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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. 74 **JUNE, 1919** **No. 2**

EDITORIAL

Tree Wireless

IN 1904, during Army maneuvers in California, General, then Major, George O. Squier, of the U. S. Signal Corps, made the important discovery that it was possible to receive radio messages, using live trees as an aërial. He found that by merely driving a metallic spike into the tree trunk, a few feet above the ground, and by connecting the wire from his radio receiving instruments to the spike, messages would come in astonishingly well over this new "aërial".

The invention, while important, received but scant notice, even in the scientific press of that day. Indeed, the majority of radio people knew very little about the invention, and those who did know considered the tree aërial as a freak, along with the bed-spring aërial and others of a similar nature.

During the war, however, the discoverer of the system, who had now become Major General Squier, Chief Signal Officer of the Army, made many new experiments with trees and radio. Recently, before the Physical Society, General Squier delivered a highly interesting lecture on the subject, and from what transpired, it is certain we have merely scratched the surface of an important invention.

General Squier, for instance, has been in constant communication with Europe for months, receiving messages from all of the large radio stations located in England, France, Italy and Germany, using nothing but trees for his aërials. But that was not all. He demonstrated that it was just as easy to *send* radio messages over a tree as it was to receive them. Indeed this holds true not only for telegraph messages, but radio telephone communication has been actually carried on between trees over a distance of *three miles!* So far no attempt has been made to increase this distance, altho it is obvious that any distance, depending only upon the power of the sending instruments, can be bridged in this manner.

That this system proved of immense value during the war can be readily imagined. Our signal corps men for that reason never were troubled with the communication lines in their rear, as long as there was a live tree about. No conspicuous wire aërial was needed for their radio work; code messages flew back and forth from the most extended points of our lines, right under the Germans' noses, who never suspected innocent-looking trees as being the carriers of priceless information.

General Squier thinks that the tree aërial will soon supplant the wire antenna entirely; even the big commercial stations, he thinks, can make excellent use of his discovery. The radio amateur particularly, will find the trees about his house a new and welcome source for his experiments. Many parents and landlords object to unsightly aërials on or about the house. An innocent-looking tree—if there is one near at hand—now solves the problem for the ambitious amateur. And the higher the tree, the better the results.

The new botanical antenna, on the other hand, brings us many new and interesting problems. One—and a curious one at that—is: How to figure the *wave length* of such an aërial! No doubt General Squier has, or will work out a standard formula for us. Undoubtedly, too, the wave length will vary from year to year—due to the growth of the tree. Then, too, in Spring, before the leaves are on the tree, the wave-length should be slightly less than in the summer time, due to the smaller area and resultant capacity. Also it would seem that in the winter time, the wave-length of the tree would be much less than in the Spring, due to the conducting sap receding from the branches.

Suppose you were to "spike up" every tree in a small wood—say, a thousand trees! The enormous area exposed to the ether, would theoretically give us a wonderfully effective antenna. We say theoretically, because we do not know how the immense added capacity would affect our instruments.

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.

New Stomachs for Old In 48 Hours

By R. S. Thompson


EUGENE CHRISTIAN

THOUSANDS of people who suffered for years with all sorts of stomach trouble are walking around today with entirely re-made stomachs—stomachs which have been re-made in from 48 to 72 hours! They enjoy their meals and never have a thought of indigestion, constipation or any of the serious illnesses with which they formerly suffered and which are directly traceable to the stomach.

And these surprising results have been produced not by drugs or medicines of any kind, not by foregoing substantial foods, not by eating specially prepared or patented foods of any kind, but by eating the plainest, simplest foods *correctly combined!*

These facts were forcibly brought to my mind by Eugene Christian, the eminent Food Scientist, who is said to have successfully treated over 23,000 people with foods alone!

As Christian says, man is what he *eats.* What we take into our stomachs today, we are tomorrow. Food is the source of all power, yet not one person in a hundred knows the chemistry of foods as related to the chemistry of the body. The result is we are a nation of "stomach sufferers."

Christian has proved that to eat good, simple, nourishing food is not necessarily to eat correctly. In the first place, many of the foods which we have come to regard as good are in reality about the worst things we can eat, while others that we regard as harmful have the most food value.

But perhaps the greatest harm which comes from eating blindly is the fact that very often two perfectly good foods when eaten at the same meal form a chemical reaction in the stomach and literally explode, liberating dangerous toxic poisons which are absorbed by the blood and circulate throughout the system, forming the root of all or nearly all sickness, the first indications of which are acidity, fermentation, gas, constipation and many other sympathetic ills leading to most serious consequences.

And yet just as wrong food selections and combinations will destroy our health and efficiency, so will the right foods quickly create and maintain bodily vigor and mental energy. In my talk with Eugene Christian, he told me of some of his experiences in the treatment of disease through food—just a few instances out of the more than 23,000 cases he has on record.

One case which interested me greatly was that of a young business man whose efficiency had been practically wrecked through stomach acidity, fermentation and constipation, resulting in physical sluggishness which was naturally reflected in his ability to use his mind. He was twenty pounds underweight when he first went to see Christian and was so nervous he couldn't sleep. Stomach and intestinal gases were so severe that they caused irregular heart action and often fits of great mental depression. As Christian describes it, he was not 50 per cent efficient either mentally or physically. Yet in 24 hours, by following Christian's suggestions as to food, his constipation was relieved, although he had formerly been in the habit of taking large daily doses of a strong cathartic. In five weeks every abnormal symptom had disappeared—his weight having increased 6 lbs. In addition to this, he acquired a store of physical and mental energy so great in comparison with his former self as to almost belie the fact that it was the same man.

Another instance of what proper food combinations can do almost overnight was that of a man one hundred pounds overweight whose only other discomfort was rheumatism. This man's greatest pleasure in life was eating. Though convinced of the necessity, he hesitated for months to go under treatment, believing he would be deprived of the pleasures of the table. He finally, however, decided to try it out. Not only did he begin losing weight within a few hours, regaining his normal figure in a matter of weeks, but all signs of rheumatism disappearing, and he found the new diet far more delicious to the taste and afforded a much keener quality of enjoyment than his old method of eating, and wrote Christian a letter to that effect.

But perhaps the most interesting case that Christian told me of was that of a multi-millionaire—a man 70 years old, who had been traveling with his doctor for several years in a search for health. He was extremely emaciated, had chronic constipation, lumbago, and rheumatism. For over twenty years he had suffered with stomach and intestinal trouble which in reality was superaciduous secretions in the stomach. The first menus given him were designed to remove the causes of acidity, which was accomplished almost overnight. And after this was done he seemed to undergo a complete rejuvenation. His eyesight, hearing, taste, and all of his mental faculties became keener and more alert. He had had no organic trouble—but he was starving to death from malnutrition and decomposition—all caused by the wrong selection and combination of foods. Almost immediately after following Christian's advice this man could see results, and after six months he was as well and strong as he had ever been in his life.

These instances of the efficacy of right eating I have simply chosen at random from perhaps a dozen Eugene Christian told me of, every one of which was fully as interesting, and they applied to as many different ailments. Surely this man Christian is doing a great work.

I know of several instances where rich men and women have been so pleased with what he has done for them that they have sent him a check for $500 or $1,000 in addition to the amount of the bill when paying him.

There have been so many inquiries from all parts of the United States from people seeking the benefit of Eugene Christian's advice and whose cases he is unable to handle personally that he has written a little course of lessons which tells you exactly what to eat for health, strength and efficiency. This course is published by The Corrective Eating Society of New York.

These lessons, there are 24 of them, contain actual menus for breakfast, luncheon, and dinner, covering every condition of health and sickness from infancy to old age and for all occupations, climates, and seasons.

Reasons are given for every recommendation based upon actual results secured in the author's many years of practice although technical terms have been avoided. Every point is explained so clearly that there can be no possible misunderstanding.

With these lessons at hand it is just as though you were in personal contact with the great food specialist, because every possible point is so thoroughly covered that you can scarcely think of a question which isn't answered. You can start eating the very things that will produce the increased physical and mental energy you are seeking the day you receive the lessons, and you will find that you secure results with the first meal. This of course, does not mean that complicated illnesses can be removed at one meal, but it does mean that real results can nearly always be seen in 48 hours or less.

If you would like to examine these 24 little Lessons in Corrective Eating, simply write The Corrective Eating Society, Department 1646, 443 Fourth Avenue, New York City. It is not necessary to enclose any money with your request. Merely ask them to send the lessons on five days' trial, with the understanding that you will either return them within that time or remit $3.00, the small fee asked.

The reasons that the Society is willing to send the lessons on free examination without money in advance is because they want to remove every obstacle to putting this knowledge in the hands of the many interested people as soon as possible, knowing full well that a test of some of the menus in the lessons themselves is more convincing than anything that can possibly be said about them.

Please clip out and mail the following form instead of writing a letter, as this is a copy of the blank adopted by the Society, and will be honored at once

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It contains the following 44 chemicals:

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Ammonium Aqua (NH_3+H_2O)
Ammonium Carbonate $(NH_4)_2CO_3$
Ammonium Chloride (NH_4Cl)
Ammonium Sulphate $(NH_4)_2SO_4$
Barium Chloride ($BaCl_2$)
Boric Acid (H_3BO_3)
Brimstone (Sulphur) (S)
Calcium Chloride ($CaCl_2$)
Calcium Oxide (CaO)
Calcium Sulphate ($CaSO_4 2H_2O$)
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.

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How I Stopped Forgetting In One Evening

How in One Evening I Discovered the Secret of a Good Memory and in Six Months Increased My Business One Hundred Thousand Dollars

By William Gerard

WHO would ever have thought that a $100,000 increase in my business would come from a simple secret learned in one evening. And yet, that is just what happened. I look back on it today, and can hardly believe that it is only six short months since I learned from David M. Roth, the famous memory expert, how to make my memory do wonderful things that I never before dreamed possible.

I consider the evening I met Mr. Roth one of the most momentous in my life. It was at a dinner of the Seattle Rotary Club. Mr. Roth was present and started his exhibition by asking sixty of those present to introduce themselves to him by name. Then he requested a gentleman at the blackboard to write down names of firms, sentences and mottos on numbered squares, meanwhile sitting with his back to the writer. After this, he was asked by various Rotarians to tell what was written down in the specific squares. Mr. Roth gave the entire list without a mistake. After finishing with this, Mr. Roth singled out and called by name the sixty men to whom he had been introduced earlier, and who in the meantime had changed seats and mixed with others present.

After the meeting, I was introduced to Mr. Roth by a mutual friend, and congratulated him upon his marvelous feats of memory. To my surprise, Mr. Roth said, "Why, Mr. Gerard, such things are nothing at which to marvel. Anyone can do these things and even greater things with his memory. A good memory is not a gift. Any person of average intelligence can easily develop his memory. I, myself, am an example of this fact. As a young man my memory was so poor I could hardly remember a man's face or name 20 seconds. I soon realized that this bad memory would scare away any chance I had for success. Right then and there I determined to improve my memory. And now, after 20 years of attention to the subject, I feel that I can do as much for other people's memories as I have done for my own. I have recently finished work on a simple and practical course through which anyone can improve his memory until it becomes a veritable sponge for absorbing facts, faces, names and all the information one wants to remember. This course contains all of my secrets and principles. If you will write to my publishers in New York, the Independent Corporation, you can make arrangements for examining the course without charge."

Needless to say I wrote the Independent Corporation, asking to examine the course. In a few days I received the seven lessons together with a little booklet of letters from many men telling what they had already done through the aid of the course. It was very encouraging for me to read the letter from C. Louis Allen, who at the age of thirty-two became president of the million dollar Pyrene Manufacturing Company, and is now the president of the Sales Company bearing his name.

"Now (says Mr. Allen) that the Roth Memory Course is finished I want to tell you how much I have enjoyed the study of this most fascinating subject. Usually these courses involve a great deal of drudgery, but this has been nothing but pure pleasure all the way through. I have derived much benefit from taking the course of instruction and feel that I shall continue to strengthen my memory. That is the best part of it. I shall be glad of an opportunity to recommend your work to my friends."

You may be sure that after reading the balance of the letters telling of *real results*, I went right at the course that very evening. I expected to find the lessons "brain breakers", but to my surprise, the Roth Course was as easy and fascinating as a game. I hated to put it by that evening and surprised my wife by repeating backwards, forwards and all ways fifty words of all sorts. My wife could not understand how a person with a memory so poor as mine could do such a thing after only about one hour's study. But the course gives the secret of a good memory *right at the start.* I played the memory improving game for a few minutes each evening for a month. And the further I got the more fascinating the game became. Long before a month was up I had amazed my family and my friends on a number of occasions by various memory feats, and to them the astounding difference in my memory was nothing short of a miracle.

And now, my memory behaves so efficiently that my business has felt the impetus of my increased mind power and has responded in a joyously lucrative fashion. Within the last six months my sales have jumped up $100,000—*with no "war-baby" or external force to boost my business.*

The reason I know that my business expansion is due to my own increased power is that I seem to have a new grip upon affairs. I employ old facts and experiences, give them a new twist and have thereby revitalized my business methods. I now remember and apply all that I have heard other people have learned. Nothing slips my mind that can be used to some business advantage. I find and store in my new, iron-bound memory real nuggets of facts and experiences that other people casually let drop. When a condition arises, I just seem to open a certain drawer of my mind, then take out and marshal together all facts and precedents that I have learned. My memory has become an ally that never fails to help me push my business ahead "on high."

I now seize many golden opportunities that before would have slipped by and been out of reach by the time I woke up.

You see the Roth Course has done vastly more for me than merely teach me how to remember names and faces, telephone numbers, etc. It has done more than make me a more interesting talker. It has done more than give me confidence in myself.

Mr. Roth's Course has endowed me with new business perspective. It has made me a keener observer. It has given me a new sense of proportion and values. It has given me visualization—which after all is the true basis of business success.

I feel that I owe the Roth Memory Course a great debt—in fact, a $100,000 debt. I feel that telling my story to the readers of The Electrical Experimenter Magazine is only a small payment for what the course has done for me. Any power that can increase a man's business $100,000 and increase his mind power 90% deserves that man's sincere and truthful endorsement. I *know* that this is what the Roth Memory Course has done for me and for my business. Not alone am I happy to be able to tell my story as it happened, but I am gratified to know that anyone can do the same thing. A mere glance over the first lesson will show that there is a course, not for "high brows" who love to bathe in theory, but practical and easy instructions for every man, woman or child, who knows the enormous value of a good substantial memory. This same hand of mine that gave out $5 for the Roth Course took in $100,000 as a result, and in telling my experience, I feel that in a small way, I am repaying the great debt that I owe to the David M. Roth Memory Course.

WILLIAM GERARD.

AMAZING MEMORY FEATS

Any man, woman or child of average intelligence can easily and quickly acquire a sure and exact memory.

When David M. Roth, the famous expert, first determined to cultivate his memory he did it because he had a poor memory. He actually could not remember a man's name twenty seconds. He forgot so many things, that he knew he could not succeed unless he did learn how to remember.

Today there are over ten thousand people in the United States whom Mr. Roth has met at different times—most of them only once—whom he can name instantly on sight. Mr. Roth can, and has, hundreds of times at dinners and lectures, asked from fifty to one hundred people to tell him their names and telephone numbers, and business connections, and then, after turning his back while they changed seats, has picked each one out by name and told him his telephone number and business.

These are only a few of the scores of other equally "impossible" things that Mr. Roth does—and yet a few years ago he could not remember a man's name twenty seconds. You too can do these wonderful things.

SEND NO MONEY

So confident is the Independent Corporation, the publishers of the Roth Memory Course, that once you have an opportunity to see in your own home how easy it is to double, yes triple your memory power in a few short hours, that they are willing to send 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 or a letter now before this remarkable offer is withdrawn.

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Publishers of The Independent Weekly

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ELECTRICAL EXPERIMENTER

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

Vol. VII. Whole No. 74 JUNE, 1919 No. 2

Listening to Theater Critics

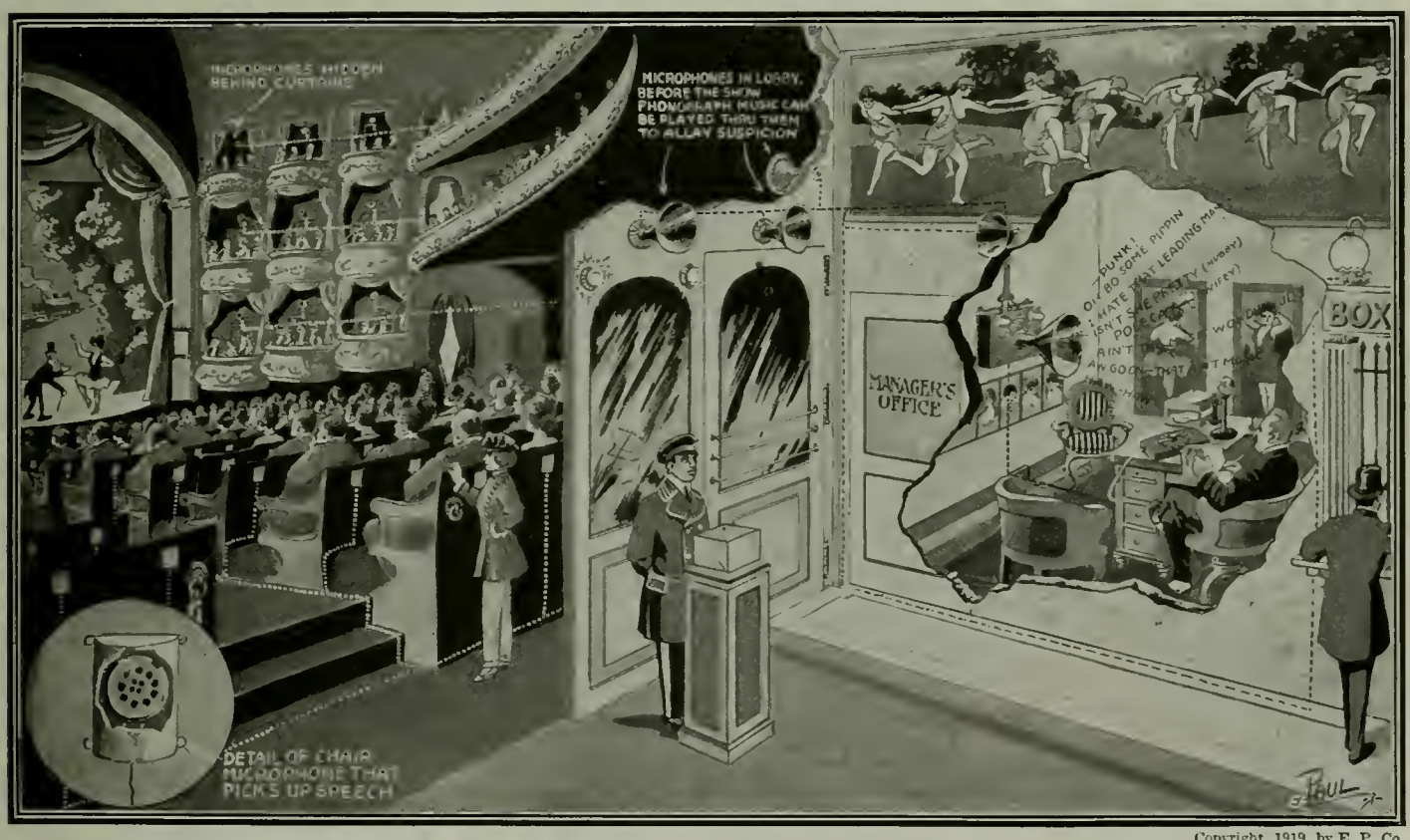
WE of the present generation have seen the dictograph or supersensitive telephone, applied to almost every purpose imaginable, from listening to the whispered machinations and plottings of criminals to the honeyed words of the philanderous husband making love to a chorus girl.

But now comes the very latest application of the dictograph, for the purpose of overhearing the criticisms of theater audiences, and it took Chicago to show us the way. In that city there is a large motion-picture theater completely equipt with dictograph transmitters or microphones, liberally sprinkled thruout the auditorium, so that the manager, by means of a small switchboard installed in his private office, may overhear the conversations, caustic or otherwise, regarding Bessy Tinkletoes and the merits and demerits of the corseted leading man, not to mention the "villiun" and the dashing, smashing "soubrette."

The *microphones* or sound-detecting apparatus, camouflaged so as to be invisible, are secured on the backs of the various chairs in the orchestra or balcony, and are connected up with separate wires leading to a switchboard in the manager's office, so that as the switch is turned, the respective microphones are switched into circuit alternately. The current modulations set up by even a whisper several feet away from one of these microphones act on a loud-speaking telephone at the manager's desk. It is also possible to connect up such apparatus with a set of head receivers strapt to the ears, the same as in the regular dictaphone sets used by crime investigators, after the fashion made famous by Detective Burns and other defenders of the common law.

Not only is it possible with such an arrangement to place microphones or sound detectors on the backs of seats in the auditorium, but they may be placed in the boxes behind portieres, and in many other advantageous and inconspicuous positions. It is rather difficult to conceal them in the foyer, but by a little clever subterfuge and ingenuity exercised by the engineers having charge of the installation, this problem is quite easily solved. For instance, an old trick of the showman may be put into play, namely, that to allay suspicion on any trick, you must convince the public that everything is apparently as it seems; and bearing in mind P. T. Barnum's famous lines—"The public likes to be fooled," and "There's one born every minute," we proceed in the present case to do a little fooling of the public ourselves, and thusly do we do it; by placing the microphones in a series of small ornamental horns about the lobby, in the bases of which there are also arranged loud-speaking telephone devices. Before the performance and during intermissions, when the foyer and lobby

(*Continued on page* 162)



A New Idea Tried Out in a Chicago Theater—Eavesdropping on the Critics in the Audience. The Remarks of These Self-appointed Dramatic Critics Prove Very Valuable to the Enterprising Theater Manager, As a Failing Show May Be Revised and Strengthened So As to Make a Real "Hit." The Super-sensitive Microphone or "Dictograph" Solves the Problem—the Instruments, Distributed Thruout the Auditorium, Can Be Switched Onto a "Loud-talking Reproducer" in the Manager's Office, in Any Order Desired.

Electric Drive on U. S. S. "New Mexico"

By CHARLES M. RIPLEY

THE battleship *New Mexico* is the pride of the United States Navy, and her electric drive is the pride of the *New Mexico*. How the electrical machinery looks, how it works, why the electric drive is preferable to other forms of propulsion, how she looks inside and outside, is here related by one of the men who recently was a passenger on Uncle Sam's latest superdreadnaught, riding between the Brooklyn Navy Yard and Rockland, Maine.

This latest leviathan weighs 32,000 tons and requires 32,000 horsepower or *one horsepower per ton*. Her weight is equivalent to a bar of iron weighing one pound to the foot and forming a band of iron from the North to the South Pole with enough in addition to reach from Maine almost to the borders of Florida. She is so huge that it requires ten tugs to push her from her pier in Brooklyn Navy Yard out into the East River. From the platform called the "crow's nest" at the top of the mast down to the level of the water is 120 feet, or equal in height to a ten-story building.

The battleship can generate enough electricity to run the giant General Electric Works and the Schenectady Railway Company.

Motors Drive Propellers.

Like everything else that is electrical, the *New Mexico* is the cleanest institution of her kind. There are no engines or turbines connected with the propeller shafts—only electric motors. There are no grates under the boilers—merely oil burners. There is not a coal or ash shovel on the ship; nor are there any cinders, smoke, dust, or soot.

The *New Mexico* "coals" thru a 6-in. hose, that is because she burns only oil for her power. The total oil capacity of the dozen or more compartments is 3,400 tons or 6,800,000 lbs., or nearly a million gallons. If the *New Mexico* were an automobile with a mileage of 20 miles per gallon, this amount of oil would drive her close to 20 million miles or a distance equal to 80 times to the moon. But a 32,000-ton battleship does not equal the mileage of a flivver, for it weighs as much as 60,000 of those vehicles, and must plow thru the water displacing her own weight of water each time she runs her own length, 624 feet. The cost of fuel is more important on ship board than on land, and this is emphasized by the fact that on the 2,000-mile trial trip alone she will displace over 620,000,000 tons of water.

From Oil to Electricity.

Following the energy of the oil fuel thru the different processes until this energy drives the propellers electrically is an entertaining and instructive trip. Escorted by courteous officers, you start for one of the three boiler rooms. You must open and close several steel bulkheads in the watertight compartment and descend steel ladders and steel steps apparently equivalent to those in a five-story building. On the way down you must pass thru an "air lock" similar to those which give the excavators access to the caissons used in building the foundations of the skyscrapers 90 feet under Broadway, or in constructing the piers under big bridges in the middle of the river. The officer who escorts you is very careful to close the steel door behind you before he opens the one in front of you.

High Air Pressure.

No sooner are the bolts loosened than you feel the increased air pressure swish into your ears. This is because the air in the fire-room is maintained at a higher pressure than the outside air. All the air which the firemen breathe is pumped air. There is more oxygen in a cubic foot of this air than there is in ordinary air. This increased pressure and increased oxygen are both useful in providing the proper combustion in the boiler.

How Smoke Screens Are Made.

If the *New Mexico* wishes to throw a smoke screen, the men in the fireroom merely turn a few tiny hand valves in a ¼-in. pipe and, presto! inky blackness will vomit from the single smoke stack and blacken vast sea areas. This is a very nice study of how different mechanical mixtures of oil and air will bring about different chemical combinations between oil and oxygen. One of these combinations eliminates smoke by effecting almost perfect combustion; while the other creates a heavy black smoke which will practically blindfold the enemy. And three little ¼-in. pipes in each boiler are all that is needed to do this.

THE day of the all-electric superdreadnaught, not to mention electrically driven war vessels and merchant ships of smaller size, has arrived. In the present article Mr. Ripley gives us an interesting authoritative description of his trip on Uncle Sam's latest superdreadnaught, the "New Mexico", with her 32,000 horse-power electric propelling plant. Like everything else that is electric, the "New Mexico" is the cleanest institution of her kind. There are no engines or turbines directly connected with the propelling shafts—only powerful electric motors. There are no grates under the boilers—merely oil burners. Electrical propulsion not only does away with reversing turbines, but also does away with reduction gears, with their accompanying mechanical loss. The battleship "New Mexico" can travel a distance of 7,500 knots at 12 knot speed before it will be necessary to take on more fuel. The electric equipment totals nearly 100,000 horsepower, including over 100 loud speaking telephones, nearly 200 electric fans, electric gyroscopic compasses, and in fact "Electricity" rules the day everywhere about this modern naval wonder.

Size of Boilers.

It is said that no other 32,000-ton battleship has as few as nine boilers. There are three boiler rooms, each in a separate compartment, and each room contains three large boilers. Each of these nine boilers can deliver over 4,000 horsepower and contains three miles of 2-in. seamless pipes. Put end to end the pipes in all nine boilers would make a seamless tube 27 miles long. The Pennsylvania has 12 boilers and the Oklahoma has 12, altho its tonnage is only 27,500.

The history of the steam engine shows that its inventor, James Watt, thruout his entire life opposed any steam pressure higher than 5 to 10 lbs. per square inch. The *New Mexico's* boilers supply *steam at 250 lbs. per square inch!*

Superheated Steam.

After the steam is generated, and has past thru the big pipe away from the water in the boiler, it is again brought in contact with the flames of the furnace and is superheated to a still higher temperature. In fact, as the steam leaves the boiler it is about 450° F., or hot enough to melt solder and tin.

Superheated steam gives super-results. This is because the steam turbine is clast among engineers as a "heat engine" and the more heat that is supplied in this steam the more energy is available for power.

Two Power Plants.

For propulsion there are two electric power plants in separate compartments. They are way down low in the *New Mexico* close to the boilers. Each of these power plants alone is able to drive the battleship at a speed of 18 knots. (A nautical mile, or knot, is 6,080 feet, as against 5,280 feet in a land mile.)

Turbine Electric Plant.

In two separate steel compartments 15 by 45 ft. are located the two turbine generator sets, each not over 27 ft. long. The turbine itself is little larger than a hogshead of molasses laid over on its side. It seems almost incredible that this small machine can generate 16,000 horsepower from steam.

The engine rooms of most ships of the past have been a tangle of bending and curving pipes, and in order to move about the men had to stoop down to go under them or climb over them or squeeze between them. When one of these pipes burst it practically meant the death of every man in the engine room. One of the advantages of these power plant rooms in the *New Mexico* is the fact that there is only one steam pipe in the room, and that is only 16 ft. long.

Steam Turbine.

In each of these two power plants the steam turbines make electricity for driving the battleship. From the outside the most interesting thing about these wonderful rotary steam engines, called turbines, is their small size, their light weight, and the fact that they are so perfectly enclosed that you cannot see anything move. A turbine of 16,000 horsepower when compared in size and weight with the great triple and quadruple expansion steam engine that had been used up until recent years, is practically a watch charm—a little toy. There is only rotary motion in the steam turbine.

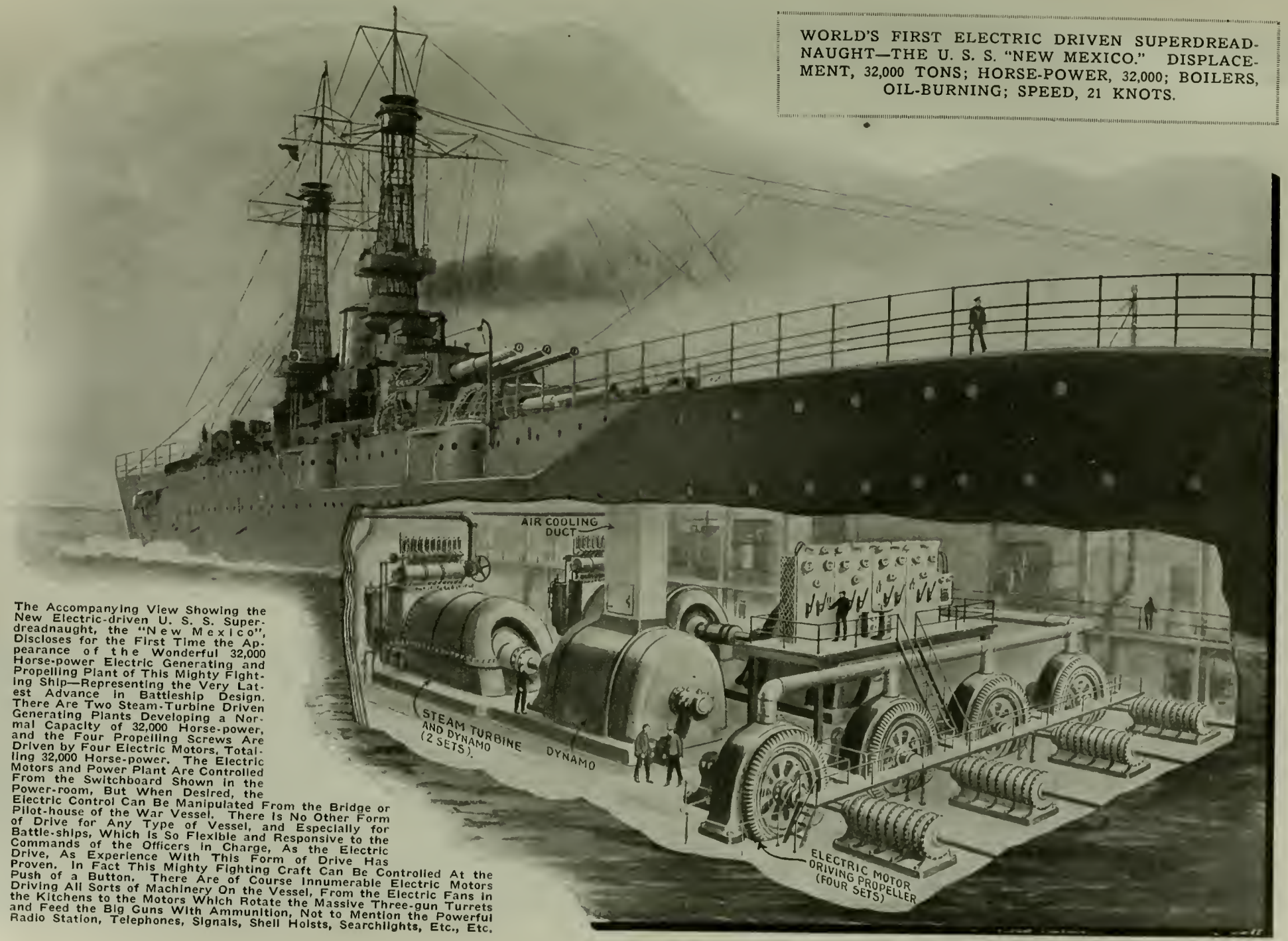
Inside the casing are ten wheels arranged side by side like the coins are kept in a bank. In the rims of all of these wheels are hundreds of buckets against which the steam strikes. The steam enters at one end of the turbine and dashes against the buckets of each of these wheels, one after the other; and as it strikes against these buckets the wheels and the shaft to which they are fixt all turn around. This shaft drives the electric generator immediately adjacent, and in it the mechanical power is turned into electricity. Then eight copper wires only slightly larger than a garden hose convey the 16,000 horsepower thru the steel walls to the next compartment where the switchboard is located. Electric fans in the power plant ventilate the room and also *cool the generator*, and the heated air is pumped outside.

The Switchboards.

When the eight electric wires leave the power plant room, they go to the electric switches back of the switchboard. Here the ship is controlled upon receipt of in-

(*Continued on page* 183)

WORLD'S FIRST ELECTRIC DRIVEN SUPERDREADNAUGHT—THE U. S. S. "NEW MEXICO." DISPLACEMENT, 32,000 TONS; HORSE-POWER, 32,000; BOILERS, OIL-BURNING; SPEED, 21 KNOTS.



The Accompanying View Showing the New Electric-driven U. S. S. Superdreadnaught, the "New Mexico", Discloses for the First Time the Appearance of the Wonderful 32,000 Horse-power Electric Generating and Propelling Plant of This Mighty Fighting Ship—Representing the Very Latest Advance in Battleship Design. There Are Two Steam-Turbine Driven Generating Plants Developing a Normal Capacity of 32,000 Horse-power, and the Four Propelling Screws Are Driven by Four Electric Motors, Totalling 32,000 Horse-power. The Electric Motors and Power Plant Are Controlled From the Switchboard Shown in the Power-room, But When Desired, the Electric Control Can Be Manipulated From the Bridge or Pilot-house of the War Vessel. There Is No Other Form of Drive for Any Type of Vessel, and Especially for Battle-ships, Which Is So Flexible and Responsive to the Commands of the Officers in Charge, As the Electric Drive, As Experience With This Form of Drive Has Proven. In Fact This Mighty Fighting Craft Can Be Controlled At the Push of a Button. There Are of Course Innumerable Electric Motors Driving All Sorts of Machinery On the Vessel, From the Electric Fans in the Kitchens to the Motors Which Rotate the Massive Three-gun Turrets and Feed the Big Guns With Ammunition, Not to Mention the Powerful Radio Station, Telephones, Signals, Shell Hoists, Searchlights, Etc., Etc.

Recent Aërial Developments

By H. GERNSBACK

In England They Have Already Mooring Towers Used to Take On and Put Off Passengers and Freight, It Having Been Proved That It Is Easier for an Airship to Anchor at a Lofty Height Than to Come Down and Dive Into a Shed. This Illustration Shows How the Woolworth Building or Any Other Building Could Be Equipt With a Revolving Landing Tower, to Which the Airship Can Make Fast. Passengers and Freight Can Then Be Readily Landed. A Project of This Kind Is Entirely Feasible From an Engineering Standpoint.

WHEN the Zeppelin, that is, the rigid type of airship, first appeared it had many inherent faults. Probably the greatest one was the inflammable gas carried in the sectional ballonets.

As fast as the Zeppelins were constructed they were destroyed mostly by fire due to electric sparks, which set on fire the inflammable hydrogen gas.

Secondly, the landing arrangements as used by the Germans were very inefficient, and it was not infrequent that the huge airship became wrecked when coming down to earth prior to entering its mooring shed. In the air, the Zeppelin type is safe enough, and even the severest storms can be ridden out with comparative safety, that is, all storms except electrical storms, which not infrequently set the dirigibles on fire, due to lightning.

Recently, the English have proposed a novel manner for landing passengers, and no longer do the huge airships of the rigid type descend to earth to discharge their passengers or cargo. The device used is a sort of huge hitching post in the form of a high tower held fast by means of cables and stays. The upper part of the tower has a revolving top section with which the nose of the airship comes into contact, and to this it is made fast. The passengers and cargo leave and enter by means of this revolving top and descend or ascend to earth by means of elevators. These towers are anywhere from three to five hundred feet high, and the airship can "land" and make fast to the tower with comparative safety, as has been actually demonstrated in England.

It makes no difference which way the wind blows or how hard, the airship will simply take its position, similar to a wind vane, where it offers the least resistance to the wind. It will ride out the most severe storm very readily in such a position and in comparative safety. This also has been actually demonstrated.

The fire danger is now being reduced entirely by the use of an American idea, helium gas, which has approximately the same lifting power as hydrogen, but which is absolutely non-inflammable.

It does seem that for many years to come the rigid type of airship will probably be the one destined to carry passengers and freight, while for a long time, the airplane will only act as a secondary unit, or as a feeder. In other words, the airship will be used to cover long distances, while the airplane will cover short distances, bringing passengers and freight to the central dirigible depots.

We have today airships with a capacity of 2,000,000 cubic feet of gas, and it will not be long until the 5,000,000 cubic foot gas dirigible will be in use. Aviation authorities think that such airships will be in operation not later than 1923.

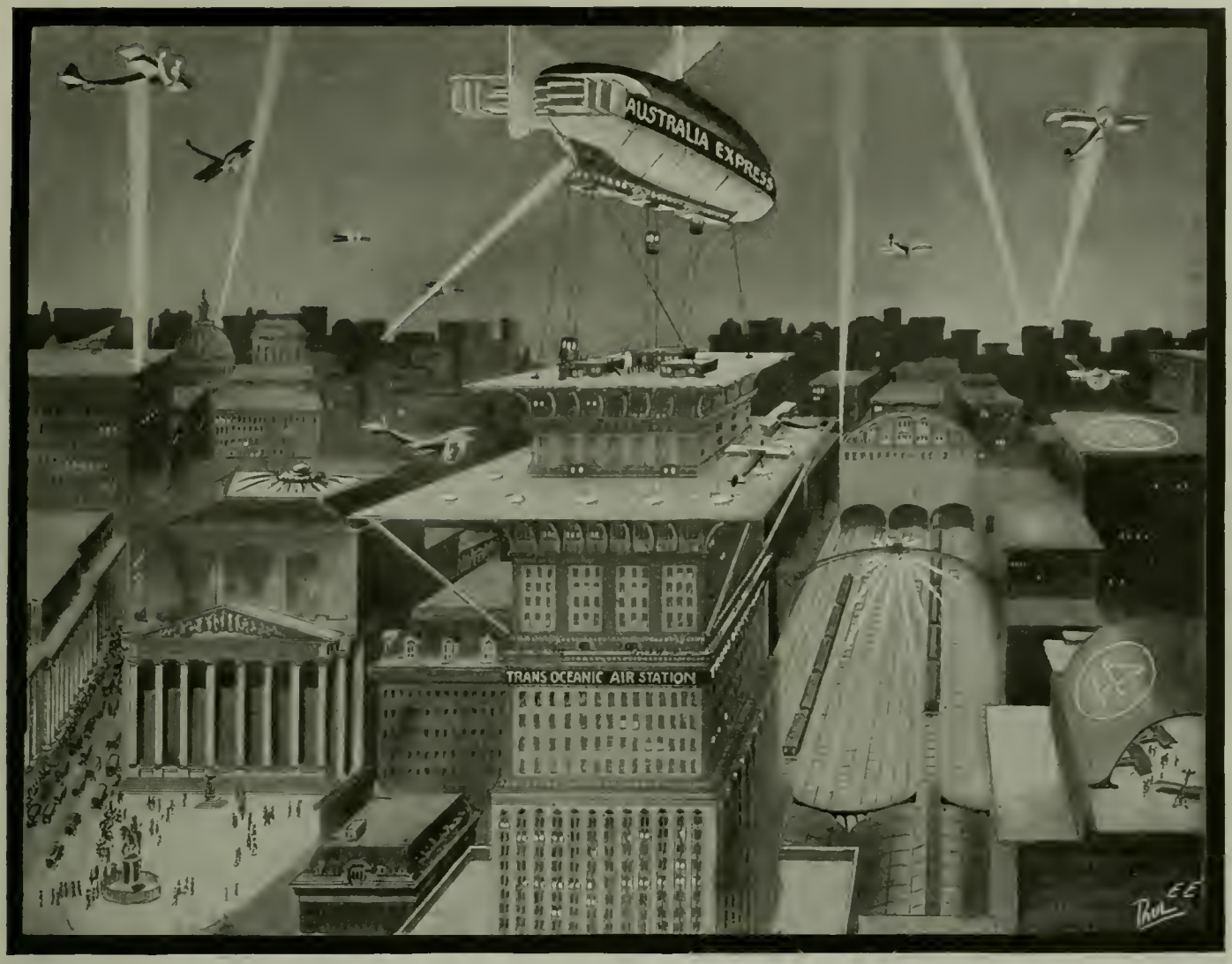
When it is considered that the huge present-day English airships have a capacity of 2,000,000 cubic feet of gas, and which can now cover a radius of 4,000 miles without coming down to earth or renewing their supplies, it will be seen that universal aërial transportation is a feature much closer at hand than is realized by most of us.

There is little doubt that before this year has ended one or more dirigibles will have crost the Atlantic Ocean. Flying at their present rate of speed, which is sixty miles per hour, it will be seen that the trip from London to New York will take only 2 to 2½ days. The huge 5,000,000 cubic feet of gas airships will probably fly at the rate of 100 miles per hour. The length of the trip will then be cut down to about 1½ days.

While the aërial tower which we discust above is probably satisfactory, it has many objections, the most important one being that it is an expensive item, and, moreover, if the airship is to rely upon such a structure, it will be almost impossible for it to come down to earth to land passengers *except at such points where the mooring towers are located.* This is a clear disadvantage.

In the accompanying illustration the writer wishes to advance an idea which so far has not been tried out, but which can be readily adapted. The idea is simply to moor the dirigible by means of four cables, which are thrown from the aërial flier. The passengers then will be able to ascend or descend from the airship by means of light elevators operated between the dirigible and earth. These elevators, electrically operated, need not be very heavy and can be constructed of aluminum, duralumin, or some such material. The power to operate these elevators can be taken from the engines of the dirigible itself, and it will be quite an easy matter to take from fifteen to twenty passengers on a single trip.

Our illustration shows the city of London, in the year 1925, with one of these dirigibles made fast to the aërial depot; we see here two elevators operating and taking on passengers and freight. The air-



The Heart of London as It Will Appear Very Shortly When the Plans Now Undergoing Completion Are Realized. It Having Been Demonstrated That It Is Very Difficult to Bring Down the Huge Airships to the Ground—Many Zeppelins Having Been Wrecked That Way—It Has Been Proposed to "Land" Airships on Top of Specially Elevated Stations as Here Shown. The Airship would Be Simply Anchored by Means of Four or More Steel Cables. Then, by Using a Number of Light Elevators or Lifts, the Passengers as Well as Freight Can Be Taken on or Put off, as Our Illustration Clearly Depicts. This Is Not a Dream of Tomorrow, but Plans Are Actually Under Way to Make This Feature a Realization. It will Be Seen That the Airplanes Merely Act as a Sort of "Feeder" and They Will Be Used Mostly to Bring Their Passengers or Freight to the Trans-Atlantic Landing Station.

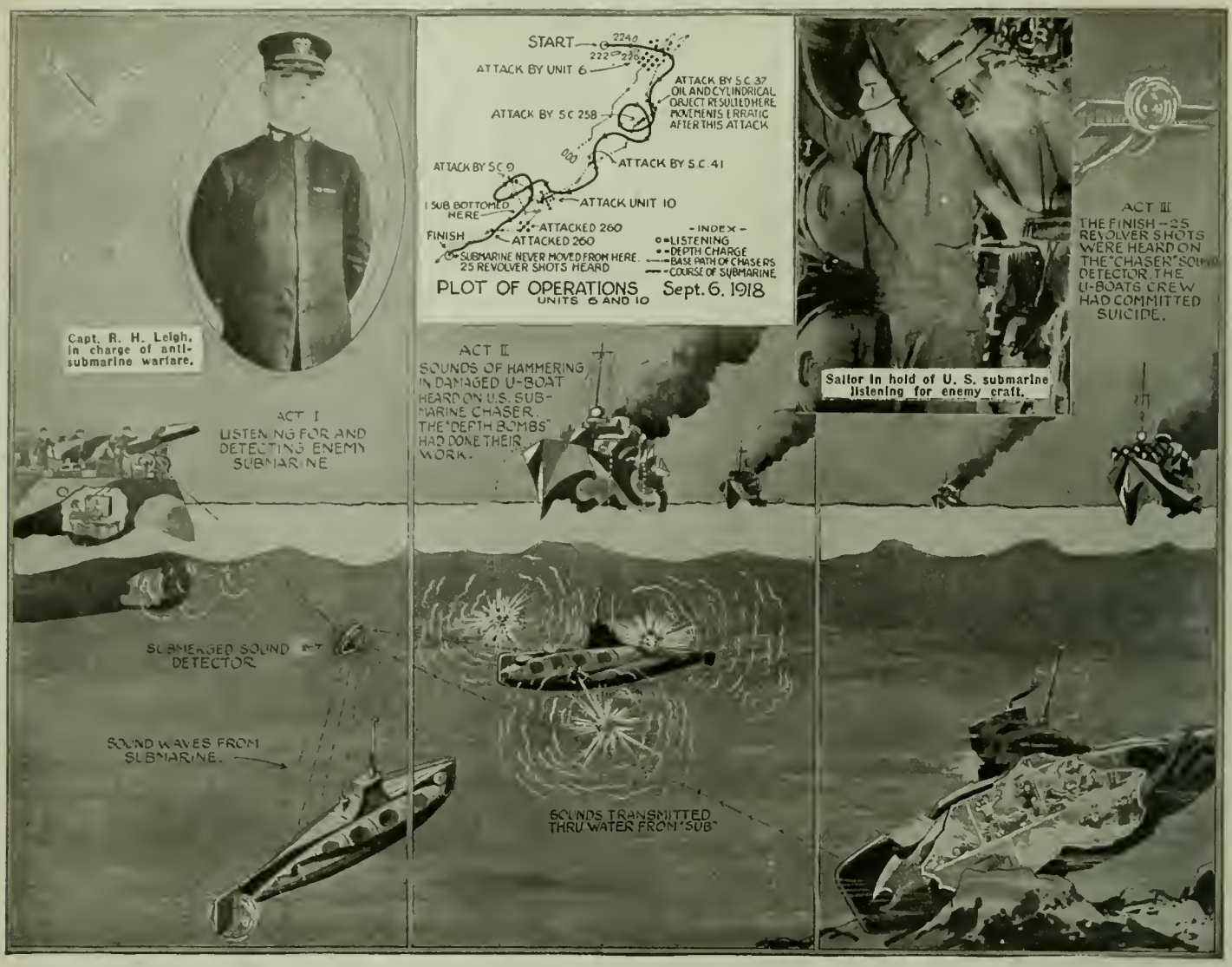
ship shown belongs to the regular trans-Atlantic Service and makes the trip between London and Perth, Australia in 4½ days. Should it become necessary to discharge or take on freight at non-important centers, it will be a simple matter to moor the airship by means of its cables even over a city which has no elaborate landing station. Nothing but four points to which to make the cables fast are required. The elevators which are carried by the airship will do the rest.

Our cover illustration shows a spectacular method of an aërial rescue at sea, which immediately demonstrates the practical use of these elevators. Indeed, the airship does not need to make fast to the wrecked airplane; it will keep its position simply by running either one or more of its propellers in order to keep from drifting. This is quite simple even for the present-day airship, as it is possible by means of its propellers to hover over a certain spot even with a strong wind blowing. In this case, the elevator cables only are made fast to the wrecked flyer, the gasoline tanks of which have been set on fire. After the elevator cables are made fast, it will be a comparatively simple matter to take off the passengers, and, if necessary, the freight, for the buoyancy of the airplane in the water will probably keep it afloat for some time. After everybody is taken off, the elevator is hoisted, the elevator cables pulled in, while the airship proceeds on its way.

Photo (c) Western Newspaper Union

This Remarkable Snapshot Shows One of Our Navy's Dirigibles Rescuing Two Airmen Who Recently Fell Into the Sea with Their Flying Boat off Key West, Florida. One of the Aviators Can Be Seen Climbing up the Rope Ladder.

This spectacular rescue might seem to be a thing of the future, but indeed it is not. Our photograph herewith shows that the very same thing has already been accomplisht on a smaller scale. Very recently the United States Navy equipt its dirigibles with rope ladders, which made it possible to rescue aviators from the sea. That such a move was indeed wise, our photograph demonstrates better than words. Our remarkable snapshot shows one of the Navy's "blimps" rescuing two airmen who recently fell into the sea with their flying boat off Key West, Fla. The nose of the airship was simply turned into the wind, and after some maneuvering it finally managed to get directly over the disabled flyer. The two marooned airmen experienced no difficulty in grasping the rope ladder and climbing aboard the airship, none the worse for their adventure.



Hunting the U-boats by "Sound" Proved a Successful and Profitable Allied Naval Game—So Successful in Fact That, Had the War Lasted Another Year, the U-boats Would have Been Driven Completely from the Seas.

Hunting Submarines by Sound

By BREWSTER S. BEACH

How Yankee Scientists Beat the German U-Boats

THIS article describes the effort made by American scientists, under the stress of tremendous urgency, to invent and perfect an instrument to successfully locate submarines while in a submerged condition, at a time when every instant of delay meant further loss to shipping, and the fate of the Allied cause practically depended on the immediate defeat of German U-boat warfare. The Submarine Detector, as eventually evolved by them, utilizes old principles in a new and startling way. It is based on the theory of sound-wave transmission thru the water and depends for its direction-getting qualities on the peculiar and heretofore little understood faculty of the human ear to detect the direction of sound by the shifting of that sound from one ear to the other.

THE United States Navy Department, after nearly two years of the closest censorship, has just given approval to the publication of certain data relating to the development in the United States during the war of submarine detecting devices, which were used to signal advantage by this country and the Allies in prosecuting and bringing to a successful conclusion the campaign against the German U-boat.

The apparatus may be termed the composite work of the General Electric Company, Submarine Signal Company, Western Electric Company, the National Research Council, assisted and advised by many eminent scientists, engineers and research specialists—chief among whom were Drs. W. R. Whitney, Irving Langmuir and W. D. Coolidge, Prof. R. A. Millikan, Prof. Max Mason, and others.

Realizing that the prompt solution of the submarine problem was the key to a successful termination of hostilities, Secretary Daniels, immediately upon America's entrance into the conflict, appointed a special board to devise ways and means to overcome it.

At the suggestion of Dr. Whitney, director of General Electric Company's research laboratories, a group of scientists was formed at Nahant, Mass., under Dr. Irving Langmuir, where the results of extensive research activity were put to practical tests under actual conditions as nearly as possible approaching those in European waters.

Another group under Prof. Millikan, head of the Physics Department of the University of Chicago, was organized at New London, Conn., where the work of both bodies was later co-ordinated.

Out of the efforts of these two groups and the work carried on in Schenectady assisted by Allied commissions of scientific men, there grew the American Submarine Detector—a development of the old principles of sound wave transmission in water in an altogether new and startling manner, and just how efficient this "detector" proved we shall see later.

The apparatus finally perfected and put to immediate use, was first designed to hang overhead from naval craft amidship below the water line and it depended for its direction-getting qualities on the peculiar and heretofore little understood faculty

of the human ear to detect the direction of sound by the shifting of that sound from one ear to the other.*

Early Experiments

Every possible application to which electricity had been put was studied with painstaking care by experts during the development of the "Submarine Detector," and many experiments were carried on at New London and at Nahant with pliotrons, with amplifiers, with the Fessenden oscillator, which had been developed by the Submarine Signal Company, and with other similar instruments, before the proper combination of the principles of electricity and acoustics produced the final and successful device subsequently used.

Specialists in physics and acoustics from the great technical schools, such as Columbia University and Harvard, from the Research Laboratory of the G. E. Co. and the W. E. Co., and in fact from all over the United States, played a prominent part in the work done, particularly by the New London Group, altho unfortunately the armistice was signed before the latest devices developed here could be put into extensive use on the other side of the water.

Owing to the interference of sounds made by the listening ship's own motors, it was found more practical to stop the engines when about to take observations and this added greatly to the effective range of the instrument.

To overcome this obstacle, another device was developed *which could be trailed off the stern a hundred or so feet away* where the engine noises of the ship were out of range and the sound was then brought into the operator in the ship's hold.

A third adaptation of the listening principle was an instrument which protruded thru the hull and was a stationary part of the vessel's equipment. A somewhat circular device was constructed for use on submarines, but all of them were used to advantage.

While demonstrating the device to the British Admiralty, our American engineers were asked to study the question of fitting submarine detection units to airplanes, balloons and dirigibles.

After some experimentation, followed by more practical tests and conferences with the Lancashire Group of scientists at Harwich, apparatus was developed which met these needs and many *aircraft* were equipt with sound detectors *which rendered it possible for them to follow the course of the enemy submarine after they had seen her submerge, a valuable faculty which such craft did not possess until the introduction of the American detector.*

Allies Adopt Yankee Invention

However, when the devices had proved themselves eminently satisfactory after exhaustive experimentation here, the Navy Department organized a special Service Party under Capt. R. H. Leigh of the Bureau of Steam Engineering to demonstrate the detectors to the British Admiralty. Shortly after the arrival of this party abroad, the American submarine detectors were universally adopted by all the Allied navies.

It was found to be much superior in many ways to any of previous development, and came to be considered one of the most effective offensive weapons ever used against the submarine.

To sum up the results achieved by these American listening devices it is only necessary to recount a few pertinent points to illustrate the device's practicability.

In spite of it all, initial experiments proved slow of entirely satisfactory developments until the fall of 1917, when it was decided to go out to sea off Cape Cod for more thorogoing tests.

The sea was clear of craft as far as the eye could see—yet the operator with his ear to the detector distinctly heard a vessel approaching—nearer—nearer—nearer. The captain from the bridge eagerly scanned the horizon with the ship's glasses—nothing in sight.

"Send a man aloft with powerful glasses," he commanded. "The detector has picked up a craft 3 points on our starboard bow."

The sailor returned. "Nothing in sight, sir."

"I'll go aloft myself. That boat sounds as if it were very near. Why, we can hear her engine as clearly as if she were alongside."

Puzzled, the captain returned from the masthead after a disappointing vision of a calm and perfectly clear sea.

"How's she coming?" shouted the first lieutenant down the hatchway.

"Heading straight for us, sir. Sound getting louder every minute."

There was nothing to do but wait.

The captain pulled out his watch and sat down. Fifteen minutes—half an hour—an hour—ticked on!

(*Continued on page* 167)

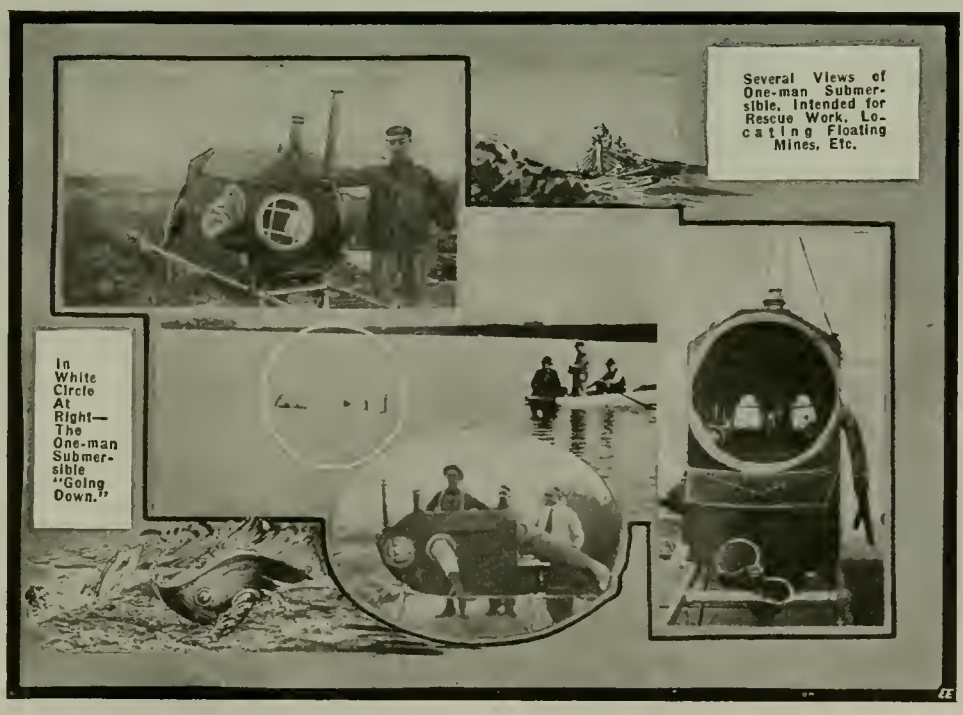
* Another very interesting point is that when mounting microphones on each side of a vessel, the *loudness* of the incoming sound is equal in both telephone receivers, i. e., if a submarine is on the starboard side of the ship, it will be heard just as loud from the port side. But, the difference can be readily detected and very accurately too, by the *phase difference* as heard in the 'phones. In other words, the sound will be heard a fraction of a second earlier in one ear than in the other. Small as this difference is, even a green operator will detect it at once.

—Excerpt from Mr. H. Gernsback's editorial in the October, 1917 issue of this journal.

That One-Man Submersible

IN the March issue of this journal there appeared an illustrated article describing a newly invented, one-man submersible boat, intended for purposes of life saving, locating floating mines and other purposes. At the time the article was prepared, the Editors only had the inventor's patent to guide them in its preparation, and the illustration was prepared by one of the staff artists. But behold! This strange animal of the deep really lives, as the accompanying photographs of the actual working device prove. The inventor of the one-man submersible is W. R. Barringer, of Denver, Col., which is a long way from the sea, and it puzzled the Editors how a rank land-lubber such as the inventor appeared to be, could have the heart to work out a complete submarine or anything akin to that device. But now the secret is out, for it appears that the inventor, who was formerly in the United States Army, had gained considerable experience while in foreign lands, and he evolved the principles underlying his submersible boat while observing the methods of pearl and sponge divers in the far-distant Sulu Archipelago.

The makers of the Barringer one-man submersible, claim, among other things, that, due to its peculiar construction, no pressure is required to offset the tremendous external pressure of the water, even when submerged to such depths as 350 feet, for which this submersible is practicable. It is interesting in this connection to mention that the maximum depth reached by U. S. Naval divers in especially constructed diving suits and bells, is less than 300 feet. Moreover, in the ordinary diving suit the tremendous internal pressure of 130 pounds per square inch is necessary to remain at a 350-foot depth for any length of time. This new submersible diving outfit requires but the normal pressure of 15 pounds per square inch, regardless of depth attained. The inventor also claims that no strain is occasioned on the operator, even after a long period under water. The operator rests on a heavy air cushion and suffers no ill effects while below the water's surface. Further, the ascent and descent of the boat need not be done gradually, as in the case of the ordinary diving suit or bell, in order to accustom the body to the changing water pressure. On the contrary, so he claims, ascent may be made rapidly, and the operator's time is, therefore not wasted in slow sinking or rising.



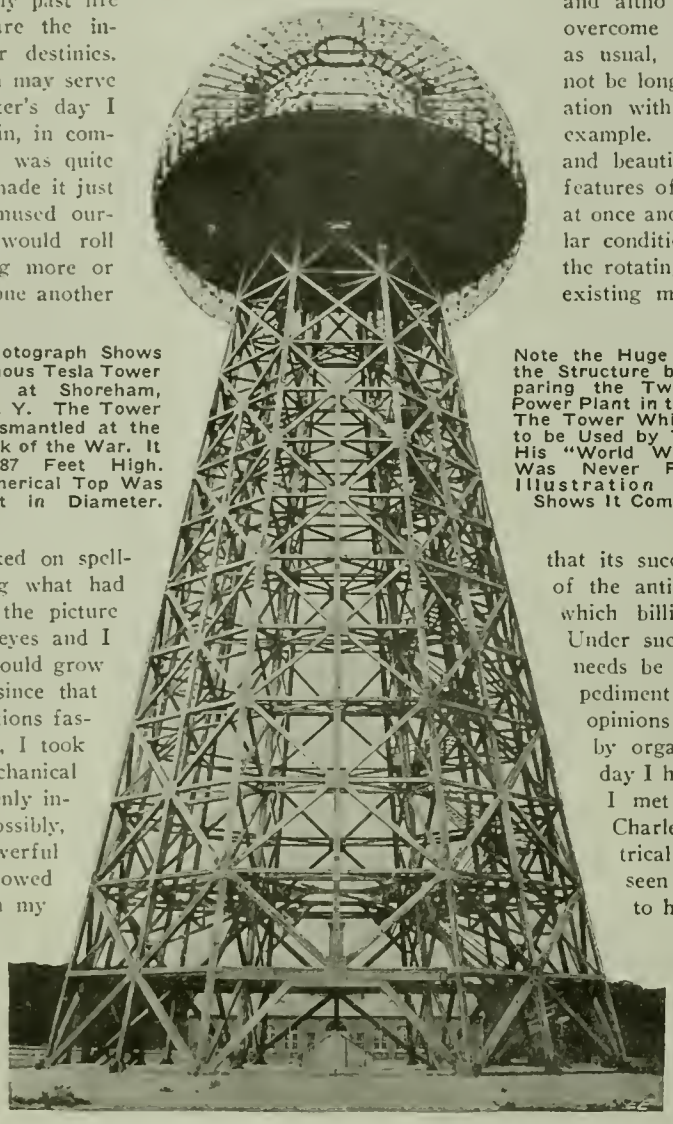
As pointed out in the previous article, there are many interesting electrical features incorporated in this device, including electrical propelling and steering means, an electric searchlight and many other novel devices.

My Inventions

By Nikola Tesla

V. The Magnifying Transmitter

AS I review the events of my past life I realize how subtle are the influences that shape our destinies. An incident of my youth may serve to illustrate. One winter's day I managed to climb a steep mountain, in company with other boys. The snow was quite deep and a warm southerly wind made it just suitable for our purpose. We amused ourselves by throwing balls which would roll down a certain distance, gathering more or less snow, and we tried to outdo one another in this exciting sport. Suddenly a ball was seen to go beyond the limit, swelling to enormous proportions until it became as big as a house and plunged thundering into the valley below with a force that made the ground tremble. I looked on spellbound, incapable of understanding what had happened. For weeks afterward the picture of the avalanche was before my eyes and I wondered how anything so small could grow to such an immense size. Ever since that time the magnification of feeble actions fascinated me, and when, years later, I took up the experimental study of mechanical and electrical resonance, I was keenly interested from the very start. Possibly, had it not been for that early powerful impression, I might not have followed up the little spark I obtained with my coil and never developed my best invention, the true history of which I will tell here for the first time.



This Photograph Shows the Famous Tesla Tower Erected at Shoreham, L. I., N. Y. The Tower Was Dismantled at the Outbreak of the War. It Was 187 Feet High. The Spherical Top Was 68 Feet in Diameter.

Note the Huge Size of the Structure by Comparing the Two-story Power Plant in the Rear. The Tower Which Was to be Used by Tesla in His "World Wireless," Was Never Finished. Illustration Opposite Shows It Completed.

Scrapping the World's Engines.

"Lionhunters" have often asked me which of my discoveries I prize most. This depends on the point of view. Not a few technical men, very able in their special departments, but dominated by a pedantic spirit and near-sighted, have asserted that excepting the induction motor I have given to the world little of practical use. This is a grievous mistake. A new idea must not be judged by its immediate results. My alternating system of power transmission came at a psychological moment, as a long-sought answer to pressing industrial questions, and altho considerable resistance had to be overcome and opposing interests reconciled, as usual, the commercial introduction could not be long delayed. Now, compare this situation with that confronting my turbine, for example. One should think that so simple and beautiful an invention, possessing many features of an ideal motor, should be adopted at once and, undoubtedly, it would under similar conditions. But the prospective effect of the rotating field was not to render worthless existing machinery; on the contrary, it was to give it additional value. The system lent itself to new enterprise as well as to improvement of the old. My turbine is an advance of a character entirely different. It is a radical departure in the sense that its success would mean the abandonment of the antiquated types of prime movers on which billions of dollars have been spent. Under such circumstances the progress must needs be slow and perhaps the greatest impediment is encountered in the prejudicial opinions created in the minds of experts by organized opposition. Only the other day I had a disheartening experience when I met my friend and former assistant, Charles F. Scott, now professor of Electrical Engineering at Yale. I had not seen him for a long time and was glad to have an opportunity for a little chat at my office. Our conversation naturally enough drifted on my turbine and I became heated to a high degree. "Scott," I exclaimed, carried away by the vision of a glorious future, "my turbine will scrap all the heat-engines in the world." Scott stroked his chin and looked away thoughtfully, as though making a mental calculation. "That will make quite a pile of scrap," he said, and left without another word!

IMAGINE a man a century ago, bold enough to design and actually build a huge tower with which to transmit the human voice, music, pictures, press news and even power, thru the earth to any distance whatever without wires! He probably would have been hung or burnt at the stake. So when Tesla built his famous tower on Long Island he was a hundred years ahead of his time. And foolish ridicule by our latter day arm-chair "savants," does not in the least mar Tesla's greatness.

The titanic brain of Tesla has hardly produced a more amazing wonder than this "magnifying transmitter." Contrary to popular belief his tower was not built to radiate Hertzian waves into the ether. Tesla's system sends out thousands of horsepower thru the earth—he has shown experimentally how power can be sent without wires over distances from a central point. Nor is there any mystery about it how he accomplishes the result. His historic U. S. patents and articles describe the method used. Tesla's Magnifying Transmitter is truly a modern lamp of Aladdin.

EDITOR.

"Aladdin's Lamp".

These and other inventions of mine, however, were nothing more than steps forward in certain directions. In evolving them I simply followed the inborn instinct to improve the present devices without

(*Continued on page* 148)

Mr. Tesla's articles started in our February issue

THIS PHOTOGRAPH OF A MODEL SHOWS HOW THE TESLA TOWER BUILT ON LONG ISLAND, EIGHTEEN YEARS AGO, WOULD HAVE LOOKED COMPLETED. FROM ITS APPEARANCE NOBODY WOULD INFER THAT IT WAS TO BE USED FOR THE GREAT PURPOSES WHICH ARE SET FORTH IN HIS ACCOMPANYING ARTICLE.

Filming "Talking" Movies" in Glass Houses

By H. WINFIELD SECOR

YOU probably remember the old adage about "people who live in glass houses, should"—etc.—but the latest is the filming of talking motion pictures in all-glass houses or studios, and the process has been invented by one —David O. Royster of St. Louis, Mo., the "show-me" state. Mr. Royster's scheme covers an improved method and apparatus for synchronously making motion pictures and sound records.

As the inventor points out, it has heretofore been very difficult, if not indeed impossible, to make talking motion pictures which would bear a perfect synchronous relation to each other when reproduced, for the reason that the camera used in taking the motion pictures must necessarily be located a certain distance away from the object to be photographed, and being that the sound recording device is located adjacent to the camera in order to operate in synchronism with it, the distance between the receiver on the sound recording apparatus, and the actors being photographed, is such that the sound waves in traveling from the object to the recorder, do not reach the latter for an appreciable length of time. As a result the recorded sounds are not exactly synchronous with the pictures, when these sounds and pictures are later reproduced in the theater projector. And besides, with such an arrangement the sound waves are insufficient in volume to make a clear and strong record on the disc or cylinder of the talking machine.

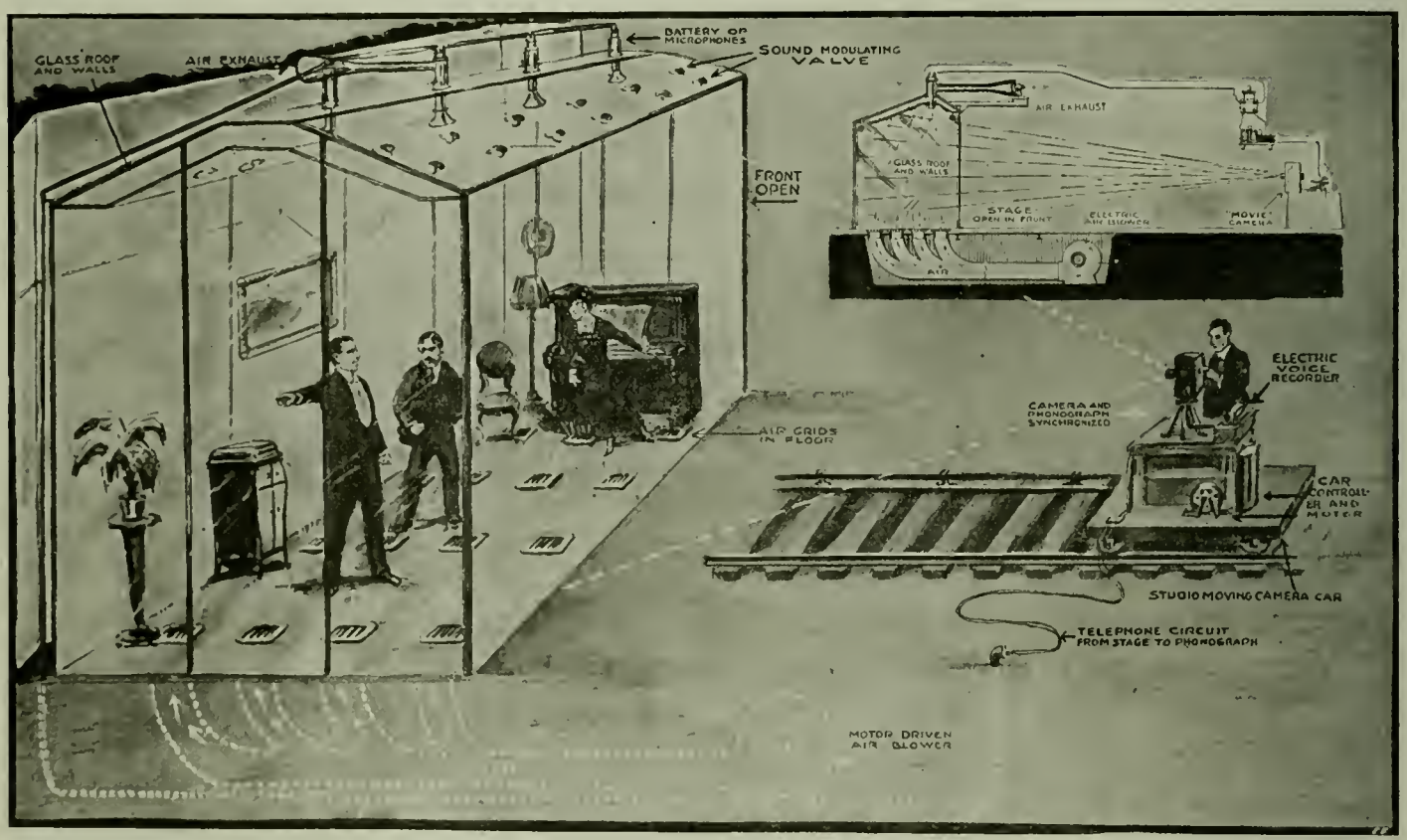
Mr. Royster, in his scheme, provides a transparent *glass studio stage*, or *all-glass house*, if the scene requires it, which is occupied by the objects to be photographed. Thus motion pictures can be made by natural light; means are also provided for concentrating the sounds produced by the speakers, which sounds are telephonically transmitted to the sound recording device, such as a phonograph, located adjacent to and operated synchronously with the motion picture camera.

As is the practise in all of the larger studios, the camera and other appurtenances, such as the sound recording phonograph, etc., are mounted on a wheeled truck, which may be moved along a track, or set of tracks, so as to take either "close-ups" or normal focus pictures, as desired, also to make changes quickly. Some studios utilize a small electric car fitted with a motor and controller, so that the camera man or his assistant can readily move the camera toward or away from the stage, as the occasion may demand. You have probably seen at one time or another a motion picture where the objects came up rapidly toward you, until the actress' face, for instance, was as big as the entire screen. This effect is obtained very easily by moving the car toward the scene. Scenes or settings which fade away, causing the objects to become smaller, are taken in the reverse manner, i. e., by moving the camera away from the stage while the picture is being taken.

There is provided in the present scheme a powerful motor-driven electric blower under the studio floor, which projects a strong draft of air upward thru a series of gratings in the stage floor, and the powerful upward vertical movement of the air thru a series of openings in the glass roof carries the sounds of the voices upward, toward the microphones or sound detectors, which effect is intensified by an electric exhaust fan at the top of the glass-enclosed stage, as shown in the diagram and illustration herewith. The battery of microphones which pick up the sounds at the ceiling of the stage are connected up with a telephone line which leads to the electric recorder on the phonograph beside the "movie" camera, there being a rigid mechanical connection between the camera and the phonograph to ensure synchronism.

Owing to the peculiar and unusual lighting arrangements with this form of all-glass stage, the "setting" or other scenery is placed back of the stage, so as to allow the daylight to pass over it and thru the glass to illuminate the stage proper. Some props and furniture can of course be placed directly on the stage. It is understood that where the light is not sufficiently strong for the taking of motion pictures, the stage can be lighted artificially. The degree of sound transmitted by the microphones fitted over the stage may be modulated by means of adjustable valves placed in front of the microphone, and also by opening more or less of the by-pass valves in the glass inner ceiling, which permits some of the air-conducted sound waves to pass between the two ceilings and out thru the fan chamber.

The apparatus as here described is comparatively simple, can be easily operated, does not require artificial light, and motion pictures and sound records of absolute synchronism can be readily made at any distance from the object within the focal length of the camera, claims the inventor. All things considered, it would seem to presents a new and successful "Movie" idea.



The Secret of Perfect "Talking Motion Pictures" Lies in the Proper Synchronism Between the "Pictures" and the "Voice," and Also in the Clarity and Even Tone of the Speech Reproduction. All Three of These Problems Have Been Solved by the Invention of the Glass Enclosed Stage Here Illustrated.

This Portable Wireless Telephone Was Perfected by W. W. Macfarlane, of Philadelphia. Photos Show Mr. Macfarlane with His Invention and Stove-pipe Aerial. With This Two Persons May Hear the Conversation Being Carried on Fifty Yards Away.

Photos by Int. Film Service

Call Up Wifey on the "Stove-Pipe" Radio

A MAN with a box slung over his shoulder and holding in one hand three pieces of stove pipe placed side by side on a board climbed into an automobile on East Country Road, Elkins Park, Pa.

As he settled in the machine he picked up a telephone transmitter, set on a short handle, and said:

"We are going to run down the road. Can you hear me?"

Other passengers in the automobile, all wearing telephone receivers, heard a woman's voice answering: "Yes, perfectly. Where are you?"

By this time the machine was several hundred yards down the road and the voice in the garage was distinctly heard.

This was one of the incidents in the first demonstration of the portable wireless telephone outfit invented by W. W. Macfarlane, of Philadelphia.

Mrs. Macfarlane, sitting in the garage back of the Macfarlane home, was talking thru the wireless telephone to her husband, seated comfortably in a moving automobile 500 yards away.

The occupants of the car were a chauffeur, a reporter and a photographer. All wore the telephone receivers and could hear everything Mrs. Macfarlane was saying. The chauffeur had no other apparatus than the receiver with the usual telephone cord attached by a metal clip to his steering wheel.

Lying beside Mr. Macfarlane was the foot-square box, the only "secret" in the whole demonstration. What is in the box is the inventor's mystery. This box weighs about twelve pounds. The other machinery used consisted only of the usual telephone transmitter and receivers and the three pieces of stovepipe standing erect on a plain piece of board. This forms the *aërial* of the apparatus.

Before starting on the automobile demonstration of his wireless telephone Mr. Macfarlane stood in the garage and directed the movements of a soldier in a field more than 200 yards away from him. This soldier assistant had a pair of telephone receivers over his head, connected by a wire with two metal clasps to his rifle (see photo herewith). He marched and halted and about-faced and left shouldered arms out there in the field the instant Mr. Macfarlane gave the order thru his little hand wireless 'phone in the garage.

Mr. Macfarlane said he would make no fanciful predictions as to what his simple, portable wireless telephone might do.

"There are all kinds of possibilities in it," he continued. "If this could have been ready for use in the war, think of the value it would have had. A whole regiment equipt with the telephone receivers, with only their rifles as aërials, could advance a mile and each would be instantly in touch with the commanding officer. No runners would be needed. There could be no such thing as a 'lost battalion.'

"No high power is necessary to operate this wireless. I am using one-tenth of an ampere in this experiment here and the results you see are so good that the voice carries as well as on the usual wire telephone. The telephone system uses about one-fourth of an ampere.

"I am working on a new theory in electricity, and in wireless. I think the accepted principle of the waves is only part of the story. There is something else. It is that something else that I am utilizing. There is no supplementary current in this system as in the usual wireless operation. There is no static and no interruption."

An umbrella, Mr. Macfarlane explains, will serve as well as a rifle for an aërial. "A plain citizen carrying a small handbag containing the compact wireless outfit and with his umbrella held aloft can walk along the street talking with friend wife at the house at the other end of the city," he said.

"How costly would this outfit be?" he was asked.

"Nothing new is used," he explained. "All the apparatus fits in with existing devices. Everything needed for the outfit could be bought for probably $15."

"My apparatus here is rather crude and not all the quality of current is obtained that I can get," he continued. "But it is no wild dream to say that a man riding on a train to New York can telephone his wife about bringing a friend home for dinner by using this device. It will be perfected thus far before very long. This apparatus here needs improvement, but it demonstrates the practicability of the thing. Even now I can connect up the end of the wireless in the house with the existing telephone system and thus can talk from my automobile with any person in the city."

Tin-Can Models—A New Art

By GEORGE HOLMES

IMAGINE if you can on one side a scene, wildly confusing, resembling a rubbish heap of every conceivable sort of tin-can, from the tomato to dainty tin-boxes which once upon a time held My-Lady's peach and cream complexion.

Picture, on the other hand, a scene with beautiful, splendid and practical toys, such as money could not buy, all evolved from these same tin-cans and boxes, with a little touch of imagination, inventiveness and mechanical knack, plus a pair of pliers, a soldering iron and the transformation is complete.

The originator and "wizard" of the tin-can toys is Mr. Edward Thatcher, of Teachers' College, Columbia University. It was he who hit upon the novel plan of utilizing waste tin-cans and from them making amusing, decorative and instructive playthings. He gave an inkling of this new art to his classes at Columbia and the students took it up with such zeal that these models were eligible for the recently successful public exhibition at the Art Alliance Galleries.

As his bit in the war, Mr. Thatcher was successful in having this artcraft introduced in the hospitals both here and abroad; and so helped the wounded soldiers to find a remunerative and amusing pastime which greatly aided in keeping their minds off their troubles. Even such men as were suffering from shell shock took to the tin-can toys; it would seem at first impression that they could not stand the noise of the hammering on the cans, but the reverse proved the rule. In cases where they would jump if a match box were dropt, they seemed not in the least inconvenienced by the sound of the constant tinkering of the tin-can artists and would work all day in the "toy-shops."

The possibilities of this new artcraft are practically unlimited. Where heretofore the wounded have occupied their time in the making of these toy models, the art is spreading the country o'er and will be one of the subjects taught in many schools. Some of the models here shown have been duplicated by ten-year-old boys at the Edgewater Manual Training School.

Most interesting of all is the composite view showing a toy *Army Truck*—"before and after." All the various forms of cans necessary to construct this truck are shown on the left, while on the right may be seen the completed model. The body of the truck was made from the side of a "Wesson" oil can, the wheels were made from evaporated milk cans, the seat from a cocoa box and the hood and radiator from an olive oil can. The indentations for the radiator, to resemble the cooling tubes, were faithfully reproduced by punching many hundreds of holes so as to give it that "corrugated" appearance; I think that would be the proper word, still not envying the long and tedious task it must have been to put all those holes into (or should we say "out of") existence. The radiator cap came from the top of a tooth paste tube and the side lamps and tail-light from screw caps of various olive oil cans.

Drifting back to our war atmosphere we have the steam tractor pulling a "Giant" gun. The tractor was brought to life from these various items: The fire-box and platform from a much abused sardine box, the boiler from another olive oil can, the steam whistle from the top of a "Lyons Tooth Powder" can, wheels from evaporated milk cans and the roof from the side of a square tin. The dummy driving wheels are made from the top covers of "Crisco" cans, soldered together so as to make a sort of pulley face for the driving cord. The long-range gun was built from a shaving-stick box, with the evaporated milk cans again doing duty as wheels.

These model toys are not self-propelling but could easily be made so. It would seem that Mr. Thatcher was born to the model business. He has constructed many real "live" models that work by themselves, notable amongst these being a large-size model of one of the Pacific Coast "mallet type" locomotives, that runs under its own power. The author also had the pleasure of seeing a model "tractor," built along the lines of the one constructed from tin-cans, only this one was made of brass and ran under its own steam.

Mr. Thatcher has found it advisable to write a book on this interesting subject which undoubtedly will find a great demand when it comes off the press. And so we see this new "rage" equally successful with the younger classes as well as at the Teachers' College at Columbia, where, among society folks, they call it "occupational therapy."

(The Editor will be pleased to receive good photos of tin-can models of electrical things. To mention a few that our readers can readily construct: Telephone, electric generator, electric locomotive, radio sets, airships, etc.—Editor.)

Making a Practical Electrician

THE world has never before witnest the vast opportunities that at the present moment lie before the people of the United States. Europe, with its shell torn territories and completely exhausted stocks of raw and finished materials, turns to the one country in the whole world fitted to rehabilitate its wastes and reconstruct its shattered industries.

America has a gigantic task before it—not only to feed practically the whole world, but to rebuild a great portion of it. The real business men, the men of creative genius and untiring skill, realize the enormity of the job they must undertake. They know that if the U. S. meets the test, a period of wonderful prosperity is open at its door. The one problem that confronts the business executive to-day is that of labor—*skilled* labor. Can we turn out enough trained men to meet the tremendous demand?

In no other field is the need of thoroly trained men more apparent than in the electrical world. On every side comes the cry for the trained electrician, the man of action, with vim and vigor and the "knowledge of how to do things." Daily we read of the marvelous accomplishments of the wonder of the age—ELECTRICITY. This power in the business life of to-day will play a leading rôle in the world's reconstruction. The United States is rapidly developing its own natural resources and enlarging its field of endeavor—to say nothing of the vast power houses, the new electrified railroads, and the thousands of other electrical needs of Europe. It is to the young man of to-day who is now considering what vocation to take up and who will be the worker of to-morrow, that we look with expectant eyes.

Dr. Charles P. Steinmetz, Chief Consulting Engineer of the General Electric Company, has said that, "The world needs men who know something of electricity, of the operations and control of electrical power. It needs men more every year, its very existence depends on the electrician."

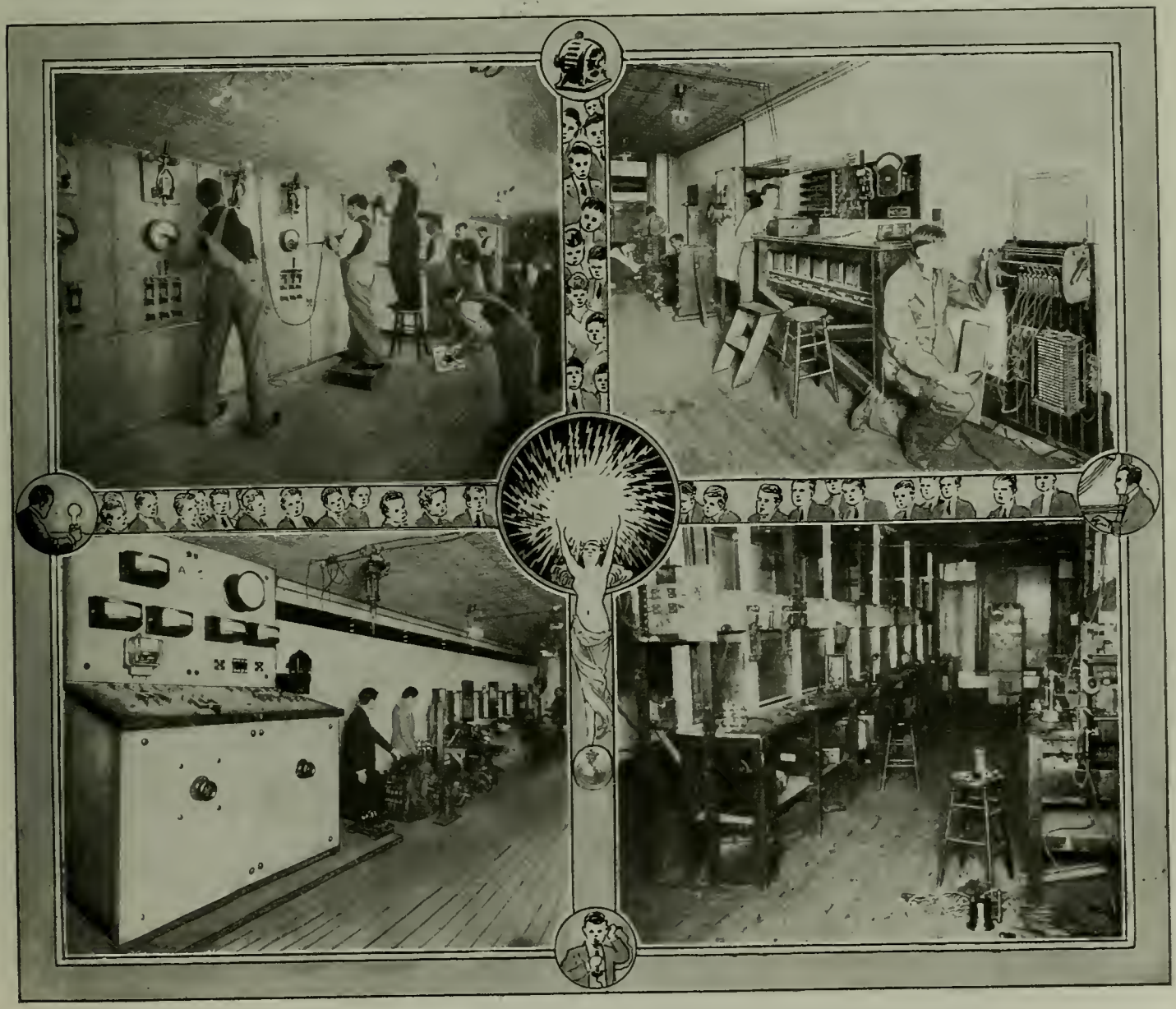
In the greatest city of the United States, in its very heart is located a school, whose aims and purposes are to teach men, both young and old and from every walk of life, the How and Why of electricity by the greatest teacher known—that of getting knowledge by actual experience.

A trained man is the finished product, one who understands the problems coupled with a broad experience in electrical engineering.

Theory is a necessity, but this busy world of ours wants more than theorists. He who is able to supplement his theoretical knowledge with the proper proportion of practical, do-it-yourself-knowledge, is the man who will get most of the world's rewards.

The school which has thus revolutionized educational methods has struck the happy medium of combining enough theory with practical work to turn out first-class electricians in the shortest possible time.

(*Continued on page* 153)



In the Top Left Photo We See the Prospective Electrician Learning the Art of Switchboard Construction. He Takes Apart, Puts Together and Connects These Boards, by Bus-bars and Other Wiring Methods. In Our Lower Left View We See These Same Men Being Initiated Into the Mysteries of Generators, Motors and All Forms of A. C. and D. C. Machines. Top Right Shows Our Men Grasping the Details of Modern Electric Vehicles. The Men Assemble, Connect and Run Complete Systems and Also Take Care of the Storage Batteries. Lower Right Shows Where the Embryo Electrician Starts on His Upward Climb in the Mysterious Art of Electricity. Here He Learns How to Connect Batteries, Bells, Buzzers, Telegraph, Telephone and Fire Alarms as Well as Many Other Systems of Inter-communication.

Close-Ups of New Scientific Movies

By GEORGE VANDERBILT

THESE up-to-date crooks had the best of everything, including a regularly equipt radio set, but ere they could use it to decoy ships to disaster, big and powerful "Reggie" had the strangle hold on our pirate Wireless Operator. Tho there were no women present, curls were in vogue in the radio shack, as can be seen in the accompanying photograph, showing the artistic hook-up of the set.

Whatever else may have happened to him, he had brawn and muscle! That, and that alone, saved Reginald Jones in the new Fox Film, "Never Say Quit," when he ran afoul of a gang of crooks on board a ship in search of sunken treasures.

The "JINX" was his constant "pal." It started by his being born on a Friday, and the thirteenth to boot, and so together some one had made a big mistake. From the very first he was in trouble, his childhood was one nightmare. As he grew older it only made matters worse.

The Rôle of Electricity and Science in the Modern Photoplay

As the gay and dashing Lothario he goes to a ball, and gets into a scrap over a girl and has to exit via the house-tops to escape the "Bulls."

Good luck seems to beckon when a rich aunt dies and leaves him a fortune. But not for Reginald! He must come to her funeral in order to get the money, and the jinx sees to it that he never gets there. On his way he is robbed by pickpockets, his eyes are blackened, and he is bruised and walloped until he thinks his head is in his shoes. He misses his train after many harrowing adventures, and so the fortune goes to charity.

To replenish his empty wallet, Reginald sets out on a voyage after sunken treasure. Adventures befall him again, for the crew turns out to be a gang of crooks. They are bent on robbing a millionaire and his daughter, who are on board.

Reginald saves the millionaire and his daughter from the dire fate the crew has in store for them. He wins the girl's hand, heart and soul, and in matrimony he believes he has conquered the jinx at last. But a year later Reginald and his wife are blest with triplets, and Reggie, superstitious cuss, ventures to believe that the jinx has had something to do with that.

In our next movie we come upon a fair and real live "Radioette." The beautiful daughter of an over-indulgent and elderly millionaire. She is abducted by a band of crooks and taken to a desert island to await the payment of a fabulous ransom by her father—or on his failing to pay it, to forfeit her life. BUT—she knew "Wireless," or, as us "hams" now call it, "Radio," and thru this knowledge outwitted the desperadoes' well-laid plans, gaining a hubby thereby, as can be seen in Metro's latest photo-

(*Continued on page* 161)

The Well Muscled George Walsh In the Fox Film "Never Say Quit" Putting an End to the Bold Crook's Machinations. Note the Radio Outfit.

We Look Pretty May Allison Over, in Metro's "Island of Intrigue" at the "Wireless Piano", Added to That the Automatic is Most Annoying to the Villain's Optic Nerve.

One of the "Wolves of Kultur" Rendered Senseless In Pathe's New Series. The Introduction of the Large Radio Direction Finder is of Special Interest.

Another of the "Wolves of Kultur" Ready to Send Off the Death-Dealing Radio Torpedo and Slowly Counting the Seconds. He Is Perhaps Unaware That a Police Whistle Is "Passe" by Most Villains.

Electro-Therapeutic Ward at Bordeaux, France, Showing the Application of Intensified Rhythmic Faradization by Professor Bergonié. Altho Muscles Are Contracted Violently During This Faradization, the Patient Feels Hardly Anything.

A Wounded Soldier With a Fractured Leg Undergoing Intensified Faradization In Order to Reconstituate the Muscles of the Calf of His Leg. He Was Able to Walk Without a Cane Within Fifteen Days After the Treatment Started.

Paris Letter

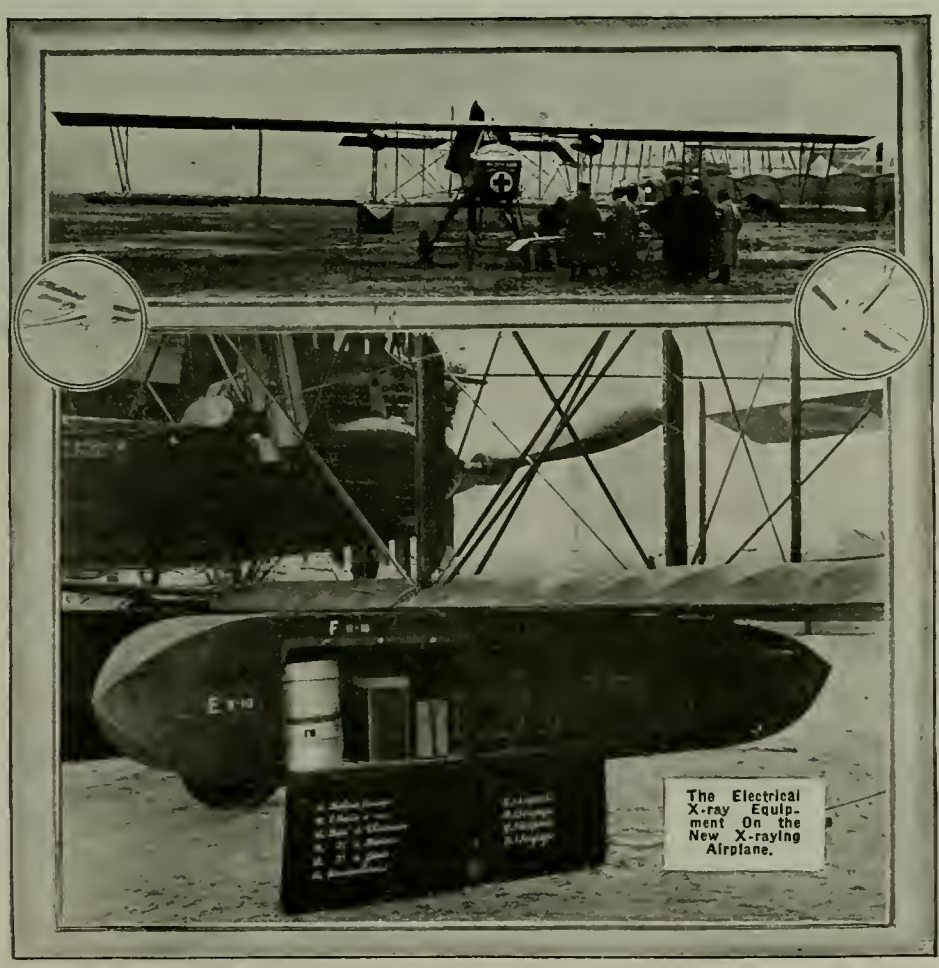
By JACQUES BOYER
Paris Correspondent, ELECTRICAL EXPERIMENTER

Paris, April, 1919.

X-RAYING AIRPLANE.

MANY great personalities of the aeronautical world have recently witnest the baptism of the "Aérochir" (from aéro and chirurgeon) at Issy-Les-Moulineaux, near Paris, at the trial of an airplane used for X-raying chirurgical purposes.

The new machine came thru the air from Ville-Coublay, having been in the air for over an hour. This flying ambulance, which can bring medical aid rapidly to the wounded, was designed by MM. Nemirovsky and Tilant and is painted with the conventional Red Cross. It carries all the chirurgical material such as instruments for operating, sterilization, etc., all X-ray machinery, such as a spark coil, transformer, X-ray tubes, fluoroscope, as well as the personnel capable of putting the apparatus to work immediately. The attendants comprise a pilot, chirurgeon and a professional X-ray man. The entire apparatus does not weigh more than 700 kilograms. In peace times a machine of this kind may be used with great success in case of catastrophes, railroad accidents, explosions, etc., which may take place in an isolated spot. In the colonies the "Aérochir" will find large application; colonies naturally not being well populated and having few doctors, located in widely separated points, it will be an easy matter to bring quick aid to patients by means of the "Aérochir," to which distances are immaterial.



The Electrical X-ray Equipment On the New X-raying Airplane.

DR. BERGONIÉ'S NEW RHYTHMIC FARADIZATION.

Many wounded soldiers in the war have seemingly recovered, with the exception of certain muscles which refuse to resume their normal work. Formerly the best method to make these muscles return to normal conditions would be by means of continuous muscular work, as suggested by Dr. Bergonié. One method required professional work or agricultural occupations every day for an indefinite time of the affected members in order to reconstruct the muscles and put them on a normal basis once more. Unhappily, it is not always possible to do this, be it on account of nervous fatigue which sets in rapidly; be it by unseasonable weather, or also where the muscles are so situated that bodily work will not profit them greatly.

For that reason, Dr. Bergonié has brought into being what he calls an *intensified Rhythmic Faradization*, which makes it possible for the wounded to develop their muscles in a remarkably short time. Moreover, such treatment gives the muscles a very strenuous involuntary exercise produced directly by the electrical current.

From the electrical standpoint, the alternating rhythmic faradization utilizes very sharp waves of a frequency giving rise to a moderate convulsing action (50 to 55 per second). The current is produced by a special coil with a well-regulated vibrator, the coil itself giving no sparks. The waves under pressure of between 12 and 14 volts maximum have a periodicity of 15. By means of a standard metronome the current is dis-

(*Cont. on page* 151)

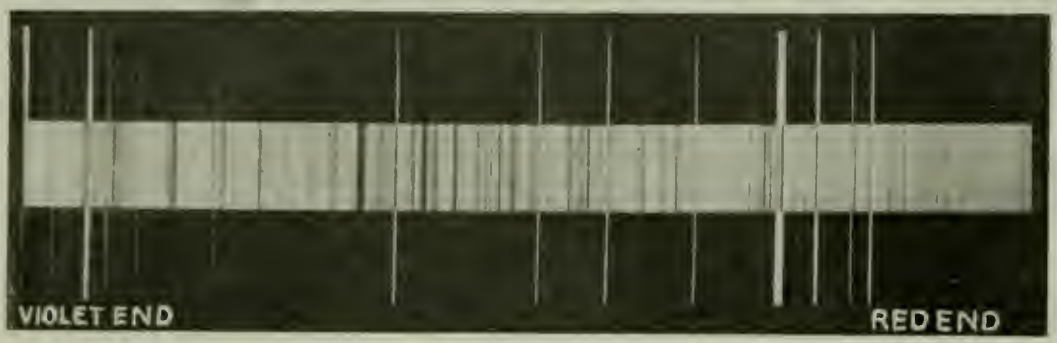
Popular Astronomy

By ISABEL M. LEWIS

of the U. S. Naval Observatory

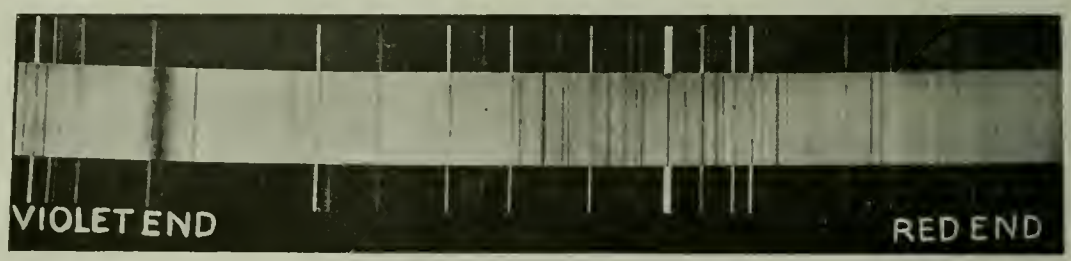
The Evolution of the Stars

If a ray of white light from the sun is past thru a spectroscope, which consists essentially of a glass prism or cham of prisms, it is broken up into its component rays of different wavelengths which arrange themselves in an orderly band of variegated colors: red, orange, yellow, green, blue, indigo and violet gradually blending one into the other crost by a great number of fine dark lines known as the *Fraunhofer lines* or absorption lines of the solar spectrum. The shortest wave lengths lie in the *violet* and the longest wave lengths in the *red* end of the visible spectrum. Below the red lie the infra-red and beyond the extreme violet the ultra-violet rays, both invisible to the human eye but rendered visible to a certain extent by means of photography and specially dyed plates.



1. Beta Geminorum (Pollux) Solar-type K0 Slightly More Advanced in Type Than Our Own Sun Which Belongs to Type G.

According to the first law of spectrum analysis an incandescent solid or liquid or gas under very high pressure gives a continuous spectrum, that is, an unbroken band of variegated color. If however, cooler gases intervene between us and the source of the continuous spectrum, they will absorb from the light beyond the particular rays of which they themselves consist and as a result the continuous band of color will be crost by a series of dark lines called *absorption lines*, belonging to the cooler intervening gases. To every chemical element belongs its own characteristic lines in this spectrum and no two elements ever have any line or group of lines in common.



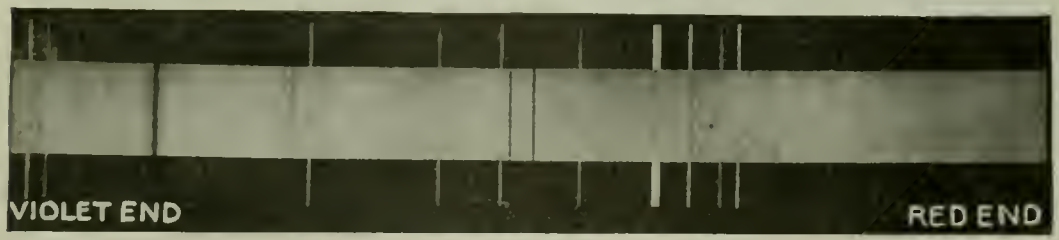
2. Eta Leonis—Helium Approaching Solar Type (Harvard Type A0). Hydrogen Lines Have Increased in Intensity. Helium Also Visible But Fainter Than Above and a Few Metallic Lines Begin to Appear.

Applying these principles to the sun, the central core, consisting either of an incandescent solid or liquid or gas under high pressure (most probably the latter), emits the continuous band of light known as the *continuous spectrum*. The cooler gases of the surrounding solar atmosphere absorb from the light of this central core the particular rays of which they themselves consist and thus produce the multitudinous fine dark lines known as the absorption lines. It is upon the position of these dark lines that we depend for our knowledge of the physical condition of the sun, for obviously, there is nothing in the continuous band of color itself to give us any clue to the nature of the substances from which it originates. If, as sometimes happens, the continuous spectrum is crost by *bright* lines instead of *dark* lines, it shows that the intervening source of light is hotter than the source beyond. An incandescent gas at low pressure, such as incandescent hydrogen, gives a bright-line spectrum or emission spectrum consisting of bright lines upon a dark background. Such a spectrum shows that the body emitting it is a true gas. Nebulae give such a type of spectrum indicating that they are true gases. If, moreover, the central core of the sun could be suddenly blotted out the dark lines of the solar spectrum would immediately appear as bright lines on a dark background, for they belong to incandescent gases, the absorption lines appearing dark by contrast with the more intense light beyond.

It is upon these principles of spectrum analysis that our knowledge of the physical constitution of the stars depends. The sun is simply one of the stars and the solar spectrum is duplicated almost line for line in a certain type of star known as the *solar stars*. Most of the chemical elements existing in the sun's atmosphere have been identified by comparing the dark absorption lines in the solar spectrum with the lines in the spectra of terrestrial elements produced in our laboratories. It has been found *that all the elements that exist on our own planet occur also in the sun* and the same elements that exist in planet and sun enter into the composition of the stars.

By passing a ray of light from a far distant star thru the spectroscope and producing its spectrums, it becomes possible to compare the positions of its characteristic lines with the lines of the same elements in the solar spectrum. It is in this way that we learn the nature of the atmospheric gases of the stars. It must be remembered that it is the *surface* conditions of the stars and their *outer* gaseous envelopes that can be studied by the spectroscope. From the star's deep interior we receive only the continuous band of color.

The first general classification of the stars according to their spectra was made by Father Secchi, the Italian astronomer, and was publisht in 1849. It was the result of a study of the visible portion of the spectrum with a small telescope and only stars showing dark absorption lines were studied. Since that time more elaborate classifications of stellar spectra have been made—chiefly at the Harvard College observatory, where many thousand spectrograms (photographed spectra) have been studied and classified. The Harvard classification of star spectra has now been generally adopted by all astronomers. The importance of the work done along this line at the Harvard Observatory can be judged by the fact that the Henry Draper catalogue of stellar spectra now in process of publication by this observatory *gives the spectra of two hundred thousand stars.* The first two volumes of the catalogue, which consists of nine volumes in all, are



1. Rigel (Beta Orionis)—A Helium Star Showing Strong Absorption Line of Hydrogen (to Left) and Helium (Near Center) and Absence of the Metallic Lines Characteristic of Solar Type Stars.

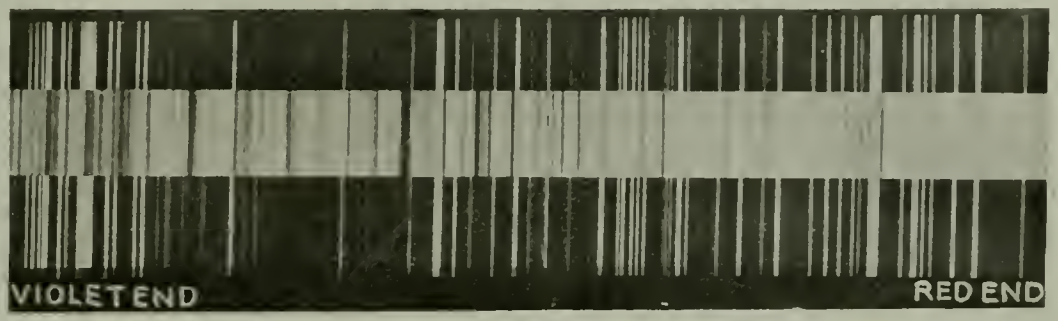
already in print. The great value to astronomy of this monumental work, which was undertaken and completed under the personal direction and supervision of the noted director, Prof. E. C. Pickering, just deceased, can hardly be overestimated. This detailed classification of star spectra shows forcibly that *evolution* is in progress among the stars. As to the exact order in which the evolution is taking place, there is still some doubt, but of the gradual transition from type to type in whatever order the evolution is progressing there can be no doubt. According to the classification of Father Secchi, which is useful for quick and approximate classification, the stars are divided into four classes or types. To Type I belong all the *bluish white or white* helium and hydrogen stars. These stars are believed to be the hottest of all the stars, and their atmospheres consist almost entirely of helium and hydrogen gases. To this class belong the Orion (helium) and Sirian (hydrogen) stars such as Rigel, Sirius and Vega.

Type II consists of the solar stars *yellow or orange* in color, whose spectra are dominated by the absorption lines of hydrogen and the metallic elements. They are generally considered to be lower in temperature than type I stars, and their atmospheres are denser and more extensive and filled with the vapors of many elements. The sun is a star of this type, and to this type also belongs such first-magnitude stars as Capella, Arcturus and Aldebaran. Type III consists of late type stars with banded or fluted spectra due to the presence of metallic compounds, chiefly of titanium oxide which appears to dominate the spectra of stars of this type and indicates a cooler atmosphere than exists in the earlier type stars, since compounds of the elements can only form at comparatively low temperatures. The absorption is strong in the violet end of the spectra of such stars, therefore they are *deeply reddish* in tinge. Antares and Betelgeuse are noted first magnitude stars of this class. Type IV consists of *deep red* stars, whose spectra are also banded or fluted, but the bands are due in this case to compounds of carbon. Their relation to the other types is somewhat uncertain, but they are believed to be connected with solar type stars by a chain of development independent of stars of the third type. That is, some solar stars develop into type III stars, others into type IV stars. Stars of this latter class are all very faint and very distant. It is believed that they are giant stars in absolute magnitude, their faintness being due to great distance.

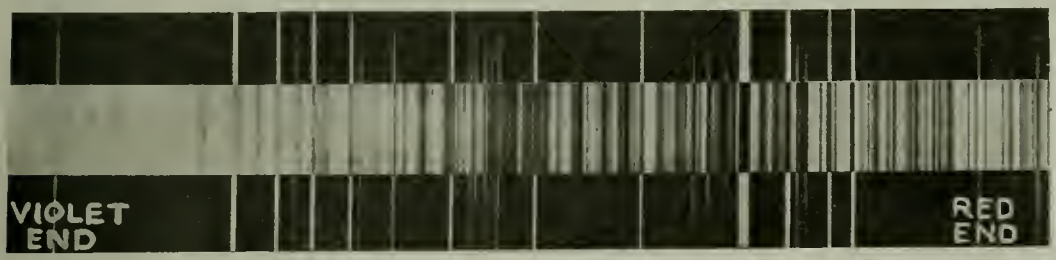
The Harvard classification is much more complete than the above. It rests upon the behavior of certain groups of lines that vary in intensity as the evolution progresses. It also assumes that the evolution of the stars starts from the gaseous nebulae and is in the direction of the late type red stars.

The spectra of the gaseous nebulae consists of bright lines of helium, hydrogen and nebulium upon a dark background. They are therefore true incandescent gases under low pressure. The first link connecting the nebulae with the stars appears to be the bright-line stars not recognized in the Secchi classification. They are referred to as the type O or Wolf Rayet stars in the Harvard notations, and their spectra show a faint continuous background (implying the formation of a central core) crost by a group of bright bands and a series of bright lines, both unknown terrestrially for a long time but finally obtained experimentally by passing a strong condensed discharge thru a mixture of hydrogen and helium in a vacuum tube. The ordinary well known hydrogen series also appears in this type, first as bright lines, but as the type progresses the bright bands and bright lines of both series become dark showing the formation of an atmosphere of cooler hydrogen and helium around the star. With the total disappearance of the bright lines and bands and the strengthening of the dark lines of helium and hydrogen, type O passes over into type B, to which belongs the beautiful blue white helium stars often called Orion stars because so many stars of this constellation are of this type. These stars have the hottest temperature and the rarest atmospheres of all the stars. The only absorption lines prominent are those of helium and hydrogen. There are a number of subdivisions of this type depending upon the relative intensity of the lines of the two gases. Toward the end of the type the hydrogen lines have become more intense than the helium lines, and faint metallic lines have begun to appear until by gradual transitions the hydrogen stars appear known as type A, or Sirian stars, after Sirius, a noted star of this type. The helium lines are now entirely gone and the spectrum of the star is entirely dominated by intense absorption lines of hydrogen. Four strong lines of this element exist in the visible spectrum (see diagram I) and the series extends rythmically far into the ultra-violet. These stars are intense white in color and their atmospheres are composed almost entirely of incandescent hydrogen. As the type progresses the faint metallic lines of the solar spectrum become stronger. The hydrogen lines reach their maximum strength in class A. (See photo of early type stars.) The next type to appear is known as the Calcium or type F group of stars which is characterized by the growing intensity of the lines of the metallic elements, which are now closely packed together in the spectrum, and by the very marked intensity of the calcium bands in the extreme violet and the continued great strength of the hydrogen lines which surpass any of the metallic lines in intensity. (See photo of type F star Procyon). To this class belongs

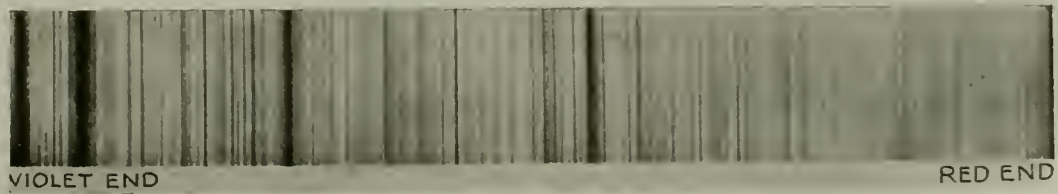
(*Continued on page* 157)



2. Alpha Tauri (Aldebaran) Advanced Solar-Type K5. Note: The Comparison Spectrum Shown Above Is That of Titanium. The Spectrum of the Star Is Superimposed Upon the Comparison Spectrum. Note in Above Spectra the Great Intensity of the Lines of the Metallic Elements Which in the More Advanced Types Have Become Stronger Than the Absorption Lines of Hydrogen Which Dominated the Spectra of Earlier Type Stars. As the Absorption Lines of the Metallic Elements Increase In Intensity the Color of the Star Becomes More and More Tinged With Red. Solar Type Stars Are Cooler (Superficially At Least) and Have Denser Atmospheres Than Stars of Type I (Helium and Hydrogen Type Stars).



Secchi's Type III, Harvard Type M Star. This Class Is Divided Into Giant (Type Ma) Stars and Dwart (Type Mb) Stars—Color, Deep Red. The Spectrum Shown Is That of a Typical Giant (Ma) Star of This Class—Betelgeuse or Alpha Orionis. The Portion of the Spectrum Shown Is In the Blue Region. Note the Heavy Absorption In This Portion of the Spectrum and the Fluted or Banded Appearance Due to the Presence of Compounds of Titanium Oxide (Characteristic Also of Sun Spots and Indicating Comparatively Low Temperature). The Heavy Absorption of the Blue Rays Gives These Stars Their Deep Reddish Color. The Bands or Flutings Are Sharp Toward the Violet and Shade Away Toward the Red. There Is a Fourth Class of Stars Known As Type IV, Harvard Type N or Carbon Stars, In Which the Direction of the Shadings Is Reversed. These Stars Are Also Very Deep Red, Few In Number and Very Distant, the Brightest Known Being Only a Fifth Magnitude Star.

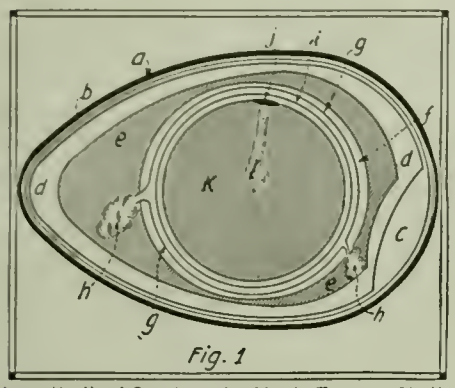


Spectrum of a Calcium or Harvard Type F Star—Alpha Canis Minoris (Procyon) Intermediate Between Secchi's Type I and Type II Stars. Color White Tinged with Yellow. The Portion of the Spectrum shown Runs From the Blue Green At the Right to the Extreme Violet At the Left. The Two Dark Bands At the Extreme Left Are the Strong Absorption Bands of Calcium So Prominent In This Type. The Other Three Dark Lines Are Absorption Lines of Hydrogen. A Fourth Line of Hydrogen Is Also Present So Close to the Second Calcium Band That They Appear Practically As One Band. The Metallic Lines Now Appear Closely Packed Together and of Growing Intensity. This Type of Star Is Dominated by the Absorption Bands of Calcium and the Absorption Lines of Hydrogen Which Are Stronger Than Any of the Metallic Lines.

Practical Chemical Experiments

By ALBERT W. WILSDON

FEW of the millions of people who eat eggs daily are familiar with, and in most cases never concern themselves with the chemical or physiological properties of this form of food. The daily consumption of eggs thruout the world is truly enormous, and the



Longitudinal Section of a Hen's Egg. a, Shell; b, Double Membrane of Shell; c, Air-Chamber; d, Outer, or Fluid Albuminous Layer; e, Thick, Middle Albuminous Layer; f, Inner Albuminous Layer; g, Membrane of the Chalaza; hh, the Chalaza; i, Vitelline Membrane; j, Germ; k, Yolk; l, Latebra. (After Macé.)

present high prices have caused many dealers to preserve eggs till the market is at a high point and then unload them, in many cases with the representation that they are *strictly fresh!* Eggs contain a relatively large proportion of *Proteid* and mineral matter which is used to furnish the salts of the bones, especially calcium phosphate, and also fat, and is one of the most concentrated forms of nutriment.

Proteids serve as a fuel for the body and also provide the important element Nitrogen, which is needed in the case of children for growth, and in the case of both children and grown people, to keep the body in repair.

Strange as it may seem, even eggs, the contents of which are contained in a brittle shell, have had substitutes placed upon the market in the guise of "egg substitutes." Nearly all these are claimed to contain all the ingredients of eggs, but most of them fall far short of these claims. There is a number of so-called *egg powders* offered for making cakes, etc., *which contain no egg at all.* They are composed of other forms of protein matter, usually casein from milk, and colored to resemble the egg in tint.

The average weight of a hen's egg is 60 grams, of which the shell weighs about 6 grams, the white 36 grams, and the yolk 18 grams. Roughly it contains 70% of water, 12% of albumin and 12% of fat.

The substance known as "white of egg" or egg albumin, when separated from the yolk, membrane and shell is a colorless, transparent, thick, sticky fluid, soluble in or miscible with water and is composed almost entirely of albumin, partially dissolved in water.

When the white of an egg is put into boiling water it undergoes a remarkable change, and is said to have *coagulated.* In this state it is insoluble in water and opaque and forms a solid mass, which, however, still contains a large proportion of water. During coagulation it is probable that chemical as well as physical changes have occurred. Thus from the foregoing we see that the white of egg is an extremely unstable and complex substance, its physical properties being so indefinite that it would be almost impossible to say that it was or it was not a definite chemical compound.

Eggs: Their Preservation and Tests

White of egg or egg albumin may, however, be taken as the representative of a group of substances which are classified together as the *Proteids*, or *Albuminoids.* They contain the five elements, Carbon, Hydrogen, Oxygen, Nitrogen and Sulfur.

Egg yolk is composed of albumin, fat, and a phosphorus bearing material of high nutritive value known as *Lecithin.* The yolk of an egg is a much richer food product than the white, containing in addition to the nitrogenous element the fat and mineral bodies necessary to nutrition.

PRESERVATION. Of particular interest to the reader will most likely be the methods of preserving and tests.

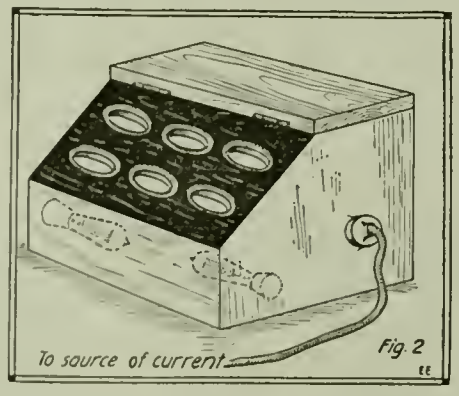
Owing to the porous nature of the shell, the moisture of the contents gradually grows less by evaporation, and the egg loses in weight. Air also passes in thru the shell pores, carrying various microbes, which result in ultimate decomposition and spoiling of the egg. Nature has provided the shell with a thin surface coating of mucilaginous matter, which, however, is easily washed off. This coating tends to partially close the pores, and for best results in keeping should not be removed by washing.

By coating the eggs artificially with a varnish or film of some kind the egg will be rendered impervious to air and water. One of the cheapest, simplest and best of these coatings is *Water-glass.* This is produced by dissolving the substance known as Sodium Silicat (or Silicat of Soda) in water, and applying the same, by dipping the egg into the solution and removing and allowing to dry. The Silicat of Soda which is thus left in a thin film over the surface of the egg penetrates and stops the pores and renders the egg-shell practically impervious both to air and water. This material possesses the property of becoming totally insoluble in water when it has once been dried so that even if the egg is afterwards subjected to contact with water the film is not removed.

One drawback to this method is that eggs so treated break more easily on boiling. This breakage may be prevented by carefully piercing the shell with a strong needle before being put into the water.

Gelatine, vaseline, wax or gum are other substances used for coating or varnishing the egg, tho they are not as efficacious as the water-glass.

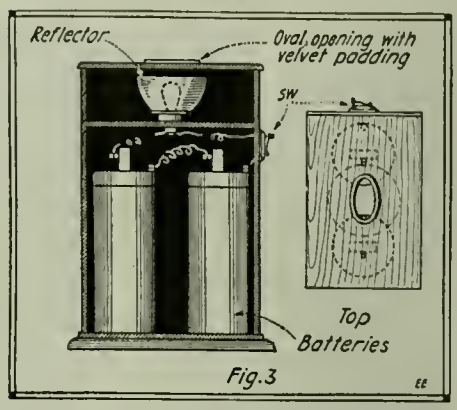
Another proposed method is to immerse the eggs in boiling water for twenty seconds with the result that a very thin layer of the egg-white next to the shell becomes coagulated, thus forming an impervious coating *inside the shell.*



A 110-Volt Two-Lamp Egg Candling Cabinet with a Capacity of Six Eggs. It Can Be Easily Built by Anyone or Purchased as Desired.

PHYSICAL EXAMINATION OF EGGS. Various physical tests have been prescribed for ascertaining the approximate age of an egg.

THE SALT SOLUTION TEST consists of



Battery Type of Egg Candling or Testing Cabinet Which Anyone Handy with Tools Can Easily Construct. The Lamp and Reflector Can be Obtained at Any Supply Store.

placing the egg in a 10% salt solution. **If perfectly fresh, the egg will sink to the bottom. If it remains immersed in the liquid, it is to be considered at least three days old. If it rises to the surface and floats thereon, it is more than five days old.** This test is a rough one, is quickly applied, and will distinguish the really fresh egg from one which is even a few days old, but is useful only for eggs that have been kept in air. Preserved eggs cannot be gaged by these means. It is possible also to apply the sinking and floating tests on a large scale. Salt water tanks of any size may be easily constructed into which hundreds of dozens of eggs may be placed at one time, thus effecting a speedy separation of *sinkers* and *floaters,* and at a minimum expense. There are some instances where a fresh egg will not sink in these circumstances, but such cases are not numerous enough to be of any importance.

CANDLING TEST. The best method of examining eggs for freshness is *"candling,"* the process consisting in placing the egg between a bright light and the eye. **If the egg is fresh it will show a uniform rose-colored tint, without dark spots.** Moreover, there is to be found in the larger end of a fresh egg, between the shell and the lining membrane, a small air cell, occupying *one-twentieth* of the capacity of the egg, which is distinctly transparent. *In an egg which is not perfectly fresh this space, unless the egg is stored with the large end up, becomes filled with egg substances and presents the same appearance as the rest of the egg. If dark spots are found in the egg, it is certain that the egg is not perfectly fresh, and its appearance will be more or less cloudy, being darker as the eggs grow older, becoming in extreme cases opaque.* At the same time the "air chambers" mentioned before grow larger as the age increases. The so-called *"spots"* are eggs which show on "candling" black patches due to fungi.

The best of all tests, however, is to open an egg and examine its general appearance, its mobility, and its odor and taste. Eggs which have been stored some time show a tendency in the white and yolk to run together, and when this phenomenon is observed it may be certain that the egg is not a fresh one, altho no perceptible odor of

(*Continued on page* 154)

Experiments in Radio-Activity

By IVAN CRAWFORD

PART IV (Conclusion)

IN the previous installments of this series the properties of the radiations from radio-active substances have been discust. It is the author's intention in this article to explain the radio-active transformations and to show that in reality *these changes are a transmutation of the elements.* Experiments will be given showing the rise and decay of the active constituents. For a more detailed account the reader is referred to Sir Ernest Rutherford's "Radio-active Substances and Their Radiations."

The disintegration theory was first proposed to account for the continuous production of thorium X from thorium compounds. This change from thorium to thorium X is in reality a breaking down of the thorium atom which has an atomic weight of 232, and the formation of the thorium X atom which has an atomic weight of 224. This is accomplished by the emission of two alpha particles. There are, however, two intermediary products, namely, mesothorium and radiothorium. Radiothorium is, however, chemically inseparable from thorium and mesothorium inseparable from thorium X, and are in reality isotopes. The word isotopes is used to designate two substances which have the same chemical properties, but different atomic weights. The rate of decay of an active substance may be calculated by using the formula given in the second article for the retardation of alpha particles. In this case I_e is the initial activity, I_t is the activity after time t, e is the base of the Naperian logarithms (2.7182), and λ in the case of thorium X is .19 days. Using this equation the decay curve may be plotted. The two assumptions of the disintegration hypothesis as given by Rutherford are: (1) that there is a constant production of fresh radio-active matter by a radio-active substance, and (2) that the activity of the matter so formed decreases according to an exponential law with the time from the moment of its formation.

An experiment proving the disintegration hypothesis will now be given. About 5 grams of thorium nitrat or some other thorium salt are dissolved in water. This solution should be left standing for about 2 days for reasons which will be given later. The thorium nitrat solution is then diluted to about 200 c.c. The solution should be heated and ammonia added in excess. The thorium and some impurities are precipitated as a hydroxid by the ammonia. The thorium X, however, remains in the solution with the mesothorium. The solution is now filtered and the precipitat dried for future use. The filtrate should be boiled down to dryness to remove all traces of the ammonia salts. The residue contains the thorium X. The solution when concentrated should be transferred to a watch-glass and dried upon it to facilitate handling. In the accompanying illustrations the apparatus necessary to perform these separations is clearly shown.

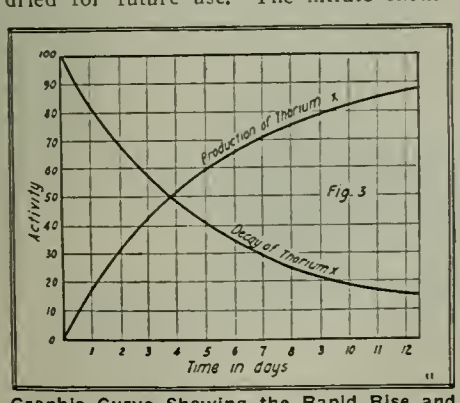
Top View—Simple Apparatus Used In the Experiment of Separating Thorium "X" from Thorium Nitrate. This Experiment Proves the Hypothesis of Radio-active Transformation or the Transmutation of the Elements. Lower View—Watch Glasses Used to Hold Thorium "X."

The reason for letting the thorium nitrat solution stand several days before using had now better be explained. Thorium compounds have been found to give off an active gas known as *thorium emanation.* This emanation when it decays forms an active deposit. In salts this deposit is always present as the emanation is occluded in the solid, and allowed to change into the deposit. This deposit, however, decays in a short time. If the thorium solution were used fresh, the thorium X would contain some of this active deposit, thus causing an initial rise in activity instead of a gradual fall. When the solution is allowed to stand for several days the amount of active deposit remaining is negligible. No more is formed, as the emanation escapes from the open vessel not being held by the solution.

The watch glass or metal plate having the thorium X deposited upon it is now introduced into the radio-active electroscope. The rate of discharge is then noted as outlined in the first article. The activity should then be measured every 12 hours for about 12 days, and the results tabulated. These figures then are the measure of the decay of the thorium X at different periods. These figures may be compared with those calculated by using the equation given in the second article. The results should now be plotted on a graph.

The plotting of the decay curves of active substances is extremely simple, the ordinates represent the activities as determined by means of the ionization current, and the abscissae represent the time in days. In arranging the graph the lower abscissa should be divided into 12 divisions to represent the 12 days in this experiment. The ordinate to the left is divided into 10 parts to represent the change in activity. The initial activity is denoted by 10 and the other activities arranged proportionally on the ordinate. The activity, then, for each half day is marked on the graph by a small circle or dot. A curve joining these circles represents the decay curve of thorium X. Irregularities at the beginning may be caused by the active deposits remaining in the solution.

The thorium nitrat or hydroxid as it is after the chemical reaction can be measured in the same way as the thorium X. It will be found that the thorium hydroxid increases in activity due to the production of thorium X. The curve denoting the rise in activity of the thorium salt is the exact complement of the curve of thorium X. Two such curves are shown in the accompanying graph. They illustrate the theoretical decay and production of thorium X. This experiment shows conclusively that it is possible for one substance to change into another. If this transmutation could be controlled the goal for which alchemists sought would be realized. In this experiment the thorium gives rise to an active substance several thousand times as active, weight for weight, than the thorium from which it was separated.



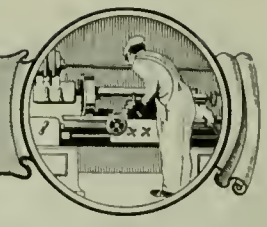
Graphic Curve Showing the Rapid Rise and Decay Periods of Thorium "X," in Days, as Well as the Relative Activity. The Decay Is Measurable by Means of the Sensitive Electroscope Previously Described.

As the reader goes deeper into the study of radio-activity the question may sometimes occur to him whether or not the property known as radio-activity is limited to a certain group of substances such as have been described here. This question has occurred to several scientists and has been met with various answers. It is, however, merely a subject for speculation, as it is impossible to secure any conclusive experimental evidence. The reason for this is apparent, as the rate at which they would give off rays is so small and their lives so long that they would have to be observed over millions of years to detect any visible change.

Radio-active compounds are being used more and more in modern every-day life. What was at first merely a peculiar phenomena is now an important branch of science. Prominent scientific magazines and institutions are now regarding radio-activity as a separate and distinct science. Large laboratories have been established for the study of this phenomena. Thousands of dollars have been spent in the establishing and equipping of factories for the extraction of uranium and radium from the carnotite. It has found extensive use in large hospitals for the cure and treatment of cancers and skin diseases. This line of research should appeal to every experimenter of the present day. It has given

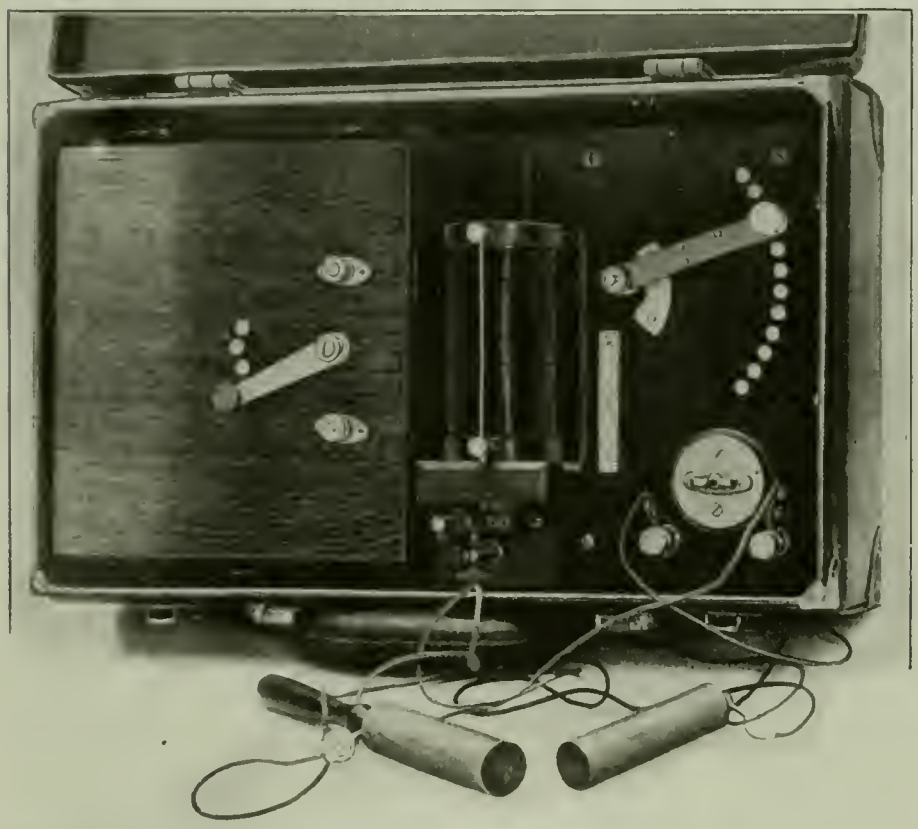
(*Continued on page* 151)

THE CONSTRUCTOR



How to Build an Efficient Medical Coil Set

By H. WINFIELD SECOR



Appearance of Finished Medical Coil Set in Carrying Case as Built by the Writer. This Coil Is Adapted to All Kinds of Testing Work, Besides the Treatment of Various Bodily Ills, Such as Rheumatism. The Primary, Secondary or Tertiary Current and Combinations of Them Are Controlled by a Double-Pole Switch.

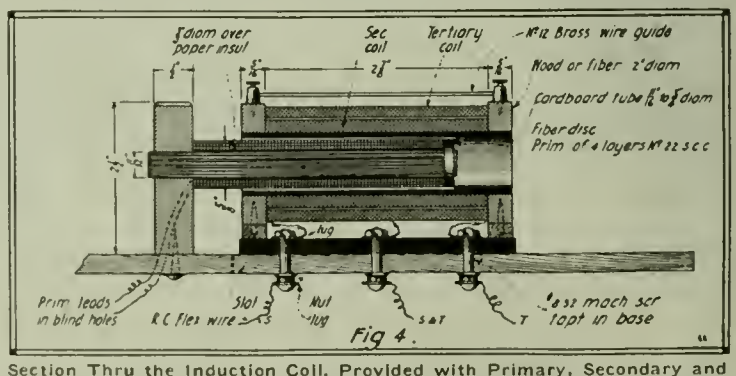
THE aim of this article is to give the constructional details so that anyone interested in shocking or medical coils may build his own apparatus at a slight cost. The outfit will produce equally as good results as any of the commercial apparatus, for all usual requirements. Medical coils are widely used for the treatment of rheumatism and other bodily ills and pains, besides furnishing lots of amusement and fun for the young folks. Not only this, but such a coil as the one here described lends itself very well to many kinds of testing, and it also can be used for telegraphing along railroad tracks for several miles, after the manner of the U. S. Signal Corps buzzer sets. We will take up the construction of the individual parts of the apparatus in detail.

Induction Coil.

The induction coil used in the present apparatus need not be as carefully insulated and constructed as that intended for producing sparks with corresponding high potentials, which constantly tend to break down the insulation between turns and between layers of wire. As the detail drawings show, the usual secondary coil is supplemented by a second fine wire winding, known as the *tertiary*, which is wound exterior to the usual secondary winding. The primary winding and the annealed soft iron wire core is mounted rigidly in a stationary block, made of mahogany or other hard wood, or else it may be cut out from a piece of black fiber, bakelite or hard rubber, whichever may be the handiest material for the builder. This primary supporting block has a hole drilled thru it, having a diameter of 11/32 inch, in which the iron wire core is to be emplaced. To make the core, you will require the softest iron wire you can procure, about No. 22 to 24 gage, measuring about 4 inches in length. The wires should be as straight as possible, and they are mounted in the upright block by placing as many of them thru the block as you can, gradually increasing the number in the hole by sticking some here and there around the outside and in the center, until as many wires are in the bundle as you can push in thru the hole. The core may be finally tightened up by driving a few small brads thru the front end and clipping these off with a pair of pliers. Afterward this core face against which the vibrator is to operate is filed off smooth, but left projecting from the block about ⅛ inch.

The next step is to insulate the long leg of the core projecting from the block, and this is done by winding some thin linen or silk tape along the core, lapping the tape slightly. A daub of glue or a piece of thread will hold the final convolution of tape. The block should previously have had two 1/16-inch holes drilled up from the base with a hand drill or drill press, thru which the two primary leads may pass without being seen. After passing thru one of the primary leads, so as to leave about 6 inches projecting and then coiled out of the way, we may proceed to wind the first layer of the primary. This is wound as evenly as possible, and, in all, four layers of the primary wire (No. 22 S. C. C. or enamel magnet wire) are put on, bringing out the final lead from the fourth layer thru the remaining hole in the upright. This coil may then be immersed in molten paraffin wax, or it may be given a coat of thin orange shellac. To give a finished appearance, a layer of black paper may be glued around it.

The secondary and tertiary coils are wound on the bobbin, as shown in Fig. 4, a wrapping of three layers of paper being placed between them. In winding the layers of these two coils, the length of the layer is made a little shorter than the bobbin, leaving a space of about ⅛ inch at each end, and a layer of thin paper, preferably paraffined paper, is placed between every layer. The size of wire for these two coils is No. 36 B. & S. gage, S. C. C. or enameled insulation. In bringing out the leads from this fine wire, it is the best practise never to rely on a single strand of this small size, which may easily break and cause no end of trouble; therefore several strands of



Section Thru the Induction Coil, Provided with Primary, Secondary and Tertiary Windings. The Tertiary Coil Is Wound Outside the Secondary and Yields a Mild Current, Very Desirable in Electro-Medical Applications.

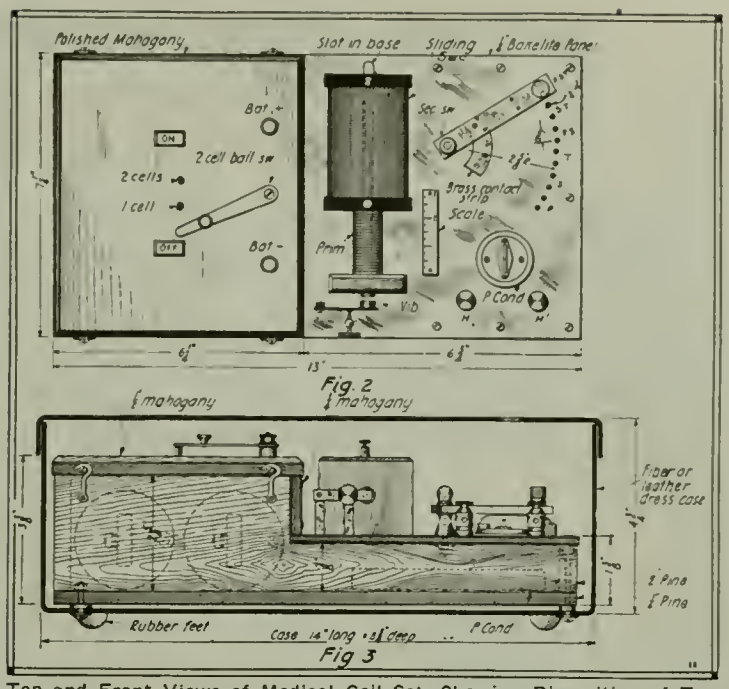
the wire should be doubled up to form a sturdy flexible lead, which should be given one or two wraps around the form and tied with a piece of thread. The fine wire forming the winding is then soldered to this heavier lead. A small winding jig, comprising two wooden uprights mounted on a base together with a piece of heavy iron wire, bent so as to form a handle or crank, and a piece of round wood such as a piece of shade roller, will serve to support the secondary bobbin while it is being wound. Proceed to wind on ten layers of the specified wire for the secondary, insulating each layer from the other by a wrapping of paraffined or other paper (but not newspaper) and when the ten layers have been wound on, the joint or common lead shown in Fig. 1 should then be put in place and the wire soldered to it. After winding three layers of paraffined paper around this coil we may proceed with the winding of the *tertiary*, or third coil, which comprises eight layers of wire, each layer separated by a wrapping of paper between. The third or outer lead, coming from the free end of the tertiary winding, completes this unit, and the coil may be finished with a few wrappings of stiff paper to protect it and give it a smooth cylindrical form. The finishing coat may be a wrapping of thin hard rubber, or simply some black paper, which may be later varnished or coated with some black shellac to correspond with the bobbin ends, as the builder may desire.

The induction coil is clearly illustrated in section by the diagram in Fig. 4, and the method of carrying the three connections from the secondary and tertiary windings is simple and efficient. Instead of the older method of providing sliding shoes and metallic rails, the writer has found it much simpler and more reliable, with no chance of intermittent makes and breaks in the current applied to the patient, to secure the three leads coming from the coils to three 8-32 machine screws threaded thru the fiber or bakelite base of the coil in the manner shown. The secondary unit, as will be perceived, is permitted to slide back and forth by virtue of the slot cut thru the wooden base of the cabinet as disclosed in Fig. 2. Three rubber-covered stranded leads such as lamp cord are firmly soldered to three lugs, clamped against the heads of these machine screws by nuts under the base, as shown. It is well to place a metal washer behind the nut, and the screws are then past thru the slot in the cabinet base and screwed into the bakelite base supporting the coil. The secondary and tertiary leads are preferably soldered to three metal lugs

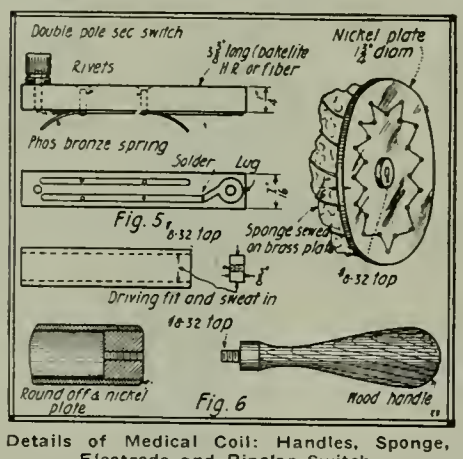
Switch Details.

There are several switches used on this medical coil outfit. (The condenser and switch are optional, and are used mostly for producing a very strong current for shocking purposes.) There are also provided a three-point lever switch for the three positions of "off," "one cell" and "two cells" of dry battery, and a special *bi-polar* secondary switch.

The only special part which needs explanation in detail is the bi-polar secondary switch, and this is illustrated in detail in Fig. 5. The lever of this switch may



Top and Front Views of Medical Coil Set, Showing Disposition of Two Dry Cells. It Works Very Efficiently on One Cell, as Proved by Tests. The Secondary Unit Is Movable.



Details of Medical Coil: Handles, Sponge, Electrode and Bipolar Switch.

be made from a piece of ¼x½-inch bakelite, hard rubber or fiber, preferably black in color. It is not necessary to give here the fractional dimensions for the phosphor bronze contact springs, as their size may be judged from the drawings, and each constructor will make these a little different possibly. They should in any case be approximately ⅛ inch in width and spaced 3/16 inch apart, so as to give as high insulation as possible between them. One of these springs remains flat at the rear, and is soldered to a brass lug, so as to be connected with the central supporting posts of the switch lever in the manner apparent. The second spring bends downward at the rear, and makes contact with an insulated brass segment, shown at Fig. 2, and which forms the second pole of this switch. The necessity of this switch will be evident from the diagram of connections, Fig. 1. The springs on the secondary switch may be of phosphor bronze, German silver, or hard springy brass, and can be quite light.

The secondary current distributing switch gives six different forms of current, namely, primary—secondary—tertiary—primary and secondary—secondary and tertiary—primary, secondary and tertiary—and therefore requires twelve contact points, which are spaced 11/32 inch apart.

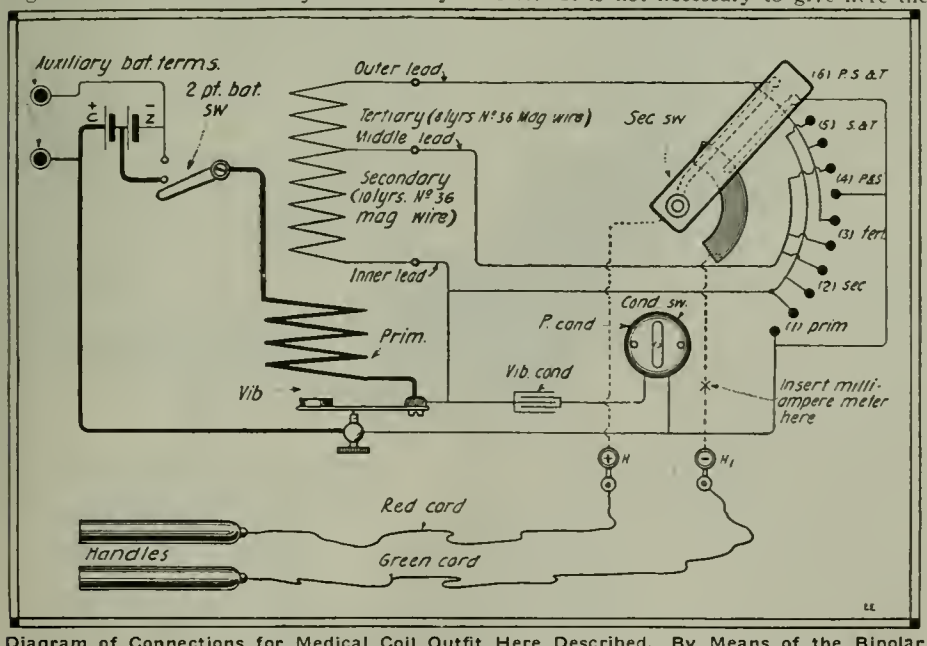
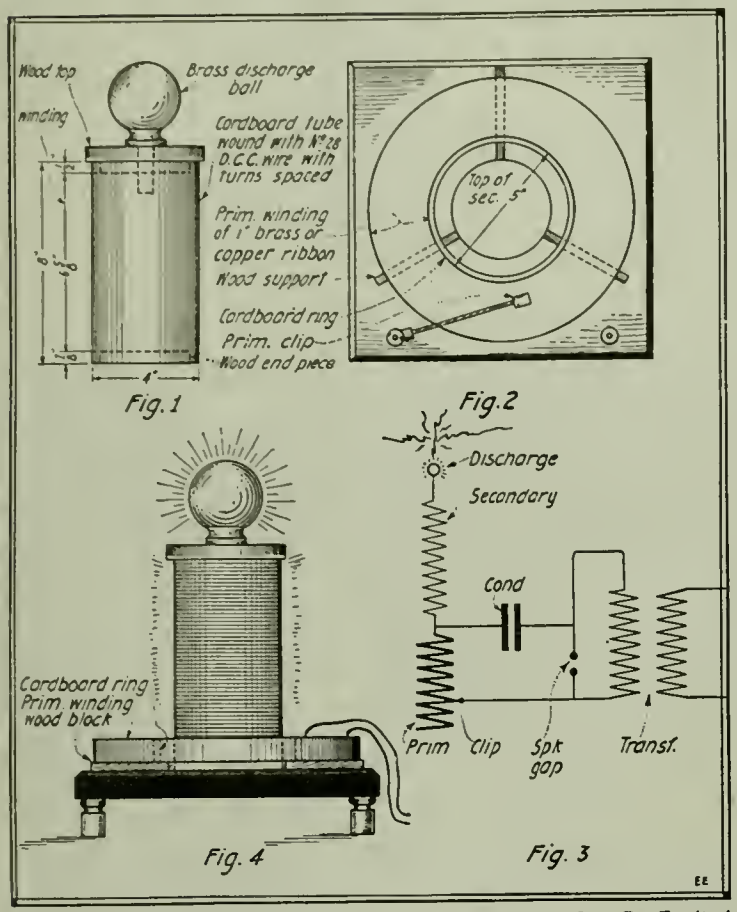


Diagram of Connections for Medical Coil Outfit Here Described. By Means of the Bipolar Current Controller any Modification of Primary, Secondary or Tertiary Current Is at Once Available.

Vibrator.

The vibrator is best removed from some cheap medical coil, or else made up by removing the armature spring from a buzzer or bell, which already has a platinum or silver contact mounted in the end of the spring. The vibrator contact screw and spring are supported on two round brass uprights, threaded for machine screws at the base, these uprights being made of about ¼-inch diameter stock. The spring should be about ¼ inch wide and fairly thin. It may be of steel, spring brass, phosphor bronze or German silver. The contact points, that on the spring and the point in the end of the vibrator adjusting screw, are preferably formed of small platinum points, or they may be the new tungsten points. Silver is frequently used, altho it is not very commendable for the purpose. These contact points are generally obtained from old bells or other electrical apparatus. The iron armature on the end of the vibrator spring, for use with this form of coil, should be about 5/16 inch in diameter and ⅛ inch thick. It may be riveted or soldered to the vibrator spring. It should be mounted so that the armature normally is about 3/32 inch from the iron core. (*Continued on page* 150)

A Small High Frequency "Oudin" Coil



An 8- to 10-Inch Spark Oudin High Frequency Coil. It Can Be Excited by a One-quarter K. W. Step-up Radio Transformer or 6- to 8-Inch Spark Coil.

The high frequency transformer here described is of the *Oudin* type. All that is necessary to use in conjunction with it are a small wireless transformer or spark coil, a high potential condenser, and spark gap. The discharge obtained when the coil is excited by a ¼ K.W. transformer *will be from nine to twelve inches* in length, while the spray discharges will reach out to still greater lengths. The results obtained with this small coil will thoroly repay the builder for the few hours spent in the construction of this simple, yet intensely interesting piece of apparatus.

The secondary of the transformer is shown in Fig. 1. The cardboard tube, upon which the wire is wound, might well be a round "Quaker Oats" box cut to length. It should be well shellacked inside and out, so as to keep out the moisture. Two wooden ends should be turned or sawed out, and for the sake of appearance should be nicely stained and varnished. A discarded ball from a brass bed will be found to suit very well for a discharger. The wire for the secondary should be numbers 28 to 30 B. & S. D.C.C. or S.S.C. wire. The winding must be done on a lathe or else on a simple winding rig, as it cannot be evenly wound by hand. The turns are separated with a thread wound on with the wire. After the wire and thread are wound, the whole should be given two or three liberal coats of shellac (or better, "armalac"). The upper end of the winding should be fastened to the brass discharge ball. This finishes the secondary coil.

The primary is very easily constructed. It is made of one-inch copper or brass ribbon. The inside turn is taped to a cardboard ring, about 5 in. in diameter, and one inch high. This is shown in Fig. 2. The ribbon should be wound tightly, the turns separated by thin corrugated paper, such as used in packing boxes. The strip of paper should be about ⅝ inch wide, so as to allow sufficient surface of the ribbon exposed to make a variable contact with the helix clip. After nine or ten turns have been wound, the spiral should be tightened and taped on the outside. This makes a quite firm winding. The inside turn is connected to the lowest turn of the secondary, see diagram Fig. 3. Also a wire is led from this connection to one binding post. The clip is connected to the other post by a piece of high tension cable. The primary rests on wood supports, which may be of any convenient size. The base should be of ¾ in. wood, and 11 inches square. The edges should be beveled. Porcelain knobs are glued under the corners by means of wooden dowels inserted into the base, as shown at Fig. 4. The complete hoop-up is shown at Fig. 3. Fig. 4 shows the transformer assembled. In operation, the clip should be moved from turn to turn, until the best discharge is obtained. It might be well to say that the current from the secondary is of such high frequency that it is entirely harmless when taken thru the body, providing the spark is allowed to jump to a piece of metal held in the hand, and not to the skin direct.

Contributed by G. W. COOKE.

An Electro Harp

[*The idea here described and illustrated is the "germ" of the marvelous electrically played "choralcello"—the piano that gives absolutely pure music, owing to the fact that the strings are set into vibration by electro-magnets, not by striking them with mechanical hammers, as in the ordinary piano. With such electrically played instruments it is possible to produce "sustained" notes of wonderful purity. Those interested in this work will find that each string must be vibrated by its own magnet coil, and each coil excited by an alternating or pulsating current having a periodicity corresponding to the natural frequency of the particular string played. A buzzer specially tuned for each string may be experimented with.*—*Editorial note.*]

Any one possessing a harp or zither and a few odds and ends to be found around any amateur work-shop, may make a most pleasing and interesting instrument.

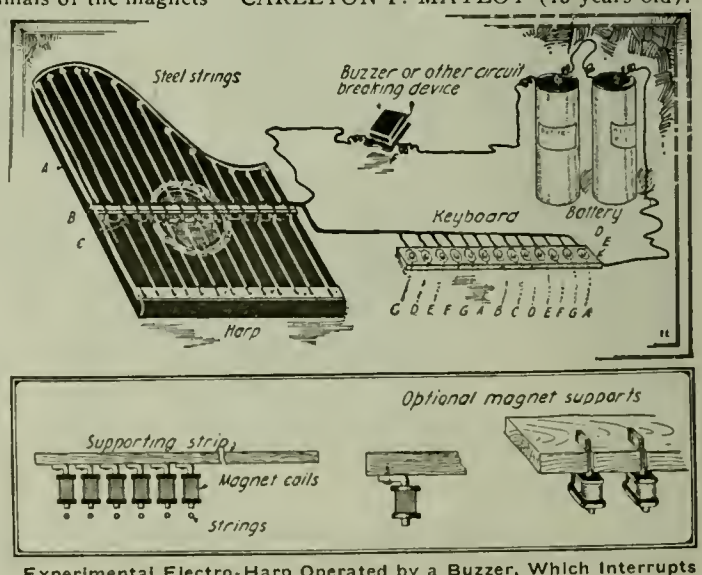
As shown in the accompanying drawing A, is an ordinary harp having steel strings. B is a wood or fiber strip on which the required number of electro-magnets, C are mounted: i. e., as many magnets as there are strings on the harp. These are suspended so as to cover, but *not touch*, the steel strings. Suitable electro-magnets are made from telephone receiver pole-pieces, which can be purchased from any supply house. A corresponding number of push buttons D, are arranged on a separate board E, serving as a key-board. The push buttons D, are lettered according to the strings they control.

The connections are as shown, each magnet being placed in series with its push-button. The other terminals of the magnets and buttons being connected, the main wires are led to a buzzer or other interrupting device F, and batteries G.

It is a good idea to construct a special keyboard, as the push-buttons cannot be played very fast. Pivoted or spring-supported strips arranged side by side can easily be assembled on a base-board, with suitable contact points mounted under each "key" strip. These contacts can be made from silver wire, platinum points off old bells or buzzers, tungsten points, or for that matter just plain brass points or springs. The smooth action of such a hand-made keyboard will really surprise you.

The instrument can be used as an ordinary piano, pressing the buttons as if they were keys.

Contributed by
CARLETON F. MAYLOT (13 years old).



Experimental Electro-Harp Operated by a Buzzer, Which Interrupts the Current Thru a Magnet Coil in Front of Each String.

Experimental Mechanics

By SAMUEL D. COHEN

LESSON XII.

IN the last lesson we considered the theory of twist drills, and having this in mind, we shall now discuss the practical end of the twist drill. It is essential to note that in grinding twist drills it is very important to have the cutting edge

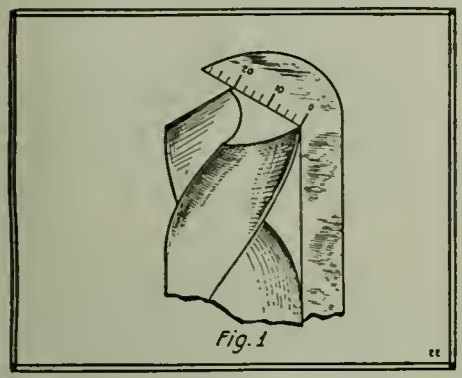


Fig. 1

Using Grinding Gage to Test Edge of Twist Drill When Sharpening It.

at the proper angle, otherwise the drill will not cut—or it may dig into the metal, thus spoiling the same or breaking the drill. The best angle at which the cutting edge should be ground is that of 59 degrees. A gage is usually provided for determining whether the cutting edge is ground to the required angle. Fig. 1 shows the gage being used for that purpose. This gage is a standard tool, and should be found in every experimenter's tool kit.

To acquire knowledge on how to actually grind a drill by reading, is a very difficult matter for the beginner. This is a subject which he must learn by actual practise, thus gaining experience as to the manner in which the drill is held against the abrasive (grindstone or usually an emery wheel), also how to determine whether the drill is ground properly so that it can perform its necessary function.

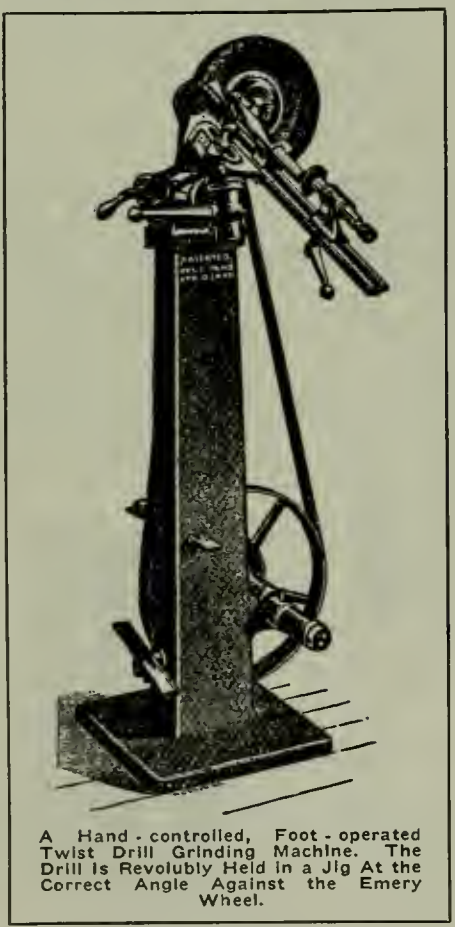
It is advisable for the beginner to obtain a drill grinder, which can be purchased for a nominal sum. There are two kinds of drill grinders—first, that wherein the drill is controlled by hand, and the grinding of the two cutting edges is performed separately; the second type, wherein the drill is clamped and the grinding is performed automatically. The latter is used extensively in large factories, where considerable quantities of twist drills have to be ground.

The point in favor of the grinding machine is its independence with regard to the ability of the workman; also the grinding is accomplished much faster. Fig. 2 illustrates a hand-controlled, foot-operated grinding machine.

In using twist drills, it is of extreme importance to have the cutting edges properly ground. To illustrate this, the results obtained from careless and inexperienced use of the free-hand twist drill are clearly depicted in Figs. 3, 4 and 5. The subject is of extreme importance, and the novice is strongly advised to procure a machine that will grind his drill to the proper cutting edge angle, thereby saving some important work that he may be engaged on, which might have been destroyed by the poor, hand-ground drill.

If the sharpening is done by a free hand drill, it is advisable to observe the cutting of the metal by the twist drill: first, the chips made by the cutting; second, the size of the hole. If the cutting lips are shaped to a proper clearance, the chips will curl as they start from the cutting edge, but, if the cutting lips lack a proper clearance, the resulting chips have the appearance of being ground off, rather than freely cut. If the cutting lips are of uneven length, the hole will be enlarged over the diameter of the drill.

The next important factor with reference to drills, is their feeding speed. In order to obtain best results with drills and drilling machines, the drill should advance



A Hand-controlled, Foot-operated Twist Drill Grinding Machine. The Drill is Revolubly Held in a Jig At the Correct Angle Against the Emery Wheel.

into the work a definitely regulated amount each revolution. The distance which the drill advances per revolution is termed the *feed*, and must be adjusted to suit the conditions under which the work is being performed. See table at end of article.

These figures are recommended for average conditions. At times they are greatly exceeded, and at others must be greatly reduced. Feeding the drill free hand, if skillfully done, may answer in certain cases, but is less effective than power feeds, with the exception of small wire drills.

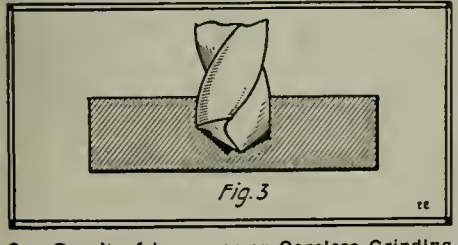


Fig. 3

One Result of Improper or Careless Grinding of a Twist Drill. The Hole Drilled with Such a Twist Drill Tends to be Ragged, Elliptical, and in Fact Most Any Shape But Round.

The drill speed is another important factor when considering the successful operation of twist drills. This appertains to the surface or peripheral speed of the drill in feet per minute, and is rated at the outer diameter. Under average conditions, the

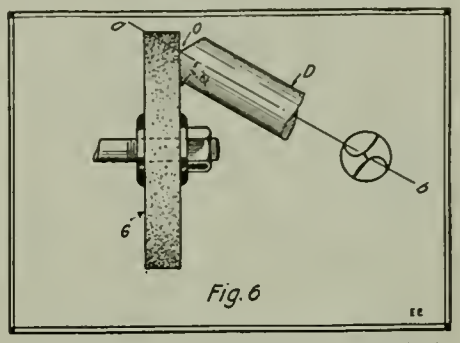


Fig. 6

In Grinding or Sharpening Twist Drills by Hand, Care Should Be Exercised to Keep the Drill Axis At An Angle of 60 Degrees with the Grinding Plane.

peripheral speed recommended for carbon steel drills is thirty to forty feet, and for high-speed drills, seventy to one hundred feet. Working conditions may at times cause a change in these figures. When the extreme outer corners of the cutting edges wear rapidly, it is evidence of too high a surface speed.

In order to grind a drill by hand, it is necessary that the axis of the drill be within 60 degrees of the grinding plane. This can be more clearly understood by referring to Fig. 6, where G is the grinding plane or grindstone, and a-b is the axis of the drill, D, to be ground. The cutting side of the drill should be kept at the required angle, $\Phi = 60$ degrees, with the grindstone surface. If now a revolving movement is made around the axis of its length toward the drill, a straight circular cone will be ground by the grinding wheel at the top, the axis of which coincides with D. If the drill is so ground that the following will be true, the drill will then perform its proper function, namely; that all the cutting lips have the same inclination to the axis of the drill; secondly, that the cutting lips be of exactly equal length; thirdly, a proper lip clearance of the surface back of the cutting edge; fourth, a proper angle of lip clearance.

In order to maintain high cutting speeds, it is necessary to use a lubricant. Those recommended below have stood the test of service.

For hard and refractory steel: Turpentine, kerosene or soda water.

Soft steel and wrought iron drilling: Lard oil or soda water.

Brass cutting: Paraffin oil.

For aluminum: Turpentine, kerosene or soda water.

Cast-iron work: Usually worked dry.

(*Continued on page* 163)

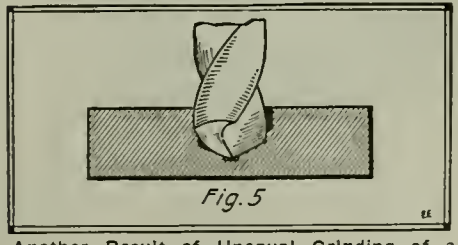


Fig. 5

Another Result of Unequal Grinding of a Twist Drill—and a Very Common Fault Too. The Lips Are of Unequal Lengths.

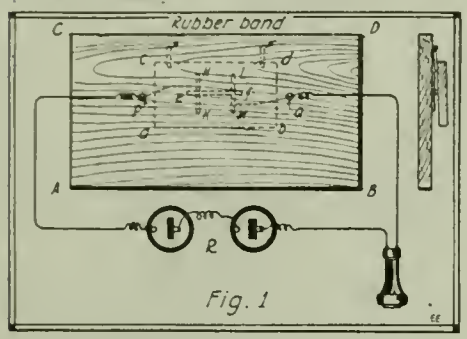
HOW-TO-MAKE-IT

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

TELEPHONE TRANSMITTER SENSITIVE AS A DICTAPHONE

A very simple, but wonderfully sensitive telephone transmitter for experimental purposes can easily be made. As shown in the

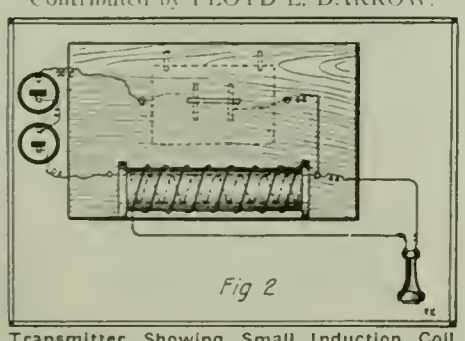


Here, ABCD = Piece of Soft Wood 5 x 3 x ¼ Inches Resting on Wooden Base. abcd = Wooden "Mouthpiece" Hanging on Back of Larger Piece and Carrying a Short Carbon Rod. ef. HK and LM = Carbon Rods Attached to the Larger Piece of Wood. Wires Lead from HK and LM Thru the Posts p and q and Two Dry Cells at R to the Standard 75 Ohm Telephone Receiver.

diagram Fig. 1, it consists of a small piece of thin board mounted on a wooden base and having two vertical carbons about 3/16 of an inch in diameter, attached by claw tacks to the back. Hanging over them is a small, thin piece of light, soft wood carrying a transverse carbon, which lightly touches the vertical ones. This constitutes the "mouthpiece." To the vertical carbons wires are attached which run through the board and connect with two dry cells and a telephone receiver. The transverse carbon resting against the vertical carbons makes a bad contact in the circuit, and the sound vibrations striking upon the *mouthpiece* produce an alternate increase and decrease in pressure, which varies the electrical resistance and current in the circuit.

To secure greater sensitiveness a small induction coil may be mounted on the front, as shown in the second diagram, Fig. 2. A few turns of No. 22 copper wire are used on the primary, and a large number of turns of No. 36 wire on the secondary. With the induction coil inserted the human voice in ordinary conversation, six feet from the transmitter, is easily heard thru the receiver, which may be placed at any distance.

Contributed by FLOYD L. DARROW.



Transmitter Showing Small Induction Coil Mounted on the Front of the Board. The "Mouthpiece" Is In Series with the Primary Winding.

SECOND PRIZE, $2.00

CONTROLLING DISTANT LIGHT WITH A MAGNET.

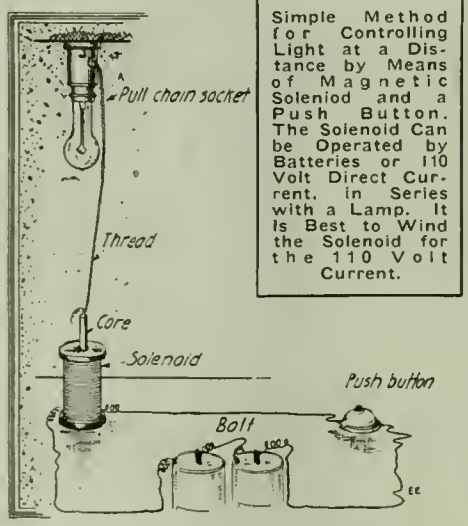
It is often convenient to have a light at the head of the stairs so connected that it may be turned on at the bottom as you go up, and turned off when you reach the top, or vice versa. But it is not always practicable or desirable to have the old wiring taken out and new installed, for this purpose. The same results can be obtained by the use of the scheme herein shown.

A common pull chain socket is used with a thread attached to the end of the chain and to the top of the solenoid core, or the chain may be fastened direct to the core for that matter. The rest of the drawing requires no explanation.

One push can be at the top of the stairs and one at the bottom, and as many others at different places as the experimenter desires. One push of the button turns the light on and another turns it off.

Contributed by

SCOTT EUGENE VANCE.



Simple Method for Controlling Light at a Distance by Means of Magnetic Soleniod and a Push Button. The Solenoid Can be Operated by Batteries or 110 Volt Direct Current, in Series with a Lamp. It Is Best to Wind the Solenoid for the 110 Volt Current.

MAGNETIZED SCREW-DRIVER A HANDY DEVICE.

I magnetized a screw-driver by holding it close to a dynamo for a few minutes, nearly two years ago, and it is still my most valued helper when it is necessary for me to do repair work on my car. It is a great help when working around the car to have this magnetized screw-driver to pick up screws and small pieces of the machinery which drop down inside, out of my reach.

In setting screws it is invaluable; simply pick up the screw by touching the head with the magnetized screw-driver, and it may be instantly set in place with only one hand. It does away entirely with the annoyance of the screw slipping away and getting lost, as it so often does. I always carry it in the tool box, and find the other fellow appreciates it when I find him having car-troubles on some lonely bit of road.

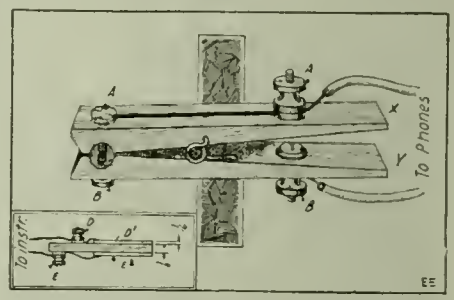
Contributed by ETHEL WEBB

THIRD PRIZE, $1.00

A QUICKLY CONSTRUCTED "PHONE CONNECTOR."

An efficient and handy "Phone Connector" can be made in a few minutes, as follows:

Obtain a spring clothes-pin; bore a hole



A Handy, Simple and Efficient 'Phone Connecting Clip. The Clip Is Clamped, on a Strip of Fiber, Lined on Either Side with Brass Strips as Shown.

thru head where line usually goes, put a battery binding post thru each hole, so that the nut will be on the outside. Then bore two other holes one inch from the opposite end and put two more posts in. Connect the two posts on each side A to A and B to B as indicated.

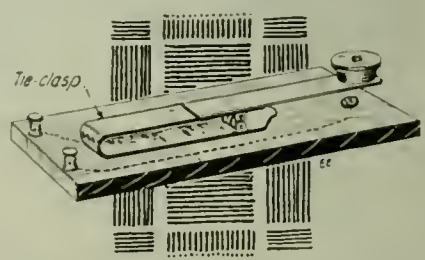
Next obtain a piece of wood 2" x ⅜" x the width of the clothes-pin; attach two strips of copper ¾" x 1/16" x ⅜" to each side. Mount two binding posts on the opposite side as D and E, then solder wire (or connect in some way) the binding posts E to plate E' and D to D'. Connect D and E with the instruments and A and B with the 'phones, and pressing X and Y together, place on stationary contact blocks so as to make connection in the manner apparent.

Contributed by JOHN W. HOPKINS.

A TIE-CLASP TELEGRAPH KEY.

The telegraph key here shown costs one-tenth as much as one purchased in any store, and is smaller, neater, and just as efficient. It consists of a tie-clasp having a strip of brass, with a hard rubber knob soldered or riveted to it. The whole is then mounted on a base 3½ x 2 inches, with binding posts taken from old batteries. The illustration herewith explains fully.

Contributed by HARRY E. FUCHS.

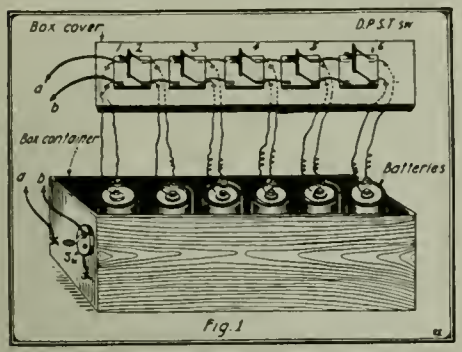


A Masterpiece! Cheap Telegraph Signaling Key Made from Tie Clasp Mounted on Wooden Base. A Brass Screw Serves as the Contact Under the Key Lever.

Connecting Up Dry Cells

By Frederick Von Lichtenow

NEARLY every experimenter who employs Dry Cells or other batteries as the main source of his current supply, keeps these cells, generally speaking, all neatly connected up—often in a dustproof container



A Neat and Effective Battery-Control Switch-Board for Connecting into Circuit Any Number of Cells, from One to Six, on Parallel.

at that—always ready for the biggest job in his laboratory, for instance his "Spark-Coil" or "Tesla Set."

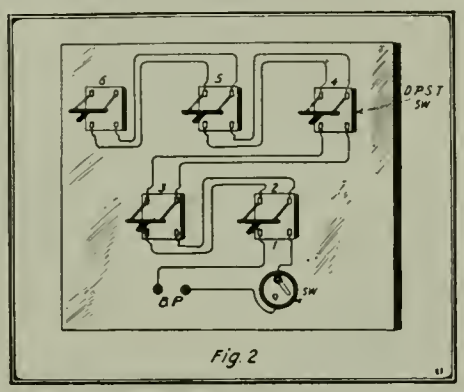
Whenever lesser pieces of apparata, such as a small motor, an electro-magnet, a buzzer, etc., etc., are to be worked, requiring only one or two dry cells, as the case may be, then these cells have to be separated from the rest of the "family", only to be put back and connected up again when the experiment is finished.

This constant disconnecting and connecting is nothing less than a genuine nuisance and does not tend to improve the condition of the connecting links, whatever they are.

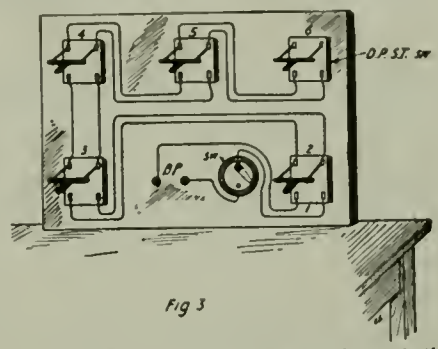
There appear now and then in the technical periodicals schemes, embodying some form of a rotary multi-point switch which are intended to remedy this trouble. To a large extent they are successful in this, but everyone of those, which have come under my observation, was suffering from two other faults, which are nearly as bad as the one above cited: First, the cells were connected up in such a manner that, with only one cell switched-in, this cell was already using energy from the next following one; and this in repetition thru the whole row. Second, as a consequence of the first fault it is impossible to properly test each cell individually without going thru the disconnecting stunt again.

The scheme treated in this article has none of these drawbacks and is the cheapest and simplest one could think of; nothing, so to speak, has to be constructed and the few necessary finished parts are obtainable anywhere at a very slight expense.

As will be seen from the illustrations, this idea of connecting cells lends itself very well to both battery-box and switch-board, whichever one prefers. The cells are arranged as if intended to be connected up in "parallel", which is clearly shown in Fig. 1. Six cells require five (small sizes) D.P.S.T.-Switches, (of which switch No. 1 serves two dry cells) with an additional circuit switch on the one side of the container. There are two binding posts brought out on the same side—one directly connected, the other to the circuit switch, as is self-evident—for the connection of apparatus.



Another Style of Battery Switchboard for Connecting up Any Desired Number of Cells on Parallel.



In this Design of Battery Switchboard the Leads from the Cells Are Brought Into the Switches from the back of the Panel.

The diagrams in Figs. 2 and 3 suggest two different ways of connecting the switches, etc., upon boards, with the battery wires running in from the back (not shown in sketches) and connected to their proper places, which are marked by figures, each representing one cell.

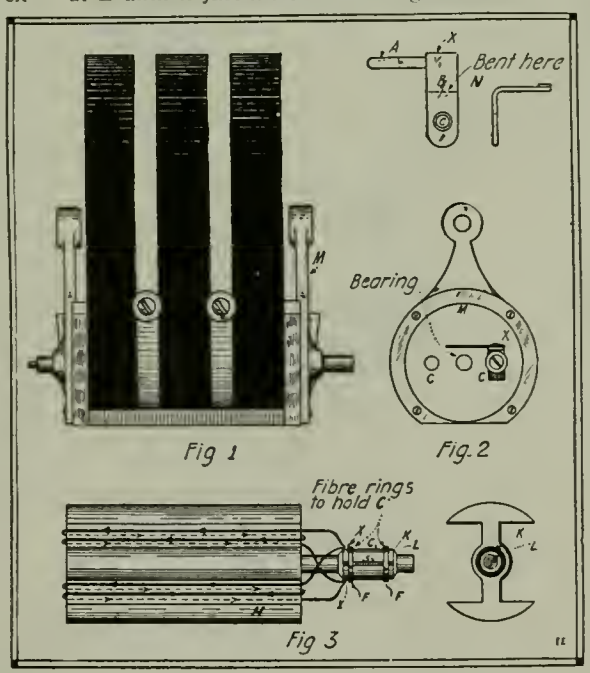
No doubt, there are several ways of eliminating those many switches without disturbing the above arrangement in the least, such as by using taps, switch-points, contact bushings in conjunction with sliding blades or rods, respectively, and other necessary parts, but these have in most cases, to be ordered, if obtainable at all, or made to order in some shop, which involves loss of time and often a respectable amount of money.

The scheme, as it is illustrated and described here, will, after all, be found to be the quickest, simplest and least expensive way of "getting there."

D. C. Dynamo from Magneto

Here is a dynamo-motor that any experimenter can make at practically no cost except a little patience and work. All the material can be purchased for a small sum. The material required are a telephone magneto and two telephone transformer coils, or about ¼ lb. No. 22 magnet wire. Also some pieces of brass, a brass tube, and some fiber and mica. Now, with all the material at hand, remove the two gear wheels on the magneto and take off the contact parts on the other end. The magneto now appears as in Fig. 1. Then take one end plate M off and drill a ¼-inch hole each side of the bearing at cc, midway between the bearing and edge of plate. Next cut two pieces of brass or copper of shape shown at N, Fig. 2. They measure about 1¼ inch. Drill a ¼-inch hole at c in each and solder a piece of spring brass A to the other end at X. Then bend into a right angle at B. These are the brushes, and they fasten to M thru cc with two battery binding posts, which are carefully insulated from the plate M.

Remove the armature of the magneto and cut away the fine wire wound thereon. Next take off about ten of the segments or laminations H, to make room for the commutator. The commutator C is made from a piece of brass tubing ½ inch long, which is slightly larger than the shaft. Now cut the tube in two halves lengthwise, being careful not to bend it. Take a piece of mica and wrap it around the shaft at L until it just fits the brass segments K.



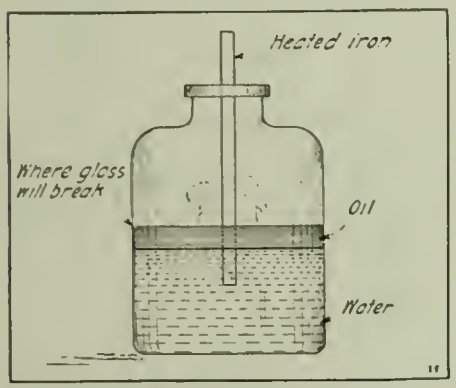
Every Telephone Magneto Can Be Made Over, with Slight Changes, into a First-Rate "Direct-Current" Dynamo. Fine for Auto or Boat Lighting and Experimental Work.

Shellac the mica to the shaft, and then shellac the segments over the mica, taking care to leave a slot S between the segments on both sides. Two short pieces of fiber tubing (rings) F, F, are then slipped tightly over C. A tight fit is necessary. These rings hold the brass pieces C securely. A word of caution here: *Place the slot S just past center as shown.* Then tie securely and put away to dry. When dry wind the armature as tightly as possible with the magnet wire in the manner indicated by arrows. Wind an equal number of turns on each side of the shaft and solder the ends to the segments of the commutator at xx. The diagram shows plainly these operations. When completed, give the windings two coats of shellac and let dry. After it is thoroly dry, place a fiber washer on each end of the shaft and assemble as originally found. Place a small pulley on the end of the shaft that protrudes and all is complete. If directions have been closely followed a nice little machine will result. *It will run either as a dynamo or motor.* As a dynamo I was able to light 4 to 5 small tungsten lamps. On 4 to 6 volts it develops remarkable power. When running as a motor it works better with one of the magnets removed, as this lessens the strength of field so that the armature revolves more freely.

Contributed by W. E. LEACH.

HOW TO CUT LARGE BOTTLES.

I herewith submit a novel way to cut large glass bottles so as to make jars. Procure a large bottle. If the top is not level or tapers it can be cut by the following means: Pour water into bottle within 1 inch of line where you want to cut. Then slowly pour linseed oil in up to the level of proposed cut. Then a red-hot iron



A Simple Way to Cut Off Large Glass Bottles, by Plunging a Red-Hot Iron Into an Oil and Water Solution Filling the Bottle Up to the Line Where the Cut Is to Be Made.

plunged vertically into the oil will cause the glass to crack at the level of the liquid and leave an open top jar.

Contributed by GERRAL EHINGER.

USEFUL LABORATORY INFORMATION.

Rain water may be used as distilled water, provided it is clean.

Baking soda is sodium bicarbonate.

Vinegar contains dilute acetic acid.

Common table salt is sodium chlorid.

Rust from a nail or other iron is ferric oxid.

Tea contains tannic acid.

Blackboard chalk is calcium carbonat.

Epsom salts is magnesium sulfate.

Sugar of lead is lead acetat.

Aqua fortis is nitric acid.

Aqua-regia is a mixture of nitric and hydrochloric acids.

Sal ammoniac is ammonium chlorid.

Sal soda is sodium carbonat.

"Hypo" is sodium thiosulfate.

Denatured alcohol is principally a mixture of wood and grain alcohol.

A porcelain mortar or pestal makes an excellent whet-stone.

Aqua ammonia is ammonium hydroxid.

"Lye" or caustic soda is sodium hydroxid.

Quicklime is calcium oxid; slacked lime is calcium hydroxid.

German silver contains no silver.

Freshly prepared ferric hydroxid is an antidote for arsenic poisoning.

The glue on postage stamps is dextrin.

Quartz is silicon dioxid.

The ruby, saffire and others gems are composed mainly of aluminum oxid.

Borax is sodium borat.

Salt-petre is potassium nitrat.

Copperas is ferrous (iron) sulfate.

Blue-stone is copper sulfate.

Hydrochloric acid and ammonium hydroxid are solutions of a gas in water.

Oxygen is made by heating potassium chlorat with manganese dioxid.

Carbon dioxid is prepared by treating marble chips with strong acid.

Hydrogen is prepared by treating zinc with strong acid.

Chlorin is easily prepared by heating a mixture of hydrochloric acid and manganese dioxid.

Sulfur dioxid is made by burning sulfur in air.

Nitrogen may be prepared by heating ammonium nitrit.

Pure silver may be prepared by treating silver nitrat with copper.

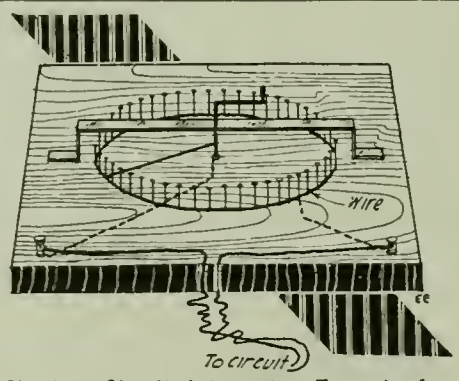
The silver is deposited as a gray powder, and may be collected by fusing into a solid.

Contributed by

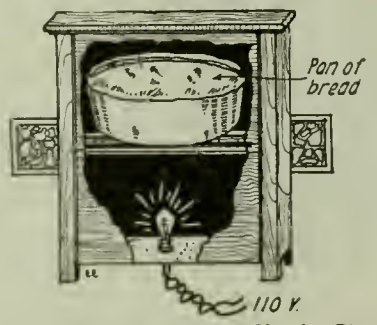
ARTHUR SILVERBERG.

SIMPLE CIRCUIT INTERRUPTER.

Small nails are driven in a board one-half an inch apart and connected together by wire. A crank pivoted in the center has a spring brass strip soldered to it. On turning the crank fast or slow, the circuit is interrupted.



Simplest Circuit Interrupter Formed of a Ring of Nails, Against Which a Brass Spring Mounted on a Crank Is Turned.



An Electric Bread Raiser—Simply Place a 32 C. P. Incandescent Lamp Under the Pan of Bread and Watch the Results.

ELECTRIC BREAD RAISER:—A box of suitable size is fitted with an air tight cover and a 32 candle-power carbon lamp screwed in the bottom of the box. The shelf that the bread rests on is made of slats, spaced about two inches apart. This is done to allow the heat to radiate freely in the box, when the bread is placed in it. The method has worked out well.

Contributed by RICHARD ANDRESS.

EXPLOSIVE GAS APPARATUS.

Having occasion to make hydrogen gas to explode in a gas cannon, I thought of the following idea: I secured an old show-case bulb and broke the tip off. After removing the filament (B), I fused a piece of glass tubing on the bulb, as shown at (A). Then I filled the bulb half full of a

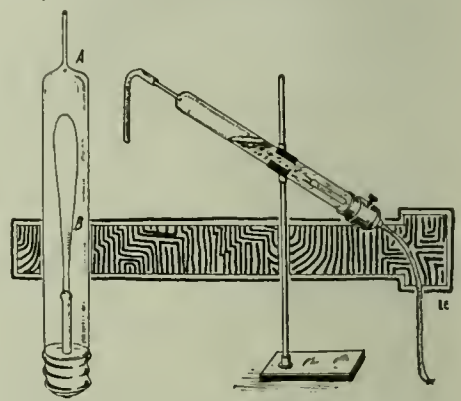


Fig. 1 Fig. 2

Explosive Gas Experimental Apparatus Constructed of Show-case Lamp with Tube Fused on Tip End.

sulfuric acid solution, screwed it in a socket, and clamped the whole on the stand, as in Fig. 2. By running a piece of rubber tubing from the tube to the cannon, I was able to get a good explosion. Care must be taken not to disturb the platinum terminals.

Contributed by

N. KENNETH MEHAFFIE.

SILVER PLATING WITHOUT A BATTERY.

Dissolve about an ounce of silver in two ounces of nitric acid. After the silver is all dissolved throw into it a pint of water and four ounces of common salt. The salt will precipitate a powder which is pure silver. Filter off the water, or if there is no filter paper handy, pour off the water and repeat until all the effects of the salt have disappeared. To this white powder add two ounces of cyanide of potassium* and three ounces of hyposulphate of soda. Now add to all this two quarts of pure rain water and the silver mixture is complete.

The plating is done in the following manner. Hang the article to be plated in the solution at the end of a strip of lead or if more convenient, immerse the article in the solution and boil it for ten or twenty minutes, according to the thickness of the silvering desired. To obtain best results the articles to be plated must be free from grease and oil or dirt.

* This chemical is a deadly poison and must be handled with the most care.

Contributed by DAVID GOODMAN.

IMITATION GOLD.

Take 16 parts of platina, 7 parts copper, 1 part zinc, put in covered crucible, with powdered charcoal and melt together till the whole forms one mass and all are thoroly incorporated. Or take 4 oz. platina, 3 oz. silver and 1 oz. copper.

Contributed by

NORMAN LIVINGSTON.

The RADIO LEAGUE of AMERICA

HONORARY MEMBERS
CAPT. W.H.G. BULLARD, U.S.N. NIKOLA TESLA.
PROF. REGINALD FESSENDEN. DR. LEE DE FOREST.

Manager, H Gernsback

Amateur Radio Restored

By H. GERNSBACK

WINNING one war seems like a great accomplishment, but winning two wars, one after the other, is a historic occurrence for which we have few counterparts.

When on Nov. 11 the glad news came that the great war had been won, the world once more breathed freely, and so did the American Radio Amateur, who had done his "bit" in bringing the war to a successful termination. But hardly was the armistice signed than the spectre of a new war—to the amateur—crept up over the horizon threatening to take away from him the freedom for which we had fought.

A nation may be oppressed by a relentless foe if conquered, or it may be oppressed in a similar manner by unjust laws which curtail the freedom of its people. Indeed, when it was proposed last winter to take away from the American Radio Amateur the freedom of the ether, which would have deprived the liberties of over 300,000 young men in this country, war was declared once more. This war was to the knife; it was as short as it was decisive. But Right as usual won over Might, and the American Radio Amateur won *his* war, as the Allies won theirs.

And, as the Allies will win the fruits of their victory in the months to come, so will the amateurs reap the fruit of their victory. Indeed, the reaping has already begun. On April 15th the ban on Radio, at least for *receiving*, was officially taken off, and a mighty shout went up when Radio Amateurs were again permitted to use the ether to their hearts' content. Altho the ban for *sending* has not been removed at this time of writing, the chances are that before the next issue is in your hands the freedom of the ether will be once more restored completely.

As soon as the newspapers published the welcome tidings on April 15th that the ban on receiving was off, hundreds of thousands of amateurs began dusting off their sets and aërials blossomed forth over night by the thousands to resume their former activities once more.

And wonders upon wonders! When we put our sets away two years ago we were accustomed to hear nothing but the crisp dots and dashes in flute-like, staccato sounds coming from the high power stations which we all had learned to love. But the war has changed everything—even radio, for now the *radio telephone* has come into its own.

Where formerly there was nothing but the *tah-de-dah* in our phones, the ether is now filled with the human voice flung far and broad over the land—nay, over the oceans—and as the months roll by the dots and dashes will grow less and less, and the human voice will come in over our aërials more and more, which is as it should be.

The writer has always contended that wireless telephony was the logical outcome of radio, and in years to come only the commercial high power stations will operate their dots and dashes with their high speed machines where the voice would not be as reliable. But the future of Radio Amateurism in this country is centered upon the radio telephone. While no doubt many of us will still cling to the dots and dashes, the radio telephone will probably soon be used in overwhelming numbers.

What a wonderful world it will be in one or two years hence! You will step out into the star-lit night and myriads of voices—noiselessly and invisibly—will fill the air all over the continent, flung thru the ether. You will hear nothing and you will see nothing. When you sit on the seashore gazing fascinated at the beauty of the tides, as they follow the moon, all the while the invisible and soundless voices will be all around you—nay, even pass thru your very body. But when you step in the humble little amateur radio station and clasp a pair of receivers onto your ears, the ether will be unlocked and all of these myriads of voices will be made audible to your ears. A perfect Babel of voices will greet you, but by means of your tuning devices you will be able to pick out the very voice you wish to listen to, tuning out all the others.

It is a glorious thought that we are fortunate enough to live in an age where such things are possible, and we must prove worthy of our new-gained liberty, now certain.

And the writer regrets to say that before the war we did not realize how fortunate we were, and we did not show by our actions that we appreciated the freedom of the ether.

There was constant bickering and quarreling on the side of the amateur, among themselves as well as with commercial and government stations. Profane talk took place not infrequently thru the ether, and many of us annoyed the commercial as well as the government operators by "hogging" the ether. Hence, it was not surprising that the government tried to pass laws to curb the amateurs and curtail their liberties.

If Radio Amateurism is to prevail in the new era, the amateurs must stop their former nonsense and must settle down strictly to business. They can and should receive all they want to their hearts' content. They can and will listen very shortly to President Wilson's voice when he speaks to us from the "George Washington," where everybody is free to listen in. Amateurs can listen in to their hearts' delight, whether it be to wireless telephone or wireless telegraph. But when it comes to sending, we must mend our ways. If we do not, laws will be past sooner or later to curtail our entire liberties, and here the writer desires to make an important suggestion.

There are now a good many Radio Clubs and Associations all over the country. We cannot have too many. The suggestion is that every club and every association should appoint one or a number of expert amateurs to listen in nightly to messages that are violating the common rules, either by profane language, by "hogging" the ether, by Q. R. M. or by wilful interference. The offender should be sought out and promptly warned, and should he repeat his offense a second time, **he should be promptly reported to the Radio Inspector of the district, and the various publications catering to the amateurs should be notified.** A sworn statement relating the offense should be submitted to the publications, who will pledge themselves to publish the name of the offender.

The ELECTRICAL EXPERIMENTER, for one, will be glad to publish such names regularly, and it is believed that such measures will do more than anything else to increase the prestige of radio amateurism in the United States, and take it out of the school-boy class. There is little doubt that if we follow such procedures Radio Amateurism in the United States will become one of the great institutions of this country. We must show the world that we amateurs are serious-minded and do not use one of the greatest inventions for a

(*Continued on page* 174)

NAVY DEPARTMENT
Naval Communication Service
Office of the Director.
Washington, April 14, 1919.

Editor Electrical Experimenter
Sir:

The Acting Secretary of the Navy authorizes the announcement that effective April 15, 1919, all restrictions are removed on the use of radio receiving stations other than those used for the reception of commercial radio traffic. This applies to amateur stations, technical and experimental stations at schools and colleges, receiving stations maintained by jewelers or others desirous of receiving time signals, receiving stations maintained by manufacturers of radio apparatus, etc.

The restrictions on transmitting stations of all types are still in effect, as are the restrictions on stations operated regularly for the reception of commercial radio traffic. Both of the above classes of stations will be permitted to resume operation as soon as the President proclaims that a state of peace exists.

Attention is invited to the fact that all licenses for transmitting stations have expired, and that it will be necessary, when peace is declared, for the owners of these stations to apply to the Department of Commerce for new licenses.

Very respectfully,

(Signed) E. B. Woodworth,
Commander, U. S. Navy, Assistant Director Naval Communications.

The Above Is the Text of the Official Notification Restoring the Freedom of the Ether Once More. The Ban on Sending Is as Yet not Lifted. When Peace Is Declared, While Technically the Ban for Sending Will be Off, It Should be Remembered That All Sending Licenses Have Been Cancelled During the War and New Licenses Must Be Secured from the Department of Commerce. Address the Office of the Radio Inspector at the Custom House of Your District for Further Particulars.

The Moon's Rotation

By NIKOLA TESLA

In this article Dr. Tesla proves conclusively by theory and experiment that all the kinetic energy of a rotating mass is purely translational and that the moon contains absolutely no rotational energy, in other words, does not rotate on its axis.—EDITOR.

IN revising my article on "The Moon's Rotation", which appeared in the April issue of the ELECTRICAL EXPERIMENTER, I appended a few remarks to the original text in further support and elucidation of the theory advanced. Due to the printer's error these were lost and, in consequence, I found it necessary to forward another communication which, unfortunately, was received too late for embodiment in the May number. Meanwhile many letters have reached me in which certain phenomena presented by rotating bodies, as the moon's librations of longitude, are cited as evidences of energy due to spinning motion, i. e., proofs of axial rotation of the satellite in the true physical sense. I trust that the following amplified statement will meet all of the objections raised and convert to my views those who are still unconvinced.

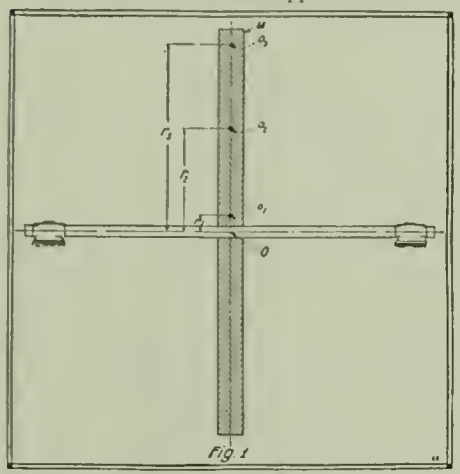


Fig. 1. In Determining the Kinetic Energy of a Rotating Mass, This Figure Shows the Selection of a Number of Points Taken Within the Straight Rod or Mass M, at Successive Distances from the Axis of Rotation O. Knowing These Values and the Speed of Rotation the Kinetic Energy of the Mass Is Readily Computed.

The kinetic energy of a rotating mass can be determined in four ways which are illustrated in diagrams, Figs. 1, 2, 3 and 4 and may be found more or less suitable.

Referring to Fig. 1, the method consists in selecting judiciously a number of points as o_1, o_2, o_3, etc., within the straight rod or mass M, respectively at distances r_1, r_2, r_3, etc., from the axis of rotation 0 and calculating the square root of the mean square of these distances. Its value being R_s, denoted radius of gyration, the *effective* velocity of the mass at n revolutions per second will be $V_e = 2\pi R_s n$ and its kinetic energy $E = \frac{1}{2} M V_e^2 = \frac{1}{2} M (2\pi R_s n)^2$.

In Fig. 2 the mass M, rotating n times per second about an axis 0 at right angles to the plane of the paper, is divided into numerous elements or small parts, most conveniently very thin concentric laminae, as l_1, l_2, l_3, etc., at distances r_1, r_2, r_3, etc., from 0. Since the kinetic energy of each part is equal to half the product of its mass and the square of the velocity, the sum of all these elemental energies $E = \frac{1}{2} \Sigma m V^2 = \frac{1}{2} m_1 V_1^2 + \frac{1}{2} m_2 V_2^2 + \frac{1}{2} m_3 V_3^2 + \ldots\ldots = \frac{1}{2} m_1 (2\pi r_1 n)^2 + \frac{1}{2} m_2 (2\pi r_2 n)^2 + \frac{1}{2} m_3 (2\pi r_3 n)^2 + \ldots\ldots$

A different form of expression for the energy of a rotating body may be obtained by determining its moment of inertia. For this purpose the mass M (in Fig. 3), rotating n times per second about an axis 0, is separated into minute parts, as m_1, m_2, m_3, etc., respectively at distances r_1, r_2, r_3, etc., from the same. The sum of the products of all these small masses and the squares of their distances is the moment of inertia I, and then $E = \frac{1}{2} I \omega^2$, $\omega = 2\pi n$ being the angular velocity.

It is obvious that in all these instances many points or elements will be required for great accuracy but, as a rule, very few are sufficient in practice.

Still another way to compute the kinetic energy is illustrated in Fig. 4, in which case the quantity I is given in terms of the moment of inertia I_c about another axis parallel to 0 and passing thru the center of gravity C of mass M. In conformity with this the energy of motion $E = \frac{1}{2} M V^2 + \frac{1}{2} I_c \omega^2$ in which equation V is the velocity of the center of gravity.

The preceding is deemed indispensable as I note that the correspondents, even those who seem thoroly familiar with mechanical principles, fail to make a distinction between theoretical and physical truths which is essential to my argument.

In estimating the kinetic energy of a rotating mass in any of the ways indicated we arrive, thru suitable conceptions and methods of approximation, at expressions which may be made quantitatively precise to any desired degree, but do not truly define the actual condition of the body. To illustrate, when proceeding according to the plan of Fig. 1, we find a certain hypothetical velocity with which the entire mass should move in order to contain the same energy, a state wholly imaginary and irreconcilable with the actual. Only, when *all* particles of the body have the same velocity, does the product $\frac{1}{2} M V^2$ specify a physical fact and is numerically and descriptively accurate. Still more remote from palpable truth is the equation of motion obtained in the manner indicated in Fig. 4, in which the first term represents the kinetic energy of translation of the body as a whole and the second that of its axial rotation. The former would demand a movement of the mass in a definite path and direction, all particles having the same velocity, the latter its simultaneous motion in another path and direction, the particles having different velocities. This abstract idea of angular motion is chiefly responsible for the illusion of the moon's axial rotation, which I shall endeavor to dispel by additional evidences.

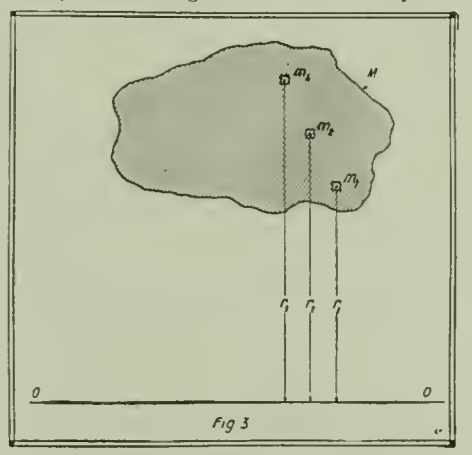


Fig. 3. Another Form of Expression for the Energy of a Rotating Body May Be Obtained by Determining Its Moment of Inertia. Here the Mass M Is Subdivided Into Minute Parts m_1, m_2, m_3, ... etc. The Sum of the Products of These Masses and the Squares of Their Distances Is the Moment of Inertia, Which with the Angular Speed, Gives the Kinetic Energy E.

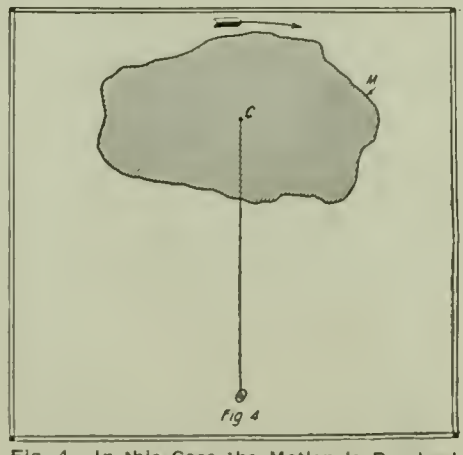


Fig. 4. In this Case the Motion Is Resolved Into Two Separate Components—One Translational About O and the Other Rotational About C. The Total Kinetic Energy of the Mass Equals the Sum of These Two Energies.

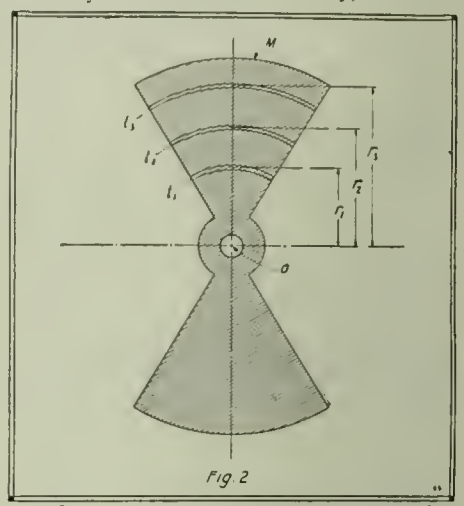


Fig. 2. In This Case the Mass M, Rotating n Times Per Second, About An Axis O, Is Divided Into Numerous Elements or Small Parts at Various Radii from O. Knowing the Kinetic Energy of Each Part, the Whole Kinetic Energy of the Mass Is Easily Determined by Taking a Summation of the Individual Quantities.

With this object attention is called to Fig. 5 showing a system composed of eight balls M, which are carried on spokes S, radiating from a hub H, rotatable around a central axis 0 in bearings supposed to be frictionless. It is an arrangement similar to that before illustrated with the exception that the balls, instead of forming parts of the spokes, are supported in screw pivots *s*, which are normally loose but can be tightened so as to permit both free turning and rigid fixing as may be desired. To facilitate observation the spokes are provided with radial marks and the lower sides of the balls are shaded. Assume, first, that the drawing depicts the state of rest, the balls being rotatable without friction, and let an angular velocity $\omega = 2\pi n$ be imparted to the system in the clockwise direction as indicated by the long solid arrow. Viewing a ball as M, its successive positions 1, 2, 3—8 in space, and also relatively to the spoke, will be just as drawn, and it is evident from an inspection of the diagram that while moving with the angular velocity ω about 0, in the clockwise direction, the ball turns, with respect to its axis, at the same angular velocity but in the opposition direction, that of the dotted arrow. The combined result of these two motions is a translatory movement of the ball such that all particles are animated with the same velocity V, which is that of its center of gravity. In this case, granted that there is absolutely no friction the

kinetic energy of each ball will be given by the product of ½ M V² not approximately, but with mathematical rigor. If now the pivots are screwed tight and the balls fixt rigidly to the spokes, this angular motion relatively to their axes becomes physically impossible and then it is found that the kinetic energy of each ball is increased, the increment being exactly the energy of rotation of the ball on its axis. This fact, which is borne out both by theory and experiment, is the foundation of the general notion that a gyrating body—in this instance ball M—presenting always the same face towards the center of motion, *actually* rotates upon its axis in the same sense, as indicated by the short full arrow. *But it does not tho to the eye it seems so.* The fallacy will become manifest on further inquiry.

To begin with, observe that when a mass, say the armature of an electric motor, rotating with the angular velocity ω, is reversed, its speed is $-\omega$ and the difference $\omega - (-\omega) = 2\omega$. Now, in fixing the ball to the spoke, the change of angular velocity is only ω; therefore, an additional velocity ω would have to be imparted to it in order to cause a clockwise rotation of the ball on its axis in the true significance of the word. The kinetic energy would then be equal to the sum of the energies of the translatory and axial motions, not merely in the abstract mathematical meaning, but as a physical fact. I am well aware that, according to the prevailing opinion, when the ball is free on the pivots it does not turn on its axis at all, and only rotates with the angular velocity of the frame when rigidly attached to the same, but the truth will appear upon a closer examination of this kind of movement.

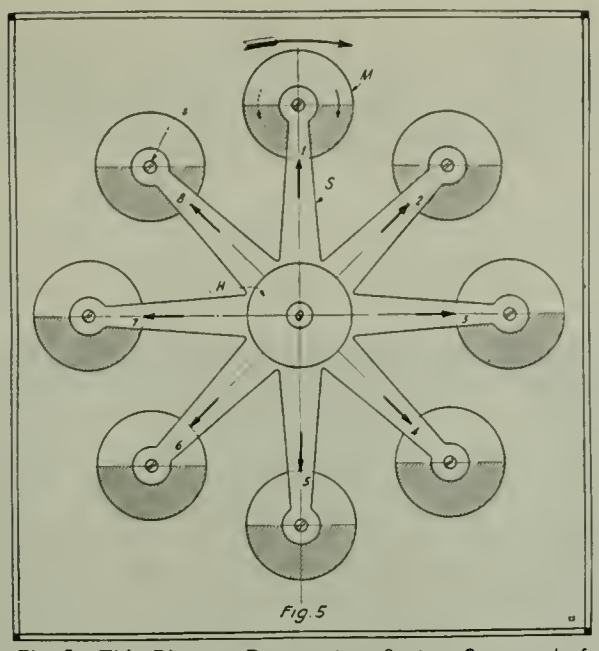


Fig. 5. This Diagram Represents a System Composed of 8 Balls M, Carried on Spokes S, and Rotating Around Center O. The Balls Are Freely Rotatable on Pivots Which Can Be Tightened. With This Model the Fallacy of the Moon's Rotation on Its Axis Is Demonstrable.

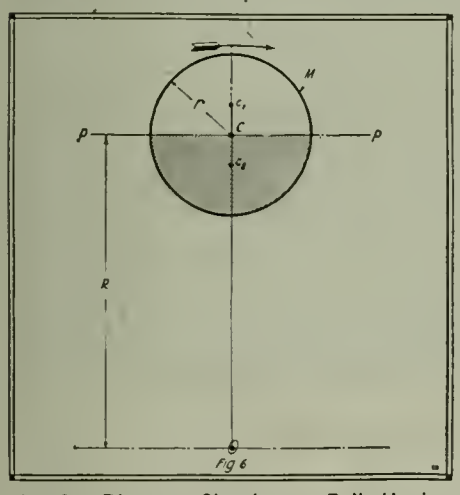


Fig. 6. Diagram Showing a Ball Having Mass M, of Radius r, Rotating About Center O, and Used in the Theoretical Analysis of the Moon's Motion.

Let the system be rotated as first assumed and illustrated, the balls being perfectly free on the pivots, and imagine the latter to be gradually tightened to cause friction slowly reducing and finally preventing the slip. At the outset all particles of each ball have been moving with the speed of its center of gravity, but as the bearing resistance asserts itself more and more the translatory velocity of the particles nearer to the axis 0 will be *diminishing*, while that of the diametrically opposite ones will be *increasing*, until the maxima of these changes are attained when the balls are firmly held. In this operation we have thus deprived those parts of the masses which are nearer to the center of motion, of some kinetic energy of *translation* while adding to the energy of those which are farther and, obviously, the gain was greater than the loss so that the *effective* velocity of each ball as a whole was increased. *Only so* have we augmented the kinetic energy of the system, not by causing *axial rotation* of the balls. The energy E of each of these is *solely* that of translatory movement with an effective velocity V_e as above defined such that $E = \frac{1}{2} M V_e^2$. The axial rotations of the ball in either direction are but apparent; *they have no reality whatever* and call for no mechanical effort. It is merely when an extraneous force acts independently to turn the whirling body on its axis that energy comes into play. Incidentally it should be pointed out that in true axial rotation of a rigid and homogenous mass all symmetrically situated particles contribute equally to the momentum which is not the case here. That there exists not even the slightest tendency to such motion can, however, be readily established.

For this purpose I would refer to Fig. 6 showing a ball M of radius *r*, the center C of which is at a distance R from axis 0 and which is bisected by a tangential plane *pp* as indicated, the lower half sphere being shaded for distinction. The kinetic energy of the ball when whirled *n* times per second about 0 is according to the first form of expression $E = \frac{1}{2} M V_e^2 = \frac{1}{2} M (2\pi R_g n)^2$, M being the mass and R_g the radius of gyration. But, as explained in connection with Fig. 4, we have also $E = \frac{1}{2} M V^2 + \frac{1}{2} I_c \omega^2, V = 2\pi R n$ being the velocity of the center of gravity C and I_c the moment of inertia of the ball, about the parallel axis passing thru C and equal to $\frac{2}{5} M i^2$ so that $E = \frac{1}{2} M (2\pi R n)^2 + \frac{1}{5} M r^2 (2\pi n)^2$. Neither of these two expressions for E describes the actual state of the body but the first is certainly preferable conveying, as it does, the idea of a single motion instead of two, one of which moreover is devoid of existence. I shall first undertake to demonstrate that there is no torque or rotary effort about center C and that the kinetic energy of the supposed axial rotation of the ball is mathematically equal to zero. This makes it necessary to consider the two halves separated by the tangential plane *pp* wholly independent from one another. Let c_1 and c_2 be their centers of gravity, then $Cc_1 = Cc_2 = \frac{3}{8} r$. In order to ascertain the kinetic energy of the hemispheres we have to find their radii of gyration which can be done by determining the moments of inertia Ic_1 and Ic_2 about parallel axes passing thru c_1 and c_2. Complex calculation will be avoided by remembering that the moment of inertia of either one of the half spheres about an axis thru C is $I_C = \frac{1}{2} \times \frac{2}{5} M r^2, = \frac{1}{5} M r^2$, and since $M = 2 m$, $I_C = \frac{2}{5} m r^2$. This can be exprest in terms of the moments Ic_1 and Ic_2; namely, $I_C = Ic_1 + m (\frac{3}{8} r)^2 = Ic_2 + m (\frac{3}{8} r)^2$. Hence $Ic_1 = Ic_2 = I_C - m (\frac{3}{8} r)^2 = \frac{2}{5} m r^2 - 9/64 m r^2 = 83/320 m r^2$. Following the same rule the moments of inertia of the half spheres about the axis passing thru the center of motion 0 can be found. Designating the moments for the upper and lower halves of the ball, respectively, I_{O1} and I_{O2} we have $I_{O1} = m (R + \frac{3}{8} r)^2 + Ic_1 = m (R + \frac{3}{8} r)^2 + 83/320 m r^2$ and $I_{O2} = m (R - \frac{3}{8} r)^2 + Ic_2 = m (R - \frac{3}{8} r)^2 + 83/320 m r^2$. Thus for the upper half sphere the radius of gyration $R_{g1} =$

$$\sqrt{\frac{I_{O1}}{m}} = \sqrt{(R + \tfrac{3}{8} r)^2 + 83/320\ r^2}$$

and for the lower one $R_{g2} =$

$$\sqrt{\frac{I_{O2}}{m}} = \sqrt{(R - \tfrac{3}{8} r)^2 + 83/320\ r^2}$$

These are the distances from center 0, at which the masses of the half spheres may be concentrated and then the algebraic sum of their energies—which are wholly translatory those of axial rotation being nil—will be exactly equal to the total kinetic energy of the ball as a unit. The

(*Continued on page* 156)

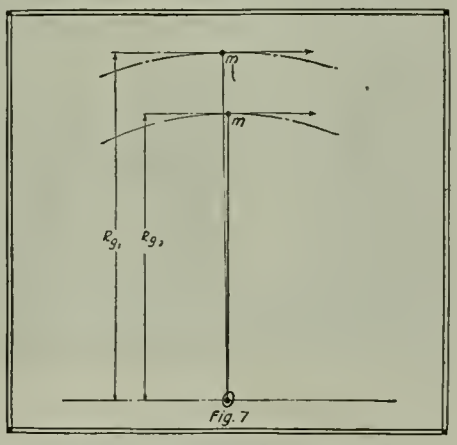


Fig. 7. Here Two Masses m-m, Are Considered as Condensed Into Points, Attached to Weightless Strings of Different Radii. If Both Strings Are Cut, and the Masses Considered as Joined, Then There Will Be No Rotation About the Common Center of Gravity.

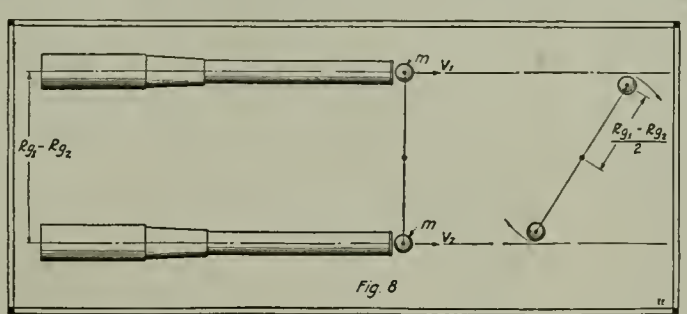
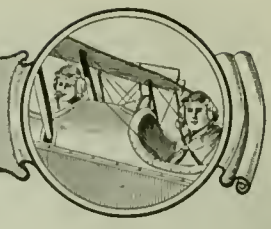
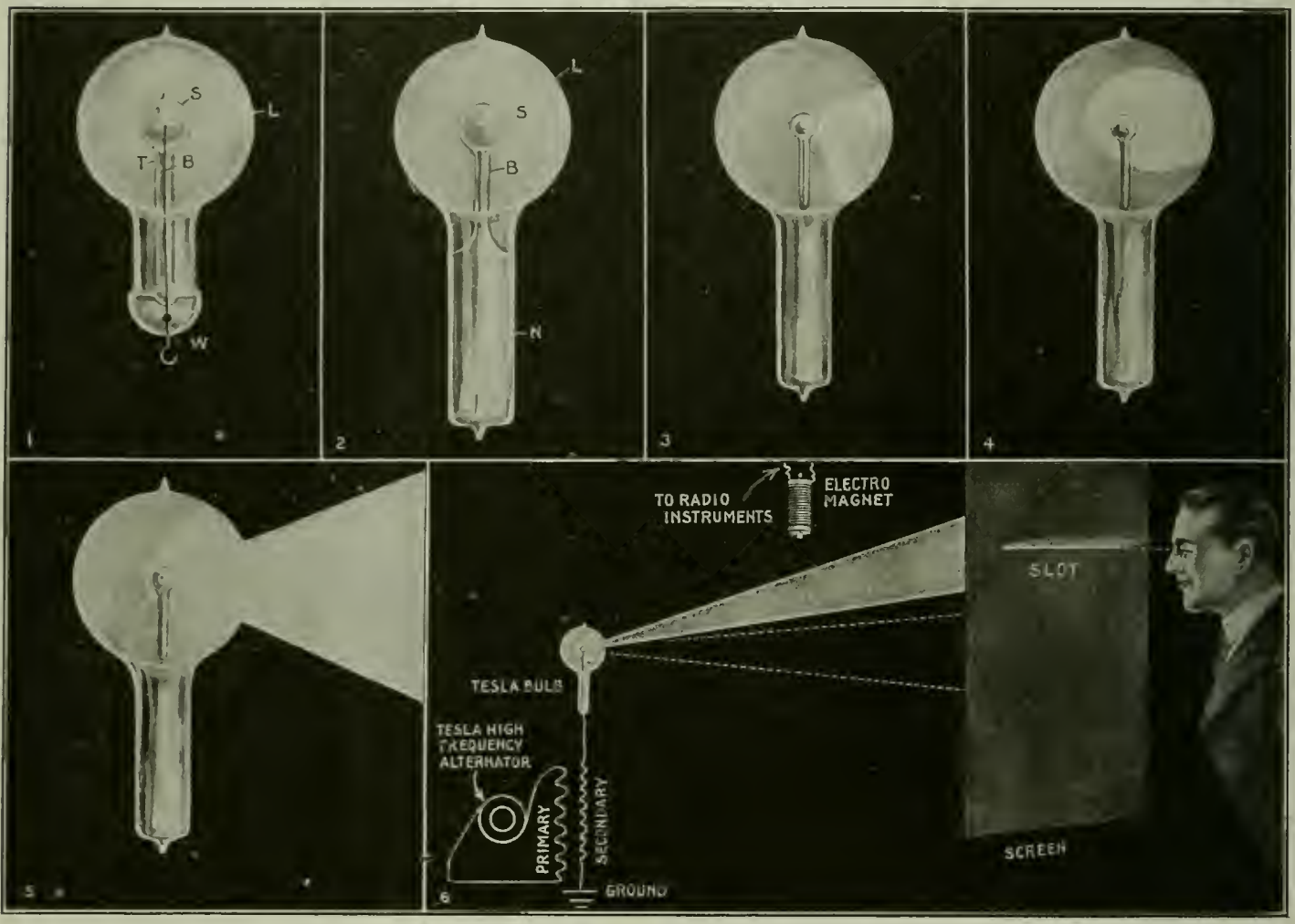


Fig. 8. To Make the Problem Shown in Fig. 7 Clear, Imagine Two Rifle Barrels Parallel to Each Other. If Two Balls M-M Are Fired Simultaneously, Joined by a Theoretical Bond, They Will Revolve About Their Common Center of Gravity, Proving That the Moon Possesses Only Kinetic Energy of Translation.

RADIO DEPARTMENT



Tesla Bulbs



Early In Nikola Tesla's Researches—In Fact as Far Back as 1892—He Discovered a Most Peculiar and Wonderful Vacuum Bulb Phenomena. The Effect was That, Under Certain Critical Conditions, This Bulb Would Cause a Ray to Be Shot off in the Manner Shown, Which Ray Would Revolve or Oscillate Under the Influence of a High-Frequency Current and in Synchrony with It. By Utilizing This Principle, Dr. Tesla Believes It is Possible to Produce a Radio Detector More Sensitive Than the Audion or Fleming Valve.

IN the May issue in his article, "True Wireless," Nikola Tesla mentions the forerunner of the Audion, a Vacuum Bulb, which he used in his earlier experiments.

We have been in receipt of numerous letters from many individuals interested in this bulb who desire further particulars as to its operation, etc.

Accordingly, we publish herewith some excerpts from a lecture by Dr. Tesla delivered before the Institution of Electrical Engineers and Royal Institution, London, February, 1892.

"I think it best at this juncture to bring before you a phenomenon, observed by me some time ago, which to the purely scientific investigator may perhaps appear more interesting than any of the results which I have the privilege to present to you this evening.

"It may be quite properly ranked among the brush phenomena—in fact, it is a brush, formed at, or near, a single terminal in high vacuum.

"In bulbs provided with a conducting terminal, tho it be of aluminum, the brush has but an ephemeral existence, and cannot, unfortunately, be indefinitely preserved in its most sensitive state, even in a bulb devoid of any conducting electrode. In studying the phenomenon, by all means a bulb having no leading-in wire should be used. I have found it best to use bulbs constructed as indicated in Figs. 1 and 2.

"In Fig. 1 the bulb comprises an incandescent lamp globe L, in the neck of which is sealed a barometer tube b, the end of which is blown out to form a small sphere *s*. This sphere should be sealed as closely as possible in the center of the large globe. Before sealing, a thin tube *t*, of aluminum sheet, may be slipt in the barometer tube, but it is not important to employ it.

"The small hollow sphere *s* is filled with some conducting powder, and a wire *w* is cemented in the neck for the purpose of connecting the conducting powder with the generator.

"The construction shown in Fig. 2 was chosen in order to remove from the brush any conducting body which might possibly affect it. The bulb consists in this case of a lamp globe L, which has a neck *n*, provided with a tube *b* and small sphere *s*, sealed to it, so that two entirely independent compartments are formed, as indicated in the drawing. When the bulb is in use the neck *n* is provided with a tinfoil coating, which is connected to the generator and acts inductively upon the moderately rarefied and highly conducting gas inclosed in the neck. From there the current passes thru the tube *b* into the small sphere *s*, to act by induction upon the gas contained in the globe L.

"It is of advantage to make the tube *t* very thick, the hole thru it very small, and to blow the sphere *s* very thin. It is of the greatest importance that the sphere *s* be placed in the center of the globe L.

"Figs. 3, 4, 5, indicate different forms, or stages, of the brush. Fig. 1 shows the brush as it first appears in a bulb provided with a conducting terminal; but, as in such a bulb it very soon disappears—often after a few minutes—I will confine myself to the de-

(*Continued on page* 179)

Alexanderson's "Barrage" Receiver

The Highly Perfected Tuning Device That Riddled the German "Radio Barrage"

E F. W. ALEXANDERSON, consulting engineer and radio expert, related before a large gathering of leading American radio experts, at the April meeting of the Institute of Radio Engineers held in New York City, how Yankee ingenuity overcame German efficiency in the battle to control the air by wireless during the war. As in the fighting on land and sea, the Americans won!

The Germans installed powerful wireless apparatus at strategic points, and blocked communication with a barrage of meaningless messages that interfered with the sending and receiving of important messages. Something had to be done, and when the American Navy unfurled its battle flag in foreign seas it overcame the German interference with the wireless, and so made a remarkable stride in the science of aërial communication.

Mr. Alexanderson was one of the engineers who perfected the barrage receiver, as the device is termed. This invention permits an operator to tune out the powerful messages sent from points near at hand, and pick out of the clashing of radio waves the message sent from greater distances. In a word, he can isolate all messages except the one he desires to hear.

The problem of combating the barrages of senseless messages became serious as the war wore along. It was rather disconcerting to an Allied operator receiving an important message to have something like this break in on him—"Don't eat apple pie on Thursday. Yours till the watch on the Rhine stops. Gott mit Uns," yet it was just such messages that literally flooded the air when the wireless of the Allies was working.

Mr. Alexanderson explained two new devices at this lecture—the first, the "bridge receiver," which permits the speaker in a radiotelephone communication to break in on the second party at any time, and the wonderfully clever radio "barrage receptor."

Alexanderson Radio Receiver—"Barrage" Section.

The first invention, the "bridge receptor," gives to wireless telephony the same efficiency as the ordinary telephone. It enables the user to interrupt the person he is talking with without manipulating any apparatus. It will make it possible in the early future for a subscriber to converse with another subscriber in Europe while using the ordinary telephone installed in his home. He also will be able to speak to friends on ships in midocean.

The object of this development was briefly to provide means for neutralizing the overwhelming intensity of the transmitted signal so as to make the receiving set sensitive to the faint impulses of the distant signal. Popularly speaking, the corresponding equivalent in sound waves would be to have an ear which could be so adjusted that a person could stand close to a steam whistle without hearing the whistle, but listen to a person speaking from a distance of a few hundred feet (about a hundred meters). A successful solution of this problem was found as described. This method of reception which is characterized by a static bridge neutralization may be properly classified as the "bridge receiver."

The Barrage Receiver.

During the war the same problem presented itself again in a form which called for a new solution. Distances are only relative, and a steam whistle located in Germany might make such a noise that it would completely drown out both in England and France the sound of the voice calling from America. To find a way to counteract such a continuance was seriously considered by the Inter-Allied conference in February, 1918; and appeals for a solution were conveyed to the author by the French representative in this country, Lieut. Paternot. The solution to this problem, which was adopted by the American as well as the French government after the first demonstration, has become known as the "barrage receiver." This name appears appropriate because the word "barrage" has not only the military mean-

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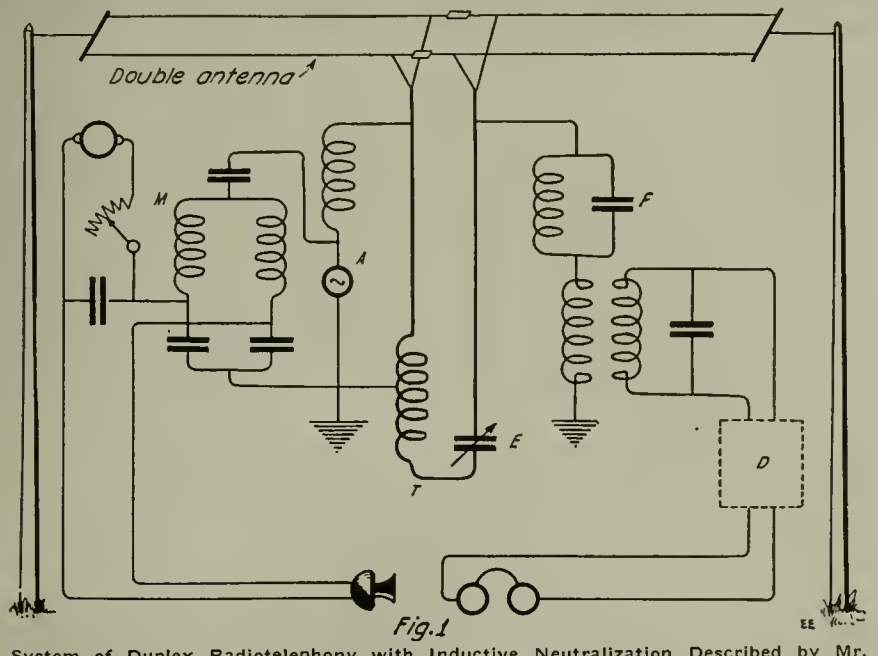


Fig. 1

System of Duplex Radiotelephony with Inductive Neutralization Described by Mr. Alexanderson Before the Institute of Radio Engineers. M—Magnetic Amplifier; A—Alternator; T—Neutralization Transformer; E—Exposure Condenser; F—Frequency Trap; D—Detector.

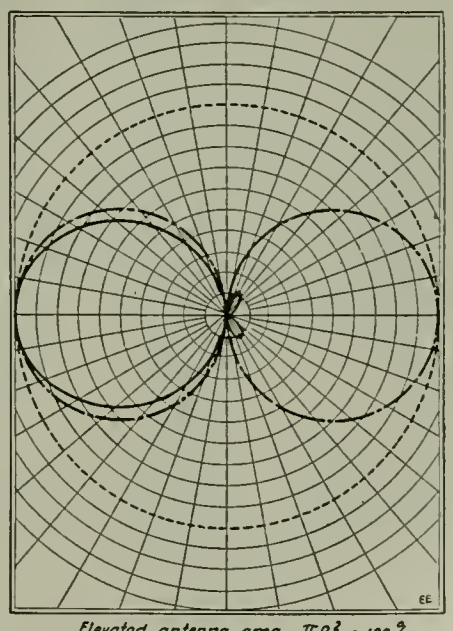


Fig. 3. Relative Directive Reception with Different Types of Receiving Systems.

The Rogers Underground Aërial for Amateurs

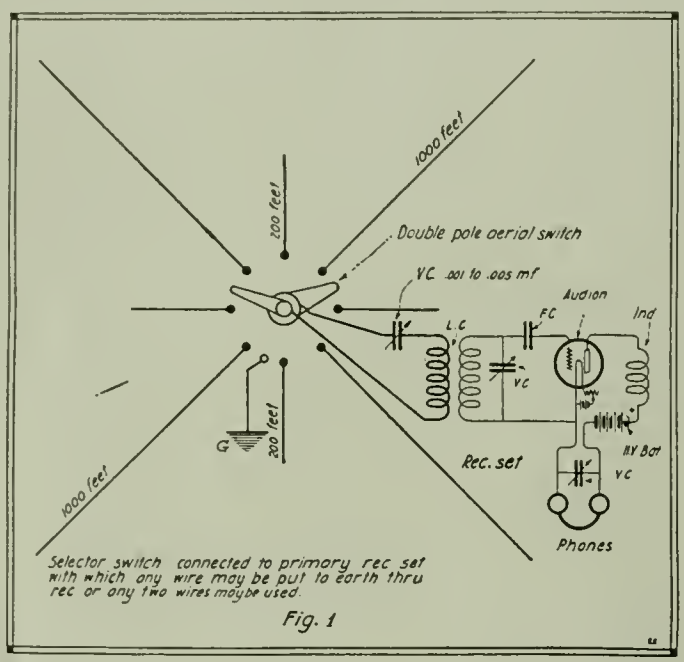
Specially Prepared with the Collaboration of Mr. James Harris Rogers

SINCE the publication of the original article on the Rogers Underground Wireless System, published in the March, 1919, issue of the ELECTRICAL EXPERIMENTER, the Editors have been literally besieged by hundreds and thousands of letters from radio experimenters in all parts of the world, asking for data on the construction of *Rogers underground aërials* suited to the requirements of the Wireless Amateur. The original article contained a great deal of valuable data, which should be carefully read and digested by every radio man, whether he be a student or a professional. In the present article an effort has been made to answer some of the questions which have seemed to annoy the average radio "bug" considerably, — especially those residing in cities where it is difficult and frequently impossible to bury an aërial longer than a few feet. We may say right here, that for those experimenters so situated, there is a solution, or in fact, two solutions, namely—to use a *spiral antenna*, such as has been tried out successfully in U. S. Naval tests on the Rogers System, and which spirals may be buried in the ground a few feet, or placed in a well or other body of water; and secondly, for the experimenter who is not allowed to disfigure an apartment house or other pretentious dwelling with an ugly looking aërial, there is the newly developed *loop antenna*, which can be used right in the radio room. Indoor aërials have been greatly perfected during the war, and now by means of greatly improved and highly sensitive wireless receiving instruments and amplifiers available, particularly those using audions as detectors and amplifiers, they are excellent, and satisfactory results are obtainable by means of a concentrated loop or spiral antenna, small enough to be placed in the radio laboratory.

For the present, we will listen to the sound advice given by our mutual friend, Mr. James Harris Rogers, on some of the practical outstanding features of his underground system, used in conjunction with straight-away single wire underground aërials, as well as loop aërials. Among other things, Mr. Rogers has the following to say regarding the installation of simple underground aërials:

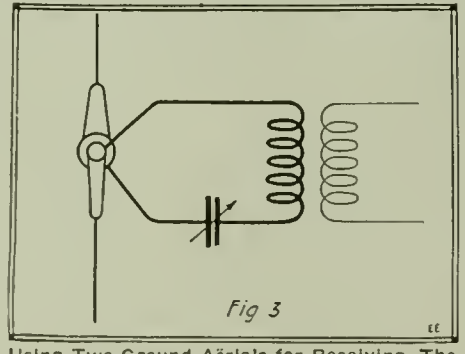
Mr. Rogers Talks to the Amateurs.

"The first installation of my underground antenna was made in the woods about a mile from my laboratory and consisted in burying wires in the earth; the wires radiated from the station as the spokes of a wheel,—*some wire bare* and *some insulated;* their lengths varied from 200 to 1,000 feet. (See Fig. 1).



Rogers Underground Aërial System for General Requirements, Showing Bipolar Selector Switch Connected to Primary Circuit of Receiving Set. Any Aërial Wire May Be Grounded Thru the "Set," or Any Two Wires May Be Used as Desired.

"It is obvious that a number of persons can receive at the same time, one operator to each wire. There is no interference, one with another. Figure 1 shows eight (8) wires and a bipolar selector switch connected to the primary receiving circuit. With this switch any individual wire may be *grounded*, or any *two wires* may be used. *Bare wires give the loudest signals but static is more pronounced.* The deeper the wires are buried, the better the signals, with a corresponding reduction of static. Short wires show a remarkable degree of directivity; long ones to a less degree and in proportion to their length. (See Figs. 2 and 3).



Using Two Ground Aërials for Receiving. The Aërials Should Lie in the Plane of the Station Being Received.

"When using two wires at right angles to each other, signals are heard from any direction. (Fig. 4).

"*The system works best in fresh water or very wet earth.* The primary circuit should have a variable condenser (.001 m.f. or higher capacity) in series. When insulated wires are covered with metal, lead, iron, etc., some remarkable results are obtained. These wires may be entirely enclosed in an iron gas pipe, for instance, (Fig. 5), or the joints may be connected by rubber hose. (Fig. 6).

"Here are some measurements taken with this last form of aërial:

Audibilities with *one bulb* only, on "Nauen" station, Germany:

Length of Antenna	*When signals are weak*	*When better*	*When best*
2,000 feet..	15	25	50
2,500 " ..	30	50	100
3,000 " ..	60	100	200
3,500 " ..	120	200	400
4,000 " ..	240	400	800

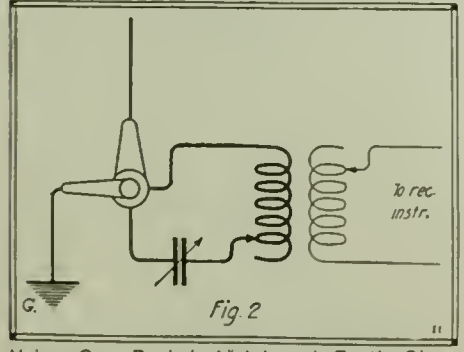
"Regarding the tests with loops I will state briefly that I have successfully tried different forms and sizes.

"I first had a well bailed out and lowered a loop antenna into it; the well was 50 feet deep. (See Fig. 7). The signals were as loud at the bottom as when above the earth. I next had the well filled with water and the results were the same, excepting that the note of the sending station became higher and higher as it was lowered. Upon revolving it I found the directional characteristics were the same in the water as when out. These tests were made about two years ago, and I at once realized that *loops* or *cages* could be used in the dugouts of France, or on submarines when submerged.

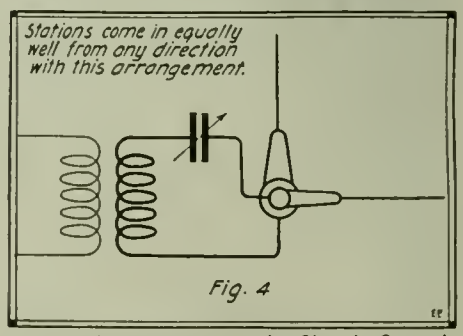
Regarding the dimensions of loop antennae used on submarines, these coils measure about 3 feet square in some instances. The wires are very heavily insulated and placed in a box filled with pitch, the connections are lead below and the coil can be revolved for directional observations."

Kind of Wire Used for Underground Aërials.

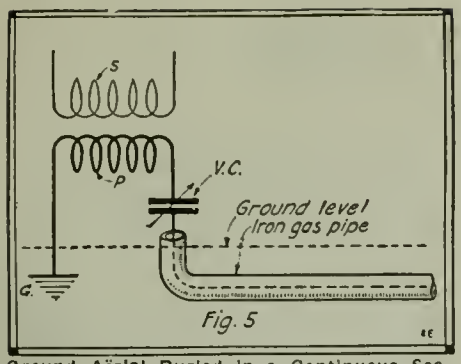
Most of the inquiries from Radio Experimenters and those intending to install experimental stations, and wishing to make use of the "static-proof" Rogers underground antenna, on which signals may be received *even thru a thunderstorm*, indicate that the greatest problem to solve seems to be the size and the kind of wire to be used, and how it shall be buried. Some very excellent results have been obtained in



Using One Buried Aërial and Earth Gives Same "Directivity" as When Two Wires Are Used.



With This Arrangement the Signals Came In Equally Well from Any Direction. A Good "Stand-by" Hook-up.



Ground Aërial Buried in a Continuous Section of Iron Pipe. Excellent Results Have Been Obtained with This Scheme.

experimental work carried on at one of the leading American universities with aërial conductors laid on the ground, and where the experimenter has the time and space to try this out, he may gain some useful and valuable knowledge by experimenting in this direction. Ordinarily the wire, of whatever kind it may be, as used when installing the Rogers underground aërial, is buried about **three feet deep in the earth.** For most Amateur requirements, the wire only need be about 100 to 200 feet long, and so the digging of the ditch is not such a great problem; in fact, it can be plowed open, at least part of the depth, and where rivers, brooks or ponds are available the insulated wire can be placed in them directly and allowed to rest on the bed.

Regarding the choice of wire to be used, it becomes evident that even bare copper or other wire may be utilized when desired, as Mr. Rogers has pointed out in the above contribution. The size of this wire should be about No. 12 or 14 B. & S. gage, the heavier the better.

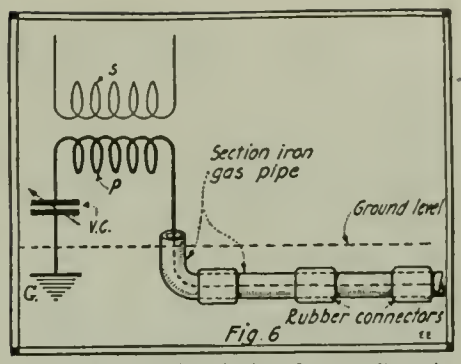
The official U. S. Navy reports of tests on the Rogers Underground System mention that no increased efficiency is obtained by using more than one wire, and that this may be a No. 12 or 14 B. & S. gage, weather-proof or rubber-covered copper conductor. In any case, the free end of the wire should be well taped, and preferably covered with some rubber cement, so as to keep it insulated. Experiments have been tried both by Mr. Rogers at his Hyattsville, Md., laboratory, and also by the Navy Department, with underground aërials placed in terra cotta pipes, but this construction is rather expensive, and the results obtained do not justify its use.

Other forms of wire used both by Mr. Rogers and the Navy Department experts include lead-covered telephone cable, which is, of course, thoroly damp-proof, while a conductor holding considerable favor with the inventor is the heavy rubber-covered, high-tension, auto ignition cable. This is highly efficient for aërial requirements, as it is stranded and therefore of low high frequency resistance.

In any case, a little common sense and logic will give the answer to many of the simple problems arising in connection with the installation of these aërials, such as, for instance, the length of aërial to be used for a certain range of wave lengths. **It is manifest that the longer the antenna, the longer the wave length to which it will properly respond.** Considering that an antenna is used having a length of, say, 150 to 200 feet, then practically all the shorter wave lengths up to 600 meters and more should be readily picked up on this antenna, especially with the variable condenser hooked up in series with the primary of the loose coupler, as shown in the accompanying diagrams. Naturally the wire buried in the ground has a higher electrostatic capacity than the old-style antenna wires, elevated 40 to 50 feet above the ground, and we can reduce this capacity as desired, so as to tune any certain wave lengths, by connecting another capacity in series with it: in exactly the same manner as short wave lengths are tuned in on the regular elevated aërials, by connecting a variable capacity in series with the antenna circuit, and the primary of the loose coupler. Long wave lengths are tunable by using large condensers and loose couplers preferably.

AUDIONS ON ALTERNATING CURRENT

Well, "Radio-Bugs," the very latest thing in Audion circuits is to cut out the expensive high voltage batteries, which are forever deteriorating and necessitating the purchase of new ones, or else the use of messy miniature storage batteries, and to operate your Audions, both filament and plate circuits, with ALTERNATING CURRENT. Sounds impossible, doesn't it? But it is a fact, nevertheless. Don't miss this important article, which will be worth many dollars to you, to appear in the next issue of the ELECTRICAL EXPERIMENTER. Read this special article entitled "Operate Your Audion Receiving Set on A.C." by Elliott A. White, formerly instructor in Radio at the Carnegie Institute of Technology, with diagrams and complete data on the building of the transformer, and other details. This is but one of the big feature Experimental Radio Engineering articles we have in preparation for the July number. It is the greatest revelation you ever read in Radio literature. Don't miss it, "Radio-Bugs"!



Here the Iron Pipe Jacket Surrounding the Buried Aërial Is Divided up into 20-Foot Sections by Means of Rubber-Hose Connectors; a Later Development.

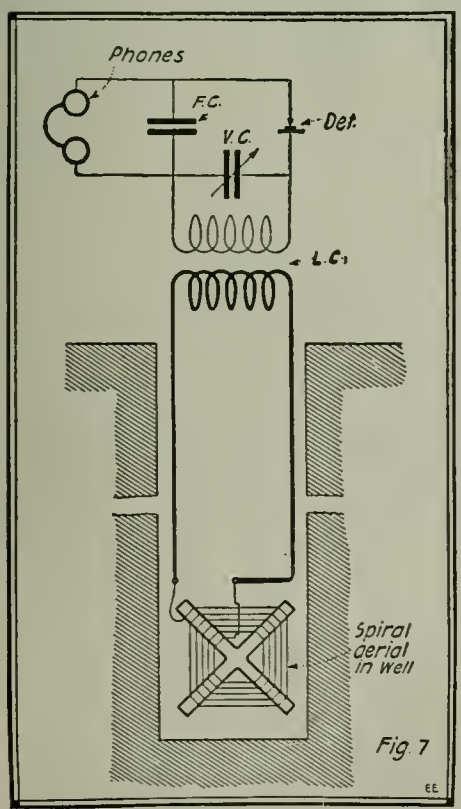
Spiral or Loop Aerials.

As shown in the diagram, Fig. 7, interesting results were obtained with a spiral antenna, composed of a dozen or so turns of insulated wire, such as high tension cable or No. 14 R. C. solid conductor lowered into a well, both with and without water in it.

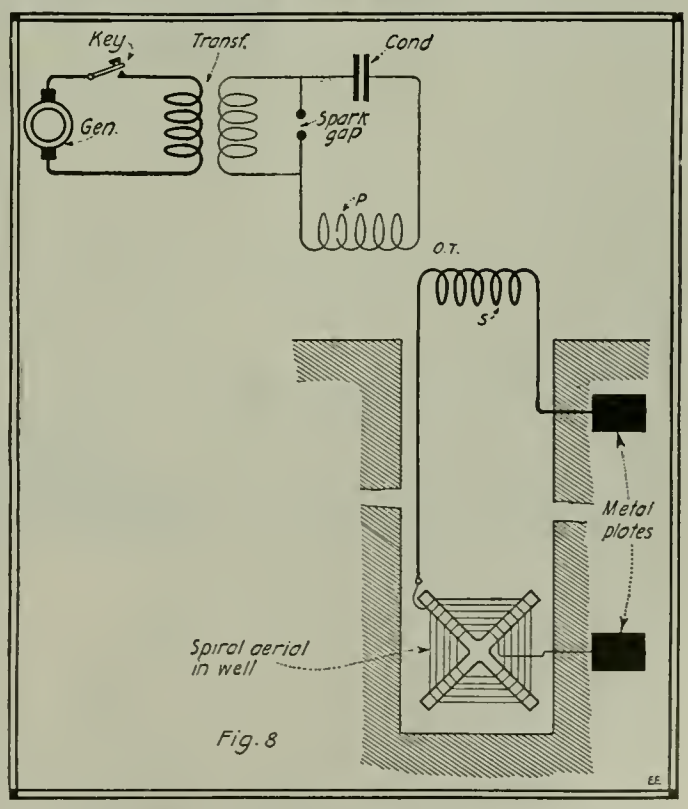
As pointed out in the original article on the Rogers underground system in the March issue, very promising results have been obtained in transmitting with the underground antenna, and Fig. 8 shows how a small transmitting set was operated with such an aërial, coupling the exciting or spark gap circuit with the antenna oscillatory circuit by means of a two-coil oscillation transformer, L, C. In this case two metal plates, about one yard square, are placed in the earth adjacent to the well, one of which connects with the secondary, S, of the oscillation transformer, while the other plate connects with the free end of the spiral antenna.

If the spiral antenna is used, it should be mounted so as to be revolvable on its vertical axis, and it should be placed in the vertical plane as shown in Figs. 7 and 8. Excellent results have been and should be obtained in transmitting with the underground antenna, with the usual insulation incident to the form of conductor above

(*Continued on page* 187)



Some Very Surprising Results Were Obtained in Receiving with a Spiral Antenna Lowered into a Dry Well. Slightly Different Results Were Noticed with Water in the Well.



Distances up to Fifty Miles Have Been Covered Very Successfully in Transmitting with the Rogers Underground Aërial. In This "Transmitter," the Spiral Antenna Is Placed Down in a Well, Metal Ground Plates Being Connected as Shown.

Learning the Code

By HOWARD D. WILDMAN

IN the June, 1918, "E. E.," page 101, there was an article by Mr. Rockwood, relating to Thomas Reed's idea in the January issue, about a new scheme for learning the Continental code. Mr. Rockwood says he tried the scheme himself, but found he often accented in the wrong place and so got the wrong letter. I foresaw this possibility before I tried out the idea and hunted up one substitute word—L—"lo-*cal*-ity." The others I found O. K. Mr. Rockwood says the catchword for "J" is "Jerusalem." It isn't. It is "Ja-*pan-nose-ums*," and I have found that you can't get it wrong.

Now as to my experience—before I read Mr. Reed's article I knew only two or three letters—e, i, t. I read the article and memorized the catchwords.

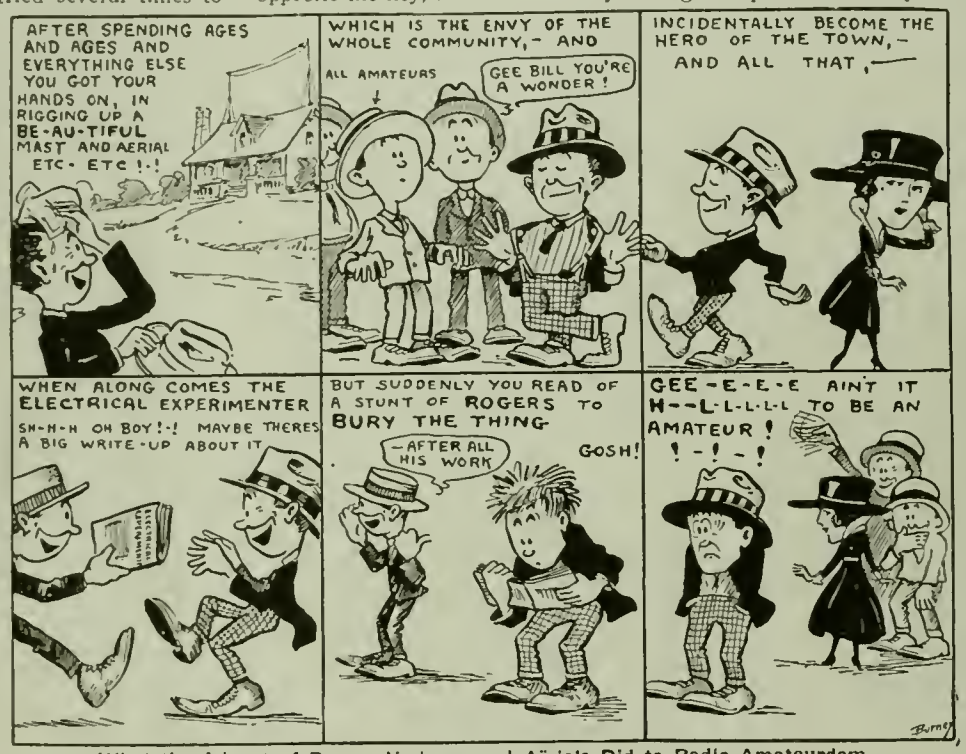
Before this I had tried several times to learn the code, but I was apt to get .—.. for .—. or ..—. for ——.— After memorizing the catchwords, in an hour or so, I could write a sentence and then rewrite it correctly in dots and dashes. At that time I had no key, receiver or anything but an A. C. toy transformer, a rheostat and a few other instruments. I made a key and receiver and practised sending to myself. A friend of mine learned the code meanwhile by memorizing the dots and dashes—a long process, during which time I learned to recognize the sound in the receivers. To this day he occasionally, when sending, shouts to me, "Hey, what's 'P'", or something similar, and I can always tell him.

Mr. Rockwood says one must by this method learn the system and then *unlearn* it. This is not quite true. One *gradually* gets to send without using the catchword. Finally one gets to the point where one sends or receives as Mr. Rockwood says it should be done. This comes of itself without effort, after a little familiarity. My friend will sometimes take .——to be "U," etc. My experience proves that if he had learned by catchwords, this would not happen. I don't confuse ..—. with .—.. or .— with —. The catchword positively prevents mistakes in sending, as you wouldn't send —. for "away," nor ..—. for "lo-*cal*-it-y."

For receiving, the catchword is useless. This can be readily seen as ..—. would not readily call to mind "fi-li-*pi*-no.". But by using the catchword to send to one's self you learn to recognize ..—. as "F." After some practise, when you want to send "F," you do not think "fi-li-*pi*-no," or ..—. but send it without thinking.

You say—"Of what use then, is the catchword? It is learned only to be discarded again." The catchword serves to teach the code, so that the student can send to himself and teach himself to receive.

Thus we see the catchword is of no help in receiving. But at first it is a great help in sending, as it prevents confusion.



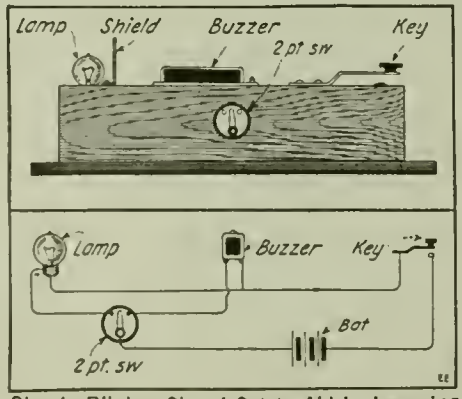
What the Advent of Rogers Underground Aërials Did to Radio-Amateurdom—By H. B. Burney.

Briefly then, the idea is to be able to send so as to teach one's self to recognize .—.. as "L," etc.

A BLINKER SIGNAL SET.

This device consists of a key, dry-cell buzzer, 2 point switch and lamp. The lamp is used for signaling at night, the key being used to make the dots and dashes which the lamp flashes. The buzzer is used when it is impractical to use the lamp.

First procure or make a wooden (small cigar box), just large enough to contain a dry (or flashlight) cell. On top of this box a strap key made from a strip of brass and with a poker chip for a knob is placed. A flat-headed screw serves as a contact point. In the center of the box is placed a box-type buzzer, and near the end opposite the key, a hole is drilled just large enough so that the lamp will fit snugly. A piece of tin is bent to the shape shown and serves as a shield to the operator's eyes. This also acts as a reflector. By using the hook-up shown, either the lamp or buzzer may be put in circuit by using the 2 pt.



Simple Blinker Signal Set to Aid in Learning the Code, with Lamp and Buzzer.

switch screwed to the side of the box.

Contributed by P. J. FAULKNER, JR.

RADIO IN THE NAVY.

THE development of wireless by the Navy Department during the war has been so remarkable in many phases that it is almost unbelievable. Apparatus known before the war to only a few scientists and perhaps a few of the more progressive amateurs has been developed by the Navy and placed in practical use to such an extent that it has entirely revolutionized radio operation and will eventually be so applied in commercial work as to greatly increase the scope of radio communication. The work of the radio operator will be so broadened that he will rank as a highly skilled technical specialist.

The development of the radio telephone, radio compass, direction finder, submarine listener devices, etc., have depended largely upon the development of the "audion" and its application to radio communication. The use of the various methods for the elimination of static have permitted the employment of extremely sensitive audion receiving sets employing a number of steps of amplification. This depends, of course, upon the application of the audion. All of these things have so complicated the art of operation as to require a very much broader and technical course of instruction than has heretofore been found necessary.

The Navy Department has approved plans for the centralization of all instruction in radio work in one of the great training stations in the Middle West where they are now organizing a school comprising a course of instruction to cover all these modern phases of radio practise, together with a thoro course in practical electricity.

The development of radio during the war has so interested scientists and others in the many advantages to be obtained from its various applications that it is certain that it will never return to the comparatively limited field which it formerly occupied.

The future in store for those possessing thoro acquaintance of the modern phases of radio work is unlimited. The entire Navy personnel is now, practically, in the course of reconstruction and offers an exceptional opportunity for men interested in electrical and scientific lines. The Naval service has need of, and promises rapid advancement to anyone willing to put forth the same effort in the service as would be necessary for him to make a success in civil life. The opportunity to secure a training in the most modern phases of radio work cannot be duplicated elsewhere.

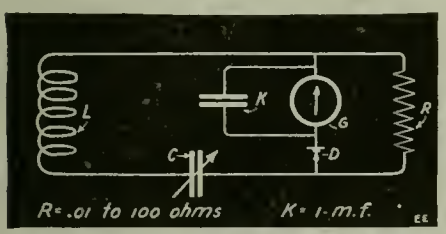
Those interested in the service may apply to the nearest recruiting officer and request from him information concerning enlistment as "Apprentice Seaman for Radio" or, should further information be required, write to the Officer in Charge of the Radio School, Great Lakes, Illinois.

USE OF CONTACT DETECTORS IN RADIO MEASUREMENTS

By Dr. L. W. Austin,
U. S. Naval Radio Laboratory.

For many measurements in radiotelegraphy it is necessary to use a radio frequency-current indicator of known resistance. If the current to be measured is small it is generally customary to use a thermoelement and galvanometer. The most sensitive thermoelements are either of the vacuum type or the welded tellurium type. The vacuum thermoelements can be obtained of any desired resistance and are very sensitive, but are slow in action and frequently show a bad zero drift. In addition, the deflection usually shows considerable divergence from the current-square law. The tellurium platinum elements are quick acting and follow the current-square deflection law with sufficient accuracy for all practical purposes. They are, however, so fragile and difficult to manufacture and transport that no manufacturer has yet undertaken to supply them commercially. It is also impossible to make the contact resistance much less than 10 ohms. It is to be noted that the resistance in both the vacuum and tellurium types changes considerably with the amount of current flowing.

On account of the difficulties mentioned, the sensitive thermoelements in our laboratory have been replaced, for the most part, by a shunted contact detector circuit arranged as shown in figure 1. Here *LC* is any oscillating circuit having inductance and capacity, *D* is a contact detector, *G* a high resistance galvanometer, *K* a paper



Owing to Several Difficulties Experienced with Sensitive Thermoelements in the Radio Laboratory, the U. S. Naval Radio Laboratory Utilizes Instead the Unique Arrangement Here Shown. This Scheme Comprises a Shunted Detector Circuit, where L-C is Any Oscillating Circuit Having Inductance and Capacity; D is a Contact Detector; G a High Resistance Galvanometer; K a Tin Foil and Paper Condenser of One Microfarad Capacity, and R a Resistance Which May Have Any Value from 0.1 to 100 Ohms. The Greater Part of the Radio-Frequency Current Passes Thru R, While a Small Portion is Shunted Thru the Condenser K and the Detector. The D. C. from the Detector After Passing Thru the Galvanometer Returns Thru R. The Sensibility of this Arrangement is Much Greater Than That of the Best Vacuum Thermoelements of Equivalent Resistance.

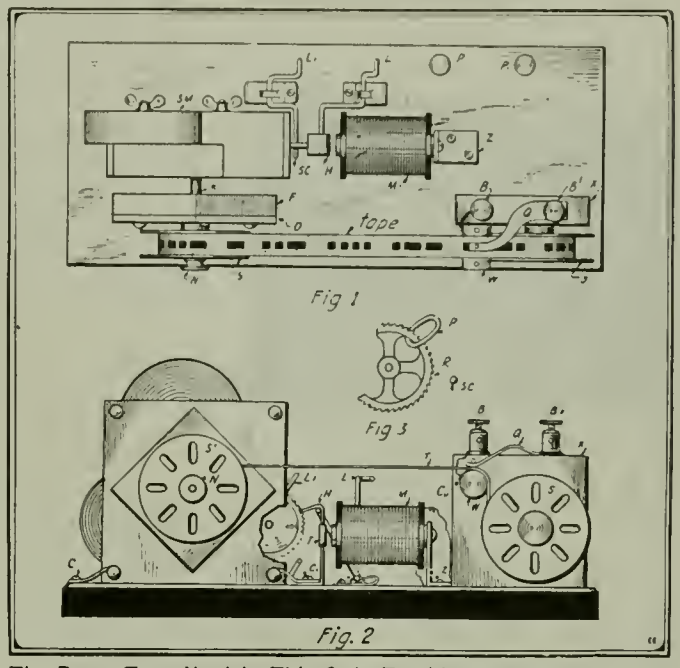
condenser of one microfarad capacity, and *R* a resistance which may have any value from 0.1 to 100 ohms. The greater part of the radio-frequency current passes thru *R*, while a small portion is shunted thru the condenser *K* and the detector. The direct current from the detector after passing thru the galvanometer returns thru R. On account of the high resistance of the detector, the total resistance of the detecting system is practically identical with *R*, as has been experimentally tested between 0.1 and 100 ohms.

The sensibility of this arrangement is much greater than that of the best vacuum thermoelements of equivalent resistance.

In the case of most of the well-known detectors the proportionality between deflection and current-square is excellent. Galena, while the most sensitive of any of the detectors tried, shows a slight deviation from the square law. For absolute current measurements the system must of course be calibrated by comparison with a known thermoelement at the time of experiment.—*Journal Washington Academy of Sciences.*

Automatic Code Transmitter

I present herewith design of an automatic tape transmitter that I constructed and which runs very well. Details: Motor —This is an alarm clock which had "given up its ghost." I pulled it out of its case, removed the balance wheel, hair spring and the little lever—whatever its name is—and also the ratchet wheel, which I kept. I also removed the face, both hands and the driving mechanism for the hour hand. I then drove on the minute hand shaft a block of wood 2 inches by 2 inches by ½ inch, so that the shaft did not come quite thru the block (Fig. 1). On F I screwed a block of thin wood 2 inches by 2 inches with an 8/32 bolt 1 inch long thru the center of it, and a nut on the bolt (Fig. 1, K); on this bolt I put an empty typewriter spool, S, which I held on by bolt and nut (Fig. I, N). Light spools for the purpose can easily be made up by the experimenter from fibre and brass odds and ends.



The Paper Tape Used In This Code Teaching Instrument Can Be Cut from the Border of a Newspaper, and the Dots and Dashes Punched in It With a Conductor's Ticket Punch.

Transmitter—On the base I fastened (Fig. 1, X) a wooden upright 2½ inches by 2½ inches by ½-inch in line with (Fig. I, F). The peg, W, covered with copper sheet, Cu, is inserted in a hole in the wood; in W are inserted two small brads to keep the paper tape in proper alignment. Cu is connected to B and a fine brass brush, Q, bears on the tape and connects with Cu when an opening appears. S is another typewriter ribbon spool running on a headless wire nail.

Regulating Devices—Speed—The ratchet wheel aforementioned is treated by cutting out about one-third of it, Fig. 3, and also an oval of wire, P, is fastened loosely around the rim of the wheel (R); this ring hits on Sc, Fig. 1, which is a wire held in a spring binding post so it can be regulated. This regulator and the cut ratchet wheel are used to keep the spring motor from running away with itself.

Brake and Release—Consists of a thin copper spring, H, Fig. 2, fastened in common with one of the two clips which hold the motor down, H, has some sheet iron wound around it at T to form an armature, so that the electro-magnet, M, fastened on support, Z, can act on it.

The auxiliary release, L, is a bent copper wire (No. 14 B. & S. gage), which swivels on a spring post to release the brake H.

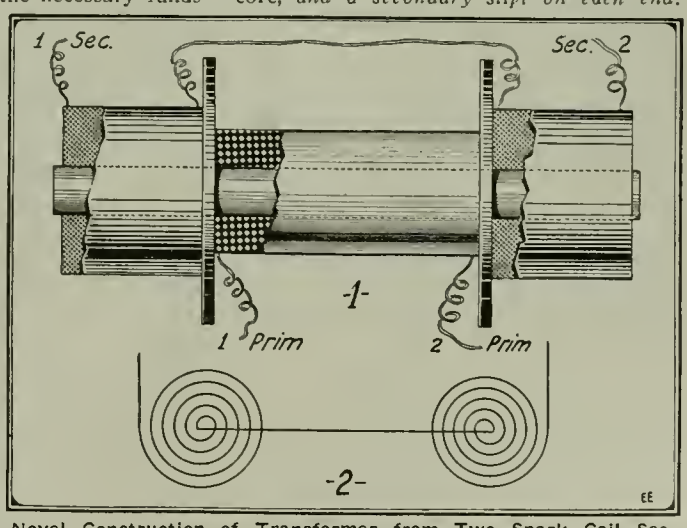
The electro-magnet is connected to binding posts, P and P, and is wound full of No. 28 B. & S. gage magnet wire.

Contributed by
GEORGE HARRINGTON.

A New Type of Transformer

A great many experimenters are in the position of having outgrown the "spark-coil" stage, but do not have the necessary funds to buy or construct a transformer using the 110 volt A. C. They are then burdened with a spark coil, which they usually attempt to use by means of an electrolytic interrupter, which will use an excessive amount of current without a very high degree of efficiency. In some cases the spark coil has been taken apart and an attempt made to use the secondaries. But it is easy to see that this cannot be done on the usual type of open-core transformer, for after winding three or four layers of heavy wire on a core about two inches in diameter, the total size is too great to permit the secondaries to be slipt on over the coil.

A plan that has given very good results is shown in the diagram. As will be noted, the primary is wound in the center of the core, *and a secondary slipt on each end.*



Novel Construction of Transformer from Two Spark Coil Secondaries, with the Primary Coil Placed Between Them.

The core is constructed of soft iron wire

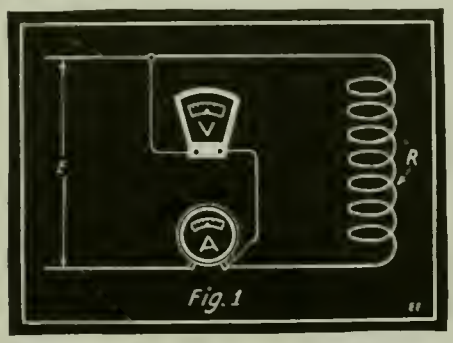
(*Continued on page* 174)

Choke Coils--Theory and Design

By F. E. AUSTIN

Professor of Electrical Engineering, Thayer School of Engineering, Dartmouth College, Hanover, N. H.

THE writer who is constantly in receipt of inquiries from those desiring to know how to construct choke coils to meet certain requirements, takes this opportunity to explain somewhat briefly the theory underlying the



When a Coil of Magnet Wire Is Connected to an A. C. Circuit, the Current Is Measured by an Ammeter and the Potential by a Voltmeter. The Current Absorbed Depends upon the Number of Turns and Kind of Core Used in the Coil.

construction of choke coils, and to give directions for the construction and operation of such coils.

Choke coils are simply coils of insulated copper wire thru which alternating currents are allowed to pass and by means of which the *amount* of the alternating currents may be regulated as desired. The regulation is effected by the action of the counter-electromotive-force induced in such coils due to the continuously varying magnetic field set up by the varying alternating currents. The consideration of the variation of counter-electromotive-force is therefore the important question in the building and operation of all choke coils.

When a coil, formed by winding a number of turns and layers of double cotton covered copper magnet wire about an insulating tube of say hard fiber or cardboard has an alternating pressure applied to its terminals, as indicated in Fig. 1, an alternating current flows thru the wire of the coil according to the well known equation:

$$I_{ac} = \frac{E}{\sqrt{R^2 + (2\pi f L)^2}},$$ in which I_{ac}

denotes the current in amperes, indicated by an ammeter connected with the coil as indicated in the figure; E denotes the applied alternating pressure in volts, indicated by a voltmeter at V in the figure; R denotes the resistance of the coil in ohms, which may be measured by experiment, using a voltmeter and an ammeter with *direct current* or by the use of a Wheatstone bridge testing set, or which value may be *calculated* from the size of the wire and its length; f denotes the frequency of the applied pressure in cycles per second, and L denotes the so-called coefficient of inductance of the coil. Should a direct current pressure be applied to the terminals of the coil, the current would be exprest simply by Ohm's law as:

$$I_{dc} = \frac{E}{R}$$

It is evident by comparing the two equations, if the applied pressure *A. C.* and the applied pressure *D. C.* should have the same numerical value in volts, there would be much less resulting current according to the first equation than from the second, if the term exprest by $(2\pi f L)^2$ has any considerable numerical value. This of course depends upon the value of f and of L. The value of f is fixt by the value of the ordinary commercial frequencies of power circuits, ranging from 40 to 100 cycles per second, with 60 cycles as a very common frequency. The value of L depends upon the square of the number of turns on the coil, and very largely upon the material that is inserted into the coil to serve as a core.

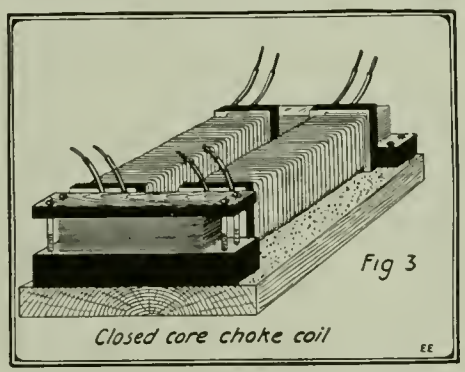
The value of L is exprest by a unit called the *henry*, may be very easily and quickly ascertained by experiment for any coil, and may be quite accurately calculated from the number of turns wound on the coil, the area of cross-section of the central hole thru the coil and the length of the coil, when there is no iron or other magnetic material near the coil.

Let us examine somewhat carefully the first equation. First, suppose the value of f is O; then $2\pi f L = O$ and the equation becomes:

$$I_{ac} = \frac{E}{\sqrt{R^2}} = \frac{E}{R}$$ or Ohm's law.

When $f = 0$, the current is a direct current, and Ohm's law should be applicable. Next suppose $L = 0$; then also will

$$I_{ac} = \frac{E}{\sqrt{R^2}} = \frac{E}{R}$$ and Ohm's law again applies. The value of L can be 0 only when the wire constituting the coil is not wound in the form of a coil; that is only when it is *straight*. The *A. C.* current in a straight wire is the same as the *D. C.* current if the numerical value of the *A. C.* pressure is the same as the numerical value of the *D. C.* pressure.



A Well-Designed Choke Coil of the Double-Pole, Closed-Core Type. One-half of the Winding Is Placed on Each Leg of the Laminated Sheet Iron Core.

For illustration, suppose the value of L is, first, 1 *henry* and that $f = 60$. The numerical value of the term $(2\pi f L)^2$ becomes $(2\pi \times 60 \times 1)^2 = 377^2$; (very nearly). It may readily be appreciated that the $2\pi f L$ term has a very important bearing on the numerical value of I_{ac} when the values of E and R are fixt. The value of E is always fixt by the pressure of supply, the value of R is of course fixt when the coil is wound. Usually the frequency is also fixt by the frequency of the supply, which leaves L as the only variable quantity remaining that allows a variation in the current denoted by I_{ac}. After a coil is wound, the value of L is not variable unless the windings on the coil may be varied. This of course is not feasible except within rather narrow limits. The coil may be wound in sections, with taps, arranged for connecting with apparatus, thus allowing a variation in a comparatively few steps.

If the coil is provided with a movable iron core consisting of varnished iron wires, the means are provided for not only giving a very wide variation to L, but for making the variation absolutely gradual,

Suppose, for example, that a coil has an ohmic resistance of 5 ohms and a coefficient of inductance of .0162 *henry*. Find the current in the coil when an alternating pressure of 110 volts at 60 cycles is applied to the terminals of the coil? Making the proper numerical substitutions in the fundamental equation gives:

$$I_{ac} = \frac{110}{\sqrt{(5)^2 + (2\pi \times 60 \times .0162)^2}}$$

$$= \frac{110}{\sqrt{25 + (377 \times .0162)^2}} = \frac{110}{\sqrt{62.7}}$$

$= 13.9$ amperes.

With an applied direct-current pressure of 110 volts the current in the same coil will be found from:

$$I_{dc} = \frac{110}{5} = 22 \text{ amperes.}$$

The coiling of the wire, therefore, accounted for $22 - 13.9 = 8.1$ amperes.

In order to reduce the current to 13.9 amperes on a direct current circuit, it will be necessary to introduce a resistance in series with the coil having a value of

$R_x = \frac{110 - 69.5}{13.9} = 2.9$ ohms. This may be understood better by consulting figure 2, which represents the coil connected in series with an auxiliary resistance R_x across a 110 volt circuit.

The current in this arrangement may be exprest by:

$$I_{dc} = \frac{E}{R + R_x};$$

and if the proper numerical values are substituted in this equation the result will be:

$13.9 = \frac{110}{5 \times R_x}$, from which

$(5 + R_x)\ 13.9 = 110;$

$5 \times 13.9 + 13.9\ R_x = 110$

$13.9\ R_x = 110 - 5 \times 13.9$

$$R_x = \frac{110 - 5 \times 13.9}{13.9} = 2.9 \text{ ohms.}$$

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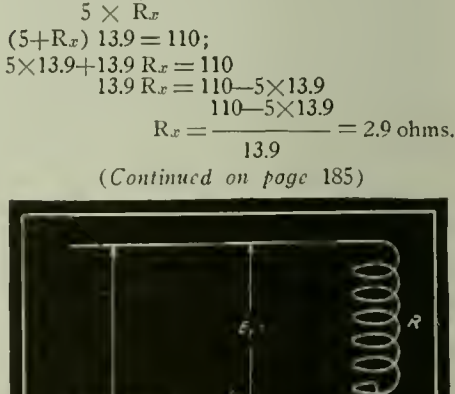
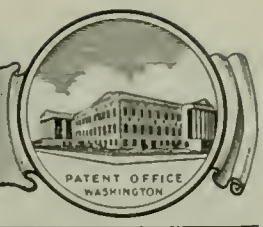


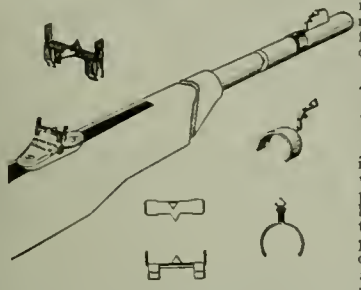
Experiment with Choke Coil Designed for A. C. Circuit Connected to D. C. Circuit, Showing the Effect of Inductance or Impedance on the Current Consumed.

LATEST PATENTS



Luminous Attachment for Gun-Sights.

(No. 1,292,211, issued to Harold S. Young and F. H. Ihde.)

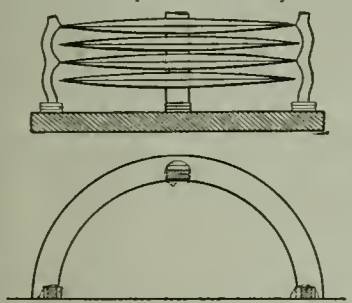


The sighting plate mounted on the front end of the firearm is coated with a covering of luminous paint, or some such other light-radiating pigment, which can be easily discerned at night. The benefit of this improvement in sights is that the marksman looking thru his rear sight can easily discern his forward point or sight due to the fact that the same is covered with this radium paint.

Electrical Condenser.

(No. 1,292,589, issued to R. F. Darmezen du Rousset and Chas. E. Brandt.)

It is a generally accepted fact that in electrical condensers formed of flat conducting surfaces separated by some dielectric the charge is unequally distributed from the center to the edges, its density being greater toward the perifery where the ruptures are always produced. In this new form of invention a condenser is provided whereby it is

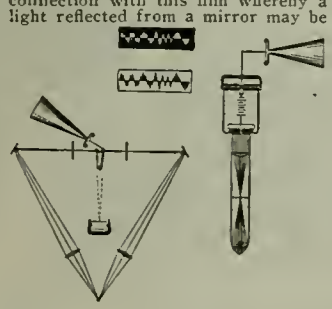


possible to localize the maximum tension at the central point of the system, and also increase the capacity for a given diameter. It consists of a number of discs arranged in the form of a quenched gap, wherein metal plates with concave surfaces are used, and between these various plates insulating discs are placed.

Photographic Phonograph.

(No. 1,291,702, issued to Frank W. Adsit.)

One of the principal points in this new invention is the providing of means for registering on a film the graphic representation of sound. Another object is to provide a means in connection with this film whereby a light reflected from a mirror may be

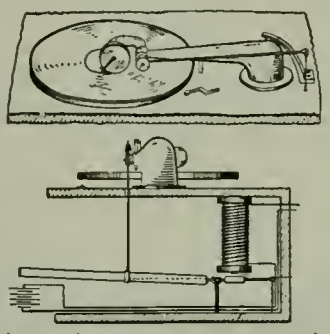


registered on either one side or the other of a center line down the film or on both sides of this simultaneously. It is also possible by special means to reproduce these graphic representations registered on the film, so that musical sounds or voice currents may be reproduced.

Automatic Record Stop for Phonographs.

(No. 1,291,985, issued to D. M. Manson.)

The principal innovation in this invention is an electrical means, whereby after a record has been played the needle will be carried back to the starting point, so that the playing of the record may be repeated. The invention as a whole consists essentially of an arm secured at one end to the sound box crook, magnetic means being provided for drawing down the opposite end of the arm, thereby raising the sound

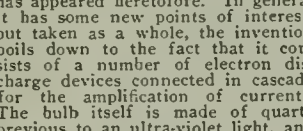


box and needle from the record. Also a means is provided for counterbalancing the weight of the sound box during its return or downward movement. An ingenious scheme is devised whereby the tapered tube, by means of an adjustable stop, can be designed to be turned in any position to correspond with the starting point of the record, and a spring connected to the tapered tube and bracket, whereby the taper tube can be turned from the center of the record when the needle is out of contact with the record and brought back to the starting position.

System for Amplifying Variable Currents.

(No. 1,297,188, issued to Irving Langmuir.)

This invention is merely a means devised for utilizing an electron discharge and comprises several novel systems of connections whereby the weak currents can be reproduced as stronger currents. Taken as a whole, it is merely a modifica-

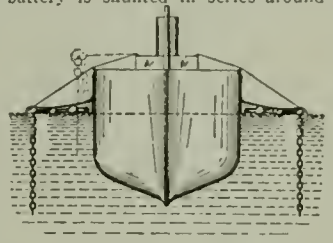


tion of the several step amplifier, as has appeared heretofore. In general it has some new points of interest, but taken as a whole, the invention boils down to the fact that it consists of a number of electron discharge devices connected in cascade for the amplification of currents. The bulb itself is made of quartz previous to an ultra-violet light, and into which are sealed in the usual manner an electron-emitting cathode and anode. The cathode of this particular bulb consists of potassium or sodium, which will emit electrons when illuminated by a source of light.

Magnetic Protector for Ships.

(No. 1,293,539, issued to John and Sophie Pies.)

The principal device is a form of arm extending from the ship on each side attached to an electro-magnet with a flexible chain banging in the water, and arranged with a number of floats to depend from these extending arms. One circuit is formed in series with these magnets to a large generator, and the battery is shunted in series around

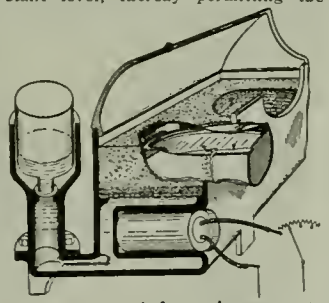


the two chains that hang from either side of the ship. The apparatus is arranged to detect submerged torpedoes, mines, etc., due to the fact that their presence would increase the conductivity between these two chains and cause the circuit to be closed and ring the bell.

Electrically-Heated Apparatus for Moistening Shoes.

(No. 1,294,533, issued to W. W. Reed.)

It has been found that much of the cracking and breaking of shoes incident to the lasting operation can be avoided by preliminarily treating with a hot vapor. A tank is provided which will maintain the water automatically at a constant level, and an electrical heating unit arranged to heat the water. A layer of absorbent material is placed on top of the heated water, and an automatic means provided for maintaining the upper surface at a constant level, thereby permitting the

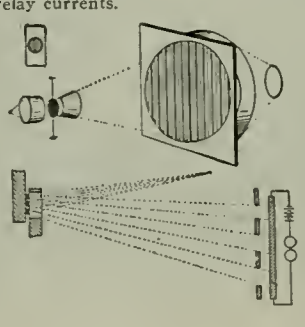


vapor generated from the water to be diffused equally around all portions of the shoe.

Selenium Relay.

(No. 1,293,098, issued to A. N. Hovland.)

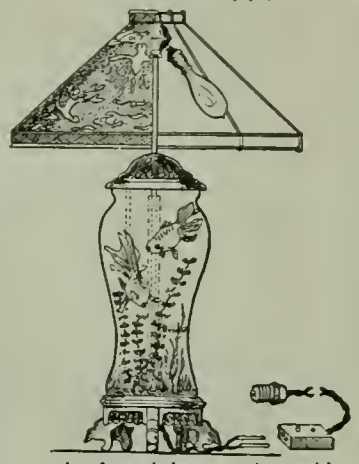
This new form of relay is built on the principle that a conducting wire placed in a magnetic field will be displaced laterally when an electric current is past thru the same. This fact is made use of, for instance, in wire galvanometers and in light-writing apparatus, also that the magnetic field is used to produce a very sensitive relay, utilizing one or more photo-electric cells on the general type of a selenium cell. A shutter means is provided for decreasing and increasing the resistance of the cell, and by such means it is possible to relay currents.



Illuminated Aquarium.

(No. 1,297,254, issued to Natsuo Sato.)

A novel and attractive improvement on the usual form of aquarium, which consists of a bowl which is permanently illuminated from above by electric lamps, and which are concealed in the lamp, and intended for use in drawing rooms. It consists of a metallic tube which runs up centrally thru the apparatus, and thru which tube also is run electric wires to operate the bulbs under the lamp shade. Were this tube to be in actual contact with the water, it might possibly cause some chemical reaction, which would be detrimental to the fish in the bowl. The inventor overcomes this by using a glass tube over the metal pipe, which

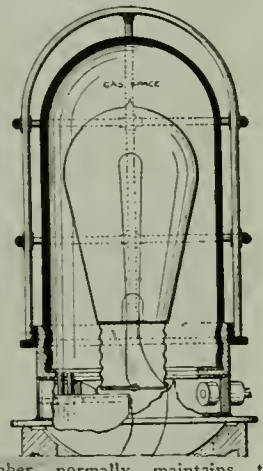


may be formed in one piece with the bowl or may be separate and cemented together in order to prevent leakage. The bottom of the bowl is arranged to present a pleasing appearance with a bed of sand.

Electric Gas-Detecting Safety Lamp.

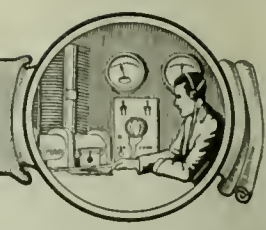
(No. 1,294,806, issued to C. G. Hunt and John H. Coyle.)

The main feature of the invention consists of a lamp and a sealed chamber, with a source of light in said chamber. A means is provided whereby a gas pressure inside the



chamber normally maintains the light, but if fumes are present on the outside, this external pressure will cause the light to be extinguished. It operates on the principle that the internal pressure of the gas will normally maintain the light, but should the gas pressure in the chamber be brought to an inferior or superior pressure to that without the chamber, then the light will be extinguished.

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—J. CARROLL TOBIAS

I AM an appreciative reader of your magazine and wait anxiously for it to arrive from month to month. I find lots of enjoyment in looking over the photos of Amateur "Labs", and so am sending a "shot" of my own little workshop.

In this room many interesting and educational experiments are performed in chemistry, electricity, metallurgy and electro-chemistry. I have apparatus for both qualitative and quantitative analysis, electric furnace analysis of iron, steel and carbon compounds and for the analysis of coal gas and by-products. A complete bacteriological outfit is also one of my valued possessions and by its means microscopic examinations of water are conducted. This about completes the chemical end.

In the electrical division I have motors, a generator (A.C., 60 volt, 60 cycle), a 50 watt D.C. generator, step-down and step-up transformers, high frequency alternator, high-frequency high-voltage transformer, Oudin coils, Tesla coils and spark coils. I have an electric arc furnace by means of which I conduct small experiments in the production of synthetic gems, electrolytic rectifier, electrolysis apparatus and "bunches" of other "junk". At present I have under construction an A.C.-D.C. switchboard, also a three-step audion amplifier and two long wave loading coils. When the "Lab" is drest out in all its new furniture, I will send you another series of photos.

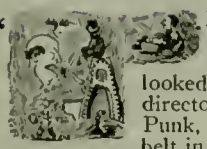
Another photo shows my radio set which has just been unsealed and which I know is just "hankering" to have the old oscillations flowing once more thru its coils. Another view shows my battery switchboard and electrical work bench with spark coils, Tesla coil, Oudin coil and other "stuff".—J. Carroll Tobias, 106 N. High St., Bethlehem, Pa.

HONORABLE MENTION (One Year's Subscription to the ELECTRICAL EXPERIMENTER) —CHESTER A. WRIGHT

Herewith are photos of my radio station. I have been a steady reader of the ELECTRICAL EXPERIMENTER for some time and get many good ideas and hook-ups. My apparatus is mostly home-made, consisting of a condenser made of heavy plate glass with aluminum sheets. The rotary spark gap is made of a 1700 R.P.M. fan, and the disc of an Edison disc record. It gives a very good tone. My oscillation transformer is made of heavy brass ribbon and is very easy to adjust. I use a Clapp-Eastham 1 K.W. transformer. My receiving apparatus consists of home-made couplers from which some very close tuning can be had. I use an audion and galena non-jarable detector, both with great results. I also have Murdock variable condensers, and two sets of Brandes' phones.—Chester A Wright, 611 Green St., Greensburg, Pa.

Science in Slang

By EMERSON EASTERLING



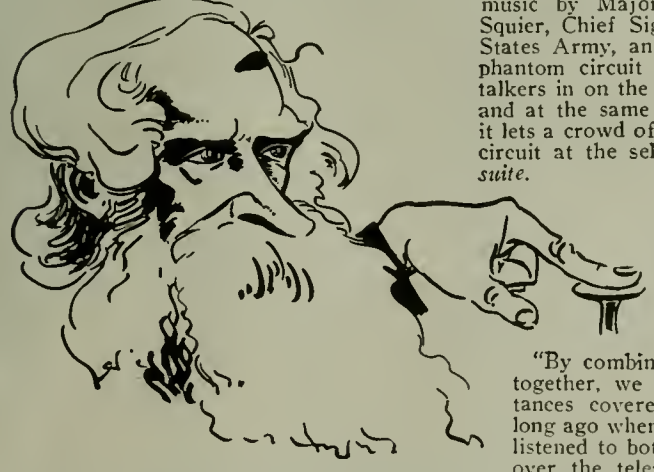
"A FUNNY thing happened the other day," laughed Punk Loomis. Stokes looked up from the telephone directory. "A guy," continued Punk, "was standing under a belt in the factory. The fellow had on rubber boots. He was talking to his wife, and when she started to leave—you see, they were newlyweds—he reached over to kiss her. WOW! You ought to have seen them! One of them got it in the nose—the other on the lips—and it cracked like a young bolt of lightning. You see, the rubber boots made a Leyden jar out of the man—a human condenser. That kiss sure had a kick."

"I guess that was about as funny to them as it was to the lady who was cleaning clothes and set the rag, saturated with gasoline, on fire in her hand by drawing a spark from the friction of the wool and silk. Both were static, you know." Here he turned and walked to the telephone and asked for long distance. In a few minutes he returned.

"Quite a commodity, this telephone. In the old days when the citizens thought it proper to run in marathons in the 'altogether,' if I should happened to have been let loose at that time, and happened to have gotten word to a guy the same distance as the present case here, I should had to have waited for at least a week—with the best runner that the country had, to tell the adjoining country to go to hades—for the answer."

"Can you reel off another sentence like that without stopping for air again?" asked Bender.

"Jumping over such improvements as Paul Revere and the pony express brought about, we land up at the chapter in scientific history where a bird by the name of Morse, with three other names before it, two of them Sam and Finley—I don't know the other—it don't make much difference anyway. What we are driving at is the fact that after muttering, 'If the presence of electricity can be made visible in any part of the circuit, I see no reason why intelligence may not be transmitted by electricity,' he rigged up a couple of magnets and an arm and anvil—behold! We have the *telegraph sounder*. Then the next thing was to contrive a series of dots, dashes and spaces to convey that intelligence he was speaking of. It took a lot of salesmanship for Sam to get his trick across, but perseverance wins out in the finale—so, first act in the comedy of the telegram.



Sam Finley Morse, the Dash and Dot Kid, Also the Ancestor of the Telegraph Messenger.

Keeping the Wires Hot

"Then another guy—you've heard of him, Bell, Alexander Graham, Proff. in vocal hygiene or physiology—drops in on us. This student of the art and mechanics of the first cause for conversation got down into the throat of the matter and found out a lot about the reason why some men leave home. While trying to make the telegraph do more work for the number of wires used, it is related that this gentleman was alleged to have developed the *telephone*—but none would recognize in the original article any resemblance to the present instrument of long-distance chatter.

"Another duck—Prof. Elisha Gray—would have landed the fish if it had not been that Bell got his draftings in the patent office (no, not the Phoney Patent Offizz) and beat the dear old chap out of the glory. Which all goes to show that some great minds do run in the same channel. But Gray should worry. He is guilty for the *telautograph* being on the market. No, he is not Elisha of the fiery chariot.

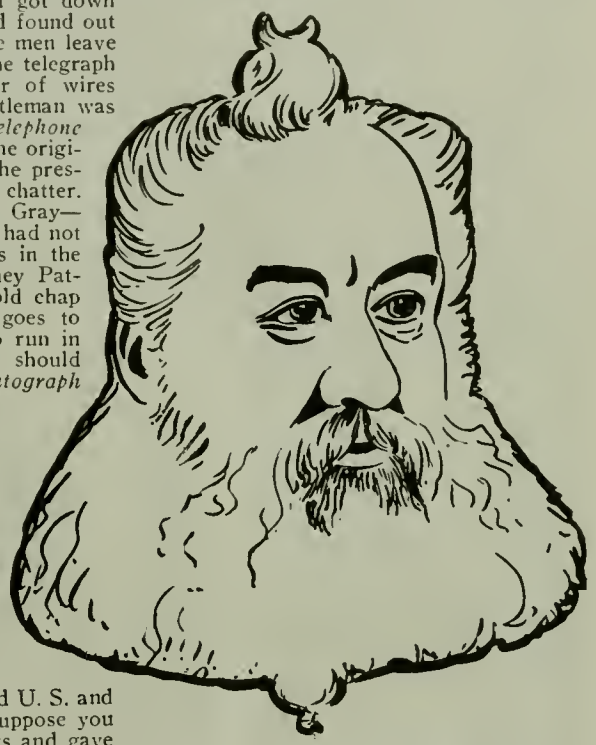
"Europe was a long way off until Cyrus Field succeeded in stringing an *undersea cable* between the two continents in one piece. That made him get in rich with Congress, and he got a medal to show his friends for the stunt, too. It was in 1858—the time that George Washington was fighting the battle of Waterloo—that the cable had one end in the good old U. S. and the other in Europe. I don't suppose you care, but Cyrus gave a few kicks and gave up in the city of New York, 1892.

"You know of Nick Tesla (his picture is on one of the other pages), the fellow that pulled one over on Columbus in the egg stunt. Well, he just had to do something for the telephone and invented a *repeater* for it. Then Tom—who? Edison—improved it a lot. And a gob of other guys boosted the proposition along. Some wise guy hops along and steps on two circuits, and sticks another to work on the same lines—Hoovering on wire. It was on the same order that Bell tried to do with the telegraph, only different. They dubbed it the *phantom circuit*, altho it is not as mysterious as the name implies. Then along comes the *multiplex system*, words and music by Major General Georgie Owen Squier, Chief Signal Officer of the United States Army, and right away he goes the phantom circuit one better by letting five talkers in on the line simultaneous together and at the same time. Not only that, but it lets a crowd of 'brass pounders' in on the circuit at the self-same operation, *tout de suite*.

"De Forest, in his wireless experiments, slipt them the pass to get in on that stunt by creating the *Audion*. That is why the system is referred to as the *wired wireless*.

"By combining wireless and the lines together, we get some pretty long distances covered by the voice. Not so long ago when some notable English guy listened to both oceans at the same time over the telephone we thought it was grand. To-day that's commonplace. Now, if the guys around the player stop coughing, and they have good conditions and sensitive instruments, it is possible to hear Hawaiian hula players do their song and dance in New York City over the wire and wireless.

"I doubt if Sam Morse knew what he really did when he constructed his first telegraph instrument. Just think of the



Prof. Alexander Graham Bell, the Gink Who Invented the Hello Girls.

war and sporting (accent on the sporting) wires! What would we do without them? Take the business as a whole. We would feel like we were lost without 'phones and 'wires.'

"When the real thing marches in, a load of by-products comes out on the next section. When Edison called up over a 'phone and instead of saying 'Are you there?' or 'Is this you?' he said 'Hello!' That took like 'Over the top,' 'Lay on, McDuff' and such slogans, saws, or what-you-call-'ems. Now we would think a boob crazy were he to say 'I am talking—is there anybody on the other end of the line?' 'Hello' is good anywhere, China, Africa, or Chile, but not in France, where it is 'Alloh.'

"Now, if we can only get rid of the central station," said Punk Loomis, "and replace the live hello-girl with an automatic one that will not get tired or angry when the customers cuss over the 'phone, then we will have it down pat."

"You're 'way behind the times," came back Stokes with an impatient gesture of his head. "What you want to do is to take a flying trip to Chicago and give their automatic telephone rinktum the once over. And, believe me, it is some contraption. Of course, Windy City citizens have the regular Bell 'phone also, so when they get tired of cussing the hello-girls they can switch to the automatic, which is some indoor sport. The two systems necessitate the use of two telephones in one office, and on any Monday morning you can see your Windy citizens doing the hula-hula trying to talk into two phones and to two cus-

(*Continued on page* 155)

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 address 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.

ROTATING MAGNETIC FIELD QUERY AND ROGER'S RADIO SYSTEM.

(1004) J. M. McDonald, St. Louis, Mo., writes:

Q. 1. Asking several questions about the rotating magnetic field and Tesla "electric egg" apparatus.

A. 1. We give you the following suggestions in answer to your questions. The rotating magnetic field is very clearly explained in the April number of the ELECTRICAL EXPERIMENTER, containing an article by Dr. Nikola Tesla on his induction motor and how it works, which we are sure will make the matter plain to you, as a clear hydraulic analogy is given therewith.

In connection with the "electric egg" apparatus, we would advise that the two opposite coils are connected so as to give North and South poles respectively.

Elsewhere in the present issue you will find a special article on the "Rogers' Underground Wireless System for Amateurs." This will answer many questions such as the one you ask concerning the length of aerial, etc., and briefly we might say that for short wave lengths of about 200 to 300 meters, a wire (rubber covered auto-cable) about 300 feet in length could be used. When the free end of the wire is grounded, the signal strength is reduced. Generally speaking, and for ordinary amateur and even commercial requirements, but one wire is found necessary.

VALUE OF THE "SOLAR CONSTANT."

(1005) Emmanuel Bellon, Peoria, Ill., writes this department:

Q. 1. About the value of the mean "solar constant."

A. 1. There seems to be indeed much promise in the development of an efficient solar energy plant, and while little has been done along this line in a commercial way of late, yet some very interesting work has been accomplished by a number of scientists, who have worked on the problem. It is a most interesting and valuable field to work in.

The result of nearly seven hundred tests conducted by the Smithsonian Institute of Washington and in various parts of the world, has resulted in accepting 1.93 *calories per square centimeter per minute*, as the mean "solar constant." This is equivalent to 7.12 British thermal units per square foot per minute. The best body for the conservation of the radiant energy into heat energy is a dead black one.

RADIO QUERIES ON MIGNON RECEIVING SET.

(1006) A. S. ———., Chicago, Ill., inquires of the Oracle:

Q. 1. What is the coil around the Audion used for in the Mignon receiving set, and also what is the object of the metal coupler core?

A. 1. Concerning the Mignon type R. W. No. 3 radio receiver, would advise as follows:

Regarding the two specific points you mention first, about the coil around the Audion tube, this is hooked up with one of the tuned oscillatory circuits, so that the oscillating magnetic field created within it, would act electromagnetically on the electron stream within the detector, somewhat in the same manner as is the case where a permanent steel magnet is placed in proximity to a vacuum tube detector to improve its operation. The effect on the electron stream is to either concentrate it or spread it, thus making the path from grid to plate either more conductive or less conductive, depending upon the polarity and position of the magnetic field.

To Our "Oracle" Friends

Do you realize that not one day passes when we do not receive from 150 to 250 letters address to "The Oracle"? If we were to publish all the questions and their answers we would require a monthly magazine five or six times the size of the ELECTRICAL EXPERIMENTER, with no other matter but questions and answers. Of late the influx of letters has become so heavy that several of our associates have been forced to discontinue important editorial work, in order to answer the mail. This we are certain you do not wish. You do not want your magazine to lower its present high standard. You want the best, the very best, and you know we never have failed you yet.

Moreover the multitude of letters are wholly unnecessary. Most of the questions Readers ask every day have been answered before in "The Oracle." Therefore. ere you sit down to write us, look over your back numbers, and nine times out of ten you will find the answer.

We strive hard to publish only such matter as has not appeared before in our columns, and for that reason, only a small fraction of the queries received by us are actually publisht.

Your magazine is steadily coming to the fore as the greatest publication in the scientific world. To keep up its present high standard and to make it a better and bigger magazine requires a tremendous amount of untiring effort on the part of the Editors. Therefore, in the future, we CANNOT in your own interest, answer questions by mail, free of charge.

For questions requiring an immediate answer our fee is 25 cents for the first three ordinary questions, and 25 cents for each additional question. We will gladly advise fee for special questions entailing considerable research work or calculations.

Stamped and addrest envelope should be enclosed with the queries, and moreover, any sketches accompanying them should be drawn in ink on separate sheets. Write plain and, PLEASE, PLEASE BE BRIEF.

Editor of "The Oracle."

Concerning the disc core transformer in the Mignon coupler, so far as we understand, this disc core was either of iron or some other alloy of a ferrous nature. Apparently the designer aimed to or tried to give the impression that this form of transformer would be much more efficient than the standard radio coupler, owing to the presence of the ferrous core, which of course would give a much higher permeability, or flux carrying power.

We refer you to the March, 1917, issue of the ELECTRICAL EXPERIMENTER, page 811, where you will find complete diagrams and explanation of the Mignon adjustable disc core receiving transformer and circuits, written by Mr. Ernest Mignon, the inventor, himself.

RECORDING RADIO SIGNALS

(1007) W. T. Smith, Stockton, Kansas, wishes to know:

Q. 1. Of methods in use for recording radio-telegraphic signals.

With reference to apparatus sufficiently sensitive to record wireless signals at considerable distances, would suggest that you look over the article entitled, "Radio Amplifiers," which appeared in the November, 1918, issue of the ELECTRICAL EXPERIMENTER. A great number of different types of amplifiers are there described, and data is also given on their make-up.

Finally, we would suggest that there are two methods now in use commercially for recording wireless signals. The first one, which is employed at the Marconi Trans-Atlantic Radio Stations, utilizes two to three stage vacuum valve amplifiers, and the signals are recorded on a phonograph or "Dictaphone." The second method is that which has been used by the De Forest engineers, and this system of recording wireless messages or signals, utilizes two, three, or higher Audion amplifiers to boost the signals to a sufficient strength to operate a polarized relay. This, in turn, actuates a Morse register or tape recorder. The De Forest people have also successfully employed a Poulsen *telegraphone* for recording the signals after amplification by an Audion amplifier.

It might interest you to know that the De Forest experts have perfected a six-stage Audion amplifier with an *amplifying capacity of one million times.*

DESIGN OF PHONOGRAPH HORNS.

(1008) Howard L. Quick, Jr., Brooklyn, N. Y., wants data as follows:

Q. 1. How a large phonograph sound chamber or horn should be built?

A. 1. Relative to construction of phonograph sound box or horn, which in every case should be of some hard wood, an eminent sound authority, Prof. Dayton C. Miller, gives data as follows: The horn is best constructed of some hard wood such as maple, mahogany, hollywood or oak. The

(*Continued on page* 146)

THE ORACLE

(Continued from page 144)

wood for ordinary size horns may be ½ to ¾ inch stock, finished perfectly smooth inside and preferably varnished. Glue the joints and do not nail them. Mahogany is very well suited to the purpose indeed. The wood stock used should be quite thick, as the whole principle of the phonograph sound chamber is to vibrate the column of air within the chamber, and with this object in mind, and as pointed out by some of the highest scientific authorities on acoustics, the walls forming the chamber should not be thin enough to vibrate, but should be *rigid, so that the column of air can vibrate freely, and only this column of air.*

The longer the horn the better, and as the wave length in air of the average voice, such as the *baritone,* is about 4½ feet, the total mean length of the sound chamber from the reproducer should not be less than this value. Providing the sound chamber has at least this length, and that the diafram of the reproducer is large enough, say at least 2½ inches, so as to vibrate at the usual range of frequencies predominant in speech and music reproduction, then you should obtain very good results.

A high authority in the field of acoustics recently mentioned to the Editor of this column that the best phonograph music he ever heard in the laboratory, was that given from a wooden horn seven feet long, which took care of all the longer as well as the shorter wave lengths and frequencies. Very fine results were obtained from a still more rigid horn, constructed of concrete, he stated.

This authority also mentioned that a very slight difference was noted as to whether the sound chamber was made *square* or *round* in cross-section. The lines of its length should expand continually and not be parallel. Furthermore, the general contour or shape of the walls of the horn may be made perfectly straight, and no increased efficiency is obtained by any fancy frills or curves in the horn, as is claimed by many phonograph companies. Also it is a proven fact by laboratory tests, that any form of wooden grill or vane whatsoever placed in the mouth or opening of the sound chamber, only lowers the tonal and acoustic efficiency of the instrument.

With regard to needles, it is also interesting to note that tests have shown where anything softer than a steel, diamond or saffire point is used, that pure and clear sound reproduction is sacrificed, such as when fiber needles are used. Prof. Miller stated the situation very succinctly and correctly, we believe, when he said that "If you use fiber needles and like them, then use them, as they of course effect a saving in the wear on the records." The fact remains however, that any such needle as this absorbs a considerable portion of the vibrations of the music picked up from the record, and dissipates it before it ever reaches the diafram. The same reasoning applies to many other fancy attachments offered to the phonograph public.

A. C. MOTOR STARTING COIL CONNECTIONS.

(1009) G. S. Golden, Harrisburg, Pa., writes:

Q. 1. How do you connect up the starting coils on an A. C. single phase induction motor?

A. 1. We give herewith diagram of connections for the four starting coils on your A. C. motor. The current must flow around the successive poles in an opposite direction,

(Continued on page 148)

Advertising Talks
NUMBER 3

LAST month I showed you how necessary it was to the life and growth of a big magazine like the ELECTRICAL EXPERIMENTER to have a large number of satisfied advertisers, and explained how more advertisers meant a bigger magazine for you and more reading matter. This month I want to give you a few more reasons why it is worth your while to patronize firms who advertise, and especially those who advertise in the EXPERIMENTER.

When you pay your good money for some article, no matter what it is, you want to get the very best quality possible for the money. Advertised articles are always of better quality than unknown, unlabeled, and unbranded goods. This is easily proven. Compare such well-known brands as the Sonora Phonographs, Starrett Tools, Brandes or Murdock Receivers, etc., with similar articles put out by firms who have not the ambition or progressiveness to standardize their merchandise. The comparison always proves the superiority of the advertised article.

There is a good reason why this is so. It costs money to advertise. An inch ad in the ELECTRICAL EXPERIMENTER costs $8.40 for one insertion—a page ad $264.60. An advertiser who is using ten or twelve magazines and spending anywhere from $1,000 to $10,000 a month to tell you about the goods he has for sale, must get his money back by keeping you as a steady customer. It costs too much to make the first sale to drop your friendship then and there. He must make you a strong booster of what he has to sell, and keep you a steady customer if he is to make money. The only way he can do it is by giving you better quality and a cheaper price than possible anywhere else. If he doesn't give you a better article and save you money you won't remain a steady customer and he loses.

Therefore, when an advertiser spends a small fortune each year to build up a reputation, don't think for a single moment that he is going to risk that reputation or run the chance of having his money thrown in the gutter by putting out inferior goods. Far from it! The advertiser lays his cards on the table. He says, "Here's who I am, and what I am and what I have to sell you." He is frank with you. He does not try to "stick" you. He cannot afford to.

When you send your orders to any concern which advertises in the ELECTRICAL EXPERIMENTER you know that you are sending them to a reliable firm (we do not accept advertising orders from any concern except those that we know are reliable.) You will know that the goods which you will get are the best that you could buy for the money. You will know that the advertiser stands back of his goods and is willing to make good if any dissatisfaction should arise.

I have given you only a few reasons why it is a business proposition for an advertiser to give better service, put out a better quality of goods, and offer you more for the money than you would get from a non-advertiser. There are many others. Next month I will take up the matter of costs and prices and show you just how the advertiser can sell goods more cheaply than his competitor.

Advertising Manager.

How to Increase Your Will Power In One Hour

Author of This Article Tells How He Quickly Acquired a Dominating Will Power That Earns Him Between $50,000 and $70,000 a Year

FOUR YEARS ago a man offered me a wonderful bargain. He was hard up for money and wanted to sell me some shares in a young, growing company for $1,000. Based on the earnings of the Company the stock offered me was easily worth $5,000—in fact, the man who finally bought the shares sold them again in five months *at a profit of* $4,300.

The reason I didn't buy the shares was that I could no more raise a thousand dollars than I could hop, skip, and jump across the Atlantic Ocean. A thousand dollars! And my income only twenty-five a week.

The second chapter in my life began a few months later, when another opportunity came to me. It required an investment of $20,000 during the first year. I raised the money easily, paid back every penny I borrowed, and had $30,000 left at the end of the first year! To date in less than four years, my business has paid me a clear profit of over $200,000 and is now earning between $50,000 and $70,000 a year. *Yet for twelve years before, the company had been losing money every year!*

The natural question for my reader to ask is, "How could you borrow $20,000 to invest in a business which had previously been a failure, after being unable to borrow $1,000 for an investment that seemed secure?" It is a fair question. And the answer can be given in two little words—*WILL POWER.*

When the first proposition came to me I passed it by simply because I didn't have the money and couldn't borrow it. I went from one friend to the next and all turned me down. Several refused to talk business with me at all. They all liked me personally, and they asked about the kiddies, but when it came to money matters I hadn't a chance. I was scared stiff every time I talked to one of them. I pleaded with them, almost begged them. But everybody had their "money all tied up in other investments." It was an old excuse, but I accepted it meekly. I called it hard luck. But I know today that it was nothing in the world except my lack of Will Power or rather my weak Will Power, which kept me from getting what I wanted.

Partial List of Contents

The Law of Great Thinking.
The Four Factors on which it depends.
How to develop analytical power.
How to think "all around" any subject.
How to throw the mind into deliberate, controlled, productive thinking.
Detailed directions for Perfect Mind Concentration.
How to acquire the power of Consecutive Thinking, Reasoning, Analysis.
How to acquire the skill of Creative Writing.
How to guard against errors in Thought.
How to drive from the mind all unwelcome thoughts.
How to follow any line of thought with keen, concentrated Powers.
How to develop Reasoning Power.
How to handle the mind in Creative Thinking.
The secret of Building Mind Power.
How the Will is made to act.
How to set your Will.
How a strong Will is Master of Body.
What creates Human Power.
The Six Principles of Will Training.
Definite Methods for developing Will.
The NINETY-NINE METHODS for using Will Power in the Conduct of Life.
Seven Principles of drill in Mental, Physical, Personal Power.
FIFTY-ONE MAXIMS for Applied Power of Perception, Memory, Imagination, Self-Analysis, Control.
How to develop a strong, keen gaze.
How to concentrate the eye upon what is before you—object, person, printed page, work.

These are only a few of the many subjects treated.

When I heard that the man sold those shares at a profit of $4,300, it seemed that my sorrow could not be greater. That profit was just about what my salary amounted to for four years! But instead of grieving over my "hard luck," I decided to find out why I was so easily beaten in everything I tried to accomplish. It must be that there was something vital that made the difference between success and failure. It wasn't lack of education, for many illiterate men become wealthy. What was this vital spark? What was this one thing which successful men had and which I did not have?

I began to read books about psychology and mental power. But everything I read was too general. There was nothing definite—nothing that told me *what to do.*

After several months of discouraging effort, I finally encountered a book called "Power of Will," by Prof. Frank Channing Haddock. The very title came to me as a shock. When I opened the book I was amazed. I realized that will power was the vital spark—the one thing that I lacked. And here in this book were the very rules, lessons and exercises through which anyone could increase their will power. Eagerly I read page after page; including such articles as The Law of Great Thinking; How to Develop Analytical Power; How to Concentrate Perfectly; How to Guard Against Errors in Thought; How to Develop Fearlessness; How to Acquire a Dominating Personality.

An hour after I opened the book I felt like a new person. My sluggish will power was beginning to awaken. There was a new light in my eye, a new spring in my step, a new determination in my soul. I began to see, in my past, the many mistakes I had made, and I knew I would never make them again.

I practiced some of the simple exercises. They were more fascinating than any game of cards or any sport.

Then came an opportunity to acquire the business which had lost money for twelve years, and which I turned into a $50,000 a year money maker. Instead of cringing before the moneyed people, I won them over by my sheer force of will. I would not be denied, and my every act and word since then has been the result of my training in will power.

I am convinced that every man has within himself every essential quality of success except a strong will. Any man who doubts that statement need only analyze the successful men he knows, and he will find himself their equal, or their superior, in every way except in will power. Without a strong will, education counts for little, money counts for nothing, opportunities are useless.

I earnestly recommend Prof. Haddock's great work. "Power of Will," to those who feel that success is just out of reach—to those who lack that something which they cannot define, yet which holds them down to the grind of a small salary.

Never before have business men and women needed this help so badly as in these trying times. Hundreds of real and imaginary obstacles confront us every day, and only those who are masters of themselves and who hold their heads up will succeed. "Power of Will" as never before is an absolute necessity—an investment in self-culture which no one can afford to deny himself.

I am authorized to say that any reader who cares to examine "Power of Will" for five days may do so without sending any money in advance. If after one hour you do not feel that your will power has increased, and if after a week's reading you do not feel that this great book supplies that one faculty you need most to win success, return it and you will owe nothing. Otherwise send only $3, the small sum asked.

Some few doubters will scoff at the idea of will power being the fountain head of wealth, position and everything we are striving for, but the great mass of intelligent men and women will at least investigate for themselves by sending for the book at the publisher's risk. I am sure that any book that has done for me—and for thousands of others—what "Power of Will" has done—is well worth investigating. It is interesting to note that among the 250,000 owners of "Power of Will" are such prominent men as Supreme Court Justice Parker; Wu Ting Fang, Ex-U. S. Chinese Ambassador; Gov. McKelvie, of Nebraska; Assistant Posmaster-General Britt; General Manager Christeson, of Wells-Fargo Express Co.; E. St. Elmo Lewis; Senator Arthur Capper of Kansas and thousands of others. In fact, today "Power of Will" is just as important, and as necessary to a man's or woman's equipment for success, as a dictionary. To try to succeed without Power of Will is like trying to do business without a telephone.

As your first step in will training, I suggest immediate action in this matter before you. It is not even necessary to write a letter. Use the form below, if you prefer, addressing it to the Pelton Publishing Company, 30 K Wilcox Block, Meriden, Conn., and the book will come by return mail. You hold in your hand, this very minute, the beginning of a new era in your life. Over a million dollars has been paid for "Power of Will" by people who sent for it on free examination. Can you, in justice to yourself hesitate about sending in the coupon? Can you doubt, blindly, when you can see, without a penny deposit, this wonder-book that will increase your will power in one hour.

The cost of paper, printing and binding has almost doubled during the past three years, in spite of which "Power of Will" has not been increased in price. The publisher feels that so great a work should be kept as low-priced as possible, but in view of the enormous increase in the cost of every manufacturing item, the present edition will be the last sold at the present price. The next edition will cost more. I urge you to send in the coupon now.

PELTON PUBLISHING COMPANY

30-K Wilcox Block, Meriden, Conn.

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

Name.....

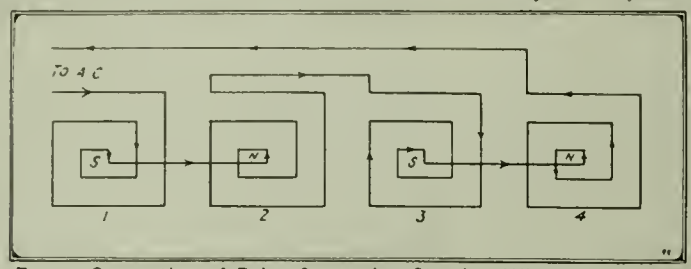
Address.....

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

The Oracle

(*Continued from page* 146)

as the diagram shows. Those you show in your letter are not correct, for they give like polarity on each pole, which is wrong. We have no data on the starting coil dimensions, but you can arrive at this by experiment, or else by getting in touch with the manufacturers of a similar sized motor.



Proper Connection of Poles Composing Starting Winding of Induction Motor.

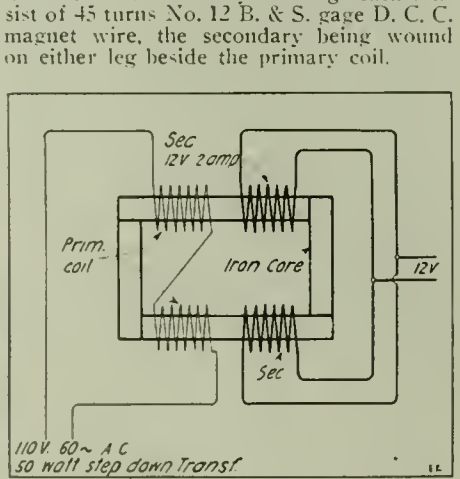
SPECIAL 110 VOLT TO 12 VOLT A. C. TRANSFORMER.

(1010) August Kling, Mobile, Ala., writes:

Q. 1. Asking for data on building a small step-down transformer to give 12 volts at the secondary, which he desires split into two coils. Total output 50 watts.

A. 1. We give herewith data on double wound closed core transformer to step-down 110 volts 60 cycle A. C. to a maximum secondary voltage of 12 volts.

The laminated sheet iron core for this transformer may measure 5 inches wide by 6 inches long, and have a cross-section of 1 inch by ½ inch. At either end of the two longer legs, as the diagram herewith shows, two primary windings may be placed, each of them consisting of 200 turns of No. 18 D. C. C. magnet wire. At either end of the two long legs, the two secondary windings may be placed, as the diagram shows, each of these developing about 12 volts and about 2 amperes, or giving 12 volts and 4 amperes or 50 watts, the total output you request for both secondaries connected in parallel. It is understood that both primaries in this design are to be connected in series on 110 volt 60 cycle A. C. at all times, i.e., whenever the transformer is used. The secondary windings each consist of 45 turns No. 12 B. & S. gage D. C. C. magnet wire, the secondary being wound on either leg beside the primary coil.



Details of 110-Volt to 12-Volt A. C. Transformer. Secondary Coils May Be Connected In Parallel or In Series.

With respect to taking off taps on the secondary for different voltages, you can easily divide up the total number of turns on the secondary yourself by means of a small battery voltmeter. You can readily test the potential by experiment. The voltage in any case is directly proportionate to the number of turns in use.

100-WATT, 32 TO 8-VOLT STEP-DOWN TRANSFORMER.

(1011) Claude Carefoot, Pasqua, Sask., Canada, inquires:

Q. 1. For data on step-down transformer to reduce 32 volts to 8 volts, A. C.

A. 1. We do not of course know how many watts you wish the transformer to carry, but we give you herewith data on a 100-watt transformer. The laminated sheet iron core may be about 8" long by 6" wide and thickness of 1". The core should have a cross-section of 1 square inch. The primary winding, on one leg of the transformer, should consist of 230 turns of No. 11 D.C.C. magnet wire.

The secondary winding should have 58 turns of No. 5 D.C.C. magnet wire.

My Inventions
By Nikola Tesla

(*Continued from page* 112)

any special thought of our far more imperative necessities. The "Magnifying Transmitter" was the product of labors extending through years, having for their chief object the solution of problems which are infinitely more important to mankind than mere industrial development.

If my memory serves me right, it was in November, 1890, that I performed a laboratory experiment which was one of the most extraordinary and spectacular ever recorded in the annals of science. In investigating the behaviour of high frequency currents I had satisfied myself that an electric field of sufficient intensity could be produced in a room to light up electrodeless vacuum tubes. Accordingly, a transformer was built to test the theory and the first trial proved a marvelous success. It is difficult to appreciate what those strange phenomena meant at that time. We crave for new sensations but soon become indifferent to them. The wonders of yesterday are today common occurrences. When my tubes were first publicly exhibited they were viewed with amazement impossible to describe. From all parts of the world I received urgent invitations and numerous honors and other flattering inducements were offered to me, which I declined.

In Faraday's Chair

But in 1892 the demands became irresistible and I went to London where I delivered a lecture before the Institution of Electrical Engineers. It had been my intention to leave immediately for Paris in compliance with a similar obligation, but Sir James Dewar insisted on my appearing before the Royal Institution. I was a man of firm resolve but succumbed easily to the forceful arguments of the great Scotchman. He pushed me into a chair and poured out half a glass of a wonderful brown fluid which sparkled in all sorts of iridescent colors and tasted like nectar. "Now," said he, "you are sitting in Faraday's chair and you are enjoying whiskey he used to drink." In both aspects it was an enviable experience. The next evening I gave a demonstration before that Institution, at the termination of which Lord Rayleigh addressed the audience and his generous words gave me the first start in these endeavors. I fled from London and later from Paris to escape favors

(*Continued on page* 173)

How to Build an Efficient Medical Coil Set

(*Continued from page* 125)

The tin foil and paraffined paper condenser used with this coil for intensifying the current for shocking purposes, etc., may be composed of about forty sheets of tin foil measuring 3x4 inches, each foil leaf separated with a layer of paraffined paper. Alternate sheets are connected together to form a terminal, and the condenser is finally connected up with the switch, as shown in Fig. 1, so that it can be cut in or out of circuit as desired.

Wooden Cabinet.

The cabinet proper, housing the two dry cells and the medical coil with control switches, in the case of the writer was made of some ¼-inch pine obtained from some old boxes. To further explain, and after considerable experience in building apparatus of this and kindred sorts, experience dictates that it is best not to bother with any elaborate wooden outer cabinets, but to make it more rugged by housing the apparatus and coils in a small dress-suit case. The author purchased one of these for $2.00, which filled the bill perfectly, the case being made of fiber with a good lock and hasp, reinforced corners and leather handle. The case measured 14 inches long by 8¾ inches in width and 4¾ inches in depth. Before building the cabinet, therefore, and providing you intend to enclose the apparatus in a case of this kind, which may be purchased at any trunk and bag store, you should ascertain the dimensions of the case beforehand, so that the cabinet will fit into it properly. As becomes apparent from Fig. 3, the top of the cabinet is the only part that shows when the case is open, and therefore it will be evident that the bottom can be made of pine and given a coat of black shellac or black coach varnish. The battery cover in the author's instrument is made of polished mahogany, being one-half of a mahogany base which originally belonged to an obsolete wireless instrument and a strip of polished mahogany was used for the central upright alongside the induction coil. The main switch panel which supports the coil of the condenser switch and the twelve points, also the secondary switch, is best made of either black fiber, polished hard rubber or bakelite. As the switch contacts are quite close together, and potentials of several hundred volts are carried thru adjacent contacts.

The battery compartment cover is held in place by means of four eye hooks, which can be purchased for a few cents at any hardware store, and as the experimenter has never yet been born, to the writer's mind, who has not wanted to use the battery which he has just locked up in a cabinet, provision is made so that the battery in this cabinet can be used at any time without having to open the compartment. For this purpose two auxiliary battery terminals or binding posts are placed on the side of the battery switch as Figs. 1 and 2 show.

Miscellaneous.

All of the connections under the panel supporting the apparatus as well as the battery connections are best made with rubber-covered flexible conductor about No. 18 B. & S. gage capacity. At Fig. 6 there are shown details for making the two metal handles, as well as a sponge electrode for treatment with saline solutions (salt water). The handles, if they are to be made instead of purchased, are very well composed of two lengths of brass tubing of about ¾-inch outside diameter by 3½ inches long. Each of these handles should be plugged up by a thick brass washer or a piece of ⅜ brass turned to make a driving fit in the tube, and which may be afterward sweated with solder so as to make a smooth tight joint which cannot be noticed, especially when the handles are afterward nickel plated. Thru the center of the plug a No. 8-32 tap hole should be drilled and threaded, into which a binding post may be secured or else a wooden handle as shown in the detail sketch, Fig. 6, may be utilized. This handle is turned up from some hard wood and given a coat of black shellac, and in the smaller end of the handle there is tightly fitted a piece of No. 8-32 screw. A small hole may be drilled crosswise thru the screw near the wood thru which the cord tip may be placed to make connection when it is used.

This wooden handle is very essential when the sponge electrode is employed, when it is screwed into the threaded shoulder in this electrode. To make the sponge electrode you will require a small piece of soft sponge about ½ inch thick which is sewed or laced with some heavy thread to the brass disc shown at Fig. 6. When using this electrode it is dipt into a salt water solution and applied over the part affected, such as a stiff muscle or cord, the patient holding the other handle in the hand, etc. The positive and negative poles of a faradic current as delivered at the binding post terminals, H and H¹, is readily determined by means of a polarity indicator, and the writer has successfully used very often one of the pole test paper indicators available on the market. This paper is dampened when it is to be used for determining polarity. Some of the papers turn red at the negative pole, and others turn red at the positive pole.

Paris Letter

(*Continued from page* 119)

tributed and is interrupted in a certain rhythmic manner, which thus gives alternating periods of rest and work to the actuated muscles. The application of the current is made by large metallic surfaces, the electrodes covering the entire muscular region under treatment. The method of application of these electrodes is carefully supervised by the physician in order to get the best results. The large surface electrodes overcome to a great extent the high resistance of the skin, and also renders it certain that the patient does not experience any disagreeable sensation.

There is no nervous fatigue. The patient himself is unconscious of this gymnastic, passive *ergotheropy;* he experiences no shocks nor any disagreeable twitching. There is no muscular fatigue; the muscles are strengthened immediately; particularly the abdominal muscles are greatly benefited. The local circulation is highly stimulated. The motor functions of the muscles rapidly emerge from their impotency.

Our photographs were taken at the Grand-Lebrun Hospital at Bordeaux, Prof. Bergonié himself being in charge of the same. One of the photographs shows one of the electro-therapeutic wards while the faradization is taking place. It is interesting to watch the patients while they undergo the treatment. They seem to be unconscious of the effect of the current, but their muscles are working overtime. Our *Poilus* continue reading their newspapers and magazines as if they were actually enjoying a pleasant rest. The treatment extends for two hours in the morning and two in the evening, but in some cases the treatment is decreased or increased as becomes necessary, all depending on the specific cases. In one of our photographs we see a *poilu,* suffering from a fracture of the leg bones and the loss of his calve muscles, who was enabled to walk again without difficulty within fifteen days.

EXPERIMENTS IN RADIO ACTIVITY.

(*Continued from page* 123)

an undisputed footing to the atomic theory and has helped to solve many problems which have been puzzling the scientists for years.

Of course this series is only a beginning and the experimenter wishing to continue should procure a standard work on the subject such as Rutherford's justly famous "Radio-active Substances and Their Radiations." It is hoped by the author that these articles have begot an interest in this far-reaching and fascinating study.

(*Conclusion*)

WIRELESS SIGNALS HEARD THREE-QUARTERS OF A MILE.

As considerable discussion is often heard among radio men, both Professional and Amateur, as to the distance over which an amplified radio signal has been heard, it may be of interest to mention in this connection that Dr. Louis W. Austin of the U. S. Naval Radio-Telegraphic Laboratory states in a recent letter to the Editors that he has often heard incoming radio signals amplified by means of *standard* radio apparatus so as to be audible for from *½ to ¾ mile!* He also states that he believes it possible to amplify phonograph music or speech thru the aid of a standard audion amplifier having several stages and loud talking attachment, so that the music could be heard over a distance of a mile or more.

What's in a Cover?

WHAT we really should say is, "What's ON a cover?"—but you *did* get the meaning after all. There are covers and covers, or to qualify it better, let us say cover illustrations. Tons of reams could be written about them and still the correct answer as to what constitutes a *good* cover would be as nebulous to you as it is to every other magazine editor. To be sure, the "pretty girl" cover has been proven *the* real seller, but so has the homely baby face, and the ugly bulldog, not to speak of Charlie Chaplin or the playful kitten cover. All of these make good covers and the public buys millions of copies of publications every day on account of them.

But the subject on the cover alone does not always mean that it will prove a big seller. Like as not the color scheme plays just as big a rôle. For if the color is not pleasing, the magazine often does not sell, even if the pretty girl *does* adorn its front. Then there is the "teaser," the "wonder-what-it-is" cover. If gotten up correctly, and if it stirs up sufficient curiosity in a man's breast—every copy will be sold as a rule. For after all, man is curiosity incarnate, and is willing to pay for appeasing it!

Our April cover was of this sort, as indeed it was an all-around ideal type. It had the mysterious element in it; it was startling, and the color combination was right and pleasing.

Some one—an authority on magazines—said that if we did get out a thousand covers, we could never hope to beat the April cover! And if the sales of the April issue is an index, his prophecy probably will come true! Indeed, we had to print an extra edition, and that did not cover the demand.

Of course, adverse criticism was not lacking. A few cranks—the usual monthly crop—were on deck, loudly denouncing us. Their virtuous ego had been shocked profoundly because we dared to show a woman unattired, save for her—skeleton!! These "critics" like as not forget that "to the pure everything is pure." They belong to that fanatic category of men who can't bear to look at the naked truth, because it is—naked!

So we were pleasantly surprised when hundreds of readers from all sections of the country began sending us clippings of the editorial which accompanies this article.

This editorial was written by Arthur Brisbane, the highest paid editorial writer in the world. It was publisht in the New York *Evening Journal*, the Chicago *American*, the Washington *Times*, the Boston *American*, the Atlanta *Georgian*, the San Francisco *Examiner*, and the Los Angeles *Examiner*.

Mr. Brisbane seldom uses illustrations in his editorials. That he picked out our April cover illustration proves that it must have been good. Indeed, we may paraphrase Mr. Brisbane's editorial by asking:

"What is a Cover Illustration? A Backbone." And again:

"While there are many *magazines*, so few of them are vertebrate that you can count them on the fingers of your two hands in the United States."

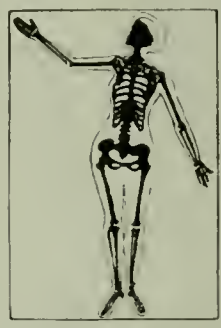
Ask yourself or your friend, "What *magazine* do you know that you can call a vertebrate? What *magazine covers* have you ever heard anybody discuss?" See how many answers you get.

Today the ELECTRICAL EXPERIMENTER is the most widely quoted scientific publication in this country. Within its covers you will find the last word on Radio, Electricity, Aeronautics, Chemistry, Astronomy, Mechanics and all the allied sciences, written so that the layman as well as the most modern theorist may enlarge his fund of knowledge. Therefore do you wonder that hardly a newspaper worth the name fails to quote the EXPERIMENTER several times a month?

What do *you* think is the reason?

EDITORIAL PAGE
OF THE
NEW YORK
EVENING JOURNAL

What Is an Editorial?
A Backbone.



Here, reproduced from that interesting scientific journal The Electrical Experimenter, is a picture showing a lady's skeleton photographed by modern methods. You will see the resemblance between these bones and the editorial

Copyright 1919 by Star Company

On your knees thank-kind Providence that we heve not X-ray eyes, but eyes that see the surface, nothing below.

If like the mysterious penetratiog rays we could see THROUGH, see the bones, the crinkly skull, with its interesting seams, and all the rest, how gruesome we should look to each other

Marriages would all be made in heaven, none of them on earth. We should all look too ugly.

But wise Providence bmits us to a millioo directioos, giving us what we need to make os useful and efficient here and nothing unnecessary

We cannot see colors below the red or above the violet. Insects probably see others. We cannot detect sound except within a narrow range We see the bloom on the cheek not the bone inside of it We see the pretty graveyard with the green grass and the flowers, but do not know what happened to the individual who went in there

We see the baby, just arrived, chewing its fist in the cradle, but don't know whence it came, what it was doing before it got here

And it is all for the best

This is written to answer a reader who asks, "What part should you say that the editorial plays in a newspaper?"

This little picture answers the question

The editorial in a newspaper, if it IS an editorial, which it usually ISN'T, plays in that newspaper the part that the skeleton, and particularly the backbone, plays in the anatomy and the activity of the young lady in this picture

She doesn't show it, her young man doesn't know it, the world at large doesn't know it, but the most important thing about her, that which makes her stand up and go through life well balanced on her two feet, is the bony structure, and particularly that BACKBONE.

The young man who doesn't know it really admires her for the backbone, admires her because she is a vertebrate, that is to say, one having a spinal column.

Without it she would lie flat on the ground, could not stand up, could not walk, could not even crawl along Beautiful hair and eyes and color would all go for nothing without the backbone.

So, inquiring reader, it is with the newspaper and the editorial column. The editorial column is the spinal column.

If the newspaper has got it, it is a vertebrate. If it hasn't got it—and newspapers usually haven't—it is a mollusk. The mollusk is good to eat, leads a prosperous, cheerful life quite often. But it is a mollusk.

In the newspaper, as in the human being, the backbone, or editorial column, makes the thing stand up and walk and gives it its power.

In this charming young person, as you can see at a glance, the skeletoo is by far the least attractive part. It cannot be compared with long, curly hair, pink cheeks, red lips, sparkling eyes, But it is more necessary than those.

The newspaper's backbone, when it happens to be a newspaper with a backbone, is perhaps the least attractivo part, the least pleasing It does not compare with the woman's page, the continued story, the fashion page, the comic page; hot it is THE BACKBONE.

While there are many newspapers, so few of them are vertebrates that you can oount them on the fingers of your two hands in the United States.

Ask yourself or your friend, "What newspaper do you know that you can call a vertebrate? What newspaper editorial columo have you ever heard anybody discuss?" See how many answers you get.

Making a Practical Electrician

(*Continued from page* 117)

The new student starts at the very beginning, under an instructor that not alone initiates him into the electrical field, but helps to mold the character and general business policy of the future electrician.

In this school no text-books are in evidence! What the student hears and sees, as well as does, is first given to him verbally by his instructor. When he has done the work with his own hands, and made such notes as will be of assistance in the future to refresh his memory, the knowledge he has gained is the only text-book he uses. In the large electrical library of the school the student may at any time refer to any topics that seem hazy or not quite clear to him.

The new man learns the elementaries first, such as the meanings of various symbols and the rudimentary rules applying to electrical calculations, after which he does the practical work at his own table. Next he performs the simple feats of connecting up bells, batteries, telephones, fire-alarms, telegraphs and all sorts of intercommunicating systems.

From here he graduates into the high branch of applied electricity and in a practise building consisting of a ten room apartment he learns how to wire for light, heat and power by all the prevailing systems, such as cleat work, wood and metal moulding, knob and tube work, armored cable, flexible and metallic conduit.

As electrical power is one of the greatest factors of American industry, and its applications many, the electrician finds a great field in his endeavors in this one branch alone. Therefore, at this school every modern power problem is studied minutely. When this part of his course is finished the student is ready to tackle anything that may come his way, be it the installing or building of switchboards to carry enormous currents, the connecting and operating of alternating and direct current motors, dynamos or generators, or the operation or installation of storage battery systems as applied to electrical vehicle propulsion, and every other phase of this branch of electrical science. With his vast storehouse of knowledge gained by actual experience the student is well qualified to enter the field of Electric Traction, the coming achievement of this century, for he will have worked on, installed and run a complete electric trolley and locomotive.

Finally the student learns the biggest bug-a-boo of all, "Armature Winding," which to most people is a science in a class by itself. At this school a complete knowledge is quickly gained in a simple and practical manner. All puzzling details are rapidly grasped and within a short time the student is winding any form of armature, stator, field or motor ever used in actual practise. This and machine shop practise, repairs, electrical drafting, etc., complete the training course.

No specified time is set for a student to complete his studies—everything depends on the individual and the rate at which he can grasp things. No entrance "exams" are needed, one can start at any time. The men hold meetings, at which all new advances in science are discust and many novel features introduced.

When finally graduated the student, diploma in hand, stands ready to meet any phase of the electrical industry. He is able to undertake any job, for he has the confidence that only comes with the knowledge that he has done with his own hands the things he will have to do in actual practise in the business world. *Photos Courtesy N. Y. Electrical School.*

Practical Chemical Experiments

(*Continued from page* 122)

decay may be at all noticeable.

COOKING OF EGGS. There is a notion prevalent that hard-boiled eggs are not digestible, and experiments made with eggs in the stomach lead to the same conclusion. Thus eggs slightly boiled have left the stomach in 1¾ hours, and raw in 2¼ hours, and hard-boiled in 3 hours. It should be noted, however, that raw eggs are only partially digested in the stomach, perhaps because they do not fully excite the flow of the gastric juice. The complete digestion is accomplished further along in the alimentary canal.

In cooking eggs, they should be placed in water at 170 to 180 degrees Fahrenheit, and allowed to remain for 10 minutes, when the yolk will be found to be more coagulated than the white, the egg albumin beginning to coagulate at 134 deg. Fahr., and it requires some time to heat the egg thruout.

A convenient method for cooking eggs without the use of a thermometer is to pour a quart or so of boiling water into a bowl, and put two or three eggs into this and allow them to remain for 10 or 12 minutes. The yolk actually cooks more readily than the white, and by this process the eggs are cooked uniformly thruout.

QUESTIONS AND ANSWERS

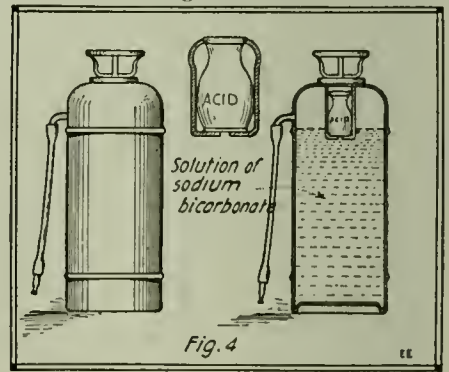
MIXING MILK AND ACID.

Ques. No. 5. A. J. Karlson, Phenix, Ariz., wants to know if it is possible after milk or cream is mixt with Sulfuric acid, to remove the latter and restore the acid to the same strength as before.

Ans. We do not quite understand your object in mixing the acid with the milk, only to revert back to the same original substances. However, this is not possible, as the acid enters into reaction with the formation of new compounds, which reaction is not reversible.

FIRE EXTINGUISHER.

Ques. No. 6. *Fire Extinguishers.* Mr. Kenneth Gordon, Tulsa, Okla., desires information regarding ingredients and operation of fire extinguishers.



Section Thru a Standard Fire Extinguisher.

Answer: A solution of sodium bicarbonat is contained in a metallic cylinder, having a flexible tube at one of the upper sides. Sulfuric acid is kept in a small container above the bicarbonat as shown in the accompanying illustration. When the extinguisher is inverted, the stopper falls out of the bottle, permitting the sulfuric acid to come in contact with the solution of sodium bicarbonat, with the formation of carbon dioxid, thus:—

$$H_2SO_4 + 2NaHCO_3 = 2H_2O + Na_2SO_4$$

The presence of the carbon dioxid gen-

erated forces the solution out thru the hose.

"Pyrene" extinguishers contain carbon tetrachlorid, a highly volatile liquid, whose vapor does not burn.

In either case the gases liberated so envelop the flame that combustion ceases, due to lack of its supporter, oxygen.

RADIOACTIVE GAS MANTLE.

Question 7. *Welsbach Mantle.* Theodore McGowan, Elmira, New York, wants to know how he can conclusively show that the Welsbach gas mantle contains radioactive substances.

Answer: The most simple and conclusive method is to place a gas mantle upon a box which contains an unexposed photographic plate, wrapt in the usual opaque paper. Set these aside for a week or ten days, and develop as usual. The result will be a photographic reproduction of the mantle, exposed by its own light, liberated by the radioactive ingredients.

FULLER'S EARTH.

Question 8. William W. Staley, Portland, Oregon, desires information as follows: Where he can obtain Fuller's earth as mentioned in the April issue, Experiment No. 3 on Butter Tests; and also the composition of the alcoholic potash solution as mentioned in Experiment No. 4 in the same issue.

Answer: (a) *Fuller's Earth* may be obtained from any chemical supply house dealing in chemicals, and may be ordered under that name.

(b) The *Alcoholic Potash Solution* mentioned is prepared by dissolving 28 grams of caustic potash (in stick form) in 1 litre of alcohol.

Science in Slang

(*Continued from page* 143)

tomers at the same time. At that, the automatic is some little system and the guy who invented it certainly had it thick behind the ears. All you have to do is to move a little disc around the front of the 'phone, having numbers from 1 to 0, and you don't have to wait for a connection, either. If the line is busy you hear the usual busy signal which means, Hang up your receiver.' After a while you try it again and you can cuss and howl all you want if it's still busy. The automatic 'phone exchange doesn't mind it in the least, and take it from me, the system works to a charm."

"That so?" interposed Punk Loomis. "When how comes it that if the system works so charmingly and charmfully, the rest of the universe doesn't adopt it?"

"You see," said Stokes, "it's like this: When a man bumps into you at the corner, almost upsetting you, it does your heart good to come back at him with a long string of verbosity that clears out your venom and makes you feel comfortable again, as soon as it is out of your system. But if you run into a lamp-post, it doesn't do you much good to cuss at it by letting loose a blue streak of hyphenated talk. Same with the automatic outfit. A man wants to have somebody to act as his personal goat once in a while. He wants to tell Central what is the matter with her. Or, if he is not inclined that way and time hangs heavily on his hands, he might want to speak to her about the color of her eyes or the texture of her soul. Never mind if she hangs up on him, that's the complexity of the human mind. So while the automatic is a fine outfit as far as it goes, it is too *inhuman*, for it refuses to be your goat and that is the reason——"

"Stokes!" yelled the steward. "Long distance is answering."

The Moon's Rotation

By Nikola Tesla

(*Continued from page* 133)

significance of this will be understood by reference to Fig. 7 in which the two masses, condensed into points, are represented as attached to independent weightless strings of lengths R_{g1} and R_{g2} which are purposely shown as displaced but should be imagined as coincident. It will be readily seen that if both strings are cut in the same instant the masses will fly off in tangents to their circular orbits, the angular movement becoming rectilinear without any transformation of energy occurring. Let us now inquire what will happen if the two masses are rigidly joined, the connection being assumed imponderable. *Here we come to the real bug in the question under discussion.* Evidently, so long as the whirling motion continues, and both the masses have precisely the same angular velocity, this connecting link will be of no effect whatever, not the slightest turning effort about the common center of gravity of the masses or tendency of equalization of energy between them will exist. The moment the strings are broken and they are thrown off they will begin to rotate but, as pointed out before, this motion neither adds to or detracts from the energy stored. **The rotation is, however, not due to an exclusive virtue of angular motion, but to the fact that the tangential velocities of the masses or parts of the body thrown off are different.**

To make this clear and to investigate the effects produced, imagine two rifle barrels, as shown in Fig. 8, placed parallel to each other with their axes separated by a distance $R_{g1} - R_{g2}$ and assume that two balls of same diameter, each having mass m, are discharged with muzzle velocities V_1 and V_2, respectively equal to $2\pi n R_{g1}$ and $2\pi n R_{g2}$ as in the case just considered. If it be further supposed that at the instant of leaving the barrels the balls are joined by a rigid but weightless link they will rotate about their common center of gravity and in accordance with the statement in my previous article above mentioned, the relation will exist $\frac{V_1 - V_2}{2} = \pi n (R_{g1} - R_{g2})$ n being the number of revolutions per second. The equalization of the speeds and kinetic energies of the balls will be, under these circumstances, very rapid but in two heavenly bodies linked by gravitational attraction, the process might require ages. Now, this whirling movement is real and requires energy which, obviously, must be derived from that originally imparted and, consequently, must reduce the velocity of the balls in the direction of flight by an amount which can be easily calculated. At the moment of discharge the total kinetic energy was $E = \frac{1}{2} m V_1^2 + \frac{1}{2} m V_2^2$ which is evidently equal to $m V_3^2$, V_3 being the effective velocity of the common center of gravity, from which follows that $V_3 = \sqrt{\frac{V_1^2 + V_2^2}{2}}$. The speed of revolution of the masses is, of course, $\frac{V_1 - V_2}{2}$ and the rotational energy of both balls, which must be considered as points, is $e = m\left(\frac{V_1 - V_2}{2}\right)$ The kinetic energy of translation in the direction of flight is then $\frac{1}{2} m V_1^2 + \frac{1}{2} m V_2^2 - m\left(\frac{V_1 - V_2}{2}\right)^2 = m\left(\frac{V_1 + V_2}{2}\right)^2 = m V_4^2$, $V_4 = \frac{V_1 - V_2}{2}$ being the speed of the

common center of gravity, so that $V_2 - V_1$ is the loss of velocity in the direction of flight owing to the rotation of the two mass points. If instead of these we would deal with the balls as they are, their rotational energy

$$e_1 = e + i\omega_1^2 = m\left(\frac{V_1 + V_2}{2}\right)^2 + i(2\pi n)^2$$

i being the moment of inertia of each ball about its axis.

As will be seen, we arrive at precisely the same results whether the movement is rectilinear or in a circle. In both cases the total kinetic energy can be divided into two parts, respectively of the same numerical values, *but there is an essential difference.* In angular motion the axial rotation is nothing more than an *abstract conception;* in rectilinear movement it is a *positive event.*

Virtually all satellites rotate in like manner and the probability, that the acceleration or retardation of their axial motions—if they ever existed—should come to a stop precisely at a definite angular velocity, is infinitesimal while it is almost absolutely certain that all movement of this kind would ultimately cease. The most plausible view is that no true moon has ever rotated on its axis, for at the time of its birth there must have been some deformation and displacement of its center of gravity thru the attractive force of the mother planet so as to make its peculiar position in space, relative to the latter, in which it persists irrespective of distance, more or less stable. In explanation of this, suppose that one of the balls as M in Fig 5 is not of homogenous material and that it is similarly supported but on an axis passing thru its center of gravity instead of form. Then, no matter in what position the ball is fixed on the pivots, its kinetic energy and centrifugal pull will be the same. Nevertheless a directive tendency will exist as the two centers do not coincide and there is, consequently, no *dynamic* balance. When permitted to turn freely on the axis of gravity the body, of whatever shape it may be, will tend to place itself so that the line joining the two centers points to O and there may be two positions of stability but, generally, if the center of gravity is not greatly displaced, the heavier side will swing outwardly. Such condition may obtain in the moon if it had solidified before receding from the earth to great distance, when the

(Continued on page 160)

POPULAR ASTRONOMY

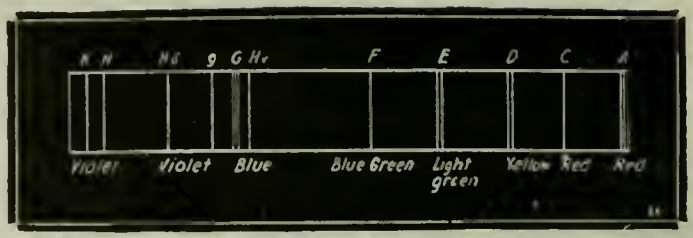
The Evolution of the Stars

(Continued from page 121)

Canopus, one of the giants of the universe. The transition of this type into the solar type stars of class G, to which our sun belongs, occurs when the group of iron lines known as group G begins to appear (see diagram 1). The lines of calcium and hydrogen still remain more intense than any other lines in the spectrum, but many fine metallic lines now appear in ever-increasing intensity. The transition of this type into the advanced solar type K occurs when some of the metallic lines surpass the hydrogen lines in intensity. The group of iron lines has also greatly increased in intensity until it becomes one of the most conspicuous features of the K type stars. Stars of the solar type such as Capella and the sun are yellow, and stars of the advanced solar type, such as Arcturus and Aldebaran, are orange colored bordering on red. Their atmospheres are filled with dense metallic vapors. (See photos of solar and advanced solar type spectra.)

Class M is divided into giant and dwarf

red stars with banded and fluted spectra corresponding to Secchi's type III. Their dense atmosphere are filled with metallic compounds and they are superficially at least much cooler than stars of the other types outlined above. (See spectrum of typical giant type M star.)



The Relative Positions of Certain Lines Prominent in Various Stellar Spectra Are Indicated in the Above Diagram of the Visible Spectrum: K and H Are the Absorption Bands of Calcium in the Extreme Violet End of the Spectrum. The Ultra-Violet Lies Beyond to the Left. Hδ, Hv, F, and C Are the Characteristic Absorption Lines of Hydrogen Prominent in Type I and Type II Stars. g is a Line of Calcium in the Violet. G is a Group of Lines Due to Iron Prominent in Solar Type Stars. E is a Second Group of Iron Lines. D is a Pair of Lines in the Yellow Due to Sodium. A is a Group of Lines in the Extreme Red Originating in Our Own Atmosphere.

Class N corresponds to Secchi's type IV and its characteristics have been mentioned above.

The position of the *Novae* or *Temporary Stars* in this scheme of evolution is somewhat uncertain, if in fact they fit into it at all. At the time of their outburst their spectra are usually rich in violet light and they are therefore to be classed with first type stars. Many sudden and peculiar changes take place in their spectra, but one characteristic is common to all novae, and that is the existence of both bright and dark bands of helium and hydrogen greatly displaced in position, the dark ones being shifted toward the violet and the bright ones toward the red.

Temporary stars usually pass first into bright line stars and later into planetary nebulae, thus reversing the generally accepted order of evolution from nebulas to bright line stars.

Tho a gradual transition from one type of star to the next can be traced, it does not necessarily follow that *all* stars pass from nebula to type M or type N stars thru all the types O, B, A, F, G and K in order and from there on to gradual extinction. It is possible that some stars become extinct or cease to shine without passing thru all of these stages.

The fact that in certain double star systems two stars physically connected and therefore evidently formed at the same time are at different stages of development calls for explanation. Some stars may run thru the course of evolution more rapidly than other stars, and some stars may lose their radiating powers before they have completed the normal course of evolution.

The marked division of the solar and late type stars into dwarf and giant stars also has a direct bearing on the problem of the order of the evolution of the stars. Tho the generally accepted order of evolution is that outlined above, it is possible that the sequence advanced by Prof. H. N. Russell may be the true one in which the evolution begins with giant stars of type M, continues in an order reverse to the one usually accepted thru giants of types K, G and F to the type B helium stars, hence in the normal order thru the *dwarfs* of types F, G, K and M to extinction. This would account for the existence of both giants and dwarfs of the later types. The Orion or Helium stars, which are the hottest of all the stars, would in this case represent the height of stellar development.

Whatever may prove to be the exact sequence in the evolution of the stars, the fact that there is evolution and change going on among the stars is indisputable. Such is the similarity existing among the hundreds of millions of stars of the universe that they can be grouped or classified under one or another of the few distinct types outlined above according to their color and the characteristic lines of their spectra.

(The next installment will appear in an early issue.)

TABLE SHOWING THE ORDER OF THE EVOLUTION OF THE STARS ACCORDING TO THE CLASSIFICATIONS OF SECCHI AND THE HARVARD COLLEGE OBSERVATORY

Type of Star Secchi	Type of Star Harvard	Typical 1st Mag. Star	Color	Characteristic Lines of Spectra
.....	Gaseous Nebulae	.....	Green	Bright lines of helium hydrogen and nebulium.
.....	O (Wolf-Rayet)	.....	Blue-White	Bright bands and lines of helium and hydrogen changing later to dark bands and lines.
.....	(Novae)	Nova Persei	....	Bright and dark bands, greatly displaced, of helium and hydrogen.
Type I	B (Helium)	Rigel	Blue-White	Dark absorption lines of helium and hydrogen, but chiefly of helium and a few faint metallic lines.
Type I	A (Hydrogen)	Sirius	White	Intense absorption lines of hydrogen, reaching maximum. Increasing strength of metallic lines.
Type I-II	F (Calcium)	Canopus	White tinged with yellow	Intense bands and line "g" of calcium in violet. Hydrogen lines of great intensity; many strong metallic lines.
Type II	G (Solar)	Capella	Yellow	Increased intensity and number of metallic lines. Strong hydrogen lines still surpassing metallic lines in intensity. Appearance of Group G lines due to iron.
Type II	K (Advanced Solar)	Arcturus	Orange	Decrease in strength of hydrogen lines. Great increase in number and strength of metallic lines and Group G of iron.
Type III	Ma (banded)	Betelgeuse	Red	Appearance of banded spectra due to compounds of titanium oxide.
Type III	Mh (banded)	.....	.....	Marked faintness of violet end of spectrum.
Type IV	N (Carbon)	.....	Red	Banded spectra due to presence of carbon compounds.

NOTE—This latter type does not follow in order after Type M, but is entirely independent of it in its evolution.

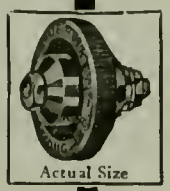
The novae also do not fit into the regular chain of evolution, but are placed after the stars they most closely resemble.

MOST SENSITIVE MICROPHONE

FOR $1.00

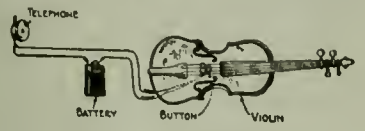
YOU can easily make a highly sensitive detectophone by using a Skinderviken Transmitter Button to collect the sound waves. You can build your own outfit without buying expensive exquipment. Think of the fun you would have with such an instrument! It's very simple, too, and inexpensive.

You can install an outfit in your home and hear the conversation being held all over the house. You can connect up different rooms of a hotel. *Our outfit was used by secret service operatives during the War. It is being used on the stage.*



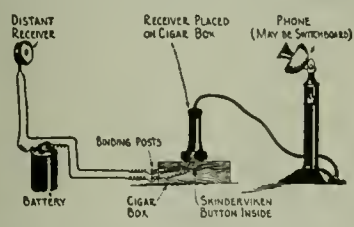
AMONG electrical experimenters the button has created a sensation. It is not uncommon to receive unsolicited letters like these: "I received transmitter button today and I wish to inform you that it works great and is *the best I have ever seen or heard of for the price.* I will certainly recommend it to my friends. I wish to thank you for your good service."

"I have been using one of your transmitter buttons, and it has proved to be worth more than its value in my experimenting." "I received one (Transmitter Button) some time ago, and they are just O. K. for experimentary." "I have been using one of your transmitter buttons for experimental work and it certainly lives up to all you say for it *and then some.*"



So much for its commercial adaptations! *You* can procure apparatus of the same type.

One of the main advantages of the Skinderviken Transmitter Button lies in its ultra-sensitiveness.



You can place it in any position you like. It is the greatest invention in micro-phones and has won recommendations from men of high standing in the scientific world. It is being used all over the world. You can mount it most anywhere. Card board boxes, stove pipes, stiff calendars and hundreds of other places will suggest themselves to you. The buttons cannot be seen by any one in the room as they are so small and light. Only a small brass nut is exposed to the view.

Full directions for connecting up the button for use as a detectophone are given in booklet No. 4 which is sent with each button.

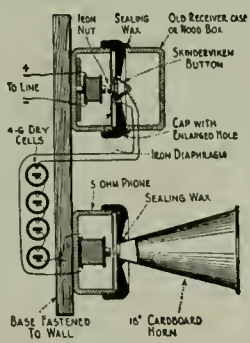
The only instruments needed to complete a detectophone outfit, in addition to a Skinderviken Transmitter Button are a receiver, battery, and, if desired, an induction coil.

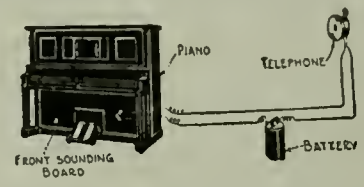
REAL BARGAINS

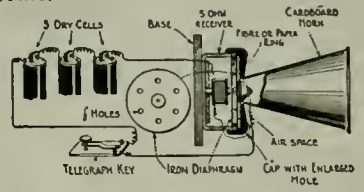
These prices are very low

All equipment is GUARANTEED. The apparatus is tbe same as sold by us to large telepbone companies. 110 volt telephone generators.

3 bar	$1.75	Weight 6½ lbs.
4 bar	2.25	" 8 lbs.
5 bar	2.75	" 10 lbs.
Ringers 80 ohm	.50	" 1 lb.
" 1000 ohm	.75	" 1 lb.
Silk cords, 6 ft. 3 cond.	.25	" 3 oz.
" " 6 ft. 4 cond.	.28	" 3 oz.
" " 3 ft. 2 cond.	.15	" 1 oz.
Transmitters complete with Steco transmitter button	$1.50	12 oz.
Induction coils	.40	6 oz.
Receivers—Watcb Case 75 ohms	1.25	1 lb.







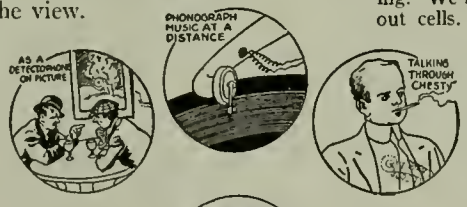
Mr. H Gernsback, editor of this magazine, who is the dean of electrical experimenters, said: "In writer's opinion, obtained by actual elaborate tests, your Transmitter Button is probably most efficient device of its kind on market today, due to its simplicity and other outstanding features. Should have a great future."

The same circuit connections apply to all experiments, regardless of how the transmitter button is mounted.

The Skinderviken Transmitter Button operates on one or two dry cells. It often happens that two cells produce too much current and the sounds are deafening. We recommend either one fresh cell or two worn out cells.

We have the utmost faith in our transmitter button. We guarantee satisfactory service or we will refund the purchase price. Boys—Young and old—send in a dollar bill RIGHT NOW! You can't lose. If you're not satisfied, you receive your dollar back. Isn't that fair?

Send a 3c stamp for a copy of Booklet No. 4.



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[ ]	110 volt generators.....bars	@	Wt.....lbs.
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[ ]	Induction coils	@ .40	Wt.....lbs.
[ ]	Transmitters with T Button	@ 1.50	Wt.....lbs.
[ ]	Receivers—Watch Case—75 ohms	@ 1.25	Wt.....lbs.

Amount Enclosed: Ship via
Enclose sufficient postage for mailing.

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The Moon's Rotation

By Nikola Tesla

(Continued from page 157)

arrangement of the masses in its interior became subject to gravitational forces of its own, vastly greater than the terrestrial. It has been suggested that the planet is egg-shaped or ellipsoidal but the departure from spherical form must be inconsiderable. It may even be a perfect sphere with the centers of gravity and symmetry coinciding and still rotate as it does. Whatever be its origin and past history, the fact is, that at present all its parts have the same angular velocity as though it were rigidly connected with the earth. This state must endure forever unless forces from without the luna-terrestrial system bring about different conditions and thus the hope of the star-gazers that its other side may become visible some day must be indefinitely deferred.

A motion of this character, as I have shown, precludes the possibility of axial rotation. The easiest way to free ourselves of this illusion is to conceive the satellite subdivided into minute and entirely independent parts, as dust particles, which have different orbital, but rigorously the same angular, velocities. One must at once recognize that the kinetic energy of such an agglomeration is solely translational, there being absolutely no tendency to axial rotation. This makes it also perfectly clear why the moon, provided its distance does not greatly increase, *must* always turn the same face to us even *without any inherent directive tendency* nor so much as *the slightest effort from the earth.*

Referring to the librations of longitude, I do not see that they have any bearing on this question. In astronomical treatises the axial rotation of the moon is accepted as a material fact and it is thought that its angular velocity is constant while that of the orbital movement is not, this resulting in an apparent oscillation revealing more of its surface to our view. To a degree this may be true, but I hold that the mere change of orbital velocity, as will be evident from what has been stated before could not produce these phenomena, for no matter how fast or slow the gyration, the position of the body relative to the center of attraction remains the same. The real cause of these axial displacements is the changing distance of the moon from the earth owing to which the tangential components of velocity of its parts are varied. In *apogee*, when the planet recedes, the radial component of velocity decreases while the tangential increases but, as the decrement of the former is the same for all parts, this is more pronounced in the regions facing the earth than in those turned away from it, the consequence being an axial displacement exposing more of the eastern side. In *perigee*, on the contrary, the radial component increases and the effect is just the opposite with the result that more of the western side is seen. The moon actually swings on the axis passing thru its center of gravity on which it is supported like a ball on a string. The forces involved in these pendular movements are incomparably smaller than those required to effect changes in orbital velocity. If we estimate the radius of gyration of the satellite at 600 miles and its mean distance from the earth at 240,000 miles, then the energy necessary to rotate it once in a month would be only

$$\left(\frac{600}{240{,}000}\right)^2 = \frac{1}{160{,}000}$$ of the kinetic energy

of the orbital movement.

Close-ups of New Scientific Movies

(Continued from page 118)

play starring May Allison in "The Island of Intrigue."

Lawrence Waring, millionaire oil magnate, compelled to go East on business, worries about leaving his daughter Maida alone. The problem is solved by the arrival of a letter from Mrs. Juliet Smith, an old friend, who invites Maida to spend the summer at her country home on Sunset Island.

A woman, who says she is Mrs. Smith, calls later and Maida, who has never met her father's friend, goes aboard a yacht, en route for the island. She meets Alaric and Lorna, Mrs. Smith's "son" and "daughter," and a "Count" Pellessier.

A few hours later the Waring house is in a state of alarm when the real Mrs. Smith arrives. It is then that Mr. Waring realizes that his daughter has been abducted.

In the meantime the yacht arrives at the island, but Maida, enjoying her holiday, does not realize that she is a captive. On one of her long walks thru the island she comes upon a camp and meets its owner, Gilbert Spear. She does not mention this to the others, but the meetings, begun as a lark, soon become a habit.

In the meantime the Count, by a wireless apparatus cleverly concealed in a piano, sends a message to Waring demanding fifteen thousand dollars as his daughter's ransom. He gets no answer and decides to force Maida to write of her peril to her father. On finding the true standing of the "Smiths," Maida refuses to write the letter and is at once locked in a room. The band have also discovered the friendship which exists between Maida and Gilbert, and after a fierce struggle he is captured, tied and gagged, and placed in a cave.

A second message is sent to Waring, which is also received at a Naval Station, and in this manner the location of the island is disclosed. A submarine chaser, with Waring aboard, goes to the rescue.

In the meantime Maida escapes from the room and flies to the camp. She finds Gilbert gone, but his dog, frantic with delight at her arrival, leads her to the cave. She soon releases him and together they hasten to his motor boat to escape. They are overtaken by the band and are just about to be taken aboard the yacht when the Naval boat comes upon the scene. The swindlers are captured and Maida introduces Gilbert to her father as the man she loves.

"America, First, Last and Always," is the theme of Pathé's new serial, "Wolves of Kultur," abounding in many thrilling radio scenes, underground and cave laboratories, and radio controlled torpedoes. It is the story of Alice Grayson, a cultured young society lady of wealth and refinement, possest of an ardent patriotism which has been stimulated by the completion of the invention by her uncle of an electrically driven wireless controlled torpedo.

Visiting her uncle's laboratory one day Alice finds he has been foully murdered by alien spies, and the plans and model of his invention stolen. Over his dead body Alice vows vengeance for his murder and for this traitorous act to America. She has learned from her uncle before he dies that "Hartman and Zaremba are guilty of this."

Alice, in her rôle of a Secret Service Agent, has finally located the death-dealing torpedo and the operator awaiting orders.

Before she can interfere the torpedo has been launched and is sent on its deadly mission, against a U. S. troop ship, when Alice, in a most superhuman effort, throws a rock at the operator and knocks him out.

She seizes the wireless apparatus and turns the course of the torpedo against the yacht, aboard which are the plotters.

Listening to Theater Critics

(*Continued from page 105*)

are usually well patronized, by "between the acts" smokers and thirsty box holders, then phonograph selections are played thru the loud-talking telephones in the horns, and the public generally is pleased—both those that like music and the others, who will enjoy it anyhow. But the psychological moment always arrives, and we have our turn after the show when the horns are "unsuspiciously silent," while the audience files out, homeward bound, chatting among one another about the show, and incidentally handing out several hundred dollars' worth of valuable criticism and suggestions, which any theater manager would almost break his neck to overhear. But even tho his office has a screen door, or if he happens to adorn the passageway with his own graceful and frock-tailed form, he hears but little of real value.

Now, all is changed, however, for, thanks to the dictograph installation, our friend the theater manager can appease his heretofore unsatiated thirst for a knowledge of "what his patrons actually think of the performance" by simply manipulating a switch at his desk, which causes the voices, no matter how low they may be, to be picked up by the respective microphones switched into circuit, and reproduce loudly and clearly thru the loud-talking telephone in his office. In the summer when naturally the office would not be closed up so tightly, the regular head phones, which resemble the telephone operator's headgear or that of the wireless operator, may be used with exactly the same results. The advantage of the loud-speaking telephone for reproducing the conversations is that everyone does not care to be inconvenienced by placing a telephone receiver band on the head, especially when we think of some of our old-time friends—the theater managers, that we have met here and there, who like to, and mostly do, resemble some of our Fifth Avenue millionaires with their sporty neck-ties, spats and a one dollar Perfecto sticking nonchalantly in the southeast corner of their jibs; and then again, who in his wildest theatrical moments can even imagine a "regular" honest-to-goodness theater manager appearing *without* his silk hat, once he has left his hotel. Well, for these poor souls we will suggest that they have available a first-rate secretary who can record the conversation, or better yet, hook up an Edison dictaphone (phonograph) to the horn of the loud-talker and record the various criticisms, so that they can be reproduced later and studied more closely at leisure.

We should imagine that such an arrangement as this will be very valuable indeed to the modern theater, where the movement toward establishing desirable plays, etc., is being brought to more nearly meet the exact wants of the theater-going public. In other words, the American theater manager has for a long time been seeking for every possible opening to gain a more perfect relation between the box office and the patron of the theater, and well this might be so, for if a performance is such that it does not suit the people at the time the play is produced, then there is no use expending additional sums in trying to foist the unwanted play on the theater-going public. Sometimes, however, in the past, and, in fact, it may be said in most cases, one of the chief reasons for the failure of a dramatic or other play, has been that the manager and producers could not quickly enough ascertain the exact feeling or obtain a comprehensive survey of the collective ideas of the audiences viewing the first performance of the play until it was too late.

Experimental Mechanics. Twist Drills

(*Continued from page 127*)

With this information on hand and a little practical experience on the subject, there should be no difficulty for the novice to become thoroly familiar with the handling of twist drills.

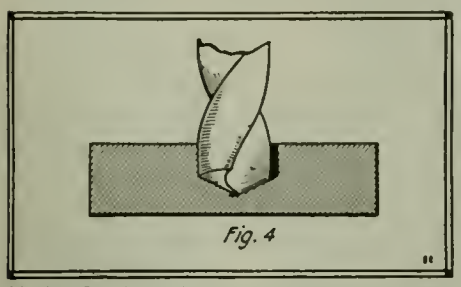

Fig. 4

If the Cutting Lips of the Twist Drill Are Ground of Uneven Length, the Hole Will Be Enlarged Over the Diameter of the Drill.

Average Cutting Speed for Drills In Revolutions Per Minute.

The following table represents the most approved practise in rate of cutting speed for drills ranging from $\frac{1}{8}$ inch to 2 inches in diameter:

Diameter of Drills	Speed on Steel	Speed on Cast Iron	Speed on Brass
$\frac{1}{8}$	1,712	2,383	3,544
$\frac{5}{32}$	855	1,191	1,772
$\frac{3}{16}$	571	794	1,181
$\frac{1}{4}$	397	565	855
$\frac{9}{32}$	318	452	684
$\frac{5}{16}$	265	377	570
$\frac{11}{32}$	227	323	489
$\frac{3}{8}$	183	267	412
$\frac{13}{32}$	163	238	367
$\frac{7}{16}$	147	214	330
$\frac{15}{32}$	133	194	300
$\frac{1}{2}$	112	168	265
$\frac{17}{32}$	103	155	244
$\frac{9}{16}$	96	144	227
$\frac{19}{32}$	89	134	212
1	76	115	191
$1\frac{1}{32}$	72	106	180
$1\frac{1}{16}$	68	102	170
$1\frac{3}{32}$	64	97	161
$1\frac{1}{4}$	58	89	150
$1\frac{5}{32}$	55	84	143
$1\frac{3}{8}$	53	81	136
$1\frac{7}{32}$	50	77	130
$1\frac{1}{2}$	46	74	122
$1\frac{9}{32}$	44	71	117
$1\frac{5}{16}$	40	66	113
$1\frac{11}{32}$	38	63	109
$1\frac{3}{4}$	37	61	105
$1\frac{13}{32}$	36	59	101
$1\frac{7}{8}$	33	55	98
$1\frac{15}{32}$	32	53	95
2	31	51	92

(*The next article of "Experimental Mechanics" will appear in the July issue*)

FRANCE BUYS BIG U. S. BORDEAUX RADIO STATION

Virtual demobilization of all the United States naval establishments in European waters, the sale of the great Lafayette wireless station at Bordeaux to the French government at a price of approximately $4,000,000 and many hitherto unpublished facts of American naval activities in the war, were announced recently by Assistant Secretary Roosevelt.

"The great Lafayette radio station near Bordeaux was intended to insure communication between Washington and the army and navy in case the cable systems were put out of commission or interfered with by German submarines. It has eight towers and could communicate with the United States day and night. It was built by the navy. I arranged with the French government that we shall complete the station, which is two-thirds finished, and they will take it over at what it cost us, about 22,000,000 francs," said Mr. Roosevelt.

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Colds	Lumbago	Sprains
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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 addrest 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.

How to Finance and Manufacture a Patent*

By Jay G. Hobson

This article is dedicated to the interest of inventors and people with commercial ideas who are inexperienced in the financing and marketing of commercial products. It tells of a practical plan that made one invention successful. It is written with the intention that it will benefit each reader financially, and will assist him in avoiding the many pitfalls encountered along the road to success.—THE AUTHOR.

MOST people think of inventors as geniuses parturient to some brilliant idea suddenly caught from the air and patent it in workable form. However, this is not the case, for as Thomas Alva Edison, the great inventor, declares: "Genius is one per cent inspiration and ninety-nine per cent perspiration," and "The three essentials to secure anything worth while are, first, hard work; second, stick-to-it-iveness; and, third, common sense."

Edison's inventions have been the result of many experiments, and exacting judgment. He has always sought to produce things that were necessities, which would benefit the masses; consequently, his wonderful success.

The first important step in financing and marketing an invention is, positive conviction that you have discovered something that is practical, not only from a manufacturing point of view, but also from the public's point of view—for it is the co-operation of the public (your eventual customers) that will insure your success. To secure the co-operation of the public, and to sell your invention, be positive you have something to offer that the public needs and demands. Then, after you have made your article commercially practical, prepare it for the market in a convenient form, that will offer the least resistance to the consummation of a sale.

Investors or people with capital (who want to assist you financially in marketing your product) observe your invention and are of the same frame of mind toward it as the public—your ultimate customers. Investors scrutinize the practicability of the commercial side, as well as the production or manufacturing side; however, they are generally more interested in the commercial side of an article, for there is the source of large profits.

Obtaining financial backing for your invention is a serious undertaking. Investors demand facts, proof, conviction, before they will take the business venture necessary for the success of a new idea. Investors are the pessimists, so to speak, while inventors are the optimists. The inventors who succeed with their figments are greater optimists than men with money are pessimists. Conviction, confidence and enthusiasm will convert the most skeptical. Get the confidence of men with money and you will get their assistance.

Men who are successful say that the shortest route to commercial success is thru the example proven by those who have gone before. While modern business necessitates individual plans of operations, yet what one man or firm did to succeed others can duplicate. Therefore, the plan employed to finance and market one invention should help finance another. Experience proves that a patent is as valuable as the inventor or his associates make it—that completing a working model of an invention and securing the patent rights upon same are only the preliminary steps to success. The greatest obstacles lie ahead in the financing, manufacturing and marketing of a new article. It is the commercial wilderness that every new manufactured product must cross before reaching that summit of success desired by all.

It matters not how wonderful or unique an invention may be, it must be serviceably made, intelligently financed and greatly ad-

* Owing to the publication this month of the promised article—"How to Finance and Manufacture a Patent" by Mr. Hobson, the Questions and Answers on Patent Advice are omitted.

vertised to make the inventor money. The public must be educated to the need of a new article before they will buy it. Few inventors appreciate these facts, and are of the opinion that all they need do is to conceive some new, useful improvement, patent it, and their fortune is made; but unfortunately this is not true. It is only the beginning of a difficult undertaking. An inventor should be as good a salesman as he is a mechanic. The public must be convinced before they will invest. The better the salesman, the greater the financial backing. Inventors should sell themselves the merits of their invention before attempting to sell others. With the backing of the convictions that you have a good thing—it will make the convincing of others an easy matter. Confidence and credit in the commercial world are more valuable than gold itself.

Only one who has gone thru a successful patent experience can adequately advise others how to succeed. For the benefit of my readers who may desire to finance a new proposition, I will enumerate the steps thru which I brought my first invention to success. It may help point the way for others.

After I had been granted full protection on my invention for a period of seventeen years, and had settled with my patent attorney for his services, it suddenly dawned upon my elated conscience that my patent certificate, with its big red seal, was not cashable like a Government bond; but, that it was only the foundation and beginning of a steep, rocky road to fame and fortune. I had spent most every cent for my patent rights and a demonstrating model of my invention. I had no money to promote the sale or manufacture of same, but I did possess an abundant confidence in its usefulness and ultimate success, if only I could secure financial backing to put it on the market before the buying public.

As it stood it was absolutely valueless to me. One of two things was necessary for its success. Either I must sell it to some one with money, or raise the capital to manufacture it myself. My friends urgently advised me to sell for any fair profit above my actual cost, saying: "It was better to accept a profit regardless of size than possibly fail in securing sufficient capital for marketing it."

Thru courtesy I listened to all this sincere advice, but was of the same opinion still—that my invention filled a long-felt public want. It was a necessity that could be made easily and profitably. I determined to stick to the first meritorious product of my brain and if possible raise the money that would enable me to place it for sale before the world. I knew that success only waited upon the introduction of my discovery to those for whom it was intended. But how best to accomplish this seemingly impossible task and overcome the colossal obstacles that were in evidence, forced me into quite a quandary.

However, remembering the old adage, "Where there is a will, there is a way," spurred me on to greater hopes for the success of my invention. I decided to tackle this proposition for all it was worth, and reap the benefits that were justly mine.

At that time I was a typical amateur in the mysteries of finances. I could not afford to make mistakes and knew few plans to pursue in obtaining the required finances for marketing my invention. Several plans came to my mind, such as borrowing the capital from relatives or friends, giving my patent as security for the loan; organizing a stock company and selling shares of stock to raise the money; or, advertise and sell part interest in my patent to some one, honest and reliable, who would agree to buy only a minority interest, thereby giving me control and protection against loss—for I was determined that I would not be frozen out by a partner.

The first plan had its precipitous faults. Relatives as a rule do not make good creditors and seldom appreciate their kin's abilities in business. The second plan meant immediate cash for incorporation of a company, as well as a long drawn out, expensive stock selling campaign, with capital possibly coming in by dribbles. The third plan appealed to me more favorably. I decided to put forth my best efforts toward this method of placing my invention on the market. How and where to find the investor with the cash who would be willing to invest under the above conditions proved to be my greatest problem. After considerable deliberation, after several demonstrations and interviews with business men whom I knew, I was convinced that the quickest and cheapest way to find *that* person with the idle cash and confident enough to take a legitimate business chance with me, was to advertise in some good newspaper or magazine, under "Business Chance." This I forthwith started and used the following advertisement:

"Wanted, a capable business man with capital to take substantial interest in patented meritorious invention. This is a public necessity that should make fortune for manufacturers. If qualified, address ——, etc."

The above advertisement cost about $1.00 per issue under classified position in a paper having a weekly circulation of upwards of five hundred thousand copies. The first replies were somewhat disappointing. But, believing I was headed right, I continued the advertisement for a few weeks, and one day I received an inquiry from a man who had ready cash, and sufficient optimism to back me up in my great ambition. For $2,000 cash I sold him forty-five per cent interest in my patent right (leaving me fifty-five per cent, or control). With this nest egg in the company's treasury we proceeded to gather all the information that we might need in the manufacturing and marketing of our invention.

First, we decided upon a firm name suitable to the article. Then we arranged with a machinery company to construct the machinery needed for quantity production. We called on the supply houses and secured their lowest prices on material for making our product. We arranged for the printing of circulars, letterheads, envelopes, bill heads, statements, etc., that would be needed for our office. From a bookkeeper friend we learned books required for our business and how to keep them correctly. We called on the wholesale and retail deal-

(*Continued on page* 181)

Hunting Submarines by Sound

(*Continued from page* 111)

"Ship ahoy!" came from the masthead.

"Where away?"

"Two points on the starboard bow, sir. Looks like she was heading this way."

The Ear Beats the Eye.

This vessel had been detected by sound waves traveling thru the water, her course and speed had been accurately charted *and her exact position* within one point of the compass had been determined *more than an hour before the vessel itself had become visible over the horizon.*

"It's almost perfect," said one of the naval engineers in an undertone. The tension under which they had worked for hours suddenly relaxed. The ship's crew gathered in groups to talk it over. There was not a dissenting opinion. The secret of detecting the presence of an unseen vessel had been solved!

The ships steered back to Nahant. A long-distance call was put in for the Navy Submarine Base at New London.

"Rush three submarine chasers to Nahant at once."

In due time they appeared. The party started out again, were joined by submarines from the Boston Navy Yard, and anchored off the Massachusetts coast line.

One submarine at a time submerged. The subchasers equipt with detectors followed her every movement, charted her position, reported to each other by special signal devices, and when everything was in readiness rushed to a spot just over the "sub." Dummy depth bombs were dropt. The submarine rose to the surface. *She had been within a few feet of her charted position.*

And now the apparatus was about to demonstrate its most valuable service. A series of practical tests proved beyond the possibility of a doubt that the detector could successfully differentiate between the sounds made by surface craft and the sub. The submarine's noises were distinctly peculiar to itself and the instrument translating this sound to the trained ear brought home the message just as you, when you pick up the long-distance telephone receiver, can identify the voice at the other end of the wire.

The Submarines On the Phonograph.

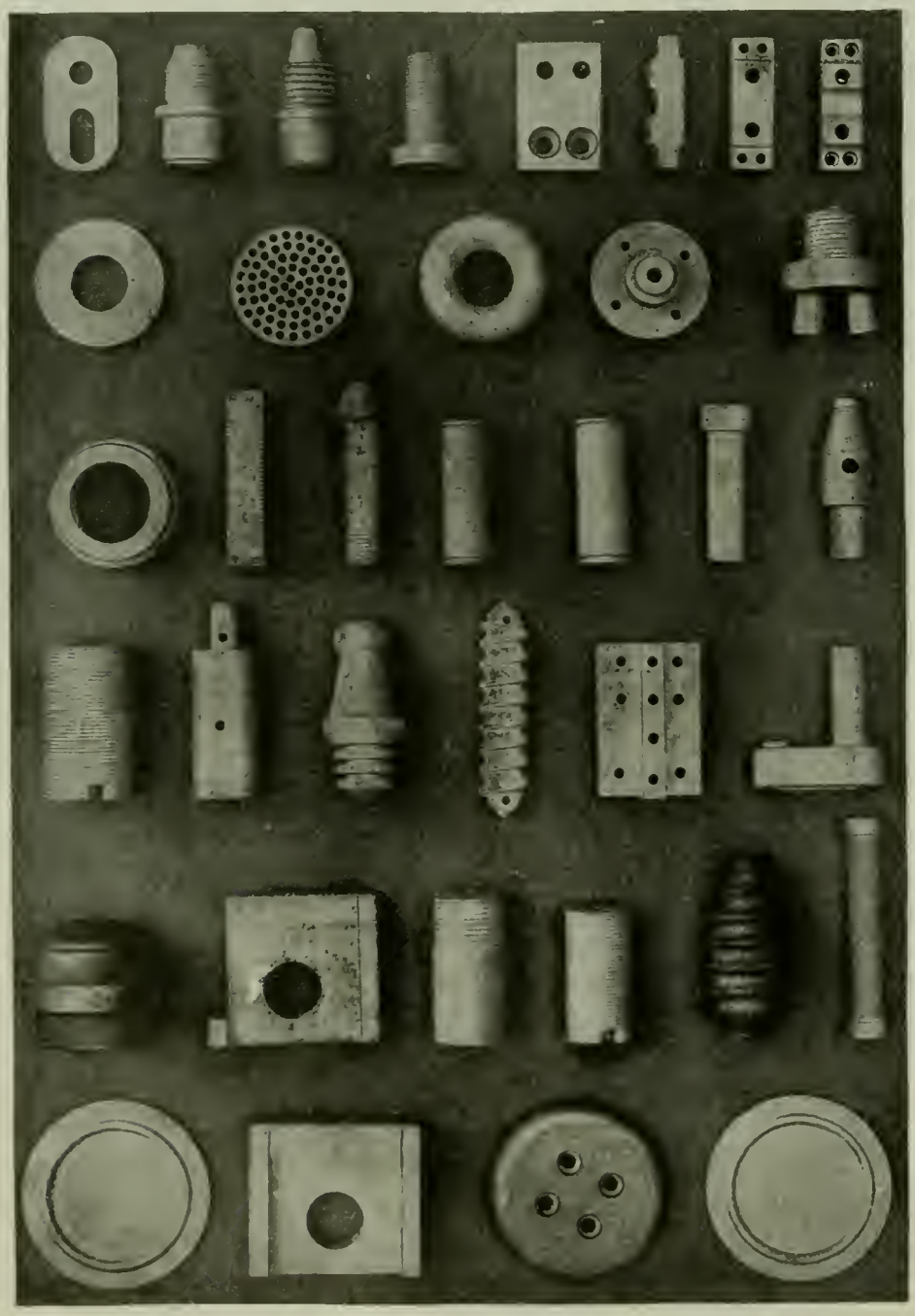
The Victor Talking Machine Company was now called upon for its contribution to the invention. *Phonograph records of the various sounds heard by the observer were made and cataloged*, thus presenting a complete record of the accomplishment of the device. The records were used principally in training students to identify the submarine noises and detect the difference between submarine and surface craft.

Further tests were made. Shore listening stations were set up. During the night trained men sat and listened to vessels going in and out of Boston harbor. The Navy attempted to slip a submarine thru the harbor entrance one night, but the craft was detected at once and a full report of her activities was sent to headquarters a few hours later. Not a ship could enter or leave Boston without being heard. In fact, so sensitive was the instrument that *trained listeners could accurately identify a ship by name*, once having heard her, the engine characteristics of different ships being plainly audible and distinctive.

It was estimated that in December, 1917, *two to five enemy submarines past thru the English Channel daily*. After July 1, 1918, only *one* submarine is known to have done so. In June the Admiralty estimated that *one out of every four submarines was destroyed*. In October the ratio had been increased to five out of every twelve. By this summer British and American naval officers believe three out of every four submarines would have been destroyed. These results were largely due to the perfection of "listening devices."

Hundreds of British craft and most of the American forces were now equipt with the submarine detector. Many French and Italian vessels were also using it. The "submarine hunt" was on in earnest.

About May, 1918, the American ships



began to go across with all these devices installed.

Hearing Subs 25 Miles.

Here are some of the outstanding features of the American submarine sound detector:

Under ideal conditions with extraneous noises reduced to a minimum or entirely eliminated *the device was effective at a range of from fifteen to twenty-five miles.*

Trained operators could clearly and invariably distinguish between the sounds made by approaching surface craft and under-water vessels (submarines).

Under average circumstances, the device was good for a range of between *three and eight miles.*

Within five miles the engine characteristics of different vessels was clearly marked even to the point of *identifying by name* certain (unseen) vessels after they had been observed previously for more than one time. (This test was substantiated by a series of night-time experiments at the entrance to Boston harbor in September and October, 1917.)

It was found practical to tell when a submarine changed from her oil engines to electrical drive, which was necessary every time she submerged.

The direction of sound could usually be computed within a very few degrees of its actual location and a good judgment of the distance could generally be made. This was proved to the satisfaction of all concerned following a number of practical tests off Cape Cod, Mass., in the late summer of 1917, in waters adjacent to Boston and in Long Island Sound.

The addition of these listening devices to submarines added the heretofore lacking *sense of hearing* to all the underwater craft and made them at once a much more effective weapon of offense.

An allied submarine on one occasion chased a German U-boat for four hours, while both craft were submerged, without once losing sound contact with the enemy.

The graphic chart publisht herewith will indicate to the reader the ability of submarine chasers to maintain "sound contact" with the enemy and the efficiency of the direction qualities of the device when used in this manner.

The actual battle engagement which it illustrates occurred one early morning in the English Channel. A small squadron of sub-chasers discovered an enemy craft moving slowly up the channel submerged. Forming for the attack they rushed over the spot where their listeners indicated the U-boat to be, dropt a pattern of depth bombs and then withdrew to take observations.

Feverish activity and the sound of hammers ringing against the ship's side was heard. The submarine engines would then start up and stop, start and stop again.

25 Germans Commit Suicide.

Further attacks were delivered and more noise came to the listeners from the hold of the submarine. Evidently the first depth charge had taken good effect and the enemy's crew was making a last desperate effort to reach the surface. Suddenly there was dead silence—then 25 revolver shots rang out—3 followed by 22. *The crew giving up in despair, had committed suicide.* The loss of this submarine was later substantiated by the British Intelligence Department.

When Capt. Leigh and his party went abroad in November, 1917, he requested the Admiralty to loan him two high-speed chasers in which operations could be begun in English waters, but was finally obliged to accept 3 trawlers of 9 to 10 knots speed, because of the then scarcity of higher speed craft.

Equipping these vessels with all of the anti-submarine detecting apparatus they went out in the English Channel on New Year's Day, 1918. Shortly afterwards a wireless message was picked up from an airship giving the position of a submarine which had just been seen to submerge. The channel had been laid out in numbered squares to facilitate the immediate location of enemy craft and the little squadron steamed over, got their devices out and picked up the submarine course.

When believing themselves about over the enemy, depth bombs were discharged and later a trawling instrument was used, **which indicated that the submarine had been destroyed.** Great quantities of oil rising to the surface also substantiated the success of the attack.

Remaining in English and French waters for several months, where the American devices proved of great value and were highly complimented both by Admiral Sims and British naval officers, another squadron was equipt and sent into the Mediterranean and Adriatic, where at this time submarine activity was at its height.

Because of the deeper water and less interference from surface traffic, listening conditions were unusually good. A "barrage" line of boats was organized across Otranto Straits, between the mainland and the Island of Corfu, to effectively put a stop to the enemy's free entrance to the Mediterranean.

Three of the chasers patrolling in formation abreast one dark night heard a "sub" approaching. The bearings obtained by the two beam vessels pointed directly toward the center boat. The middle boat now heard the submarine approaching from a position dead astern. The enemy came nearer and nearer and finally past right under the sub-chaser so close to the surface that those on board felt a wave of water along the keel of their ship.

When the German had past on and out in front the attack was made in unison, a *pattern** of depth bombs was "let go" and the little fleet halted for further observations. Pretty soon the whirl of the submarine's electric motors was heard—evidently in an effort to reach the surface.

The Germans "Cash In."

Then came a crunching noise not unlike the popping in of a blown-up paper bag. It was apparent that the submarine had been damaged—put out of control—and sunk, and that she had collapsed from the tremendous water pressure at these depths.

Many incidents of this kind occurred during the subsequent operations in foreign waters and several submarines were accounted for thru the direct aid of the American listening devices.

In fact, naval experts who were closely in touch with submarine detection development during the war period state with conviction that if the conflict had continued thru another summer the submarine would literally have been driven from the ocean, the promise of a condition due in a large measure to the perfection of submarine detecting apparatus.

It has also been stated that the noticeable change in naval tactics—from defensive to offensive—which marked this country's entrance into the war was largely caused by the application of American principles to the pursuit and attack of the U-boat, something made possible by the practical use to which it was found the American submarine detector could be put.

* A pattern of depth bombs refers to the plan of dropping them simultaneously in certain prearranged figures, such as squares, circles, etc. The chart herewith shows the pattern scheme quite clearly—notice the black dots at points marked "attack."

Alexanderson's "Barrage" Receiver

(*Continued from page* 135)

ing which has become so familiar, but also the original meaning of toll or stoppage prevention. Thus the barrage receiver may be used not only in time of war to counteract the offensive barrage of an enemy radio station, but it may be used to multiply the number of peaceful communications that may be carried on simultaneously without disturbing each other.

Duplex Radiotelephony.

NEUTRALIZED RECEIVING ANTENNA MOUNTED ON THE SAME MAST AS THE SENDING ANTENNA

If two sets of wires are mounted on the same masts, the radiation from one set to the other is obviously so strong that the overpowering of an ordinary receiving set by the transmitted energy would be almost of the same order of magnitude as if the identical wires were used. The quantitative relations may be better appreciated by mentioning specific figures. In the tests made in Schenectady, the receiving antenna consists of five wires mounted as an umbrella

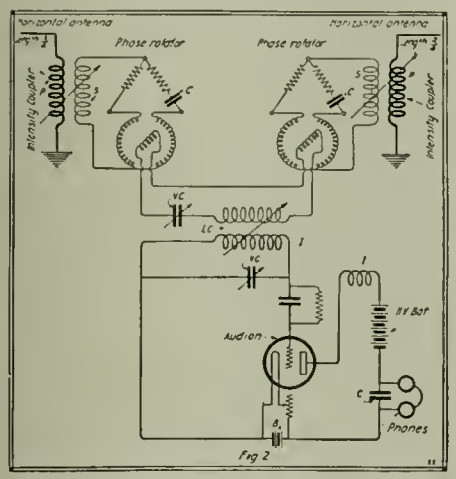


Fig. 2. Duplex Antenna Used with Phase Rotator Units and Regular Receiving Instruments in Alexanderson "Barrage" Receiving Set.

around the main mast, while the sending antenna consists of two wires extending from this mast to another building. The capacity to ground of the sending antenna is 0.003 microfarad, the receiving antenna 0.0011 microfarad, and the mutual capacity such that 10,000 volts on the sending antenna produces 500 volts on the receiving antenna when it is disconnected. While it is obvious that an antenna oscillating with 500 volts continuous waves could not be used with ordinary methods of reception, the system for neutralization which will be described has proven so effective that an ordinary receiving set can be used for receiving signals from such distances as the Pacific coast (2,500 miles or 4,000 km.) without any appreciable interference from continuous wave radiation from the main antenna of 20 amperes and 10,000 volts!

Two methods of neutralization have been used: *inductive* neutralization and *static* (*capacitive*) neutralization. While both methods have been used successfully, the capacitive neutralization is much preferable both on account of accuracy of adjustment and simplicity. A diagram of inductive neutralization is shown at Figure 1. The transformer *T* is used to create a potential of opposite phase to the potential of the sending antenna. The negative potential thus created is transferred to the receiving antenna thru the exposure condenser *E*. The negative potential thus imprest upon the receiving antenna thru the transformer and the exposure condenser is adjusted so as to counterbalance exactly the direct exposure from antenna to antenna, thus leaving the receiving antenna at ground potential. The phase relation of the transformer is, however, not exactly 180°, and a residual potential is left on the receiving antenna which is sufficient in most cases to interfere with reception unless further precautions are taken. If, however, a frequency trap *F* is introduced the neutralization becomes good enough so that an ordinary receiving set can be used.

The arrangement shown in Figure 1 was used to demonstrate duplex radio telephone conversation between Pittsfield and Schenectady (50 miles or 80 km.)

The "Barrage" Radio Receiver.

The barrage receiver is fundamentally a *uni-directional receiver*. The principle of uni-directional reception was first developed by Bellini and Tosi. While the uni-directional Bellini-Tosi receiver has been used as a direction finder, it has, to the knowledge of the author, not been used to any extent for reception of long distance signals. The Bellini-Tosi receiver is based on the principle of receiving the signal thru two antennas of different characteristics and neutralizes the signals received from one direction by a system of balancing.

The uni-directional Bellini-Tosi receiver works on the principle that the *electromagnetic* and *electrostatic* exposures are 90° out of phase. The *barrage receiver* takes advantage of the geographic phase *displacement* in the wave as it travels over the surface of the earth. In the first barrage receivers which have been installed the antennas consist of two insulated wires laid on the ground a distance of two miles (3.2 km.) in each direction from the receiving station. It was originally intended by the author to mount the wires on poles, but the easier procedure of laying the wires on the ground was adopted at the suggestion of Lieutenant-Commander A. Hoyt Taylor, and the arrangement has proven entirely satisfactory. The barrage receiving set, photograph of which is shown herewith, consists of a standard receiving set, combined with a *phase rotator* set. When used as a barrage receiver, a condenser is used in place of the antenna and the standard receiving set is coupled to the aperiodic antenna by the phase rotator set. The diagram of the phase rotator set is shown at Fig. 2. Each antenna is connected to ground thru an intensity coupler, the secondaries of the intensity couplers are connected to the primary of the phase rotators. Each phase rotator is built on the principle of a split phase induction motor or induction regulator. A single phase current introduced in the primary is split into a quarter-phase current which produces the equivalent of a rotating magnetic field inductively related to the secondary. By adjusting the position of the secondary coil the electromotive force induced in it may be made to assume any desired phase relation to the primary voltage. The receiving set proper when used with the barrage receiver has all the normal characteristics of a standard receiving set. A signal originating in any direction whatever may be neutralized by adjustment of the intensity couplers and phase rotators. This adjustment is very easy to perform, even by an inexperienced operator, and is perfectly stable after it has been made.

An experimental barrage receiving set was operated for several months of the

summer and fall of 1918, about three miles from the New Brunswick, N. J., radio station. Records were kept on the reception of European stations during the operation of the New Brunswick station. As the New Brunswick wave is 13,600 meters and the Carnarvon, Wales, wave is 14,200 meters, the reception of Carnarvon was the hardest test to which the set could be put. It was found that in spite of the overwhelming intensity of the New Brunswick signals on an unbalanced receiver, the barrage receiver could be adjusted so that the transmitted wave not only did not interfere with the Carnarvon signals, but the New Brunswick signals could be made entirely inaudible. During these tests it was found that the directive characteristics of the barrage receiver was a material help in reduction of interference by static and strays, as it was found very frequently that solid copy could be obtained by proper directive adjustment, while the signals were practically unreadable with ordinary methods.

The improvement of reception of signals by the use of the barrage receiver depends upon the highly directive qualities of this receiving system. For comparison with other methods of directive reception, a tabulation of directiveness is given in Fig. 3. In this comparison the symmetrical elevated antenna which receives equally from all directions is designated at 100 per cent. The percentages of directivity are calculated from the areas of the corresponding horizontal plane intensity diagrams here shown. If the directivity represented by the intensity diagrams can be taken as relative measure of the average stray-to-signal ratio, we find that the magnetic loop should have 50 per cent. as much strays as the elevated antenna, the differential horizontal antenna (Sayville, Long Island), probably about the same as the magnetic loop, and the barrage receiver 22 per cent. Statistics of reception indicate that these figures are reasonably in agreement with facts, when the strays are evenly distributed. When the strays are directive the improvement is much greater.

A rather surprising characteristic was discovered by the use of the barrage receiver. It was expected that this receiver could be used to neutralize signals from all directions except the direction close to the signal to be received. As a matter of fact it was found that interference could be neutralized by originating in the same direction as the signal. This was first discovered in the New Brunswick installation. Signals from San Diego, Cal., right in line with the transmitting station, could be received without great reduction in intensity, while the set was adjusted so as to neutralize the transmitting station. The explanation for this is the fact that in the case of the nearby station the wave front is curved and the radiation diverging, whereas in the case of the far-away station the radiation is parallel. The receiving antenna covers a space of four miles (6.4 km.), and in this space there is sufficient divergence of the radiation from the nearby station so that an adjustment can be made whereby the diverging and parallel radiation have different effect upon the receiving set. The phenomenon is comparable to the focusing of a field glass on nearby and distant objects. In this case we have a radio field glass of four miles (6.4 km.) in diameter; and, for such dimensions, the focusing effect is sufficient, even at considerable distances, to produce an effective discrimination.

While the barrage receiver was worked out primarily to avoid interference in transoceanic communication, it may be found useful also for the purposes for which the bridge receiver was developed—that is, simultaneous sending and receiving from small shore stations or ship stations. In such cases it has the advantage over the bridge receiver that it can be used not only to neutralize the transmitting station to which it belongs, but can neutralize interference from any other ship or shore station.

My Inventions

By Nikola Tesla

(Continued from page 148)

showered upon me, and journeyed to my home where I passed through a most painful ordeal and illness. Upon regaining my health I began to formulate plans for the resumption of work in America. Up to that time I never realized that I possessed any particular gift of discovery but Lord Rayleigh, whom I always considered as an ideal man of science, had said so and if that was the case I felt that I should concentrate on some big idea.

Nature's Trigger.

One day, as I was roaming in the mountains, I sought shelter from an approaching storm. The sky became overhung with heavy clouds but somehow the rain was delayed until, all of a sudden, there was a lightning flash and a few moments after a deluge. This observation set me thinking. It was manifest that the two phenomena were closely related, as cause and effect, and a little reflection led me to the conclusion that the electrical energy involved in the precipitation of the water was inconsiderable, the function of lightning being much like that of a sensitive trigger. Here was a stupendous possibility of achievement. If we could produce electric effects of the required quality, this whole planet and the conditions of existence on it could be transformed. The sun raises the water of the oceans and winds drive it to distant regions where it remains in a state of most delicate balance. If it were in our power to upset it when and wherever desired, this mighty life-sustaining stream could be at will controlled. We could irrigate arid deserts; create lakes and rivers and provide motive power in unlimited amounts. This would be the most efficient way of harnessing the sun to the uses of man. The consummation depended on our ability to develop electric forces of the order of those in nature. It seemed a hopeless undertaking, but I made up my mind to try it and immediately on my return to the United States, in the summer of 1892, work was begun which was to me all the more attractive, because a means of the same kind was necessary for the successful transmission of energy without wires.

Four Million Volts.

The first gratifying result was obtained in the spring of the succeeding year when I reached tensions of about 1,000,000 volts with my conical coil. That was not much in the light of the present art, but it was then considered a feat. Steady progress was made until the destruction of my laboratory by fire in 1895, as may be judged from an article by T. C. Martin which appeared in the April number of the *Century Magazine*. This calamity set me back in many ways and most of that year had to be devoted to planning and reconstruction. However, as soon as circumstances permitted, I returned to the task. Although I knew that higher electro-motive forces were attainable with apparatus of larger dimensions, I had an instinctive perception that the object could be accomplished by the proper design of a comparatively small and compact transformer. In carrying on tests with a *secondary in the form of a flat spiral*, as illustrated in my patents, the absence of streamers surprised me, and it was not long before I discovered that this was due to the position of the turns and their mutual action. Profiting from this observation I resorted to the use of a high tension conductor with turns of considerable diameter sufficiently separated to keep down the distributed capacity, while at the

(Continued on page 176)

Amateur Radio Restored

(*Continued from page* 131)

plaything only or just a mere hobby.

The ELECTRICAL EXPERIMENTER thru the RADIO LEAGUE OF AMERICA shall be only too glad to publish letters from amateurs suggesting new ways and means to benefit the cause of Radio Amateurism, our columns being open to all worthy suggestions.

While for the present there is nothing to be feared of adverse legislation, still it is impossible to forecast that such legislation will not be attempted in the future. We have won the freedom of the ether due to the splendid coöperation of Radio Amateurs in this country, and if we have won once we will win again.

The RADIO LEAGUE OF AMERICA is a clearing house for all Radio Amateurs in the United States, and today has more members than any other league, but it has not enough members. It wishes to have every amateur as an enrolled member. The membership of the Radio League, established in 1915, is gratuitous. There are no dues or fees to be paid. All the League wants is the name of every amateur and his address, so that first of all, if a national emergency arises, the Government can rely on the amateurs for quick communication. Also in case adverse legislation should be attempted, the League wishes to notify every member immediately, as it did last December when the freedom of the ether was threatened.

We ask every amateur who is not a member of the League to sign the blank appended herewith. It costs nothing but a 3-cent stamp to do so. Every enrolled amateur is entitled to the membership certificate free of charge which is mailed to all members. The membership of the Radio League of America now comprises 21,309 members. If you are not a member at the present time, you should enroll at once by all means.

LONG LIVE THE RADIO AMATEUR!

A NEW TYPE OF TRANSFORMER.

(*Continued from page* 139)

(Nos. 20 to 30 gage), and is twelve inches long. The exact diameter cannot be given, but it must be slightly smaller than the inside diameter of the secondaries, usually from one to one and one-half inches.

The primary can consist of three pounds No. 16 D. C. C., which when connected in series with an adjustable reactance or rheostat, will give a power range of approximately two to six amperes.

The core is wound with two or three layers of Empire cloth, and then the primary wire is wound on. Between the primary and each secondary should be placed a hard rubber disc about an inch wider than the secondaries, and then the secondaries, covered with Empire cloth, are slipt in place. If a hard rubber disc is not available, three or four layers of the Empire cloth may be used. Great care must be taken with the insulation on account of the peculiar construction, and it is especially necessary that the insulation along the core, between primary and secondaries, be well taken care of. Connections for the secondaries are shown in the diagram (2).

When properly constructed, a thick spark, the length depending on the secondaries used, will be obtained. The transformer has proved especially good in use with a rotary gap.

A transformer constructed along similar lines, using two secondaries from a three-inch spark coil, has been giving me excellent service, and I hope other amateurs will have a similar experience.

Contributed by WM. HOLLADAY.

GERMANS' WIRELESS CODE

Dr. J. A. Fleming, in a lecture on "Electric Wave Telegraphy" at the British Royal Institution, revealed the fact that the Germans had, during the war, conveyed much important information from Tuckerton radio station in America by a code which was dependent on a certain method of "spacing," being otherwise harmless.

Application for Membership in the Radio League of America

I, THE UNDERSIGNED, a Radio Amateur, am the owner of a Wireless Station. My station has been in use since....., and I herewith desire to apply for membership in the RADIO LEAGUE OF AMERICA. I understand that the Radio League of America is a National Scientific Organization for the pursuit of the Radio Arts. I will not be called upon to pay membership fees, or dues, and once enrolled I am to share in all the privileges of a regular member.

Upon receipt of this form properly filled out you are to send me your eight-page booklet describing the purpose of the League, rules, etc.

Name.....

City.....

State.....

Date.....191

Mail this blank to Radio League of America, 231 Fulton St., New York City.
6-19

My Inventions

By Nikola Tesla

(*Continued from page* 173)

same time preventing undue accumulation of the charge at any point. The application of this principle enabled me to produce pressures of 4,000,000 volts, which was about the limit obtainable in my new laboratory at Houston Street, as the discharges extended through a distance of 10 feet. A photograph of this transmitter was published in the *Electrical Review* of November, 1898. In order to advance further along this line I had to go into the open, and in the spring of 1899, having completed preparations for the erection of a wireless plant, I went to Colorado where I remained for more than one year. Here I introduced other improvements and refinements which made it possible to generate currents of any tension that may be desired. Those who are interested will find some information in regard to the experiments I conducted there in my article, "The Problem of Increasing Human Energy" in the *Century Magazine* of June, 1900, to which I have referred on a previous occasion.

The Magnifying Transmitter.

I have been asked by the ELECTRICAL EXPERIMENTER to be quite explicit on this subject so that my young friends among the readers of the magazine will clearly understand the construction and operation of my "Magnifying Transmitter" and the purposes for which it is intended. Well, then, in the first place, it is a *resonant transformer* with a secondary in which the parts, charged to a high potential, are of considerable area and arranged in space along ideal enveloping surfaces of very large radii of curvature, and at proper distances from one another thereby insuring a *small electric surface density everywhere* so that *no leak can occur even if the conductor is bare*. It is suitable for any frequency, from a few to many thousands of cycles per second, and can be used in the production of currents of tremendous volume and moderate pressure, or of smaller amperage and immense electro-motive force. The maximum electric *tension is merely dependent on the curvature of the surfaces* on which the charged elements are situated and the area of the latter.

100 Million Volts Possible.

Judging from my past experience, as much as 100,000,000 volts are perfectly practicable. On the other hand currents of many thousands of amperes may be obtained in the antenna. A plant of but very moderate dimensions is required for such performances. Theoretically, a terminal of less than 90 feet in diameter is sufficient to develop an electro-motive force of that magnitude while for antenna currents of from 2,000-4,000 amperes at the usual frequencies it need not be larger than 30 feet in diameter.

In a more restricted meaning this wireless transmitter is one in which the Hertz-wave radiation is an entirely negligible quantity as compared with the whole energy, under which condition the damping factor is extremely small and an enormous charge is stored in the elevated capacity. Such a circuit may then be excited with impulses of any kind, even of low frequency and it will yield sinusoidal and continuous oscillations like those of an alternator.

Taken in the narrowest significance of the term, however, it is a resonant transformer which, besides possessing these qualities, is accurately proportioned to fit the globe and its electrical constants and properties, by virtue of which design it becomes highly efficient and effective in the

wireless transmission of energy. Distance is then absolutely eliminated, there being *no diminution in the intensity of the transmitted impulses.* It is even possible to make the actions *increase with the distance from the plant* according to an exact mathematical law.

This invention was one of a number comprised in my "World-System" of wireless transmission which I undertook to commercialize on my return to New York in 1900. As to the immediate purposes of my enterprise, they were clearly outlined in a technical statement of that period from which I quote:

"The 'World-System' has resulted from a combination of several original discoveries made by the inventor in the course of long continued research and experimentation. It makes possible not only the instantaneous and precise wireless transmission of any kind of signals, messages or characters, to all parts of the world, but also the inter-connection of the existing telegraph, telephone, and other signal stations without any change in their present equipment. By its means, for instance, a telephone subscriber here may call up and talk to any other subscriber on the Globe. An inexpensive receiver, not bigger than a watch, will enable him to listen anywhere, on land or sea, to a speech delivered or music played in some other place, however distant. These examples are cited merely to give an idea of the possibilities of this great scientific advance, which annihilates distance and makes that perfect natural conductor, the Earth, available for all the innumerable purposes which human ingenuity has found for a line-wire. One far-reaching result of this is that any device capable of being operated thru one or more wires (at a distance obviously restricted) can likewise be actuated, without artificial conductors and with the same facility and accuracy, at distances to which there are no limits other than those imposed by the physical dimensions of the Globe. Thus, not only will entirely new fields for commercial exploitation be opened up by this ideal method of transmission but the old ones vastly extended.

"The 'World-System' is based on the application of the following important inventions and discoveries:

"1. *The 'Tesla Transformer.'* This apparatus is in the production of electrical vibrations as revolutionary as gunpowder was in warfare. Currents many times stronger than any ever generated in the usual ways, and sparks over one hundred feet long, have been produced by the inventor with an instrument of this kind.

"2. *The 'Magnifying Transmitter.'* This is Tesla's best invention—a peculiar transformer specially adapted to excite the Earth, which is in the transmission of electrical energy what the telescope is in astronomical observation. By the use of this marvelous device he has already set up electrical movements of greater intensity than those of lightning and passed a current, sufficient to light more than two hundred incandescent lamps, around the Globe.

"3. *The 'Tesla Wireless System.'* This system comprises a number of improvements and is the only means known for transmitting economically electrical energy to a distance without wires. Careful tests and measurements in connection with an experimental station of great activity, erected by the inventor in Colorado, have demonstrated that power in any desired amount can be conveyed, clear across the Globe if necessary, with a loss not exceeding a few per cent.

"4. *The 'Art of Individualization.'* This invention of Tesla is to primitive 'tuning' what refined language is to unarticulated expression. It makes possible the transmission of signals or messages absolutely secret and exclusive both in the active and passive aspect, that is, non-interfering as well as non-interferable. Each signal is like an individual of unmistakable identity and there is virtually no limit to the number of stations or instruments which can be simultaneously operated without the slightest mutual disturbance.

"5. *The terrestial Stationary Waves."* This wonderful discovery, popularly explained, means that the Earth is responsive to electrical vibrations of definite pitch just as a tuning fork to certain waves of sound. These particular electrical vibrations, capable of powerfully exciting the Globe, lend themselves to innumerable uses of great importance commercially and in many other respects.

"The first 'World-System' power plant can be put in operation in nine months. With this power plant it will be practicable to attain electrical activities up to ten million horsepower and it is designed to serve for as many technical achievements as are possible without due expense. Among these the following may be mentioned:

"(1) The inter-connection of the existing telegraph exchanges or offices all over the world;

"(2) The establishment of a secret and non-interferable government telegraph service;

"(3) The inter-connection of all the present telephone exchanges or offices on the Globe;

"(4) The universal distribution of general news, by telegraph or telephone, in connection with the Press;

"(5) The establishment of such a 'World-System' of intelligence transmission for exclusive private use;

"(6) The inter-connection and operation of all stock tickers of the world;

"(7) The establishment of a 'World-System' of musical distribution, etc.;

"(8) The universal registration of time by cheap clocks indicating the hour with astronomical precision and requiring no attention whatever;

"(9) The world transmission of typed or hand-written characters, letters, checks, etc.;

"(10) The establishment of a universal marine service enabling the navigators of all ships to steer perfectly without compass, to determine the exact location, hour and speed, to prevent collisions and disasters, etc.;

"(11) The inauguration of a system of world-printing on land and sea;

"(12) The world reproduction of photographic pictures and all kinds of drawings or records."

I also proposed to make demonstrations in the wireless transmission of power on a small scale but sufficient to carry conviction. Besides these I referred to other and incomparably more important applications of my discoveries which will be disclosed at some future date.

A plant was built on Long Island with a tower 187 feet high, having a spherical terminal about 68 feet in diameter. These dimensions were adequate for the transmission of virtually any amount of energy. Originally only from 200 to 300 K.W. were provided but I intended to employ later several thousand horsepower. The transmitter was to emit a wave-complex of special characteristics and I had devised a unique method of telephonic control of any amount of energy.

The tower was destroyed two years ago but my projects are being developed and another one, improved in some features, will be constructed. On this occasion I would contradict the widely circulated report that the structure was demolished by the Government which owing to war conditions, might have created prejudice in the minds of those who may not know that the papers, which thirty years ago conferred upon me the honor of American citizenship, are always kept in a safe, while my orders, diplomas, degrees, gold medals and other distinctions are packed away in old trunks. If this report had a foundation I would have been refunded a large sum of money which I expended in the construction of the tower. On the contrary it was in the interest of the Government to preserve it, particularly as it would have made possible—to mention just one valuable result—the location of a submarine in any part of the world. My plant, services, and all my improvements have always been at the disposal of the officials and ever since the outbreak of the European conflict I have been working at a sacrifice on several inventions of mine relating to aerial navigation, ship propulsion and wireless transmission which are of the greatest importance to the country. Those who are well informed know that my ideas have revolutionized the industries of the United States and I am not aware that there lives an inventor who has been, in this respect, as fortunate as myself especially as regards the use of his improvements in the war. I have refrained from publicly expressing myself on this subject before as it seemed improper to dwell on personal matters while all the world was in dire trouble. I would add further, in view of various rumors which have reached me, that Mr. J. Pierpont Morgan did not interest himself with me in a business way but in the same large spirit in which he has assisted many other pioneers. He carried out his generous promise to the letter and it would have been most unreasonable to expect from him anything more. He had the highest regard for my attainments and gave me every evidence of his complete faith in my ability to ultimately achieve what I had set out to do. I am unwilling to accord to some small-minded and jealous individuals the satisfaction of having thwarted my efforts. These men are to me nothing more than microbes of a nasty disease. My project was retarded by laws of nature. The world was not prepared for it. It was too far ahead of time. But the same laws will prevail in the end and make it a triumphal success.

Tesla Bulbs

(*Continued from page 134*)

scription of the phenomenon, as seen in a bulb without conducting electrode. It is observed under the following conditions:

"When the globe L (Figs. 1 and 2) is exhausted to a very high degree, generally the bulb is not excited upon connecting the wire *w* (Fig. 1), or the tinfoil coating of the bulb (Fig. 2) to the terminal of the induction coil. To excite it, it is usually sufficient to grasp the globe L with the hand. An intense phosphorescence then spreads at first over the globe, but soon gives place to *a white, misty light.* Shortly afterward one may notice that the luminosity is unevenly distributed in the globe, and after passing the current for some time the bulb appears as in Fig. 4. From this stage the phenomenon will gradually pass to that indicated in Fig. 5, after some minutes, hours, days or weeks, according as the bulb is worked. Warming the bulb or increasing the potential hastens the transit.

"When the brush assumes the form indicated in Fig. 5, it may be brought to a state of *extreme sensitiveness to electrostatic and magnetic influence.* The bulb hanging straight down from a wire, and all objects being remote from it, *the approach of the observer at a few paces from the bulb will cause the brush to fly to the opposite side, and if he walks around the bulb it will always keep on the opposite side.* It may begin to spin aronnd the terminal long before it reaches the sensitive stage. *When it begins to turn around, principally, but also before, it is affected by a magnet,* and at a certain stage it is susceptible to magnetic influence to an astonishing degree. A small permanent magnet, with its poles at a distance of no more than two centimeters, will affect it visibly at a distance of two meters, slowing down or accelerating the rotation according to how it is held relatively to the brush. I think I have observed that at the stage when it is most sensitive to magnetic, it is not most sensitive to electrostatic, influence.

"When the bulb hangs with the globe L down, the rotation is always clockwise. In the southern hemisphere it would occur in the opposite direction, and on the equator the brush should not turn at all. The rotation may be reversed by a magnet kept at some distance. The brush rotates best, seemingly, when it is at right angles to the lines of force of the earth. It very likely rotates, when at its maximum speed, in synchronism with the alternations, say, 10,000 times a second. The rotation can be slowed down or accelerated by the approach or receding of the observer, or any conducting body, but it cannot be reversed by putting the bulb in any position. When it is in the state of the highest sensitiveness and the potential or frequency be varied, the sensitiveness is rapidly diminished. Changing either of these but little will generally stop the rotation. The sensitiveness is likewise affected by the variations of temperature. To attain great sensitiveness it is necessary to have the small sphere *s* in the center of the globe *L*, as otherwise the electrostatic action of the glass of the globe will tend to stop the rotation. The sphere *s* should be small and of uniform thickness; any dissymmetry of course has the effect to diminish the sensitiveness.

"The fact that the brush rotates in a definite direction in a permanent magnetic field seems to show that in alternating currents of very high frequency the positive and negative impulses are *not* equal, but that one always preponderates over the other.

"Of course, this rotation in one direction may be due to the action of the two elements of the same current upon each other, or to the action of the field produced by one of the elements upon the other, as in a

series motor, without necessarily one impulse being stronger than the other. The fact that the brush turns, as far as I could observe, in any position, would account for this theory. In such case it would turn at any point of the earth's surface. But, on the other hand, it is then hard to explain why a permanent magnet should reverse the rotation, and one must assume the preponderance of impulses of one kind.

"As to the causes of the formation of the brush or stream, I think it is due to the electrostatic action of the globe and the dissymmetry of the parts. If the small bulb *s* and the globe L were perfect concentric spheres, and the glass thruout of the same thickness and quality, I think the brush would not form, as the tendency to pass would be equal on all sides. That the formation of the stream is due to an irregularity is apparent from the fact that it has the tendency to remain in one position, and rotation occurs most generally only when it is brought out of this position by electrostatic or magnetic influence. When in an extremely sensitive state it rests in one position, and most curious experiments may be performed with it. For instance, the experimenter may, by selecting a proper position, approach the hand at a certain considerable distance to the bulb, and he may cause the brush to pass off by merely stiffening the muscles of the arm. When it begins to rotate slowly, and the hands are held at a proper distance, it is impossible to make even the slightest motion without producing a visible effect upon the brush. A metal plate connected to the other terminal of the coil affects it at a great distance, slowing down the rotation often to one turn a second.

"I am firmly convinced that such a brush, when we learn how to produce it properly, will prove a valuable aid in the investigation of the nature of the forces acting in an electrostatic or magnetic field. If there is any motion which is measurable going on in the space, such a brush ought to reveal it. It is, so to speak, a beam of light—frictionless, devoid of inertia.

"I think that it may find practical applications in telegraphy. With such a brush it would be possible to send dispatches across the Atlantic, for instance, with any speed, since its sensitiveness may be so great that the slightest changes will affect it. If it were possible to make the stream more intense and very narrow, its deflections could be easily photographed.

"I have been interested to find whether there is a rotation of the stream itself, or whether there is simply a stress traveling around the bulb. For this purpose I mounted a light mica fan so that its vanes were in the path of the brush. If the stream itself was rotating the fan would be spun around. I could produce no distinct rotation of the fan, altho I tried the experiment repeatedly; but as the fan exerted a noticeable influence on the stream, and the apparent rotation of the latter was, in this case, never quite satisfactory, the experiment did not appear to be conclusive.

"I have been unable to produce the phenomenon with the disruptive discharge coil, altho every other form of these phenomena can be well produced by it—many, in fact, much better than with coils operated from an alternator.

"It may be possible to produce the brush by impulses of one direction, or even by a steady potential, in which case it would be still more sensitive to magnetic influence."

Fig. 6 shows a practical application of the Tesla bulb. The bulb itself, as will be seen, is excited by means of a Tesla high frequency alternator which, in turn, is connected to the primary of a transformer. The secondary of the transformer is grounded at one end, while the other end of the transformer connects with the Tesla bulb.

Dr. Tesla, in an interview, stated that

(*Continued on page* 184)

How to Finance and Manufacture a Patent

(Continued from page 167)

ers in reference to handling and pushing our goods, when ready for the market (using models of our invention for demonstration) and secured several substantial orders for future delivery. We also consulted an advertising agency about the future advertising of our product.

When the machinery for our little factory was completed we were ready for operation. After a few test runs, everything moved smoothly. In a short time, our factory was busily engaged filling the orders we had secured before starting. Before many months our sales began to mount into large proportions. The public were demanding more and more of our product. Business men began to get interested in our invention and its success. They began to uncover idle money they did not possess when I first asked for their backing. Several offers to buy us out were made from time to time, which we declined. One day the head of a supply company where we obtained the material for making our finished product made us a very attractive offer which we accepted. He knew of our profits better than any one except ourselves. This business man, my partner, not only received his investment, but a handsome profit besides; and I received more money for my patent than would have been possible had I sold it for "Whatever I could get," as my good friends advised.

In conclusion, I wish to suggest the following: If your invention has merit, is a public benefit or necessity, or an attractive novelty, do not sell out for "Whatever you can get," unless it is mighty good. If it is worth your best efforts to originate and perfect, it is also worth further efforts to raise the capital to manufacture it yourself. You might as well receive its full value instead of allowing some one else to do so. However, if you are forced to sell, and feel you cannot command the ability and persistence required to finance it yourself—don't be too anxious to close the deal. Don't accept the first offer made you. Of course, you should not turn it down entirely, consider them all, then decide and you will be sure of getting a fair price.

If your invention is a good one, and investors want it bad enough, they will keep after you until you sell. Fame and fortune come to Inventors who work hard while they are waiting.

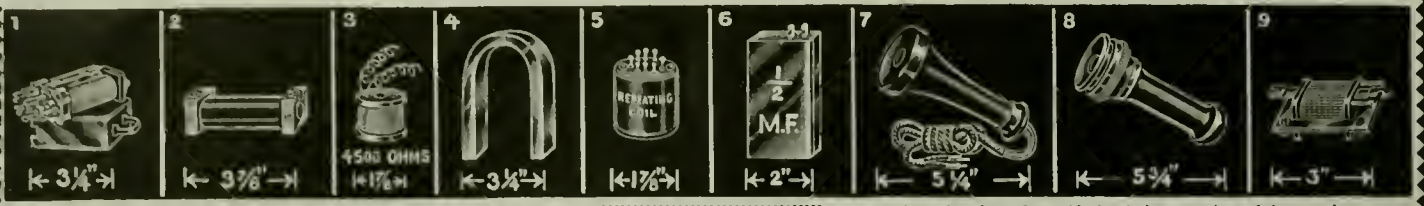
RADIOPHONE BETWEEN STORES.

A prominent electrical and radio manufacturing concern of New York City will install, as soon as the ban on sending is lifted, a complete Radio Telephone System between their factory and several branch stores, so as to relieve a greater portion of the land telephone traffic between these units of the organization.

PERPETUAL MOTION?

What promises to be the world's greatest invention, according to a modest inventor hailing from Jersey City, is the "harnessing of gravity" to run a perpetual motion power plant of millions of horsepower, supplying us forever and ever (??) with light, heat and power almost free. ! ! ! In the near future, he expects to give his invention a "showing," and bring it into the light, till then—"We're from Missouri," he'll have to show us. So, beware! fellow experimenters and line your pockets with fish hooks—for Ssh! The inventor has distributed illustrated stock-selling brochures by the millions to get the billions he needs in order to wish this marvelous invention on a long suffering and struggling public.

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.

RUSH

Cut out and attach to your order. It will leave us within 24 Hours.

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 adjoining coupon. 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**

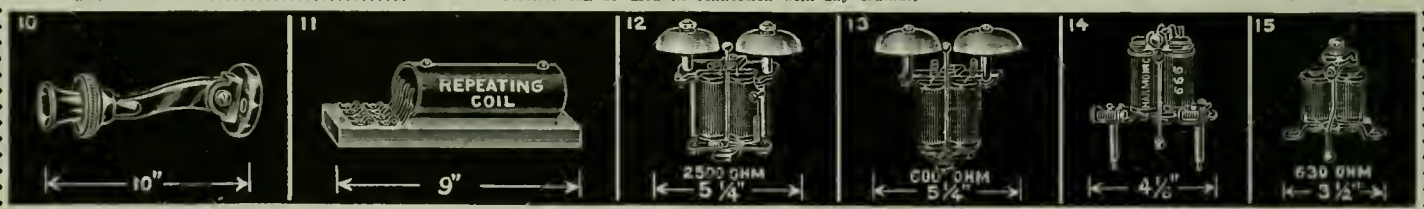
NO. 5 REPEATING COIL (Transformer). This is a standard small repeating coil and is used by all telephone companies. It has 4 different windings and eight contacts. Entirely enclosed in iron. The resistance being respectively 72 and 120 ohms, and 90 and 100 ohms. Diagram is furnished. Can be used for 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, 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**

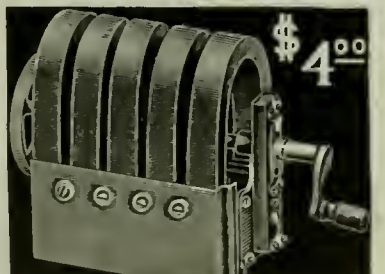
NO. 11 REPEATING COIL (Transformer). A standard repeating coil used for telephonic work. The coil windings are encased in an iron tube 2¾ inches in diameter. There are eight terminals for the four windings to connect to and the instrument is invaluable in connection with radio work to boost up signals, 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 instead of 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**

Complete Wall Set

This is a complete commercial telephone station. The cabinet is of polished oak, piano finish, within which is contained the powerful magneto, the 300 Ohm polarized ringer, and induction coil. The magneto is exceptionally efficient, being of the two bar type with brass gear transmission. The extra sensitive microphone, mouthpiece and two gongs are mounted on the front of the cabinet, giving the entire instrument that desirable appearance of compactness and efficiency. Guaranteed to work over 20 miles. The telephone receiver is a double poled one, and has a hard rubber case. Seven binding posts are provided for connections. The instrument is one which we can offer with pride to our patrons at a ridiculously low price. It is unobtainable anywhere else at less than $15.00 and is an instrument unequaled in value for the price we ask. Size over all 11" x 10" x 8". Shipping weight, 15 lbs.
No. 26 Long Distance Telephone Set..... **$8.00**

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CARBON GRAIN TRANSMITTER

A special design of transmitter for long distance work. Is used on wireless telephone sets where a steady current of ¾ to 1 ampere is constantly required. Sizes over all 3¼ x 2½ inches. Shipping weight, 3 lbs.

No. 6080 Carbon Grain Transmitter as described..... **$1.00**

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Electric Drive on U. S. S. "New Mexico"

(*Continued from page* 106)

structions from the captain, sent either by loud speaking telephones, by indicators, by lights, or by messenger. Following these instructions, the engineers standing at the switchboard can start the vessel forward, or start it backwards; they can make it go many different speeds in either direction; they can run all four of the motors from one of the power plants, or from the other power plant; they can even split up the load so that one power plant will run two of the motors forward and the other power plant will run the other two "astern." Another combination they can effect is that both power plants can equally share the load of driving the four motors—one to each propeller.

If one of the propellers becomes foul the engineer can disconnect this motor from the circuit, and then all of the power in the two power plants is available for the three remaining motors.

Giant Motor for Each Screw.

Can you imagine a motor twice as high as a six-foot man? Can you imagine *one motor capable of doing the work of* 30,000 *horses working at three eight-hour shifts?* If so, then you can appreciate the picture which these made in their steel compartments. One of these giant motors is provided for each of the four propeller shafts. The screw is at one end of the shaft in the water, and the motor is at the other end of the shaft inside the ship. One reason for their efficiency is the fact that the shaft can be short as the motor can be close to the propeller. There is an additional advantage also, because the turbine generators can be located near the boilers, and this permits of a short steam pipe. These very desirable features are a result of electric drive, because it doesn't make any difference what is located between the power plant and the motors.

No Reversing Turbines.

With electric drive, no reversing turbines are necessary, *the reversing is done electrically.* So with the electric drive, the turbine in the power plant always runs in the *same direction* and at highest efficiency.

Electrical propulsion not only does away with reversing turbines, but also does away with reduction gears. The wonderful simplicity of the arrangement can be appreciated also when you remember that the battleship *Pennsylvania* has ten turbines and the *New Mexico* only two.

Propeller More Efficient.

Electric propulsion has another advantage in making the propeller more efficient. This is because, within limits, the faster a propeller turns, the less efficient it becomes. If it turns too rapidly, it merely churns the water, and therefore does not effectively drive the ship ahead. When turbines are directly connected to the propeller shaft, the turbine rotates too slowly to be at its best efficiency, and the propeller shaft rotates too rapidly to operate at its maximum efficiency. So you can look at electric propulsion as a means of speed reduction; for it permits the turbines to rotate at their normally high speed, where they show the best fuel economy, and also permits the propeller to operate at comparatively low speed, where it gives the best driving economy. Without electric propulsion, there were at many different speeds practically "compromise" arrangements, by which either the turbine was rotating too slowly or the propeller too fast. This is obviated in the *New Mexico*, which is one reason why, with one filling of her oil tanks, she can cruise over 50 per cent. further than with any other equipment. In fact, she can go 7,500 knots at 12 knots speed before it will be necessary to take on any more fuel.

Nearly 100,000 Horse Power.

The *New Mexico* is practically the only 100 per cent. electric boat. This will be seen by glancing over, or, better yet, carefully reading the following table, showing her electrical equipment.

Particular attention is called to the loud speaking telephones, 104 in number, located all over the ship. From three different transmitting stations the bugle calls or other instructions can be sent to all or any one of five different groups of these telephones.

Electrical Equipment

2	main generators	33,000 h.p.
4	motors for propelling	33,000 h.p.
6	dynamos	3,000 h.p.
6	air compressors	400 h.p.
2	vacuum pumps	80 h.p.
20	motor generator sets totaling almost	100 h.p.
4	boat crane motors	220 h.p.
2	anchor motors	250 h.p.
4	winch motors totaling	200 h.p.
20	turret motors	1,300 h.p.
10	ammunition hoists	500 h.p.
2	refrigerator motors	40 h.p.
8	motors in kitchen (Peel potatoes, mix dough and cake, and wash dishes, cut butter, make ice cream, meat grinder, all bread and cakes baked electrically.)	15 h.p.
6	in carpenter shop	20 h.p.
10	in machine shop	30 h.p.
6	in laundry (5 machines use electric heat)	10 h.p.
5	motors in print shop totaling	6 h.p.
14	pumps water	140 h.p.
4	oil pumps	8 h.p.
50	electric air heaters	30 h.p.
12	searchlights	300 h.p.
160	fans, 60 blowers, 6 electric toasters, 1 electric percolator, 15 electric irons, 104 loud speaking telephones, 176 ship service telephones, 170 fire control telephones, 2 Sperry electric gyroscopic compasses, 7 portable electric drills, 2 electric glue pots, 6 electric soldering irons.	

Airplane Speeds 300 Miles an Hour

An airplane with a speed of from 200 to 300 miles an hour which will bring America within a short day's journey of Europe, is the prospect held out by the invention of a French engineer, Auguste Rateau.

At the present time without the invention the higher an airplane mounts the less power does its engine develop on account of the rarefying of the air. The loss at 15,000 feet, for instance, is 50 per cent.

M. Rateau's device is said to be very simple. It consists of an arrangement by which the exhaust from the engine works a small turbine, which compresses the air drawn into the engine to normal pressure so that the engine develops full power no matter what the altitude. As the resistance of an airplane decreases enormously at high altitudes, it follows that the higher a machine fitted with the new device mounts the greater will be its speed. This fact, it is declared, was demonstrated by the famous German long-range gun.

It has been found that a heavy day bombing machine whose speed at 15,000 feet ordinarily did not exceed 80 miles an hour, made 140 miles an hour when fitted with this invention, an increase of 75%.

READ THE CLASSIFIED ADS. ON PAGES 188 - 190

Tesla Bulbs

(*Continued from page* 180)

the best way to use the bulb for such experiments is when the shaft of light is in the position as shown in Figs. 5 and 6, at rest, but in a state of equilibrium inconceivably delicate. This is fully described above in Dr. Tesla's lecture. The inventor states that in such a condition, the shaft of light is marvelously sensitive to magnetic disturbances. Dr. Tesla informs us that a toy permanent horseshoe magnet not longer than ½" and with its poles ⅛" apart could with ease throw the shaft of light out of its normal direction across the whole room. In our illustration, an electromagnet is shown a few inches away from light ray, and we can imagine a slot in a screen in such a way that normally no light falls thru it. If, however, very faint radio-telegraphic impulses surge thru the electromagnet, the light ray will immediately become displaced, and will fall into the slot. Inasmuch as this shaft of light has no inertia, it will follow exactly the dot and dash impulses surging thru the electromagnet, no matter how rapidly they take place. They can then either be read off by the eye, or if desired, can be registered upon a fast moving film. This method will, of course, only be used where the transmission is made at high speed, and where it would be impossible for an operator at the receiving end to follow the dots and dashes with the eye.

The method shown by us in Fig. 6, of course, represents only one. Many others can undoubtedly be evolved to use the Tesla bulb to advantage.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912, of Electrical Experimenter, published monthly at New York, N. Y., for April 1, 1919.

State of New York, County of New York—ss.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Hugo Gernsback, who, having been duly sworn according to law, deposes and says that he is the Editor of the Electrical Experimenter, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations:

1. That the names and addresses of the publisher, editor, managing editor, and business manager are: Publisher, The Experimenter Publishing Co., 233 Fulton Street, New York City; Editor, Hugo Gernsback, 233 Fulton Street, New York City; Managing Editor, Harry Winfield Secor, 233 Fulton Street, New York City; Business Manager, Hugo Gernsback, 233 Fulton Street, New York City.

2. That the owners are: Experimenter Publishing Co., 233 Fulton Street, New York City; Hugo Gernsback, 233 Fulton Street, New York City; Sidney Gernsback, 233 Fulton Street, New York City; Mrs. K. Hymes, 233 Fulton Street, New York City; Harry Winfield Secor, 233 Fulton Street, New York City.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but, also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

5. That the average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the six months preceding the date shown above is —(Required only of daily publications.)

(SEAL) H. GERNSBACK.

Sworn to and subscribed before me this 4th day of April, 1919.

BEATRICE K. OWEN.

(My commission expires March 30, 1921.)

Choke Coils: Theory and Design

by Prof. F. E. Austin

(*Continued from page* 140)

It is evident that with a current of 13.9 amperes in a resistance of 2.9 ohms, there will be considerable heating effect, denoted by $R_x I^2_{dc} = 2.9 \times 13.9^2 = 560.3$ watts. If the current passes thru the circuit for one hour, about one-half kilowatt hour of energy will be paid for, which is simply a *heat waste* in the auxiliary resistance R_x.

When connected with a 110 volt alternating current circuit, the current of 13.9 amperes was maintained without this heat loss, simply because of the counter-electromotive-force of induction of the coil itself.

The financial saving effected by the use of a choke coil is therefore very apparent, since the coil reduces the current in the circuit from 22 to 13.9 or 8.1 amperes, at no operating expense for power.

The usual condition governing the use of a choke coil is either the amount of current to be past thru the coil is known, or the amount of pressure reduction is known.

The size of the wire constituting the coil must be large enough to carry the desired current without overheating the coil. The choking effect of any coil depends upon the *square of the number of turns* of wire composing the coil. That is, if the *number of turns* on a coil are *doubled*, its choking effect is increased *four* times.

A very serviceable choke coil for a wide range of choking effect may be made by winding ten pounds of No. 14 double cotton covered copper wire in two sections on a hard fiber tube, measuring 2 inches in outside diameter, and 9½ inches long. The tube should be provided with wooden ends about 4½ inches square and ¾ inch thick, with a middle partition of wood ¾ inch thick. It will be advisable to shellac the insulated wire very thoroly and allow it to dry before using the coil.

An iron core should be made up of about No. 18 iron wire stock, carefully varnished with shellac varnish, and measuring about 14 inches long by 1¼ inches in diameter.

Such a coil will carry as high as 15 amperes for a short time and as high as 5 amperes for a long period without seriously heating.

With both sections in series, without an iron core and with an applied pressure of 110 volts at 60 cycles, the current in the coil will be about 6 amperes. The insertion of an iron core such as described above will reduce the current to less than ½ ampere.

With one section of such a coil, connected across 110 volts at 60 cycles, with no iron core, the current will be nearly 12 amperes, and by inserting the iron core may be gradually reduced from 12 amperes to less than one ampere.

Such a coil may be connected in series with other coils or lamps such as an arc lamp and the desired pressure applied to the apparatus. In using a choke coil always have the iron core inserted in the coil before closing the circuit, so as to have *maximum* choking effect in operation at the *start*.

The effect of the iron core is to greatly increase the coefficient of inductance L, thus increasing the numerical value of the term $2 \pi f L$. The iron core takes the place of a very large number of turns of wire, greatly reducing the expense of construction.

A very useful equation by which choke coils may be designed is as follows:

$$L = \frac{4 \pi n^2 \mu A}{10^9 b};$$

in which L denotes the inductance of a coil in *henries;* n denotes the number of turns on the coil, μ denotes the so-called magnetic permeability of the medium (iron, etc.), in-

(*Continued on page* 187)

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The Rogers' Underground Aërial for Amateurs

(*Continued from page* 137)

specified, where the transmitting set is one employing an audion oscillation generator. The voltage in this case will not be extremely high, and special precautions need not be taken to provide extra heavy insulation on the buried antenna. Official tests by the U. S. Navy have shown transmission by radio over 50 miles with the Rogers underground antenna. *The wire in such a case, however, should be especially well insulated* to stand the higher voltage.

Regarding loop aërials in general, it would appear that we can expect a great deal from them, as some of the really remarkable results achieved during the war would seem to point out. The number of turns and the amount of wire to be used in a spiral antenna, such as shown at Figs. 7 and 8, will vary of course for different wave lengths, etc., and here is where the Radio Amateur will have a chance to carry out some original experiments, which may net him some real knowledge, fame and money. Another form of loop antenna, so-called, and which has been tried out several years ago with such success that European stations could be copied in a laboratory located in Florida, is one composing a square form, several feet in height. This was used, as just mentioned, to receive stations using fairly long wave lengths, say from 8,000 to 12,000 meters, W. L. Here the insulating form was wound with a layer comprising several hundred turns of insulated wire, such as ordinary annunciator wire. This antenna was successfully used in some tests made by the Marconi radio engineers at a laboratory in Florida several years ago. Trans-Atlantic radio reception was effected at the radio laboratory of Union College, Schenectady, N. Y., just prior to America's entrance into the world war. This aërial comprised about two dozen turns of No. 14 or 12 bare or R.C. wire, mounted on porcelain knob insulators screwed on the inside wall of the laboratory. The turns were spaced about 3 inches apart. The inside turn was 3 feet square. Flexible leads, fitted with clips, serve to connect as many turns as desired.

Choke Coils: Theory and Design

By Prof. F. E. Austin

(*Continued from page* 185)

side the coil, A denotes the cross-sectional area in square centimeters of the central hole thru the coil, and b denotes the length of the *coil* (not of the wire) in centimeters. For air the magnetic permeability μ is 1. For an iron core μ varies considerably, according to the kind of iron used. For ordinary iron μ will be between 1,500 and 2,000 which shows how L increases from an air core to an iron core value. Consult any text-book containing a magnetization table, which gives the various permeability values for different flux densities. The flux density in each case depends upon the ampere-turns produced by the coil; this value is found by multiplying the amperes by the number of turns in the coil. Thus it is seen how the value L constantly varies as the core is moved in and out of the coil, or the number of turns varied, as well as any variations of the amperage, which would change the flux and in turn the permeability. It is usual to allow 1,000 circular mils per ampere in designing choke coil or transformer windings; a common core flux density is 25,000 to 30,000 lines per square inch of cross-section.

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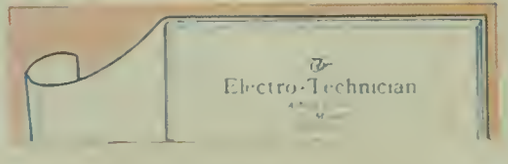

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