so we will consider it first.

As the illustration shows it comprises a spherical form of glass bulb, which is eventually pumped out to a very high degree of vacuum. One thing decidedly noticeable about both the French and American tubes, is the simplified and highly improved form of base which incorporates four contact pins, which form a juncture with four sockets in the bayonet-joint receptacle supporting the audion. Two of the contact pins lead to the incandescent filament, while the other two connect to the grid and the plate respectively. It is thus but a moment's work to snap a bulb out of its socket and replace it with another one.

The French audion is unique in its general design, as will be noted from the accompanying illustration, the filament being in the form of a fine straight wire passing thru the center of the grid, which takes the form of a helical coil of non-oxidizing wire. Outside of the helical grid, we find the wing or plate element, which is made in the form of a small cylinder or tube. Each of the three distinct elements comprising the audion are spaced about 3/32 inch apart. It is stated on good authority that during the war the French Government manufactured five thousand of these audion bulbs every day, or almost two million of them in a year. This rate of audion production was carried on during the last two years of the war. The French bulb here shown is particularly interesting as being efficient and suitable in all three functions,—detector, amplifier and oscillator.



At the Left—U. S. Army and Navy Type de Forest Audion. At Right—the Famous French Type of Three Electrode Audion, Five Thousand of Which Were Manufactured Every Day during the Last Year of the War. It Serves as Detector, Amplifier and Oscillator.

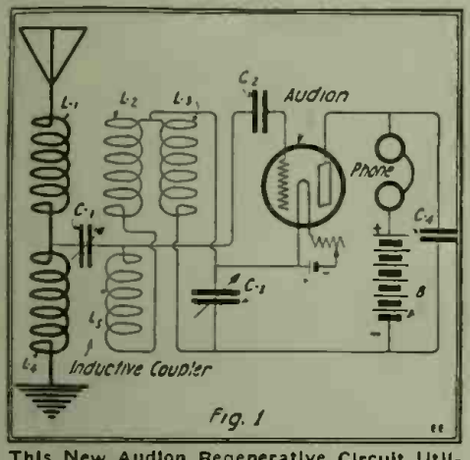
The Standard United States Army type of three-electrode audion here shown comprises filament, grid and plate, rigidly secured in place in the manner indicated. Particular attention has been given in this design to the manner of supporting the inverted "V" type filament as well as the grid and plate elements, so that as a matter of fact these rugged bulbs can be handled without any particular pains, and none of the electrode elements can move as they could in the older types. A still better construction is involved in a modified and improved form of audion being developed for the United States Signal Corps by Dr. de Forest. It will be seen how the plate member is bent into the shape of an inverted "U" and rigidly secured by two wire members securely molded or fused into the glass stem. The fine wire grid is securely mounted in place inside of the plate member on two upright wire legs as shown, and the top of the filament is anchored and supported by a third wire secured in the glass stem. There is still a slight chance for a little movement between the electrode elements in this detector, and in the improved form aforementioned and which is now being developed and perfected, the filament, grid and plate are still further strengthened, so that no matter how much the bulb is jarred or shaken, no variation whatsoever can occur in the spacing between any two of the three electrodes.

New Regenerative Vacuum Tube Circuits

By SAMUEL D. COHEN

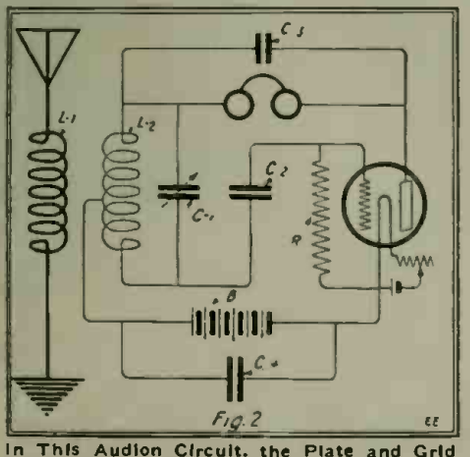
DURING the war the vacuum tube has gone into very extensive use in radio communication and other allied electrical fields. The regenerative circuits used until now have been found satisfactory. However, certain improvements were discovered and it is the privilege of the writer to give the results of some of these improvements that were made on regenerative vacuum tube circuits for the reception of long distance stations using long wave lengths.

One of the schemes tried by the writer was to couple the grid to the plate of the vacuum tube directly in the antenna system of the oscillating circuit, in order that heterodyne method of reception might be accomplished with maximum efficiency. For this work it was essential to construct a coupled magnetic system in order to accomplish the desired effects and the accompanying photograph shows a special type of inductive coupler utilized thruout these experiments. It will be noted from the

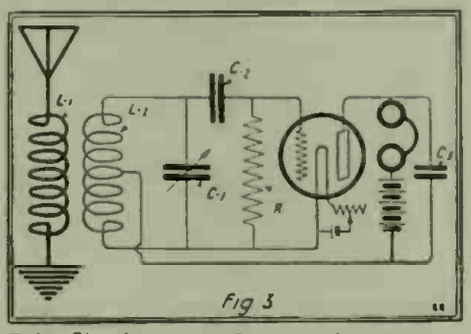


This New Audion Regenerative Circuit Utilizes a Five Coil Loose Coupler, Which Is Described In Detail by the Author. By This Arrangement the Grid and Plate Circuits Are Coupled Magnetically. There Are Two Secondary Coils Which Form a Variometer.

photograph that the primary winding consists of two distinct coils *wound on the same tube* and in the same direction. The third coil which is swung on a pivoted arm as indicated moves into the magnetic field of one of these coils. The secondary of the coupler also consists of two coils, moving one inside of the other, thus comprising



In This Audion Circuit, the Plate and Grid Are Coupled Magnetically Thru Coil L_2, and the Central Tap Should Be Accurately Taken Off.



This Circuit for a Regenerative Vacuum Tube Is Similar to That Given In Fig. 2, and Needs no Special Comment.

a variometer. The coupling of both of these coils can be changed at will, both within the main primary and outside of the primary. This was essential in order to eliminate the use of switches for the control of the inductance of the coils.

The coils were built with great care, in order to eliminate the undesirable oscillations produced within the coil circuits, due to the inherent distributed capacity of the coils.

A circuit giving remarkable results in amplifying received signals is that shown in Fig. 1. The main inductance L_1 is the main primary connected in series with the small coil wound on the same tube L_4, which is thereafter connected to the ground as indicated. L_2 and L_3, which comprises the secondary of the coupler are connected in a variometer manner as indicated. The joint point of these coils is connected to the filament terminal of the vacuum tube. The end of the coil is linked to the battery B, of the plate, while coil L_2 is connected

ROGERS UNDERGROUND ANTENNA

Since the publication of the Rogers underground antenna in our March issue we have been flooded with letters from amateurs all over the country who desire to have further information on this wonderful radio development. The standard question asked by most of these correspondents is, how large is the antenna, how to connect it, etc. In a few words, we might say that a satisfactory method is to use about 100 to 300 feet of ordinary standard automobile rubber cable, burying same in a 3-foot earth trench. The cable is then covered up entirely. One end is insulated, the other end goes to the instruments *taking the place of the former aeriol.*

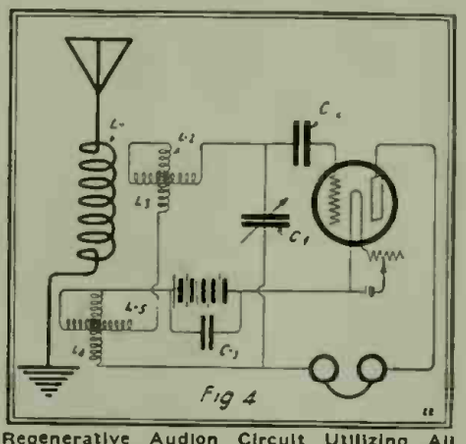
In our next issue we shall have a comprehensive article specially prepared for amateurs on the Rogers Underground System.—*Editor.*

to the tertiary coil L_5, which coil is the one mounted on the moving arm as indicated on the right of the photograph. Coils L_5 and L_4 are coupled magnetically and electrostatically thru the condenser C_1. It will thus be seen from the diagram that the plate and grid are coupled thru the inductance L_3 and which said inductance is coupled to the antenna system L_1. A critical adjustment is necessary between L_4 and L_5, and between L_2 and L_3, to give maximum radio frequency amplification in the circuit. Condenser C_3 has a magnitude of the order of two microfarads and is used in general to permit the high frequency current to readily pass to the plate.

Another circuit is shown in Fig. 2, which gave excellent results. In this circuit, the plate and grid are coupled magnetically thru coil L_2. In this particular case, it is very essential to note that the filament coil line should be tapt off exactly at the center of coil L_2 in order to give best results. This is done in order to equalize the potentials between the grid and plate circuits. Coil L_2 can be made as a variometer as will be shown later. Condenser C_1 is a regular oscillatory secondary tuning condenser. The resistance R is a grid leak-resistance and its magnitude depends upon the operating characteristics of the tube.

A similar circuit to that of Fig. 2 is shown in Fig. 3, and needs no comment.

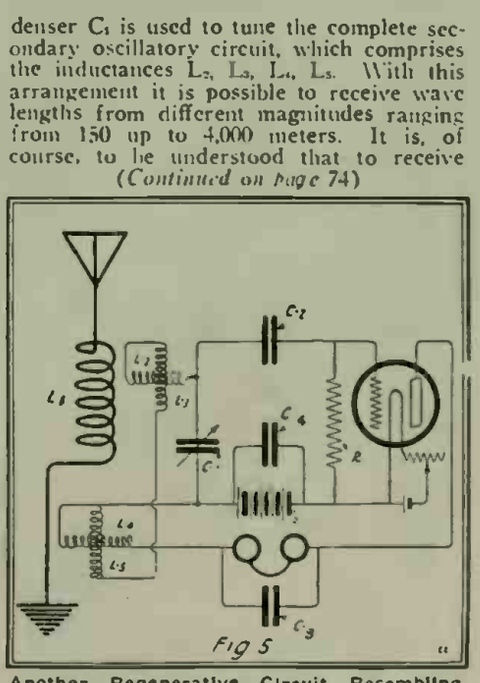
In Fig. 4 is shown another circuit for accomplishing the necessary results for regenerative effects for better efficiency. It will be noted that the inductances L_2 and L_3 comprise a variometer secondary coupled to the primary L_1. The inductance L_1 is coupled magnetically to the antenna inductance L_1 and to inductance L_5, which comprises another variometer of both L_4 and L_5, coupled magnetically to the plate and wing circuit of the vacuum tube. Con-



Regenerative Audion Circuit Utilizing All Five Coils on the Loose Coupler. Variable Condenser C_1 Is Used to Tune the Complete Secondary Oscillatory Circuit in the Manner Indicated.

denser C_1 is used to tune the complete secondary oscillatory circuit, which comprises the inductances L_2, L_3, L_4, L_5. With this arrangement it is possible to receive wave lengths from different magnitudes ranging from 150 up to 4,000 meters. It is, of course, to be understood that to receive

(*Continued on page 74*)

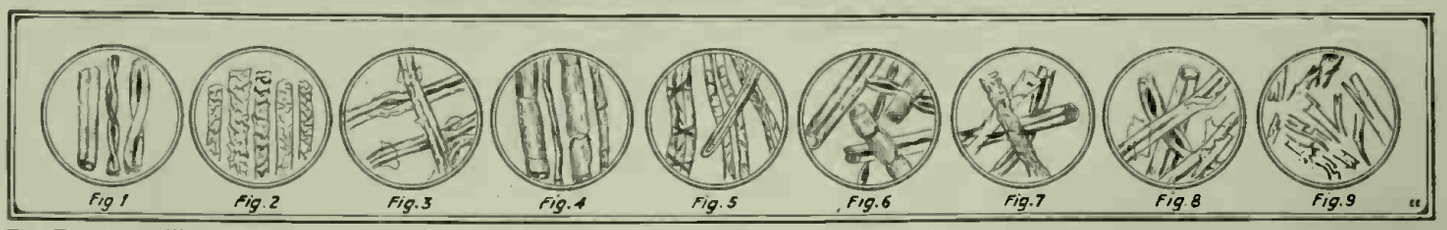


Another Regenerative Circuit Resembling Fig. 4. Here the Radio Frequency Bridging Condensers C_3 and C_4 Are Used to Permit Radio Frequency Currents to Pass Freely to the Plate.

Practical Chemical Experiments

Testing of Wool, Cotton and Linen

By ALBERT W. WILSDON



The Two Long Illustrations on This Page Show How Various Textiles Such as Cotton, Silk, Linen, Etc., Look Under the Microscope. Microscopic Examination of Such Textiles Is Considered One of the Best Methods of Determining Just What a Certain Fabric Is Composed of. Microscopic Drawings of the Various Fabrics Shown In the Illustration Above are:—1—Cotton, 2—Wool, Various Kinds, 3—Silk, 4—Linen, 5—Hemp, 6—Cotton and Linen Mixed, 7—Cotton and Wool, 8—Cotton and Silk, 9—Shoddy, Made from New, Fine, Blue Worsted Clips.

IN order that the layman may be more familiar with methods of making quick and accurate tests of varied textiles, this article is written, and not with an object of a complete treatise on "Textile Testing," which work in its entirety may be written in several volumes.

A person buying a piece of material, let

Fig. 19. The Burning Test Applied to Various Cloth Materials to Determine Their Composition, Particularly the Presence of Wool. Vegetable Fibers May Be Readily Distinguished from Animal Fibers By Burning, Animal Fibers Such as Silk and Wool Giving Off the Smell of Burnt Horn. They Do Not Fire Like Vegetable Fibers, But Cease to Burn When Removed from the Flame. Vegetable Fibers Give Off a Slight Odor of Burnt Wood When Ignited, and They Burn Away Very Rapidly With a Flash, leaving No Hard Cinder, But a White or Gray Ash Only.

us say for a suit, does not want to feel that he is being imposed upon by having inferior substitutes sold him when he believes it is all wool. He must, therefore, have immediately available some means of testing.

Textiles may be separated into two main divisions, as we may call them. VEGETABLE FIBERS, under which heading appear *Cotton*, *Flax*, *Hemp*, etc., and ANIMAL FIBERS, as *Wool* and *Silk*.

COTTON appears under the microscope as a wide band, generally twisted, as shown in Fig. 1. Chemically, cotton fiber, separated from all impurities, may be looked upon as pure Cellulose, similar in composition to the Cellulose in starch. Ordinary raw cotton is not pure Cellulose, containing as it does, various impurities such as wax, oil, coloring matter, water and about 1 per cent. of mineral matter.

The appearance of various kinds of WOOL under the microscope is shown in Fig. 2. Wool differs very considerably in chemical composition from Cotton and Flax. It consists of horny-matter (*Keratin*), Carbon, Hydrogen, Oxygen, Nitrogen and Sulfur. This composition is strikingly noticed when wool is burnt, accounting for the peculiar and disagreeable smell of *burning horn* which is given off. Boiling Caustic Soda or Potash solutions dissolve Wool, and if Acetic Acid in excess is added to the solution obtained Hydrogen Sulfid is given off.

SILK, under the microscope, exhibits no definite structure, but consists of cylindrical or flattened, sometimes helical, compact threads, having the appearance of a smooth cylinder without any contents. Fig. 3 depicts Silk as seen under the microscope. Chemically, Silk is composed of silk gelatine, silk fiber, with fat, coloring matter and mineral substances.

FLAX-LINEN fibers consist of chemically pure Cellulose, and are of regular thickness. The cells are built up in a regular manner, cylindrical in shape, having *nodes* arranged at regular intervals as shown in Fig. 4.

In HEMP the cells are very irregular in form, and do not possess *nodes* as in the former case. The cell walls are not of such constant thickness as Flax, and the ends of the fibers are blunt, having thick walls, frequently branching laterally.

SHODDY is old woolen or worsted materials, torn to pieces by a machine having spiked rollers, which reduces them to fibers. They are then cleaned, and the fiber spun with a certain proportion of new wool.

Broadly, shoddy fibers are of two kinds, namely—those obtained by mechanical disintegration alone from the clippings, and second, those fibers that are obtained from rags that have been carbonized. It thus becomes necessary to consider first the result of a purely mechanical operation, and in the latter case, combined chemical and mechanical operations. Naturally, we con-

Fig. 20. This Shows Apparatus Arranged for the Accurate Testing of Cotton and Wool Content of Cloth, and One That Is Used By Practically All Commercial Cloth Testers. One Glass Contains a Solution of Caustic Potash, or Caustic Soda, Into Which Is Immersed a Sample of the Wool to Be Tested: A Precipitat Indicates the Relative Amount of Cotton and Other Substances Present. Likewise When Cotton Is Immersed in an Acid, a Precipitat Will Show the Relative Amount of Adulterants. See Also Fig. 7.

sider whether the chemical operation of carbonizing has in any way altered the fibers so that they might differ microscopically from those treated only mechanically.

Pure wool, when first sheared from the sheep, shows that the fibers are terminated at one end with a slightly rounded point, while the other end shows a more or less

(*Continued on page 79*)

Microscopic Appearance of Various Fabrics Under Microscope, Continued. 10—Shoddy, Made from New, Fine, Black Worsted Clips, 11—Shoddy, Made from Carbonized Brown Serge, 12—Shoddy, Made from Brown Serge That Has Been Carbonized and Subsequently Stript, 13—Fibers Made from Blue Serge That Had Been First Carbonized, Then Stript, and Afterward Dyed Green, 14—Shoddy, from the Same Batch as That Shown In Fig. 12, Except That It Has Been Dyed a Full Red, 15—Originally a Brown Serge That Had Been Carbonized, Then Stript, Afterward Dyed a Deep Orange, and Finally Garneted, 16—Shoddy, Made from Brown Serge Which Had Been Carbonized, Stript and Dyed Olive Shade, 17—Shoddy, Made from Various Knit Goods of Different Colors, 18—Shoddy, Made from Serges That Were Carbonized, Stript and Dyed a Deep Maroon.

Experiments in Radio-Activity

By IVAN CRAWFORD

PART III.

IN the last article ionization by a-rays was discust. The radiations of radium also possess the property of affecting photographic plates. This action of radio-active substances is essentially an ionizing property and the effect produced is

Arrangement of Plate and Uranium Salt in Taking Radiographs.

proportional to the ionizing power of the substance.

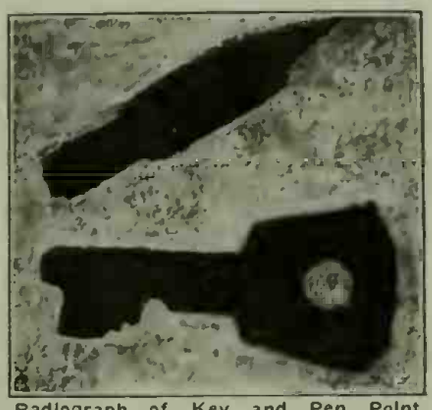
Both the a and b particles ionize the air thru which they pass; however, the a-particles do this to a larger extent. In fact the total number of ions per sec., due to the complete absorption of a-rays from one gram of radium, is 2.56×10^{10}, while the beta rays from the same amount of radium produce only 9×10^{4}. It will be seen from this that the a-rays would affect the plate to a much greater degree than the b-rays. This is only true when there is no obstruction between the substance and the plate. When a solid is interposed the effect is accomplished almost entirely by the b-rays on account of their greater penetrating power.

Geitel, and afterwards Becquerel and Mme. Curie showed that the b-rays were subject to magnetic deflection. The experiments conducted by Kaufmann and Becquerel have shown that the b-particles consist of negatively charged particles projected with an exceedingly high speed, indeed almost approaching that of light. These experiments also proved their mass was equal to that of the cathode particle in vacuum tube phenomena. Really, however, the b-particles are electrons ejected from radio-active substances at a considerably higher speed than that observed for the cathode particle.

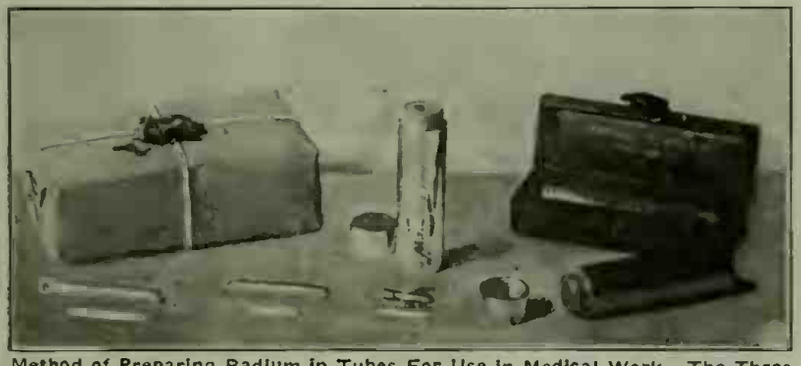
To show the effect of b-rays on photographic plates a very simple device suffices. The following experiment may be easily carried out. An ordinary photographic plate is wrapt in black paper; a few metal objects, such as coins, keys, etc., are then placed upon it and covered with a piece of radio-active ore. Any uranium or thorium salt may be used instead. The exposure should last several days. The action is much slower than X-rays and the results much less clearly defined. A plate with uranium salts on it is shown in Fig. 1. This lack of definition makes this method ill-adapted for practical radio-graphy. The salts of uranium and thorium have been found to give off the beta particles which affect the photographic plate. An interesting experiment is to take an incandescent gas mantle which contains thorium, and spread it evenly over a photographic plate. After a long exposure the plate will be seen to be affected.

Niewenglowski has shown that phosphorescent calcium sulfid after being exposed to sun-light, assumes the power of emitting beta particles. These particles are extremely penetrating, and are capable of affecting photographic plates even thru comparatively thick sheets of intervening metal. This property, however, differs from ordinary radio-activity. The sunlight seems to cause a disintegration of the calcium atom, causing an emission of beta rays.

Much better radiographs may be obtained if the ionizing agent is the active portion from a spinthariscope. This is a wonderful little instrument and should be in the hands of every experimenter of radio-activity. Considering the great variety of experiments which may be performed with it, and the comparatively small sum for which it may be procured from several leading houses, the experimenter, if at all possible, should possess himself of one. It is, while being an extremely interesting and instructive apparatus, a very simple one. In its common form it somewhat resembles the eyepiece of a microscope. The distal lens is removed, and in its place is put a metal plate upon which a thin layer of phosphorescent zinc sulfid is glued. Just above this screen and with its end about over the middle of it, a small watch hand is secured. To the extremity of this a small quantity of radium salt is fastened. In some spinthariscopes the arm which supports the active substance is removable, allowing it to be utilized in the making of radiographs. Those, however, which are fitted with stationary arms or those in which the active substance is placed directly on the screen, may be employed by removing the lens portion and using the case alone. When using a spinthariscope for making radiographs the exposure need only last about two days. This is because of the much greater activity of the substances used in the construction of these instruments. If figures such as letters be cut from heavy lead foil or some metal sheet and interposed between the spinthariscope element and the plate, their shadow will be clearly discernible. Many interesting photographs may be made in this manner. The author has found that it is impractical to attempt the construction of such an instrument as they are more cheaply bought. Of course there are many variations of the experiments just described which will not be given here as they will doubtless suggest themselves to the reader's mind.



Radiograph of Key and Pen Point Taken with Radium Ore. Exposure Three Days.



Method of Preparing Radium in Tubes For Use in Medical Work. The Three Small White Tubes Contain Radium Sulfate and Have Respectively 2,550 and 100 Milligrams of Radium Element Content. Beside them Are the Silver and Platinum Screens Used, Back of Which Is the Brass Carrying Tube, Together with a Package Ready for Shipment.

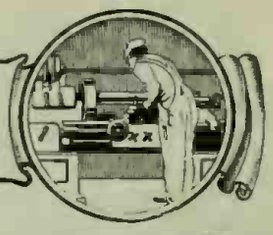
A Small Silica Capsule, Shown in Natural Size, Containing 1.764 Milligrams of Anhydrous Radium Barium Bromid, Having a Radium Element Content of 740 Milligrams. At the Present Market Price of $120 Per Milligram, This Radium Shown in the Dish Has a Cash Value of $88,800.

Before closing this article it has been thought fitting, however, to describe several experiments with this remarkable little instrument—the spinthariscope. If the experimenter will take the spinthariscope into a dark room he will be able to see wonderful flashes of light resembling shooting stars. It is best for the observer to remain for several minutes in the dark before attempting his observations, so to allow the eyes to become accustomed to the darkness. Upon further observation a pulsating nebula of light surrounded by flashing meteors will be seen. This is caused by the fluorescence due to the ions from the disintegrating atom striking the zinc and sulfid screen. The spinthariscope clearly shows the constant shower of particles given off by radio-active substances without any sensible depreciation in their weight or power.

The spinthariscope may be used in another very interesting and instructive experiment. The earlier experimenters with

(*Continued on page* 68)

THE CONSTRUCTOR



The "Noiseless" Phonograph

By THOMAS REED

I WISH you knew Gladys Doolittle. No I don't, either. I've got no grudge against you. The Doolittles live in the next wing of my hotel, and as their parlor windows face mine I know all about the family, except who they are. "Gladys Doolittle," is only *one* name I call her—among others, yes, many others!

Gladys entertains a young man quite frequently. It isn't the same young man—I wish it was. She's "looking 'em over," and the specimens come on in a remarkably even procession, one at a time, some way she has it fixt. No fights, or jostling in the ante room; never any novelty like that.

Her entertainment is a stock sketch, always the same. From 8 to 9, the visitor engages in conversation with "Pa" Doolittle about what they've both read in the newspaper, while Gladys butts in occasionally with remarks on the sock she's trying to knit. Thus "Pa" samples him, and at the same time the victim makes up his mind whether he likes this better than the hall bedroom on the whole. About 9, he tries to pet the dog—one of these micro-dogs it is—and it bites him; the cake hound has to have his sample, too, I suppose. At 9:15, "Pa" retires. He's a nervous wreck or something, and needs the sleep; if he forgets he needs it, Gladys reminds him. Then, new scene: she turns off all the bulbs except the pink reading-lamp, chases the knitting off the davenport, and trails over and opens up the phonograph. The "vamping" is about to begin.

So far the performance has been confined to the home, but from this on it invades the neighborhood, and atrocities come hard and fast. Gladys uses "haunting" melodies in her vamping business, and as the vampees are always different, one haunter is all she needs at a time. When she first came it was "Memories," but that wore out on her, and ever since then it's been "Poor Butterfly." Does it haunt? Well, look: when Gladys laps her lily finger and gives that record the initial twirl, and old "But" soars out into the community with his ragtime triplets fluttering around him, we know too well it'll be an hour before the trusty insect will be allowed to fold his painted pinions and beat it back to the envelope. Does it haunt? Woof!

I'm slowly getting crazy from it. Perhaps you've noticed signs of it in my writings. What's that, somebody says—"What d'ye mean *slowly?*" Well, all right, you know the cause of it, anyway. I have an idea I could sue Gladys or her father or somebody and get damages—if the jury should decide I was less valuable crazy than the way I was before. If anybody wants to buy my claim, I'll make an attractice price on it, for cash "or what have you?"

I suppose it isn't really Glad's fault that the instrument she's using in her "laboratory" operates on the neighbors as well. Phonographs are loud! all of 'em. The manufacturers took pains to make 'em so, out of an absolute misconception. They got the idea very early that several or more people would like to hear 'em at once. Why, even now, when they ought to know better, they publish those pictures showing the whole family sitting spellbound, mother dropping her sewing and Johnny his Meccano or volume of Browning, and all that.

The facts are just the other way. Johnny delights in the jangled jazz that nobody can follow but himself, that makes the baby cry and the others want to. If Little Sister starts the well-worn maxixe, and falls to dreaming of the slim-waisted lounge-lizard she's seen in the movies, mother fidgets and glances at her offspring with apprehension; and when Big Sister puts on the $7.00 "operatic," father picks up his paper and stealthily makes for the kitchen. And so it goes. The Home has been endangered by these instruments ever since the "Pup first heard His Master's Voice," and you know it.

It's a "Noiseless Phonograph" that's needed, and as usual I have to invent it—nobody else will waste the time. Sometimes I get almost discouraged raking around after the big inventors and clearing up the poisonous by-products they leave. Everything falls on Patsy Bolivar. However, here's your new phonograph, not only *inaudible* except to the persons who want to hear it, but one that you can make yourself with hardly any trouble. With this and the prohibition law in operation, I feel as tho the Home might straighten out and survive for several years.

This machine has become possible, in a practical sense, only lately, thru the invention of the Skinderviken transmitter-button, a complete transmitter in itself; and right here I sure won't object if Mr. Skinder makes one simoleon on his part of the rinktum, because he advertises in our "Mag." like a regular fellow, and will sell you a single button if you want it.

Fig. 1 shows the general layout. For the whirling table, take one of these round shallow tin pans they use for baking Washington-pie sections — or strata, I guess you'd call 'em. The Five and Ten 'll have 'em. Take some pains to fix it true on the spindle.

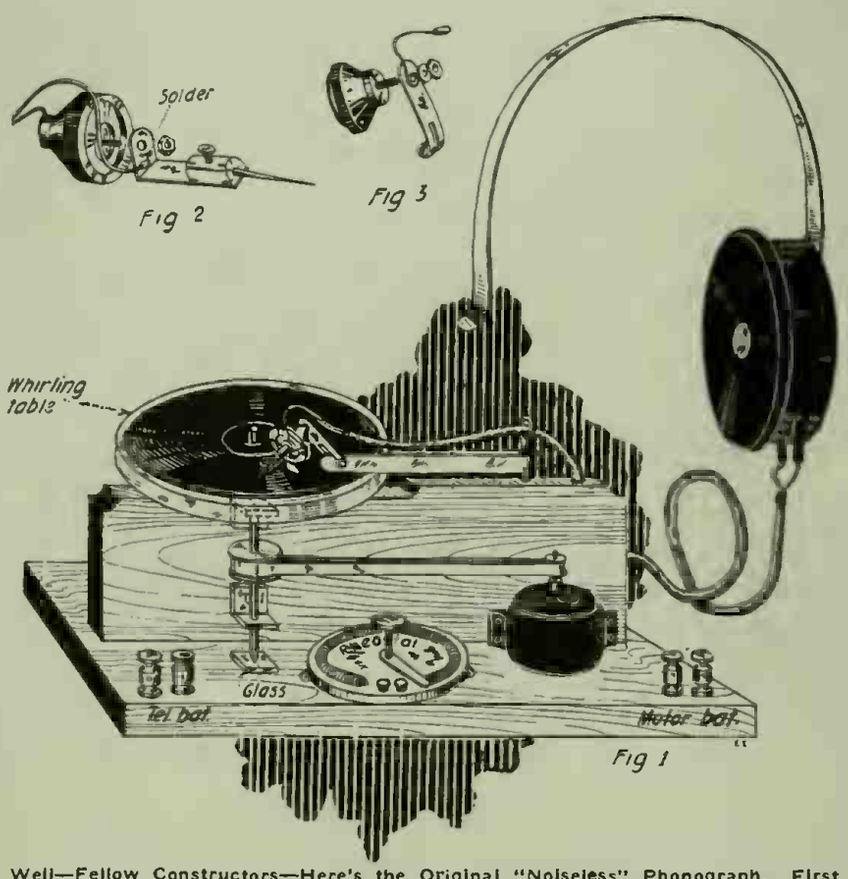
The spindle runs in holes thru two brass elbows. At the lower end, to reduce friction, point it off and have it bear on a piece of glass.

As the transmitter-button is so much lighter than the ordinary reproducer, the pressure of the needle on the record will be negligible, so you won't need a governor. Your battery motor will run it evenly enough, and the speed is regulated by your rheostat.

Fig. 2 shows the method of attaching the needle to the front stem of the button.

Fig. 3 shows the short arm for perpendicular play and method of attachment to the back stud of the button.

Of course it's understood you can connect up as many receivers as there are folks who want to listen. But say—if any fellow starts to laugh at you or me for our "silent phonograph," just remove the gentle little receivers altogether and hitch on a couple of audion amplifiers from your old wireless set, then sick "Poor Butterfly" on that critic, magnified up till he'll think the pretty creature is a night-flying airplane with a ton of bombs on its chest. Oh! Boy!



Well—Fellow Constructors—Here's the Original "Noiseless" Phonograph. First You'll Need One of Those Transmitter Buttons That's All the Rage Now-a-Days. You Stick a Needle Holder On Said Button, Rig Up a Pie Tin Turn-Table, Hook Up a Battery and 'Phone to the Button, and Let 'Er Go!

Automatic Bell-Ringing Attachment

By T. A. NEELIN

THE present diagram illustrates a simple home-made attachment for an ordinary eight-day clock, for the purpose of automatically ringing a bell or working a relay at certain fixt times. It was primarily designed for use in a small

The Clock Fitted with Automatic Electric Bell-Ringing Switch. This Arrangement Has Given Entire Satisfaction in a High School for Some time, and Provides 18 Rings Between 9 A. M. and 4 P. M.

high school where it was not thought desirable to purchase an expensive clock especially designed for that purpose. The clock in question has given entire satisfaction and rings at intervals of about 35 minutes with intermissions of three minutes between periods, making some 18 rings between 9:27 a. m. and 4 o'clock p. m. An attachment constructed according to the enclosed diagram should cause the bell to ring at the following times: 8:55, 9, 9:55, 10, 10:55, 11, 11:55 and 12 noon; 1:25, 1:30, 2:25, 2:30, 3:25, 3:30 and 4 p. m. The accompanying photograph shows the clock as it is in use at the present time.

CONSTRUCTION

A wooden disc bounded by the inner and outer circles c^1 and c^2 was cut from whitewood and finished to about 3/8 of an inch in thickness. A copper strip of the form c^3 was then cut and attached to the wood by means of a screw at s^1 and a coating of shellac to hold it in place in the other parts. A narrow slit s^2 just wide enough for insulation purposes, separates the ends of this strip. The screw s^1 serves to connect the bare end of an insulated copper wire c^4 to the copper strip c^3. This wire connects to one pole of the battery B as shown. Copper plates of the form c^{11} c^5 c^6 c^7 c^8 c^9 c^{10} were next cut and in c^6, c^8, c^9, c^{11} holes just large enough to admit a 3/8 inch screw were bored. Corresponding holes were bored in the wood disc. The copper plates were then laid down in shellac and insulated from each other by narrow spaces as shown; c^6 and c^9 were connected by a wire attached by means of the screws s^6 and s^7, and passing behind the wood disc; c^8 and c^{11} were similarly connected. The dial was then removed from the clock and the disc inserted in its place. The hands were next prepared.

To the outer extremity of the hour hand was attached a little brush made of fine strands of copper wire obtained from a piece of "lamp cord" and bound tightly about the hand. The hand was then adjusted in place so as to press the brush evenly on the surface it past over. A small brass wheel w^1, say 5/16 of an inch in diameter rotates freely and smoothly on the pin which fixes it to a piece of wood as shown. Into the other end of this piece of wood the outer end of the minute hand was inserted. The object of the wood was to insulate the minute hand from the wheel. The minute hand was then curved upward in the middle to allow the whole to freely pass over the hour hand while at the same time the curved minute hand acts as a spring to hold the wheel firmly against the copper parts beneath. The minute hand was then put in place; c^{12} is an insulated copper bell wire attached from the rear to the metal works of the clock, and continuing to the bell, or relay if a number of bells are to be worked at the same time, and thence to the battery B.

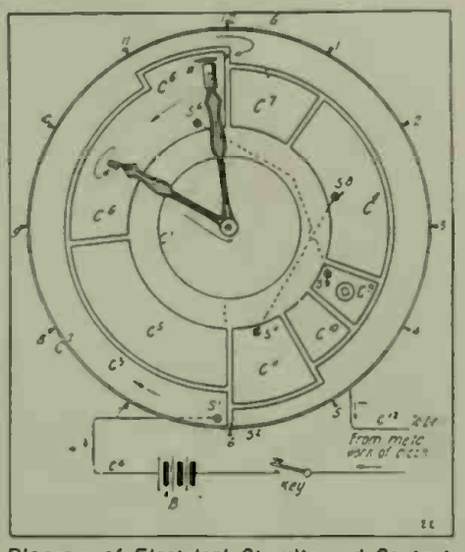
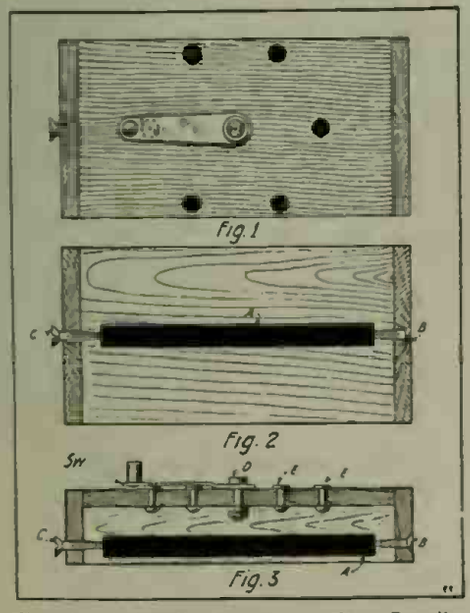


Diagram of Electrical Circuits and Contacts Fitted to Hands of Clock for Ringing One or More Bells at Different Hours.

ACTION

From the battery B the current may be thought of as travelling thru the wire c^4 to the copper plate c^3. As soon as the wheel w^1 bridges the gap at G the current can then pass to c^6, thence thru the brush and hour hand, the works of the clock, thru the wire c^{12} completing the circuit and thus ringing the bell or working the relay. In a few seconds the circuit is broken again at "G" by the minute hand moving on, and the bell stops ringing. The wires shown by the dotted lines are necessary to get the current from the hour hand to the proper plates so that the bell may ring at the times indicated.

A "Lead Pencil" Rheostat



The Lead-Pencil Rheostat. The Pencils, Without Rubber Erasers, Are Supported Between Wood Screws, as Shown. Proper Wire Connections Being Made Between the Switch-Points and Screws.

The accompanying drawing shows a lead pencil rheostat. The idea is new and very simple at the same time. The lead pencils used are in no way spoiled and can be taken out of the frame and used as if new.

Fig. 2. A, is a pencil (a drawing pencil) which has the lead exposed at both ends. B is a screw which is flush with the wood, F, and makes connections with a wire not shown. C is another screw longer than B. D, E, E are the parts of a switch.

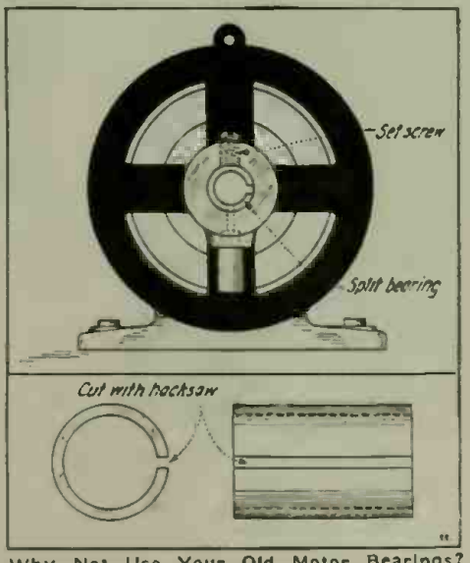
Fig. 3. It shows the switch side of rheostat. The pencil, A, is set between screws B and C. Screw C is screwed down until the both screws make good connections with the exposed lead in the ends of pencil. Connect wires with the screws, connect the wires in the right place on the switch. The number of pencils used and their length will determine the size of the rheostat. It is best to use good drawing pencils as their resistance is higher.

Contributed by JONAS GULLBERG.

USE YOUR OLD MOTOR BEARINGS.

The accompanying sketch illustrates how the bearings of small motors can be easily used when badly worn. Remove bearing from motor and cut with hacksaw as shown in sketch, drill and tap bracket for set-screw and replace bearing; tighten set-screw until motor runs without vibrating.

Contributed by HENRY L. BEIMEL.



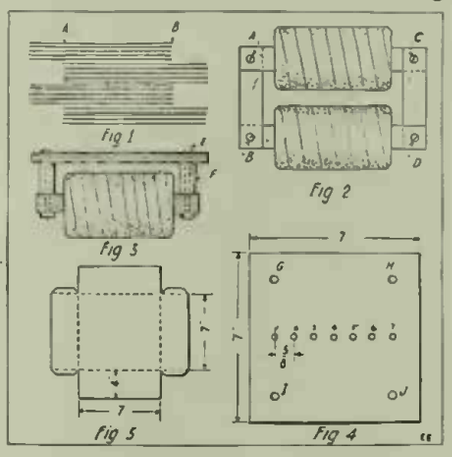
Why Not Use Your Old Motor Bearings? Cut a Slot in the Lining and Close It Up With a Set Screw.

A HEAVY DUTY 110 VOLT, 60 CYCLE STEP-DOWN TRANSFORMER.

BY RAY SEITZ

With this article I intend to fill the want of the experimenter for a good and efficient transformer.

The first step is to make the core. From a piece of black sheet iron cut enough



A 250-Watt Step-Down Transformer for Use in the Laboratory, in Cautery Work, and General Experimental Work.

strips 5" long 1½" wide to make a pile 3" high and 3¼" long and 1½" wide to make a pile 3" high. Now build four cores like those shown in Fig. 1, two from the the larger size and two from the small size strips. When you have done this clamp tightly in a vise and wrap well with three layers of good friction tape. On the long legs wind three layers No. 12 D. C. C. copper magnet wire, 30 turns to the layer, taking a tap off at each layer. The two legs will require 2¼ pounds of wire. Now wrap two layers of good friction tape over this and begin winding the primary which consists of 6 layers No. 22 S. C. C. magnet wire, 80 turns per layer, using a layer of paper between each layer of wire. This winding, the primary, will require 1½ pounds of No. 22 S. C. C. magnet wire. After you have both of the legs wound wrap again with two layers of friction tape and paint the whole heavily with shellac and bake in an oven for three hours. Now put the four legs together and drill a hole in each corner to pass a ¼" bolt A*B*C*D—Fig. 2.

After the holes are drilled, the next thing to do is to solder the taps on with short pieces of No. 12 R. C. wire and brought to their proper binding posts. No. 1 comes from the beginning of secondary winding, No. 2 from first tap, No. 3 from second tap. No. 4 from end of winding on first leg, (end of winding on first leg and beginning of winding on second leg are joined together, and tap 4 also comes from this joint). No. 5 from first tap on second leg. No. 6 from second tap on second leg, No. 7 from end of winding on second leg.

When connecting the ends of the windings together care should be taken to see that they will help each other along and not "buck" each other. By applying the hand-rule for electro-magnets you can easily figure which ends have to go together. The primary sections are connected up in series with each other, applying the hand rule as in the case of the secondary and the two remaining ends are spliced to a piece of black extension cord for connecting up to the supply. The hole, 8, in Fig. 4, is for this piece of extension cord to go thru, having first bushed it out with a piece of fiber tube from a 30 amp. cartridge fuse.

The top is made from a piece of ½" red birch, cut to the dimensions in Fig. 4. The holes marked 1-2-3-4-5-6-7 are for the binding posts and 8 for the connecting cord. The other holes are for fastening the transformer to top. When fastening transformer to top, four pieces ¼" gas pipe 1½" long, will separate the core at the right distance from the top.

Fig. 5 gives the dimensions and shows how to cut the sheet for making a box to fit the transformer. It is made from 24 gage sheet iron, having the corners riveted together.

Short-circuits and heavy overloads will not harm this transformer, if not left on for too long a time. This transformer, if built the way described, will work perfectly and is absolutely noiseless at low load and at full load produces a slight hum. It consumes about five watts at no load and draws about 250 watts at full load. The secondary has six steps of three volts each, three volts between each terminal. This transformer is designed to operate on the standard current of 110 volts 60 cycles. The writer has built several of these transformers and they work to perfection under many different conditions.

A NEW WRINKLE IN ROLLER BEARINGS.

Most machine bearings are made of the ring-oiling type, that is, the bearing is supplied with a reservoir for oil, into which dip one or more rings that run upon the shaft, and thus supply the journal continually with oil. During the operation of the machine there is a continuous flow of oil thru the bearing, which not only keeps the shaft well lubricated, but tends to wash away any particles of metal that may be worn from the rubbing surfaces.

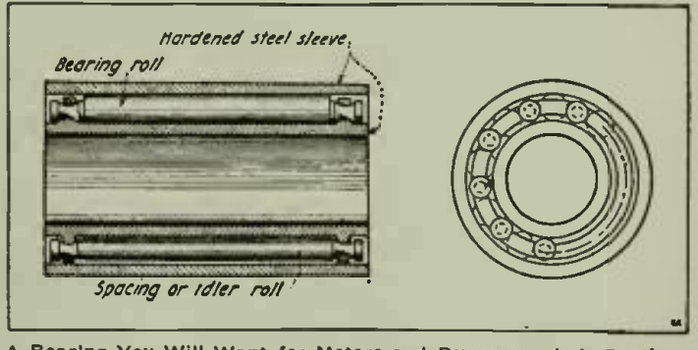
In a dynamo, it is important that the oil from the bearings should not follow the shaft and run out on the armature. The oil itself is not so injurious, altho it tends to destroy the insulating varnishes, but it causes an undesirable accumulation of dust that may greatly impair the insulation.

The accompanying diagram shows a new type of roller bearing, so designed as to run without the use of any lubricants. It is as simple as it is efficient.

This bearing consists of an outer hardened-steel casing and an inner hardened-steel sleeve. Between these are placed two sets of rollers of two different sizes, the smaller serving as the spacing or idler rollers and the larger being the essential bearing rollers. The relative position of these rollers is shown in the sectional sketch. The idler rollers are so designed to run on what may be called a *track*, and are held loosely in place by two retaining rings.

The bearing is suitable for all kinds of work. When used in connection with line shafting, the outer sleeve fits into a shell, held in place in the hanger in the usual manner.

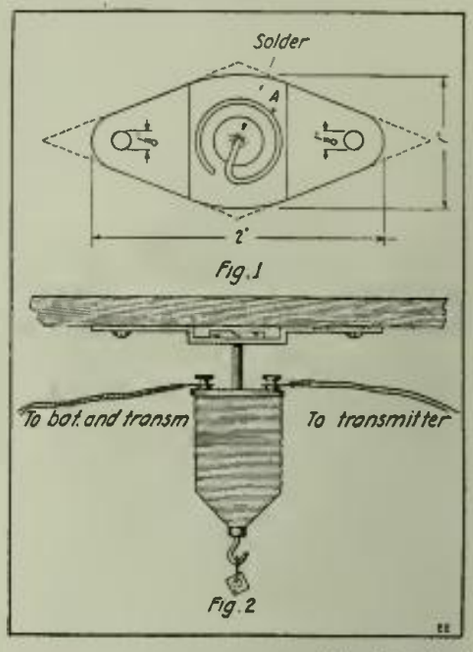
Contributed by
PETER J. M. CLUTE, B.Sc.



A Bearing You Will Want for Motors and Dynamos. It is Particularly Strong and Runs Without Oil or Other Lubricants.

THE "TALKING TABLE."

If the apparatus here described is fastened to the under-side of a dinner table it will set the table in vibration so that any



An Entertaining Wrinkle for the Electrical "Bug" to Try Out—the Talking Table. The Magnet Connects Up with a Microphone and Battery.

number of persons putting their ears flat upon the table, will hear a person talking over the 'phone, if it is connected up as shown in the accompanying sketch.

A small piece of sheet brass is cut as shown in Fig. 1. A piece of soft iron wire, such as that used for cores of induction coils and about 6 inches long, is bent at one end as indicated at (A) Fig. 1 and put thru a hole in the center of the brass plate; the other end is bent into the form of a small hook. Next cut off about 2 inches of a cheap lead pencil and soak it in water till the lead will come out easily, then glue the pieces of pencil to the wire just above the hook. Take a piece of cigar-box wood and cut a piece about 1⅜ inches in the center so it will fit over the leadless pencil on the wire, and 2 holes to receive the two binding posts, Fig. 2. Glue the disc over the pencil on the wire near the upper end. The binding posts are then placed thru the other two holes. The pencil is now wound with No. 24 B. & S. silk or cotton covered wire, the end of the wire being fastened to the two posts. A small weight, weighing about two or three ounces, is hung on the hook. The apparatus is then screwed to the under side of the table and connected up to a microphone and battery.

Contributed by
WADE ROBINSON.

CLEANING PAINT BRUSHES.

For cleaning hard paint brushes make a hot solution of lye water; stand the brush so that just the bristles are in the solution.

For making old corks new. Boil in hot water for one-half hour.

Contributed by AN EXPERIMENTER.

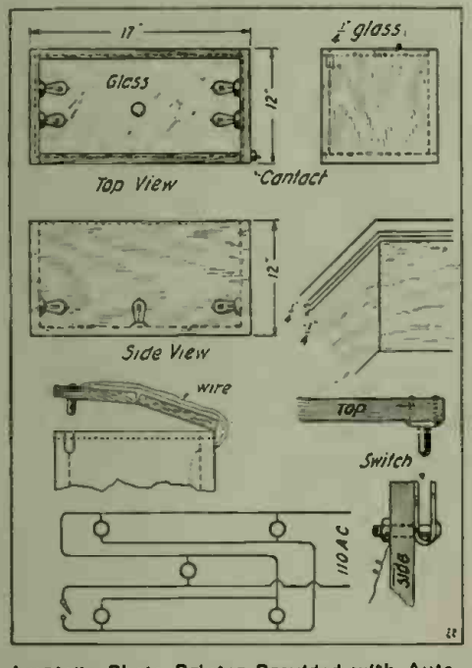
A new thermostatic metal which is remarkably sensitive to heat has been invented. The metal may be used in connection with an electric thermostat to control heating systems and to give the alarm in case of fire.

A PHOTOGRAPHIC PRINTING BOX.

The inconvenience of the printing frame is entirely done away with in this electric printing box. In regard to time the saving is enormous. The necessary material required follows: 1 piece wood 1"/12"/17" (base); 2 pieces wood 1"/12"/15" (sides); 2 pieces wood 1"/12"/12" (ends); 2 pieces wood 1"/6"/17" (top-hinged in the middle); 1 piece glass (plate) 15½"/10½"; 4 tungsten lamps; 1 ruby lamp; 5 sockets, and 1 lamp cord with plug.

The box is assembled as shown in the figure. The sockets are screwed 2" up from the bottom on the ends and are 5" apart. One socket is put in the middle for the ruby lamp. The next step is to wire the sockets according to the diagram, leaving enough wire to go over the top for the automatic switch which now will be taken up. The object of this switch is to turn on the four white lights when the lid is down. It consists of an L-shaped piece of spring brass or phosphor bronze that is screwed to the cover and fits into a V-shaped piece of metal when the cover is down tight. A piece of wire about 2' long runs over the top to the L-shaped switch. The other side can be wired up from the inside of the box.

The remaining step is to put on the glass plate. The glass should be as heavy as possible; plate glass is the best. There is often quite a heavy strain on the plate from printing and consequently a light glass is liable to crack. The top of the box is now rabbited out ¼" deep and ¼" wide from the inside all around, so that the glass will fit in flush with the top. The top is hinged in two places in the middle opening, and two more places on the end to give no play at all to the cover. It is well to cover the inside of the top with a piece of cotton flannel the size of the glass plate. This insures that the negative will be in firm contact with the printing paper.



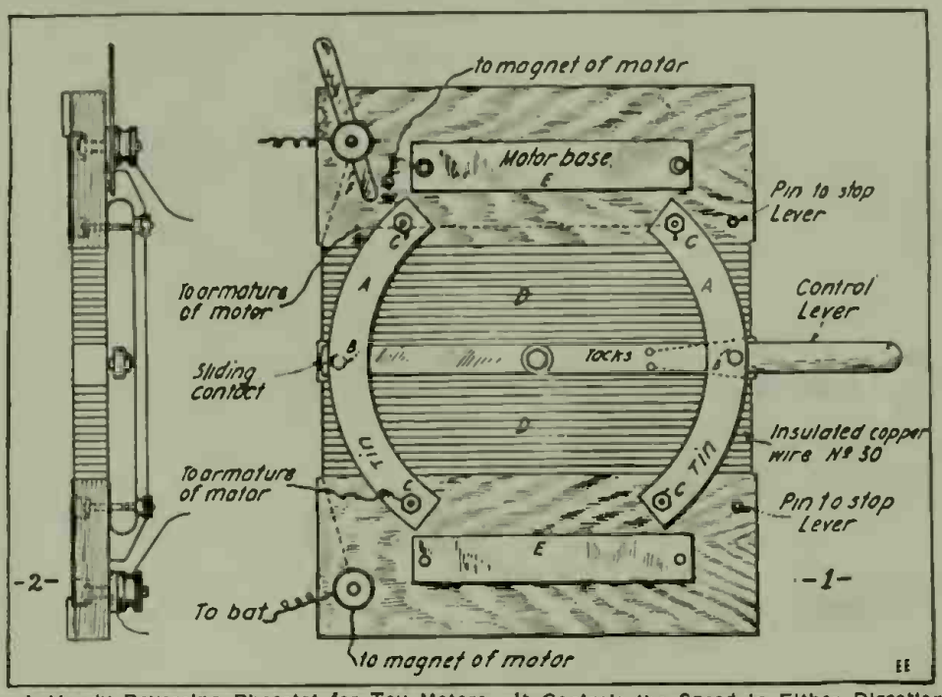
Amateur Photo Printer Provided with Automatic Switch for Opening and Closing the Light Circuit When the Lid Is Operated.

It is seen from the wiring diagram that the ruby lamp is kept burning all the time. This is to allow for printing masks to be adjusted, the negative to be arranged, etc. This printing box is capable of turning out prints at a rapid speed, doing away with the clumsy printing frame. It is very simple in construction and will repay anyone who constructs it.

Contributed by
MALCOLM MACURDA.

Reversing Rheostat for Small Motors

This rheostat is built under the motor on a wood base 6 x 8 x ½ inches. On each side of the base, 2¼ inches from the ends, cut two grooves ⅜ inch deep and 1 inch wide, leaving a space of ½ inch between. Take about thirty-five feet of No. 28 insulated copper wire, fasten one end to a binding post under the base as shown in Fig. 1, and wind it around the base closely and evenly, gluing it near the place where the sliding contact, B, is to work. The final end of the wire is tacked to the lower side of the base. Wind the other side in like manner. The lever is a thin piece of wood ½ inch wide, carrying two short binding posts, B B, which serve as sliding contact points, connecting the arc, A A, and the coil, D, off of which the insulation has been scraped in the path of the slider, B. The nearer the glue is to this path the better.



A Handy Reversing Rheostat for Toy Motors. It Controls the Speed in Either Direction and Can Be Actuated from a Distance by a String Attached to the Handle.

Contributed by OSCAR ROSE.

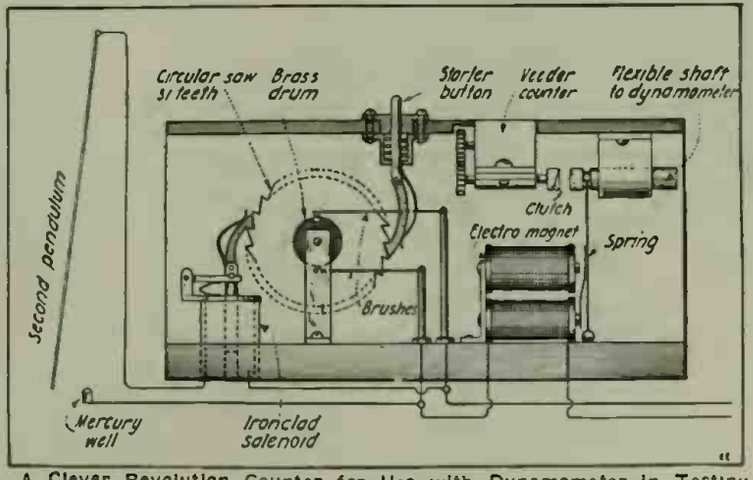
Revolution Counter for Dynamometer

Electric tachometers have not proven a success where accuracy is demanded such as in dynamometer testing work and therefore several revolution counting apparata have made their appearance on the market. These latter usually take the form of solenoid operated clutches operating in turn revolution counters. When the fuel-weighing apparatus makes contact, the clutch is engaged and a stop watch started. When the weighed quantity of fuel is used up the scale breaks contact, the counter is stopt and the stop watch stops. Thus an accurate method of determining *pounds of fuel per brake horse-power hour* is secured.

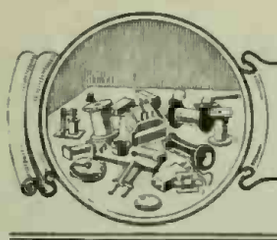
A "seconds pendulum" is a pretty handy piece of apparatus to have in any laboratory. I built such a pendulum so that at every swing the lower end of the pendulum would brush thru a mercury cup fastened on a suitable adjustable support. The requisites are one solenoid with laminated soft iron core, one old electric bell magnet, a circular saw, a few small gears and a little work.

The small brass drum attached to the saw has a piece of insulation in the path of one of the brushes whose length is sufficient to cover the circular distance of all teeth over thirty, so that there will be thirty movements of the saw or a time

(Continued on page 73)



A Clever Revolution Counter for Use with Dynamometer in Testing Work.



HOW-TO-MAKE-IT

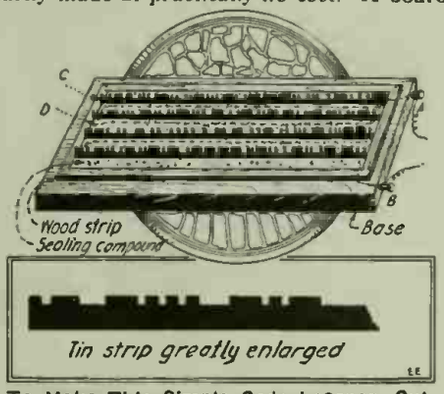
This department will award the following monthly prizes: First Prize, $3.00; Second Prize, $2.00; Third Prize, $1.00.
The purpose of this department is to stimulate experimenters towards accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department, a monthly series of prizes will be awarded. For the best idea submitted a prize of $3.00 is awarded; for the second best idea a $2.00 prize, and for the third best prize of $1.00. The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings. Use only one side of sheet. Make sketches on separate sheets.

FIRST PRIZE, $3.00

A MANUAL TYPE CODE LEARNER.

I give below drawing of a "code teacher" which I am contributing to the "How to Make It" Department.

This code teaching instrument can be easily made at practically no cost. A board



To Make This Simple Code Learner, Cut Out the Dot and Dash Characters On Strips of Tin and Embed Them In Sealing Compound. The Buzzer Circuit Is Made and Broken Over These Projections.

(any size to suit the maker) has slits cut into it lengthwise with a knife or saw, as indicated. Tin or brass strips are procured, with a length equal to that of the board. The dots and dashes are cut out along the edges of the strips, as in the drawing. They are put in the slots, then connect all together with a wire. Then take some wood about ¼-inch square and put it around the edge on the top. Melt some sealing compound and pour it in the box just made by putting the wood strip around the board, to within ⅛-inch from the top of the tin. Then cut out a piece of tin to make the "pen;" connect it up to a buzzer or telegraph sounder and slide the "pen" across the tops of the tin strips, which makes the dots and dashes at any speed desired.

Contributed by LOUIS C. KING.

IMPROVED MORTAR AND PESTLE.

When a mortar and pestle are used for grinding chemicals dust often gets into the eyes, or small particles are driven out of the mortar and are lost, particularly in the case of hard crystals requiring a consider-

Make This Simple Cover for Your Mortar and Pestle and Keep Out the Dirt.

able force to break them. A simple but very efficient safeguard consists in making a cover for the mortar from a circle of cardboard, with a central hole just large enough to admit the pestle as sketch shows.

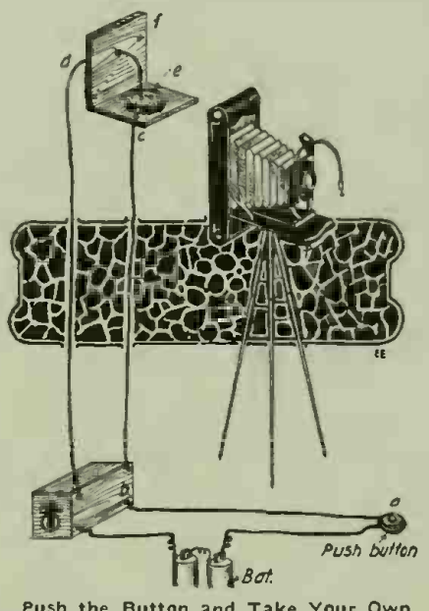
Contributed by H. J. GRAY.

SECOND PRIZE, $2.00

TAKING YOUR OWN "MUG" IN GROUP FLASHLIGHTS.

When taking group photos by flashlight it is often desired that everyone be in the picture, but as someone must hold the flash-pan and set it off at the proper moment, this is often impossible. I have a plan, which is explained below, which allows everyone to be in the photo.

In the diagram *a* is push-button held by photographer; *b* is spark coil, the wires from *a* being connected to the primary side of the coil, with set of dry cells in circuit; *c* is one wire, from secondary side of coil, which is taken thru hole in bottom of holder and soldered to *e*; *d* is other wire from secondary side of coil which is taken thru hole in back of holder *f* and turned down until there is a gap of about one-fourth inch between it and *e*; the covering should be removed from *d* for about one inch from end; *e* is baking powder can cover which should be securely fastened to holder *f* as shown; *f* is holder made of two pieces of



Push the Button and Take Your Own "Mug" with This Unique Electric Flashlight Scheme.

wood about six inches wide fastened together at right angles and covered on the inside with sheet asbestos, which acts as reflector and protects wood. Holder can be placed on either side of camera, but must be *back of camera.*

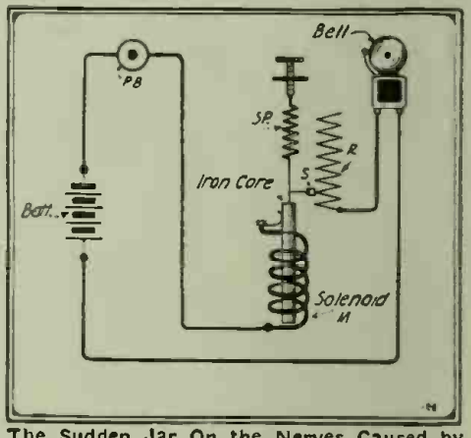
How It Works.—The operator puts the proper amount of flash powder in the baking powder can cover, in and around the point of wire *d*. He then arranges his group, using the camera finder for this purpose, leaving, however, a place for himself. The light in the room should be turned low, leaving only enough to see by. The camera shutter is now opened, the photographer takes his place in the group, and at the proper moment pushes the button. The spark between wire *d* and baking powder can cover sets off the powder, after which the photographer closes the shutter, and the picture has been taken.

Contributed by GLEN M. ROYSTON.

THIRD PRIZE, $1.00

A PROPOSED "BELL SOFTENER."

When some one comes to the door and rings the bell, its sudden sound scares



The Sudden Jar On the Nerves Caused by Ringing the Ordinary Bell Can be Obviated by Inserting a Solenoid-Controlled Rheostat In Series with the Bell and Battery.

everyone. With this device it starts softly and gets louder gradually. The apparatus used is the same as generally employed for this purpose with the exception of the softener, which is a large cylinder wound with resistance (R), which is entirely in circuit at the start, but is varied by the slider S. When the key PB is released, the slider is pulled back to the original position (having been pulled down by the magnet M) by the spring SP.

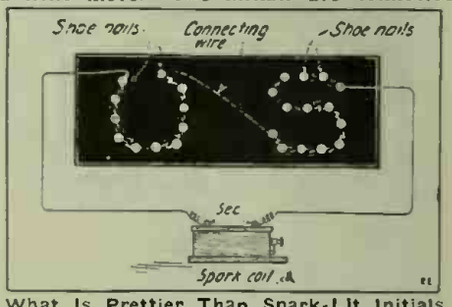
CAUTION: Do not have the slider too far from the magnet; make the cylinder short but large in diameter. Do not use too much resistance; allow enough current to pass so that the magnet will work.

Contributed by
ERNEST INNES and ETHBERT REED.

SPARK-LIT INITIALS

I here give a description of spark-lit initials formed from old shoe nails, driven into a block of wood so as to form letters.

A piece of wood ¾" x 1½" x 3" is used for the base, initials one inch high are drawn on the base and the shoe nails are driven into the initials about 1/32" apart, or a little more. The initials are connected



What Is Prettier Than Spark-Lit Initials Such as These, Which Can be Lit Up by Even a Small Spark Coil.

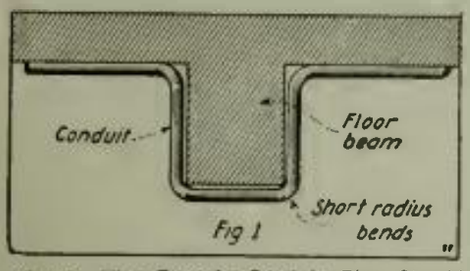
together as shown and wires are connected from the secondary terminals of a spark coil to the letters. When the coil is excited, sparks jump from nail to nail, lighting up the initials in a very pretty way in the dark.

Contributed by
DE FOREST G. STICKNEY.

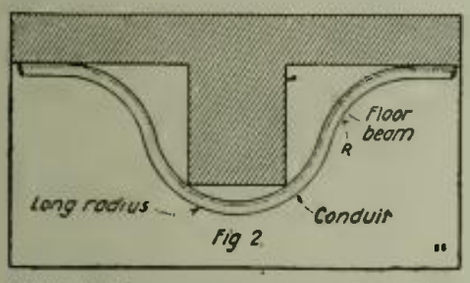
METHOD OF FORMING A SHORT-RADIUS BEND IN CONDUIT.

By George W. Shirley

To make a short radius bend in conduit for a location such as that indicated in Fig. 1, the method to be described can be used. Where turns of the usual radius are



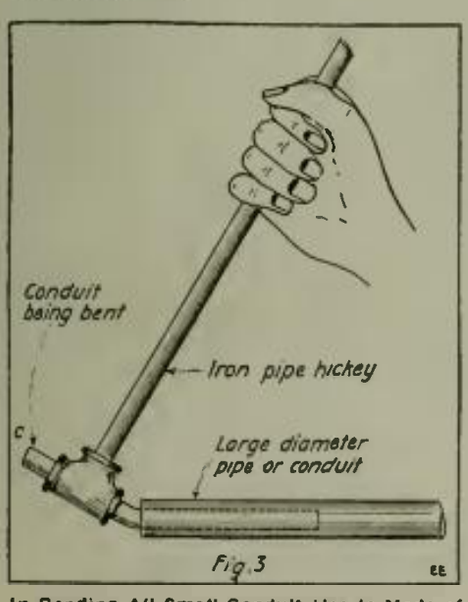
Above: The Electric Conduit Pipe Should Always Be Neatly Bent and Fitted In Place Like This. The Bends Must Be Even Curves, Not Kinked Bends.



Above Is Illustrated How Not to Bend Electric Conduit. Such Pipe Bends Soon Loosen, and Besides Present a Very Unworkmanlike Appearance. How to Bend Conduit Right Is Explained Herein.

made, the conduits do not lie close to the surfaces and present the undesirable appearance delineated in Fig. 2. But with this method, bends of the approximate form diagrammed in Fig. 1 can be so made that the inner face of the conduit will lie not more than 1¼ inches from the faces of the beam. A sleeve, *P*, of a larger diameter than the conduit, *C*, being bent, is slipt over the end of the conduit (Fig. 3) and then the short-radius turn can be formed with a hickey, *H*.

The electrician uses what is known as a *hickey* for bending all small pipe curves. The hickey is nothing more or less than a substantial pipe *tee* fitted with a handle of pipe as shown in Fig. 3. The handle is threaded, of course, so as to screw into the fitting firmly.



In Bending All Small Conduit Use Is Made of What Electricians Call a "Hickey." This Is Made of a Short Length of Pipe Threaded Into a Heavy "Tee."

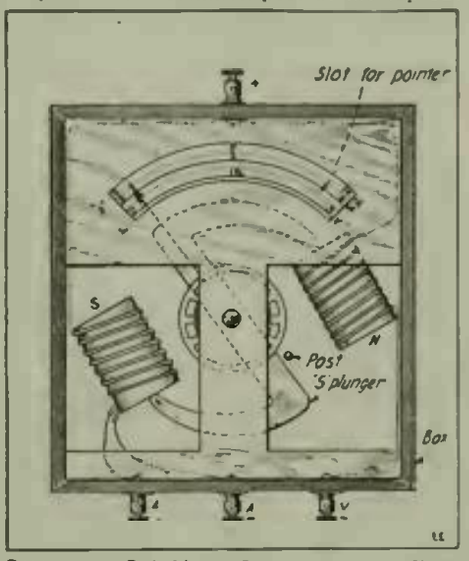
A Low-Reading Volt-Ammeter

Remove the balance wheel, bearings, and hair-spring from an old alarm clock. Using composition wall-board or thin wood, make a box 3x3½ inches and ⅞ in. deep. For ease in adjusting, the front should be cut away as shown, and the front should be easily removable. In the center, both back and front, bore a small hole to receive the bearing screws, which are cup-shaped in the ends. The balance wheel should spin freely when in place.

On a thin sheet of soft iron, taken perhaps from an empty tomato can, draw a circle with a radius of one and one-sixteenth inches. Inside this circle cut an armature like the letter S, as shown in the drawing. Punch a small hole in the center of this "tin" letter S, and slip on the balance-wheel shaft and fasten to it. Push the hair-spring on the shaft above the wheel. The free end of the hair-spring is secured to a small post. The spring must of course be adjusted to the proper tension. A thin pointer made of No. 32 wire is made fast to the balance wheel, letting the end project up thru the slot cut at the top of the instrument. A bit of colored paper should be glued to the end of the pointer.

Around a stick of wood half inch thick and ⅝ wide, wrap a couple of thicknesses of cardboard, gluing carefully. On this form wind one layer of No. 20 four feet. Fasten this with shellac. Over this coil wind 5 turns of heavier wire, say No. 14. For the voltmeter coil 40 feet of No. 32 may be used. This makes 200 turns and has a resistance of nearly 7 ohms. A dry cell giving 1.5 volts will send over 1/5 ampere thru this coil. 200 x .2 amp. gives 40 amp. turns, or 40 feet x .2 amp. equals 8 amp. feet. .2 amp. at 1.5 v gives .3 watt. When the ammeter coil having 20 turns or 4 feet is carrying 2 amperes it too will have 40 amp. turns or 8 amp. feet, and will exert the same magnetic pull as the voltmeter coil at 1.5 volts.

If we wish to measure a little higher voltage we may use 140 feet of No. 36 copper wire, having a resistance of 50 ohms. Now at 4.5 volts the energy absorbed will be nearly .3 watt. One watt should pull the armature or plunger the full distance into the coil. A square of paper covers the opening in the front and a glass fitted into slots excludes the dust. Each coil may be joined to a common post at the top but



Procure an Old Alarm Clock. You Are Then Ready to Start Building This "Triple Scale" Volt-Ammeter, a Most Useful and Desirable Measuring Instrument for the Experimental Laboratory.

to a separate post at the bottom. Instrument will work in either horizontal or vertical position. Calibration should be done last. If no standard instruments are at hand, each dry cell in series adds 1.5 volts. For the ammeter scales, two cells in series will send 6 amperes thru 48 feet No. 20; one cell will give 3 amperes thru the same wire, and 1 ampere thru 9 feet of No. 32. My "battery tester" has been used often during the past year. Tester may be used for a moment on much stronger currents than examples given.

Contributed by H. H. DAVIS.

Converting Small Motor Into a Dynamo

If your motor is not already mounted on a base, it would be well to do so for this experiment. On this base mount two binding posts BB.

Then disconnect the wires which come from the field coil and connect them to two dry cells, as shown in the sketch. Connect two short wires from the brushes to the binding posts BB, the wires being indicated by AA. A switch may be put between the field coil and batteries if desired.

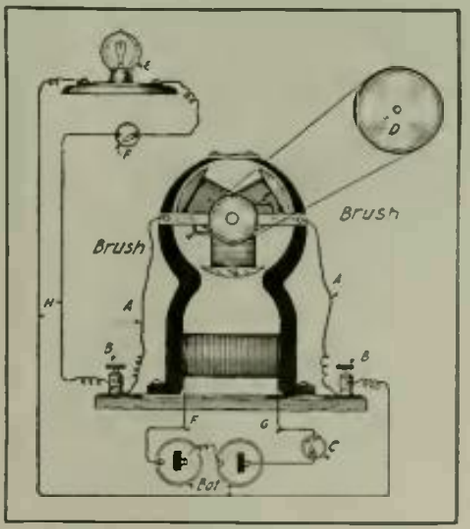
Now belt the motor to any large wheel, D, such as a fly-wheel of a sewing machine. A water motor serves the purpose very well.

When the armature is revolved at a high rate of speed, current will be generated, which will pass thru the wires HH, connected to a small electric bulb, storage battery or to another toy motor.

In my case the motor was very small, only three inches high, designed to run on two batteries, and when converted into a dynamo it gave sufficient current to burn out a two and seven-tenths (2.7) volt bulb, which I had taken from a flash-light.

It must be borne in mind, however, that the voltage of a dynamo is controlled by the size and number of wires with which it is wound and the speed at which the armature is rotated, as well as the strength of the field magnet.

Contributed by E. L. DURGEN.

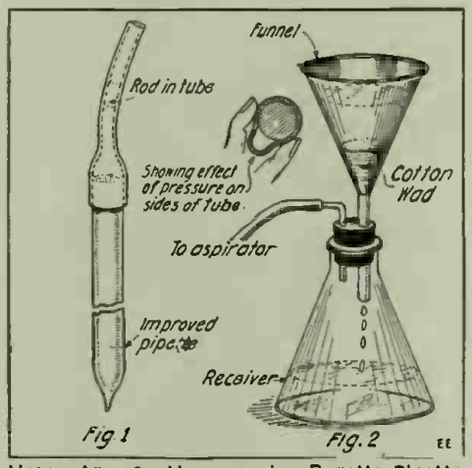


To Demonstrate the Principle of the Dynamo the Experimenter Will Find It Extremely Interesting to Drive a Small Toy Motor with a Steam Engine, a Water Motor, or Another Motor, and Exciting the Field by a Few Dry Cells. A Small Lamp Can be Lighted.

PRACTICAL CHEMICAL LABORATORY DEVICES.

By Thomas W. Benjamin.

THERE are many instruments and operations in chemistry that can be so improved as to make them handier or to shorten the time required for a given

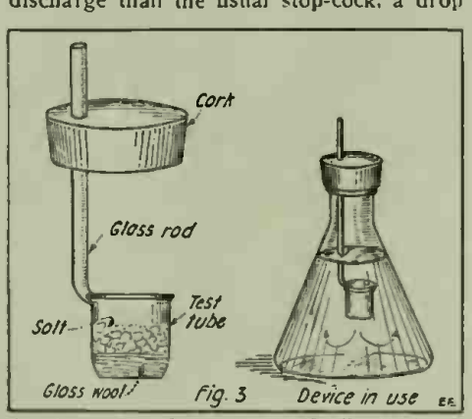


Here Are a Home-made Burette-Pipette and a Vacuum-Filter of Simple and Ingenious Construction Welcome in Every Laboratory.

process. Many of these are in everyday use in large laboratories but the experimenter hears but little of them.

A form of burette, or more properly a pipette, having several advantages is shown in Fig 1. Instead of the usual form with the stop-cock at the bottom, a plain graduated tube is fitted at the top with a 6-inch length of rubber tubing. The valve in this case is made by sliding a short length of glass rod into the rubber tube, locating the same midway of its length. The tube is normally kept closed by this rod but a slight pressure on one side of the rubber will cause the tube to buckle out and form a channel thru which liquids or air can flow.

The device can be filled either by sucking the fluid up into the tube with the mouth or by immersing it into the fluid with the valve open and removing after the valve is closed. This valve will give a finer regulation of the discharge than the usual stop-cock, a drop



An Automatic Saturator Is Easily Made as Shown in Above Diagram and May Come In Handy.

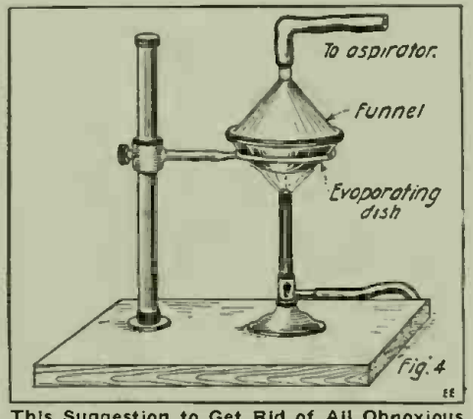
at a time or a steady stream being readily attainable.

VACUUM FILTER: When filtering thick fluids the process may be speeded up by the use of a vacuum filtering device. To create the vacuum, use can be made of the glass aspirators which are procurable at a very reasonable price. To use this for filtering, the receiver is fitted with a cork having two holes. One, large enough to take the spout of the funnel, the other having a short glass tube inserted. See Fig. 2.

A wad of absorbent cotton is placed in the bottom of the funnel and reaching a short distance up the sides. This is to support the filter paper and prevent it breaking under air pressure. The bent glass tube is connected to the aspirator and when the water flow is started a slight vacuum will exist in the receiver. Any liquid poured into the funnel will be filtered at a rapid rate due to the air pressure forcing it thru.

SATURATED SOLUTION APPARATUS: Saturated solutions of salts can be more quickly made by supporting the salt near the surface of the liquid. The idea being that as the salt dissolves the fluid gets heavier and sinks to the bottom, being replaced by other fluid. This circulation is automatic and continues till the saturation point is reached.

A little device, easily made of glass, that can be used with all chemicals is shown in Fig. 3. The body is made by cutting a two inch length from a large test tube and bending in the edges at the cut by heating till soft in a Bunsen flame. A wad of glass



This Suggestion to Get Rid of All Obnoxious Fumes in the Small Laboratory Is Certainly Meritorious and Shows What a Little Ingenuity Will Attain.

wool is placed in the tube, being held in place by the turned-in edge. The glass rod used to support the device is fastened in place by heating the rod and tube where they are to be joined until soft and then pressing them together. A cork fitted over the rod will support the device inside a bottle.

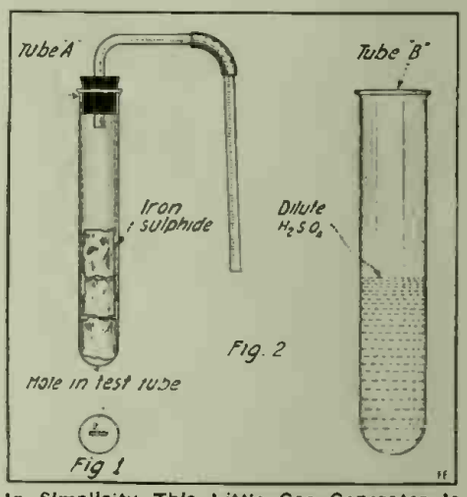
In use the tube is filled with the salt to be dissolved and placed in the bottle containing the solvent at such a height that the top of the tube is just below the surface. Additional salts may be added from time to time as found necessary.

The aspirator mentioned in connection with filtering can be used with advantage when drying or evaporating. In this case the evaporating dish is covered by a funnel the spout of which is connected to the suction tube of the aspirator; see Fig. 4. The vacuum created will draw off all fumes and vapors at a rapid rate. Should the vapor be required for further experiment a condenser can be connected in the line between the funnel and the aspirator to condense the vapor.

A SIMPLE GAS GENERATOR.

Frequently small quantities of gas are desired in the chemical laboratory, and no convenient and simple method of generation can be found. The apparatus described is very simple, yet it serves the purpose admirably.

First, procure two test tubes, one having

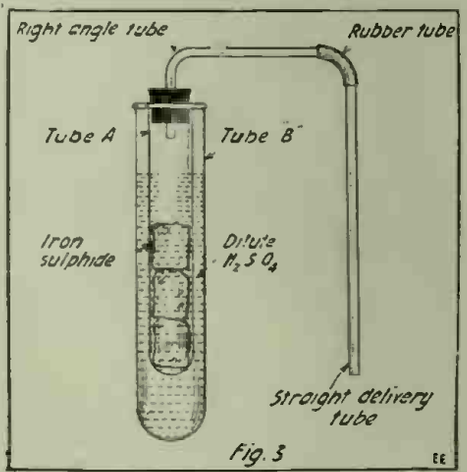


In Simplicity This Little Gas Generator Is Undoubtedly Unrivalled. Two Test-Tubes, a Cork, Some Rubber and Glass Tubing—That's All!

dimensions approximately 5/8" x 7" long, the other approximately 7/8" x 10" long. In the bottom of the smaller test tube file a small hole with a triangular file (Fig. 1), into this test tube fit a one-hole rubber stopper. Fit stopper, with a right angle, connecting tube, and straight delivery tube, as in Fig. 2, and insert in smaller test tube. The smaller tube A, is inserted in the tube B, the flare of tube A prevents it from slipping thru to the bottom of tube B.

In operating: If H_2S is to be generated, a stick of FeS, iron sulfid is placed in tube A, and the cork inserted. Dilute sulfuric acid is put into tube B, filling it about two-thirds full. When tube A is inserted into tube B, a large volume of gas is produced.

If hydrogen is wanted, small clippings of iron or iron filings are put into tube A.



The Gas Generator Ready Assembled for Business. Get the Gas-Mask, Archimedes!

and lowered into the dilute acid in B. Removing tube A stops the generation of gas.

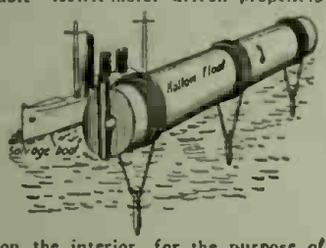
(Continued on page 87)

LATEST PATENTS

Electric Device for Raising Sunken Ships.

(1,288,108, issued to Vladimir V. Messer.)

In this novel scheme for raising sunken ships, a number of large floating members or tanks are utilized, which are provided with suitable electric-motor driven propellers

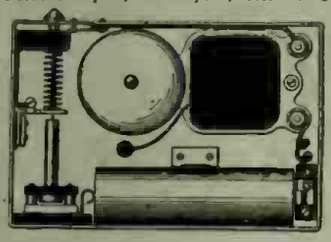


on the interior, for the purpose of causing the float to rotate in the water either in one direction or the other, about its axis. By means of flexible insulated conductors leading from the salvage boat to the float, the motors may be properly controlled, and current supplied to them for their operation. The dependent cables at the bottom of the float are made fast to the sunken vessel, by divers or by other means. These cables can be let out or reeled up by causing the float to rotate, and the cables wound up or reeled off from differentially grooved drums rigidly mounted on the exterior of the float.

Safety-Chest for Valuables.

(No. 1,291,051, issued to James L. McQuarrie.)

By means of an ingenious safety chest, a continuous alarm is sounded in the event of any unauthorized disturbance of the chest. The alarm mechanism is entirely enclosed in a small separate compartment, which may be readily removed, when the chest is open, for repair, etc. The

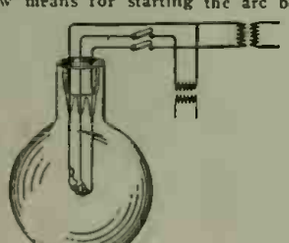


alarm is actuated by a gravity operated pendulum member, which is freely movable in response to any disturbance of the chest, once it has been set and the chest locked. Also magnetic means are provided for holding the gravity operated pendulum when it is thus moved by agitation of the chest, so as to keep the alarm bell circuit closed continuously.

Incandescent Arc-Lamp.

(No. 1,290,930, issued to Philip K. Devers, Jr.)

In this interesting form of incandescent arc lamp, the arc is operated between two electrodes of tungsten or other suitable material, in a gaseous medium of considerable pressure. The inventor provides a new means for starting the arc be-

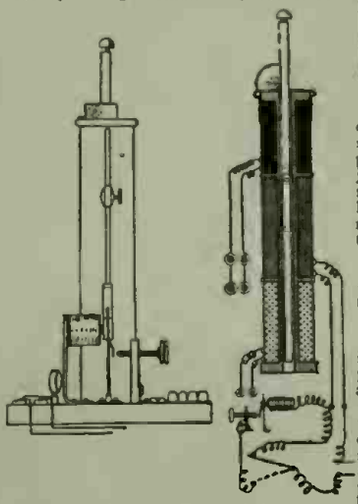


tween the electrodes at low potential, while the electrodes are below a temperature at which the electron emission occurs. Surrounding the gap between the electrodes, there is provided a spiral heating coil, and the arc-supporting current is impressed across the electrodes at the same time that the heating coil is switched into circuit.

Medical Coil Apparatus.

(No. 1,290,628, issued to Louis Mayor.)

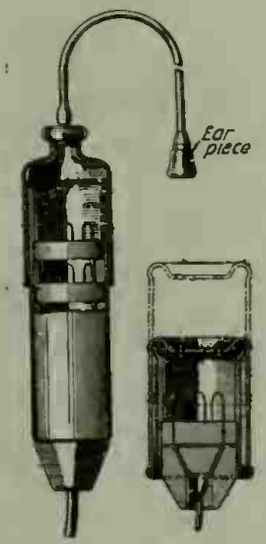
Can be operated from commercial A. C. lighting circuits. There are three windings on the apparatus, one primary and two secondaries. One secondary is connected with sponge or other electrodes for applying the current, while the lower secondary coil provides a low voltage current for operating a small lamp for endo-



scopic work, etc. The soft iron core passing thru the coils is adjustable as to position, by means of a control knob fitted with rack and pinion attachment.

Adjustable Thermic Telephone.

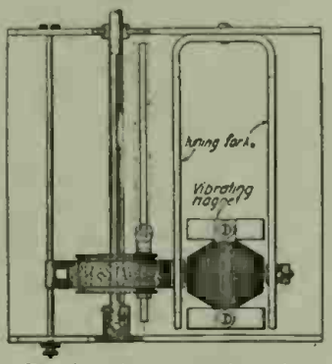
(No. 1,290,114 issued to Picter de Lange and Robert Aeronut Baron van Lynden.)



An improved form of thermic telephone adapted for certain purposes, or wherever it becomes an object to accurately regulate the intensity of the sound reproduction by varying the volume of the sound chamber. In this particular arrangement the sounding chamber is arranged in two parts, so that one may be slid over the other, thus either lengthening or shortening the chamber.

Constant Amplitude Vibration Motor.

(No. 1,290,264, issued to Leslie R. McDonald.)



This ingenious motor is made up of a rotary member mounted on a square shaft, which is actuated or propelled about its axis by an adjustable belt member, which is alternately and regularly pulled taut and loosened, by virtue of its attachment to an electrical tuning fork in the manner here illustrated.

A Vacuum Tube Peak Voltmeter.

(No. 1,287,161, issued to Richard H. Wilson.)

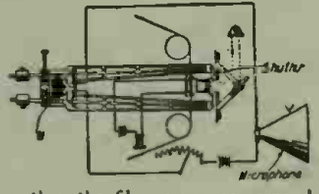
An improved method for measuring the peak voltage between two points of an electrical net-work, and a further object of which is to measure a direct or alternating voltage without the necessity of constant calibration of the measuring instrument. These results are accomplisht by connecting the input circuit of the thermionic valve between the net-work terminals, across which the voltage is to be measured, and allowing the resulting uni-directional pulsating cur-

rent in the output circuit to pass thru a resistance or impedance.

Sound Recorder and Reproducer.

(No. 1,290,711, issued to Manuel Calderon.)

In "recording" the sounds on a photographic film by creating variations and graduations in light to dark, the sound waves are picked up by a microphone, or a battery of microphones. These microphones, thru a battery and rheostat, are caused to actuate an electromagnet, M. This magnet operates on two armatures attached to the pivoted levers shown, to the longer ends of which there are attached light beam shutters, which may enter the beam of light in the manner apparent. The variations as aforementioned in the light and dark graduations are photographed on the film, and correspond to the voice waves. In "reproducing" the voice, the film is past before the beam of light, and the variations in light value pass-

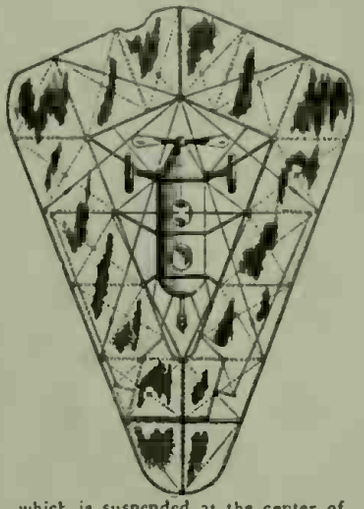


ing thru the film, cause corresponding variations in a battery and telephone receiver circuit, by virtue of their action on a selenium cell placed behind the film.

A Non-Capsizing Airplane.

(No. 1,284,373, issued to Platon Lazarides.)

The design of this airplane may be of the biplane type. The inventor provides a triangular form of wing, both of which are similar in shape and area, the center of the wings being open, so that the aviator can see upward as well as sideways and downward. One of the principal objects of the inventor is to provide a flying machine such that if the engine should stop in mid-air, it would then become possible for the airplane to settle to the surface of the earth in much the same way as a parachute does. This is accomplisht by carefully balancing the entire plane, and the ear or body

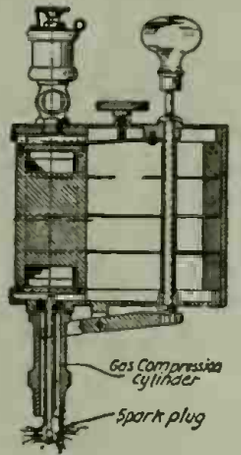


which is suspended at the center of the wings.

Spark Plug and Generator Combined.

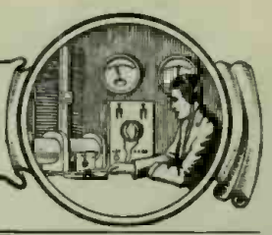
(No. 1,290,190 issued to Albert B. Herrick.)

This interesting patent covers a very ingenious gasoline engine spark plug and generator combined, which is operated by the compression of the engine. In other words, this device includes an electro-magnetic generator similar in principle to a magneto which is adapted to be automatically operated by the com-



pression of the gases in the cylinder of an internal combustion engine. In the form shown, the generator constitutes but one coil wound on a soft iron core. This is surrounded by a series of strong steel magnets. At the base of the generator there is a threaded terminal which fits into the spark plug orifice of the gasoline engine, so that the compression can operate therein to push against the piston member.

WITH the AMATEURS



Our Amateur Laboratory Contest is open to all readers, whether subscribers or not. The photos are judged for best arrangement and efficiency of the apparatus. To increase the interest of this department we make it a rule not to publish photos of apparatus unaccompanied by that of the owner. Dark photos preferred to light-toned ones. We pay $3.00 each month for the best photos. Address the Editor, "With the Amateurs" Dept.

"Amateur Electrical Laboratory" Contest

THIS MONTH'S $3.00 PRIZE WINNER—N. NUSHAWG

HEREWITH are three views of my "Chemical Laboratory." I think it will be needless for me to give a description of the contents of my laboratory as I had the view so photographed as to cover that part. A brief outline or history of my laboratory I think would not be out of place. The "Lab." as you see it in the accompanying views is an accumulation of five years of experimental work. My first laboratory consisted of an old wash-stand, of which a part can be seen directly behind "yours truly" in the view in which I am standing. Year by year I added to the aforesaid wash-stand, as my finances would permit, until today I have what I consider a model "Amateur Chemical Laboratory."

My laboratory is not only a place which affords me much amusement but is also my "Study Hall" and my "College of Chemistry" combined in one. I maintain a schedule of study which embraces two hours each evening, including the study of chemistry, electricity, biology and other studies interesting to those contemplating a life of science.

Two articles which I would like to call to your attention, noticeable in the general view of my laboratory, are first: the electric furnace constructed from the description found in the April, 1918, issue of the ELECTRICAL EXPERIMENTER. This furnace will be found on the ledge below my apparatus shelf in the right hand side of the picture. The other article is the hydrogen sulfid generator, which will be observed beside my specimen cage just beneath the window (to the left). I am sending a separate description of this apparatus to the Editor, hoping he will see fit to publish the same in "your magazine"; so keep an eye peeled for it.

This laboratory is located in the cellar of my home and is twenty-two feet in length and fourteen feet in width. It is constructed of plaster board and has a four inch air cushion around it on three sides, so as to protect it against any dampness from the cellar. It is heated by a furnace pipe that you will notice running thru the laboratory. It is fitted with electric lights for general illumination and a gas lamp for use in the printing of photos. I have gas and running water at hand. A hood is also among the apparatus; this serves in eliminating all obnoxious odors.

I have been taking the ELECTRICAL EXPERIMENTER since the August issue of 1915, and have each copy since that time. I find it to be the best magazine in its field and have highly recommended it to my friends, gaining the "E. E." quite a few friends by so doing. I have found the "Experimental Chemistry" course by Albert W. Wilsdon very interesting, having followed and studied each lesson since the first.—N. Nushawg, 534 Arbor Ave., Dayton, Ohio.

Science in Slang

3. The Specks in Space

By EMERSON EASTERLING

T was one of those clear bright summer nights when the moon and stars stood out against the black background of the sky, casting a silvery light upon the faint landscape. We were motoring along a highway, and as the sky loomed out as the cynosure of the time, our conversation drifted to astronomy, being of the scientific trend, and our company being more or less scientifically inclined. Pointing to the moon, Stokes made the remark, "Old girl, since Adam quit rubbing his eyes and became aware that he was a sentient being your reflections have permeated space and we have become familiar with your lunar highness. Lovers have sworn their LOVE by you, and coyotes have howled under your rays. But not until the spectroscope shows up and dissects the moon beam, laying its vibratory secrets bare before us, we were not so sure after all but that you were green cheese, as the story book affirmed.

"The old time Chinks were the first guys to finger around and get on to the ways of the welkin—in fact they looked right thru the welkin and got wise to such things as eclipses and other primary stuff of the great all-around. It was reported that two old timers named Hi and Ho who profest to be 'there' on the astronomical dope failed to inform their boss, the Emperor of Cathay, of the eclipse that came around unannounced, and it is further stated that according to the regulations of the country, the men were forced to suffer the amputation of their heads.

"Next in order came the Chaldeans, who claimed to be wised up on the aerial phenomena, and who were able to predict eclipses and so forth. They blew their horn and left some records that are real amusing and historically instructing, but they started the ball so that we hear from such guys as Thales, Anaximander, Pythagoras, Anaxagoras and Eudoxus, Hipparchus, Meton and a few choice more astronomers and not from other lines—of course we have heard from some of the birds in other lines, but as a whole they were star gazers and dreamers.

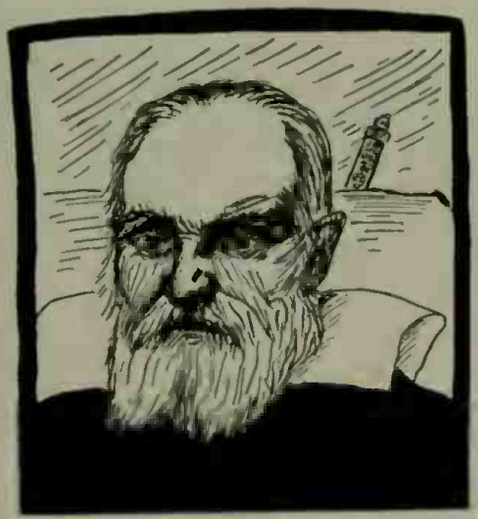
"Then we read of the endeavors of the Egyptians, from the school at Alexandria, and of Ptolemy and his ideas. You know he was the duck that was guilty for the Epicyclic System, which has it down in such a manner that the believer is led to accept the statement concerning the revolution of the planets around a center that is itself doing the merry-go-round stunt. From his standpoint he was right—the only trouble with him was that he overlooked, while gazing so far into the heavens, that our little elongated spheroid was one of the ethereal company in motion with the rest. But the old boy unhitched the old plugs with which Apollo had pulled the old glare around and run the brow wrinkles in other directions when he let loose with his treatise 'Almagest'. All this was way back in B. C. about 200.

"On astronomy, and more so on astrology, the Gypsies were 'there', but to the Greeks we owe the coining of the word 'ASTRONOMY', from the word *νόμος*, or nomos, which means LAW; and *αυγρου*, or astron, which means star or + we get the same which means Star-Law. From the Greeks spring Thales, the man who stands out in the first discoveries of the electrical phenomena, and who was so good at the heavenly twinklers that he was termed the Father of Astronomy. It was him and not Chrissy Columbus that told the World in general that the globe that we now know as the 8,000 mile in diameter ball of dirt and water (which is not necessarily mud) was round instead of a flat chunk upon the shoulders of Atlas. It was he who determined when the equinoxes and the solstices were due to arrive, and he knew beforehand when the famous eclipse of the Sun was to occur—the one that caused the Lydians and the Medes to throw up the sponge in their famous battle, you've read of the incident in history. Then the sundial was invented by a Greek, Anaximander.

"Getting back to the history of the thing we see a poor guy gazing up thru a dilapidated old farmhouse roof—where there was no roof—and thinking. Well, he thought so hard that we now still read of the Copernican theory of the universe. He stuck our planet in with the rest of the whirling globes and fireworks. He got a hunch from Pythagoras.

"Brahe then came along and modified the theory of Copernicus and cut out the 'cycles and epicycles' stuff, and as he was not housed up in a farmhouse he built a magnificent observatory. Then came the apt pupil of Brahe's, Kepler, who compounded a pile of laws and stamped his cognomen on history,

"After a while Galileo grew up from the skipping rope and marbles age and invented the telescope and pendulum. Looking thru the glass instrument he found that Jupiter had a moon—not the kind that showed up when some of his marbles collided with too much force, tho. After he slipt us a handful of physics and astronomy and the like we become aware that from the dressing room of Life there steps out a Sir Isaac Newton, who saw the apple fall and told us all about gravitation. Of all the 'Big Bugs' in astronomy, as well as mathematics, we lift our hat a little higher to Ike."



Galileo, the Bird Who Defied the World by Telling It that It Turned Around Instead of Standing Still, as Was Thought.

"I once read of the Arabians as being up on the Astronomical dope," I ventured.

"Yes, they were," Stokes replied. "A duck by the name of Ulugh Beg, who was not an ugly beggar but an astronomer, catalogued a bunch of stars. They took to that and astrology, like the Egyptians and Moors.

"Then Laplace topt off Newton's 'Principia' with his *Mécanique Céleste*.

"Naturally, the first thing to be considered is the Sun. The savages recognized it as the means of life on our planet (of course they knew of no other) and worshipt it as their God, in the same manner as we do the $, only they openly acknowledged it. In plant life we are aware of an attraction by it. Only the blind cannot see the effect it has upon everything in general. Now, with a lot of the experiments behind us, we have it figured out that we are 93,000,000 miles from Old Sol, and that the hot old

Ike Newton, the Gink Who Invented Gravitation by Means of the Cider-Fruit.

boy is composed of much the same material as our Earth, and we also have it doped out that the temperature up at the Sun arrives at the twelve thousand mark, F. It has a 'photosphere' where we have our hydrosphere and a 'Chromosphere' where we have our atmosphere. The mathematical wonders have it down in their note books as follows for the weights of the Earth and Sun, respectively: 6,000,000,000,000,000,000,000 and 2,000,000,000,000,000,000,000,000 *tons*. To reduce that down to ounces would take Steinmetz at least a second—you know him. Then the candle-power looks like this on paper: 1,575,000,000,000,000,000,000,000,000,000."

"How would you say that if you did not have your pencil along" asked Bender.

"Well, the first, replied Stokes, looking down at his paper, "is six sextillion. The

(*Continued on page* 69)

THE ORACLE

The "Oracle" is for the sole benefit of all electrical experimenters. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be published. Rules under which questions will be answered:

1. Only three questions can be submitted to be answered.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink, no penciled matter considered.
3. Sketches, diagrams, etc., must be on separate sheets. Questions addrest to this department cannot be answered by mail free of charge.
4. If a quick answer is desired by mail, a nominal charge of 25 cents is made for each question. If the questions entail considerable research work or intricate calculations a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.

REWINDING TELEPHONE MAGNETO.

(993) Walter F. Hawley, Buffalo, N. Y., writes us:

Q. 1. How can he rewind a 3 bar telephone magneto to produce 10 volts?

A. 1. This question cannot be answered exactly, excepting on one condition, and that is that you would need a magnetomometer at hand with which to measure precisely the strength of the magnetic flux in maxwells per square inch of pole-face area.

We can suggest from our experience in this line, however, that the armature be wound full with No. 17 to 18 B. & S. gage S. C. C. or enameled magnet wire. This would be suitable for a potential of 8 to 10 volts. Of course, the voltage can always be increased by raising the speed, but naturally there is a limit to this, as the machine will not safely stand too high a speed.

A. C. SOLENOID.

(994) Stanley Dohrzynski, Cuyahoga Falls, Ohio, asks the Oracle:

Q. 1. For data on winding a small A. C. solenoid about 3 inches in diameter and 3½ inches long, with a ⅝ inch iron core.

A. 1. Unless such an A. C. electromagnet is very carefully designed, which would require elaborate calculations, and also unless it is carefully and very exactly built according to these specifications as computed, then the current taken will vary considerably from that calculated. Also in the case of the solenoid, with a movable core, the current will vary from a very high value when the core is just entering the coil, down to a certain minimum value, when the core is pushed all the way into the coil.

The only thing we can suggest in your case would be to experiment with several sizes of wire. For the size of solenoid you have in mind, you might try winding it full with No. 18 D. C. C. magnet wire. The weight which such a solenoid could lift with the core all the way in the coil would probably be in the neighborhood of one-half pound. The iron core must be laminated, not a solid piece.

1 K. W. WIRELESS TRANSFORMER DATA.

(995) J. R. Johnson, McConnelsville, Ohio, writes this department:

Q. 1. Please give data for winding a 1 K. W. radio step-up transformer.

A. 1. We are pleased to give you herewith data on 1 K. W. close core step-up transformer.

The laminated sheet iron core should measure 15 inches long and 8¼ inches wide, and have a cross-section of 2 × 2 inches, or 4 square inches. The primary winding which should have taps taken off from each layer should comprise 344 turns of No. 10 B. & S. gage D. C. C. magnet wire. The secondary should comprise about 12 pounds of No. 32 D. C. C. magnet wire, thoroly impregnated with paraffin and beeswax while being wound into pies. There should be 24 pies or coils, each ¼ inch thick. This secondary winding should give 14,176 volts with 300 turns in the primary; 21,265 volts on 200 turns in the primary, and 42,530 volts with 100 turns in the primary in use. Of course, when the normal number of primary turns are reduced in order to raise the secondary voltage, a suitable iron core choke coil or impedance must be used in series with the primary winding in order to control the current, so that the transformer will not over-heat and burn out the windings.

2 K. W. STEP-DOWN PIPE THAWING TRANSFORMER.

(996) Joel H. M., Carney Point, N. J., inquires:

Q. 1. Can you supply data on a 110 volt, 60 cycle, A. C. step-down transformer for pipe thawing, the secondary giving about 12 volts.

A. 1. We give herewith data on the construction of a 2 K. W. transformer suitable for operation on 110 volt, 60 cycle, A. C. The secondary is suited to develop a current of about 13 volts and 150 amperes.

The primary winding of this transformer consists of 13½ pounds or 244 turns of No. 8 B. & S. D. C. C. magnet wire, or 2 No. 11 D. C. C. wires can be wound side by side and connected in parallel. The laminated sheet iron core, on one leg of which the primary is wound, should measure 17½ inches long by 8¾ inches wide, and have a cross-section of 2¼ × 2¼ inches.

The secondary winding for this transformer should comprise 31 turns of No. 0 B. & S. gage D. C. C. magnet wire, and will develop a current of about 13 volts and 150 amperes. If this is too difficult to wind on, 2 No. 3 wires may be used or 4 No. 6 wires, connecting these wires in parallel.

REWINDING DYNAMO.

(997) A. C. McLellan, La Porte, Ind.:

Q. 1. I want to know what size wire the armature or field or both will have to be wound with to get 40 volts and as much amperage as possible from a dynamo as follows:

Field is 6 pole, now wound with No. 20 D. C. wire, 1¼ pound to the pole. The armature has 28 slots, wound with 28 coils, parallel lap winding, and has 2 brushes at an angle of 60 degrees from each other. Each coil is wound with 20 turns of No. 20 D. C. wire. Commutator has 28 bars, diameter is 4¾ inches, length 3 inches, and at a speed of 2,000 R.P.M. it now generates 105 volts and 9 amperes. The dynamo is shunt wound, and when wired for 40 volts I want it shunt also. It seems to pull very hard now without any load on it at all.

A. 1. We would advise as follows concerning the rewinding of your 105 volt, 9 ampere dynamo:

For 40 volts the field should be rewound with the same amount of wire, or 1¼ pounds per pole of No. 15 B. & S. gage D. C. C. magnet wire. The armature should be rewound with the same number of coils and in the same fashion or style of winding as previously used, but each coil should be composed of 7 turns of No. 15 B. & S. gage D. C. C. magnet wire.

You mention that the dynamo armature seems to turn very hard without any load on it at the present time. This most likely is not due to any electrical reasons, but merely mechanical ones. We would suggest that the bearings be carefully inspected; also on some small dynamos fitted with a number of brushes, the brush friction is made too great, and they should be readjusted so as to have just sufficient spring tension against the commutator to eliminate any undue sparking. In some cases,

(*Continued on page* 50)

Thousands of Wonderful Opportunities in the Electrical Field

The Trained Man Is Needed Everywhere

By L. L. COOKE,
Chief Engineer, Chicago Engineering Works

BUSINESS conditions throughout America and even the world today are such that there are now truly wonderful opportunities for trained men in the electrical field. The electrical business has grown so fast and electricity is being continually applied to so many new uses that the demand for trained electrical men is growing faster than the supply.

Even on the farm electricity is now becoming common and thousands of farm lighting and power plants have already been installed. This shows how broadly electricity is applied today, and suggests something of the very great demand for hundreds of thousands more of trained electricians.

"Where will we get the men," is the question heard on every side. Electrical Manufacturers are spending thousands of dollars a week advertising merely for help. Look at the "Help Wanted" columns of any newspaper and see for yourself the demand for trained men. The salaries paid to young men with a thorough knowledge of electricity are unbelievable. The size of the pay envelopes going into the pockets of electrical workers every week reflects the scarcity of men to fill these responsible positions. So, not only is the electrical field greatly vacant now due to the absence of electrical men enlisted in the war services of our government, but it will be more greatly vacant when war's results are counted, and the need for men to fill the industrial places of our soldiers and sailor boys will swell the demand.

Moreover, the reconstruction and readjusting periods to follow in the war's wake are going to increase the employment of electrical workers beyond even the natural immense requirements. Electricity is yet to do its biggest services to the world after the war. Tho unlimited are its boundaries now, electricity and men who know its functionary phases and operations will have even wider scope and opportunity for years after peace is declared.

The most vital question for the young man of today to answer is not "Shall I enter the electrical profession?" but "What is the quickest, easiest and surest way to become a trained electrical man?" Time was when it took from three to four years to turn out an accomplished electrician who could be entrusted with any job that came along. Only a few years ago it used to cost thousands of dollars to make an accomplished electrician, which amount was made up in expensive tuition, board, etc., as well as money lost in non-production while the student was learning. Hundreds of thousands of dollars were lost in this manner because the student, seldom, if ever, is a producer while studying. This means a tremendous loss to the nation, as a minute's reflection will readily show.

Correspondence instruction has changed all this. By this method the student wastes no time on unnecessary branches. He gets exactly the training he will use in practical work and throughout his entire course he has the direct personal instruction of specialists in the branch he has selected.

Further, he can do his studying at home, in his spare time. He does not have to give up his regular job until he has qualified as a Certificated Electrician and is ready to enter his new profession. Think of the thousands of dollars this one great feature of correspondence instruction has saved this country in the past year alone.

I urge every young man with ambition and pluck to grasp the opportunity that present conditions offer the electrically trained man. Don't hesitate because of age or experience. Young men, boys and old men are needed and must fill the gaps to keep business going. Do your part. Prepare yourself for a real position by specializing in some branch of electricity. All you need is a few months' practical, snappy instruction from a competent engineer and you will be ready to go after some real money. But do it now. Our boys are returning filled with ambition, strong and healthy after two years' out-door living. How can you hope to compete throughout the reconstruction period without the special knowledge and advantages training will give you?

The Chicago Engineering Works are ready to help you. A specially designed course has been prepared that will fit you in the shortest possible time to take up the extremely interesting and profitable work as a Certificated Electrician. The course is the result of many years' teaching of young men in this vast field. It is intensely practical. It is highly condensed, simplified, up-to-date and complete. You can make a splendid success in this study, and the school will guarantee, under bond, to return every cent paid for tuition, if you are not entirely satisfied when you receive your Electrician's Certificate granted you as a graduate of the school. We teach contracting and electrical drafting along with the course and hundreds of our graduates are now successful contractors.

You can take the entire course in your spare time. No interference with your regular duties. We understand just what you must know and have devised a really wonderful way of instruction by mail. We have trained thousands of men and will train you to your complete satisfaction or the course will not cost you one cent.

Remember, that you will not be under the slightest expenses except the tuition price. A splendid Electrical Outfit is given free to every student and much of the training is done by actual work with this outfit. You have no car-fare or living expenses as you would have if you studied at a trade-school. You don't have to buy your outfit, or pay for the maintenance of expensive school equipment as you would elsewhere. The electrical outfit which we give every student includes Electrical Tools, Instruments, Materials, etc., and is given absolutely free.

The price of the course, you can pay in small installments if you want to—in other words, you can pay as you go along. These payments you can take out of your salary which you receive from your regular employment, it not being necessary to give this up until you are fitted and ready to take a good position as a real electrician.

One excellent feature of the assistance the Chicago Engineering Works is giving young men to help them succeed is the free employment service. The standing of the school is so high and the quality of students so well known that many firms rely entirely upon our graduates to fill vacancies in their staffs. We are continually receiving requests from employers to send them trained Electrical men. We assist our students to good positions and keep in touch with them for years, helping and advising them in every way possible.

I cannot urge all young men too strongly to get into the field of electricity. I know the vast opportunities for bright men and the opportunities have never been better than they are now and will be for the next ten years. The industry needs you and will give you a good chance to make a success of your life. Write us and let us tell you all about what we can do for you.

We have just prepared a new book on Electricity and its Opportunities and I want to send you this wonderful book—FREE. Write me personally telling me just what you are doing and what you would like to do. I'll gladly answer your letter myself and give you the benefits of my many years' experience in this field. But whatever you do, don't neglect the golden opportunity now offered live men. Address L. L. Cooke, 443 Cass St., Chicago, Ill.—Adv.

BE A CERTIFICATED ELECTRICIAN

A Real Position Like This—For You

The country needs thousands of trained, Certificated Electricians to fill good positions—and at big pay. It's all a matter of knowing how, and I will teach you by up-to-date, modern instruction. You can learn at home, without interfering with your regular work, by my highly successful method of *Home Instruction* in *Practical Electricity*.

Prepare NOW and be ready in a few months to earn your $46 to $100 A WEEK

Send for this Book

My book, "HOW TO BECOME AN EXPERT ELECTRICIAN," has started thousands of young men on the way to splendid success. A new edition of this has just been printed. I want every young man interested in Electricity to have a copy, and will send you one, ABSOLUTELY FREE and PREPAID. Write me today.

How I Train My Students

As Chief Engineer of the Chicago Engineering Works I know exactly the kind of training a man needs to enable him to get and hold good positions, and to earn big pay. I have trained hundreds of men who are holding splendid electrical jobs.

I give each of my students personal attention and a complete and thorough training. I give him a SPLENDID ELECTRICAL OUTFIT FREE, and much of the training is done by actual work. When my students graduate and receive their Certificate, they are ready for a real position. But *still more*, at any time you wish you can come to our splendidly equipped Electrical Shops for special training. No other school can give you this.

A Real Opportunity for YOU

Wishing is never going to make your dreams come true. You've got to *study*—to *learn*. A man is worth possibly $2 or $3 a day from his neck down—and no more; but there is *no limit* to what he can be worth from his neck up.

A *trained mind* is what gets the big pay. It is this training that you need, and I can train you in a few months. Are you ambitious to make a real success—then send me the coupon—today.

Electrical Outfit FREE

To every student who answers this ad I am giving a Splendid Electrical Outfit of standard size Electrical Tools, Instruments, Materials, etc., *absolutely free*. Furthermore, to every Electrical Student I give a truly *valuable* surprise that I cannot explain here.

Free Employment Service

I am continually receiving requests from employers to send them trained Electrical men. I assist my students to secure good positions. I keep in touch with them for years, helping and advising them in every possible way.

Write Now—Don't Delay

Delay never got you anything. Action is what counts. Get started—and get started now. Write me send me the coupon right NOW.

L. L. COOKE, *Chief Engineer*

CHICAGO ENGINEERING WORKS

441 Cass Street Dept. 25 Chicago, Ill.

YOU CAN DO IT

USE THIS "FREE OUTFIT" COUPON

CHIEF ENG. COOKE, Dept. 25, 441 Cass St., Chicago, Ill.

Sir: Send at once—fully prepaid and entirely free—complete particulars of your great offer for this month.

Name.....

Address.....

City..... State.....

THE ORACLE

(*Continued from page* 46)

also, the armature may rub against the field poles, and this can be easily ascertained by removing the armature and noting if there are any shiny spots on the field poles or armature core.

ELECTRIC ARC TEMPERATURE

(998) James G. Peck, Elmira, N. Y., says:

Q. 1. What is the temperature of the electric arc produced between two ½ inch carbons?

A. 1. In regard to data for building an arc light from two ½ inch diameter carbons to give you a temperature of 3,500 degrees Centigrade, any arc, large or small, gives about the same temperature roughly speaking; the large arcs using larger carbons simply giving a greater quantity of heat, but not a higher temperature. The electric arc will give you the greatest temperature of any ordinary source of heat known. The average arc, using ½ inch carbons, either cored or solid, consumes about 5 amperes, on 110 volts, and the candle power is about 1200.

Appended are some interesting high temperature sources of heat:

Bunsen burner	1,870 deg. C.
Oxy-coal gas flame	2,000
Oxy-hydrogen flame	2,800
Oxy-acetylene flame	3,500
Electric arc (furnace)	3,500

RADIO LOOSE COUPLER DESIGN

(999) Alvin Harrison, Albert Lea, Minn., asks:

Q. 1. Several questions on designing loose couplers for wireless receiving circuits.

A. 1. In standard practice it is usual to provide both primary and secondary coils with loading inductances, these inductances being either a separate part of the circuit, or else combined with the coupler windings themselves, preferably the latter.

The primary as well as the secondary circuits are, in the most efficient design of coupler, made so as to form a continuous coil capable of being tuned to the highest wave length which it is desired to receive. Any other form of loading inductance which is separate from the windings of the coupler only form a source of loss, for it requires a certain amount of energy (I^2R) to excite this separate loading inductance, and, as it does not form a part of the main coupler winding, and is not useful in producing a part of the common electromagnetic field which transfers the energy from the primary to the secondary circuit, as you will see, in any event then it must be a source of *unrecoverable loss.*

We would refer you to a very good article on "Building a 20,000-meter Undamped Receiving Set," by William Burnett, Jr., page 258, August, 1917, issue; also

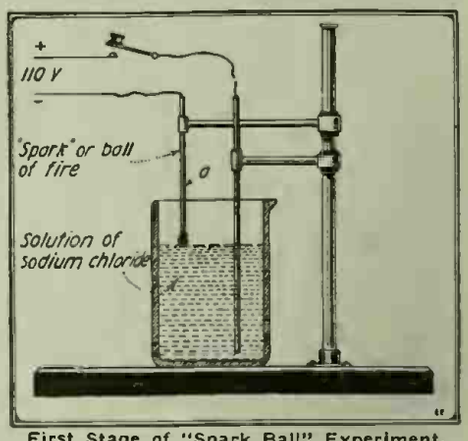
"The Design of Large Radio Receiving Transformers," by Chas. S. Ballantine, Radio Engineer, page 732, February, 1917, issue.

"The Calculation and Measurement of Inductance," by H. Winfield Secor and Samuel Cohen, parts 1, 2 and 3, which appeared in the March, April and September, 1917, issues.

PECULIAR SPARK BALLS.

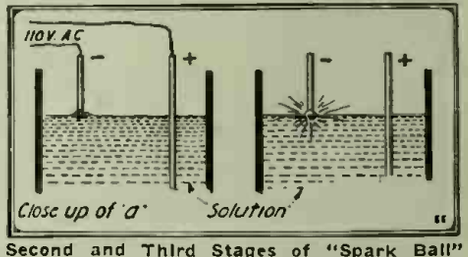
(1000) R. J. O., San Antonio, Texas, writes:

Q. 1. I am a reader of the ELECTRICAL EXPERIMENTER and desire some information regarding an experiment performed in my "Lab" some time ago which I am at a loss to know "the why and wherefore" of. Thus: I made a solution of Sodium Chlorid and water, in a small beaker. (See sketch.) Using a current of 110 volts and a small telegraph key to open and close the circuit, I connected it as shown in the "hook up." I proceeded as in sending a telegraph message and found that a rapid movement of the key produced a stream of what appeared to be sparks between the neg. (—) pole about 1/32 of an inch above the solution. The so-called "sparks" will continue to appear as long as the copper wire lasts. (It melts rapidly). My question is "What are those sparks?" If not sparks, what is it?



First Stage of "Spark Ball" Experiment.

A. 1. The experiment which you describe is nothing new and is well known to those who have experimented with electrolytic interrupters a good deal. This experiment can be performed not alone with sodium chlorid, but with almost every acid. Providing the current is strong enough, a ball of fire will appear at the end of one wire which touches the surface for the following reason: As soon as the point touches the liquid which has a more or less high resistance, the solution at this point immediately starts to boil. At the same time hydrogen gas is evolved, and the electric current setting fire to it explodes this minute quantity of gas, thereby giving rise to a small explosion. This phenomenon occurs in very rapid succession, and the explosions take place several thousand times per second. Mr. H. Gernsback some years ago obtained quite large "fire balls" of this sort by using a fine carbon pencil as one electrode.



Second and Third Stages of "Spark Ball" Experiment. The Theory of Its Action Is Very Interesting.

200 WATT TRANSFORMER DATA.

(1001) James Dicks, Delhi, La., inquires:

Q. 1. Please give me data on 200 watt step-up wireless transformer for operation on 110 volts, 60 cycles.

A. 1. The laminated sheet iron core for this transformer should measure, for a 200 watt transformer, 10½ inches long by 6½ inches wide and 1 x 1 inch in cross-section. The primary winding, placed on one of the long legs, should comprise 660 turns No. 15 B. & S. gage D. C. C. magnet wire. Before winding on the primary coil, the iron core leg should be insulated with four layers of oiled linen or Empire cloth.

The secondary winding should comprise 17 pies or sections, each ¼ inch thick, with paraffin paper discs between them when assembled. The size of the secondary wire should be No. 34 B. & S. gage D. C. C. and 3.7 pounds of secondary wire are required. There should be about 35,000 turns in the secondary, and the secondary voltage with

(*Continued on page* 52)

THE ORACLE

(*Continued from page* 50)

all primary turns in use is 5,890. The secondary voltage is increased in proportion as the number of primary turns in circuit at any time are decreased. The secondary leg of the core should be well insulated with 10 layers of oiled linen before placing the pies in place.

NEUTRAL POINT OF D. C. DYNAMO AND A. C. MOTOR SPEED CHANGES.

(1002) R. G. LeTourneau, Stockton, Cal., asks the Oracle:

Q. 1. Several questions concerning the shifting of the neutral point on a D. C. generator and speed changes of induction motors.

A. 1. The neutral point on the commutator of the D. C. generator changes at least slightly with changes in speed of the armature as you mention, unless the machine has one of the following precautions taken in its design: The machine might have a very powerful field, which would cause a very even and rigid distribution of the flux at the pole tips; the machine might be provided with *interpoles*, such as provided on any one of the leading machines on the market at the present time, which tends to preserve an even distribution of the field flux, and thus to preserve a practically fixt neutral point, thus obviating the necessity for shifting the brushes, even on overloads of 50 per cent. Or again the machine might be provided with variable air gaps between the field pole tips and the armature, such as in the Stow design, where all of the field poles are geared together by means of worms and gear rods to a common handwheel on the top of the machine, which enables the field poles to be advanced toward or receded from the armature and the air-gap flux distribution varied.

You are correct in assuming that several different speeds can be obtained from an A. C. motor by changing the groupings of the field poles, i.e., by changing the number of poles, such as by causing the field to produce 4 poles, 6 poles, 8 poles, and so on. This system is adopted in some of the leading A. C. motors now on the market. You will find data on this subject by referring to books on A. C. machinery.

A. C. TEST FOR "SHORTED" ARMATURE COILS.

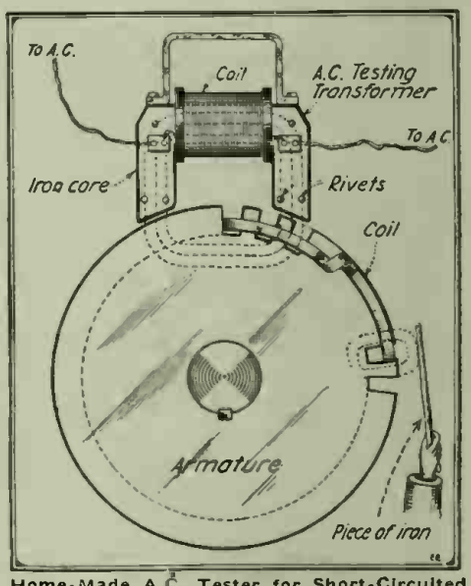
(1003) Earl E. Teater, Wheeling, West Va., writes the Oracle:

Q. 1. For data on a simple A. C. testing scheme for short-circuited armature coils.

A. 1. Herewith we describe an A. C. testing device for determining whether armature coils are short-circuited or not and which is used in repair shop work. The small transformer has a single winding on it, which is excited with alternating current suitably controlled by connecting it in series with a lamp bank or choke coil, etc. Using this transformer primary, as it may be called, and holding it in contact with the armature, in successive positions, as the armature is turned from coil to coil, there is set up thru the armature core a magnetic flux, which induces a current in the armature windings. If one of the coils happens to be short-circuited, as becomes apparent, this current will heat up the coil. Also by turning the armature a complete revolution and holding a small piece of iron against it, the coils being tested for short-circuits will be easily located, as the piece of iron held near the coil will vibrate, due to the resultant magnetic field set up by this coil and the current passing thru it. The transformer device should not be put in position nor removed while current is flowing thru the magnetizing coil of course.

To make this testing transformer, a laminated sheet iron core of the shape indicated in the diagram is built up, and it may be riveted at several points. It should have a width equal to the approximate length of the armature, and also a pole-face curvature as nearly like that of the armature core as possible. The winding on this transformer may, for a small size device to be used in testing out small magneto or auto lighting dynamo armatures, be composed of about 75 turns of No. 14 B. & S. insulated magnet wire.

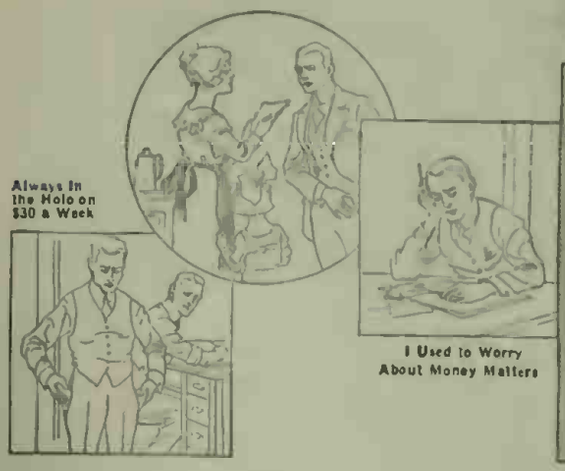
A very satisfactory and simple test for short-circuited as well as open-circuited armature coils can be carried out by connecting a buzzer across the brushes, and thus testing from bar to bar with a 75 ohm telephone receiver. If a coil is short-circuited or partially short-circuited, then no sound or a weak sound will be heard in the telephone receiver. It has been found that this test will give better and more accurate

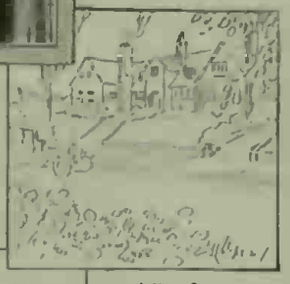


Home-Made A.C. Tester for Short-Circuited Armature Coils. The Materials Required to Build It Are Available About Any Shop. Its Action Is Simple, Yet Positive.

results in a minimum of time, than is the case where the Wheatstone bridge is used. Open-circuited coils will manifest their presence when the proper bars are bridged by a very loud noise in the receiver. It is common practice in many shops to use this test in connection with the 110 volt, 60 cycle A. C. lighting current, the necessary current being past thru the armature in series with a 110 volt lamp.

If you have a good voltmeter on hand or posibly an ammeter without the shunt on it, you can also make tests quickly for open or short-circuited coils or grounds by the bar-to-bar test, passing direct current thru the brush points on the commutator. For this work the armature is usually mounted in a testing cradle, comprising a wooden frame and one upright which carries a pair of adjustable copper or other brushes which will transmit the testing current to diametrically opposite points on the commutator, for the two-pole armature, or four points ninety degrees apart for a four-pole armature. In any case where the telephone receiver and A. C. or buzzer method are used, or the voltmeter method, the criterion of the tests for a perfect armature is to obtain a similar or very closely similar degree of sound in the receiver for each coil, or an equivalent similarity in the voltmeter readings for every coil on the armature. If any appreciable difference is noted in the meter readings or in the telephone, then the connections of the commutator, and also the leads of the coils should be carefully examined. Sometimes a high reading will result from a poorly soldered lead connection to the commutator bar, which on a superficial examination may appear to be a first-class soldering job.





"At Dawn the Answer Flashed on Me!"

How a young man jumped from $30 a week to $50,000 a year. His remarkable success he attributes to the way he uses his will. "What I've done, I believe anyone can do," he says.

THERE are only a few $50,000 jobs—yet of all the men in the country it is difficult to find enough to fill the few big jobs available. There are plenty of men for the $25-a-week positions—but the thousand-dollar-a-week openings "go begging." How this young man trained himself for earnings of $50,000 a year is one of the most interesting chapters in the annals of even present-day fortune making. This is the story told me, almost word for word, by the young man *who did it*.

"Three short years ago I was $5,000 'in the hole'—and earning $30 a week. I had a wife and two children to support, and I used to worry myself sick about the future.

"Today—it seems like a dream—all my troubles are over. I am worth $200,000—enough to keep me and my family in comfort for the rest of our lives. I own two automobiles. My children go to private schools. I have just purchased, for cash, a $25,000 home. I go hunting, fishing, motoring, traveling, whenever I care to.

"LET me say in all sincerity that what I have done I believe any one can do. I am only an average man—not 'brilliant'—have never gone to college—my education is limited. I know at least a hundred men who know more than I, who are better educated and better informed—and their earnings probably average less than $50 weekly while my income is over $1,000 weekly. I mention this to show that earning capacity is not governed by the extent of a man's education—to encourage those who have not had the advantage of a comprehensive education.

"What, then, is the secret of my success? Let me tell you how it came about.

"One day, about three years ago, something happened that woke me up to what was wrong with me. It was necessary for me to make a decision on a matter which was of little consequence. I knew in my heart what was the right thing to do, but something held me back. I said one thing, then another; I decided one way, then another. I couldn't for the life of me make the decision I knew was right.

"I lay awake most of that night thinking about the matter—not because it was of any great importance in itself, but because I was beginning to discover *what was wrong with me*. Along towards dawn the answer flashed on me and I resolved to make an experiment. I decided to cultivate my will power, believing that if I did this I would not hesitate about making decisions—that when I had an idea I would have sufficient confidence in myself to 'put it over'—that I would not be afraid of myself or of things or of others. I felt that if I could smash my ideas across I would soon make my presence felt. I knew that heretofore I had always begged for success—had always stood, hat in hand, depending on others to give me the things I desired. In short, I was controlled by the will of others. Henceforth, I determined to have a strong will of my own—*to demand and command what I wanted.*

"WITH this new purpose in mind, I applied myself to finding out something more about will power, and in my investigation I encountered the works of Professor Frank Channing Haddock. To my amazement and delight, I discovered that this eminent scientist, whose name ranks with James, Bergson and Royce, had completed the most thorough and constructive study of will power ever made. I was astonished to read his statement, 'The will is just as susceptible of development as the muscles of the body!' My question was answered! Eagerly I read further—how Dr. Haddock had devoted twenty years to this study—how he had so completely mastered it that he was actually able to set down the very exercises by which anyone could develop the will, making it a bigger, stronger force each day, simply through an easy, progressive course of training.

"It is almost needless to say that I at once began to practice the exercises formulated by Dr. Haddock, and I need not recount the extraordinary results that I obtained almost from the first day. You already know the success that my developed power of will has made for me.

"People sometimes worry because they cannot *remember* or because they cannot *concentrate*. The truth is, will power will enable them to do *both*. The man who can use his will can not only concentrate and remember, but can *make use* of these two faculties. And I want to leave this one word with you—no knowledge, no plan, no idea is worth a penny unless it is used—and it cannot be used unless some one's power of will does it!"

PROF. Haddock's rules and exercises in will training have been placed in book form, and I have been authorized by the publishers to say that any reader who cares to examine his startling book on will power may do so without sending any money in advance. In other words, if after a week's reading you do not feel that "Power of Will" is worth $3, the sum asked, return it and you will owe nothing.

When you receive your copy for examination I suggest that you first read the articles on: The law of great thinking; How to develop analytical power; How to guard against errors in thought; How to drive from the mind unwholesome thoughts; How to develop fearlessness; How to use the mind in sickness; How to acquire a dominating personality.

It is interesting to note that among the 225,000 owners who have read, used and praised "Power of Will" are such prominent men as Judge Ben B. Lindsey; Supreme Court Justice Parker; Wu Ting Fang, ex-U. S. Chinese Ambassador; Gov. McKelvie of Nebraska; Assistant Postmaster-General Britt; General Manager Christeson, of Wells Fargo Express Co.; E. St. Elmo Lewis; Senator Arthur Capper, of Kansas, and thousands of others.

As a first step in will training, I would suggest immediate action in this matter before you. It is not even necessary to write a letter. Use the blank form below, if you prefer, addressing it to the Pelton Publishing Company, 30-J Wilcox Block, Meriden, Conn., and the book will come by return mail. This one act may mean the turning point of your life as it has meant to me and to so many others.

Pelton Publishing Company,
30-J Wilcox Block, Meriden, Conn.

I will examine a copy of "Power of Will" at your risk. I agree to remit $3 or remail the book in 5 days.

Name .....

Address .....

.....

Popular Astronomy

Astronomical Distances

(*Continued from page* 25)

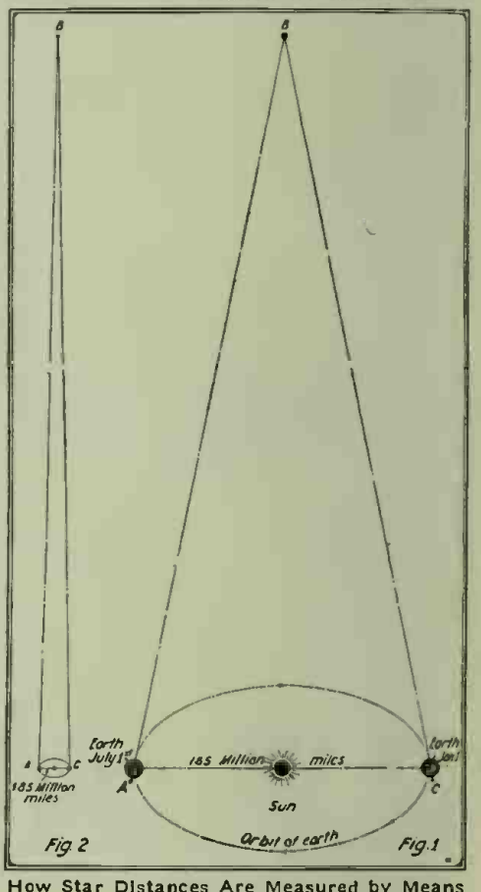
ured with considerable accuracy and is known to be four and a third light years. Tho there may be a few faint stars or non-luminous stars nearer to us than Alpha Centauri, and there is, in fact, one inconspicuous star known to be slightly nearer, the distinction of being the nearest of the brighter stars has long been held by Alpha Centauri. As our own sun continues his journey thru the universe the two stars (our sun is a star just like Alpha Centauri) will finally draw away from each other after many ages have past and some other sun of space will be our nearest star. The distances that separate the stars from each other probably average as great as the distance from the sun to Alpha Centauri. Within a sphere whose center is at the earth and whose radius is five parsecs, or about sixteen light years, there are only about twenty known stars. There is therefore small chance of collision among bodies that are so small in proportion to the tremendous intervals of space that separate them from each other. There is ample room for the individual stars to pursue their journeys thru space without interfering with each other's motion so long as they are as widely scattered as they appear to be in this portion of the universe. That our own sun has continued its journey thru the universe for some hundreds of millions of years without any catastrophe such as would result from closely approaching or colliding with another sun of space shows on how grand a scale our sidereal system is fashioned.

Stars that are ten, fifty or even one hundred light years from the earth are our near neighbors in space. They are the stars that show a slight displacement in the heavens or measurable parallax viewed from opposite sides of the earth's orbit. There are probably a thousand stars among the hundreds of millions of stars within reach of the greatest telescopes whose distances have been determined in light years by direct measurement of their displacement in the heavens resulting from the change of position of the earth in its orbit. The most distant of the stars are apparently immovable in the heavens showing neither the effect of the sun's motion or their own motion thru space. Methods for ascertaining the distances of many far remote stars and star-clusters have been devised, however, and some comparatively recent investigations have yielded determinations of the distances of these objects indicating that the diameter of the system of stars to which our sun belongs approximates to at least three hundred thousand light years. It is difficult to grasp the full significance of this fact. It means that hundreds of millions of the suns of space throng the visible universe at distances from us and from each other running into hundreds, thousands and even hundreds of thousands of light years. The light waves from some tiny object that we can just barely glimpse in one of our great reflectors may have started on their journey thru space over one hundred thousand years ago when men of the Old Stone Age inhabited our planet earth!

Astronomers have found as a result of their investigations that the sidereal system to which our solar system belongs is in the form of a flattened spheroid with its longest axis in the plane of the Milky Way. We have shown in a preceding article on the Milky Way how all the various units of our system, stars, nebulae and star clusters are distributed with reference to this plane, including our own sun. The extent of this star system composed of hundreds of millions of individual suns in addition to nebulae and clusters is, as we have said, at least three hundred thousand light years along its longest axis, while globular star clusters distributed above and below its central plane have been found to be at distances from it ranging from ten thousand to two hundred thousand light years. This entire organized system is our sidereal universe. Space beyond is unexplored. The globular star clusters are the most distant celestial objects so far discovered. The spiral nebulae may be entirely within the limits of this system or future determinations of the distances of the fainter spirals may extend the limits set by the globular clusters to include spirals found to be still more distant.

We can conceive the possibility that our sidereal universe, vast as it is known to be, may be but a unit in some still greater organization and that other similar systems lie beyond the reach of existing telescopes at unimaginable distances of a higher order.

The mind of man is overwhelmed by the thought of sidereal systems as vast as our own lying far beyond our ken. Whether or not such external systems do exist and are with our own sidereal system units in some still vaster creation we cannot know.



How Star Distances Are Measured by Means of Parallax.

We have attempted to grasp feebly the vast expanses of time and space that are to be found within our own sidereal system, but the finite mind of man cannot grasp the wonders of a creation in which our entire sidereal system may hold a position as subordinate as does our own planet in the sidereal universe to which our sun belongs.

The distances of stars are almost inconceivable to the human mind. They are computed by what is known as the parallax. In order to make this plain to the non-technical reader, Fig. 1 shows the method used. When the astronomer wishes to measure the distance of a distant star, he takes an exact observation of the star on January 1st when the earth is in position C. Then on July 1st he again observes the same star with very accurate instruments. Then he will have an angle A, B, C. The

(*Continued on page* 56)

ASTRONOMICAL DISTANCES.

(*Continued from page* 54)

distance from A to C being roughly 185,000,000 miles, and the angle being known, it is easy to figure the distance from B to A by means of trigonometry. But if the star B is at an immense distance such as is shown in Fig. 2, the angle A, B, C becomes very small. As some of the stars are billions upon billions of miles removed from the earth, it will be readily seen that there will come a point when the angle A, B, C ceases to exist. In other words, the distance A to C, altho 200,000,000 miles, will practically vanish—as it is so little—and the angle becomes so sharp that A, B, C is practically nothing but a straight line. As a matter of fact most of the stars which we see are so far removed from the earth that they have no appreciable parallax, and it is therefore impossible to know how many billion miles such a star is removed from the earth. As a matter of fact only a comparatively few stars exist that show an appreciable parallax, even with the extraordinary degree of perfection attained in measuring instruments. Such is the inconceivable magnitude of interstellar distances.

Distances from the sun to the planets and to the nearest star in terms of the astronomical unit (distance from earth to sun) and in millions of miles.

Table I.

	In Astronomical Units	In Million Miles
Mercury	0.39	36.0
Venus	0.72	67.2
Earth	1.00	92.9
Mars	1.52	141.5
Jupiter	5.20	483.3
Saturn	9.54	886.0
Uranus	19.19	1,781.9
Neptune	30.07	2,791.6
Alpha Centauri (nearest star)	273,000.00	26,000,000.0
Value of light year	63,000.00	6,000,000.0
Parsec	206,265.00	20,000,000.0

Table II.

Time required to travel from the earth to sun, moon, planets and nearest star by airplane, (at the rate of 200 miles per hour), and with velocity of light, (at rate of 186,324 miles per second).

To	By airplane	With velocity of light
Moon	7 weeks	1¼ seconds
Sun	52.99 years	7 min. 59 sec.
Venus	14.37 years	2 min. 18 sec.
Mercury	32.46 years	5 min. 6 sec.
Mars	27.72 years	4 min. 21 sec.
Jupiter	222.68 years	35 min. 15 sec.
Saturn	452.37 years	1 hour 11 min.
Uranus	963.38 years	2 hours 32 min.
Neptune	1,539.30 years	4 hours 2 min.
Alpha Centauri (nearest star)	14½ million years	4.35 years

Note: The above results were obtained by using the *mean* distances of the planets from the sun and the nearest approach of the planets to each other.

RELIEVING THE CAR CRUSH.

(*Continued from page* 15)

lide! The westerner wants to get off and the easterner wants to get on, naturally.

Now an old axiom says that one mass can't take the place of another mass without displacing that first mass. But tho we have learned in our physics class that water is not compressible, Subway passengers are compressible to the NTH degree.

Then after a homeric battle in which both sides display a titanic amount of muscular effort the "westerner" is finally ejected forcibly from the car and a half dozen "easterners," with the "gentle" help of the subway gladiator, are packed into the train, which proceeds on its way until the next station, where the same little game of forcible subtraction and addition is enacted all over again.

The cure? There are three doors on each New York subway car: Two on each end and one (about the same size as the front and end door combined) in the center. If the outgoing passengers could use, say, the end doors only and the incoming travelers the middle doors only, and if this rule would be strictly enforced, don't you think that this would help to make the Subway a better place to travel in?

And, besides, Kipling *would* be right. "East and West, they never shall meet!" Anyway, not so rudely!

ELECTRIC VIOLIN-VIRTUOSO A MARVEL.

(*Continued from page* 21)

is obtained by means of a third magnet which vibrates the tail piece thru the medium of the shaker bar.

To produce the wonderful orchestral effects achieved by the Violano-Virtuoso, as the instrument is called, it is necessary to use not one but *four* bows—one for each string.

These bows consist of numerous conical discs of specially prepared flexible celluloid, the edge of each disc acting as the hair of a bow. And it is possible for these revolving bows *to play simultaneously on all of the four strings.* These 4 bows are operated by bow magnets and are mounted on a bow shaft extending over the bridge. This, in connection with the fact that the instrument has sixty fingers against the *four* available to the human violinist, is the reason why this instrument can, with facility, render the most difficult concertos, etc.—the master-pieces of the world's musical literature—some of which it is manifestly impossible for any save the greatest human virtuosi to achieve.

The bows are automatically rosined. Suspended above the strings is the *rosin box* from which the strings automatically obtain the proper supply of rosin. This box is controlled by a governor and according as the speed of the motor raises or lowers—the greater the bow speed and the closer the box comes to the bows, which by their revolutions against the surface of its rosin, automatically obtain a greater or less supply as required.

Our illustration shows the electrically operated violin, as well as its accompanying player piano. Both instruments playing together, thus give rise to a very creditable musical performance.

ALL KINDS OF LIGHTNING.

(*Continued from page* 20)

denly took it into his head that he was going to take some superlative lightning photos on a certain summer day. In this particular instance, the thunder storm had not been behaving very nicely, according to the photographer's notions, but he thought he would take a chance any way. We might mention before going further, that the thunder storm did not come up in the usual way, and proceed to discharge veritable forked "Bolts of Thor," but satisfied itself with merely hanging around in the offing, and giving a perfect imitation of the best flash, or so-called "heat" lightning, you ever saw. What happened was this. The photographer waited until several of these flashes had occurred and the rain had begun to fall, when he thought the lightning discharges would sharpen up enough to photograph most beautifully. However, he miscalculated the extent and the frequency of the flash lightning, which in this particular case hung on for a long time, and accompanied each flash of forked lightning, which was rather slight in quantity, with the total result that after six 8x10 negatives had been exposed, and then rushed expectantly into the dark room and developed, they showed,—what do you suppose? Well, sir, those six plates turned out to be six of the finest snap-shots of the surrounding landscape and buildings that you ever laid eyes on. By actual comparison you could not tell them from a sunny mid-day snap-shot of the surrounding country taken with the same camera.

Thus the motto would seem to be, that to obtain good lightning photos, one should take advantage of a very dark overhanging storm which gives the greatest contrast of course, for the lightning flashes to appear against. At night would seem to be a most opportune time to photograph lightning discharges, but many excellent pictures have been obtained in the day time as well, under suitable conditions as just outlined.

"The Joy of Father and Boy."

"ELECTRO"

Chemical Laboratory

We present herewith to our friends our new **E. I. Co. Chemical Laboratory** which contains real chemicals and apparata to perform real chemical experiments. This outfit is not a toy, put up merely to amuse, but a practical laboratory set, with all the chemicals, apparata and reagents necessary to perform real work and to teach the beginner all the secrets of inorganic chemistry. With this outfit we give free a book containing a **Treatise in Elementary Chemistry, useful data and recipes, and 100 instructive and amusing experiments.**

It contains the following 44 chemicals:

Alum $Al_2(SO_4)_3$, $(NH_4)_2SO_4$
Antimony (powdered) (Sb)
Ammonium Aqua (NH_3+H_2O)
Ammonium Carbonate $(NH_4)_2\ CO_3$
Ammonium Chloride (NH_4Cl)
Ammonium Sulphate $(NH_4)_2\ SO_4$
Barium Chloride $(BaCl_2)$
Boric Acid (H_3BO_3)
Brimstone (Sulphur) (S)
Calcium Chloride $(CaCl_2)$
Calcium Oxide (CaO)
Calcium Sulphate $(CaSO_42H_2O)$
Charcoal (Carbon) (C)
Chloride of Zinc $(ZnCl_2)$
Copper Sulphate $(CuSO_4)$
Ferrous Sulphate $(FeSO_4)$
Ferrous Sulphide (FeS)
Glycerol (Glycerine) $C_3H_5(OH)_3$
Hydrochloric Acid (HCl)
Iodine (I)
Iron Chloride $(FeCl_2)$
Iron Oxide (Fe_2O_3)
Lead Acetate Pb $(C_2H_3O_2)_2$
Litmus Paper
Magnesium Carbonate $(MgCO_3)$
Manganese Dioxide (MnO_2)
Mercury (Quicksilver) (Hg)
Nickel Chloride $(NiCl_2)$
Oxalic Acid $(H_2C_2O_4)$
Sodium Bicarbonate $(NaHCO_3)$
Sodium Borate $(NaBO_2)$
Sodium Carbonate (Na_2CO_3)
Sodium Chloride (NaCl)
Sodium Nitrate $(NaNO_3)$
Sodium Phosphate (Na_2HPO_4)
Sodium Sulphate (Na_2SO_4)
Sodium Sulphite (Na_2SO_3)
Stannous Chloride $(SnCl_2)$
Sulphate of Nickel $(NiSO_4)$
Sulphate of Zinc $(ZnSO_4)$
Sulphuric Acid (H_2SO_4)
Tin (Granulated) (Sn)
Zinc (Metal) (Zn)
Zinc Carbonate $(ZnCO_3)$

The following apparata are furnished:

One Standard Washbottle
One Alcohol Lamp
One Conical Glass Measure
One Erlenmeyer Flask
One Glass Funnel
One Delivery Tube
Six Assorted Test-Tubes
One Test-Tube Holder
Ten Sheets of Filter Paper
One Glass Dropper
One Spoon Measure
Glass Tubing
One book containing Treatise on Elementary Chemistry and 100 Chemical Experiments to be performed with this outfit.

DESCRIPTION OF THE OUTFIT:

The outfit consists of forty-four (44) Chemicals all C. P. (chemical pure) put up in appropriate wooden boxes, glass bottles, and hermetically closed jars. The acids are put up in glass bottles, with ground-in glass stoppers and there is a sufficient quantity of chemicals supplied (mostly one to two ounces) enough to make dozens of experiments with each. See list of Chemicals herewith.

The apparata furnished are all of the best obtainable make and of standard laboratory size and shape. A list of the 17 pieces of apparata furnished with this outfit is printed also herewith.

The Instruction book is a real Chemistry Course for the Beginner. Some of the Contents are: **Division of Matter:** This is a Treatise on Elementary Chemistry and deals with the theory of the Elements, Molecules and Atoms, etc. **Chemical Nomenclature.** This explains in simple language the derivation of the chemical names of the Elements and their compounds. There is a chapter on **Laboratory Operations; Glass Working; First Aid; Fire Extinguishers; Experimenters' Aphorisms,** etc.

A good part of the book is devoted to Weights and Measures. The Metric System, the English system and the U. S. System are fully explained.

The following tables are furnished: Symbols and Atomic weights of the Elements; Measures of Weights, Volume, Capacity and Length; Per Cent solutions; Conversion of Measure expressed in parts; Poisons and their antidotes; Technical and common name of chemical substances; Formulas for Cleaning various substances, etc., etc.

Among the 100 Experiments are:

How to make chemical tricks; How to make invisible and magic inks; How to test flour; How to test soil; How to Make Chlorine Gas and smoke (German War Gas); How to bleach cloth and flowers. How to produce Oxygen and Hydrogen; How to make chemical colors; How to test Acids and Alkalies and hundreds of interesting hints and formulas.

The price is still $5.00

Shipping Weight 10 lbs.

(Can be shipped by Express only.) Send your order today to:

TRADE MARK **THE ELECTRO IMPORTING CO., Mfrs.** TRADE MARK
231 FULTON STREET NEW YORK CITY

See our full page Ad, on page 88 for Free Cyclopedia

Will Man Freeze the Earth to Death?

(*Continued from page 8*)

Rising prices and increasing scarcity surely will drive us to other fuels. Alcohol has been cited as a probability, mainly because it can be produced anywhere crops are grown. The truth of this matter is that if the fuel requirements of the world were to be supplied by the world's crops there would be no crops left to feed the world's inhabitants.

The final summation simply is that when coal and oil both give out we will have an era of substitutes beside which the war bread of the past year will be heavenly. We will scratch around, burn up all our forests, dig our peat bogs to the bottom, and do what we can to find other substances to supply the deficiency. All the substitutes will be costly, both from point of view of actual price and in point of efficiency. Those who cannot afford to use them will simply have to move toward the equator or freeze to death.

Radium is the one direct answer to the problem raised by this situation. True, it exists only in minute quantities in the earth's crust. True, under our present system of extraction it costs prohibitively. Still, it is the only logical answer.

Why? While radium is present only in proportions of from one to three grains per ton in the outer thirty miles of the earth's crust—excluding the oceans, of course, in which there is only a trace—there is sufficient of it in the upper two miles of crust to supply all possible power wants of man. The fact that it now costs us over a half-million dollars a pound to extract it is no argument. The scientific brains of the world never has been focust on the problem of securing radium. Only the inventive skill of a small number of people has been concerned with the processes of mining and extracting any kind of precious metal. With only a few dozen laboratories in the world knowing anything whatever about radium, the cost of securing the metal has been *cut in half in the last four years.* In the event that radium showed itself to be the only salvation for men outside of the equatorial zone, would not this cost be slaughtered? Would not radium be extracted by the ton instead of by the milligram? When it is considered that by the extraction of all the radium in a belt of land, ten miles wide by three miles deep, extending around the earth sufficient of the metal would be secured to run civilization just as it stands until eternity, without further outlay for power of any kind, does this seem impossible? It would be an undertaking for centuries, undoubtedly, but what of it? There would be little or no depreciation in the metal secured year by year, and every tiny particle mined and extracted would do away with the necessity for just so much other fuel. In case the project were started under Government or other competent supervision, the probability would be strong that the descending price curve of radium would cross the rising cost curve of other fuels in the course of from fifty to one hundred years.

The only alternative to this desperate plan that seems to be offered to our descendants is the piping of steam and hot air from the earth's interior. On a small scale this has been done already in Italy, but scientists have pointed out that serious disturbances, earthquakes, cracking of the crust and other disasters involving huge losses of human life would be certain to follow the experiment of trying this on a large scale. The trouble mainly would be caused by the sudden cooling of certain portions while the other parts remained in a molten state. The great catastrophe of a tremendous crack appearing in the middle of the Pacific Ocean, with the resultant clouds of live steam and poison gas covering the earth and killing all animal and vegetable life, would be the great debacle most to be dreaded. Taking all into consideration, radium seems like the best and safest possibility.

One strange possibility which has an equally queer parallel in the case of radium extraction on a large scale is the quick doom which would face the earth if men piped all their heat from the earth's interior. Providing millions of these vents for power uses on all continents would cool the iron center of the earth speedily.

Under the present scheme of things, Professor Maurier estimates that the earth will cool to the temperature of the moon (—110 degrees Centigrade) in twenty-eight million years. Human life as we know it will have been extinct, in all probability, for twelve or thirteen million years of this term, unless man finds some material in which to clothe himself thru which body heat cannot pass, and grows his crops in huge heat-insulated greenhouses.

If the vents were opened, however, the heat of the earth's center would flood the atmosphere, even if used as economically as possible. It would rise to the outer edges of our air, coming into contact with the bleak (absolute zero) temperatures of the void, and cooling. Instead of the gradual change extending over millions of years, man would be confronted by a situation to which he probably could not adapt himself. The end of the world would come in ten thousand, yes, perhaps in five thousand years.

Even if the radium power system were inaugurated, something similar might take place, tho by no means as suddenly. Radium apparently was placed in the earth's crust for one particular purpose. That was to keep the earth from cooling off quickly.

We have seen that twenty pounds of radium would equal nine tons of anthracite in a year's time. The amount of radium in the thirty-mile crust of the earth, according to Professor Henri Becquerel of the French Academy, *is sufficient almost to equalize the daily loss of heat thru the atmosphere!* That means that if there were a little more radium in the earth this planet never would cool off at all! Also it means that if the earth were of the same consistency all the way thru, and not mostly molten iron or steel, the amount of radium being of the same proportion as at the surface, the globe would get hotter constantly. In the course of a few decades or centuries it would burst into flames and burn to a cinder.

The big point for us to grasp, however, lies in the fact that we are living now on earth solely because the crust contains radium. If this had not been the case the earth would have become cold and dead eons ago. If man, for any reason, becomes so grasping or in such dire necessity that he extracts all of the radium from the crust, he simply will be limiting his chances of a long stay very definitely.

This, however, is a remote possibility. The radium is scattered thru the whole crust to an average depth of *thirty miles.* Below this there is a highly heated tho solid zone in which there probably is a certain amount of radium. This zone extends *eighty miles* in depth, and below it is molten iron, the *core* of the earth. Man will have his hands full extracting the radium from the upper two or three miles of the crust. Since this will give him all he ever can need, unless the demands of future civilization grow much faster than any of our estimates figure, he would not touch the greater portion.

New York Aëro Show

(*Continued from page* 19)

ily imagined for the visitor was shown a complete composite photographic map of the city of Washington, D.C., which was taken from an airplane in a trip lasting but two hours and fourteen minutes. Hundreds of photos are taken by the rapid-fire cameras, and after developing and printing these have to be evenly matched and assembled. Large photographs taken about New York along the river, showing the ferry boats, etc., were taken during the afternoons of the different days, and the plates would be rushed to the aëro show, there developed and finished and prints made by the Army's photographic experts, the mounted photographs being on exhibit at the show in from one hour to an hour and one-half after they had been taken by the aviator flying above the city.

The machine gun exhibit attracted much attention, particularly the means used for synchronizing two machine guns on the battle-planes, so that they both fired dead ahead and thru the revolving propeller, the bullets passing accurately thru the spaces between the blades every time these spaces came in line with the machine gun barrels. The Packard Automobile Company, makers of the well-known Packard motor car, exhibited a new pleasure and battle-plane fitted with the Packard 12-cylinder aircraft engine, which somewhat resembles the Liberty motor. The Liberty motor, which was on exhibit, attracted considerable attention, and the number of these motors built by each of the large automobile concerns during the war were shown. There was a large sea-plane on exhibit which had flown to the show.

Speed enthusiasts in the flying world had their attention riveted on what was purported to be the fastest airplane in the world, the "Christmas Bullet," a small model of which was exhibited at the Aero Show. It was very well built, and the most remarkable feature of the design of the "Bullet" is that there are no struts between the planes, and also there are no guy wires, as in the usual types of monoplanes. The wings are supported by the cantilever principle, and besides they are *flexible*. The "Christmas Bullet" bi-plane is guaranteed to make 200 miles an hour, and it attained a speed of over 185 miles per hour on a recent trial flight, when equipt with a six-cylinder 185 H.P. Liberty motor. It is claimed by its builders to be the safest and fastest airplane in the world. Not only this, but its lifting capacity compared to its size is greater than that of any other 'plane, it is stated. As will be evident, this ingenious design of 'plane is constructed on the principle of true bird flight, which therefore makes it self-balancing and serviceable in any kind of weather. The wing surface is 170 square feet, and the total weight is 2,100 pounds, which includes fuel for three hours.

This airplane is intended to play the rôle of the first "taxi-plane" ever used in steamship service, and is to be operated at the port of New York by one of the leading steamship companies for overtaking a ship a day out at sea with sacks of belated mail, dispatches, etc.

Among the interesting airplane engines exhibited at the Show was the well-known "Dusenberg." This Company exhibited a powerful new model 12-cylinder aircraft engine, in which each set of six cylinders operated a separate crank shaft of its own. The power from the individual crank shafts was then transmitted to the propeller shaft by means of two gears, one on each side of the main driving gear secured to the propeller shaft.

The True Wireless

By Nikola Tesla

(Continued from page 30)

trates an arrangement described in my U. S. Patent No. 568178 of September 22, 1896, and corresponding dispositions of wireless apparatus. The captions of the individual diagrams are thought sufficiently explicit to dispense with further comment. I will merely remark that in this early record, in addition to indicating how any number of resonant circuits may be linked and regulated, I have shown the advantage of the proper timing of primary impulses and use of harmonics. In a farcical wireless suit in London, some engineers, reckless of their reputation, have claimed that my circuits were not at all attuned; in fact they asserted that I had looked upon resonance as a sort of wild and untamable beast!

It will be of interest to compare my system as first described in a Belgian patent of 1897 with the Hertz-wave system of that period. The significant differences between them will be observed at a glance. The first enables us to transmit economically energy to any distance and is of inestimable value; the latter is capable of a radius of only a few miles and is worthless. In the first there are no spark-gaps and the actions are enormously magnified by resonance. In both transmitter and receiver the currents are transformed and rendered more effective and suitable for the operation of any desired device. Properly constructed, my system is safe against static and other interference and the amount of energy which may be transmitted is *billions of times greater* than with the Hertzian which has none of these virtues, has never been used successfully and of which no trace can be found at present.

A well-advertised expert gave out a statement in 1899 that my apparatus did not work and that it would take 200 years before a message would be flashed across the Atlantic and he even accepted stolidly my congratulations on a supposed great feat. But subsequent examination of the records showed that my devices were secretly used all the time and ever since I learned of this I have treated these Borgia-Medici methods with the contempt in which they are held by all fair-minded men. The wholesale appropriation of my inventions was, however, not always without a diverting side. As an example to the point I may mention my oscillation transformer operating with an air gap. This was in turn replaced by a carbon arc, quenched gap, an atmosphere of hydrogen, argon or helium, by a mechanical break with oppositely rotating members, a mercury interrupter or some kind of a vacuum bulb and by such *tours de force* as many new "systems" have been produced. I refer to this of course, without the slightest ill-feeling, let us advance by all means. But I cannot help thinking how much better it would have been if the ingenious men, who have originated these "systems," had invented something of their own instead of depending on me altogether.

Before 1900 two most valuable improvements were made. One of these was my individualized system with transmitters emitting a wave-complex and receivers comprising separate tuned elements cooperatively associated. The underlying principle can be explained in a few words. Suppose that there are n simple vibrations suitable for use in wireless transmission, the probability that any one tune will be struck by an extraneous disturbance is $\frac{1}{n}$. There will then remain $n-1$ vibrations and the chance that one of these will be excited is $\frac{1}{n-1}$, hence the probability that two tunes would

be struck at the same time is $\frac{1}{n(n-1)}$. Similarly, for a combination of three the chance will be $\frac{1}{n(n-1)(n-2)}$ and so on. It will be readily seen that in this manner any desired degree of safety against the statics or other kind of disturbance can be attained provided the receiving apparatus is so designed that its operation is possible only thru the joint action of all the tuned elements. This was a difficult problem which I have successfully solved so that now *any desired number of simultaneous messages is practicable in the transmission thru the earth as well as thru artificial conductors.*

The other invention, of still greater importance, is a peculiar oscillator enabling the transmission of energy without wires in any quantity that may ever be required for industrial use, to any distance, and with very high economy. It was the outcome of years of systematic study and investigation and wonders will be achieved by its means.

The prevailing misconception of the mechanism involved in the wireless transmission has been responsible for various unwarranted announcements which have misled the public and worked harm. By keeping steadily in mind that the transmission thru the earth is in every respect identical to that thru a straight wire, one will gain a clear understanding of the phenomena and will be able to judge correctly the merits of a new scheme. Without wishing to detract from the value of any plan that has been put forward I may say that they are devoid of novelty. So for instance in Fig. 12 arrangements of transmitting and receiving circuits are illustrated, which I have described in my U. S. Patent No. 613809 of November 8, 1898 on a Method of and Apparatus for Controlling Mechanism of Moving Vessels or Vehicles, and which have been recently dished up as original discoveries. In other patents and technical publications I have suggested conductors in the ground as one of the obvious modifications indicated in Fig. 5.

For the same reason the statics are still the bane of the wireless. There is about as much virtue in the remedies recently proposed as in hair restorers. *A small and compact apparatus has been produced which does away entirely with this trouble,* at least in plants suitably remodelled.

Nothing is more important in the present phase of development of the wireless art than to dispose of the dominating erroneous ideas. With this object I shall advance a few arguments based on my own observations *which prove that Hertz waves have little to do with the results obtained even at small distances.*

In Fig. 13 a transmitter is shown radiating space waves of considerable frequency. It is generally believed that these waves pass along the earth's surface and thus affect the receivers. I can hardly think of anything more improbable than this "gliding wave" theory and the conception of the "guided wireless" which are contrary to all laws of action and reaction. Why should these disturbances cling to a conductor where they are counteracted by induced currents, when they can propagate in all other directions unimpeded? The fact is that the radiations of the transmitter passing along the earth's surface are soon extinguished, the height of the inactive zone indicated in the diagram being some function of the wave length, the bulk of the waves traversing freely the atmosphere. Terrestrial phenomena which I have noted conclusively show that there is no *Heaviside layer,* or if it exists, it is of no effect. It certainly would be unfortunate if the human race were thus imprisoned and forever without power to reach out into the depths of space.

The actions at a distance cannot be proportionate to the height of the antenna and the current in the same. I shall endeavor to make this clear by reference to diagram in Fig. 14. The elevated terminal charged to a high potential induces an equal and opposite charge in the earth and there are thus Q lines giving an average current $I = 4Qn$ which circulates locally and is useless except that it adds to the momentum. A relatively small number of lines q however, go off to great distance and to these corresponds a mean current of $i = 4qn$ to *which is due the action at a distance.* The total average current in the antenna is thus $I_m = 4Qn + 4qn$ and its intensity is no criterion for the performance. The electric efficiency of the antenna is $\frac{q}{Q+q}$ and this is often a very small fraction.

Dr. L. W. Austin and Mr. J. L. Hogan have made quantitative measurements which are valuable, but far from supporting the Hertz wave theory they are evidences in disproval of the same, as will be easily perceived by taking the above facts into consideration. Dr. Austin's researches are especially useful and instructive and I regret that I cannot agree with him on this subject. I do not think that if his receiver was affected by Hertz waves he could ever establish such relations as he has found, but he would be likely to reach these results if the Hertz waves were in a large part eliminated. At great distance the space waves and the current waves are of equal energy, the former being merely an accompanying manifestation of the latter in accordance with the fundamental teachings of Maxwell.

It occurs to me here to ask the question—why have the Hertz waves been reduced from the original frequencies to those I have advocated for my system, when in so doing the activity of the transmitting apparatus has been reduced a billion fold? I can invite any expert to perform an experiment such as is illustrated in Fig. 15, which shows the classical Hertz oscillator and my grounded transmitting circuit. It is a fact which I have demonstrated that, altho we may have in the Hertz oscillator an activity thousands of times greater, the effect on the receiver is not to be compared to that of the grounded circuit. This shows that *in the transmission from an airplane we are merely working thru a condenser,* the capacity of which is a function of a logarithmic ratio between the length of the conductor and the distance from the ground. The receiver is affected in exactly the same manner as from an ordinary transmitter, the only difference being that there is a certain modification of the action which can be predetermined from the electrical constants. It is not at all difficult to maintain communication between an airplane and a station on the ground, on the contrary, the feat is very easy.

To mention another experiment in support of my view, I may refer to Fig. 16 in which two grounded circuits are shown excited by oscillations of the Hertzian order. It will be found that the antennas can be put out of parallelism without noticeable change in the action on the receiver, this proving that it is due to currents propagated thru the ground and not to space waves.

Particularly significant are the results obtained in cases illustrated in Figures 17 and 18. In the former an obstacle is shown in the path of the waves but unless the receiver is within the effective *electrostatic* influence of the mountain range, the signals are not appreciably weakened by the presence of the latter, because the currents pass under it and excite the circuit in the same way as if it were attached to an energized wire. If, as in Fig. 18, a second range happens to be beyond the receiver, it could only strengthen the Hertz wave effect by reflection, but as a matter of fact it detracts

(Continued on page 87)

My Inventions

(Continued from page 17)

lamp there. It was the exact spot which I had originally chosen.

So it went day after day with variations, but I was determined to achieve at whatever cost and in the end my efforts were rewarded. By the spring of 1884 all the differences were adjusted, the plant formally accepted, and I returned to Paris with pleasing anticipations. One of the administrators had promised me a liberal compensation in case I succeeded, as well as a fair consideration of the improvements I had made in their dynamos and I hoped to realize a substantial sum. There were three administrators whom I shall designate as A, B and C for convenience. When I called on A *he* told me that B had the say. This gentleman thought that only C could decide and the latter was quite sure that A alone had the power to act. After several laps of this *circulus vicious*, it dawned upon me that my reward was a castle in Spain. The utter failure of my attempts to raise capital for development was another disappointment and when Mr. Batchellor prest me to go to America with a view of redesigning the Edison machines, I determined to try my fortunes in the Land of Golden Promise. But the chance was nearly mist. I liquefied my modest assets, secured accommodations and found myself at the railroad station as the train was pulling out. At that moment I discovered that my money and tickets were gone. What to do was the question. Hercules had plenty of time to deliberate but I had to decide while running alongside the train with opposite feelings surging in my brain like condenser oscillations. Resolve, helped by dexterity, won out in the nick of time and upon passing thru the usual experiences, as trivial as unpleasant, I managed to embark for New York with the remnants of my belongings, some poems and articles I had written, and a package of calculations relating to solutions of an unsolvable integral and to my flying machine. During the voyage I sat most of the time at the stern of the ship watching for an opportunity to save somebody from a watery grave, without the slightest thought of danger. Later when I had absorbed some of the practical American sense I shivered at the recollection and marvelled at my former folly.

Tesla in America

I wish that I could put in words my first impressions of this country. In the Arabian Tales I read how genii transported people into a land of dreams to live thru delightful adventures. My case was just the reverse. The genii had carried me from a world of dreams into one of realities. What I had left was beautiful, artistic and fascinating in every way; what I saw here was machined, rough and unattractive. A burly policeman was twirling his stick which looked to me as big as a log. I approached him politely with the request to direct me. "Six blocks down, then to the left," he said, with murder in his eyes. "Is this America?" I asked myself in painful surprise. "It is a century behind Europe in civilization." When I went abroad in 1889—five years having elapsed since my arrival here—I became convinced that *it was more than one hundred years AHEAD of Europe* and nothing has happened to this day to change my opinion.

Tesla Meets Edison

The meeting with Edison was a memorable event in my life. I was amazed at this wonderful man who, without early advantages and scientific training, had accomplished so much. I had studied a dozen languages, delved in literature and art, and had spent my best years in libraries reading all sorts of stuff that fell into my hands, from Newton's *"Principia"* to the novels of Paul de Kock, and felt that most of my life had been squandered. But it did not take long before I recognized that it was the best thing I could have done. Within a few weeks I had won Edison's confidence and it came about in this way.

The S. S. *Oregon*, the fastest passenger steamer at that time, had both of its lighting machines disabled and its sailing was delayed. As the superstructure had been built after their installation it was impossible to remove them from the hold. The predicament was a serious one and Edison was much annoyed. In the evening I took the necessary instruments with me and went aboard the vessel where I stayed for the night. The dynamos were in bad condition, having several short-circuits and breaks, but with the assistance of the crew I succeeded in putting them in good shape. At five o'clock in the morning, when passing along Fifth Avenue on my way to the shop, I met Edison with Batchellor and a few others as they were returning home to retire. "Here is our Parisian running around at night," he said. When I told him that I was coming from the *Oregon* and had repaired both machines, he looked at me in silence and walked away without another word. But when he had gone some distance I heard him remark: "Batchellor, this is a d—n good man," and from that time on I had full freedom in directing the work. For nearly a year my regular hours were from 10.30 A. M. until 5 o'clock the next

morning without a day's exception. Edison said to me: "I have had many hard-working assistants but you take the cake." During this period I designed twenty-four different types of standard machines with short cores and of uniform pattern which replaced the old ones. The Manager had promised me fifty thousand dollars on the completion of this task but it turned out to be a practical joke. This gave me a painful shock and I resigned my position.

Immediately thereafter some people approached me with the proposal of forming an arc light company under my name, to which I agreed. Here finally was an opportunity to develop the motor, but when I broached the subject to my new associates they said: "No, we want the arc lamp. We don't care for this alternating current of yours." In 1886 my system of arc lighting was perfected and adopted for factory and municipal lighting, and I was free, but with no other possession than a beautifully engraved certificate of stock of hypothetical value. Then followed a period of struggle in the new medium for which I was not fitted, but the reward came in the end and in April, 1887, the Tesla Electric Company was organized, providing a laboratory and facilities. The motors I built there were exactly as I had imagined them. I made no attempt to improve the design, but merely reproduced the pictures as they appeared to my vision and the operation was always as I expected.

In the early part of 1888 an arrangement was made with the Westinghouse Company for the manufacture of the motors on a large scale. But great difficulties had still to be overcome. My system was based on the use of low frequency currents and the Westinghouse experts had adopted 133 cycles with the object of securing advantages in the transformation. They did not want to depart from their standard forms of apparatus and my efforts had to be concentrated upon adapting the motor to these conditions. Another necessity was to produce a motor capable of running efficiently at this frequency on two wires which was not easy of accomplishment.

At the close of 1889, however, my services in Pittsburg being no longer essential, I returned to New York and resumed experimental work in a laboratory on Grand Street, where I began immediately the design of high frequency machines. The problems of construction in this unexplored field were novel and quite peculiar and I encountered many difficulties. I rejected the inductor type, fearing that it might not yield perfect sine waves which were so important to resonant action. Had it not been for this I could have saved myself a great deal of labor. Another discouraging feature of the high frequency alternator seemed to be the inconstancy of speed which threatened to impose serious limitations to its use. I had already noted in my demonstrations before the American Institution of Electrical Engineers that several times the tune was lost, necessitating readjustment, and did not yet foresee, what I discovered long afterwards, a means of operating a machine of this kind at a speed constant to such a degree as not to vary more than a small fraction of one revolution between the extremes of load.

The Invention of the Tesla Coil

From many other considerations it appeared desirable to invent a simpler device for the production of electric oscillations. In 1856 Lord Kelvin had exposed the theory of the condenser discharge, but no practical application of that important knowledge was made. I saw the possibilities and undertook the development of induction apparatus on this principle. My progress was so rapid as to enable me to exhibit at my lecture in 1891 a coil giving sparks of *five inches*. On that occasion I frankly told the

(*Continued on page* 89)

FUTURE RAPID TRANSIT

(*Continued from page 7*)

an airplane and provided with planes or wings. This provision of planes on either side of the car renders it possible to modify their angle of incidence, to relieve the supporting rail of a larger part of the weight of the vehicle.

The aërial monoflier, as our artist has here depicted, may be propelled by means of one or more propellers placed either at one end of the car or at both ends, and in any case these could be electrically driven, the current necessary for operating the electric motors being taken thru appropriate contact shoes or brushes, resting in contact with insulated conducting rails fixt to the frame-work upon which the monorail is supported. The end view of the monoflier shows clearly the arrangement of the two third rails, one on either side of the monorail, constructed so that they may also serve to insure the maintenance of the car in the proper vertical position, by preventing any lateral displacement thereof. For the purpose of maintaining the car in the proper vertical position by virtue of the third rails just mentioned, there are provided two series of wheels inside the car, as the end view indicates, one set on either side of the monorail structure. From one end of the car to the other, the slot, as it might be called, slightly expands so that the car can negotiate curved sections of rails, which it could not do if the slot running thru the car from front to rear were made perfectly straight. The car is provided with electric lights and the usual protective features, such as electric braking means, electric fans in warm weather, signal lights, etc. The motorman, whose cab is placed in the forward part of the car, has full control of the electric propeller motors, and he can also change the angle of the planes, on either side of the monoflier, so as to cause it to practically float in the air when it is under full headway, the monorail passing thru its center merely acting as a guide rail along which it flies. Electric heaters could be used in the cold weather, and for heating coffee and cooking light meals, etc., in the buffet lunch on board, electric stoves would be available.

In general the monoflier is ovoid in form, thus following the latest practise in the design of dirigible airships, so that it will encounter the minimum of resistance from the air during its displacement. Such a craft should be easily able to attain a speed of 175 to 200 miles an hour and higher, as when it has attained its highest velocity and the planes are properly elevated, the craft will be practically *floating in the air*, without encountering any retarding friction from engagement with the monorail, excepting when passing around curves. Even here the friction which would normally be encountered might be reduced considerably if not entirely obviated by the provision of a proper air rudder at the rear of the car. When the car had reached the end of its run, owing to its peculiar ovoid shape, etc., it would have to be reversed in position before starting back, or else sent back to its destination by a parallel monorail system, which would undoubtedly be the usual practise, much in the manner shown in the accompanying view. Undoubtedly in the years to come, when such highly congested localities as New York City have become more and more built up with towering office structures, with a daily working population of say 12,000,000 to 15,000,000 people, and the subways and street elevated lines have become crowded to the limit of endurance, then it seems that such a system as this should serve a very useful purpose indeed.

If such a system as here illustrated were properly constructed and designed, it would not only serve as a fine piece of industrial engineering, but it would also give

high speed traveling facilities for suburbanites, who have to travel ten to twelve miles every night and morning to and from business, such as those who live in the rapidly developing Westchester County section, where undoubtedly many hundred thousand of New York's future populance will reside, as well as those who will make their homes on Long Island.

As the illustration shows, the monoflier is divided into several floors, and if desired, each floor may be subdivided into compartments. The lower floor is preferably reserved for luggage, freight and mail, while the upper floor may be very well utilized for the electric motors operating the propellers and lifting planes. Stairways lead from the lower floors to the upper floor or floors, depending upon the size of the car. The main frame-work of the car is composed of rolled steel sections, and the rest of the structure including the floors and outer covering is of aluminum, the seams being electrically welded so as to present a perfectly smooth surface on the entire exterior in order to minimize the resistance to the air. The windows, which afford an excellent view to the passengers as they skim along over the tops of the skyscrapers far above the city and the surrounding country, are fitted with the new unbreakable glass. Also the outer contour of the windows and doors are made so as to fit very tightly and to preserve an even surface both vertically and horizontally for the purposes aforementioned.

Some other novel features involved in the design of this aërial monoflier, which seem to possess great practicability are as follows: The inventor points out that in order to impart greater stability to the car, its longitudinal axis should preferably be located below the top of the monorail. In other words, the greater part of the weight should be distributed on a line below the monorail level, which line is at a point about one-third the height of the car from the top of the same. The large wheels in the interior slot of the car, which rest on the upper or monorail, are heavily flanged. In order to provide against the possibility of the vehicle leaving the track vertically under the influence of the air pressure beneath its wings, the lower portion of the third rail rollers may be given a circular flange, which in the case under consideration would bear against the lower flange of these rails, and thus serve to maintain the car in contact with the rails. The car could be made longer as desired, but, of course, it could not be made too long, or otherwise it would be impossible to turn curves, unless they had very long radii.

Most probably the reader has become interested in the general working principles of such an aërial monoflier system, particularly in the probable arrangement of the stations, which could be of several types, as our illustration herewith shows. Some of the stations could be erected on the roofs of tall buildings where these were of appropriate height for the purpose, and in some cases where the railway past directly thru the tower of the skyscraper, the station could be built in the "hole in the wall", as it might be called. Each station could be designed in several ways—for instance, it might in some cases be provided with one platform, and the passengers on the monoflier in this case would have to descend from the upper to the lower floors by means of the stairways provided in the car, before reaching the station. The station platforms could be enclosed and provided with sliding doors, so as to be draft-proof in the cold weather, and high speed express elevators would carry the passengers from the aërial railway station to the street, or by taking a local elevator, they could alight on any floor of the building—all of which seems very good from a strictly engineer point of view.

LOCATING ENEMY GUNS BY FLASH AND SOUND

(*Continued from page* 14)

As the name suggests, "sound ranging" is based for its operation on the transmission of sound, either thru the air or thru the earth, whenever a gun is fired. Some of this work is performed in conjunction with the flash spotters, for by observing the flash of a distant gun, and then counting the seconds on a split-second watch until the sound is heard, the distance at which the gun is located may be accurately computed, as the velocity of sound thru air is about 1,100 feet a second. The velocity of light is practically instantaneous, or 186,000 miles per second, and secondly it serves very accurately to consider the flash of the gun as the starting point of the onward journey of the sound wave. The accurate locating of any gun is accomplished by having two observers take telescopic or other sightings on the gun, and noting the distance between the two observers and the angles as measured on their respective instruments. Thus it is a simple matter to solve accurately by triangulation the definite location of the enemy cannon.

This is only one side of "sound ranging" science, however, as applied to modern artillery tactics, and the scientists and engineers connected with the work of the artillery, particularly the locating of enemy gun positions, early in the war worked out a highly sensitive sound detecting apparatus which picked up the sound of enemy guns, even at a great distance, as transmitted thru the earth. For this purpose detectaphones and Audion amplifiers prove highly efficacious. Enemy guns 15 miles distant were accurately located by this means, the same triangulation maneuvers as previously outlined being followed. Two and usually three observation (sound-detecting) points being employed, advantage being taken of the values as given by the velocity of sound when transmitted thru the earth, and also by the difference of time at which these sounds arrive at different sound-detecting stations. Used in conjunction with the regular angular measurements, the locating of enemy guns became as simple to General Pershing's artillerymen as weighing out a pound of butter would be to a groceryman.

EXPERIMENTS IN RADIO-ACTIVITY.

Part III.

(*Continued from page* 35)

radio-activity noticed that radium induced an activity into substances placed in its vicinity. This induced activity was found to consist of an active deposit formed by the disintegrating radium. In the spinthariscope the lens portion was found to assume this induced activity because of its proximity to the active substance. This may be easily shown by use of the electroscope, described in the first article. Using the spinthariscope in the possession of the author, the following results were obtained:—empty, the electroscope discharged in 700 seconds; the lens portion was then removed and introduced into the electroscope. This time it only required 320 seconds. This conclusively shows that radium induces an activity into other objects exposed to its radiations. This induced activity, however, soon decays. Other uses for the spinthariscope will suggest themselves to the reader, but in any case he will certainly never regret purchasing or else making one.

Radiograph Taken by the Author, Using An E. I. Co. Spinthariscope with Lens Removed. The Figure "U" Was Cut from Brass Sheet.

(*To be continued*)

SCIENCE IN SLANG
THE SPECKS IN SPACE

(Continued from page 45)

last is one octillion, five hundred seventy-five septillion. The weight of the Sun is two octillion."

"Then the Sun weighs twenty-three decillion, forty nonillion grains," put in Punk.

"Approximately," returned Stokes, with his quaint smile.

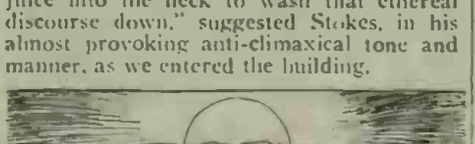
"Do you think that the lines of—er, force, or electricity, that are radiated from the Sun act upon the Earth turning on its diurnal axis and traveling in its course around the Sun in the same manner as the armature of a dynamo?" enquired Bill Dean.

"That is possible, I suppose. At least the radiations from the Sun are, more than likely, responsible for our electrical phenomena and along with it—but we do not know to what extent tho—plant and animal life.

"Some have one theory, some have another, but I would not be surprised at some new stuff that will do to our dope what Galileo did to the old 'Seven Stars' idea. From the thought that our planet was the center (natural to the more or less egotistical Man) of the universe, to the idea that the Sun was IT and then that the Pleiades are the center. Some say they are—we cannot disprove it, as far as I know of the matter. But that is not saying it is final. At present we have no way of peering way out into the infinite space and discerning the outer stellar orbs. With the innovation of the instrument that makes it possible, we will step on a stride further as Galileo did with his telescope, and discover other systems and the orbs that go to make up the system. The more, I believe, we go into the study of the universe and its gloriousness the more aware will we be of its true greatness and vastness.

"Now, as we have inches and feet as linear measurements, we have the distance between the Sun and Earth as the 'Astronomical Unit'—then, when ascertaining the distance of a star way out there in the vast infinite depths that we cannot reach or understand by figures nor even imagination, but can only term Space, by determining its parallax, we are only able to express its distance in 'Light Years'—and when you stop to consider that light travels at the rate of 186,000 miles per second—well buy a tablet and figure it for yourself. To our minds, we cannot conceive of anything without beginning nor end (excluding the circle), and to our minds things must have three dimensions to be understood by us. Now the universe has apparently no beginning nor end as far as we are able to discern.

At this point we drew up at a road house, or Inn. "How about a shot of raspberry juice into the neck to wash that ethereal discourse down," suggested Stokes, in his almost provoking anti-climaxical tone and manner, as we entered the building.



AN OMISSION

We wish to state that credit for the photographs accompanying the article entitled "The City of Splendid Night," by Amos Stote, publisht in the January, 1919, issue, should have been given to the New York Edison Co.

Supplied with current from the light socket, a two-fan electric ventilator has been invented which, when set in a window, draws in fresh air and expels that already in a room.

Edited by H. GERNSBACK

In this Department we publish such matter as is of interest to inventors and particularly to those who are in doubt as to certain Patent Phases. Regular inquiries address to "Patent Advice" cannot be answered by mail free of charge. Such inquiries are publisht here for the benefit of all readers. If the idea is thought to be of importance, we make it a rule not to divulge all details, in order to protect the inventor as far as it is possible to do so.

Should advice be desired by mail a nominal charge of $1.00 is made for each question. Sketches and descriptions must be clear and explicit. Only one side of sheet should be written on.

NOTICE TO CORRESPONDENTS

Questions on Patent Advice are answered in this department every month, and naturally each question must take its turn. We have received so many letters during the past months that it is absolutely impossible for us to answer them all in the "Experimenter." Thus, for instance, the answers appearing in this issue are of letters going back as far as Oct., 1918. We would therefore urge our correspondents to bear this in mind, and if an answer is wanted quickly, correspondents should make themselves acquainted with the rules printed above.

Sectional Automobile Radiator

(318) Edwin Schade, Camden, N. J., writes: "I have noted in a recent magazine a photograph of a pile of automobile radiators that have been damaged in the war. It has been my experience in repairing the present type of radiator that it takes anywhere from one-half hour to as high as three days to fix a leak. This is true especially when it happens to be in the interior. My idea is to build a radiator in units. Should one or more units be damaged, they could be replaced by others in a very short time. Kindly advise if such an idea would be of any benefit, and if it could be patented.

A. It is doubtful that a device of this kind would prove satisfactory, for the reason that there would probably be a good deal of trouble to interconnect the various sections, and there would probably be just as much trouble in keeping these connections from leaking as in a well-made radiator. That a device of this kind can be patented is also very doubtful to us.

Telephone Appliance

(319) R. C. Kennan, Indianapolis, Ind., submits a drawing and description of a telephone appliance which is designed primarily to eliminate trouble for the man who talks several feet away from the phone and expects people to hear him on the other end of the line. The arrangement also permits using the phone without holding the receiver in the hand. Our correspondent wishes our advice if this device is patentable and if we think a market exists for such a device.

A. This is one of those devices of which probably five thousand have been patented in various forms in the past. Our correspondent's device has a lever at the end of which the receiver is fastened. The arm and the receiver swing in a half circle, and is then locked. The subscriber can then talk without using his hands. The hook connection is automatically established as soon as the lever is raised.

A There is nothing new to this and, as we stated, many thousand similar ones have been patented in the past. There does not seem, moreover, to be a market for such an appliance.

Trolley

(320) Frederick E. Barber, Syracuse, N. Y., encloses a sketch and description of a device to keep the pole of a trolley from jumping off the wire. Our advice is asked.

A. We have exprest our views as to trolleys a great many times in these columns. Our advice to trolley inventors is: "don't". Our ideas were fully exprest in a recent answer to one of our correspondents in these columns. We refer to our March issue, page 825, Patent Advice No. 308

Magazine Mailer

(321) Carlyle Rudolph, Minneapolis, Minn., says: "Is there such a thing as a magazine mailer? A machine that folds, wraps, stamps and gets magazines all ready for mailing. I have an idea which I think is worth something, but don't like to start on it until I know if there is anything similar in use."

A. There are certainly machines to do this. For instance, the ELECTRICAL EXPERIMENTER is folded and wrapt every month on a machine of this kind. While the machine does not automatically stamp the wrappers, this, however, can readily be accomplisht by a simple attachment on the market now. If our correspondent has something fundamentally new, he is advised to get in touch with any of the large printing houses who have such machines and he can hear from them as to what the requirements are.

Safety Elevator Device

(322) Ralph E. Hast, Elkins, W. Va., explains his invention as follows: "The idea of this invention is to have a device on elevator doors which, when the doors were closed, would close a circuit, allowing the operator to ascend or descend, but when the doors are *not* closed the circuit would be open, thus rendering it impossible to operate the elevator. The device on the doors would be a partly concealed socket which operates easily but forms a constant circuit when closed and cannot be jarred out of place."

A There is nothing new in our correspondent's idea. Safety devices of this kind have been used for many years, and are in use right now. Take for instance the New York Subway Elevators, particularly the ones at 181st Street and Broadway, operate with this device.

Depth Bomb

(323) George W. Curtis, Detroit, Mich, has invented a depth bomb which works on the sea water-conductivity plan by means of which contacts are closed when the sea water enters the intake of the bomb. Our advice is asked as to the practicability of this device.

A. There is nothing new about this device—many bombs of this kind having been proposed during the war. The regular depth bombs, however, working on the hydro-static principle, are very much simpler and better.

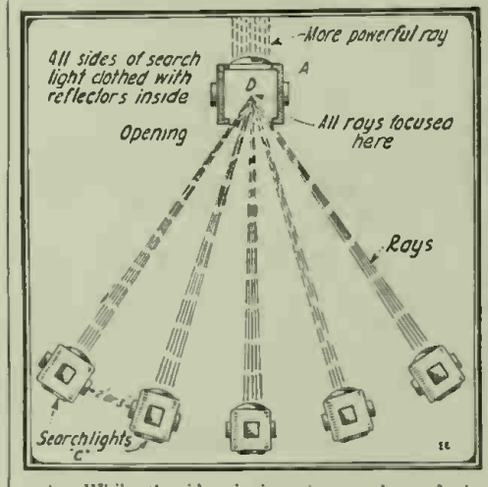
Phonograph Needle

(324) R. W. Napper, B. Guiana, S. America, asks us: "Do you think that a patent of any value could be secured on a double-ended gramaphone needle, i. e., a needle sharpened at both ends? This would tend to save steel, as each needle could be used *twice* instead of only once."

A. We do not think that a needle of this kind would be of great benefit and we believe a needle of this kind was once tried. The reason is that a needle of this sort cannot be held as securely as one with the squared off end; it tends to rattle because the upper end is not supported except by a sharp point.

Searchlight

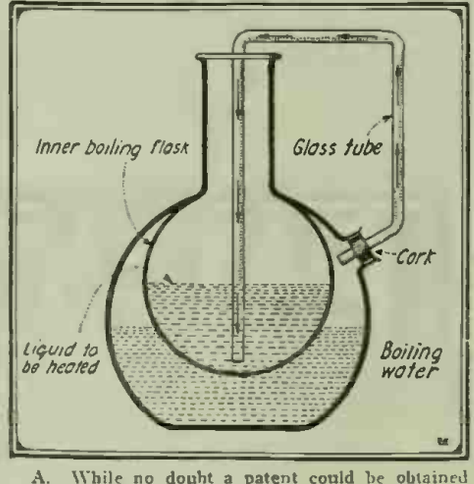
(325) Joel Silver, Newark, N. J., submits the following idea: "I think that if about five searchlights have their rays focused on the inside of another larger searchlight (see illustration) there will be more power; hence a small searchlight, with the aid of others, can be made more powerful. The rear of the main light (A) is cut open (B). All the searchlights (C) have their rays focused upon the center (D) of A. With very good reflectors and a very powerful lens, I am quite sure that a longer distance will be obtained. That is, it will be five times as powerful as one of its size."



A. While the idea is ingenious and no doubt novel, it certainly is not practical, for nothing could be gained either electrically or economically to arrange the searchlights as shown. The reason is that one searchlight can be made to give the same amount of light by using large enough carbons and consuming a corresponding amount of current. Of course, a multiplicity of searchlights are used in a great many cases, but not to concentrate the light on a point. They are usually employed to throw the light over an extended surface.

Chemical Flask

(326) Eug. Lavigne, Montreal, Can., submits diagram and sketch of a combined water bath and boiling flask. It is shown in our illustration. He wishes to know if this idea is patentable and if it is practicable.



A. While no doubt a patent could be obtained on this device, we do not think it would be of much value for the reason that it could be used only in very few cases. As our illustration shows, the evaporating water would flow into the central flask and it is quite certain that more or less water would find its way into the central flask, where surely it is not wanted or needed. This is our main objection to the idea.

In the June issue: "HOW TO FINANCE AND MANUFACTURE A PATENT," by Jay G. Hobson.
A very important article for all interested in patents.

COLD LIGHT

(*Continued from page 23*)

proper conditions the small light wave may be given off by the electron without affecting the whole molecule in the least. *That is cold light.*

An interesting experiment can be performed with a vacuum tube, which illustrates completely the principle of light production by ionization, and at the same time explains the principle of the Moore light. Few people, other than scientists, realize what a peculiar thing the production of light in a vacuum or Geissler tube is. The light is evidently not the product of heat, but depends on the fact that the electric spark breaks the gas molecules up into charged particles or ions. And this phenomena is most noticeable when a certain degree of exhaustion is reached in the tube.

When air is pumped out of a tube in which there is an electric spark discharge, several different stages, as shown in Fig. 3, are successively reached. At first the discharge in the tube is the ordinary disruptive spark. In the next stage it forms a quiet thread of light thru the tube. Then the thread of light becomes a broad pencil of light, and finally with more exhaustion the whole tube is filled with a soft luminous glow, which is technically known as the *positive column*. This is the point of highest conductivity of the tube, and may be reached with an ordinary air pump. With further exhaustion, by means of a special air pump, the resistance increases, the cold light disappears, and the point is reached where X-ray phenomena and fluorescence appear. The color of the light in the tube depends on the gas used in the tube and is undoubtedly the product of the ions. Just before the war a Frenchman, Claude, devised a means of producing in quantities the rare gas, *neon*, which gives an intense yellow light in a vacuum tube. The carbon dioxid which Moore uses gives a white light. Other gases, possibly rare ones, may be found which are better still, and *helium* has been suggested as a standard by some. However, up until the time the U. S. Government discovered the way of producing it in immense quantities for balloon work, during the war, it was too rare to be practical. The more the conditions in such a light can be improved, and the more nearly the light is a pure ionization or cold light, the higher the luminous efficiency will be. An interesting table is given, showing the progress which has been made up to the present, including the vacuum tube.

Luminous Efficiency of Various Illuminants

Candle	2 per cent
Gas mantle	5 per cent
Carbon lamp	6 per cent
Flaming arc	15 per cent
Vacuum tube	40 per cent

REVOLUTION COUNTER FOR DYNAMOMETER

(*Continued from page 39*)

duration of thirty seconds. The time element may be changed at will by the use of saws of any desired number of teeth.

To start the apparatus, the starter button is brought into action until both brushes bear on the metal drum. This completes the circuit and engages the clutch thru the electro-magnet and spring thus starting the counter. At every swing of the pendulum, the circuit thru the solenoid is made and broken, thus drawing the saw—as illustrated—thru a circumferential distance equal to one tooth. After thirty swings of the pendulum one brush is again bearing on the insulated section of the drum and the counter clutch is disengaged. A reading of the counter gives accurately the number of revolutions of the dynamometer in thirty seconds. This counter may also be used in connection with a fuel weighing apparatus.

Contributed by W. H. WEBER.

RADIO DEPARTMENT
Continued

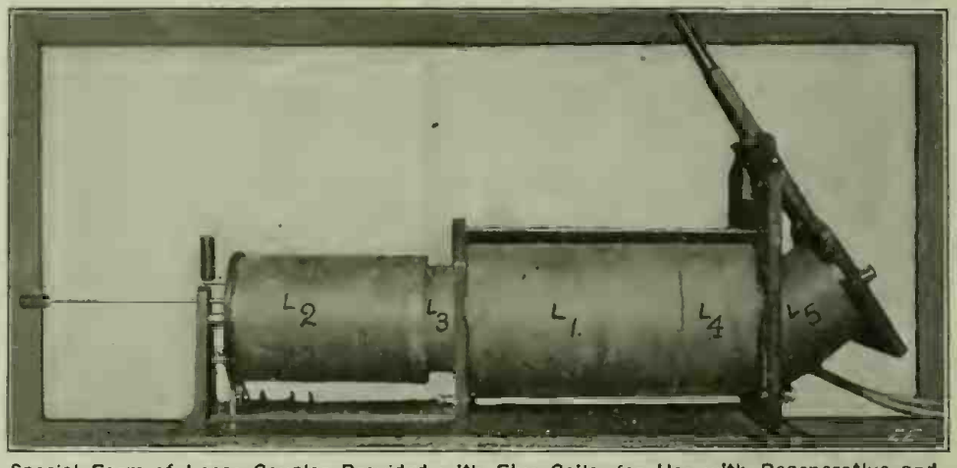
New Regenerative Vacuum Tube Circuits
(*Continued from page 33*)

these wave lengths, the proper size inductances are always to be utilized. It is advisable to use this circuit whenever large amplifications are desired at extremely low wave lengths. Tests have been made with this circuit in comparison with other low wave length regenerative circuits, and it was found that the above circuit gave better and more efficient results and that it was possible to produce regeneration in the plate circuit with much greater ease than that obtainable with the usual type of circuit.

A similar but a more complicated circuit is shown in Fig. 5. The radio frequency bridging condensers C_3 and C_4, are used to permit radio frequency currents to pass freely to the plate.

circuit is to amplify the audio frequency currents of the first vacuum tube. This audio amplification is accomplisht thru coils L_6 and L_7, which are mutually coupled with this arrangement, and it is possible to amplify the signals to 1000 or more times their original value. It was possible, in tests, to amplify signals received from a distance of 5000 miles to such a value as to cause the incoming signals to be heard twenty feet away from the telephone receiver. The telephone receiver was equipt with the proper megaphone.

In Fig. 7 is delineated a radio telephone circuit using a vacuum tube for the generation of sustained oscillations. The grid and plate are coupled magnetically thru inductance L_2, which also energizes the antenna circuit thru inductance L_1. Condenser C is used to tune the oscillatory circuit CL_2. The plate voltage in this work is considerably higher than the plate voltage used in receiving sets and it usually ranges from 300 to 1500 volts. This is usually accomplisht by the use of the generator G. The inductance L_3 which is a choke



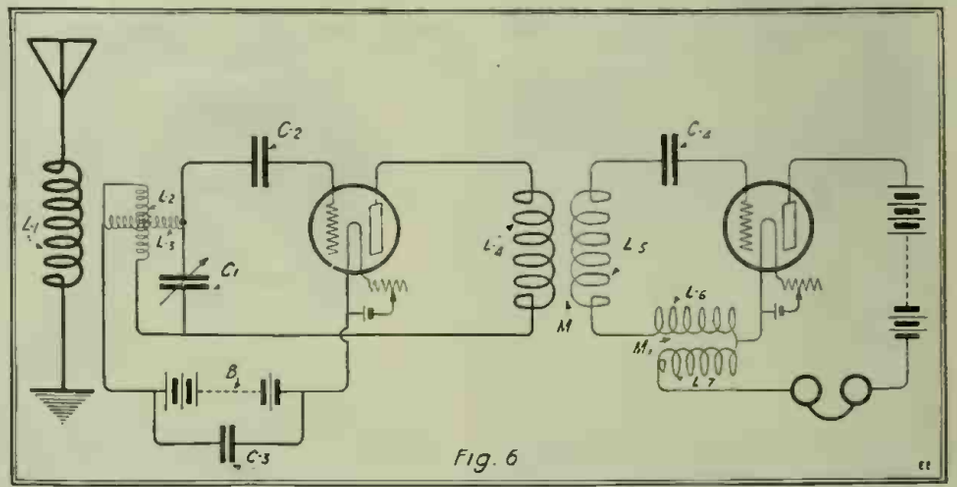
Special Form of Loose Coupler Provided with Five Coils, for Use with Regenerative and Wireless Telephone Audion Circuits Here Described.

With all the above circuits so far described, it will be noticed that the regenerative coupling is accomplished in the antenna circuit, thereby amplifying the incoming radio frequency oscillations and therefore producing maximum amplification without the loss of any feeble currents due to coupling in the secondary oscillatory circuits, which means of regeneration of incoming signals is accomplisht with present forms of circuits. Thus, it is seen that direct results and better efficiency can be accomplisht with the circuits described.

Fig. 6 outlines a circuit similar to Fig. 5 in which the plate of the first vacuum tube is coupled magnetically thru coils L_4 and L_5. The purpose of another vacuum tube coil is used to prevent high frequency currents from the plate circuit entering the generator. Modulation is accomplisht by shunting a telephone transmitter T, thru a resistance R and battery B across the grid and filament of the tube, as indicated.

Another successful circuit is shown in Fig. 8 and voice modulation in this circuit is accomplisht by coupling the telephone transmitter thru an induction coil I, comprising coils L_8 and L_9. The primary L_8 is connected to the transmitter and battery B, as shown. The modulated wave is imprest upon the grid in the vacuum tube, which wave is superimposed upon the main radio frequency oscillations.

(*Continued on page 76*)

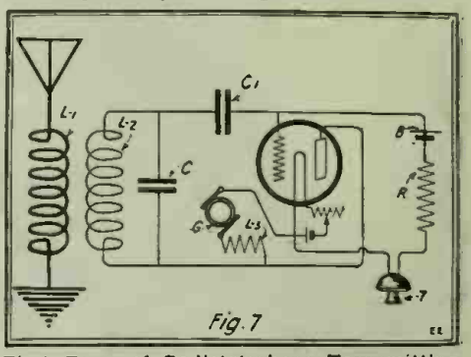


Two Stage Audion Amplifier, the Circuit of the Second Audion Being Magnetically Coupled to the First Audion Circuit. Amplifying Power 1,000 Times and Better.

NEW REGENERATIVE VACUUM TUBE CIRCUITS.

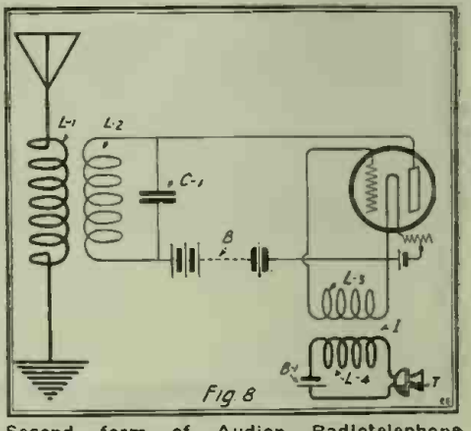
(*Continued from page 74*)

Another circuit to accomplish the same result as above, is indicated in Fig. 9, in which case the oscillations are started thru the coupling coil M and the voice modulation imprest upon the grid circuit is ac-



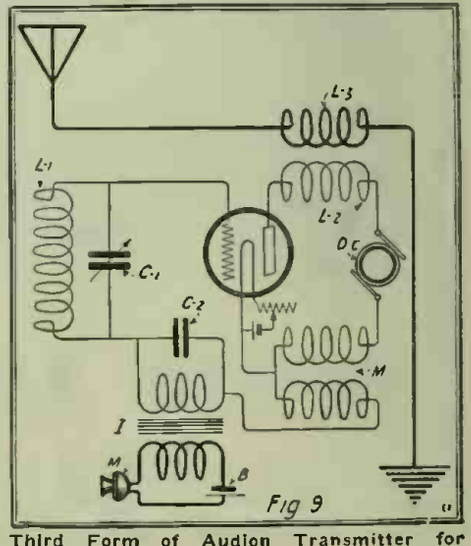
First Form of Radiotelephone Transmitting Circuit, Utilizing an Audion, of Interest to Amateurs.

complished thru the telephone induction coil whose secondary is connected thru the grid and one leg of the coupling coil M, and the other to the main oscillatory coil inductance L_1. The primary of the induction coil is connected with the microphone and battery as indicated. Tuning is accomplished with condenser C_1, which is in the oscillatory circuit C_1L_1. Energy trans-



Second form of Audion Radiotelephone Transmitter with Magnetically Coupled Modulating Circuit.

ferred to the antenna circuit is accomplished thru the plate inductance L_2, inductively coupled to the antenna inductance L_3. To reduce the impedance of the grid circuit due to the high inductance of the secondary of the telephone induction coil, it is necessary to shunt a capacity C_2 of considerable magnitude to overcome this excess impedance.



Third Form of Audion Transmitter for Radiotelephony.

PUTTING IT OVER ON FRITZ.

(Continued from page 22)

see the sector thus marked out—by triangulation the position of every wireless sender could be ascertained—abandoned. This prediction came true every time, and tho the secret was guarded jealously during the war, it now can be let out, as Germany is harmless, and every other nation knows just how the prophecy was made.

It was not often that the Germans kept Allied brains working overtime on a puzzle. In a single instance, however, the Huns thought up a devilishly clever plan for getting secret information into Germany. This was called for weeks and weeks the "Nauen-Madrid Buzz."

Nauen, of course, was the official German Government wireless station, while in Madrid, Spain, was situated a station capable of sending messages to any part of the German empire in Europe. During all the months of the war in which direct communication between Germany and the outside world was practically severed official war bulletins and "inspired" news came out from Nauen thru Madrid. The latter station sent back neutral news and views of the war.

In the spring of 1917, however, came a queer development. Every now and then Nauen would seem to be badly bothered by "static" or by some imperfection in the sending apparatus. The station would emit an unintelligible buzz, like unto no message known to operators. This was regarded with grave suspicion by the Allied intelligence departments, and when Madrid started the same thing a whole corps of military wireless detectives were assigned to the problem. No one doubted that this was some new form of communication, but what on earth could anyone make out of that continuous buzz?

Weeks past with no light on the question. The two stations had grown bolder and were using the buzz constantly. Valuable information leaked to the enemy, and it was made practically certain that the "buzz" was responsible.

The mystery was solved by the help of a lucky accident. The technique of studying every code wireless message of the enemy had been to take down the sounds of the spark on a cylinder phonograph record; this gave the intelligence officer an accurate reproduction at any time he desired. On the occasion mentioned an officer had been trying to establish some basis of similarity between several of the records without success, when his machine ran down. As the needle grated to a stop on the cylinder the officer sat up suddenly. He thought he detected something that sounded just a little like a message!

He wound the phonograph and turned its speed indicator down so that the record revolved only a few times a minute. Then he applied the needle again. Aha! *There was something there!*

Tho this arrangement gave him insufficient to enable him to solve a code, he had the idea. Next the phonograph cylinder was attached to a motor, revolving at three hundred revolutions a minute, and several records taken at high speed of the peculiar buzz. When these records were re-run at moderate speed it was simple; the messages were decoded in an hour and were found to be questions and answers on topics the Germans were not even supposed to know existed!

The method used by the Germans and by the Madrid operator had been simply to punch in the message on a perforated paper roll. Then running this thru the sending equipment at high speed the message had gone into the ether waves at too rapid a rate to be caught by ordinary methods. At the other end the receiving station used the phonograph equipment to catch and record the message.

Advertising Talks
NUMBER 2

IF you have ever stopped to figure out the terrific cost involved in publishing a magazine, and the small amount of money that you pay for your issue each month, you probably wonder how a publisher can afford to give you as much as he does. If it were not for the advertising carried, he could not do it. Your 20c would not buy a magazine one-half the size, or quality, of the "Experimenter" unless that magazine were supported by the advertisers who use its columns every month.

The *Electrical Experimenter*, especially, costs a vast sum of money every month to produce. The magnificent wash drawings and expensive cuts that you see in every issue and which have made the "Experimenter" famous are only one of the many items that makes the publishing of your magazine a severe and heavy strain. The price you pay for your copy helps to meet part of this expense, but the advertisers foot the most of the bills. Don't let that fool you, however. They are not doing it for any love of the "Experimenter"—it is a business proposition with them. Each and every one have something that they feel is of interest to you. Perhaps it is a piece of merchandise that they want to sell; a new wireless outfit, a correspondence course that they know will improve your mind and equip you to earn more money; maybe it is a book or a novelty that you would enjoy having; but, whatever it is, they are willing to pay their good money to support the magazine in order that the magazine can print their advertisements.

The more advertisers we have, the more income there is each month, and the publishers of the *Electrical Experimenter* have committed themselves to putting back into the magazine, in enlarging its size, and improving its articles, and its drawings, every penny that comes in through the circulation or advertising. You will notice that with this issue eight more pages of *pure text* have been added, making this number the biggest ever published. This was made possible by the big increase in advertising during the past few months. You can help the work along and make the magazine still larger and better, if you will purchase what you need and the things you require in your work or for your pleasure, from the advertisers who are helping you. Read what they have to say in every issue, and when you want anything, no matter what it is, look it up in the advertising columns of the "E.E." and send your orders to those firms who are helping give you a magazine that you would not want to do without.

Live concerns that advertise sell better goods and at a cheaper price, *quality considered*, than unknown firms who persist in "hiding their light under a bushel." Next month I will tell you the real reasons why the quality of any advertised article has to be the very best and show you why you should patronize your own advertisers for this one reason, if for no other.

Advertising Manager.

PRACTICAL CHEMICAL EXPERIMENTS

(*Continued from page 34*)

clean cut, due to the shears. Since new wool is distinctly elastic, there is a certain amount of *give* to the fibers when subjected to tension. In the case of wool that has been scoured and dyed, the elasticity has somewhat decreased, the fibers becoming considerably firmer. If subjected to tension and rupture, the break has the appearance of a fracture, like a bone.

Referring to Figs. 9 to 18, inclusive, Fig. 9 shows shoddy made from new, fine, blue worsted clips. Notice the great variety of broken ends of fibers, and also the tendency of the fibers to split or tear lengthwise. The fibers showing the side breaks are evidently due to a tearing action of the shoddy machine.

Fig. 10 is a shoddy made from new, fine, black worsted clips. Here again may be noticed their peculiar terminal fractures, where the fiber has been pulled asunder. One of the fibers has a number of *spines* projecting from it. These so-called *spines* are really the fiber cells, which, no doubt, were loosened by the tension on the fibers in the machine. Note that both Figs. 9 and 10 represent new wool that has been simply mechanically reduced to shoddy, and at no time carbonized.

Fig. 11 is shoddy made from carbonized brown serge. Here it may be seen what indicates the brittle character of the fiber, devoid of elasticity. The breaks of the fibers are seen to be quite abrupt.

Fig. 12 is a shoddy made from brown serge that has been carbonized and subsequently stript. The abrupt character of the breaks is plainly noticeable, while at the same time the fibrils comprising the body of the wool fiber are very distinct. Their presence may be attributed to the chemical action of the stripping.

Fig. 13 shows fibers made from blue serge that had been first carbonized, then stript, and afterwards dyed green. Here again we notice the tendency to break longitudinally, and where a terminal break occurs, the fibrils appear distinctly.

Fig. 14 is shoddy from the same batch as that shown in Fig. 12, except that it has been dyed a full red. Here we notice that one of the fibers has been split longitudinally, while the other three fiber terminals show break characteristics that indicate the brittleness of the stock.

Fig. 15 was originally a brown serge that had been carbonized, then stript, afterwards dyed a deep orange, and finally garneted. A great majority of the breaks of fibers in this sample are extremely abrupt. There appears to be no longitudinal ruptures, and this seems to indicate little or no elasticity. Even the fibrils do not show plainly.

Fig. 16 is a shoddy made from brown serge that has been carbonized, stript and dyed an olive shade. Here again we see the abrupt fractures of the fiber and a tendency to longitudinal splitting. The fibrils are entirely wanting.

Fig. 17 is a shoddy made from various knit goods of different colors that were first carbonized, then stript, and afterwards dyed blue, producing finished colors of varied hues. The fibers show a rather curious side abrasion; a form of mutilation that appears to be quite common in this lot of shoddy.

Fig. 18 is a shoddy made from serges that were carbonized, stript and dyed a deep maroon. It will be seen that the tendency of some of the fibers is to split longitudinally. The terminal shown is characteristic of a fiber pulled apart lengthwise, when the fibrils have a tendency to separate, forming a brush-like head.

The various characteristics above re-

ferred to, and illustrated, will serve to draw attention to what one must look for in an examination of cloth that is believed to contain shoddy. In masses of shoddy such as are usually taken for microscopic examination, there will always be found many short fibers due to mechanical breaking of long fibers, but to separate them is an operation of great delicacy, tho yielding results of no value.

THE "BURNING" TEST

Vegetable fibers may be readily distinguished from animal fibers by burning. Animal fibers, such as Wool and Silk give off the smell of burnt horn. They do not fire like vegetable fibers, but cease to burn when removed from the flame, and the burnt portion curls up, forming a hard cinder at the end of the thread. Vegetable fibers, on the other hand, give off a slight smell of burnt wood when ignited. They burn away very rapidly with a flash, leaving no hard cinder, but a white or gray ash only. The above tests broadly distinguish vegetable from animal fibers, but further chemical examination is necessary to distinguish mixtures of any of them when woven into cloth. (See Fig. 19.)

Referring again to Figs. 1 (Cotton) and 4 (Linen) we can readily distinguish the difference by means of the microscope as shown. If the fabric is without starch, oil makes linen translucent and cotton opaque. The finish must be washed out of highly finished materials before this test can be used.

A test to distinguish between linen and cotton, which only an expert, or at least a person having quite some experience, can perform, consists of what is known as the *"tearing"* test. The linen weaves in general are more difficult to tear than cotton. The torn ends of the linen threads appear uneven in length and the individual fibers are twisted in every direction. The sound of tearing linen is shrill, and that of cotton dull or muffled.

An easy way to distinguish between the highly-sized and calendered *Cotton Damask* and true *Linen Damask* is to boil a sample. After being dried and ironed, if it is *cotton it will have a dull and somewhat fuzzy appearance*, while the *luster and smoothness of real linen will not be affected* by this treatment. *Mercerized Cotton Damask* keeps more luster than untreated cotton, but less than linen.

Since the price of pure, new wool is relatively high, it is the practise of manufacturers to mix other materials with it, the most common of which is *"Shoddy."* Such goods have many uses, being a full-bodied, but flimsy fabric, it is made chiefly into cheap cloth, table covers, etc. Manufacturers state that the best grade of worsted shoddy—that having long fibers—is superior to a low grade, short staple, new or virgin wool; also that it is impossible to get the texture and finish required for some of the best grade goods *without* the use of some shoddy. Owing to the fact that shoddy is made from wool fibers, as stated under the heading "Shoddy," it is very difficult to determine its presence by chemical means, owing to the fact that it will respond to the same tests as applied for wool. The microscope is the most accurate means available for determining the presence of shoddy in woolen cloth. It is true that the rough feel and cheap appearance of the fabric gives some idea of the presence of a *large percentage of shoddy*, but the famous "feeling test" for cotton or shoddy in moderate quantities must give way today to a more scientific analysis, as herein given.

Shoddy is not alone as an adulterant of woolens. Cotton is employed quite extensively. It is a simple matter to detect the presence of cotton, *as wool is dissolved in alkalies* and *not affected by acids* while on the other hand *cotton is dissolved by acids* and *not affected by alkalies*. Fig. 20 shows

a convenient method of testing for cotton and wool. One glass contains a solution of Caustic Potash or Caustic Soda into which is immersed a sample of the wool to be tested. A precipitat indicates the relative amount of cotton and other substances present. Likewise when cotton is immersed in an acid, the precipitat will show the relative amount of adulterants. See Fig. 7.

It is easy to determine heavily-weighted silk material by burning a small sample. Pure silk burns rapidly, smells like wool, and produces a small amount of brittle, curled-up ash. Material which is heavily-weighted will have an ash which is stiff and which often holds the shape of the sample. Cotton is frequently mixt with silk. It is easy to detect cotton in silk by the microscope, as the fibers of silk are round and smooth, while the cotton fibers are ribbon-like and fuzzy. See Fig. 8. Cheap but heavy silks are usually loaded with lead in granular form. A chemical test for lead will readily reveal its presence.

QUESTIONS AND ANSWERS

Ques. No. 5. Edward J. Walsh, Lexington, Ky., wants to know how he can remove Iodin stains from light clothing.

Ans. You fail to state whether the material from which you desire to remove the stains is starched or unstarched. This is an important factor. Stains which are present in unstarched material produce a brown or yellow stain. Whereas on starched materials, the presence of starch causes the stain to become deep blue or black.

Fig. 21. Removing Iodin Stains from Light or Other Colored Cloths By Application of Ammonia. The Ammonia May Be Applied With a Glass Rod or Sponge, and Should Be Immediately Washed Out as Soon as the Iodin Stain Is Removed.

For unstarched stains, sponging with Ammonia, or alcohol, the latter being frequently used on materials which water would injure. See Fig. 21.

Starch, such as prepared for laundry purposes may be used for washable materials. Immerse the stained parts in the starch and boil. It first turns blue and then disappears. Flour may be used in the same manner as the starch.

For starched materials, the stains may be immersed in a dilute solution of Sodium thiosulfate (known photographically as "Hypo") and then rinsed thoroly. Sodium sulfite (not sulfate) may be used in the same manner as the thiosulfate. Another method is to soak the stains in dilute ammonia (sp. gr. 0.95) until they disappear.

HOW THE FRENCH LOCATED SUBMARINES.

(*Continued from page 9*)

major problems, if not indeed the predominant one, to be met with in working out a more selective and accurate form of submarine listening device was that, whatever its form, it should be susceptible of operating and functioning on any vessel while it was under full headway, and further, that the indications given by the instrument of the direction of such sounds should be sufficiently accurate to permit the commander of the vessel on which it was installed to set a straight course for the indicated spot where the submarine lay in wait for its prey. Contrary to general opinion, many authentic instances are on record where submarines were surprised in this way during the war and sent to the bottom, sometimes by armed merchantmen or converted yachts, and again by fast destroyers or submarines. The English in particular seem to have obtained very gratifying results in fighting the U-Boats with their own submarines.

Lieut. Walser designed his apparatus after first carefully studying a well known, yet heretofore overlooked, principle of physics, viz: that sound, identical to light, upon passing thru one medium into another, is *refracted*. The orthodox theory concerning the complex light beam or ray from a given object states that they comprise a number of component waves, which may be considered as parallel when their source is situated a sufficient distance, and which parallelism is upset only when an obstruction is placed in their path, when they are thus caused to enter a new medium having a density of a different value from that in which they were propagated. Lieut. Walser had the forethought to perceive that sound waves must follow the same theory. To prove his theory, he interposed in the path of sound waves a device which would respond to various vibrations, and which formed what we might term an *acoustic lens*. As has been found in explaining the theory of light transmission, a similar effect takes place in sound transmission thru the air or water and other mediums, and the result of thus interposing such an acoustic lens or vibrating member causes the individual waves composing the complex wave propagated from a given source to come to a focus. This has the two-fold effect of intensifying the individual waves and also of isolating them precisely from other sounds emanating from the sources foreign to the one being localized. Naturally, the different sources of sound will create a corresponding number of foci, of which the geometric focus can be ascertained by mathematical computation. In a similar manner from the position of the sound focus which corresponds to any individual source of sound, the definite direction of that source can be readily estimated.

The accompanying illustrations show the "Walser submarine detector" gear as installed on French vessels, and the detail view shows how the sound detecting lenses, which are fitted into large steel bulges or "blisters", secured to the hull of the vessel, are connected to two trumpets, which may be traversed in a circle above them, so as to accurately localize the various sounds heard from different vibrating diaframs comprising the lenses. One trumpet picks up and localizes the sounds from the *port* lens, and the other the sounds picked up and intensified by the *starboard* lens. The spherical segments supporting the multiplicity of lenses is indicated by *A* in the detail figure. This segment is provided with a circular series of openings, *B*, each of which contains a sensitive vibrating diafram, *C*. The general effect of this arrangement is to focus all of the sounds picked up, the focal points all lying on a circle, *I*. As aforementioned, the vessel fitted with this apparatus has two of these lenses, one to *port*

and one to *starboard* of the keel. Just over these two lenses, there is built a specially solid sound-proof room or cabin, in which the operator of the submarine detector is located. The arrangement of the apparatus is such that the operator can sit in the center of the cabin with the listening helmet on his head, and by means of two ear trumpets. *D*, in the diagram, any sounds passing thru the lenses can be quickly picked up and localized for direction. One trumpet takes care of the sounds from the port lens and the other the starboard lens.

By means of the large rotating drum, which appears just to the right of the operator, the edge of said drum being calibrated, so that as the handle of the drum is turned the trumpets over the lenses are rotated about the respective focal circles of any sounds received. The control drum, which is manipulated by the operator, revolves the trumpets, *D*, which are pivoted on a fork, *E*, thru the movement. *H*. *J* represents the counterweight, which by means of cord, *K*, maintains the trumpet in such a position that its axis is always pointed toward the center of the spherical lenses. The function of the counterweight, *L*, is to maintain the balance of the movable arm on which the trumpet is supported, while the weights, *M*. *M'*, cause this arm to oscillate about the pivots, *N*, *N'*, in such a way that the rolling of the vessel is counterbalanced, thus tending to keep the mouth of the trumpet in the same horizontal plane at all times. The complete apparatus is carried by the metal frame marked *O*.

With the apparatus in use, the operator hears the sound with the greatest intensity and sharpness when the trumpet axis is in line with the focus of that particular sound. He can also hear a certain sound when the trumpet is anywhere in the vicinity of the focal point. The operator proceeds in any event to explore the various foci by manipulating the central control drum, which revolves the trumpets around the focal circles. This centralized control drum having been calibrated beforehand, it becomes a simple matter for the observer to accurately locate the direction of a certain sound, or more strictly speaking,—its origin, as soon as he has manipulated the trumpet to the proper focal setting, so as to hear the received sound with the greatest intensity and clarity. By a quick calculation based upon the value of the minimum intensity of the sound received, the range of the submarine can be approximately calculated. It is then a comparatively simple matter to steer a straight course for this spot, and if the object of the search turns out to be a submarine, then the destroyer will pass over it and discharge depth bombs upon it.

Of course the wiseacre will say, it is all very well to locate a submarine and then steering a course so indicated for the object of dropping several carloads of "ash cans" (depth bombs, in navy vernacular) upon it, but what about the movements of the U-Boat, which may have paddled off a mile or so from the spot so dear to the heart of the naval officer. This problem would seem to be solved by the fact that contrary to the usual apparatus utilized for such purposes heretofore, the operator may keep right on taking the soundings of the submarine, while the vessel is under full headway and moving toward it. The sensations experienced by the submarine detection officer located in his steel-bound cubbyhole down near the keel of the on-rushing vessel, as the sound of the submarine's engines and propellers pound louder and louder in his ear trumpets, probably can be better imagined than described, for the submarine commander may have a "card up his sleeve" and be just about scrappy and clever enough to lay for the on-coming destroyer or war vessel and discharge a torpedo at it or open up with a broadside from some nifty "seven inchers."

THE THOUGHT RECORDER

(*Continued from page 12*)

ent upon wave motion, it should not be surprising therefore that thoughts or active thinking should give rise to wave motion as well.

This theory is greatly strengthened by the fact that it has been proven beyond doubt that active thinking necessitates an expenditure of energy. If you sit perfectly quiet in a chair without expending any visible muscular energy, and if you concentrate very hard upon a certain problem, it is not infrequent that perspiration appears on your forehead from the simple effort of thinking. Of course, this is rather a complex phenomenon, as the perspiration is not produced directly, but rather indirectly by the nerve centers working upon the human organs, principally the heart. Nevertheless, we know that thinking proper calls for an expenditure of energy in the brain itself. That this energy is considerable can also be shown experimentally.

It therefore cannot come as a surprise that the act of thinking should give rise to a direct wave motion, sending out from the brain certain waves in an analogous manner, to the spoken word which produces sound waves of a certain wave length. It is quite probable, however, that thought waves are simply another form of ether waves, the same as radio waves or light waves. Just as light rays traverse thru a thick glass pane without suffering any appreciable loss, just so will thought waves probably pass readily thru the human skull. If once we admit this theory it follows that it should be possible to detect such waves, and the only thing we need to know about them are the wave length and other important characteristics. We may take it for granted that the human brain, sensitive as it is, probably is not at all sensitive to these waves, and that by suitable apparatus it should become possible to detect such waves.

Just what apparatus are necessary to detect thought waves, or the effects therefrom, the writer does not venture to predict, but there is no doubt that the apparatus will be eventually found. Very little is known about the emission of the thought waves, and as a matter of fact the entire mechanism which produces thoughts is practically an unknown quantity, but every effect can be translated and recorded if once we understand its fundamentals.

Thus, fifty years ago the recording of the voice would have appeared just as fantastic as the recording of thought appears today. People then rightly said, how could it be possible to hold the spoken word; it goes into the air and vanishes instantly. But once acoustics were better understood, it became a simple matter for the inventor of the phonograph to record the voice. Similarly, the day will come when thoughts will be recorded in an analogous manner. All that is necessary, as stated above, is suitable apparatus, and this should be easy to find.

The writer, in suggesting the audion as a thought-wave detector, does not do so because he thinks that it is suitable in all respects, or even feasible. His main idea is to set the stone rolling, and get other people to think about the problem, when sooner or later something surely will emerge. The writer has suggested the audion because it is known as one of the most sensitive electrical detecting apparatus for wave motion which we have today. If thoughts give rise to electrical waves, then by winding a few turns of wire on a headband and slipping it over the head, it should be possible to detect the presence of thought waves in the audion. On the other hand, too, the audion is enormously sensitive to capacity effects,

as is well known. Thus, for instance, an oscillating audion is so sensitive that when the human hand is approached to it at a distance of even two feet, the presence of the hand will be heard plainly in the telephone receiver. If this is the case, the disturbance created in the mind should certainly make its presence felt in the audion, for thinking being first of a chemical nature, the act certainly must give rise to capacity effects. But let us assume that active thinking does not give rise to waves, electrical or otherwise, then the mere chemical action (and resulting capacity effects) should produce a disturbing influence upon the audion. These variations, if ever so slight, could then be amplified by the use of an audion or other amplifier, and the resultant effect be sent into an Einthoven string galvanometer. The small mirror attached to the string of the galvanometer will send its luminous pencil upon a light-sensitive paper tape which moves at a certain rate of speed in front of the mirror. The result will be a wavy line traced upon the paper tape in the well-known manner. The paper tape traveling on will pass thru its fixing tank, and from there will emerge from the outside of the machine after it has past thru a small drying chamber heated by electrical coils.

From this, it will be understood that a man sitting in front of his Thought Recorder will be able to actually see on a tape his recorded thoughts, the same as the telegrapher working on a trans-Atlantic cable watches his tape and its wavy line produced by the Syphon recorder, emerging from the latter. Of course, it will be necesary for everyone to learn the "thought alphabet" just as the stenographer today must learn the various characters, or as the child is taught how to read and write, and as the cable operator must learn how to read the Syphon recorder "alphabet." All this, however, is simple, and is only an educational feature once the apparatus has been invented.

The objection naturally comes to the mind immediately that even if we have a machine to record the thoughts, all we will get on the tape will be a jumble of confused thoughts, and we might get a lot of things on the tape that were not meant for recording or registering at all. Such criticism, of course, is beyond controversy for the simple reason that when you write a letter by hand or on the typewriter, you have also at first a lot of confused thoughts, but you do not record such thoughts even by hand or by machine. It often happens after you have written down certain thoughts that you must change them. The same is true of the thought recorder, of course.

Here the man who is doing the recording has a push button in his hand, shown at A in our illustration; if he does not press the button nothing is recorded. Once he wishes to record his thoughts in an orderly manner, he pushes the button and the tape begins moving simultaneously—he will begin thinking in an orderly and slow manner the subject he wishes to record. He will think just as hard and just the same as if he were to pen down his thoughts by hand. The machine will then do the rest. If he thinks the wrong thoughts, naturally the wrong thoughts will be recorded, exactly the same as if he had written them by hand. There is no difference. In our illustration, our artist has endeavored to show what will happen in the future business office when the thought recorder comes into universal use. The business man of tomorrow will dictate his correspondence on the thought recorder, while his stenographer, who is perfectly familiar with his "thought writing," will type out the correspondence from the tape, which is kept moving by electric motors, in front of her eyes. A foot pedal stops or starts the motor, and there is also a reversing attachment so the tape will run backwards should she wish to re-read a certain portion of the tape.

FREE TO YOU!

Read this Remarkable Offer!

OFFER No. 1

Wireless Course

The most comprehensive Wireless Course ever printed. Contains 160 pages, 350 illustrations. Size of book 6¾"x10". Very fine flexible cloth cover.

FREE with a year's subscription.

Add 5c for postage

OFFER No. 2

Experimental Electricity Course

This masterpiece contains 160 pages, 400 illustrations. Size of book 5"x9". Printed on extra thin paper, so book can be slipped into pocket. Handsome flexible cloth cover.

FREE with a year's subscription. Add 5c postage

OFFER No. 3

How to Make Wireless Sending Apparatus
By 20 Radio Experts

How to Make Wireless Receiving Apparatus
By 20 Radio Constructors

These books are by far the most successful wireless books on the market. Size of each book 5"x7", well bound on good book paper. Covers in two colors. We really cannot praise these books too highly. Each book contains 100 pages and from 88 to 90 illustrations. BOTH books FREE with a year's subscription. Add 5c for postage

This is a very limited offer. It may be withdrawn at any time, due to the tremendous cost of paper, which IS JUST DOUBLE WHAT IT WAS ONE YEAR AGO. We have only a limited supply of these fine books on hand; after they are gone we cannot reprint the books until conditions become normal again. Now is your chance.

The publishers of this journal have earned an enviable reputation of giving more than 100 cents' worth for each dollar spent with them. Profit by this liberal opportunity NOW; it may never be made again.

HERE'S THE OFFER

Subscribe to the ELECTRICAL EXPERIMENTER for one year, at the regular subscription price of $2.00 per year (Canada, foreign and N. Y. C. $2.50) and we will send you either books shown in one of the above offers. If you subscribe for two years, two offers will be given, etc.

If you are a subscriber at present take advantage of this wonderful opportunity anyway. If you do, we will extend your present subscription.

This Offer Limited. *Act Now.*

EXPERIMENTER PUB. CO.
223 FULTON STREET NEW YORK CITY

FILL IN — TEAR OUT — AND MAIL

5-19

Gentlemen: Please enter my subscription to the ELECTRICAL EXPERIMENTER for the term of .... year..for which I enclose herewith $..... You will also send me at once FREE your book..... as per offer No.....

.....

.....

Name.....

Address.....

The True Wireless

By Nikola Tesla

(Continued from page 63)

greatly from the intensity of the received impulses because the electric nivean between the mountains is raised, as I have explained in connection with my lightning protector in the EXPERIMENTER of February.

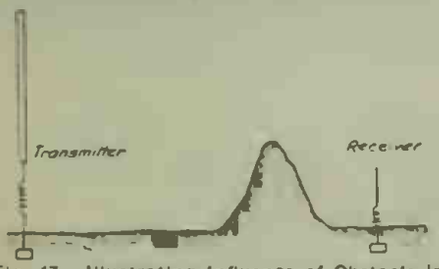


Fig. 17. Illustrating Influence of Obstacle in the Path of Transmission as Evidence Against the Hertz-wave Theory.

Again in Fig. 19 two transmitting circuits, one grounded directly and the other thru an air gap, are shown. It is a common observation that the former is far

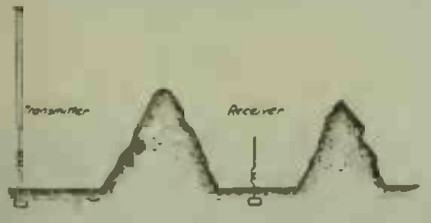


Fig. 18. Showing Effect of Two Hills as Further Proof Against the Hertz-wave Theory.

more effective, which could not be the case in a transmission with Hertz radiations. In like manner if two grounded circuits are

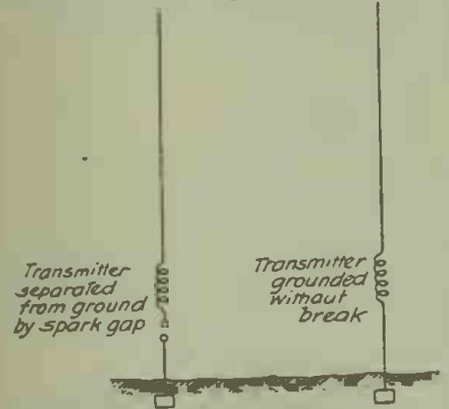


Fig. 19. Comparing the Actions of Two Forms of Transmitter as Bearing Out the Fallacy of the Hertz-wave Theory.

observed from day to day the effect is found to increase greatly with the dampness of the ground, and for the same reason

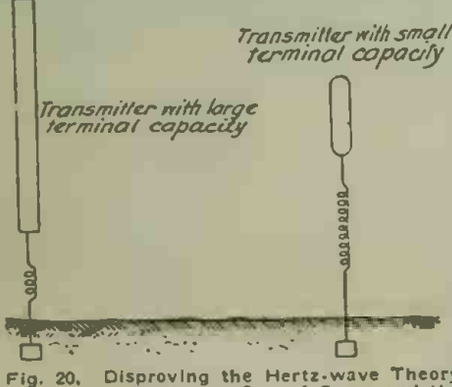


Fig. 20. Disproving the Hertz-wave Theory by Two Transmitters, One of Great and the Other of Small Energy.

also the transmission thru sea-water is more efficient.

An illuminating experiment is indicated in Fig. 20 in which two grounded transmitters are shown, one with a large and the other with a small terminal capacity. Suppose that the latter be 1/10 of the former but that it is charged to 10 times the potential and let the frequency of the two circuits and therefore the currents in both antennas be exactly the same. The circuit with the smaller capacity will then have 10 times the energy of the other but the effects on the receiver will be in no wise proportionate.

The same conclusions will be reached by transmitting and receiving circuits with wires buried underground. In each case the actions carefully investigated will be found to be due to *earth currents*. Numerous other proofs might be cited which can be easily verified. So for example *oscillations of low frequency* are ever so much more effective in the transmission which is inconsistent with the prevailing idea. My observations in 1900 and the recent transmissions of signals to very great distances are another emphatic disproval.

The Hertz wave theory of wireless transmission may be kept up for a while, but I do not hesitate to say that in a short time it will be recognized as one of the most remarkable and inexplicable aberrations of the scientific mind which has ever been recorded in history.

TO ALL RADIO AMATEURS

We have received many thousands of communications from radio amateurs for the past few months asking us about the status of their radio stations, and when they will be allowed to operate them again.

Inasmuch as there has been no official information as to the reopening of amateur stations, during the armistice, we can only say that in all likelihood, amateurs will not be allowed to operate until actual peace has been signed. In his executive order of April the 6th, 1917, President Wilson closed all radio stations in the United States by an act approved in the Radio Law of August 13, 1912.

Such a measure, according to law, is only for the duration of the war, there being at present no legislation which prevents any station, amateur or otherwise, from operating after peace has actually been declared. Therefore, the minute newspapers announce that peace between the United States and the Central Powers has been signed, *all amateur stations automatically revert to their former status*, and amateurs need not wait for permission to operate their stations, once peace has been declared.

EDITOR.

WRINKLES, RECIPES & FORMULAS.

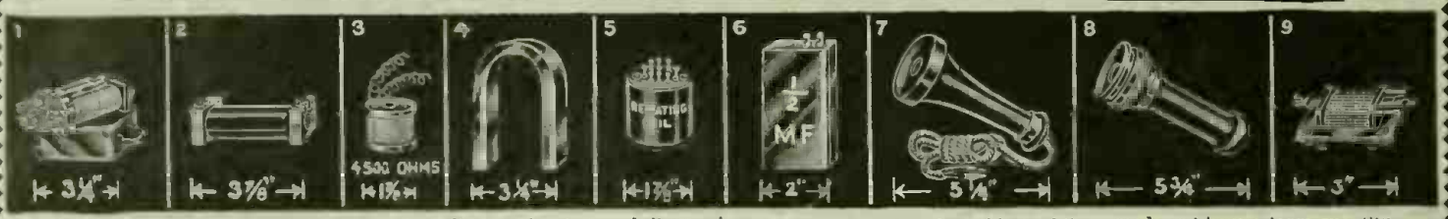
(Continued from page 42)

If carbon dioxid is to be generated, fill tube A with marble chips and tube B with dilute hydrochloric acid.

It is evident that the parts of the generator can be easily cleaned and new chemicals put in. The completed apparatus is shown in Fig. 3.

Contributed by S. WEISINGER, JR.

FOR EXPERIMENTERS ONLY!!



WE have in the past held many extraordinary sales, but we believe that the present one eclipses all by the wonderful values we are offering. The goods which we offer on this page are all standard telephone apparatus. Every piece we are offering is equipment that for one reason or another was discontinued by the telephone companies. If you wanted to buy any of the pieces which we offer herewith, from the manufacturers, the price would at least be ten times what we are asking for it. You can readily ascertain this for yourself by looking over our wonderful prices.

We have bought a large block of these goods and have a large quantity of every item on hand. Immediate shipment can be made on all of the goods in practically any quantity within reason. *Shipment within twenty-four hours* will be made if you use the coupon at the bottom of this page. This coupon saves you several days and your order will then be considered a rush order. We guarantee every piece to be as represented, and we will refund the money if goods are not exactly as claimed by us.

NO. 1 TELEPHONE RELAY. 1500 ohms—has two silver-contact springs and is very sensitive. Can be used wherever a sensitive relay is needed. It is adjustable and can be used for a variety of purposes.
No. 1 Relay—shipping weight, 2 lbs. Price..... **$1.50**

NO. 2 STANDARD TELEPHONE Induction Coil. primary 1 ohm, secondary 55 ohms. Used wherever you need a good induction coil. Has primary and secondary and iron wire core; fibre heads.
No. 2 Induction Coil as described—shipping weight, 2 lbs. Price..... **$0.50**

NO. 3 STANDARD RESISTANCE wound with German silver wire—4,500 ohms, can be used as a choke or plain resistance, and has many other uses that readily suggest themselves to the experimenter.
No. 3 Standard Resistance as described—shipping weight, 4 oz. Price..... **$0.40**

NO. 4 HORSESHOE MAGNET. size 3¼ inches wide x 5 inches high. Will lift about 1 lb. Quality such as used on magnetos, which means the best.
No. 4 Horseshoe Magnet — shipping weight, 2 lbs. Price..... **$0.30**

NO. 5 REPEATING COIL (Transformer). This is a standard small repeating coil and is used by all telephone companies. It has 4 different windings and eight contacts. Entirely enclosed in iron. The resistance being respectively 72 and 120 ohms, and 90 and 100 ohms. Diagram is furnished. Can be used for wireless, for boosting signals, etc.
No. 5 Repeating Coil—shipping weight, 2 lbs. Price..... **$0.50**

NO. 6 ½ M.F. CONDENSER. This is a standard telephone condenser and has ½ microfarads. Condenser comes in neat metal casing. This condenser is used in connection with spark coils to absorb the vibrator spark. Invaluable for test buzzers to absorb spark and make the sound of buzzer more steady. Is also used by every experimenter in connection with wireless where a fixed capacity is needed. Several of these condensers should be in every experimenter's laboratory.
No. 6 Condenser, ½ M.F.—shipping weight, 1 lb. Price..... **$0.50**

NO. 7 DOUBLE POLE BELL TELEPHONE RECEIVER—hard rubber casing with 4 ft. cord and tips. Standard 75 ohms—very powerful magnets. This receiver can be used in connection with any ordinary telephone work, and you will even find it sensitive enough for short distance wireless work.
No. 7 Bell Telephone Receiver—shipping weight, 3 lbs. Price..... **$0.80**

NO. 8 STANDARD TELEPHONE RECEIVER with Metal Head. This receiver is made by Stromberg Carlson Co., with genuine hard rubber handle and ear cap. A very good fool-proof as well as sensitive receiver that cannot be put out of order if you try. Used for the same purpose as No. 7 Telephone Receiver.
No. 8 Standard Telephone Receiver—shipping weight, 3 lbs. Price..... **$0.75**

No. 9 IMPEDANCE COIL (Close Core Transformer). This is a very fine little transformer and is used extensively in connection with telephone work. It is in reality an A.C. transformer for which you would pay $5.00 if you had it made to order. The primary has 0.15 ohms, secondary 2000 ohms. It can be used for a variety of purposes that will suggest themselves to every experimenter. Can be used successfully to boost wireless signals. Also in connection with audions, etc. An A-1 instrument. Size 3 x 3 inches.
No. 9 Impedance Coil—shipping weight, 2 lbs. Price..... **$0.65**

NO. 10 MICROPHONE AND BRACKET. An A-1 sensitive microphone of the carbon grain type. Has hard rubber mouthpiece and enamel steel bracket, the instrument being 10 inches long. This microphone, in connection with our No. 7 or 8 Receiver and No. 16 Ringer Box, will constitute a complete telephone outfit, good to speak 50 miles or more, at a remarkably low price.
No. 10 Microphone and Bracket—shipping weight, 5 lbs. Price..... **$1.00**

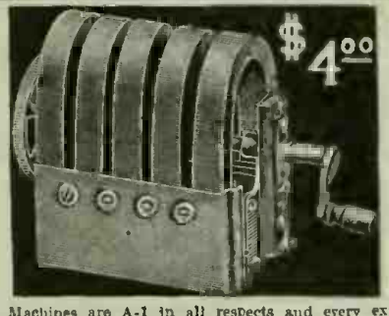
NO. 11 REPEATING COIL (Transformer). A standard repeating coil used for telephonic work. The coil windings are encased in an iron tube 2¼ inches in diameter. There are eight terminals for the four windings to connect to and the instrument is invaluable in connection with radio work to boost up signals, audion work, etc. Many interesting uses will be found for this coil. Resistances are: 100, 120, 145, 175 ohms.
No. 11 Repeating Coil—shipping weight, 8 lbs. Price..... **$2.00**

NO. 12 POLARIZED RINGER with Bells. The resistance of the two coils is 1250 ohms each. The armature is perfectly adjustable. Bell will work on any magneto. We also furnish blue print with ringer showing how *a first class polarized relay* can be made by anyone using only a few pieces of metal and screws.
No. 12 Polarized Ringer with Bells—shipping weight, 2 lbs. Price..... **$1.50**

NO. 13 POLARIZED RINGER with Bells. This is the same kind of ringer as the No. 12, except that it is not adjustable and that the resistance is less. First class in all respects. Blue print furnished with this to *make polarized relay* same as with No. 12. Solenoids on this ringer are worth more than the price we ask for the entire ringer, and do not forget a powerful magnet that goes with it.
No. 13 Polarized Ringer with Bells—shipping weight, 2 lbs. Price..... **$1.00**

NO. 14 HARMONIC RINGER. This ringer is also polarized and has a powerful magnet. It works on 66.6 cycles and any magneto will operate it if run at a certain speed. A very finely built instrument. Resistance of each coil being 200 ohms. Can be converted into a polarized relay by substituting a very fine leaf spring inside the heavy one furnished. A most interesting instrument with which to experiment.
No. 14 Harmonic Ringer — shipping weight, 4 lbs. Price..... **$1.60**

NO. 15 RINGER without Bells—630 ohms. This also is a polarized ringer and has an adjustable armature. The adjustment is done by means of the top screw. A beautiful little instrument. With this instrument, too, we furnish a blue print showing how a *polarized relay can be built*. You should have several of these beautiful little instruments. They are worth their weight in gold; the powerful magnet alone being worth more than the price we ask for the entire instrument.
No. 15 Ringer—shipping weight, 2 lbs. Price..... **$0.80**



No. 55 5-bar magneto, 110 Volt A. C. Generator

This is one of the most powerful magnetos ever built, when manufacturers could afford to put good stuff into them; equipt with transmission, make and break, etc. Transmission wheels are all brass, crank handle furnished. This magneto, as well as the other ones listed below, will light a 110-volt lamp merely by turning the crank handle slowly. While this magneto gives alternating current only, it can be rewound so it will light up a number of four, six and 10-volt lamps, all depending upon the thickness of the wire you wind on the armature. As we furnish these magnetos, they will give a powerful alternating current and you will not be able to stand the current when grasping hold of the terminals. This makes an ideal shocking machine. All our generators can be transformed into a direct current machine by equipping it with a home-made commutator. Machines are A-1 in all respects and every experimenter should have one of them in his shop. Many other experiments which can be performed with this machine will readily suggest themselves to any experimenter. The magnets furnished with these generators are very powerful, each one being able to lift one pound easily.

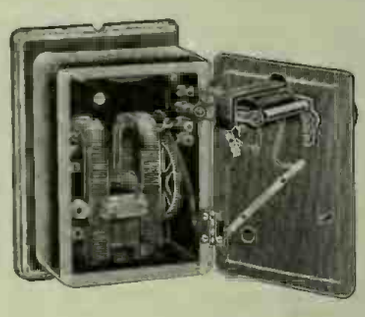
NO. 55 5-BAR MAGNETO GENERATOR as described—shipping weight, 25 lbs. Price..... **$4.00**

NO. 33 3-BAR GENERATOR. same as described above except that it has only 3 bars, and is somewhat smaller.
No. 33 3-bar Generator—shipping weight, 10 lbs. Price..... **$2.00**

NO. 44 4-BAR GENERATOR, same as No. 55 except that it has 4 bars, and is somewhat smaller.
No. 44 4-bar Generator—shipping weight, 15 lbs. Price..... **$3.00**

NO. 66 6-BAR GENERATOR, same as No. 55 except that it has one more magnet and the armature is somewhat larger and more powerful. This is the biggest type made and is extremely powerful.
No. 66 6-bar Generator—shipping weight, 30 lbs. Price.. **$4.50**

No. 16 Western Electric Ringer Box



complete with 2500 ohm polarized ringer, bells in front of cabinet. The magneto furnished is of the two-bar type, brass gear transmission to drive it, and crank on the outside of the cabinet. The cabinet is of polished oak, piano finish and if you mount our No. 10 microphone and bracket in front of the cabinet and use our No. 7 or 8 receiver, and then use a switch to break the current you have a first-class telephone outfit at a ridiculously low price. This ringer box is one of the greatest bargains that has ever been put out. Even if you do not need it for telephonic work, you should have it as the instruments themselves are worth much more money than we ask for the entire outfit.

No. 16 Western Electric Ringer Box—shipping weight, 15 lbs. Price..... **$4.50**

"The Livest Catalog in America"

Our big, new electrical cyclopedia No. 20 is waiting for you. Positively the most complete Wireless and electrical catalog in print today. 176 Big Pages, 400 illustrations, 300 instruments and apparatus, etc. Big "Treatise on Wireless Telegraphy," 20 FREE coupons for our 160-page FREE Wireless Course in 20 lessons. FREE Cyclopedia No. 20 measures 7x5¾". Weight ½ lb. Beautiful stiff covers.

ELECTRO IMPORTING CO., 231 Fulton Street NEW YORK

RUSH

Cut out and attach to your order. It will leave us within 24 Hours.

ELECTRO IMPORTING COMPANY
231 Fulton St., New York City

I enclose herewith 6 cents in stamps or coin, to cover postage, for which please send me your latest Cyclopedia Catalog No. 20 as described.

NAME .....

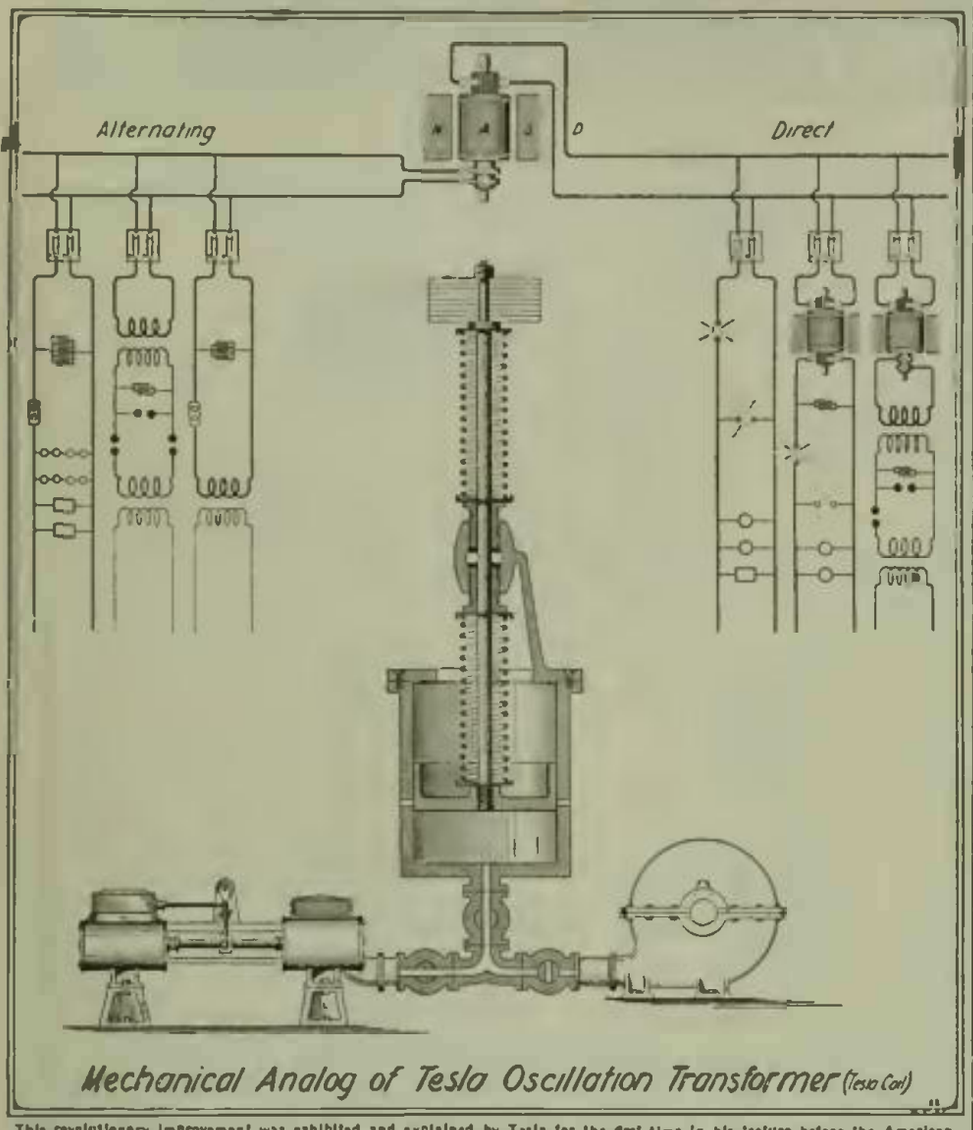
ADDRESS .....

STATE.....E. E. 5-19

My Inventions

(*Continued from page 65*)

engineers of a defect involved in the transformation by the new method, namely, the loss in the spark gap. Subsequent investigation showed that no matter what medium is employed, be it air, hydrogen, mercury vapor, oil or a stream of electrons, the efficiency is the same. It is a law very much like that governing the conversion of mechanical energy. We may drop a weight from a certain height vertically down or carry it to the lower level along any devious path, it is immaterial insofar as the amount of work is concerned. Fortunately however, this drawback is not fatal as by proper proportioning of the resonant circuits an *efficiency of 85 per cent* is attainable. Since my early announcement of the invention it has come into universal use and wrought a revolution in many departments. But a still greater future awaits it. When in 1900 I obtained powerful discharges of 100 feet and flashed a current around the globe, I was reminded of the first tiny spark I observed in my Grand Street laboratory and was thrilled by sensations akin to those I felt when I discovered the *rotating magnetic field*



Mechanical Analog of Tesla Oscillation Transformer (Tesla Coil)

This revolutionary improvement was exhibited and explained by Tesla for the first time in his lecture before the American Institute of Electrical Engineers May 20, 1891. It has made possible to generate automatically damped or undamped oscillations of any desired frequency and, what is equally important, of perfectly constant period. It has been instrumental in many great achievements and its use has become universal. The underlying principle may be briefly stated as follows: A source of electricity is made to charge a condenser and when the difference of potential at the terminals of the latter has reached a predetermined value, an air-gap is bridged, permitting the accumulated energy to be discharged through a circuit under resonant conditions, this resulting in a long series of isochronous impulses. These are either directly used or converted to any desired volume or pressure by means of a second circuit inductively linked with the first and tuned to the same. The above diagram is taken from Tesla's lecture before the Franklin Institute and National Electric Light Association in 1893 and shows more elaborate arrangements of circuits, now quite familiar, for the conversion of ordinary direct or alternating currents into high frequency oscillations by this general method. In the mechanical apparatus illustrated, an attempt is made to convey an idea of the electrical operations as closely as practicable. The reciprocating and centrifugal pumps, respectively, represent an alternating and a direct current generator. The water takes the place of the electric fluid. The cylinder with its elastically restrained piston represents the condenser. The inertia of the moving parts corresponds to the self-induction of the electric circuit and the wide ports around the cylinder, through which the fluid can escape, perform the function of the air-gap. The operation of this apparatus will now be readily understood. Suppose first that the water is admitted to the cylinder from the centrifugal pump, this corresponding to the action of a continuous current generator. As the fluid is forced into the cylinder, the piston moves upward until the ports are uncovered, when a great quantity of the fluid rushes out, suddenly reducing the pressure so that the force of the compressed spring asserts itself and sends the piston down, closing the ports, whereupon these operations are repeated in as rapid succession as it may be desired. Each time the system, comprising the piston, rod, weights and adjustable spring, receives a blow, it quivers at its own rate which is determined by the inertia of the moving parts and the pliability of the spring exactly as in the electrical system the period of the circuit is determined by the self-induction and capacity. Under the best conditions the natural period of the elastic system will be the same as that of the primarily impressed oscillations, and then the energy of the movement will be greatest. If, instead of the centrifugal, the reciprocating pump is employed, the operation is the same in principle except that the periodic impulses of the pump impose certain limitations. The best results are again obtained when synchronism is maintained between these and the natural oscillations of the system.

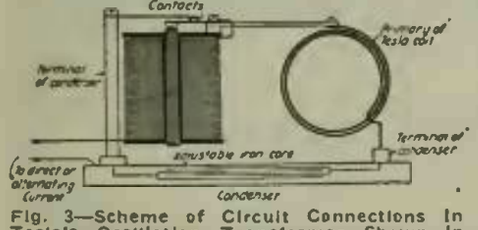


Fig. 3—Scheme of Circuit Connections In Tesla's Oscillation Transformer Shown In Fig. 1. The Secondary Circuit Which Slips Into the Primary Is Omitted.

Opportunity Ad-lets

YOU will find many remarkable opportunities and real bargains in these columns. It will pay you to read and investigate the offerings made every month by reliable firms, dealers and amateurs from all over the country. No matter what you may be seeking, whether supplies, automobile accessories, the opportunity to make money, or anything else, you will find listed here the best and most attractive specials of the month.

Advertisements in this section seven cents a word for each insertion. No advertisement for less than 50c accepted. Name and address must be included at the above rate. Cash should accompany all classified advertisements unless placed by an accredited advertising agency. Ten per cent discount for 6 issues. 20 per cent discount for 12 issues. Objectionable or misleading advertisements not accepted. Advertisements for the June issue must reach us not later than April 22.

The Circulation of the Experimenter is over 100,000 and climbing every month

EXPERIMENTER PUBLISHING CO., INC., 233 Fulton Street, New York, N. Y.

Automobile Accessories.

Liquid Silk Automobile Polish, finish lasts as long as new car, or money back. Sample 25c. prepaid. Liquid Silk Mfg. Co., Delanson, N. Y.

Ford power Mechanical Products greatly increase ability Ford Cars, Sedans, Trucks, Tractors, Racers, "4 Speed Forward Auxiliary Transmission"; Double Power, High, Low; Reverse; Powerful Motor Brake descending hills; "Absolute Neutral." Easy winter cranking. "Full-power" "16-Valve Cylinder Head," 20%-64% Power increase, government test. Other Ford Power Devices coming. Opportunity agent, dealer, owner. Send for trial plan K. Victor-Ford Trans. Mfrs., 246-248 W. 54th, New York.

Fords run 34 miles per gallon with our 1919 carburctors. Use cheapest gasoline or half kerosene. Start easy any weather. Increased power. Styles for all motors. Runs slow high gear. Attach yourself. Big profits for agents. Money back guarantee, 30 days trial. Air-Friction Carburetor Co., 270 Madison St., Dayton, Ohio.

Aeronautics.

Flies 2,000 Feet—Manhattan Racer, 26" wing spread, made finest materials, strictly a speed and distance aeroplane for amateurs. Great for spring and summer outdoor sport. Complete materials, knockdown, carved propellers, assembling and flying instructions. $3.50 Postpaid in U. S. Blueprint only, 35c. Postpaid. Blueprint Bleriot racer, guaranteed 600 foot flyer, 35c. Postpaid. Hec Aeroplane Co., 6 West 48th Street, New York City, N. Y.

Motorcycles.

Motorcycles from $25 up—New and second-hand. Easy terms, large list to choose from, all makes. Send 4c. stamp for Bulletin "A." Peerless Motorcycle Co., Watertown, Mass.

Telegraphy.

Telegraphy (both Morse and wireless) and Railway Accounting taught thoroughly and quickly. Big salaries now paid. Great opportunities. Oldest and Largest School—est. 45 years. Catalog free. Dodges Institute, 7th St., Valparaiso, Ind.

Stamps and Coins.

100 Different Stamps 10c., 200, 25c. Michaels, 5600 Prairie, Chicago.

Free—Packet Valuable Stamps to Applicants 50% Approval. Benj. Forbes, 160 Devilliers, Pittsburgh, Pa.

300 Different Stamps, 35c; 100 different U. S. 21c. C. Reitter, Box 1054, Detroit, Mich.

78 Different Stamps to approval applicants. Enclose 5c. Harland Burgett, 419 Spring St., Lima, Ohio.

For Sale—Twenty large American cents, all different dates, for only $1.55. Old coins bought up to 1916. Catalogue, 10c. Savage, 436 Melville St., Rochester, N. Y.

Stamps—61 all different free. Postage, 3c Mention paper. Quaker Stamp Co., Toledo, Ohio.

Stamps—Send 25c. for our collection. Some fine ones. Facastenhz, 425 LaGrave, Grand Rapids, Mich.

California Gold, Quarter size, 27c.; Half-dollar size, 53c.; Dollar size, $1.10; Large cent, 1820, and catalogue, 10c. Norman Shultz, Kings City, Mo.

500 Finely Mixed United States or Foreign Stamps, 12c. Philatelic Star, Madison, N. Y.

Old Money Wanted.

We Buy and Sell Old Coins. $2 to $500 each paid. Keep All Old Money; you may have valuable coins. Send 10c. for New Illustrated Coin Value Book, 4 x 6. Guaranteed prices. Get posted. Clarke Coin Co., Box 110, Le Roy, N. Y.

Tricks, Puzzles and Games.

Magic—Card Tricks—Sensational Escapes—Jokes—Novelties. Everything in the amusement line. Large illustrated catalog of a thousand tricks free. Write today. Largest amusement goods manufacturers in the world. Heaney Magic Co., Desk 200, Berlin, Wisconsin.

Leading Magical Magazine! All magicians like it! You will, too! Why? The value is there. Sample, 10c.; three months, 25c.; year, $1.00. Eagle Magician, Dept. E. Minneapolis, Minn.

Black Art Hindoo Experiments. 1919 Edition, 25c. Invisible Ink. Free Trick. Catalogue each order. Linhorst Magic X Shop, St. Louis.

1000 Stage Tricks with 500 illustrations. Catalogue 10c.; small catalogue free. Hornmann Magic Co., Sta. 6, 170 Eighth Avenue, New York.

Tricks, Puzzles, Jokes, Toys, Games, Novelties, Doll and Cane Racks, Plays, Wigs, Stage Supplies, Escapes and Illusions. Large 1917 catalog free. Oakes Magical Co., Dept. 549, Oshkosh, Wis.

100 Kinds Wire and Steel Puzzles. Catalog and leader, 10c.; postpaid. Western Puzzle Works, St. Paul, Minn.

77 S. Spencer Street,
Aurora, Ill.
Feb. 6, 1919.

Editor E. E.

Dear Sir:—The small ad I had in the February issue is surely bringing some great results, about six letters each day from all over the United States and Canada.

I would like to know the price of one insertion of the one-inch ad I am inclosing also cost of six insertions.

Please answer quickly.

Yours truly,

HOWELL RANG.

Exchange Ads.

For Sale—Single barrel shotgun, 110 v. Portable electric heater, Hawkins' Guides, Zeno chewing gum vending machine, and other articles. For description and prices, send three-cent stamp. Earl Brown, 514 Virginia Ave., Martinsburg, W. Va.

Wanted—Small motion picture machine for home, price about $10. Donald Porter, Frazee, Minnesota.

Sell—Motorcycle engine; telescope; chemicals; electric motor. Shank, 521 Jefferson St., Dayton, Ohio.

For Sale—1 K.W. Packard transformer, round detector and amplifier bulbs. Will buy old type General Electric Induction Fan Motor. Harry Weber, 1113 Walnut St., Dover, Ohio.

Wanted—Rifle telescope sight and Kraig rifle or carbine. A. L. Chamberlin, Box 132, Davenport, Iowa.

Bargains—Cyclopedia Applied Electricity, $15.00; Popular Science Library, $10.00; Excellent condition. First money order takes same prepaid. T. H. Blacknall, Box 107, Raleigh, North Carolina.

Sale—Regenerative Receiver, Storage Battery, other apparatus. Write for description. Thompson, 36 John St., Worcester, Mass.

For Sale—Twin Motorcycle, or engine, New Sayville Rotary spark gap, $7.00. Two Portable Wireless Sets, spark coils, wireless and electrical instruments. H. Gary, 600 Main St., Aurora, Ill.

Wanted—Smith motor wheels. Johnston, 9 Rutherford, Binghamton, N. Y.

Wanted—Small Graflex camera. A. Hofman, P. O. Box 809, City Hall Sta., N. Y.

For Sale—Wireless instruments. Vincent Natalish, 68 West 56th St., New York City.

Head Set—New Brandes distance phone—3,000 Ohm, $13.50, sell $8.00. Send stamp, large list Receiving Electrical apparatus. Dare, 94 Clinton Ave., Brooklyn, N. Y.

For Sale—Omnigraph five dials clock driven wireless code, quenched gap, polarized relay 5 ohms, stepup transformer. Will accept no less than $25 for outfit. Pastime Theatre, Union Hill, N. J.

Exchange Ads.—Continued.

Sell—Variety of articles, apparatus, etc. Write wants. Send stamped envelope. Vernon Palen, Sparta, Wisconsin.

"Multi-Audi-Fone", brand new, $15. Try this with your Audion or any detector. C. Francis, Box 1504, Providence, R. I.

Wanted—Quick! Volumes 1, 2, and 3 "Electrical Experimenter" either bound separate or any odd copies purchased. Good prices offered. Write for particulars and price to Box 70, Care Electrical Experimenter.

For Sale—Receiving set $10.85; consists of 15 and 7 inch double slider coupler, cat-whisker, detector, 14 point loading coil 17 and 3 inch. Have other wireless things. Send for list quick. George Faunce, 5 Green Street, Millville, N. J.

Cheap—Cyclopedia Applied Electricity. Stamps, Coins, junk. Howorth, University, Miss.

Exchange—Cycle-car for Smith Motor Wheel or bicycle engine or $50. Send stamp for particulars. Carl Mayo, Orleans, Mass.

Wanted—Whimshurst Static Machine. All letters answered. J. Picucci, 670 57th St., Brooklyn, N. Y.

For Sale—Shaw Motor attachment, $20. Harold Lambert, Haverstraw, N. Y.

Typewriter—Like new—For sale or exchange. John Galbreath, Rogers, Ohio.

For Sale—25 Watt Dynamo parts, $10. ½ K.W. Transformer Coil, $5. Electro Oscillation Transformer, $5. Loose Coupler, $2. Navy Receiving Transformer, $15. Blitzen Variable Condenser, $3. Murdock Variable Condenser, $3. Variable Condenser, $2. Ground Switch, $1.50. 2000 ohm phones, $2.50. Home Medical Apparatus, $3.50. Post Card Projector, $3.50. Bell Ringing Transformer, $1.50. $30 Mecanno, $20. All in good order. First draft or money order takes them. Burrows Rogers, Cainsville, Mo.

Sell or Exchange—Ford Gray & Davis Starting and Lighting system; Shaw bicycle motor attachment. Want Dynamo ½ K.W. or larger, 24 to 60 volts direct current, or screw cutting lathe 8" swing or larger. Frank Pantel, Muscatine, Iowa.

For Sale—Blueprints of motor windings, see ad under Blueprints, etc., this issue. Charles L. Chittenden, 811 West 181 St., Kansas City, Mo.

I have wireless apparatus and other things for sale. Write for list now. George Sharp, 73 Everett Ave., Providence, R. I.

Sale—Send stamp for list of wireless instruments, all bargains. Geo. Sprouls, 5624 Palethorpe St., Philadelphia, Pa.

Sell—New $50 Phonograph, $25. C. Gillespie, 72 Woodward, Buffalo, N. Y.

Sell—Motorcycle engine, $10.00; Magneto, $3.00; Spark coils, $1.50; Generator, $1.25; Motor, 75c. Harley-Davidson Motorcycle, $30.00. Ruben Hilborn, Brown City, Michigan.

Wanted—½ K.W. transformer, Packard or Thorderson. Clyde Stream, 2537 Elmwood, Kansas City, Mo.

Boys! Big mechanical Engineering Set. Contains three motors. All for $75.00, cost a lot more. Send cash in registered letter. Russell McQuilkin, Millport, Col. Co., Ohio.

Pocket Tester for electricians, trouble-shooters and maintenance men. For use in place of lamps on 90 to 500 volt lines for locating shorts, grounds, opens and blown fuses. Size 2½" x 5", in neat leather case with leads for testing. $1.50 postpaid. Falls Electric Shop, Cuyahoga Falls, Ohio.

Sell—White Cross Vibrator. Almost new, half price. Write Wm. Waldrip, Attico, Ind.

Sale—Swop. Whole Laboratory! Electrical Bargains. Write for list. All answered. Chas. Derrick, Grampian, Pa.

For Sale—$60.00 Regina Vacuum Cleaner with attachments, $25.00. P. Crawford, 13 Ten Broeck St., Albany, N. Y.

Sell—5 H.P. 2 cylinder gasoline engine, $46. Will exchange for screw cutting lathe. Herbert Sicklesteel, 802 12th St., Detroit, Mich.

Scenery for Hire.

Collapsible Scenery for all Plays. Amelia Grain, Philadelphia, Pennsylvania.

Agents Wanted

Easy, Pleasant Work for mechanics, shop men, clerks, during spare hours, will add many dollars to their salaries. Also want persons who can give full time. Big wages assured. Novelty Cutlery Co., 98 Bar St., Canton, Ohio.

Insyde Tyres, inner armor for automobile tires, double mileage and prevent punctures and blowouts. Quickly applied. Costs little. Demand tremendous. Profits unlimited. Details free. American Automobile Accessories Co., Dept. 54, Cincinnati, O.

Mechanical Novelty for Old and Young. Barrel of Laughs—Amusement and Fun Everybody possible customer. Samples with particulars, 25c. Rullet Co., Hartford, Conn.

Klean-Rite Marvelous Washing Compound. Whirlwind seller. Great Repeater. Big Profits. Shipments prepaid. Special offer and samples free. Bestever Products Co., 2426-E5 Polk St., Chicago, Ill.

$10 Daily refinishing chandeliers, brass beds, automobiles by new method, without capital or experience. Free particulars and proofs. Write today. Gunmetal Co., Ave. D, Decatur, Ill.

Miracle Motor-Gas amazes motorists. 3c. worth equals gallon gasoline. Eliminates carbon. 300% profit. Isom, Idaho, wires: "Ship 500 packages. Made $70 yesterday." Samples free. Chas. A. Butler, Sec'y, Dept. 70, Toledo, Ohio.

"History of the World War," by Francis A. March, brother of General March. Authentic, complete—750 pages—illustrated—official photographs. Freight paid—credit given. Agents making fortunes. Free Outfit. Victory Publishing Company, 649 Manhattan Bldg., Chicago, Illinois.

Install Farm Lighting Plants. Big Profits. Get our Agency Plans at once. Wolkee Co., Louisville, Ky.

Cameras, Supplies—Photo Developing.

Kodakers: How would you like to get a 9 x 11 enlargement of your best negatives free? Drop us a card right now asking about it. Films developed at 10c. per roll, prints 3c., 4c. and 5c. each. Satisfaction guaranteed. Ford's Foto Studio, Ellensburg, Washington

Mail Us 15c with any size Film for development and 6 velvet prints. Or send 6 negatives any size and 15c. for 6 prints, 8 x 10" mounted enlargements 35c. Prompt, perfect service. Roanoke Photo Finishing Co., 255 Bell Ave., Roanoke, Va.

Frane's Brownatone 25c. Tones 250 pictures beautiful brown; easy as washing prints. Frane, Eureka, Ill.

Special Trial Offer. Your next Kodak film developed, 5c. Prints 2c. each. Moser & Son, 1910 St. James Ave., Cincinnati, O.

Clean, Neat, Perfect Kodak Finishing at the lowest prices. Work returned the same day received. Send film for sample print and copy of Catalog on Developing, Printing, Enlarging and Hand Coloring, also copy of Photo Craft Magazine, which will help you make better pictures. Photo Craft Co., Box 60, Ann Arbor, Mich.

Make real mystic photos without camera or plates by using Star Photo Papers. No experience necessary. Complete outfit for making 15 pictures, 25c. Abrams Co., 1305 Peoria St., Chicago.

Any six or eight exposure film up to Post Card size developed and printed, 10c. or enlargement, 8 x 10, your favorite negative, 20c. Special Introductory offer to show high quality work. Associated Photo Co., Dept. 12, Cincinnati, Sta. A.

Chemicals.

Chemicals and Laboratory Apparatus for analysis and experimenting. April list 5c. Frane, Eureka, Ill.

Chemicals or Chemical apparatus—We have just what you need. Our lists are without end. State your requirements. We also make up experimental sets of any value. The particulars of our standard sets will be furnished upon request. Zeigler Experimental Laboratory, Rochester, N. Y.

Stammering.

Stammering permanently eradicated at home. Cure positively guaranteed. Particulars free. Cheshire Training System, Keene, N. H.

For Advertisers.

Unheard-of Trial Offer! Inch display or 30-word classified advertisement ten weeks, $1.00. Record Advertiser, Box 2E, Houston, Va.

"Quick-Action Advertising How it is Building Business for the Progressive Advertisers of America"; A little story of results told by the advertisers themselves—not the publisher. You will be interested in reading this little booklet which we have prepared for prospective advertisers, a copy of which will be gladly mailed to you upon request. It tells you how to talk business with 1,000,000 intelligent, interested and responsive Americans every month—men who know what they want and who have the money to buy it. Write for particulars and rates today. Douglas Wakefield Coutlee, 225 West 39th St., New York.

Business Opportunities.

Make Die-Castings. Sketch, Sample, Booklet, and Proposition, 12c. Byrd & Blair, Box 227E, Erie, Pa.

Why Sell Perfumes and Toilet Goods for others? Make your own; get all the profits. Particulars, Laboratory Box 1316-X— Memphis, Tenn.

Manufacturer desires electrical specialties. Devices or supplies having possibilities of large sales wanted. What have you? North Phila., Pa., P. O. Box 5801.

Earn Money at Home. "The Reliable Plan" tells how. Ten cents. Edw. C. Maher, Dover, New Jersey.

Victory—Mechanical Toy Soldier window attraction. 30 inches high. Salutes, turns head, points with finger, etc., as set. Well made, nicely dressed officers, privates, Uncle Sam, etc. Electrically operated. Does some stunt every half minute or oftener as set and will salute soldier and pay no attention to other if desired. Representative wanted in each city and town. Write for prices. The John M. Biggs Co., Box 324, Chattanooga, Tenn.

Dollars Yearly in Your Back Yard. No ginseng, mushroom dope. New ideas. Investigate. Particulars free. Metz, 313 East 89, New York.

Enter a new business. Earn $3,000 to $6,000 yearly in professional fees making and fitting a foot specialty, openings everywhere with all the trade you can attend to; easily learned by anyone at home in a few weeks at small expense; no further capital required; no goods to buy; job hunting, soliciting or agency. Address Stephenson Laboratory, 18 Back Bay, Boston, Mass.

Build Up an Income in Oil—Others are doing it—Why not you? Today is the opportunity. Join our easy monthly payment plan now—it may mean hundreds in profits. Write for information. National Oil Drilling Co., Dept. K, Houston, Texas.

$30.00 a week evenings. I made it with a small mail order business; continued my regular job daytime. Free Booklet tells how. 2 cents postage. Albert W. Scott, Cohoes, N. Y.

Patents for sale. To buy or sell patents address Patent News-H, Washington, D. C., only inventors' newspaper published.

Install Farm Lighting Plants. Big Profits Get our Agency Plans at once. Wolkee Co., Louisville, Ky.

"Quick-Action Advertising—How it is Building Business for the Progressive Advertisers of America"; A little story of results, told by the advertisers themselves—not the publisher. You will be interested in reading this little booklet, which we have prepared for prospective advertisers, a copy of which will be gladly mailed to you upon request. It tells you how to talk business with 1,000,000 intelligent, interested and responsive Americans every month—men who know what they want and who have the money to buy it. Write for particulars and rates today. Douglas Wakefield Coutlee, 225 West 39th Street, New York.

Are you in search of a formula to produce a certain preparation? If so, perhaps we can help you. We are ever on the alert and closely following the development of the industrial arts in all its branches. Our standard price for each formula or process issued is Thirty-five cents. Let us hear from you. Industrial Methods Bureau, 320 Fifth Ave., New York City.

Iceless Refrigerators. Particulars for stamp. Bachman, Box 57, Fullerton, Penn.

Hurry: Our First Issue. Plans and specifications for building National Advertising Weather Service. Sales talk picture of finished machine, etc. Profit $150.00 for manufacturer. Protected territory. Descriptive literature, terms and picture 25 cents. None free. National Sales Co., Box 421, Lima, Ohio.

Start a profitable business manufacturing "Puffed Crisp". Delicious confection. Whirlwind money-maker. Machine, Instructions complete $6.50. Samples 10c. Bestever Products Co., 2426-E5 Polk St., Chicago.

Want to make $30 a week in spare time? Particulars, 20c. Walker, Box 465, Dayton, Ohio.

Opportunity—I have a comprehensive, electrical idea; available for development, that should revolutionize a certain industry. Interesting research is here afforded experimenters and inventors in something new, useful and worthwhile for amateur and experienced electrical people. Postpaid three dollars. Roy Y. Hughes, Electrician, Mitchell, South Dakota.

Big possibilities in new profession. Easy to learn in comparatively short time. Field of practice unlimited. Many so engaged earning $2,500.00 to $10,000.00 a year. Exceptional opportunities for women. Write to Howard College, 527 S. Ashland Blvd., Chicago, Illinois.

Collections.

How to Collect Accounts; also Exposure of Membership and Contract Collection Agencies. Booklet 25c. Smith Mercantile Agency, Jefferson, Ohio.

For Men.

Razor Blades sharpened right. Single edge 25 cents, double edge 35 cents Kreneclge Shop, 7 South 10th, Philadelphia, Pa.

Help Wanted.

30 Men-Women, 18 or over, wanted immediately. U. S. Government positions. Commence $92 month. Vacations. Common education sufficient. Hundreds Permanent Peace Positions. Write immediately for list. Franklin Institute, Dept. E 26, Rochester, N. Y.

Wanted Ambitious Workers to start Collection Bureaus. Be independent—make big income yearly. We train and refer business to you. "Scientific Facts" free. National Collection Bureau, Dept. 20, 65 Maynard, Columbus, O.

Dollars Saved—Used correspondence courses, bought and sold. MacMichael Educational Bureau, Victor, N. Y.

Be a Detective. Good income. Excellent opportunities to travel. Particulars free. Write American School of Criminology, Dept. E, Detroit, Mich.

Make Die-castings. Sketch, Sample, Booklet and Proposition, 12c. Byrd & Blair, Box 227F, Erie, Pa.

Books.

Books for Real Live People. Lists free. J. E. Sheridan, 417 E. 151st St., New York.

Dear Reader—If Occult, New-Thought and Scientific books appeal to you, send for my catalog, it's free. I have books on Personal Magnetism, Concentration, Spiritualism, Clairvoyance, Seership, Will, Mind, Hypnotism, Mesmerism, Character Reading, Healing, Mysticism, Success, Salesmanship, Mechanics, Entertainment, etc. A. W. Martens, J-49, Burlington, Iowa.

24 Money-Making Formulas, 25c. $15 course in candy making—6 complete lessons for 50c. Both books 60c. Alton Studio, Alton, Iowa.

Where to Buy Right; How to Advertise; no expense 2—25c. Box 115, San Francisco, Calif

Invisible Inks—30 formulas, 15c. Horton P. Jones, Perry, Ia.

"Nature Book" facts every married and engaged person should know, 35c. Central Company, 509 Ninth Avenue, New York.

World-Romic System, Masterkey to All Languages. Six Textbooks, $1.44. French Chart, 35c; Spanish, 37c; Aviation Dictionary, $1.50. French-English Aviation Dictionary, 61c. Languages, 143 West 47th, New York.

To Get Better Pictures: Read the Amateur Photographers' Weekly; illustrated; weekly prize competitions; print criticisms; many unique features; $1.50 per year; three months' trial subscription 25c. Abel Publishing Company, 401 Caxton Bldg., Cleveland, Ohio.

Old E. E. Back Numbers: We have some valuable old E. E. back numbers on hand as follows: 1915—Jan., March, April, May, June, July, Aug., Sept., Oct., Nov., Dec., price each 35c. 1916—Jan., Feb., March, May, June, Sept., Dec., price each 35c. 1917—Jan., April, May, Aug., Nov., Dec., each 35c. 1918—Jan., Mar., May, 35c; 1918—June, July, Aug., Sept., Oct., Nov., Dec., each 20c. 1919—Jan., Feb., Mar., Apr., 20c. We can fill orders at once upon receipt of your remittance, and if you have not these numbers already, now is your chance to get them, as they probably will be snapped up very quickly. Experimenter Publishing Co., 233 Fulton St., New York City.

Health.

Tobacco or Snuff Habit Cured or no pay; $1.00 if cured. Remedy sent on trial. Superba Co., SA, Baltimore, Md.

Pyorrhea—H. E. Kelty D. D. S., M. D., pyorrhea specialist for 15 years, has developed a successful home treatment for pyorrhea. Purifying, healing, preventative. Full month's treatment and booklet $1.00. Circular free. Dr. H. E. Kelty, 106 Gladwin Ave., Leonia, N. J.

Cigarette, pipe or chewing habit conquered. Nature's method. Guaranteed. Write for free brochure. Edw. J. Woods, TA-300, Station F, New York.

Formulas.

500 Formulas. Resilvering Mirrors, Renewing Dry Batteries, Luminous Paint, Mechanics' Soap, 25c. Catalogue 2c. Ideal, 5501-E North Robey, Chicago, Ill.

20,000 Formulas. $1.00 postpaid. List 4c. Oscar C. Hanson, Mentor, Minn.

Consult Us when in need of definite and reliable data concerning any trade formula or industrial process. Our standard price for each formula or process issued is Thirty-five cents. Write us now. Industrial Methods Bureau, 320 Fifth Ave., New York City, N. Y.

News Correspondents.

Earn $25 Weekly, spare time, writing for newspapers, magazines. Experience unnecessary; details free. Press Syndicate, 566 St. Louis, Mo.

Continued on page 94

For Inventors.

Inventors. Protect your idea before exposing it. Advice Free. Inventor's Patent Service, Park Row Building, New York City.

600 Mechanical Movements, also illustrations and explanations of 50 perpetual motions. My book, Inventors' Universal Educator, 4th edition, tells how to procure and sell a patent for your new invention. Government and other costs. Covers the matter from A to Z. 140 pages elegantly bound. Contains noted Court decisions on Patent cases. Mechanical Movements greatly assist inventors—suggest new ideas that might prove of great aid in perfecting inventions. Tells how to select an attorney. Has valuable information regarding Patent Sharks, Selling Agents and Brokers. Price $1. Postage free. Fred G. Dieterich, 603 Ouray Building, Washington, D. C.

Inventions Commercialized. Cash or royalty. Adam Fisher Mfg. Co., 205 St. Louis, Mo.

Inventors join National Institute of Inventors, World Building, New York City; membership society 1,900 strong; will help protect, develop, finance and market your invention. Absolutely no charge. Write for booklet.

Patent Attorneys.

Patents Procured—Trade Marks Registered—A comprehensive, experienced, prompt service for the protection and development of your ideas. Preliminary advice gladly furnished without charge. Booklet of information and form for disclosing idea free on request. Richard B. Owen, 130 Owen Bldg., Washington, D. C., or 2278-T Woolworth Bldg., New York.

M. F. Miller, Ouray Building, Washington, D. C. Patent Attorney, Mechanical and Electrical Expert. Best quality of work and results. Moderate charges. Advice free.

Millions spent annually for ideas! Hundreds now wanted! Patent yours and profit! Write today for free books—tell how to protect yourself, how to invent, ideas wanted, how we help you sell, etc. American Industries, Inc., 212 Patent Dept., Washington, D. C.

Inventions Patented. Trade-marks Registered, Labels, Prints and Publications Copyrighted, reasonable fees; correspondence solicited; detailed information free; booklets. Jaynes & Jaynes, 702 Kellogg, Washington, D. C.

Protect Your Invention. Personal Service. Send sketch for honest advice. J. Reaney Kelly, 732 C, Woodward Bldg., Washington, D. C.

Patent Your Own Inventions. Save attorney's fees; we prepare applications; furnish full instructions and give satisfaction. Free information. Carl Larsen Co., Park Row Building, New York City.

James N. Lyles—Patents, trade-marks, copyrights. 734-D Eighth St., N. W., Washington, D. C.

Patents—My fee payable in monthly installments. Send sketch for advice. Booklet free. Frank Fuller, Washington, D. C.

John M. McLachlen, Atty. at Law, Patents, Trade Marks, Copyrights, 410 McLachlen Bldg., Washington, D. C.

Patent Attorney, Electrical Engineer, Mechanical Expert; Thorough Personal Service. Frank Ledermann, 21 Park Row, New York.

Printing.

100 Quality Printed Envelopes, size 6¾, 50c. Postpaid. Name cards same price. R. Wiese, Atlantic, Iowa.

100 Engraved Style Visiting Cards 50c; 100 Emblem Cards 70c. H. Gregory, Warwick, N. Y.

Wireless.

Complete receiving sets $8.50, $9.50 and up. Instruments, parts, minerals. Circular for stamp. Inquiries invited. Jenkins, 923 Purchase Street, New Bedford, Mass.

Switch Points. Binding Posts, Switch levers, and small parts, send 2c for catalogue describing these and other goods. A. W. Bowman & Co., 23 Church St., (Harvard Square), Cambridge, Mass.

Before you build that new set get our free circular on switches and contact points. Hard rubber knobs used. Eureka Secondary Co., 6939 S. May St., Chicago, Ill.

Radio Apparatus of Quality—Manufactured to your own specifications. Radio Engineering Company, Baltimore, Md.

Bargains—¼" Wireless Coils complete, guaranteed, 90c., except postage. Also Wireless Coils without vibrators, 45c., except postage. A. Dubs, 1534 Pitkin Ave., Brooklyn, N. Y.

Our Universal Radio Receiving, Detector, and Transmitting apparatus. The best that science and skill can manufacture. If interested write for catalogue. Universal Radio Mfg. Corporation, Elmira, N. Y.

Amateurs! Drop us a postal and receive interesting information that is of vital importance to you and future amateur radio. American Institute of Radio Engineering, Omaha, Nebr.

Gold Catwhisker is best for mineral detectors. Hard drawn 18 Kt. Gold Wire 26 B. & S. 3½ inches, 50c. Sterling silver, 15c. Geo. Schuler, Jr., 126 W. 46th St., New York City.

Patents for Sale.

Automobile Direction Indicator, Electrically operated. Just Patented. Manufacturing cost low. Ability to Finance means money. Royalty or contract. Investigate. L. A. & A. A. Ownbey, 1210 East 5th St., Chattanooga, Tenn.

Miscellaneous.

Wanted—Small Gasoline and Steam Engines. Cash paid for 1 to 4 cylinder light weight Motors. ¼ to 10 H.P. Johnston, West End, Pittsburgh, Pa.

Blacksmith, Listen! Prepare for big wages in Navy and Arsenal with Toy's Modern Methods doing hard jobs easy. Forging and making solid welds, hardening and tempering to a standard, with colored tempering charts. All for one dollar. Sample free. W. M. Toy, Sidney, Ohio.

Snow Plow. Removes snow from sidewalks, etc. Easy to raise or lower. Thoroughly tested. Can also be used as toy. A. H. Tallyn, Benson, Ill.

Be a Top Notcher—Get into the 100% Class. Be Prosperous. Powerful. Happy. Our system has shown thousands HOW. It can show YOU. No guesswork. Proved. A true-to-life Personality Sketch and first lesson on Happier Living for 10c. and birthdate. Thomson-Heywood Co., Dept. 350, Chronicle Bldg., San Francisco, Cal.

For Sale—Choice Silver Black breeding foxes. Reid Bros., Bothwell, Ont., Canada.

Julian's Liquid Fishing Lure. Doubles your catch. Trial bottle, One Dollar. George Julian, Albany Building, Boston, Mass.

Special—Cardboard tubing, impregnated, 5" diameter. 20c per foot. Postage extra. Mater, 335 East 93d St., New York.

Plastography Instruction with model or mould, $2.00. Success awaits you. P. B. Spahr, York, Penn.

Fancy Mice—30 Varieties; send stamp for list, or 50c for book giving full information on varieties, housing, breeding, etc. Holman's Mousery, Dedham, Mass.

Music composed to words. Bauer Bros. (formerly of Sousa's Band), Oshkosh, Wis.

Marvelous! Send for our time-saving multiplication table. Products of any amounts readily calculated. Handy pocket size card. Price 10 cents (coin) by mail. Remittance with orders. Tabluated Information Card Co., 2040 Chestnut St., Philadelphia, Pa.

"Opportunity Adlets" bring quick results. Our 100,000 circulation, net. Other firms are making money—so can you. For proof address Classified Department, Electrical Experimenter, 233 Fulton St., New York City.

Motors, Engines and Dynamos.

Small Motors and Generators: 1000 New Motors and Generators from Bankruptcy Stock, ¼ H. P. A. C., $18.50 each; ½ H. P., $30.00. Battery Charging Sets—Robbins & Myers new outfits, all sizes, $30.00 each and up. Charging, Lighting and Moving Picture Arc Generators, $10.00 each and up. Motors for all phases of current. Immediate delivery. Less than ½ regular prices. Write for late bulletin. Johnston, West End, Pittsburgh, Penna.

For Sale—Motors, all sizes. Write your wants. We have them. E. Billstone, Jamestown, N. Y.

Gas Engines for every purpose. Marine, rowboat, stationary and motorcycle. Engines from $10 up. Guaranteed one year. Write United Motor Repair & Supply Co., 305-309 Broadway, New York.

500 Watt Motors, Modern, Efficient, cost me $12. Investigate! Duplicate! Clark, Barnes Road, Newton, Mass.

50-H.P. Gasoline Engine, 4 cylinders, aluminum, cost $1,500. Will take $450. Geo. B. Boutelle, 324 N. Eutaw St., Baltimore, Md.

10 Volt, 20 Ampere Dynamo, brand new, under half price. Call Saturday evening, 354 Convent Ave., New York.

Novelties.

Latest Fad, $1.00. Blanket flag sofa pillow. Covered with 24 flags, 8 shield of arms, satine lined. Fletcher & Fletcher, 1711 S. Oregon Ave., St. Louis, Mo. Agents write for particulars.

Snappy girl pictures. You will like them and want more; 20 for 25c. Write today. Smith's Novelty, (Dept. 5) 6735 Elizabeth, Chicago, Ill.

For the Hair.

I was Bald. Obtained hair growth by an Indian's ointment containing genuine bear oil and rare plant juices. Many others have good hair-growing results. Will send box, postpaid, with recipe, 10c. John Hart Brittain, 150 E. 32nd St., BA-300. New York.

Personal.

Are you self-conscious—embarrassed in company—lacking in self-control? These troubles overcome. C. E. Veritas, 1400 Broadway, New York City, N. Y.

Electrical Supplies & Appliances.

Make Your Own Transformers. Costs a few cents to make. Will ring bells, buzzers, etc. No batteries required. Guaranteed, instructions, 25c. Abrams Co., 1305 Peoria St., Chicago.

Install Farm Lighting Plants. Big Profits. Get our Agency Plans at once. Wolkee Co., Louisville, Ky.

Repairing and rebuilding Galvanometers, Voltmeters, Ammeters on any electrical instruments. V. W. Bradbury, Winnsboro, La.

Propellers for Air Propulsion. Practice and Professional blades made to order. Crawford Motor and Aeroplane Manufacturing Co., Pittsburgh, Pa.; New Orleans, La.

Inventors' and Manufacturers'. Experimental work, models, tools, instruments, light machinery. Over twenty years' specialized experience working from samples, blue prints, rough sketches, explanations. Customers' supervision in machine shop permitted. Manufacturers' and Inventors' Electric Co., 29D Gold St., New York.

Get the proper apparatus for your experiments. Coils, Electro-magneto, Solenoids, Resistances, Inductances and Condensers, designed and constructed to your order. J. E. Fast, 5840 W. Erie St., Chicago, Ill.

Problems and advice in Radio, Mathematics, Electricity, Chemistry, etc., answered by experts for $1.00 and up. Paragon Technical Bureau, 329 East Fifth Street, New York City.

10 Security Ford Locks, new, at $3.50 each, regular $5.00 locks; 100 ampere combination Ford Locks for switch at $2.00 each, new, regular price $3.50; one Palor Cut 6" Electric Fan, new, at $4.25; one telephone, new, 50c.; one Premo Camera, No. 1—3½ x 4¼ Second-Hand at $6.00. Electrical, Optical and Technical Supplies. H. C. Hancock, Bogota, N. J.

Look! Save Money! Heavy aluminum 10 x 12 sheets, fifty cents; inch strip, 12c. ft. Heavy 1¼ inch brass strip, 18c. ft.; ¾ inch, 10c. ft. Postpaid. Robert Duffield, Detroit, Mich.

25c. in coin will answer that question on Storage Batteries. Henry G. Oakes, 81 Triangle St., Buffalo, N. Y.

Look! Penlites exact representation of fountain pens, 65c.; 6½" tubular flashlight, $1.05. Postage 5c. extra on either. Extra batteries sold. J. McLardie, 424 Edgewater, Dayton, Ohio.

Will buy and sell anything electrical, chemical or mechanical. Send for list and send in list and prices. Box 255, North Bennington, Vermont.

24 Dry Cells Recharged for 40c. Instructions, 10c. Walker, Box 465, Dayton, Ohio.

Blue Prints.

Blue Prints of Motor windings. 108 A.C. connections, 132 D.C. armature windings, complete 240 diagrams $5.00 cash. Send 25c. for 12 samples or write for particulars. Charles L. Chittenden, 811 West 18th Street, Kansas City, Mo.

Blue Prints: ⅛ H.P. Gas Engine, 30c; ¼ H.P. Steam Engine, 50c; ⅛ H.P. Boiler and Engine, 70c; all 3 for $1.00. Circulars on Castings and Engines for stamp. Universal Gas Motor Co., 364 Monadnock, Chicago.

Instruction.

Typewriting learned easily and quickly at home by Modern Fingering Gymnastic Method. New discovery by long experienced typewriting instructor makes expert typists. Demand increased salary. Complete course, twelve lessons, five dollars. Guaranteed. Enroll today. School of Modern Method Typewriting, Warren, Ohio.

Over 100 Branches thoroughly taught by mail. For "Free Tuition", apply Carnegie College, Rogers, Ohio.

Song Poems Wanted.

Write the Words for a Song. We write music and guarantee publisher's acceptance. Submit poems on war, love, or any subject. Chester Music Co., 918 So. Michigan Ave., Room 265, Chicago.

You Write the Words for a Song—Submit poems on war, love, or any subject. Chester Music write music, guarantee copyright and assist in securing publisher. Metropolitan Studios, Room 113, Morton Bldg., Chicago, Ill.

Phonographs.

Build Your Phonograph. "Perfection" high-quality spring and electric Motors, Tone Arms, Reproducers. Wonderful results. Big saving. New catalog and building instructions mailed for ten cents. Indiana Phonograph Supply Co., Indianapolis, Indiana.

Build Your Own Phonographs and manufacture them for profit. Drawing instructions, Parts, Price List, Blue Prints, etc., complete, sent free upon request. Write today. Associated Phonograph Co., Dept. E-1, Cincinnati, Ohio.

Letter Specialists.

Letters That Land Orders and Money Orders—written for $4.00; three for $10.00. Guaranteed. Criterion Service, Dept. 3, West New York, New Jersey.

These Are The Hours That Count

MOST of your time is mortgaged to work, meals and sleep. But the hours after supper are *yours*, and your whole future depends on how you spend them. You can fritter them away on profitless pleasure, or you can make those hours bring you position, money, power, *real success* in life. Thousands of splendid, good-paying positions are waiting in every field of work for men *trained to fill them*. There is a big job waiting for *you*—in your present work or any line you choose. Get ready for it! You can do it without losing a minute from work or a wink of sleep, without hurrying a single meal, and with plenty of time left for recreation. You can do it in one hour after supper each night, right at home, through the International Correspondence Schools.

Yes—You Can Win Success in an Hour a Day

Hundreds of thousands have proved it. The designer of the Packard Twin Six and hundreds of other Engineers, climbed to success through I.C.S. help. The builder of the great Equitable Building, and hundreds of Architects and Contractors, won their way to the top through I.C.S. spare-time study. Many of this country's foremost Advertising and Sales Managers prepared for their present positions in spare hours under I.C.S. instruction.

For 28 years men in offices, stores, shops, factories, mines, railroads—in every line of technical and commercial work—have been winning promotion and increased salaries through the I.C.S. Over 100,000 men are getting ready *right now* in the I.C.S. way for the bigger jobs ahead.

TEAR OUT HERE

INTERNATIONAL CORRESPONDENCE SCHOOLS

Box 6186, SCRANTON, PA.

Explain, without obligating me, how I can qualify for the position, or in the subject, before which I mark X.

☐ ADVERTISING	☐ ELECTRICAL ENGINEER	☐ MECHANICAL ENGINEER
☐ SALESMANSHIP	☐ Electrician	☐ Mechanical Draftsman
☐ Traffic Management	☐ Electric Wiring	☐ Machine Designer
☐ BUSINESS (Complete)	☐ Electric Lighting	☐ Machine Shop Practice
☐ Commercial Law	☐ Electric Car Running	☐ Boilermaker or Designer
☐ Certified Public Accountant	☐ Heavy Electric Traction	☐ Patternmaker
☐ Higher Accounting	☐ Electrical Draftsman	☐ Toolmaker
☐ Railway Accountant	☐ Electric Machine Designer	☐ Foundry Work
☐ BOOKKEEPER	☐ Telegraph Engineer	☐ Blacksmith
☐ Stenographer & Typist	☐ Telephone Work	☐ Sheet-Metal Worker
☐ Good English	☐ ARCHITECT	☐ STEAM ENGINEER
☐ Window Trimmer	☐ Architectural Draftsman	☐ Stationary Fireman
☐ Show-Card Writer	☐ Contractor and Builder	☐ MARINE ENGINEER
☐ Sign Painter	☐ Building Foreman	☐ GAS ENGINE OPERATING
☐ CIVIL SERVICE	☐ Carpenter	☐ Refrigeration Engineer
☐ Railway Mail Clerk	☐ Concrete Builder	☐ CIVIL ENGINEER
☐ Mail Carrier	☐ PLUMBER & STEAM FITTER	☐ Surveying and Mapping
☐ CARTOONIST	☐ Heating and Ventilation	☐ R. R. Constructing
☐ Illustrator	☐ Plumbing Inspector	☐ Bridge Engineer
☐ Perspective Drawing	☐ Foreman Plumber	☐ SHIP DRAFTSMAN
☐ Carpet Designer	☐ CHEMIST	☐ Structural Draftsman
☐ Wallpaper Designer	☐ Analytical Chemist	☐ Structural Engineer
☐ Bookkeeper Designer	☐ MINE FOREMAN OR ENGINEER	☐ Municipal Engineer
☐ TEACHER	☐ Coal Mining	☐ NAVIGATION ☐ Spanish
☐ Common School Subjects	☐ Metal Mining	☐ Motor Boat Runs'g ☐ French
☐ High School Subjects	☐ Metallurgist or Prospector	☐ AGRICULTURE ☐ Italian
☐ Mathematics	☐ Assayer	☐ Fruit Growing
☐ AUTOMOBILE OPERATING	☐ TEXTILE OVERSEER OR SUPT.	☐ Vegetable Growing
☐ Automobile Repairing	☐ Cotton Manufacturing	☐ Live Stock and Dairying
☐ Auto. Electrical Work	☐ Woolen Manufacturing	☐ POULTRY RAISING

Name _____

Occupation _____ Employer _____

Street and No. _____

City _____ State _____

Canadians may send this Coupon to International Correspondence Schools, Montreal, Can.

Your Chance Is Here!

No matter where you live, the I.C.S. will come to *you*. No matter what your handicaps, or how small your means, we have a plan to meet your circumstances. No matter how limited your previous education, the simply written, wonderfully illustrated I.C.S. textbooks make it easy to learn. No matter what career you may choose, some one of the 280 I.C.S. Courses will surely suit your needs.

Make Your Start Now!

When everything has been made easy for you—when one hour a day spent with the I.C.S. in the quiet of your own home will bring you a bigger income, more comforts, more pleasures, all that success means, can you afford to let another single priceless hour of spare time go to waste? Make your start right now! This is all we ask: Without cost, without obligating yourself in any way, put it up to us to prove how we can help you.

Just Mark and Mail This Coupon

THE CAREY PRINTING CO. INC.
NEW YORK