Beginning: "My Inventions," by Nikola Tesla

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EDITORIAL

The New Wireless

IT will come as a profound shock to all wireless enthusiasts, scientific and amateur alike, that their present-day notions on wireless are totally erroneous and not based upon actual facts. For years we clung to the theory that a wireless message radiates from the aerial wires of the sending station and speeds over the surface of the earth thru the ether towards the receiving station. We thought that we were sending out pure Hertzian waves from our transmitters. We thought that we received these waves over the aerial wires of our receiving station. All of these theories are wrong and will be relegated shortly into the past along with the early notion that the earth stood still, while sun, moon and stars revolved around it.

Remain only the physical facts that we did send and did receive messages without wires—but they are not sent by means of pure Hertz waves, nor do they go by way of the ether as radiations.

In a highly illuminating article printed elsewhere in this issue, Nikola Tesla explodes all of our present orthodox views as to wireless propagation and makes it clear that the earth is the sole medium thru which our wireless impulses travel, in the form of true conduction. Particularly does this hold true for long distance messages: Here we are sending out a compound impulse three quarters of which is a galvanic current, traveling thru the conducting earth, the other quarter or less is in the form of Hertz waves, going by way of the ether. This explains why we can send signals to airplanes and vice versa; but even here we probably have to do not with pure Hertz waves it is almost certain that we have capacity-inductive effects as well.

Tesla maintaining that there can be no long distance effects by radiations transmitted thru the ether, but rather only by currents thru the earth, it follows that in his opinion all our radio apparatus is designed and operated faultily. Indeed, this is not a brand new idea of the famous inventor. He has been preaching it ever since he took out his first patents and described his system in 1893—long before Marconi thought of wireless But he was preaching to a stone deaf scientific world.

But how simple it all becomes when we stop to apply a little reason and logic to Tesla's claims. For instance, we can send radio impulses three to five times as far over salt water as over land. Why? Simply because the impulses go *thru* the water, which is a much better conductor than earth alone. If we were sending pure Hertzian waves, why do we connect one wire at both sending and receiving station to the ground? Hertz never dreamt of such a thing. If you are still unconvinced that the earth is the chief medium of transmission, disconnect your ground wires entirely and try to send and receive. Now you may work with Hertz waves, but the distances you can bridge will be pitifully small.

Already Tesla's logic is filtering into our radio scientists' minds. *All the big stations are beginning to scrap their towers and aerial wires, at least for receiving. They now bury their "aerial" wires in the ground,* and lo! they can receive signals twice as far as before. Incredible, but it is being done every day. And—wonders upon wonders—how we will laugh at our present and past blindness—*the static interference is practically gone* the minute we pull our aerial wires down and bury them! Static Electricity? There never was a reason for having the bugaboo, for there is no "static" in the ground.

But Tesla goes much farther. In time he will show the world wireless power transmission effected *not by ether waves but by currents thru the earth,* which is a first rate conductor. Like all big things, the problem is simple. At some point on the globe he will erect a station powerful enough to charge the whole earth with electricity—and keep it charged. To do this we need about 10,000 kilowatts. Then at *any* point on the globe the current can be tapt by means of suitable apparatus. Like a bell ringing transformer, *connected* to your supply line, no current is consumed unless you close the secondary circuit. Tesla's world wireless works just that way. *No current is consumed till it is tapt at the distant receiving station.*

H. GERNSBACK.

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El Paso, Texas, Oct. 1, 1917.

MR. CHARLES F. HAANEL, St. Louis, Mo.
In Re "The Master Key"

My Dear Mr. Haanel: The value of an idea is determined by its application. Pragmatism has long since spread beyond the confines of Missouri. The world insists on being shown.

The lash of circumstances and the logic of events are, more than ever, impelling men to think. Whether an idea be a new process for picking cabbages, or an old process (Kaiserism, for instance) for preserving kings, we are from Missouri.

A philosophy of life having as its base blind optimism; a religion that won't work seven days a week, or a proposition that isn't practical, appeals to the intelligent not at all. It is results that we want and the acid test is: will it work?

The Master Key qualifies. It is the most lucidly scientific statement of "Truth" that I have seen. It reconciles rationalism and religion; illumines economic determinism and the materialistic conception of history, and is an infallible guide to understanding. It contains in condensed form the substance of an entire library on science. Its teaching, if consistently applied, will make a man healthy, wealthy and wise. Its distribution is super-missionary work in excelsis. Those who wish to think intelligently will find it invaluable.

Intelligence rules. Desire, intelligently directed, is a creative force which automatically causes its object to manifest on a material plane. It is the law. Let him that hath an ear to hear, hear.

Yours truly,
CHAS. A. HEARD.

May 15, 1918.

Dear Mr. Haanel: Ever since I have been old enough to read, I have been reading occult and metaphysical literature. I have waded ears deep through the books from all ages, all lands, all schools.

I have rejected tons of lies, oceans of misconceptions, an entire universe of false deductions.

I have found grains of truth in mines of folly, and worlds of truth in a single grain. The pursuit was interesting in itself, and I do not regret the time spent upon it. But it was a genuine surprise to read your Master Key System and find within, the essence of all that I had read, with much more added thereto.

In this extraordinary system you have sifted the true from the false; you have given in concrete form all that is worth while in many schools of philosophy.

You have placed arcane truths into the hands of the uninitiated as weapons they can learn to use without danger to themselves. I congratulate you. You are doing mankind a service.

Yours very sincerely,
CHARLES F. OURSLER.
501 Fifth Avenue, New York City, N. Y.

THE LOWE OBSERVATORY
Edgar Lucien Larkin, Director
Los Angeles, Cal., Dec. 6, 1916.

MR. CHAS. F. HAANEL, St. Louis, Mo.

Dear Sir: Your booklet, Master Key, ought to be expanded into a book. Its teachings that Mind is the all-dominating creative force is precisely in line with the wonders of the most recent psychology. All persons having desks should have this pamphlet thereon. And it would be a fitting pocket companion.

EDGAR LUCIEN LARKIN.

Detroit, Mich, May 28, 1917.

Dear Sir: The words, "Your world will change as if by magic, the moment you realize the marvelous power within your control," page 6, I have underlined. They state a fact, a real live fact; and to me this is the most wonderful, the most important fact of all—that one may put this knowledge to an immediate test, that one may, after learning of this power, proceed to apply it with a definite knowledge as to results.

W. M. HOWE.

which can throw wide the doors which seem to bar men from the Treasure House of Nature. This may seem "too good to be true," but remember that within a few years science has placed almost infinite resources at the disposal of man, is it not possible that there are other laws containing still greater possibilities? Get the Master Key and find out for yourself how the invisible forces of Faith and Desire are converted into actual, tangible, concrete facts in the objective world.

Chattanooga, Tenn., Feb. 22, 1918.

The Master Key is wonderful, it has brought about a most remarkable change in my environment, attitude toward life, mental and physical condition. I am an entirely new person and improving daily, discouragement, lack of ambition, physical ills, mental distress, and fear are things of the past.

I cannot find words that express my gratitude for all that the Master Key has done for me. With heartfelt thanks to you, I am,

Yours sincerely,
R. J. ARNOLD.

---

160 Claremont Avenue, New York
New York, Nov. 18, 1916.

I have made a thorough examination of the little booklet which you so appreciatively have called the Master Key, and can unhesitatingly endorse it and its teachings.

In this pamphlet of only a few pages you have led a hungry world to the threshold and placed in their hands a "key" with which the understanding ones may unlock the door and enter "The Secret Places of the Most High," and enjoy the abundance of all good to be found therein. With best wishes,

AGNES MAE GLASGOW.

HOME LIFE INSURANCE CO. OF N. Y.
James Lee Bost, General Agent
Washington, D. C., Dec. 29, 1916.

Dear Sir: Your little booklet, entitled "The Master Key," has been received and I had great pleasure in studying it carefully. It is a very clear and concise, yet forceful presentation of the big subject handled, and shows a very wide study of the absolute teachings and deep understandings of the same.

Very truly yours,
JAMES LEE BOST.

"I am able to extract from this system all that can be made known by the finite mind relative to origin, evolution, destiny and the much-mooted riddle of the Universe."

"I can hardly grasp the full significance of the facts. The vastness of this subject is so overwhelming it seems a life-time of effort could never fathom all its possibilities."

"You have given a wonderful analysis of the power that is the creative force by which the master mind controls his destiny."

"The Master Key is too modest a title for such a stupendous revelation."

"I have found the Key and with it each day am opening the store-house of wisdom and success, of which for many years I was utterly ignorant."

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CHARLES F. HAANEL, 423 Granite Bldg., St. Louis, Mo.

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NOTE—*Tomorrow; today* will be *yesterday*. Get your Master Key TODAY! NOW!

Electrical Experimenter

H. GERNSBACK - EDITOR
J. W. SECOR - ASSOCIATE EDITOR

Vol. VI. Whole No. 70 | FEBRUARY, 1919 | Number 10

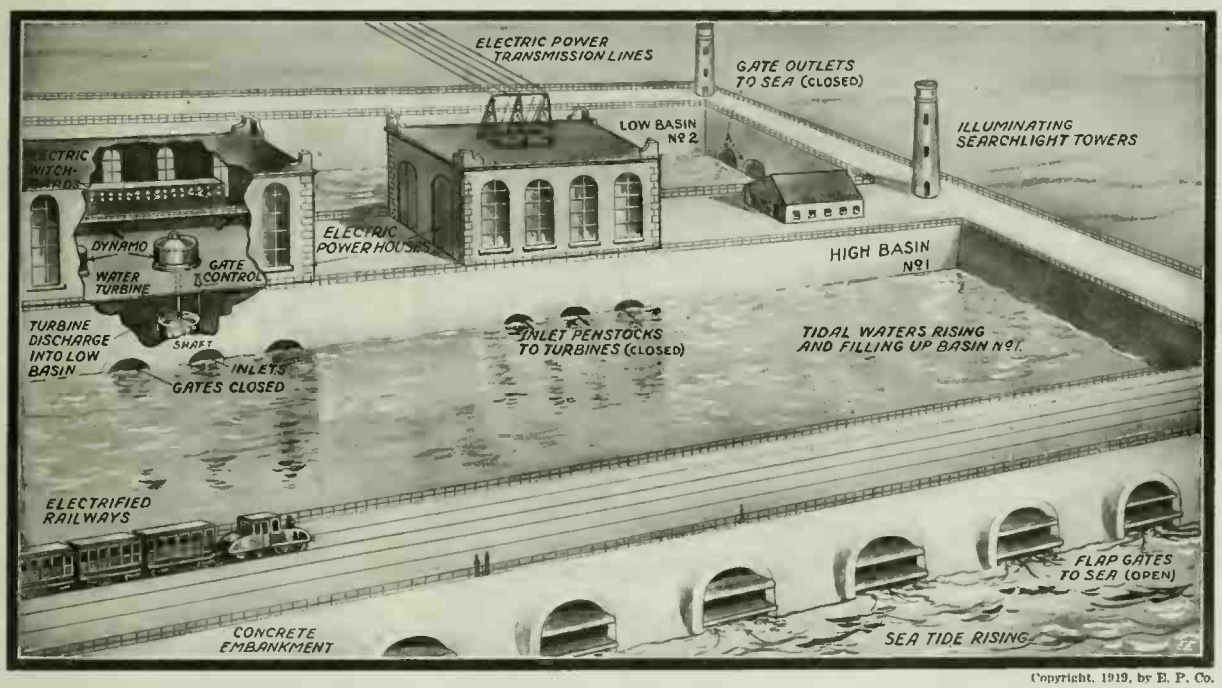
Tidal Power Problem Solved at Last

TIDAL power is one of those long dreamed of possibilities in engineering which has occupied the minds of great philosophers for generations. Why not,—for who can stand down by the ocean shore, or even by any large river having an appreciable tidal rise and fall, and fail to be imprest with the gigantic natural power here spread out before us, and let go to waste for all these years. Think of it—tens of thousands, yes, millions, of horse-power dissipating itself on our coastal and river shores every day in the year. To realize this fact fully we need but reflect for a moment. If the tide brings us a rise of several acres (many thousand cubic feet) of water, why let it fall again, *uselessly?* Allow the water to flow, without friction, into huge basins at high tide; trap it, and when the tide falls, permit the imprisoned water to escape, *but thru turbines*, back to the tidal level.

That is the idea several engineers have had, but an English engineer seems to have solved the problem successfully with his specially designed tidal turbines and triple basins. His name is J. O. Boving, and his scheme is so practical that it has been proposed for the development of electric power from the tide water at the mouth of the River Dee. Mr. Boving's description of the tidal power plant is as follows:

Altho the (English) Government a few months ago took a very wise and necessary step in appointing a committee to inquire into the possibilities of water power development in the British Isles, there is one aspect of the question which does not seem to have attracted adequate attention, and that is the utilization of *tidal power*. The rise and fall of the tides around the English coasts vary greatly, from a maximum of nearly *fifty feet* in some places on the west coast to only a few feet at others. Generally speaking, the differences on the east coast are small, but on the west coast there are many river estuaries and other inlets which offer abundant possibilities for obtaining power from the tides.

Some years ago I had an opportunity of examining the possibilities of developing a tidal water power on the estuary of the River Dee, where the tidal differences are roughly *thirty-five feet* at *highest* Spring tide and *thirteen feet* at *lowest* neap tide. The scheme put forward was to form a railway embankment across the mouth of the estuary so as to connect up the Welsh railway system with Birkenhead and Liverpool. The area of the impounded water behind this dam was to be *forty-four square miles*. On account of local conditions it was not difficult to divide this basin into two equal parts, and to arrange these two inner basins, the sea forming the third, in



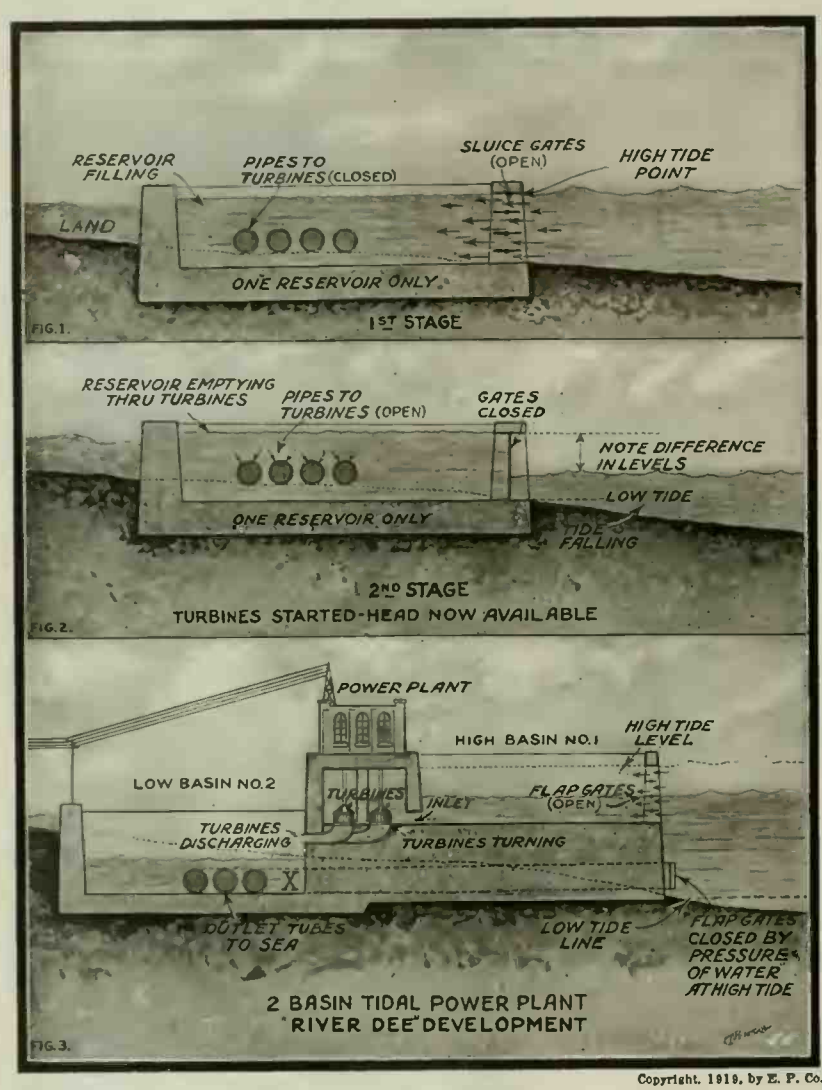
The Proposed River Dee Tidal Power Development As Designed By a Famous English Engineer—J. O. Boving. This View Shows His Two Basin Proposal Where the Area of the Impounded Water Would Amount To Forty-Four Square Miles. The Maximum Tidal Difference Is In This Case About Thirty-Five Feet. A Large Railway Embankment Is a Part of the Scheme, This Railway to Connect Up the Welsh Railway System With Birkenhead and Liverpool.

such a way that a power station could be worked *continuously* under constant head and with constant output. The plan was roughly as follows:

Supposing that we start with high tide, the flap gates leading from the sea to the high basin would be open, and the water would flow in and pass thru turbines into the lower basin, the automatic flap gates to this basin being closed by the water pressure outside. This flow would continue until the level in the sea equaled that in the high basin, when the flap valves to this would slowly close. *In the meantime the level in the high basin would slowly SINK as water was consumed, and the level in the low basin would INCREASE until the moment when the water level in the sea had fallen to such a point that the gates of the lower basin would open and discharge the water in it completely.* On the rising tide a similar sequence would be followed, and a continuous development of power would thus be maintained.

There are a great number of cases along the coast where it would be easy to create a reservoir at a considerable height adjacent to the tidal power station, or at least within a distance which would make electric transmission easy. In such cases the surplus power might be used during the periods when it is available for pumping up water to such reservoirs, while during the intervals, when power is required, it could be obtained thru high-pressure turbines driven by the stored-up water supplied.

It will perhaps be argued that this is a very elaborate and costly arrangement which would not pay. The problem in fact resolves itself to this: Assuming (1) that an ordinary water power in a river was developed and used for commercial purposes during twelve hours out of the twenty-four and that it was a good commercial scheme under these conditions; and (2) that a high pressure power development could be obtained by using stored water for twelve hours of the twenty-four, and that this also was a commercially good undertaking in itself; then it must be equally sound commercially to link the two together and produce power around the twenty-four hours. In the tidal scheme the only things added to the arrangement described above are pumps, which are a negligible factor in the general costs (they would correspond to something like $3.75 per h. p.). The pipes thru which the water is pumped up are, of course, the same as those which return the water from the high pressure plant. Everything else is in common.



Progressive Illustration Showing How the Tidal Power Plant Works. First Figure Shows How the Rising Tide Fills the Large Basin Or Reservoir With Water. At Full Tide the Sea Gates Are Closed and After the Tide Has Fallen a Few Feet, a Working "Head" Becomes Available As Fig. 2 Shows. The Impounded Water Discharges Thru Turbines Back to the Sea. Fig. 3 Shows a "Two Basin" Plant Which Discharges the Impounded Water In Two Stages, Giving Steadier Power Development.

The calculation for such a scheme is simple, and in the case referred to, assuming that in any case a bank was needed across the Dee mouth, for railway purposes, there is no doubt that this power development would pay well. In cases where two tidal plants of similar size are close together the necessary conditions could be realized by connecting them. There would be nothing novel in such plans; the turbines would be of standard design, the variation in the head would be only such as would be allowable for in ordinary turbine plants, and there would be no need to bridge over any periods when the power developed fell much below the average power.

However, in most cases it would be impossible to develop the three-basin idea, and it would be necessary to rely only on one inner reservoir and the sea. Obviously under such conditions the engineer has to contend with very great variations in head and power. The great differences that occur in the tidal ranges at various times compel him to calculate his turbines for the average head derived from neap tides.

The general idea of a one-reservoir tidal scheme is as follows: At the beginning of high tide the sluices are open fully and the water rushes into the inner reservoir, filling it up as quickly as possible. Then the gates are shut for a certain time, *until the water level outside has fallen to give a desired difference in level between the reservoir and the sea.* (See detailed illustration of one reservoir scheme herewith.) The turbines are now started and kept in operation under virtually constant head, while the level in the reservoir falls at the same time as the tide. Some time before the lowest level of the tide the turbines are shut off, the gates opened, and the remaining water in the reservoir allowed to rush out with the lowest tide. Then the gates are closed, the tide rises outside until the difference in level between the sea and the reservoir has again reached the agreed amount, the turbines are started, and the same procedure is gone thru for the rising tide as just described for the falling. Thus for certain definite periods power is obtained at a nearly constant rate, but in the intervals no power is produced.

Up until now we have been satisfied to mine and burn coal, prospect for oil gushers, and, in fact, have tried out about every expensive source of power we could think of. This comes of prosperity. America is rich, and the keynote of the hour is "speed." Design, develop, build,—do all these things—say our great philosophers and educators, but do them FAST. Speed is a fine thing—in its place; but there is bound to be a big bill to pay, some day. Why not live and work efficiently; not necessarily in a slow, plodding, unenlightened way, but in an economical manner. Coal and oil will not last forever. If you have ever visited Holland, you have undoubtedly been imprest with the simplicity of things, and those windmills. There is a fine bit of antique engineering. The Hollander is using an untaxable, free, and powerful source of natural power—the wind. Besides these you will find in all parts of Europe the ever-present water wheel and turbine. Excellent, steady power, untaxed in most cases; but do the American farmers and developers put the *free* wind and water power to work? Yes, they do NOT. They would rather spend a thousand dollars or so for a gasoline engine and then work their heads off for the rest of their lives buying gasoline and oil to run it with. You can see hundreds of windmills and waterwheels rusting to pieces all over the country. A great pity and a prodigious waste.

Sweden, which is rich in water power, sends electricity across the sound to Denmark.

Producing Rain by Electricity and X-Rays

FROM time to time in the world's history, there have been schemes promulgated for and attempts made at producing rain by artificial means under the control of man. One of the most promising of the recent schemes for producing rain-fall at any desired time, providing there happened to be aqueous particles contained in the atmosphere, is that due to an Australian scientist, John Graeme Balsillie. He has taken out patents on his system of producing rain-fall electrically, and one of his latest American patents is here pictured and described.

The illustration shows how Mr. Balsillie proposes to send up a series of balloons or large box kites of sufficient size to carry an extra large X-ray tube, and also capable of supporting two thin electric wires of considerable length. As the inventor states in his patent, his invention "consists in electrical means for assisting and promoting under suitable meteorological conditions the formation of aqueous particles in the atmosphere and assisting in promoting the deposition of water particles (rain-fall) from the atmosphere, and further to provide suitable apparatus for producing the necessary electrical conditions for that purpose." This balloon may be controlled from a motor truck which can speed over the country to various points wherever it may be desired, and a portable gasoline engine and dynamo outfit on the truck may supply the necessary current for operating the powerful X-ray tube carried by the balloon, as shown in the illustration, and also for developing the high potential current, about 350,000 volts, which is employed for *charging the metallized surface of the balloon.*

As has been pointed out in previous articles on similar inventions in this Journal, —and as substantiated by the opinion of several well-known scientists, included Dr. Henryt Arctowsky, the Arctic explorer, of New York,—the inventor informs us in his patent that his discovery is susceptible to practical use *only* when the cooling of aqueous vapor resulting from its expansion in elevated regions of the atmosphere and other natural influences brings the vapor *above the saturation point,* so that *condensation* becomes possible.

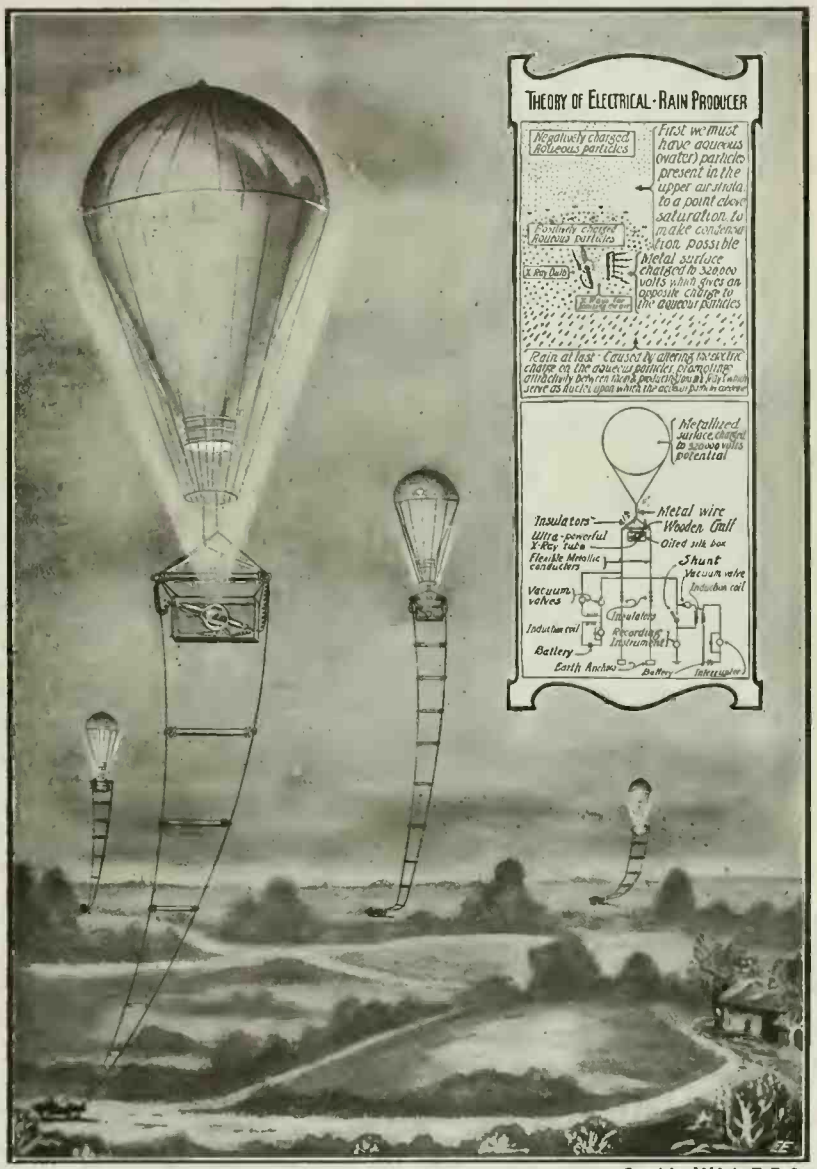
It has been ascertained that ions, produced in this case by Mr. Balsillie by the powerful X-rays, which ionize the atmosphere in the vicinity of the balloon, may act as nuclei, upon which, under certain conditions, water vapor will condense. Aqueous particles comprising cloud, fog or mist are invariably electrified by natural causes, and altho their electrification is of one sign, the potential or voltage distribution thruout the mass is uneven. Aqueous particles of approximately equal dimensions and potential will therefore naturally repel each other, and no condensation will result. However, nuclei, upon which water condensation may take place, can be created by ionizing the atmosphere, such as by powerful X-rays, and further if under normal conditions, a *mutual repulsivity* of charge of the aqueous particles is altered to a condition of *mutual attractivity,* then coalescence of such aqueous particles will be assisted, and rain caused to fall.

As the accompanying detail illustration shows, if a metal plate (or the metallized surface of the balloon) is charged at a very high potential of say several hundred thousand volts, then this electrified body serves to give an opposite charge to the aqueous particles floating in the atmosphere.

The aqueous particles thus become possest of a charge of *opposite sign* to that which they originally had. This charge of opposite sign, however, is not and cannot be communicated instantaneously to all the particles in said zone. The particles in close proximity to the source of electrification are rapidly charged by electrostatic induction with a charge of opposite sign to that which they originally possest. This inversion of sign of charge is gradually communicated to all the particles in said zone in an ever-expanding circle, about the source of electrification as a center. At the perimeter of the circle of imprest electrification, at any instant, a condition exists whereby particles in close proximity to each other are possest of electrical charges of opposite sign. Such particles consequently attract each other, coalesce, and then fall as rain, under the influence of gravity.

The apparatus used for producing the high potential uni-directional current for charging the metallized balloon surface is produced by a transformer and interrupter supplied from a dynamo or other source on the ground. The secondary circuit of the induction coil is equipt with rectifying valves in order to rectify the current. Similar appratus, also provided with vacuum

(*Continued on page* 749)



Man Is Slowly But Surely Learning the How and Why of Nature's Secrets. Rain and How It Forms Has Particularly Interested An Australian Scientist—John Graeme Balsillie, and His Method of Ionizing and Charging the Aqueous Particles Is Here Illustrated and Described. Ionization Is Accomplisht By Large X-Ray Bulbs Suspended From Balloons.

Moving Platform for New York's Cross-Town Subway

By H. WINFIELD SECOR

SUBWAY commuters and others who use New York's great underground transportation systems daily, have been much provoked and harast in the past several months by the various difficulties occasioned by the change in the two principal North and South arteries of subway travel. In other words, the subway system was changed over a few months ago from the old familiar "Z" system to the new so-called "H" system, which gives a continuous east-side and west-side subway express route, the—bar of the "H" connecting at the present time by shuttle trains running under 42nd Street between the Grand Central Station and the Times Square Station. The Grand Central Station is located at Park Avenue and East 42nd Street, while the Times Square Station is located on the west side at the juncture of 7th Avenue, Broadway and 42nd Street.

For several reasons the shuttle train service seems apparently not to be the best solution of the problem confronting the subway engineers in smoothly and quickly transferring the cross current of traffic between these two stations, and therefore Public Service Commissioner Travis H. Whitney has proposed that a *continuous moving platform* such as here illustrated be installed in the space now occupied by two of the four shuttle tracks. Mr. Whitney's original idea called for the installation of this continuous moving platform on the two northerly tracks of the shuttle system, leaving the two southerly tracks for train service, which might be necessitated whenever the moving platform might for instance get out of order, when the shuttle train service could be put in use. Also these two tracks could be used for the extension of the Queensboro Subway system, which is another proposal in the minds of the Public Service Commission engineers, so that eventually the Queensboro trains which now end their westward run at the Grand Central Subway Station, two levels underground as here illustrated, will terminate at Times Square.

In a recent interview with Mr. M. Everhart Smith, consulting engineer of the construction concern which will build this gigantic moving platform, six thousand feet in length and capable of carrying ten thousand people at one time, a different suggestion was made concerning the location of this proposed continuous moving platform. Instead of having it occupy the space over which the two northerly tracks now run, Mr. Smith pointed out that it is much more feasible and practical in every way to have it occupy the present position of the extreme northerly and southerly tracks, leaving two tracks in the center for emergency shuttle train service or for the extension of the Queensboro system to Times Square. This modification of the design and layout of the moving platform system is a very important one and practically necessitated, for the reason that if the return loop of the platform past along in the position now occupied by one of the inside tracks, then passengers could not alight at any point desired, excepting at the terminal stations at either Grand Central or Times Square.

As is pointed out there should be not less than three moving platforms in any case, each moving at a different speed, the outer one say at three miles, the intermediate at six miles, and the inner platfrom carrying the seats, at nine miles per hour. Therefore, as Mr. Smith suggested, in discussing Mr. Whitney's original idea, it would not be possible for passengers traveling *east* to attempt to cross a high speed (9-mile per hour) platform moving *west*. To give the greatest service, and to enable passengers to alight from or board the moving platform at any point along the entire route, the moving platform system should occupy the space now used by the two center or the two outside tracks. In other words the two moving platforms would have to have adjacent to them a stationary platform provided with suitable exits and entrances.

If the present shuttle train service should be extended to connect with other subways on avenues farther west than 7th Avenue at Times Square, the trains, Mr. Smith explained, would not conflict with the moving platforms, because the latter would operate only between two of the train stations. In this case the moving platform would be used merely for the collection and distribution of passengers within the area of Times Square and east and west of it.

Concerning the initial cost of this great moving platform it is estimated that it would approximate $1,000,000.00, and that it would take six months to build and install. At the present time the engineers of the Public Service Commission and the subway staff, as well as the experts of the moving platform concern, are busy trying to find a satisfactory space for the platform return loops at the station ends at Times Square and Grand Central; these loops being quite an extensive affair, the minimum diameter of the loop being about 130 feet.

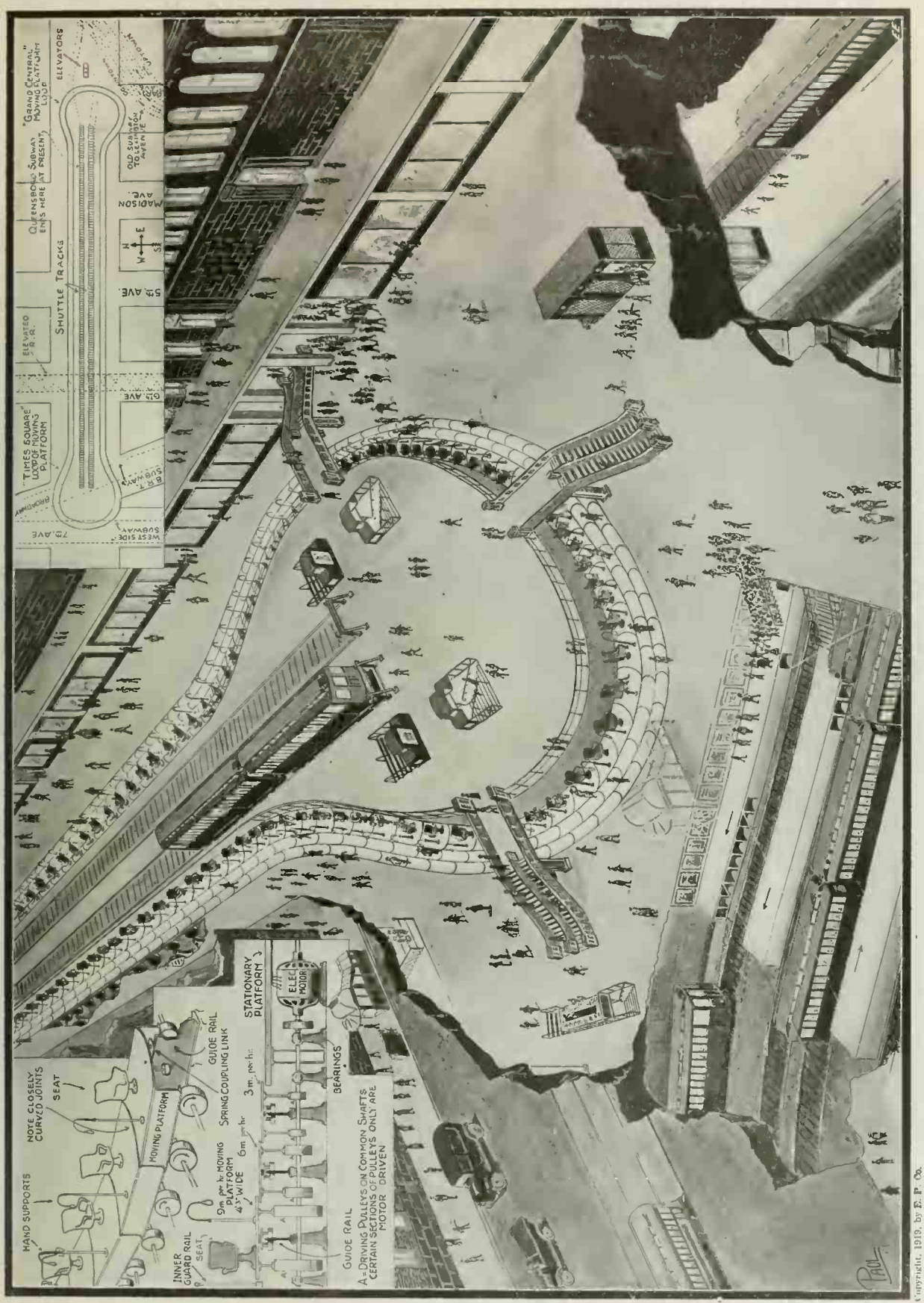
The moving platform idea is not so entirely new or untried, as it might appear at first. They have been built and used at different times quite a number of years ago, both abroad and in the United States. The same concern which is now designing the one for installation under 42nd Street, had one in successful operation at the World's Fair in Chicago, 4,400 feet in length. Visitors to that Fair will undoubtedly remember the great attraction, the platform of which was operated by electric motors to the total of 150 horsepower, which had a carrying capacity of 6,000 passengers. On "Chicago Day," 185,000 passengers—twice the daily traffic of the Brooklyn Bridge—were carried without any inconvenience. The total live and dead weight was 900 tons. As aforementioned, the new platform proposal for 42nd Street, New York City, is approximately 6,000 feet in length, with a capacity of 10,000 passengers, and will require electric motors distributed along its length to a total of about 250 horsepower.

Undoubtedly some of our readers will be interested in some of the more or less obvious technical details and just how the various parts are to operate. Thru the courtesy of Mr. M. Everhart Smith, we are pleased to give several details here, which have seemed of paramount interest to the editors. First, the three moving platforms, moving at three gradually increasing velocities in order to allow a person to board it without being thrown over or requiring acrobatics, will not be exactly on the same level, but each platform will slightly overlap the next succeeding platform, this practise having been found the best from past experience. The detailed drawings in the accompanying illustrations show clearly how the platform is made in a large number of jointed sections, each of which is provided with a flexible coupling so as to easily negotiate the curves at the station loops. Under the whole moving platform there is installed a stationary series of wheels or pulleys mounted on axles. The depending rails of the various platforms rest on the respective pulleys or wheels belonging to that particular platform in each case, as the drawing indicates. At about every eighth or tenth pulley there will be located a small electric motor connected by driving chains to several of the pulley shafts. All together about 250 horsepower in electric motors will be required, which is quite small indeed compared to the two thousand horse-power in electric motors necessary for the operation of a ten-car subway train.

The matter of seats on the third or high-speed platform is a very flexible one, and at first most probably but one row of seats will be installed, as the illustration shows, but more seats can readily be added at any time. It will only require a few minutes to go from Grand Central to the Times Square Station or vice versa on the moving platform, and the seats would probably only be used by women, as Mr. Smith pointed out. Another feature at this point is that those in a hurry can walk along any one of the moving platforms and gain time; for instance, if a man walks at the rate of four miles per hour on the nine mile per hour platform, he will actually be moving in that particular direction at the rate of thirteen miles per hour. In addition to the advantages of constantly moving platforms with no waits for shuttle trains, and with entrances and exits at every cross-street, such as at Madison, Fifth and Sixth Avenues, an immense income could be derived from the stores and large advertising spaces along the platforms.

Referring once more to the platform and its operation, it will be seen how the motor-driven wheels under the rails of the platform sections will cause these sections to be propelled forward in a direction depending upon the rotation of the wheels. The endwise juncture between the sections and the moving platforms is on an even level, and they are closely curved on the order of a knuckle-joint so that no gap occurs between them. The rails of each section are so designed as to correspond both at front and back, and thus this unique design permits of the section moving around the loop curves in a smooth manner. Light steel posts, containing straps for the use of the "strap hangers' brigade," without which metropolitan life would lose a large part of its vim and pep, will be provided, as the illustration shows. Of course the chaps on the way home from the club will have to "mind their step," as the English say, or—well—WELL, by that time the Nation will be dry anyway, so we should worry!! And besides the late home-comers using the platform during the "G. M. hours" will most probably be lucky enough to find it pretty well deserted in the event that they may have drunk one too many glasses of near-beer or cherry flip.

Regarding the heating of this long tunnel, Mr. Smith has suggested that during severe cold weather the tunnel system, in which the moving platform was installed, could be steam-heated at regular intervals, and also special ventilating fans and baffle walls could easily be provided at the various stations, as well as at the terminals, so as to ensure the proper ventilation and heating of the passageway.



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New York City Will Soon Have Something New To Interest Out-of-Town Visitors If This Recently Proposed Moving Platform Is Installed Under Forty-second Street to Connect the "Grand Central" and "Times Square" Subway Stations. There Are Three Moving Platforms, the One Carrying the Seats Traveling at 9 Miles Per Hour, and the Outer Two At 3 and 6 Miles Per Hour, Respectively. The Platform Required Would Measure 6,000 Feet or About 1¼ Miles, Have a Carrying Capacity of 10,000 Passengers, and Be Propelled By a Total of 250 Horsepower In Electric Motors. The Shuttle Trains May Be Retained for Emergency Use.

(For full description see opposite page)

The Unknown Purple

By DOROTHY KANT

WHAT would you do if you had the power to make yourself invisible—not by means of Aladdin's wonderful lamp, but by an actual scientific invention? Ask Dad, he knows! Thus, for instance, it certainly would be a boon to some delicately balanced husband, homeward bound, to escape the shark eye of his better half, not to mention the rolling pin; to some suspicious wife, etc., etc., *ad infinitum*. Then think what a shock it would be to a Hun general, after the blimp observers had spied an advancing American Army, with the guns ready to be set off, when whisto! the American army wasn't there at all! In other words Grimms' Fairy Tales in real life.

That other minds have peeped into the bright future of this wonderful invisible "source," which would make radium cheap by comparison, is well exemplified in the fact that not so long ago in the March and April, 1918, numbers of the ELECTRICAL EXPERIMENTER, in a story entitled "At War With the Invisible" the underlying idea of up-to-date scientific invisibility was shown. Here we had a young and handsome lady of the year 2011 who possest a bracelet of bells encircling her wrist, which bracelet was concealed to the human eye, or rather invisible to it, due to an optical invention of a certain scientist. . . .

The author of the "Unknown Purple" evidently thought along the same lines, for here we have a plot with almost the same underlying principle, wherein a certain scientist discovers and perfects a substance by which he can make himself invisible merely by holding that substance in his hand. But let us delve a little deeper into a play that seems to have so big a success with New York's critical audiences.

The scientist in this play who is incidentally our hero uses his invention to wreak vengeance upon his unfaithful wife and her paramour by making himself invisible and by playing pranks with the fortunes of both wife and lover.

But how does he do it and at the same time raise the tension of the audience to such a height that you can hear a "dew" drop?

One of our ingenious readers not so long ago wrote, jocularly, suggesting that we run a perfectly blank cover on the magazine under the caption *"Camouflaged Ship on the Ocean"*. The joke was supposed to be that the ship was so well camouflaged that you could not see it at all—hence the blank cover page! The authors of the "Unknown Purple" evidently used a similar line of reasoning on which they built up their play.

The problem was how to show a man walking across the stage who is supposed to be invisible. The answer is simplicity itself: don't show him at all, but make the audience believe that he is really there. This is certainly simplicity reduced *ad absurdum*. But in order to show that the man was really there,—altho, of course he wasn't,—something had to be done, else the audience would not be sufficiently imprest and would take the hero's "absent treatment" as a joke. So the authors simply have a purple spot light arranged overhead, which light travels at a slow gait across the stage, and the lighting effects are so cleverly arranged that the audience obtains the impression that the invisible man is really concealed within the purple shaft of light.

For some reason or other the authors seem to think that to make oneself invisible, such action should be electric and accompanied by a purple light, in order to heighten the tension and to give the mysterious touch that is particularly impressive on a lay audience. So, in addition, whenever the purple light appeared, and when our invisible hero was on the stage, the effect was still further heightened by a certain low buzz produced by a spark coil vibrator or the like and which buzz was supposed to emanate from the substance in the hero's hand which created the invisibility. Needless to say it had the desired effect and many a young damsel felt purple gooseskin take the place of her natural one, and becoming the recipient of creeps and thrills such as never were hers before.

Three Exciting Scenes from "The Unknown Purple." Left, the Invisible Hero Goading the Husband to Kill His Wife by Whispering into His Ear. Center, the Invisible Hero Once More in the Act of Foiling the Detectives. Right, Working on the Villain's Imagination by Talking to Him, the Hero of Course Being Invisible.

Of course, the usual stage tricks were resorted to, as for instance when our noble hero stealthily and invisibly opens the safe to abstract certain important papers. We thus see the purple spot or ray centered on the safe, amidst the mysterious buzzing sound—then the click of the combination as it is turned—the opening of the safe door slowly and mysteriously. Yes, you guest it, the safe was opened by invisible threads or strings, as no hands or anyone were visible. A similar trick was used whenever the hero entered the stage by means of the door. The door, of course, opened without any visible mechanical means and the solution in this case too obviously was strings or threads. There was only one scene that was staged elaborately and that was in the

(*Continued on page* 748)

Zeppelin Flew 4,130 Miles Round Trip from Bulgaria to Khartoum

A RECENT wireless dispatch from a Berlin correspondent contains some most interesting news concerning Teutonic developments in giant aircraft. It is said that the Germans are busy constructing a mammoth airplane intended to cross the Atlantic Ocean. This huge aërial craft, now under construction, is stated to have a wing spread of 198 feet, and it is to be engined by 3,000 horse-power in petrol motors.

The Teuton aërial flight experts are said to be busy constructing a gigantic Zeppelin craft at Friedrichshafen, which is to be propelled by nine engines and eight propellers. It will have a carrying capacity of one hundred passengers, and it is hoped that the international situation will clear up so that the first trans-oceanic flight may take place this coming July. The voyage across the Atlantic from a point in Germany to New York City is expected to take about forty hours.

But coming down to cold facts and past performances, the accompanying illustration shows one of the most remarkable aërial trips accomplisht during the great war, in which a giant Zeppelin flew from Jamboli, in Bulgaria, to a point over Khartoum, on the river Nile in Africa, a distance as the crow flies of 2,065 miles, and a distance of *4,130 miles for the non-stop return trip*. The Zeppelin carried a crew of twenty-two men besides twenty-five tons of ammunitions and medicines for the Teuton army in German East Africa. The great craft glided from its hangar at Jamboli at eight o'clock on the morning of November 21st, 1917. On the night of November 22nd-23rd, the monster airship had arrived over Khartoum, when it picked up a wireless message from the German radio station at Nauen, ordering it to return at once, as the Government at Berlin had ascertained in the meantime that the majority of Gen. von Lettou-Worbeck's troops had surrendered to the Allies.

Consequently the air-ship turned about in mid-air *without making a landing* and arrived at Jamboli at eight o'clock in the morning on November 25th. The technical director of the factory where this aërial craft was built has stated that a ship of this type was easily capable of flying from Berlin to New York and returning *without a stop*. The air-line distance from Berlin to New York City is approximately 3,930 miles, and the round trip distance would be 7,860 miles, or nearly eight thousand miles.

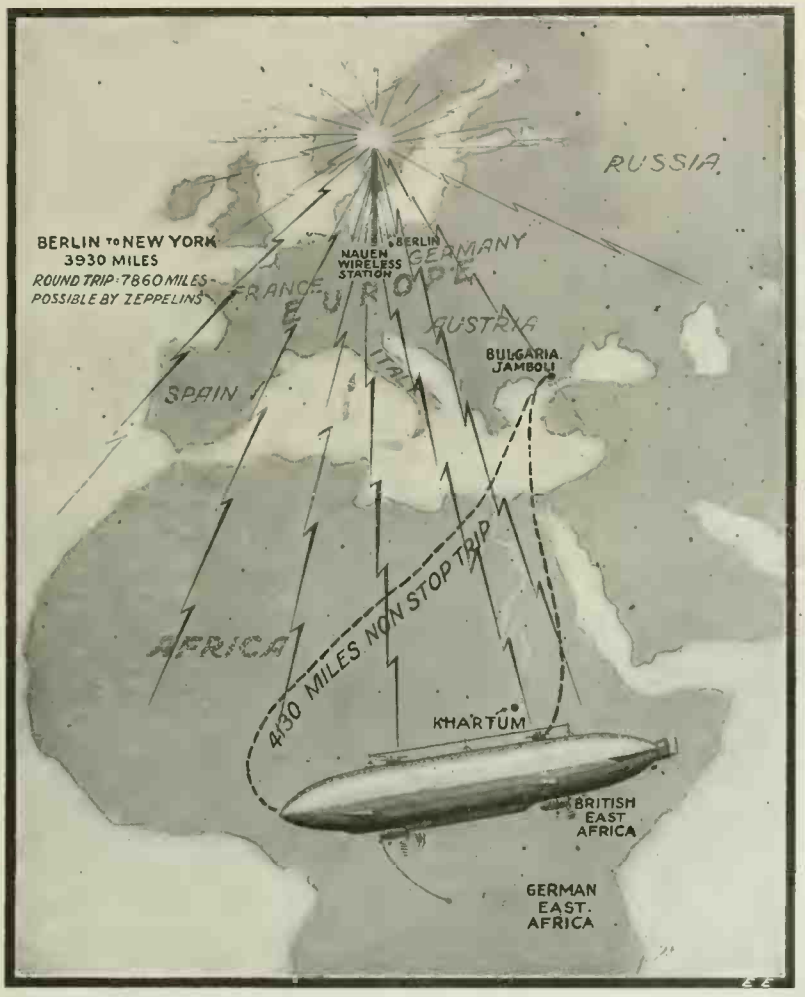
Talking of dirigible gas-bag types of aircraft, the U. S. Navy Department has just announced a remarkable new gas, which is available by a new process. Discovery of this new inert, non-inflammable gas for balloons, dirigibles and other lighter-than-air craft was revealed by the Navy Department on December 9th in a statement explaining expenditures for its production now being made jointly with the army.

The department states that the use of this new element, officially termed "argon," will eliminate the hazard of fire and explosion that always has accompanied balloon operations where "hydrogen" has been used to inflate the gas bags.

The gas from which "argon" is obtained comes from the wells at Petrolia, Tex., owned by the Lone Star Gas Company, the statement said, and a ten-inch pipe line to cost $1,050,000 is being laid for a distance of ninety-four miles from the wells to a plant at North Fort Worth, where the gas will be comprest into cylinders for shipment to the balloon fields.

High proof gasoline is obtained in a ratio of about five gallons per 1,000 cubic feet of gas, it was said, and after the 1 per cent of "argon" is removed, by agreement with the oil company, the remainder of the gas is turned into the city mains of Fort Worth and Dallas.

The Department estimates that the plant at North Fort Worth, designed by the Navy Bureau of Yards and Docks, and which will cost $900,000 will be completed by April 1.



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One of the Great Scientific Feats of the World-War Was the Non-Stop Flight of a German Zeppelin Over the Route Here Illustrated—a Distance of 4,130 Miles. Such a Craft Could Fly Easily From Europe to New York, and the Engineers That Built the Airship Claim That It Is Capable of Flying From Berlin to New York and Return, Without Stopping.

INJURING THE EYES BY PHOTOGRAPHY.

When one sees so many veteran photographic workers, in both amateur and professional ranks, suffering from astigmatism, one wonders what is the actual cause of this distressing optical defect. On inquiry, it will be found that in many cases the eyes were strained during the early days of dryplate-photography, when the plates—then coated with a very slow emulsion—were handled, and examined during development, by the light of a deep ruby oil-lamp. Amateurs at first used advisedly a small pocket-lamp, and undoubtedly incurred serious injury to the sight. Later—thank goodness—light of greater volume was employed, ruby light being also superseded by orange light; preferably fabric instead of glass being used to expose the dryplates sparingly to the rays of this brighter light. Now the photographer confronts the danger of ruining his eyes from exposure to the electric arc when used for printing-purposes. To look at the bare arc is obviously injurious to the sight. Arc-rays reflected from the surface of the negatives are also bad for the eyes. A good plan is to use a printing-lamp in which only reflected light reaches the negatives, or to use a printing-cabinet in which the arc is enclosed, care being taken to cover up empty spaces with pieces of cardboard so that the arc or its reflections do not reach the printer's eyes.

Famous Scientific Illusions

By NIKOLA TESLA

Written specially for the Electrical Experimenter

In this original and revolutionizing discussion, Nikola Tesla gives us something really new to think about. First—Does the moon rotate on its axis? Second—Is the Franklin pointed lightning rod correct in theory and operation? Third—Do wireless signals fly thru space by means of so-called Hertzian waves in the ether, or are they propagated thru the earth at prodigious velocity by means of earth-bound oscillations? World-famous conundrums these—questions which have been answered in many ways by some of the greatest scientists. Dr. Tesla explains these three predominant scientific fallacies in a masterly way, so that everyone can understand them.

THE human brain, with all its wonderful capabilities and power, is far from being a faultless apparatus. Most of its parts may be in perfect working order, but some are atrophied, undeveloped or missing altogether. Great men of all classes and professions—scientists, inventors, and hard-headed financiers—have placed themselves on record with impossible theories, inoperative devices, and unrealizable schemes. It is doubtful that there could be found a single work of any one individual free of error. There is no such thing as an infallible brain. Invariably, some cells or fibers are wanting or unresponsive, with the result of impairing judgment, sense of proportion, or some other faculty. A man of genius eminently practical, whose name is a household word, has wasted the best years of his life in a visionary undertaking. A celebrated physicist was incapable of tracing the direction of an electric current according to a childishly simple rule. The writer, who was known to recite entire volumes by heart, has never been able to retain in memory and recapitulate in their proper order the words designating the colors of the rainbow, and can only ascertain them after long and laborious thought, strange as it may seem.

Our organs of reception, too, are deficient and deceptive. As a semblance of life is produced by a rapid succession of inanimate pictures, so many of our perceptions are but trickery of the senses, devoid of reality. The greatest triumphs of man were those in which his mind had to free itself from the influence of delusive appearances. Such was the revelation of Buddha that self is an illusion caused by the persistence and continuity of mental images; the discovery of Copernicus that, contrary to all observation, this planet rotates around the sun; the recognition of Descartes that the human being is an automaton, governed by external influence and the idea that the earth is spherical, which led Columbus to the finding of this continent. And tho the minds of individuals supplement one another and science and experience are continually eliminating fallacies and misconceptions, much of our present knowledge is still incomplete and unreliable. We have sophisms in mathematics which cannot be disproved. Even in pure reasoning, free of the shortcomings of symbolic processes, we are often arrested by doubt which the strong-

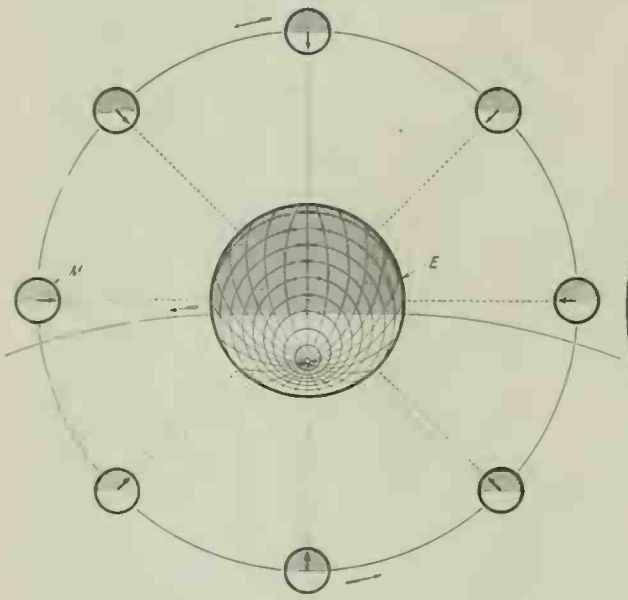


Fig. 1

It Is Well Known That the Moon, M., Always Turns the Same Face Toward the Earth, E, as the Black Arrows Indicate. The Parallel Rays From the Sun Illuminate the Moon in Its Successive Orbital Positions as the Unshaded Semi-circles Indicate. Bearing This in Mind, Do You Believe That the Moon Rotates on Its Own Axis?

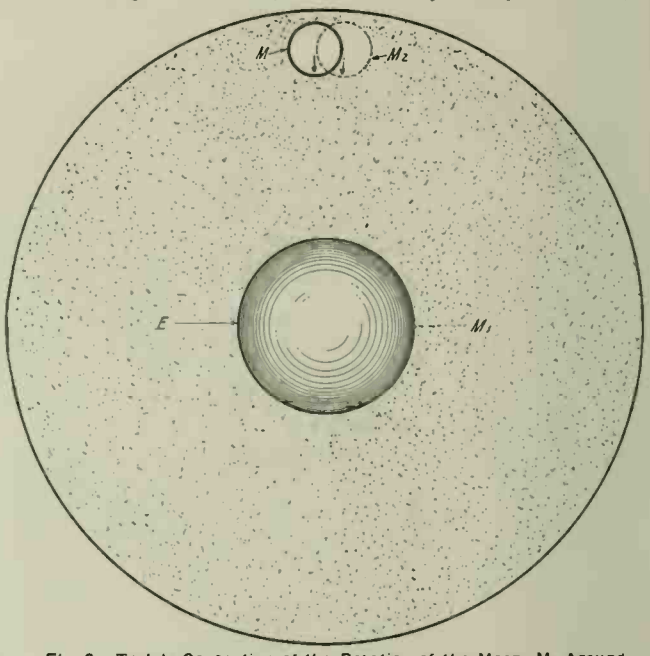


Fig. 2.—Tesla's Conception of the Rotation of the Moon, M, Around the Earth, E; the Moon, In This Demonstration Hypothesis, Being Considered as Embedded In a Solid Mass, M_1. If, As Commonly Believed, the Moon Rotates, This Would Be Equally True For a Portion of the Mass M_2, and the Part Common to Both Bodies Would Turn Simultaneously In "Opposite" Directions.

FOR over a century and a half the whole world, educated and otherwise, thought that the moon revolved around its axis. Nikola Tesla in the present highly instructive article disproves that theory and will convince scientists and all others alike that the moon does no such thing.

For thousands of years it was thought that the sun and stars revolved around the earth and all kinds of experimental proofs were furnished to substantiate this theory. The illustrious Galileo thought different, and everyone today knows that the earth revolves around the sun.

So it is with Tesla's discovery. Tesla also, in the second part of the present paper, shows us that the ancient and time-worn theory advanced by Benjamin Franklin as to the lightning conductor is not substantially correct as viewed by latter day science. It will come as a shock even to our professors that the lightning rod actually aids the lightning in hitting the building. The reason is that the lightning rod helps in ionizing (making conductive) the surrounding air.

Mr. Tesla has devised a lightning conductor with no points, and there is no doubt whatsoever that his theory is right. Scientists the world over will acknowledge this very shortly.

In a third section of the same paper Tesla explodes still another popular delusion, viz., that wireless waves follow the curvature of the earth when messages are transmitted, let us say from a point in the United States to a point in Europe. In his revolutionary arguments, supported by facts as well as by logic, Tesla shows why the currents do not travel around the earth but directly thru it. In other words, Tesla maintains that wireless communication is accomplished ONLY thru the medium of the earth itself. His contention seems very sound. If it were not so, let every wireless station, commercial or otherwise, do away with its ground connection. None could then operate as is well known, except perhaps over very limited distances.

Mr. Tesla's present article will arouse world-wide comment due to the revolutionary philosophy contained therein. We are sure our readers will appreciate Mr. Tesla's most timely and illuminating article on this but little understood subject.

est intelligences have been unable to dispel. Experimental science itself, most positive of all, is not unfailing.

In the following I shall consider three exceptionally interesting errors in the interpretation and application of physical phenomena which have for years dominated the minds of experts and men of science.

I. The Illusion of the Axial Rotation of the Moon.

It is well known since the discovery of Galileo that the moon, in travelling thru space, always turns the same face towards the earth. This is explained by stating that, while passing once around its mother-planet the lunar globe performs just one revolution on its axis. The spinning motion of a heavenly body must necessarily undergo modifications in the course of time, being either retarded by resistances internal or external, or accelerated owing to shrinkage and other causes. An unalterable rotational velocity thru all phases of planetary evolution is manifestly impossible. What wonder, then, that at this very instant of its long existence our satellite should revolve exactly so, and not faster or slower. But many astronomers have accepted as a physical fact that such rotation takes place. It does not, but only appears so; it is an illusion, a most surprising one, too.

I will endeavor to make this clear by reference to Fig. 1, in which E represents the earth and M the moon. The movement thru space is such that the arrow, firmly attached to the latter, always occupies the position indicated with reference to the earth. If one imagines himself as looking down on the orbital plane and follows the motion he will become convinced that the moon *does* turn on its axis as it travels around. But in this very act the observer will have deceived himself. To make the delusion complete let him take a washer similarly marked and supporting it rotatably in the center, carry it around a stationary object, constantly keeping the arrow pointing towards the latter. Tho to his bodily vision the disk will revolve on its axis, such movement does not exist. He can dispel the illusion at once by holding the washer fixedly while going around. He will now readily see that the supposed axial rotation is only apparent, the impression being produced by successive changes of position in space.

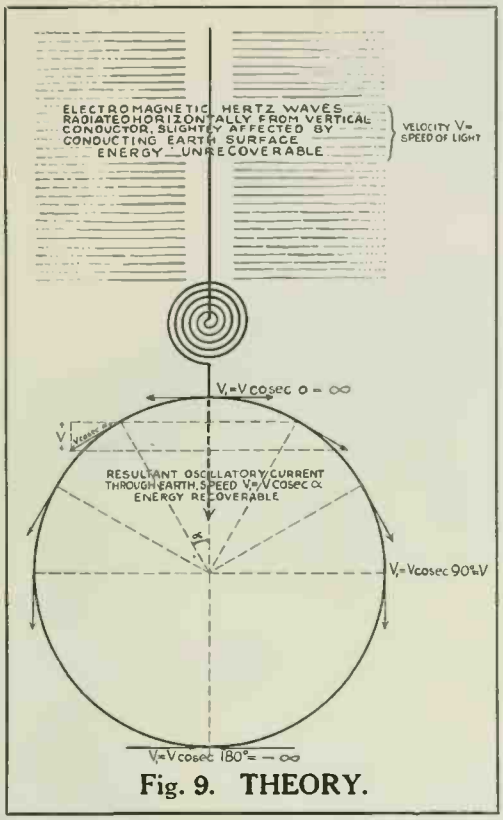
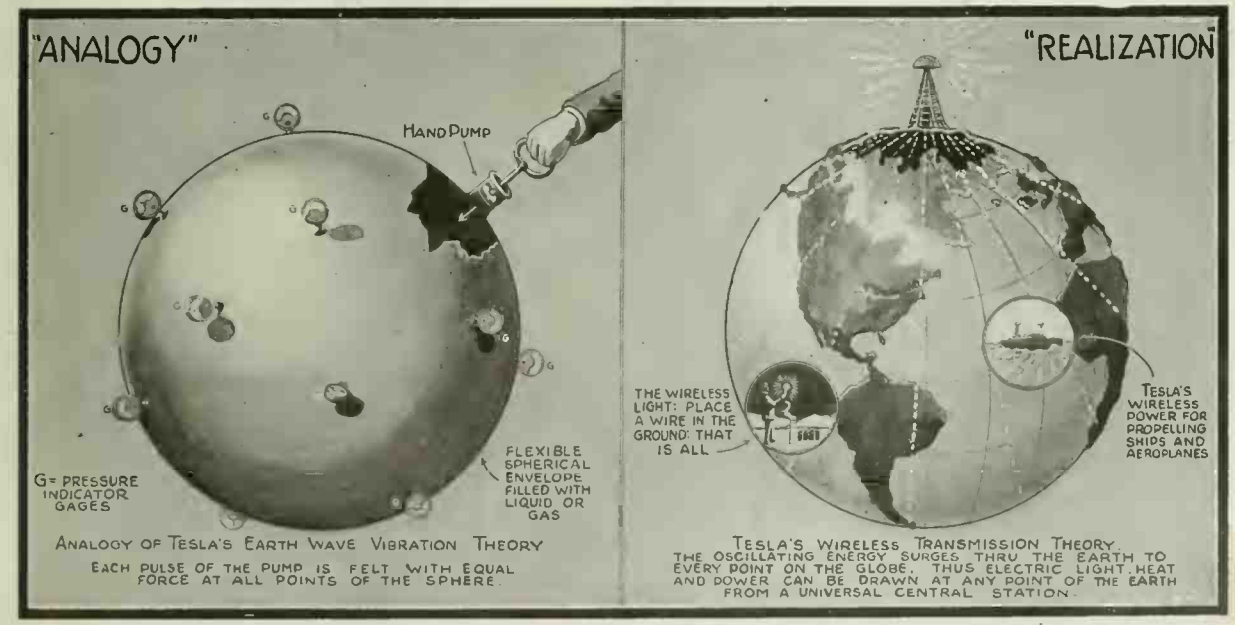


Fig. 9. THEORY.

But more convincing proofs can be given that the moon does not, and cannot revolve on its axis. With this object in view attention is called to Fig. 2, in which both the satellite, M, and earth, E, are shown embedded in a solid mass, M_1 (indicated by stippling) and supposed to rotate so as to impart to the moon its normal translatory velocity. Evidently, if the lunar globe could rotate as commonly believed, this would be equally true of any other portion of mass M_1, as the sphere M_2, shown in dotted lines, and then the part common to both bodies would have to turn *simultaneously in opposite directions*. This can be experimentally illustrated in the manner suggested by using instead of one, two overlapping rotatable washers, as may be conveniently represented by circles M and M_2, and carrying them around a center as E, so that the plain and dotted arrows are always pointing towards the same center. No further argument is needed to demonstrate that the two gyrations cannot co-exist or even be pictured in the imagination and reconciled in a purely abstract sense.

The truth is, the so-called "axial rotation" of the moon is a phenomenon deceptive alike to the eye and mind and devoid of physical meaning. It has nothing in common with real mass revolution characterized by effects positive and unmistakable. Volumes have been written on the subject and many erroneous arguments advanced in support of the notion. Thus, it is reasoned, that if the planet did *not* turn on its axis it would expose the whole surface to terrestrial view; as only one-half is visible, it *must* revolve. The first statement is true but the logic of the second is defective, for it admits of only one alternative. The conclusion is not justified as the same appearance can also be produced in another way. The moon does rotate, not on its own, but about an axis passing thru the center of the earth, the true and only one.

The unfailing test of the spinning of a mass is, however, the existence of



Tesla's World-Wide Wireless Transmission of Electrical Signals, As Well As Light and Power, Is Here Illustrated In Theory, Analogy and Realization. Tesla's Experiments With 100 Foot Discharges At Potentials of Millions of Volts Have Demonstrated That the Hertz Waves Are Infinitesimal In Effect and Unrecoverable; the Recoverable Ground Waves of Tesla Fly "Thru the Earth". Radio Engineers Are Gradually Beginning to See the Light and That the Laws of Propagation Laid Down by Tesla Over a Quarter of a Century Ago Form the Real and True Basis of All Wireless Transmission To-Day.

energy of motion. The moon is not possest of such energy. If it were the case then a revolving body as M₁ would contain mechanical energy other than that of which we have experimental evidence. Irrespective of this so exact a coincidence between the axial and orbital periods is, in itself, immensely improbable for this is not the permanent condition towards which the system is tending. Any axial rotation of a mass left to itself, retarded by forces external or internal, must cease. Even admitting its perfect control by tides the coincidence would still be miraculous. But when we remember that most of the satellites exhibit this peculiarity, the probability becomes infinitesimal.

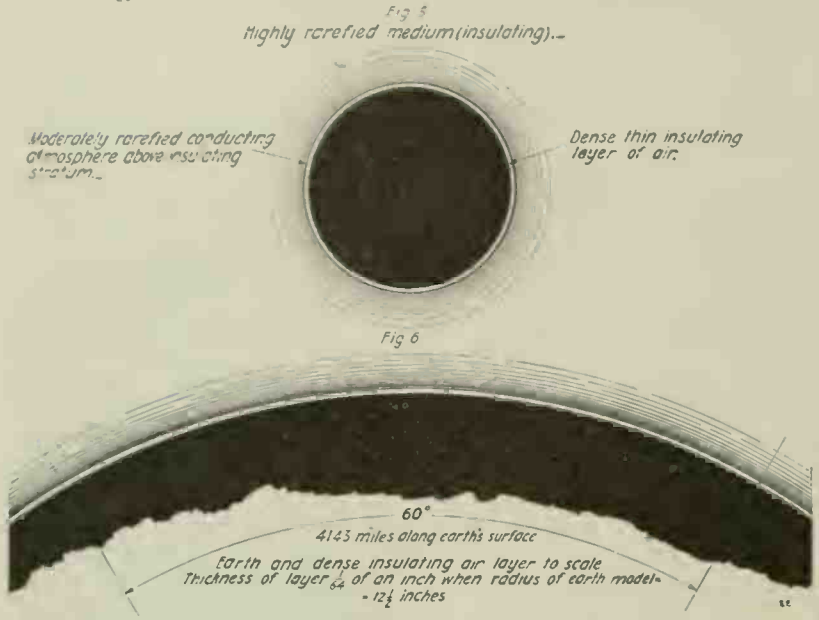
Three theories have been advanced for the origin of the moon. According to the oldest suggested by the great German philosopher Kant, and developed by Laplace in his monumental treatise "Mécanique Céleste", the planets have been thrown off from larger central masses by centrifugal force. Nearly forty years ago Prof. George H. Darwin in a masterful essay on tidal friction furnished mathematical proofs, deemed unrefutable, that the moon had separated from the earth. Recently this established theory has been attacked by Prof. T. J. J. See in a remarkable work on the "Evolution of the Stellar Systems", in which he propounds the view that centrifugal force was altogether inadequate to bring about the separation and that all planets, including the moon, have come from the depths of space and have been captured. Still a third hypothesis of unknown origin exists which has been examined and commented upon by Prof. W. H. Pickering in "Popular Astronomy of 1907", and according to which the moon was torn from the earth when the later was partially solidified, this accounting for the continents which might not have been formed otherwise.

Undoubtedly planets and satellites have originated in both ways and, in my opinion, it is not difficult to ascertain the character of their birth. The following conclusions can be safely drawn:

1. A heavenly body thrown off from a larger one cannot rotate on its axis. The mass, rendered fluid by the combined action of heat and pressure, upon the reduction of the latter immediately stiffens, being at the same time deformed by gravitational pull. The shape becomes permanent upon cooling and solidification and the smaller mass continues to move about the larger one as tho it were rigidly connected to it except for pendular swings or librations due to varying orbital velocity. Such motion precludes the possibility of axial rotation in the strictly physical sense. The moon has never spun around as is well demonstrated by the fact that the most precise measurements have failed to show any measurable flattening in form.

2. If a planetary body in its orbital movement turns the same side towards the central mass this is a positive proof that it has been separated from the latter and is a true satellite.

3. A planet revolving on its axis in its passage around another cannot have been thrown off from the same but must have been captured.



A Section of the Earth and Its Atmospheric Envelope Drawn to Scale. It Is Obvious That the Hertzian Rays Cannot Traverse So Thin a Crack Between Two Conducting Surfaces For Any Considerable Distance, Without Being Absorbed, Says Dr. Tesla, In Discussing the Ether Space Wave Theory.

II. The Fallacy of Franklin's Pointed Lightning-Rod.

The display of atmospheric electricity has since ages been one of the most marvelous spectacles afforded to the sight of man. Its grandeur and power filled him with fear and superstition. For centuries he attributed lightning to agents god-like and supernatural and its purpose in the scheme of this universe remained unknown to him. Now we have learned that the waters of the ocean are raised by the sun and maintained in the atmosphere delicately suspended, that they are wafted to distant regions of the globe where electric forces assert themselves in upsetting the sensitive balance and causing precipitation, thus sustaining all organic life. There is every reason to hope that man will soon be able to control this life-giving flow of water and thereby solve many pressing problems of his existence.

Atmospheric electricity became of special scientific interest in Franklin's time. Faraday had not yet announced his epochal discoveries in magnetic induction but static frictional machines were already generally used in physical laboratories. Franklin's powerful mind at once leaped to the conclusion that frictional and atmospheric electricity were identical. To our present view this inference appears obvious, but in his time the mere thought of it was little short of blasphemy. He investigated the phenomena and argued that if they were of the same nature then the clouds could be drained of their charge exactly as the ball of a static machine, and in 1749 he indicated in a publisht memoir how this could be done by the use of pointed metal rods.

(*Continued on page 728*)

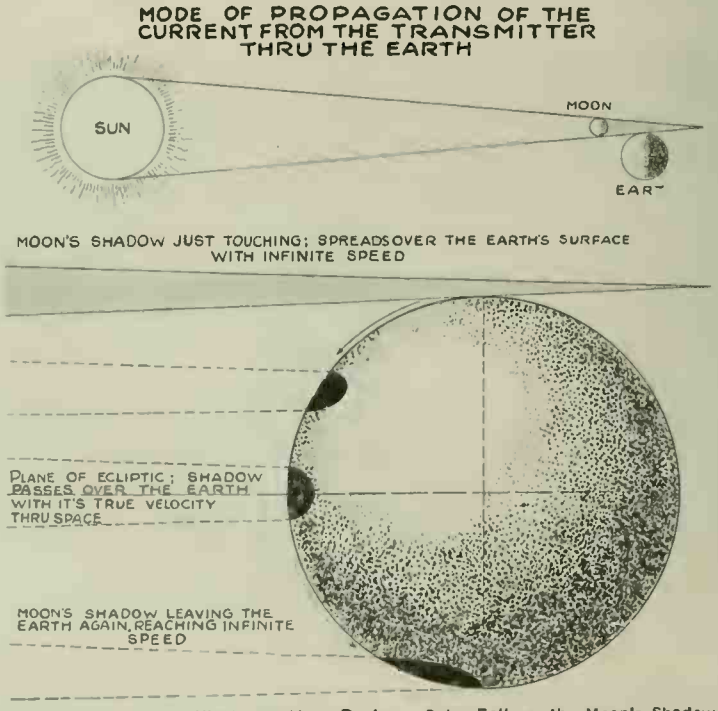


Fig. 8.—This Diagram Illustrates How, During a Solar Eclipse, the Moon's Shadow Passes Over the Earth With Changing Velocity, and Should Be Studied In Connection With Fig. 9. The Shadow Moves Downward With Infinite Velocity at First, Then With Its True Velocity Thru Space, and Finally With Infinite Velocity Again.

Curing Soldiers' Ills with Electricity

By PAULINE BERGINS

ELECTRICITY is playing no mean rôle in the vast reconstruction work now being carried on in the great Red Cross as well as Army and Navy hospitals thruout the country. Not only has the electric current been cleverly employed in many diversified ways to treat the many ills and maladies with which the soldiers and sailors have been afflicted in this country, but thousands of these appliances have been and are being used every day in the field hospitals in France, and in other lands which were not many months ago raging battlefields. Portable yet powerful X-ray ambulances sped over the battlefields but a few miles behind the front line trenches, ever ready to loan a helping hand in the merciful work of the medical corps. And not only do we find in these shell-torn regions the invaluable

Three Interesting Views Showing Electricity's Role In the Reconstruction Work of the Army Hospitals. Above: Fig. 2, Soldier Patient Receiving Electric Arm Bath Treatment For Rheumatism, at the American Red Cross War Hospital at Paignton, Devon, France. Fig. 1, Below, Shows American Soldier Being Treated in the Bergonié Electric Chair, Extensively Used for Shell Shock Treatment, at Fort MacPherson, Ga. Fig. 3, at Left, Illustrates the Electric Light Bath Cabinet in Use. A Wounded Marine Is Enjoying the Glowing Warmth Produced By This Electrotherapeutic Apparatus For Treating Sore and Stiffened Muscles.

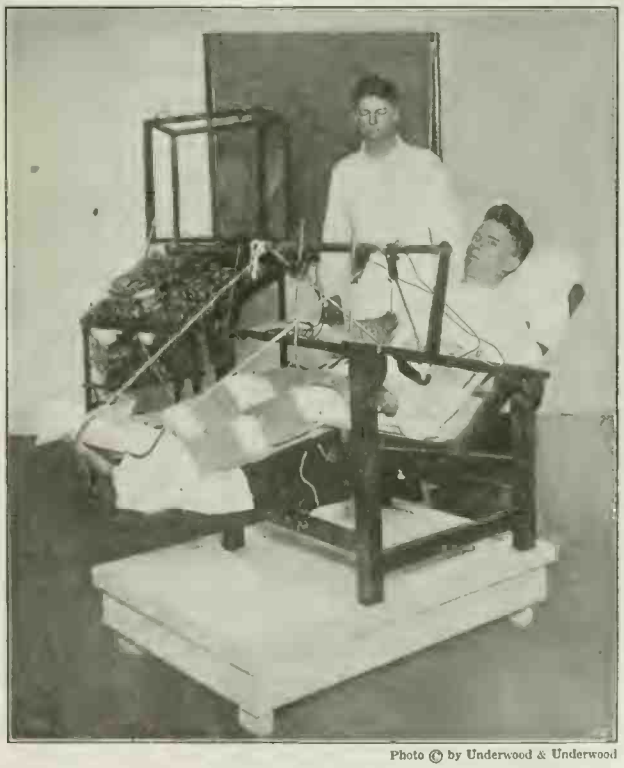


Photo © by Underwood & Underwood

X-ray machines, but many other appliances such as electric heating devices for the treatment of "trench feet", electric sterilizers and cauterizers, Faradic outfits for the treatment of lameness and rheumatism, electric light baths, etc.

The accompanying photographs show several very interesting and practical applications of the electric current for the treatment of war ills. The photograph, Fig. 1, showing an American soldier seated in the large reclining chair, was taken at Fort MacPherson, Ga. This curious and complicated looking electric outfit comprises one of the most wonderful electro-medical devices ever invented—the "Bergonié" Electric Chair. The Bergonié invention involves the application of low voltage electric currents of peculiar wave form to the patient's body while seated in the chair here shown, the body being weighted with a number of sand bags. The switch-board in the background contains a number of regulating rheostats and motor-driven interrupters as well as measuring instruments, such as a voltmeter and milliampere meter for indicating the strength of the current applied to the patient. The Bergonié chair treatment produces rythmic pulsations in the nerves and muscles and has been found very efficacious for shell-shock victims as well as for treating severe nervous cases caused by excessive fatigue, and for over-strained muscles and cords.

There are more shell-shock victims from this great World War than there have been in any other. And therefore, the fact that the Bergonié electric chair will help to alleviate and cure these cases, is indeed a great blessing.

It might be said that the majority of shell-shock victims lose a part or all of their mental faculties, and to all appearances cannot use their reason at all. They have all sorts of delusions as to whom their folks are, or where their home is. Practically everyone has heard of, or has been in contact with, one or more cases of shell-shock, and so it is not necessary to expatiate further on this important phase of the problem of reconstruction, except to say that the various hospitals and sanitariums engaged in this work are doing wonders over night, literally as well as metaphorically, for some of these cases of shell-shock are cured suddenly and instantly by the most peculiar incident or happening. In a large French hospital just prior to the signing of the armistice there

(*Continued on page* 748)

My Inventions

By Nikola Tesla

1. MY EARLY LIFE

THE progressive development of man is vitally dependent on invention. It is the most important product of his creative brain. Its ultimate purpose is the complete mastery of mind over the material world, the harnessing of the forces of nature to human needs. This is the difficult task of the inventor who is often misunderstood and unrewarded. But he finds ample compensation in the pleasing exercises of his powers and in the knowledge of being one of that exceptionally privileged class without whom the race would have long ago perished in the bitter struggle against pitiless elements.

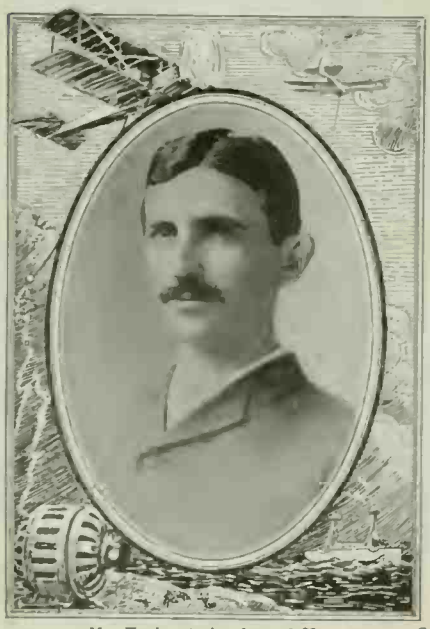
Speaking for myself, I have already had more than my full measure of this exquisite enjoyment, so much that for many years my life was little short of continuous rapture. I am credited with being one of the hardest workers and perhaps I am, if thought is the equivalent of labor, for I have devoted to it almost all of my waking hours. But if work is interpreted to be a definite performance in a specified time according to a rigid rule, then I may be the worst of idlers. Every effort under compulsion demands a sacrifice of life-energy. I never paid such a price. On the contrary, I have thrived on my thoughts.

In attempting to give a connected and faithful account of my activities in this series of articles which will be presented with the assistance of the Editors of the ELECTRICAL EXPERIMENTER and are chiefly addrest to our young men readers, I must dwell, however reluctantly, on the impressions of my youth and the circumstances and events which have been instrumental in determining my career.

Our first endeavors are purely instinctive, promptings of an imagination vivid and undisciplined. As we grow older reason asserts itself and we become more and more systematic and designing. But those early impulses, tho not immediately productive, are of the greatest moment and may shape our very destinies. Indeed, I feel now that had I understood and cultivated instead of suppressing them, I would have added substantial value to my bequest to the world. But not until I had attained manhood did I realize that I was an inventor.

This was due to a number of causes. In the first place I had a brother who was gifted to an extraordinary degree—one of those rare phenomena of mentality which biological investigation has failed to explain. His premature death left my parents disconsolate. We owned a horse which had been presented to us by a dear friend. It was a magnificent animal of Arabian breed, possest of almost human intelligence, and was cared for and petted by the whole family, having on one occasion saved my father's life under remarkable circumstances. My father had been called one winter night to perform an urgent duty and while crossing the mountains, infested by wolves, the horse became frightened and ran away, throwing him violently to the ground. It arrived home bleeding and

Nikola Tesla at the Age of 23.
From An Unpublished Photograph.

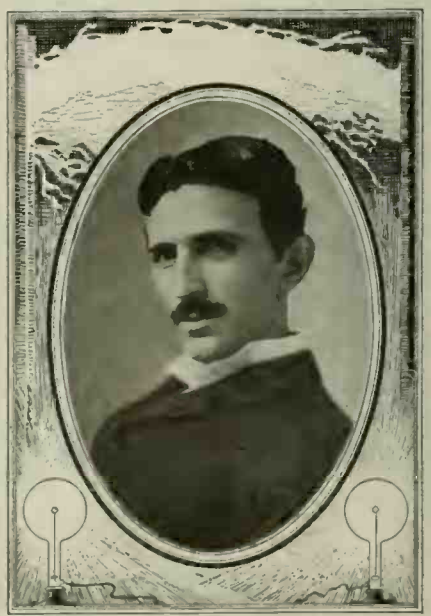


Mr. Tesla at the Age of 29.

HOW does the world's greatest inventor invent? How does he carry out an invention? What sort of mentality has Nikola Tesla? Was his early life as commonplace as most of ours? What was the early training of one of the World's Chosen? These, and many other very interesting questions are answered in an incomparable manner by Nikola Tesla himself in this, his first article.

In his autobiography, treating mainly on his early youth, we obtain a good insight into the wonderful life this man has led. It reads like a fairy tale, which has the advantage of being true. For Tesla is no common mortal. He has led a charmed life—struck down by the pest, the cholera and what not—given up by doctors at least three times as dead—we find him at sixty, younger than ever. But—read his own words. You have never read the like before.

—Editor.



Mr. Tesla at the Age of 39.

exhausted, but after the alarm was sounded immediately dashed off again, returning to the spot, and before the searching party were far on the way they were met by my father, who had recovered consciousness and remounted, not realizing that he had been lying in the snow for several hours. This horse was responsible for my brother's injuries from which he died. I witnest the tragic scene and altho fifty-six years have elapsed since, my visual impression of it has lost none of its force. The recollection of his attainments made every effort of mine seem dull in comparison.

Anything I did that was creditable merely caused my parents to feel their loss more keenly. So I grew up with little confidence in myself. But I was far from being considered a stupid boy, if I am to judge from an incident of which I have still a strong remembrance. One day the Aldermen were passing thru a street where I was at play with other boys. The oldest of these venerable gentlemen—a wealthy citizen—paused to give a silver piece to each of us. Coming to me he suddenly stopt and commanded, "Look in my eyes." I met his gaze, my hand outstretched to receive the much valued coin, when, to my dismay, he said, "No, not much, you can get nothing from me, you are too smart." They used to tell a funny story about me. I had two old aunts with wrinkled faces, one of them having two teeth protruding like the tusks of an elephant which she buried in my cheek every time she kist me. Nothing would scare me more than the prospect of being hugged by these as affectionate as unattractive relatives. It happened that while being carried in my mother's arms they asked me who was the prettier of the two. After examining their faces intently, I answered thoughtfully, pointing to one of them, "This here is not as ugly as the other."

Then again, I was intended from my very birth for the clerical profession and this thought constantly opprest me. I longed to be an engineer but my father was inflexible. He was the son of an officer who served in the army of the Great Napoleon and, in common with his brother, professor of mathematics in a prominent institution, had received a military education but, singularly enough, later embraced the clergy in which vocation he achieved eminence. He was a very erudite man, a veritable natural philosopher, poet and writer and his sermons were said to be as eloquent as those of Abraham a Sancta-Clara. He had a prodigious memory and frequently recited at length from works in several languages. He often remarked playfully that if some of the classics were lost he could restore them. His style of writing was much admired. He penned sentences short and terse and was full of wit and satire. The humorous remarks he made were always peculiar and characteristic. Just to illustrate, I may mention one or two instances. Among the help there was a cross-eyed man called Mane, employed to do work around the farm. He was chopping wood one day. As he swung the axe my father, who stood nearby and felt very uncomfortable, cautioned him, "For God's sake, Mane, do not strike at what you are looking but at what you intend to hit." On another occasion he was taking out for a drive a friend who carelessly permitted his costly fur coat to rub on the carriage wheel. My father reminded him of it saying, "Pull in your coat, you are ruining my tire." He had the odd habit of talking to himself and would often carry on an animated conversation and indulge in heated argument, changing the tone of his voice. A casual listener might have sworn that several people were in the room.

Altho I must trace to my mother's influence whatever inventiveness I possess, the training he gave me must have been helpful. It comprised all sorts of exercises—as, guessing one another's thoughts, discovering the defects of some form or expression, repeating long sentences or performing mental calculations. These daily lessons were intended to strengthen memory and reason and especially to develop the critical sense, and were undoubtedly very beneficial.

My mother descended from one of the oldest families in the country and a line of inventors. Both her father and grandfather originated numerous implements for household, agricultural and other uses. She was a truly great woman, of rare skill, courage and fortitude, who had braved the storms of life and past thru many a trying experience. When she was sixteen a virulent pestilence swept the country. Her father was called away to administer the last sacraments to the dying and during his absence she went alone to the assistance of a neighboring family who were stricken by the dread disease. All of the members, five in number, succumbed in rapid succession. She bathed, clothed and laid out the bodies, decorating them with flowers according to the custom of the country and when her father returned he found everything ready for a Christian burial. My mother was an inventor of the first order and would, I believe, have achieved great things had she not been so remote from modern life and its multifold opportunities. She invented and constructed all kinds of tools and devices and wove the finest designs from thread which was spun by her. She even planted the seeds, raised the plants and separated the fibers herself. She worked indefatigably, from break of day till late at night, and most of the wearing apparel and furnishings of the home was the product of her hands. When she was past sixty, her fingers were still nimble enough *to tie three knots in an eyelash.*

There was another and still more important reason for my late awakening. In my boyhood I suffered from a peculiar affliction due to the appearance of images, often accompanied by strong flashes of light, which marred the sight of real objects and interfered with my thought and action. They were pictures of things and scenes which I had really seen, never of those I imagined. When a word was spoken to me the image of the object it designated would present itself vividly to my vision and sometimes I was quite unable to distinguish whether what I saw was tangible or not. This caused me great discomfort and anxiety. None of the students of psychology or physiology whom I have consulted could ever explain satisfactorily these phenomena. They seem to have been unique altho I was probably predisposed as I know that my brother experienced a similar trouble. The theory I have formulated is that the images were the result of a reflex action from the brain on the retina under great excitation. They certainly were not hallucinations such as are produced in diseased and anguished minds, for in other respects I was normal and composed. To give an idea of my distress, suppose that I had witnest a funeral or some such

(Continued on page 743)

NIKOLA TESLA
THE MAN
By H. Gernsback

THE door opens and out steps a tall figure—over six feet high—gaunt but erect. It approaches slowly, stately. You become conscious at once that you are face to face with a personality of a high order. Nikola Tesla advances and shakes your hand with a powerful grip, surprising for a man over sixty. A winning smile from piercing light blue-gray eyes, set in extraordinarily deep sockets, fascinates you and makes you feel at once at home.

You are guided into an office immaculate in its orderliness. Not a speck of dust is to be seen. No papers litter the desk, everything just so. It reflects the man himself, immaculate in attire, orderly and precise in his every movement. Drest in a dark frock coat, he is entirely devoid of all jewelry. No ring, stickpin, or even watch-chain can be seen.

Tesla speaks—a very high almost falsetto voice. He speaks quickly and very convincingly. It is the man's voice chiefly which fascinates you.

As he speaks you find it difficult to take your eyes off his own. Only when he speaks to others do you have a chance to study his head, predominant of which is a very high forehead with a bulge between the eyes—the neverfailing sign of an exceptional intelligence. Then the long, well-shaped nose, proclaiming the scientist.

How does this man, who has accomplished such a tremendous work, keep young and manage to surprise the world with more and more new inventions as he grows older? How does this youth of sixty, who is a professor of mathematics, a great mechanical and electrical engineer and the greatest inventor of all times, keep his physical as well as remarkable mental freshness?

To begin with, Tesla, who is by birth a Serbian, comes from a long-lived hardy race. His family tree abounds with centenarians. Accordingly, Tesla—barring accidents—fully expects to be still inventing in A. D. 1960.

But the chief reason for his perpetual youth is found in his gastronomical frugality. Tesla has learned the great fundamental truth that most people not only eat all of their bodily ills, but actually eat themselves to death by either eating too much or else by food that does not agree with them.

When Tesla found out that tobacco and black coffee interfered with his physical well-being, he quit both. This is the simple daily menu of the great inventor:

Breakfast: One to two pints of warm milk and a few eggs, prepared by himself—yes, he is a bachelor!

Lunch: None whatsoever, as a rule.

Dinner: Celery or the like, soup, a single piece of meat or fowl, potatoes and one other vegetable; a glass of light wine. For dessert, perhaps a slice of cheese, and invariably a big raw apple. And that's all.

Tesla is very fussy and particular about his food: he eats very little, but what he does eat must be of the very best. And he knows, for outside of being a great inventor in science he is an accomplished cook who has invented all sorts of savory dishes.

His only vice is his generosity. The man who, by the ignorant onlooker has often been called an idle dreamer, has made over a million dollars out of his inventions—and spent them as quickly on new ones. But Tesla is an idealist of the highest order and to such men money itself means but little.

Subways of Down-Town New York

THE down-town section of lower New York, including the financial or banking district in the vicinity of Wall and Broad Streets, and other well-known thorofares, such as Broadway and the Bowling Green section, bids fair to become the most thoroly subwayed section of any city in the world. A glance at the accompanying illustration, prepared by Mr. George Wall, a well-known New York artist, shows clearly some of the most ingenious engineering features connected with the gigantic subway plans which have been worked out for this narrow strip of land, which constitutes one of the most thickly populated districts anywhere in the world. Here office buildings rise twenty to thirty stories in the air, —while the heavy steel trains rumble along thru the bowels of the earth under these gigantic business structures day and night. Lucky for New York that it has a very solid rock foundation, or it is doubtful if all the ambitious subway and other arteries of travel now in operation and contemplated, could be operated with any degree of safety. In preparing the accompanying illustration, courtesy is due to the engineers of the Public Service Commission, who have supplied the necessary information concerning the various subway routes here illustrated, several of which are now under construction and not just yet in operation.

In looking at this illustration of down-town New York, the well-known "battery loop" section is shown at the bottom, the top of the illustration being north, the bottom south, and the right and left—east and west respectively. The insert map shows the general plan of the subway systems including the Hudson Tubes under the North River, as well as the Pennsylvania Railroad Tunnels under the North and East Rivers. Beginning at the west side of the perspective view we come to the new West Side Subway, sometimes referred to as the 7th Avenue Subway. This is a two-track underground railway, which runs under the 9th Avenue Elevated Railroad, as becomes apparent. A down-town train moving toward the Battery, on the West Side track, passes down around the loop on the outer or "A" track, and after it has past the Battery Subway Station, goes down an incline so as to complete its loop, two levels underground, thru a tunnel which passes under the East Side Subway (which runs on Broadway in this district) and comes out on the up-town track running north, as the second arrow "A" indicates. Right here we have one of the most unique and clever bits of subway engineering imaginable, for this two-track system fulfills two important functions.

Firstly, and as just explained, it serves as the *return loop* for the trains of the West Side Subway. Secondly, the inner track of this battery loop, or track "B," is used to return the local trains of the East Side Subway (also referred to as the old Broadway Subway), and by following the inner or "B" track around the loop, by means of the dotted lines, it will be seen that the down-town or south-bound local train can complete the loop, and eventually swing around on to the north-bound local track. The two center tracks of the East Side Subway go to Brooklyn, and are the express tracks. As the dotted lines convey, these trains dive downward two levels and pass thru the two westerly East River Tubes, one of the tubes carrying the trains to Brooklyn, and the other the trains returning from Brooklyn to New York. The East Side Subway is the older one, and the one that visitors are most familiar with and until recently,—when the change was made to the subway shuttle service between the Grand Central station and Times Square, due to the opening of the West Side Subway,—the route of the East Side Subway trains was northward from the Brooklyn Bridge terminus along Fourth Avenue, to Park Avenue, Grand Central station, thence westward under 42nd Street, then northward along Broadway, etc. At the present time, owing to the change caused by the shuttle service put into effect between the Grand Central and Times Square stations, these trains make a turn to the eastward, at Grand Central station, and then proceed northward along Lexington Avenue.

The next subway of interest is the new Triboro Subway, which is often referred to as the B. R. T. Subway, but the official name given to it just recently, is the *Triboro Subway System*. These trains will come from Brooklyn thru two new under-river tubes shown in the illustration, and proceed along under Whitehall Street at a depth of two levels, so as to pass under the East Side Subway, as the illustration clearly shows. The most southerly point of operation at the present time, is the Whitehall Street station. Passengers going south transfer at Canal Street for Brooklyn. This subway passes along Church Street, and there is a station in the Hudson Terminal Building. Somewhat north of this, it makes a turn eastward and passes back to Broadway, and from here it runs north along Broadway to Times Square. At this point there is a station two levels underground with communicating passageways, so that at this interesting transfer station a passenger may take one of several subway routes, to up-town or down-town New York, or to Brooklyn, as well as to Queens, *via* the Queensboro Subway, which operates from the Grand Central Station under the East River, thru the Steinway tunnel.

The Triboro Subway makes a turn north-eastward at 44th Street, and then runs under Seventh Avenue directly north to 59th Street, then proceeds eastward across New York at the south side of Central Park, and passes under the East River to Queens.

Referring to the two river tubes down at the Battery where the Pump Station and Construction Shaft are shown, it is interesting to note that but two tunnels will be utilized at this point to take care of four distinct arteries of subway traffic, i.e., the Brooklyn-bound subway trains from the Triboro line, as well as those from the Nassau-Broad Street Subway, as the arrows indicate; while the other East River Tube takes care of New York-bound subway trains for the Triboro and Nassau-Broad Streets Subways. This remarkable engineering feat is taken care of by means of two interlocking two-way switches in the switch bulkheads shown at this point, and, of course, a very elaborate system of interlocking switches and signals has been provided in order to prevent any collisions, as may well be imagined. It must be said to the credit of the New York Subway System, that there have been very few accidents, and these were very slight, due to the fact that very accurate and cleverly conceived electrical safety systems are in use, whereby one train cannot pass into the next "block," while it is still occupied by another train.

At present the two westerly under-river tubes leading to the Triboro Subway at the Battery are finished and ready for use, but the two easterly branches are dead-ended a short way underground, in the vicinity of the Construction Shaft.

The "Interboro" William Street Subway will soon be completed and connects with the West Side Subway, running across town at Park Place, diving underneath the East Side Subway in order to reach its destination. The William Street Subway will pass thru the Clark Street Tunnel to Brooklyn (under the East River), and will connect with the present I. R. T. system in Brooklyn between Borough Hall and Hoyt Street stations. This tunnel takes its name from Clark Street, Brooklyn.

In this illustration, the several modes of travel available in New York City are vividly depicted by the artist, including the surface or trolley cars which run along the various streets, as well as under the elevated railways. In the Battery district, here illustrated, the 6th Avenue and 9th Avenue elevated roads are shown just below Rector Street, the 6th Avenue and 9th Avenue "L" lines branching into one another, and run as a single system down to the Battery Station, which is just above the Battery Subway Station. A similar plan is followed in the operation of the 2nd and 3rd Avenue "L" lines, as the illustration indicates. Thus two lines run as a single system from the Battery "L" Station up to a short way past the Brooklyn Bridge, where they branch out into two distinct lines of traffic. From this point one elevated system runs along 2nd Avenue and the other along 3rd Avenue.

PUBLISHER'S ANNOUNCEMENT

Beginning with this issue the type size of ELECTRICAL EXPERIMENTER *pages is increased from* 10 *to* 10½ *inches. This adds an equivalent of over four pages of live articles to your magazine, and we hope that you will welcome the improvement.*

The Publishers

WHAT IS AN ENGINEER?—ASK UNCLE SAM.

Especially interesting, from the standpoint of the war, is the publication of a new definition of the engineer which has been written by A. H. Krom, director of engineering, United States Employment Service, Chicago. The definition comes as the result of the many queries that have originated thru a confusion of engineering terms and standards now in general use. After serious study and consultation with eminent, authorities, Mr. Krom prepared the following definition:

"An engineer is one who economically directs man power and, by scientific design, utilizes the forces and materials of nature for the benefit of mankind."

In writing this definition, Mr. Krom hopes to offer a practical, workable statement that will be of real value to technical men and to employers of technical men. The definition will doubtless be useful in clarifying popular misconceptions. Students of engineering and prominent scientific authorities declare that Mr. Krom's definition is representative of the highest engineering ideals and that it covers all classes of engineering. In view of the importance of the engineer in the present war, it is highly important that his status be properly defined.

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A Comprehensive Semi-Sectional View of the Battery Section of New York City and Its Multifarious Modes of Travel, Including Subways, Elevated Lines, Surface Cars, and Ferry-Boats. This Represents One of the Most Thoroly "Subwayed" Sections of Any City in the World, and There Are As Many As Four Levels of Passenger-Carrying Railways in Operation At Some Points. This View Shows the 6th and 9th Avenue Elevated R.R. Lines On the West Side, and the 2nd and 3rd Avenue Lines Running As a Single System In This District Down to a Common Station At the Battery. At This Point There is a Large Subway Station for the Local Trains of the "East Side" (Old Broadway) Subway. These Local Trains Returning Around the "B" Track of the Loop to the Up-Town Track. The Express Trains Drop Down Two Levels Underground and Dive Thru the Two Under-River Tubes to Brooklyn. The "A" Track of the Loop is Used to Return the Trains of the "West Side" Subway to the Up-Town Track. As the Dotted Lines Indicate. These Trains Use the South Platform of the Battery Subway Station, Which is Not Shown Here. The Many Other Interesting Problems Which Are Being Engineered At This Point, Are Clearly Explained In the Accompanying Article.

(For full description see opposite page)

Popular Astronomy

THE MILKY WAY

By ISABEL M. LEWIS

OF THE U. S. NAVAL OBSERVATORY

Taken by Barnard with the 3.4-inch Lens of the Bruce Telescope Temporarily Located on Mt. Wilson, Cal. This Photograph Shows the Great Star Clouds of the Milky Way in Sagittarius. It Is In This General Direction that the Center of the Entire Galactic System Is Believed to Be Located.

THE Galaxy or Milky Way defines in the heavens the position of the fundamental plane of the visible universe and the equatorial belt of the celestial sphere. Our own sun, attended by its planet family, is but one of the innumerable stars that stream to and fro in paths as yet undefined in form, but lying closely confined to the galactic regions and apparently controlled by the strong gravitational forces that exist therein. In fact all celestial objects, whether stars, nebulae or star clusters, are influenced by the Milky Way and as a result either crowd closely toward it or seek to avoid it so far as possible. Among the objects that particularly favor the Galaxy are to be counted the helium or blue stars and the hydrogen or white stars. The giant red stars known as the *type N* stars are found almost exclusively here as are also the stars that appear to form the connecting link between stars and nebulae—the *Wolf-Rayet* stars. Here also are to be found all the gaseous nebulae, all the temporary stars, except those that have appeared in spiral nebulae, and all the loosely-formed groups or clusters of stars, such as the *Hyades* and the *Ursa Major* group, which includes *Sirius* and the brighter stars of the *Big Dipper*.

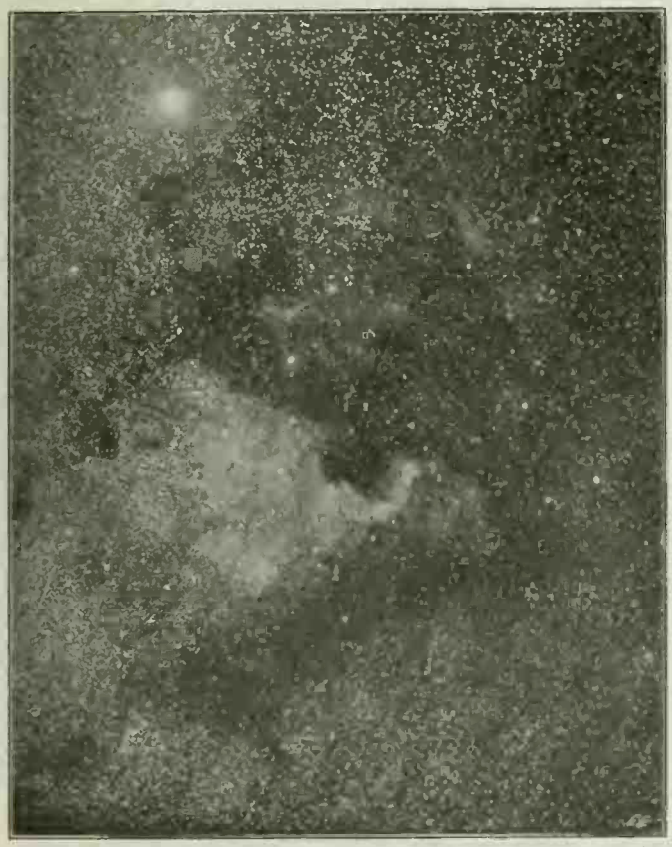
The average width of this equatorial belt of the celestial sphere has been placed at approximately twelve thousand light years, according to most recent investigations, while its diameter is now known to be at least *three-hundred thousand light years in extent*. Outside this central segment, but symmetrically distributed with reference to it, lie the vast compact systems known as the globular star clusters. Tho limited in number to less than one hundred they are composed individually of thousands, if not hundreds of thousands, of stars far superior to our own sun in size and brilliancy. The spiral nebulae, to be counted by numbers running into the hundreds of thousands, and the Greater and Lesser Magellanic clouds of the southern hemisphere, vast systems of stars and nebulosities resembling fragments of the Milky Way in appearance, are also to be included in the objects that avoid the vicinity of the Milky Way. All of these objects are characterized by extremely high velocities compared with the sluggishly moving members of the Milky Way. Their distances from the Galaxy, moreover, are inconceivably great. An estimate of the distance of the Lesser Magellanic cloud, and which is extremely reliable, places it *thirty thousand light years* away while the average distance of the globular star clusters from the central plane of the Milky Way is more than *twenty thousand light years*. Tho the distances of the spiral nebulae are still in doubt these objects are believed to be as far away on the average as the globular clusters. The theory has been advanced by Dr. Shapley of the Mt. Wilson Solar Observatory as a result of his extensive investigations of the globular star clusters and their relations to the Milky Way, that these vast systems and probably also the spiral nebulae are not found in the vicinity of the Milky Way because it would be impossible for them either to form or to exist as independent systems in the strong gravitational field of the equatorial belt. The loosely-formed star clusters that are to be found in profusion within the Milky Way may be, he considers, the remnants of compact globular clusters that have attempted to cross the central plane.

For many years it has been doubtful whether the numberless tiny points that make up the star clouds of the Milky Way are suns comparable in size to our own sun or mere star-dust, that is, fragmentary matter of planetary rather than stellar dimensions. It is now believed that thruout the length and breadth of the Milky Way the stars average the same as they do in the immediate neighborhood of the sun. There are in the star clouds of the Galaxy giant suns that surpass our own sun hundreds and even thousands of times in size and brilliancy, and there are on the other hand dwarf suns that possess only a hundredth, a thousandth or, in some instances, a ten-thousandth part of the luminosity of the sun.

Star Clouds in Sagittarius. Photographed by Mr. Barnard of the Yerkes Observatory. This Covers a Field of About Twenty Degrees.

The hazy, milky light of the Galaxy is a familiar feature to all who have seen it at its best over sea or prairie on a moonless night of early fall, spanning the heavens in a glorious arch of awe-inspiring beauty. With the aid of the most powerful telescopes the nebulous background is resolved into innumerable individual points of light, each representing a star of the universe, a sun attended possibly by planet-worlds of its own. The impression one receives of dense clouds of stars is due, it is believed, to the great extent of the galaxy in the fundamental plane rather than to an actual crowding together of the stars. The Milky Way is known to be extremely intricate and irregular in form. It encircles the heavens in the form of a great circle, but its width varies from twenty or thirty degrees in some parts of the heavens down to barely five degrees in others. For nearly one-third of its circumference it divides into two branches. In the constellation *Argo* in the southern hemisphere, it separates into several branches crost by dark lanes that in one portion of its path nearly sever it completely. Still further south, in the vicinity of the Southern Cross, is the noted Coalsack, a huge opening in the midst of dense star clouds. The dark markings that are such a characteristic feature of the Milky Way are due in some instances to actual breaks in the star formations thru which it is possible to gaze into the immensity of space beyond, in others to the presence of dark absorbing matter that intercepts the light from the more distant star strata. There are numberless examples of such dark nebulae intermingled with vast star formations and luminous gaseous nebulae. There are all gradations in these dusky markings from an inky blackness to the greyish tinge produced by a feebly glowing nebular light. The form assumed by the star streams of the Milky Way is still unknown. There is no clue to the structure of the whole in the infinite variety of its intricate formations. No two portions of the Galaxy are alike. There is no way of determining the relative distances of the various star clouds when even the nearest are immeasurably distant. It is the comparatively recent investigations of the globular star clusters, which have been found to be symmetrically arranged with reference to the plane of the Milky Way, that have furnished a clue to the great extent of the Galaxy in the central plane of the visible universe amounting to a distance of approximately three hundred thousand light years, a value far greater than any previously assigned to celestial distances. Within six thousand light years of the central plane and fairly evenly distributed above and below it, are to be found nearly all of the stars so far catalogued, including all the naked-eye stars and, in addition, all the irregular and planetary gaseous nebulae.

Photographed by Barnard with the 10-Inch Lens of the Bruce Telescope While Temporarily Located on Mt. Wilson, Cal. (May 8, 1905, Exposure 3 h. 30 m.). This Photograph Shows About 13° of the Sky North of Theta Ophiuchi. Considered the Most Extraordinary of All the Regions of Dark Markings in the Milky Way.



Still Another View of the Wonders of the Milky Way, Photographed by Mr. Barnard. The White Spot at the Upper Left Is a Small Nebula.

In Fig. 1 is shown a section of the celestial sphere made by a plane perpendicular to the plane of the Milky Way. The crosses represent the positions of some of the globular star clusters projected upon this plane. The equatorial section, A-B, is twelve thousand light years in width and three hundred thousand light years in diameter. Midway between its upper and lower limits lies the plane of the Milky Way the pole of which is at P. C marks the center of the entire system and the globular clusters are distributed symmetrically with reference to this point. The center of the black dot, S, defines the position of our solar system in the Milky Way. The small black dot has a radius of about 1,500 light years. Within a sphere of this radius with a center at the sun lie all stars and nebulae with parallaxes greater than two thousandths of a second of arc. Therefore within the black dot lie all the stars and nebulae, the distances of which have been determined by direct means, that is practically all the stars visible to the *naked eye*, including such well-known stars as Capella, Vega, Antares, Polaris and, of course, Sirius and Alpha Centauri. Even the most massive stars of the Galaxy, thousands and tens of thousands of times more luminous than the sun, appear blended in indistinct milky light at the distance of C. Only the great telescopes break this misty light up into minute distinctive points of light of the *sixteenth* or *seventeenth stellar magnitudes*. These stars form the characteristic star clouds of the Milky Way and it is readily seen from the diagram why one receives the impression of great star density when gazing in the direction of C, from the position of the solar system at S, tho the actual star density may be nearly uniform

(*Continued on page 751*)

Women Now Trained as Meter Readers

Can women read electric meters satisfactorily? They can. Even when the meters are located in the darkest cellars. All of which has come to pass because the government had indicated that industries must help produce the needed additional military man power, and a Chicago electric light company has begun to train and employ women as meter readers. To train these new employees a temporary meter readers' school in charge of the foreman of meter readers has been opened. The equipment consists of chairs and tables, an exhibit of a number of meters and parts of meters, and a large model of a meter dial. This latter is used in meter reading practise, and examinations are held after the class has been thoroly instructed by talks accompanied by demonstrations concerning the construction and working of meters. Twenty or thirty changes are made on the large dial, each student marking down her record each time on a sheet of paper. These sheets are then collected and marked up by the instructor.

Photo Chicago Commonwealth Edison Co.

Here's a Class of Women Meter Readers Being Taught the Errors and Ways of One-Stepping Watt-Hour Meters. "The Hand Is Quicker Than the Eye," Says the Instructor. It Points to 7, but It's Only 6! What the —— ?X! That's Why They have a School. Incidentally They Are Trained How to Shoot Rats at Forty Paces.

TORPEDO TURNS TO STRIKE SHIP.

The case of the Norwegian steamer Somerstadt, which was sunk on August 12th off Fire Island by a *recurving torpedo*, as stated in the official report, has raised the question among experts as to whether the Germans have not utilized the American invention of radio or wireless-directed missiles of that character.

While there is nothing in the official report to indicate that the torpedo which destroyed the steamer took its eccentric course of passing the bow and returning to strike fatally on the port side by the use of radio power, it is not denied that such might be the case.

Secretary Daniels called in an expert when the matter was discust at Washington. In the latter's opinion there was nothing remarkable about the return of the torpedo.

He explained that there were well-known mechanical devices, such as the gyroscope, by which a torpedo could be made to go forward from the point of departure for a certain distance and then recurve, as in the present case.

Both the Army and Navy have investigated the directing of torpedoes by wireless from shore, and have found they can be given such direction. One of the inventions which attracted much attention some few years ago in this line was that of John Hays Hammond, Jr. Tests were made off Sandy Hook, and the torpedoes were given practically any desired direction.

It is noted today that the case of the Somerstadt is not the first instance of the boomerang motion of a torpedo. The same effect was produced in the submarine attack on the steamship Antilles and on the destroyer Jones.

Officials therefore are inclined to the belief that the Germans would not put any additional radio service on board a submarine to guide torpedoes when they could be directed just as well by the gyroscope plan.

An electric lighting company in New Orleans, La., has devised a portable electric light attached to a long pole. The pole is pushed into the ground and the attaching cord connected to the nearest lighting socket. The light is used for illuminating gardens, tennis courts and lawn parties.

The greater efficiency of electric cooking and the consequent conservation of fuel was pointed out in a recent article in *Elektro-Technich and Maschinenbau.* Cases are cited of bakeries in which, other factors being as nearly as possible identical, steam ovens used 0.19 to 0.21 kg. of coal per kg. of bread (i.e., 955 to 1,060 calories), while electric ovens used 0.39 to 0.42 kw-hr. per kg. of bread (i.e., 322 to 359 calories). The power consumption of the electric ovens was 90 kw. and 50 kw. respectively.

SCIENCE IN THE EVOLUTION OF BIG GUNS AND SHELL.

The view below shows one of the laboratories at Sheffield University with a number of the students at that well-known English institution studying closely the recalescence of steel, or in other words, the minute molecular changes occurring in steel by means of the apparatus shown and which are thermally registered.

So interesting and important is this particular branch of scientific work, that the King of England, who recently visited this University, was particularly impresst with the results obtained. He manifested great pleasure in observing how an elaborate chart of the changes taking place in the steel under heat treatment in an adjacent furnace, could be registered continuously by a form of tape recording machine working in conjunction with the split-second clock shown in the photograph.

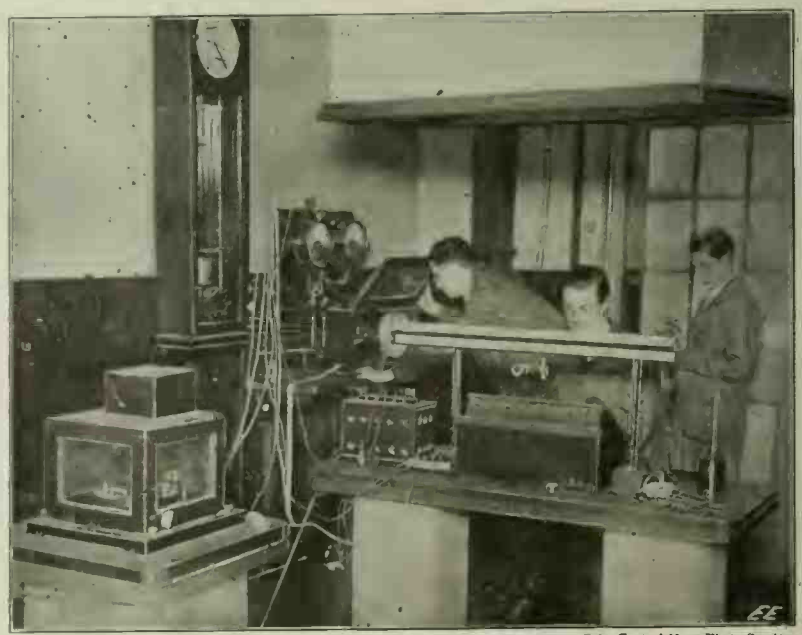


Photo © by Central News Photo Service

An English Laboratory Which Greatly Interested the King of England. Elaborate Electric Apparatus Enables the Observers to Record and Study the Heat Treatment of Steel in Adjacent Furnaces. Tape Recorders Register the Successive Changes in the Steel Under Treatment.

MT. WILSON'S HUNDRED INCH TELESCOPE

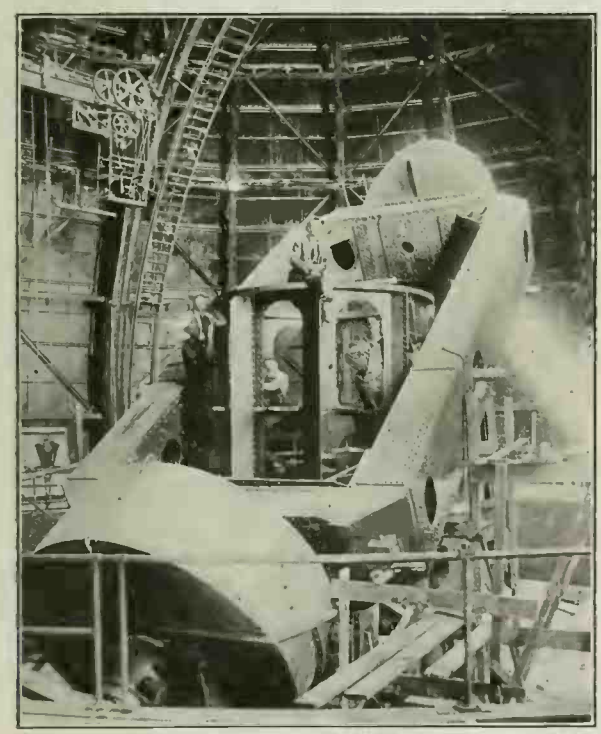
By Professor Walter S. Adams, D. Sc.
Mount Wilson Astronomical Observatory

WITH the introduction into astronomy of the instruments used in the physical laboratory for analyzing light sources and studying their brightness and mode of radiation, the telescope has come to be regarded mainly as an instrument for collecting light. The physicist to a certain extent has the light source at his control, but the light of a star is a fixt quantity, and the only way in which the astronomer can increase the brightness of the image which he desires to examine or to analyze is to increase the aperture of his telescope, say the writer in the bulletin of the *Southern California Academy of Sciences*. One instrument of *twice* the diameter of another will collect *four* times as much light, and, will form an image of a star *four* times as bright, other things being equal. At a period in astronomy when powerful spectroscopes are being employed for studying the motions and the chemical constitution of stars, and when the problem of the structure of the universe requires that we discover and determine the brightness of as many as possible of the faintest stars in the heavens, the value of a great telescope is obvious.

The project of the 100-inch reflecting telescope took form in 1906, when Mr. John D. Hooker provided the funds for the purchase of a suitable disk of glass, the erection of a building for the necessary optical work, and the employment of skilled opticians to figure the surface of the mirror. In the winter of 1908 a disk was received from the St. Gobain Glass Company of France. The mirror was finally completed in the summer of 1916. During that period the work was not strictly continuous, it being necessary occasionally to suspend polishing for considerable intervals on account of unsuitable temperature conditions.

It is not possible here to enter into a

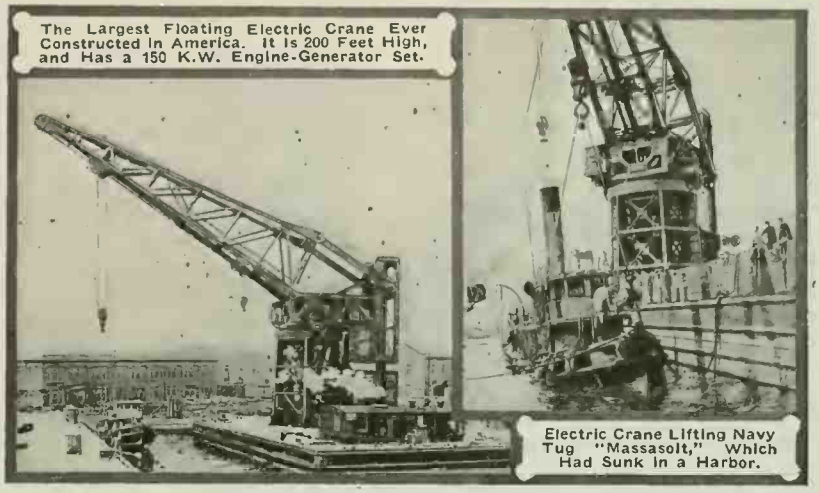
(*Continued on page 755*)



View of Mounting for Mt. Wilson's 100-Inch Reflecting Telescope. The Finished Mirror Weighs 4.5 Tons. The Telescope Is Floated on Mercury. The 600-Ton Dome Rotates Very Smoothly by Electric Motor.

Largest Electric Crane Lifts Complete Tug-boat

THE world is fast beginning to realize that American-made goods are the best to be had, and, also that they are built on integrity, and will not collapse like the German character has



The Largest Floating Electric Crane Ever Constructed In America. It Is 200 Feet High, and Has a 150 K.W. Engine-Generator Set.

Electric Crane Lifting Navy Tug "Massasoit," Which Had Sunk In a Harbor.

and the German Floating Cranes did for the Panama Canal. This "Made in America" crane is said to be the largest ever constructed in this country.

To give a more concrete idea of the amount of work this apparatus can accomplish it may be said that its capacity is equivalent to the weight of 100 of the largest touring cars. The empty lifting hooks weigh about two tons, or the equivalent of a large touring car. When the jib is raised to its maximum height it is over 200 feet above the water level, a height greater than that of an 18-story building. As previously stated, the whole structure is mounted on a flatboat, or floating pontoon, and must not be endangered by handling these immense loads.

The boat contains a complete boiler plant, and an engine driven generator which supplies the electric current for operating the various motions of the crane, which are controlled from a small house mounted high above the deck. By the means of a few levers and master controllers one operator is able to control all the functions with the utmost delicacy.

The speed can always be controlled by the means of the electrical mechanism of the crane. When heavy loads are lowered, the motors are turned into generators and thus the speed is controlled with great accuracy. In the case of an accidental interruption of electric current, all of the crane's motions are automatically locked by means of brakes, and so ensures the impossibility of dropping the load. Safety and accuracy are essential, as the crane is used to handle large guns and turrets on battleships, and if thru carelessness or inaccuracy these should be damaged, it would mean a loss of hundreds of thousands of dollars.

One of the illustrations shows the first work which the crane did. The navy tug *Massasoit* was suddenly sunk in one of the harbors. After divers had past the necessary cables under the tug, the crane rapidly and quickly lifted it to the surface, as shown.

The following data will give a good idea of the enormous size of this machine. Size of pontoon 140 feet long by 85 feet wide by 15 feet deep; size of engine generator set, 150 kw.; the crane has a main hoist consisting of two hooks of 75 tons, each fixt on the jib; an auxiliary hoist of 25 tons capacity movable up and down on the boom; the crane rotates in a *complete* circle, the rotating being controlled by two 60-h.p. motors; the boom luffs up and down from a practically vertical position to an agle of about 30 degrees from the horizontal in its lowest position; the luffing is accomplisht by two 10-inch screws operated by two 60-h.p. motors; the main hoists can operate separately or simultaneously, as desired; when lifting the maximum load it is operated by two 60-h.p. electric motors; the auxiliary hoist has separate motors for hoisting and trolleying, each of which is 60-h.p. The counter-balance at the rear end of the crane is fixt and amounts to 600,000 pounds; the total weight of the pontoon crane (displacement) is 5,000,000 pounds; the capstans are electrically driven, four in number, one at each corner of the pontoon; the anchor hoists are steam driven, two in number, one at each end. The main pivotal bearing, or step bearing supports a ball or universal joint and carries a maximum load of 2,021,000 pounds; the speed of the main hoist under maximum load is about 6 feet per minute; the speed of the auxiliary hoist is 30 feet per minute; the speed of the rotation is one revolution in four minutes; speed of luffing boom, entire range 12 minutes. The boom is of the cantilever type.

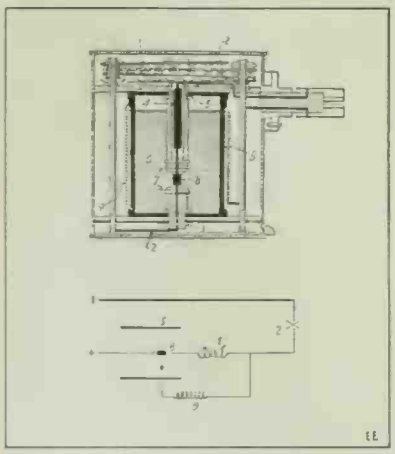
Photos courtesy Westinghouse Electric & Manufacturing Co.

SELLING ELECTRICITY BY THE "CAN."

WE of this generation are quite familiar with the method of supplying kerosene and gasoline by the "can," but who ever heard of *selling electricity by the can?* But such an arrangement promises to come into vogue in Chicago, where the new "metering can" here illustrated has recently been developed and perfected. It has been protected by United States patents issued to Mr. E. O. Sweitzer, of Chicago, Ill., and the various details have been practically all worked out, including the design of the metering element for direct current as well as alternating current service. Owing to the abnormal conditions resulting from the great war, it was not deemed advisable to try to put this device so far on the general market, but now that peace conditions are with us, the concern who has developed this remarkably simple device are getting ready to place it on the general market. This "metering can," as it may be called, is intended to take the place of the conventional watt-hour meter, or kilowatt-hour meter, especially for small current consumers, where it is firstly—quite expensive to install a watt-hour meter, and secondly, — considerable expense is incurred on the part of the operating company, by having these meters read by professional meter-readers every month.

"Electricity by the Can." It Will Do Away with Thousands of Expensive Watt-Hour Meters. It Operates by Electrolysis, the Current, After a Certain Number of Hours, Eating Away the Conducting Member and Opening the Circuit.

When these metering units have become available, all Mr. Householder will have to do will be to go to the electric light company or their agents, and purchase several of these cans. These he takes home and uses one at a time as necessary. The apparatus works on the electrolytic principle, a certain amount of metal being acted upon by the passage of the current thru it, and after a certain number of hours the metal will have been sufficiently eaten away to open the circuit.



Section and Diagram of "Metering Can": 1. Series Resistance. 2. Copper Leads Forming Part of Main Circuit, and Making Connections with the Anode. 3. Protecting Tubes of Hard Rubber. 4. Solid Copper Cylinder Forming Part of Main Circuit, and Connected to Copper Lead at Its Upper Terminal by Means of Special Solder Which Melts at 60 Degrees. 5. Copper Cylinder. 6. Copper Sulfate Solution. 7. Rubber Washers. 8. Copper Anode. 9. Shunt Resistance.

The measurement of current depends upon the electrolytic action of a small copper cylinder of known weight, this being gradually disintegrated by electrolytic action during such time as the current may be used to light lamps or operate motors, etc., but is unaffected during the time when no current is being used. The electrolyte used either for D. C. or A. C. is a saturated solution of copper sulfate. These metering cans are arranged to give a warning signal so that the householder will know ahead of time when he should replace one of the units with a new one. The accompanying photographs show how the metering can is plugged into a wall receptacle in a very simple manner. The meter can here illustrated is so constructed and enclosed in a metal case, as to remove all chances of tampering with it or derangement by accident.

As aforementioned, the can is provided with a projecting contact arm which is inserted in the keyhole of a switch box. It is then given a slight twist to engage the contact with the spring clips of the main circuit and left there until the predetermined amount of current has been consumed. Truly it may be said that this device will mark a new era in electric service to the public.

NEW ELECTRIC FURNACE REGULATOR.

The device is installed easily, and when once in operation relieves the householder of all of his cares in relation to the furnace except the merely mechanical process of "putting on coal." The time clock arrangement makes it possible to maintain a low temperature during the night, and at the time set in the morning, opens the drafts and increases the temperature to the point desired.

This device consists of a thermostat with a clock attachment which operates a motor in the basement, which, in turn, regulates the drafts and dampers of the furnace. Two types are provided, one for use in houses already wired for electricity, and the other in which two dry batteries supply the impulse from the thermostat to the motor box, and a spring motor operates the drafts and dampers.

In the type used in houses already wired the alternating current motor is connected to the alternating main house wires. A transformer on the bottom of the motor box steps the 110 volts down to 6 volts, for use on the thermostat circuit. Thus the dry batteries are dispensed with.

The diagram shows clearly how the regulator works. The thermostat may be set at the heat desired and it will keep the room in which it is installed at that temperature, because if the temperature falls the motor in the cellar will operate sufficiently to open the drafts and increase the heat. The reverse is true when the temperature rises. The thermostat should be installed in a room as near the center of the house as possible and should not be in such a position that its action is subject to the effects of drafts from doors and windows opened for only a moment. — (*Photo courtesy W. E. Co.*

Automatic Electric Regulator Which Tends the Furnace Drafts for You. It Comprises a Thermostat, Clock, Motor and Battery or Other Sources Of Current.

AMONG the hundreds of new devices and appliances publisht monthly in the Electrical Experimenter, there are several as a rule, which interest you. Full information on these subjects, as well as the name of the manufacturer, will be gladly furnisht to you, free of charge, by addressing our Technical Information Bureau.

AN ILLUMINATED SERVICE FLAG FOR HOME AND STORE WINDOWS.

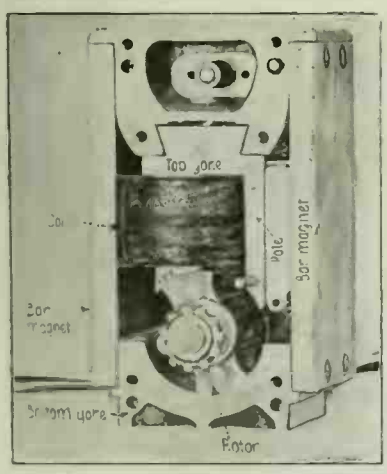
An enterprising electrical concern of Milwaukee is now offering the device shown in the accompanying illustration, known as the

A Handsome Window Decoration in the Form of an Electric-lighted Service Flag.

"Honorlite," which is made in a form to take the place of a military service flag. The device consists of a handsome indestructible wood pulp pedestal with two modelled eagles holding a flat alabaster globe, which is 8 inches in diameter. A 3- by 5-inch service flag is shown on one face of the ball, while five blue stars are furnished loose and can be attached to the circumference or face of the ball as desired. This decorative device stands 12 inches high by 6¼ inches wide at the base, and is wired with 6 feet of cord and plug. It is pointed out by the maker that this device is one which can be used for other purposes, such as special advertising and as a special window display.

A NEW "INDUCTOR" TYPE MAGNETO FOR AUTOS.

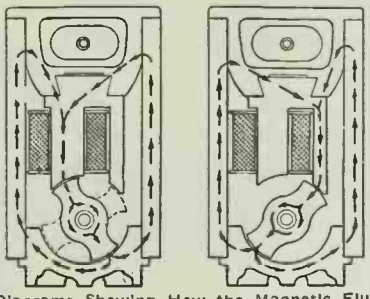
This new auto and motor-boat ignition magneto is of the *inductor* type, which means that the coils in which the current is induced are stationary, and the revolving part or rotor consists merely of a block of laminated steel. Instead of horseshoe



View of Interior of New "Inductor" Type Ignition Magneto. The Rotor Is Simply a Moving Iron Member—No Rotating Coils or Collecting Rings.

magnets, as always used in the conventional type of magneto, this magneto employs straight bar magnets, which are accurately ground and securely clamped to top and bottom yokes. The bottom yoke forms a pole piece extending nearly half way around the rotor tunnel, while the top yoke has two poles, one carrying the windings or coils, and the other serving as a magnetic by-pass. The magnetic circuit is shown diagrammatically in the two accompanying sketches. In one the rotor pole is shown opposite the pole of a top yoke which carries the windings or coils, and with the rotor in this position, the maximum flux passes thru the coils. In the other sketch the rotor is shown opposite the end of the magnetic by-pass, and in this position all of the magnetic flux passes thru the by-pass and none thru the coils. As the rotor has two poles, the flux thru the coils passes thru a maximum and a minimum twice during every revolution of the rotor.

As all coils and current carrying parts are stationary, there are no slip rings or brushes, except the brush in the distributor. The distributor gears, of bronze and steel, are of ample dimensions, and in connection with the rotating member of the current distributor, are carried in steel and bronze bearings, the sleeve of which is cast integral with the front die casting. The base and top yokes are made of gray iron, and are tied to the die-cast end plates by screws. They are located in place by dowel pins. The field structure is bored and ground as a unit, thus insuring thoroly accurate alignment of bearings and pole-faces. The stationary coil, condenser and laminated pole piece are assembled as a



Diagrams Showing How the Magnetic Flux In the "Inductor" Magneto Is Sent Thru the "Coil" Pole and Then By-past Thru a "Shunting" Pole.

unit and mounted integral with the top yoke.

This new inductor magneto gives two sparks per revolution. The spark characteristics are said to be such as to insure very effective ignition, the current rising suddenly to substantially its maximum value at the beginning, and being well sustained. One feathure that distinguishes the spark obtained from this type of magneto compared to that obtained from other magnetos, is that it passes thru the gap of the spark plugs always in the same direction. That is to say, the same part of the spark plug is always positive.

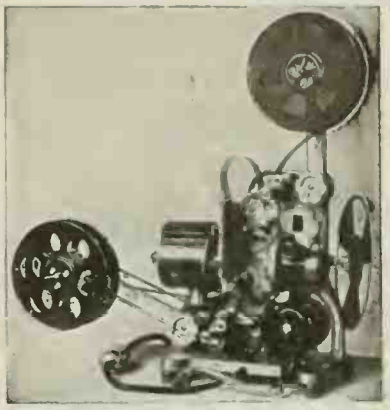
AN ELECTRIC "MOVIE" MACHINE FOR THE PARLOR.

A new type of moving picture machine for commercial, educational and home use has just been brought out by a New York concern.

Its special features are electric motor drive, by a motor that can be used on both direct and alternating currents; high illumination, and a feed mechanism that gives practically perfect results.

Motor drive was used on the older types, but it was necessary to have separate motors for the different kinds of current, and this naturally limited the use of the motor-driven machines. The new motor used here, however, operates at practically the same speed with either kind of current. Hence this machine can be used wherever there is electric light.

The illumination is provided by a 14-volt, 2-ampere, argon-filled, high efficiency light, that is sufficiently brilliant for throws as long as 100 feet, and for pictures up to 12 feet wide. The 110-volt current received



You Have Often Wisht for a Small "Movie" Machine for the Parlor—Here It is. Its Universal Motor Operates on Alternating or Direct Current.

from the lighting circuit is reduced to low voltage for the use of the lamp, by means of a rheostat; this rheostat is adjustable, so that the degree of illumination can be varied to suit conditions.

The film-moving mechanism is of the intermittent type and is of a novel design. The manufacturers claim that this projector projects an absolutely flickerless picture.

This machine is safe to use since it can take only slow-burning films, the standard celluloid film being unusable in it. Many hundreds of these special films have already been made up; special subjects can be made up as desired, and standard films can be copied on to the special stock.

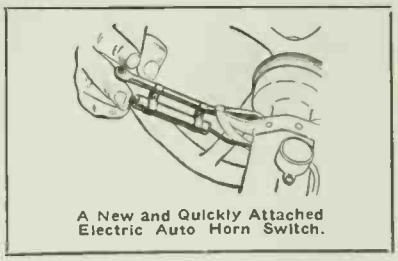
The weight of the machine is 23 pounds and it is arranged for packing in a carrying case similar to a small dress suit case.

India has increased its annual coal production to 12,000,000 tons and is introducing electrical machinery into some mines.

An electric alarm clock which awakens deaf sleepers by jarring their beds has been invented in Germany. They need it.

A NEW ELECTRIC HORN SWITCH.

Something new in the way of an electric horn switch or push button, for Ford cars, has been recently put on the market. It is attached to the throttle lever by means of two small clamps, and therefore is always within reach of the hand without an extra movement.



A New and Quickly Attached Electric Auto Horn Switch.

The device is a tube-shaped cylinder about ½ inch in diameter and 3 inches long, which contains contact point and wiring, which are cemented in place to insure durability and safety from dampness. The connection is made to the regular equipment by cutting in on the main wiring on the post.

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

Amateurs Win Questionable Victory

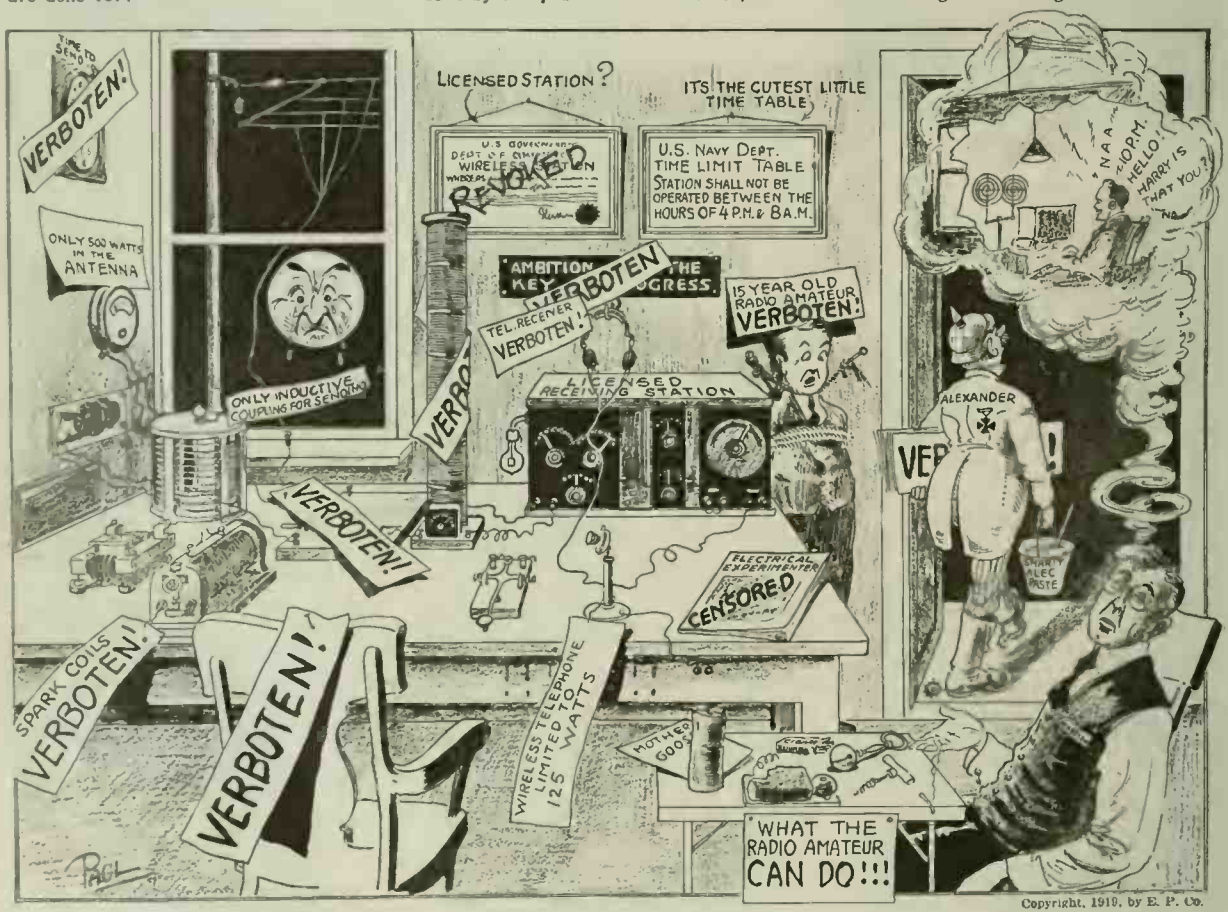
By H. GERNSBACK

PYRRHUS, when congratulated by his friends on the occasion of his victory over the Romans under Fabricius—but which cost a terrible slaughter of his own men, threw up his hands and exclaimed:

"Yes, but one more such victory, and we are done for!"

attempted any nation wide movement to secure the defeat of the bill in question, save and only the ELECTRICAL EXPERIMENTER. Altho several companies manufacturing radio instruments sent out a few thousand letters, no concentrated effort was made to appraise the entire radio fraternity as was done by this publication. About 50,000 letters were mailed out to all radio amateurs interested, and the response we know has been nothing short of wonderful. The writer was in receipt of thousands of letters from amateurs, who in turn in concert with their friends had protested vigorously to Washington, with the result that the amendment printed elsewhere in this issue came about.

The surprising thing however was that none of the other technical publications—there were only two of them commenting about the bill at all—had the situation right in hand. One publication which professes to have the interests of the amateur at heart did not even know that there was such a thing as the Padgett bill! Not one line was printed about it, and the whole situation was therefore more or less mishandled, as all the facts had not been stated clearly, if at all, as they were in the January issue of the ELECTRICAL EXPERIMENTER.



You Are Wrong. This Is Not In Darkest Prussia Where Everything Is Verboten (Forbidden). It Merely Represents An American Amateur Station A. D. 1919 When the Alexander Amendment Becomes a Law.

This was precisely the writer's thoughts when he read the amendments to the Alexander Bill, which has been under discussion for over a month, and which was discust at length in our January issue. After the original Alexander bill H. R. 13159 had been rushed into life, there were immediately regrets by its framers, greatly accentuated by thousands of letters of protest which came pouring in upon Mr. Alexander's committee.

Without wishing to take the credit for everything, it must be stated here that no publication, no radio club, or organization

Not only that, but the press was also appealed to as well, and many papers publisht comments and exprest themselves in no uncertain language about the drastic and entirely unjustified measure known under the title of H.R. 13159.

We wish to repeat here that if any change is to be made, we stand for the Padgett bill. It gives the amateurs exactly the same privileges as he had before the war, and this, we know, is just what the amateurs want.

Now that the situation has cleared somewhat, we are not justified in saying that we think the amateur will be suppresst entirely, for we know that he will not. As a

matter of fact, as things stand today we are not at all excited even about the amendment of the Alexander bill, for we have good and sufficient reasons to believe that the Alexander bill amended has little chance of becoming a law

There is no occasion or necessity for such a drastic measure at the present time. It is not justified, and if we take the propaganda which has been carried on for the last month in Washington, the thousands of protest letters sent to Senators and Representatives, as a fair indication as to how the wind blows, we think we are correct in saying that the temper of the statesmen in Washington today is not such as would support legislation of this kind at this time.

We might write volumes why amateurs should not be suppress, but we believe that official Washington today understands the situation fully. They know by this time what service the amateurs have rendered their country, and how many thousands of expert operators were recruited into the Army and Navy at the outset of the war. Congress will surely not blot the amateurs out of existence in recognition of their work, particularly when there has not been advanced one single, solitary, good reason why the amateur should not be allowed to pursue his innocent endeavor.

America, the greatest democratic country in the world, the one that cherishes the highest ideals of any nation, is not going to start in at this late date to take away the liberties of hundreds of thousands of loyal citizens who have already proved their worth, and will do so again.

In printing the amendment of the Alexander bill below, we call particular attention to paragraph 13. This constitutes nothing but a joker, for if the bill below became a law, and if the Navy Department was in power, it could very readily and without any trouble whatsoever prohibit the sending of messages, let us say, between the hours of 5 P.M. to 1 A.M. This, in the language of the bill, would be "definite periods of the night or day."

If we must have a law, let us have a law without "ifs" and "buts". Paragraph 13 is entirely too elastic in favor of the Government and would inevitably result in shutting the amateurs out at the slightest pretext.

There are certain things in the amendment which are undoubtedly satisfactory to everyone, but as a whole, we are not in favor of the measure. It is too autocratic, particularly the clause whereby it would be necessary for amateurs who had *receiving apparatus only* to secure licenses. Not one in a hundred would wish to go to the trouble of obtaining a license for very obvious reasons. It has been found in the past, that wherever an amateur had to obtain a *sending license*, it was done most reluctantly, and it was the cause of keeping thousands of amateurs away from wireless. It would work even more disastrously if every receiving station were to be licensed. Most of the jewelers—who receive time by wireless—and many young men would prefer not to operate their receiving stations for the word, "Government License", to many simple folk means a big undertaking, and in many cases when a young man finds out that he must obtain a Government license in order to have his wireless set, he prefers to be without it.

What good is it anyway to license a receiving wireless station? If a record of amateur stations is wanted in Washington why not let us insert a clause in the bill which would make it compulsory for every manufacturer or seller of radio apparatus to give a list of the amateurs buying such instruments, which to all intents and purposes would be the same thing as licensing and thus frightening the amateur. This system was in vogue during the war where it became necessary for all manufacturers to supply a list of radio sales to the Navy Department.

No manufacturer would object to this, we are certain, and as the government would then have the list of names it would work out the same way without discouraging thousands of amateurs.

The Alexander bill, amended, follows with our comments in parallel columns:

Alexander Wireless Bill—Amended

65TH CONGRESS, 3D SESSION, H. R. 13159.

IN THE SENATE OF THE UNITED STATES, DECEMBER 11, 1918.

Referred to the Committee on Commerce and ordered to be printed.

AMENDMENTS.

Intended to be proposed by Mr. Watson to the bill (H. R. 13159) to further regulate radio communication, viz:

On page 2, after line 8, add the following:

"The word amateur, or private, station shall be construed to mean any radio station operated by a citizen of the United States for the benefit of himself and science, and which does not do bona fide commercial radio communication."

On page 2, line 14, insert the words "private or amateur" before the words "technical and training school stations."

On page 2, strike out section 3 and in lieu thereof insert the following:

"First. The wave length of private or amateur stations shall be from one hundred and fifty meters to two hundred and twenty-five meters.

This is wholly satisfactory in all respects. It would give the amateurs twenty-five more meters to operate on than he has now. The present wireless law confines the amateur to 200 meters.

"Second. The Government shall have the right to stipulate that the power used by private or amateur stations shall not be greater than five hundred watts as measured in the antenna circuit, except by special license; and shall not be greater than two hundred and fifty watts as measured in the antenna circuit, except by special license, within one hundred and fifty miles of any seacoast, lake front of the Great Lakes, or coast of the Gulf of Mexico.

We can see no fundamental objection against this.

"Third. The Government shall have the right to prevent all persons below the age of fifteen years to use, operate, or own any sending outfit for the sending of radio disturbances into the ether.

We are wholly in accord with this as well. Boys under fifteen years of age in the past have made most of the trouble, and we believe it would be better for the fraternity if boys below this age should start in with a receiving station to obtain proficiency in the radio art.

"Fourth. The Government shall have the right to require all private or amateur station operators of receiving stations to be licensed, and failure to procure a license shall be punishable by a fine not exceeding $600.

Object most strenuously against this unjust measure. There is no necessity for licensing receiving stations only. Our jewelers, thousands of them scattered all over the country must have receiving stations to receive accurate time from Arlington and the like. Not many would want to be licensed under this measure. Secrecy in wireless is impossible anyway. If anyone must receive signals he can do so very readily and easily anyway, law or no law. Important messages are never sent out by the Government or commercial companies unless they are in code. On top of this the present wireless law already has penalties for divulging contents of messages.

"Fifth. The Government shall have the right to require all owners or operators of private or amateur stations to pass an examination whereby the operator of such station shall be able to receive ten words a minute before said operator may be licensed to operate any sending station.

We see no fundamental objection to this, except that it seems rather mysterious to us why an operator should *receive* ten words a minute. What good does the *receiving* do him. Perhaps the framers of the bill meant *"send"* not "receive."

"Sixth. Private or amateur station operators shall not be permitted to operate undamped sending outfits of greater capacity than two hundred and fifty watts as measured in the antenna circuit, except by special license, within the territorial limits of the United States.

This restriction to us seems to be too severe. We should like to see ½ K. W. inserted instead.

(*Continued on page* 735)

Don't fail to read a very interesting discussion appearing on Page 735, entitled "Amateurs Discust Officially" by Lieut. J. S. Cooper, U. S. N. R. F.

President Wilson Always in Touch with Washington—via Radio

FOR several days, going and coming in completing his mission to the European peace conference, it was and will be necessary for the President to administer the affairs of Government from the high seas. Unique as this situation is, hardly less so were the preparations made to enable him to keep in communication with the world during the voyage.

What is considered the most powerful wireless system ever installed on any ship is that carried by the steamship *George Washington*. A corner of the wireless room, fitted with the new radio devices, the latest word in invention and design, is seen in the accompanying picture.

Special arrangements never before used were made for handling President Wilson's wireless messages and to keep him in constant touch with Washington.

This announcement was made by Secretary of the Navy Daniels in connection with a statement that the Navy Department was in continuous communication with the *George Washington* and the flagship *Pennsylvania* on their trip from New York.

Means were at hand whereby he could be brought instantly into communication thru the powerful navy radio station at Annapolis, Md., and Arlington.

Mr. Daniels said:

The *George Washington* and the battleship *Pennsylvania* are both equipt with the most modern radio apparatus, some of which was installed for this particular trip.

"This apparatus includes, on the *Pennsylvania*, the most powerful transmitting set on any United States naval ship and also special receiving apparatus for receiving from high power stations used ordinarily only for transatlantic messages. The *George Washington* was also especially equipt with similar receiving apparatus. On board both ships were installed radio telephones and the newest type of low power sets for use only in communicating from ship to ship. The *George Washington* and the *Pennsylvania* were thus able to communicate with each other and at the same time receive messages from shore.

"All messages for the President were sent by the new naval high power station at Annapolis, which is five times as powerful as the Arlington station. These messages were received by the *George Washington* and the *Pennsylvania* simultaneously. All replies were forwarded from the *George Washington* to the *Pennsylvania* and then instantly relayed to shore by the *Pennsylvania*.

"At three special naval radio receiving stations, one in Maine, one in New Jersey and one in the Navy Building, Washington, expert operators listened continuously for the *Pennsylvania's* messages. The messages when received were forwarded with utmost despatch to the transatlantic radio division of the office of the Director of Naval Communications in the Navy Department, and the three copies were compared to insure accuracy. The messages were then delivered to the addresses. All outgoing messages past thru the same office in Washington.

"As the Presidential party approached Europe, by arrangement of the Navy Department, special receiving stations in both England and France listened for messages from the *Pennsylvania*, and one of the French high power stations forwarded messages direct to the ship. The President was thus kept in touch with Washington and Paris or London simultaneously, for the *George Washington* easily received the messages sent from the Annapolis station until the end of the voyage and the ship was in Brest, France."

The first Cabinet meeting in all history, directed to a certain extent by wireless from mid-ocean, was held in the White House on December 10th, with Vice-President Marshall officiating in the President's absence.

A wireless message from the *George Washington* asked Vice-President Marshall if he would preside and the latter assumed his temporary duty as acting President.

President Wilson was in constant communication with the United States and France during his entire voyage from the United States to France thru the U. S. S. *Pennsylvania's* powerful radio transmitting and receiving sets. The Annapolis high power transmitting station, transmitting on 16,900 meters, the high power transmitting set at New Brunswick, N. J., transmitting on 13,000 meters, the high power transmitting set at Tuckerton, N. J., on 9,200 meters and the high power transmitting radio station in Lyons, France, on 15,500 meters were used for communications to and from the President.

The President on board the U. S. S. *George Washington* was convoyed by the U. S. S. *Pennsylvania* (which is the best equipt ship afloat for signalling purposes in regard to radio communications) and five torpedo boat destroyers. The *Pennsylvania's* radio equipment consisted of the following apparatus: One 30 kilowatt Federal arc transmitter, which was used for transmitting messages to the United States and France on 3,600 meters, one 10 kilowatt Lowenstein spark transmitter, transmitting on 600 and 952 meters, which was used for intermediate communication with low power coastal stations; one short range radio telephone transmitter, transmitting on 297 meters and one vacuum tube short range transmitting set, transmitting on 450 meters, which were used for intercommunication between the U. S. S. *Pennsylvania* and U. S. S. *George Washington*.

The *Pennsylvania* transmitted messages direct to the United States up to a distance of 2,500 miles. Communications with

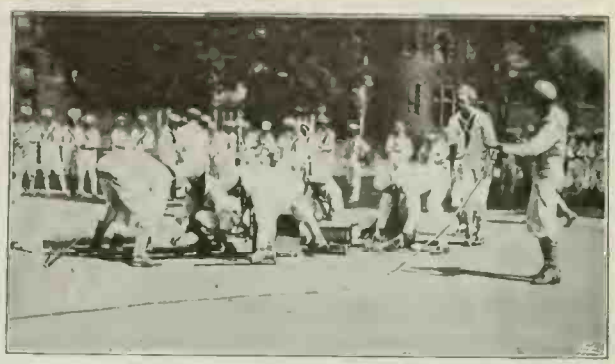
(*Continued on page 743*)

Photo © by Underwood & Underwood

It Will Undoubtedly Be of Extreme Interest to Our Radio Readers to Learn That Two of the Wireless Operators Selected For Duty on the President's Ship—the "George Washington"—Were Formerly "Radio Amateurs". See Testimony As to the Worth of This Class of Men to the Navy Given By Lieut. Cooper Before the Committee On the Merchant Marine and Fisheries, Printed Elsewhere Under the "Radio League of America" News.

Harvard Naval Radio Men Expert with Portable Sets

THE Harvard Radio School has developed thousands of expert radio operators for the United States Naval Service, and a group of them are here illustrated practising with one of the portable wireless outfits which landing parties use. It is surprising how quickly they can erect an aerial mast and connect the various instrument cabinets together with the dynamo, ready for instant service. It is all a matter of discipline, the commanding officer will tell you. Discipline and system whereby each man does a certain thing, but does it well. That in a nutshell is the whole secret of Uncle Sam's naval efficiency. These men are trained to perform their duties with clock-like precision, and each move in erecting the wireless set here shown is done identically the same each time, which is the only way that real speed can be obtained. Unlike the German system, Uncle Sam's boys are trained not only to do a certain thing in a complex task and to do it well, but they are each and every one of them educated and carefully instructed on all the details governing the operation and functioning of the complete radio outfit. Thus in an emergency any one of these radio men can do anything from tapping the key to erecting the antenna, or dissembling the gasoline engine driving the dynamo, in the event that it fails to work, and ascertain just what the trouble may be. It has been a great task to train all of these thousands of radio operators in the various complex branches of the art, but Uncle Sam's radio instructors, both naval as well as civilian, have proven their worth.



A Radio Squad From the Harvard Naval Radio School Show What They Can Do In Rapidly Setting Up a Portable Type Radio Pack Set. 1st Act—Unpacking the Instruments.

345 MARCONI RADIO STATIONS BOUGHT BY U. S. NAVY DEPARTMENT.

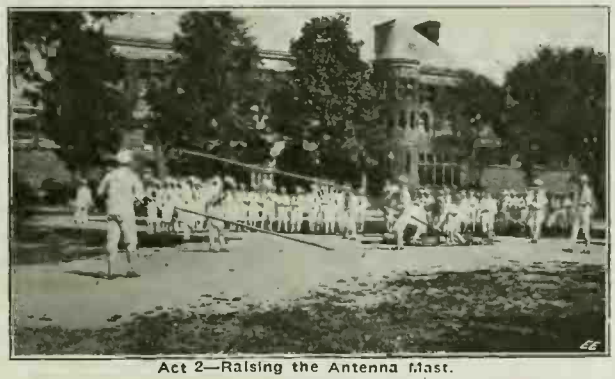
All of the American Marconi radio stations, except the four high power plants, have been bought by the Navy Department, a Washington dispatch of December 5th stated.

At the same time it developed that the department purchased the great Sayville station recently from the Alien Property Custodian along with the Marconi purchases. The American Marconi company relinquishes the field of handling ship to shore messages.

The purchase includes 45 Marconi coastal stations, nineteen of which are situated on the Atlantic and Gulf coasts, sixteen on the Great Lakes, and ten on the Pacific coast.

The four high power units which the company still retains include the Belmar-New Brunswick station in New Jersey, for transmission of messages to England; Chatham-Marion, Massachusetts to Scandinavia; Marshall-Bolinas, California to Hawaii; and Koko Head-Kahukee, Hawaii to Japan. Two units represent each station, each about fifty miles apart, one being utilized for transmission and the other for receiving.

In taking this action the United States is merely following the lead of other nations in controlling the ship to shore business; England took over these stations on her coast 12 years ago, and since that time they have been operated by the Postal Department. The same applies to France, Italy, Germany and countries in South America. Brazil has always operated her coast radio stations.



Act 2—Raising the Antenna Mast.

An official of the company points out that the cream of the business in the future will be the transatlantic message traffic. The ship to shore business has never been a big proposition, for with the exception of a few ships the private business aboard ships or to them has never been large. At the same time development of the transatlantic business is going forward, and when the Government relinquishes control of these big stations, they undoubtedly will produce big results for the company.

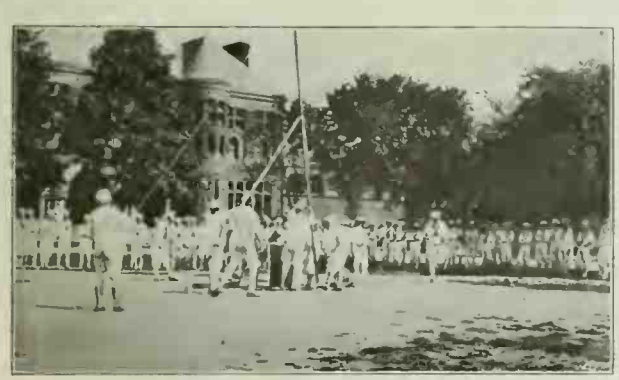
The price paid by the Government is not announced at this time altho it has been definitely settled.

The Government has also purchased from the Marconi Wireless Telegraph Company of America wireless apparatus on some 300 ships now under Government control. An announcement to that effect was recently made by Edward J. Nally, vice-president and general manager of the company.

The sale of apparatus to the Government, Mr. Nally said, is "the first result" of a change in the company's policy whereby "it will in the future sell as well as lease wireless apparatus."

A recent London dispatch quotes Godfrey Isaacs as saying that the Marconi Company would outfit airplanes employed in air passenger and mail service with wireless and would supply operators in the same way as it now serves ships. It also is intended to receive regular reports of air conditions in different localities and to circulate these for the information of the pilots. As every airplane will have either a name or distinguishing number, it will be possible to send telegrams from any part of the world or from any ship to an airplane. It is intended that this organization will be ready by the time the peace treaty is signed.

Arrangements recently have been made for the erection of wireless stations in the extreme parts of China, one on the frontier of Cashmere, and another on the Chinese side of Siberia. Mr. Isaacs has arranged with Handley-Page for the transport of the necessary machinery by one or more of his big machines. The journey inland will take two or three days in place of the same number of months.



Act 3—Mast and Aerial Raised and Apparatus Ready For Service.

NAVY MODIFIES RADIO RULES.

Naval conditions in the North Atlantic are such now that restrictions upon commercial radio communications are being removed, according to an official announcement. Personal and commercial traffic with naval vessels as well as with merchant vessels is now permitted west of the 40th meridian.

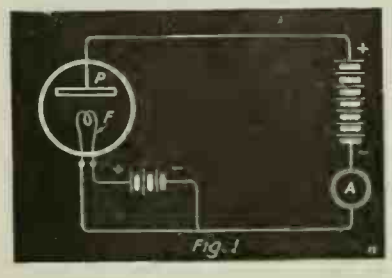
The restrictions upon land wire telegrams address to naval personnel on board naval vessels, which caused such telegrams to be forwarded thru the Bureau of Navigation, have been removed, and it is now permissible to address personal telegrams direct to men on naval vessels in an American port. Restrictions on amateur wireless stations have not been lifted.

Vacuum Valve Action and the Electric Current

By K. G. ORMISTON, ASSOC., I. R. E.

RADIO INSTRUCTOR, HEALD'S ENGINEERING SCHOOL, SAN FRANCISCO

NEARLY all text-books on physics and electricity state that the direction of the electric current in the external circuit is from the positive terminal of the source of pressure to the negative terminal. The average radio student, from the time he first takes up the study of electricity, is taught that the positive pole of a battery or dynamo is in a state of high pressure and the negative pole in a state of low pressure, and that the



This Diagram Represents a Vacuum Valve Circuit, Minus the Grid Which Does Not Enter Into the Present Discussion. This Article Discusses the Direction of Current Flow Thru the Valve—a Mooted and Foggy Point to the Majority of Radio Men. Does the Current Pass from Filament to Plate Or Vice Versa?

direction of the eletcric current is from positive to negative. This conventional theory is quite satisfactory until the vacuum valve and its action is considered; then the confusion begins.

Figure 1 represents a vacuum tube with the filament heating circuit and plate circuit. (The grid is omitted as it has no bearing on the present discussion.) The positive terminal of the battery B is necessarily connected to the plate P. In studying the action of this circuit the radio student is asked to believe that the current in the plate circuit flows from the positive terminal of the battery B to the negative terminal; that is, from plate to filament within the tube, in spite of the fact that the ELECTRON STREAM IS FROM THE FILAMENT TO THE PLATE.

In this connection the leading text-books make the following statements:

1. "Using the ordinary convention for the direction of current flow (which is *opposite* to the direction of flow of the electron stream), we say that a current flows from the plate to the filament."

2. "It will prevent confusion . . . if the student understands that inconformation with the old theory electricity FLOWS IN THE DIRECTION OPPOSITE TO THE FLOW OF THE ELECTRONS."

3. ". . . the number of electrons drawn from F to P per second, that is, conventionally the current from P to F, is found . . . to be roughly proportional to the square of the field intensity."

The instructors in a certain Government Radio School, in their efforts to "conform with convention," even go so far as to teach that positive ions flow from the battery B to the plate P to *neutralize* the negative electrons discharged from the filament to the plate, and thus endeavor to show that a current actually flows from positive to negative. But these instructors fail to explain how positive ions, WHICH ARE ATOMIC IN SIZE, can flow freely thru a copper conductor or a vacuum!

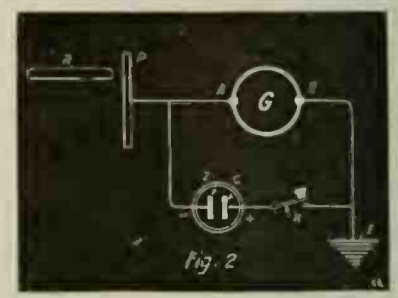
It is my personal experience that much confusion is avoided, and a far better understanding of vacuum valve action, as well as certain other phenomena, is gained if the radio student is taught from the start that the electric current is in reality a flow of negative charges, or electrons, from the negative (high potential) to the positive (low potential) pole of the source of E. M. F.

The above statement concerning the direction of the electric current is not a theory; it is a conclusion drawn from experiment. That the electric current consists of a movement of ELECTRIC CHARGES can readily be shown by the following simple experiment.*

In Figure 2, P is an insulated metal plate. G is a sensitive D'Arsonval galvanometer, connected between the plate and the earth. The simple cell ZC and key K are connected as shown, with the zinc or *negative* terminal of the cell connected to the same side of the galvanometer as the metal plate P. R is a gutta-percha rod, which is held in the hand and may be electrified by rubbing with cat's-fur. The gutta-percha rod when subjected to friction becomes *negatively* charged. When the charged rod is moved near the plate P, the galvanometer will deflect in a certain direction, let us say to the right. The deflection of the galvanometer is caused by an electric current passing thru its windings, and the current must consist of a flow of electric charges. Negative charges may be repelled from the plate by the presence of the negatively charged rod, and flow thru the galvanometer to the earth, or positive charges may be attracted from the earth and flow to the plate. In either case, it is the flow of electric charges which produces the effect of an electric current. As would be expected, when the charged rod is removed the galvanometer deflects in the opposite direction, that is, to the left. The removal of the rod either allows the negative charges which were driven from the plate to the earth, to return to the plate, or releases the excess of positive charges which had been attracted to the plate and they pass off to the earth.

During the first part of the experiment the key K has remained open. Now place a heavy shunt on the galvanometer, so the current from the simple cell cannot damage the instrument. Then close the key K. The galvanometer will deflect TO THE RIGHT. Note that the deflection is in the same direction as when the charged rod was made to approach the plate P, and therefore either *negative* charges are flowing thru the galvanometer from A to B or *positive* charges from B to A. We can now draw this conclusion: The electric current consists of either a stream of negative charges flowing from the negative terminal to the positive terminal, or a stream of positive charges flowing from positive to negative, or possibly both.

The smallest possible electric charges, both positive and negative, have been isolated in experiments by J. J. Thompson and other scientists, and their mass and velocity are definitely known. The smallest charge is *negative* in sign, that is, it shows the same characteristics as a gutta-percha rod when electrified; is approximately 1/1800th the size of the smallest atom (hydrogen), and is called the "Electron." The smallest *positive* charge is found in the atom which has lost one or more electrons, and is therefore atomic in size. This smallest positive charge, which is but an atom deficient in negative electricity, is called an "Ion."



Experimental Circuit Which Students Are Trained to Learn the Actions of and Which Proves the Audion Explanation Here Set Forth. G Is a Sensitive Galvanometer, Z-C a Simple Battery Cell, K Represents a Key, E the Earth Connection, P a Metal Plate, R a Gutta Percha Rod, Which Can Be Electrified.

It is evident that the positive ion cannot act as a carrier of electricity in a solid medium, or in a vacuum, on account of its size which must be at least as large as the smallest atom. But the electron, bearing the negative charge, can easily pass between the atoms of a solid conductor.

From the experiment of Figure 2, we concluded that the so-called electric current consists of a stream of electric charges, either positive or negative. Thompson's measurements show that the positive charge cannot flow (in the media with which we are dealing); therefore, we may state that the electric current is a movement of electrons (negative charges) from the negative pole of the source of pressure to the positive pole.

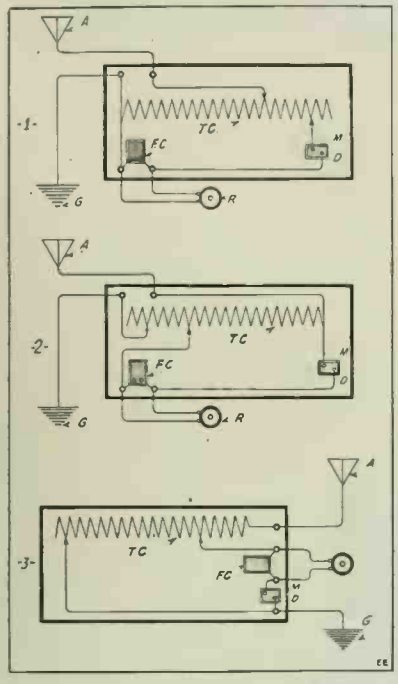
For further proof let us again consider the vacuum tube circuit of Figure 1. We have a circuit connected to the battery B, made up of copper conductors and the space F—P, which is devoid of all matter. The ammeter A indicates that an electric current flows in this circuit. Since no ponderable matter exists in the vacuum tube, the only possible carriers of electric charges within the tubes are electrons. The filament F is heated to incandescence in order that ionization will take place, and electrons will be emitted from it. It is necessary, in order to have any current at all in the plate circuit, that the positive pole of the battery B be connected to the plate P, so that the negative charges (electrons) will be attracted to the plate rather than repelled from it. With the arrangement of Figure 1 there will be a stream of electrons or negative charges flowing from F to P within the tube, and it follows that the current in the plate circuit indicated by ammeter A must consist of a *movement of electrons from the NEGATIVE pole of battery B to the POSITIVE pole.*

Let us not be hampered by "convention" and "old theories," but endeavor to seek the Truth. Then Progress will be assured.

* All students in elementary electricity at the Los Angeles Polytechnic High School are required to perform this experiment. See "Elementary Electricity," by Prof. H. LaV Twining.

THREE GOOD "HOOK-UPS" FOR A SMALL RECEIVING SET.

Four instruments are needed for this simple receiving set, and all are of the "E. I. Co." make. They are, one small tuning coil, one Miniature detector, one



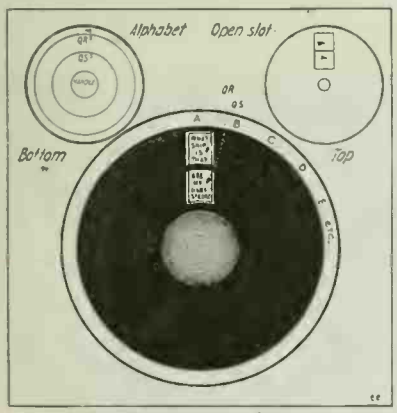
Here Are Three Simple, Yet Very Effective Hook-ups for a Small Wireless Receiving Set, Which Is Equipt with a Tuning Coil, Condenser, 'Phone and Mineral Detector.

fixt condenser and one Pony telephone receiver. In the diagrams, which are self-explanatory, A is the Aerial; G the Ground; T.C. the Tuning Coil; M.D.—Miniature detector; F.C.—fixt condenser and P.R.—Pony receiver. With a suitable aerial and ground system, you will be surprised by the good work this little set will do. It is interesting to try the different "HooR-Ups" to find which works best in your locality.

Contributed by FRED FLOYD, JR.

HOW TO LEARN THE INT'N'T'L CODE ABBREVIATIONS.

The attached drawing is that of a rotating dial to be used in quickly ascertaining the definition of the various International Radiotelegraphic Abbreviations. Such as:



Clever Dial Scheme for Use In Quickly Ascertaining the Definition of the Various International Radio Abbreviations, Such as Q R A?—Q S A?, etc.

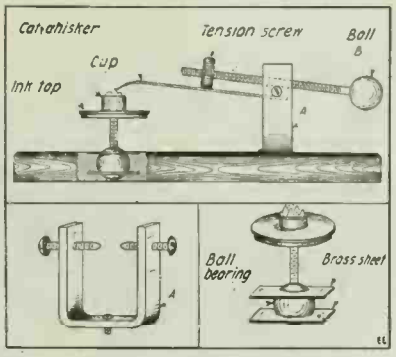
QRA? What ship or coast station is that? QSA? Are my signals strong?

As shown in the drawing the bottom or larger disc is made stationary to a wooden base and upon it the various definitions are printed above the QR's and below the QS's, so that when the smaller disc, firmly held by the rod holding the handle, is rotated in alignment with the letters of the alphabet, the definitions are indicated thru the slot cut in the rotating disc.

Contributed by E. T. J.

EFFICIENT GALENA DETECTOR.

Everyone is sure to have a small piece of brass rod for which he can find no use. The hard rubber top to an ink bottle in connection with a brass cap from an old dry cell forms a cup. A garage will give you all the slightly worn ball bearings you can use and you need but two. If you have never broken a ruler with a brass strip in it you are a wonder. A few screws, a nut, a couple of binding posts and a piece of board or fiber and you have the makings of a good detector. The accompanying illustration tells the rest. Once you have the tension screw, all you do is hook her up



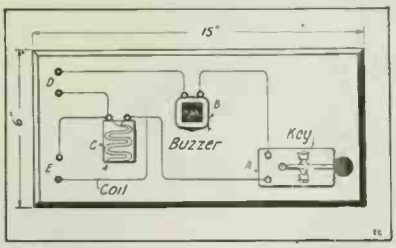
A Real "Ball-Bearing" Detector—"Radio-bugs." The Cup Swivels Nicely, While the Cat-Whisker Arm Is Balanced—a Design In Great Favor by Experts.

and with a second's adjustment (which won't knock out) in come the signals fine and clear.

Contributed by H. C. BENEDICT, JR.

NOVEL BUZZER PRACTISE SET.

In the drawing (A) is a key of any type, mounted on a board as shown. (B) is a buzzer of high pitch. (C) is a coil of



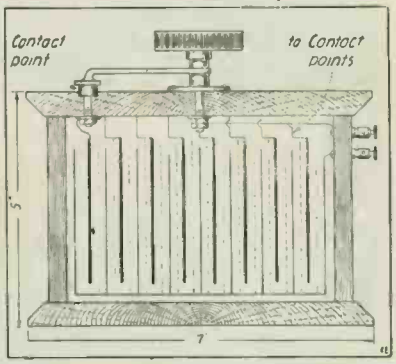
Unique Buzzer Practise Circuit in Which the 'Phones Are Shunted Across a Resistance Coil, In Series with the Buzzer.

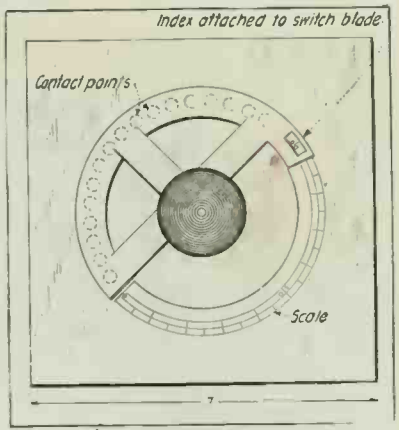
wire which is wound non-inductive; an inductive coil will not work. This coil may be made by using 50 feet of No. 24 insulated wire, doubling it and winding it double, starting with the loop end. Why this is done need not be explained here. (D) are the battery binding posts, and (E) are for the phones. A 75 ohm receiver will work fine.

Contributed by M. ABRAHAM.

A HANDY ADJUSTABLE CONDENSER.

The feature of this condenser is that the capacity units are stationary and therefore least apt to get out of order; the switch element only rotates. The builder can make the condenser of any size desired. The case is made of hardwood, sandpapered and varnished in the usual way. This con-





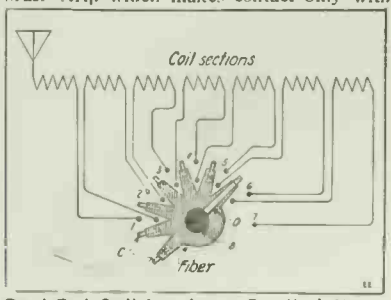
An Adjustable Condenser Suitable for Use in Radio or Spark-Coil Primary and Other Circuits. The Switch Is of the Accumulative or Integrating Type.

denser has been found suitable for every kind of work where an adjustable capacity is employed. The scale is read thru an index window attached to the moving switch blade.

Contributed by H. B. MASSINGILL.

DEAD-END SWITCH.

The ends of coil units are brought to switch points, one on each end of wire, (1, 2, 3, 4, 5, 6, 7). Note the fiber or other insulated plate, carrying at the under edge brass strips (C) which, when disc is turned (by knob B) connects the switch points over which the strips lie. D is a brass strip which makes contact only with



Dead-End Switches Are a Practical Necessity Nowadays On All Radio Receptors.

outside row of points. Suppose (D) were on point 5. Then the pairs 1, 2, 3 and 4 would be connected, but 6 and 7 would be entirely out of circuit, because (D) touches only the outside switch point. D connects to ground.

Contributed by HERBERT RICHTER.

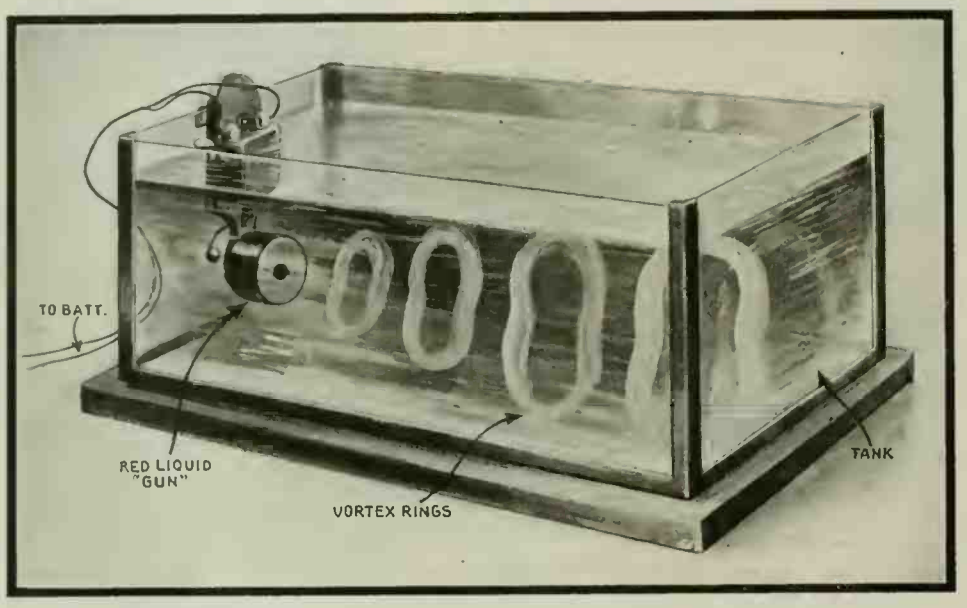
The Vortex Ring Theory of the Electron

By F. W. RUSSELL and J. L. CLIFFORD

THE discussion of the various theories of matter is one of the most important problems that confront the scientist today. Chemistry, Physics, and nearly all branches of science hinge upon this question. The atomic theory has been thoroly establisht, but the ultimate structure of the atoms is still an open question. The leading theories of today make use of smaller particles called electrons to form their hypothetical atoms. These particles were first discovered by Crookes, and about 1897 were definitely proved by Weichert, and Sir J. J. Thomson, to be negatively charged particles traveling with the enormous velocity of nearly 100,000 miles per second. In addition it was found that these particles had an extremely small mass. In fact about one eighteen-hundredth the mass of an hydrogen atom, the smallest known atom. The presence of these particles was again proved by the disintegration of Radium, and even an electric current is now believed to be a flow of these electrons. The electron then is one of the most important entities in the world today, and yet there are very few theories as to the nature of the electron. The physicist has side-stept the problem in the past by simply calling it a hard negatively charged corpuscle, but what a hard corpuscle is, is left to the reader's imagination to picture. Lately, however, the new school of French physicists have brought forward the theory which seems most complete and astounding. They claim that the electron is nothing more or less than a minute whorl in the ether, or as we shall call it an ether vortex ring.

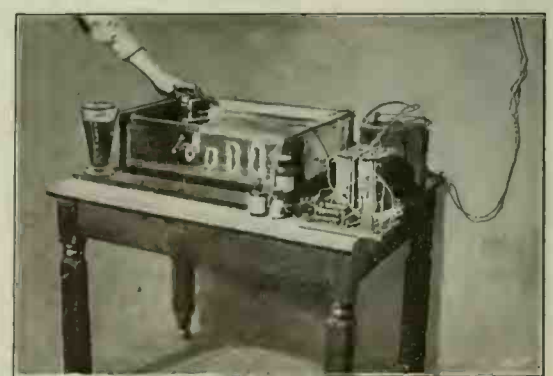
When Lord Kelvin brought forward about 1870 his famous vortex ring theory of the atom, the scientific world hailed with delight this tangible explanation of the structure of the atom. Upon the discovery of the electron, however, the vortex atom theory was thrown into the background and into obscurity. Since the new theory of the electron has been proposed, however, it is interesting to repeat and discuss the experiments with smoke and liquid rings performed by the experimenters wishing to prove the vortex atom theory.

The simplest form of apparatus needed to produce rings of smoke is a round cardboard box with a small aperture in one end. If the box is filled with smoke or with fumes of Ammonium Chlorid formed by the action of Ammonia and Hydrochloric Acid, and the opposite end tapt sharply, rings of smoke will be projected from the box and will hold their shape for some time. The rings move swiftly forward, carrying with them the same material with which they issued from the box, and seemingly possess elasticity of form. Altho many interesting phenomena may be observed using this simple form of apparatus, for accurate and detailed experiment the liquid ring apparatus, described below, will be found the more practicable.



A Most Beautiful Laboratory Experiment is that of the "Vortex Ring". With the Simply Constructed Apparatus Here Illustrated Vortex Rings of Various Sizes and Kinds Can Be Set Up At Will, By Means of the Red Liquid "Gun" At the Left of the Tank. Various Colors of Rings Can Be Made with Different Solutions. The "Gun" Is Actuated By an Electric Bell Movement, Minus the Gong.

The first requisite is a glass tank at least 30 inches long by 12 inches wide and high. A gold fish aquarium will answer the purpose, provided it conforms to the dimensions. If an aquarium is not available, a tank may be easily constructed by making a box with the base of wood and the sides of glass plates. This box should be well coated with asphaltum in order to make it water tight. When the experimenter has provided himself with a suitable tank, the next problem which confronts him is the construction of the "gun" or projector with which to generate the vortex rings. An efficient gun may be easily manufactured from odds and ends to be found in any experimenter's laboratory. As may be seen in the drawing, Fig. 1, the two principal parts of the gun are the liquid container and the electric agitator. At one end of the liquid container, which consists of a round tin box, is fastened a diafram of Phosphor-Bronze sheet or other flexible substance. In the opposite end, which may be the cover to the box, a small hole about $^{3}/_{16}$ of an inch is cut, care being taken that the sides of the hole are smooth in order to insure perfectly formed rings.



Here We See the Actual Vortex Ring Apparatus Set Up In the Authors' Laboratory.

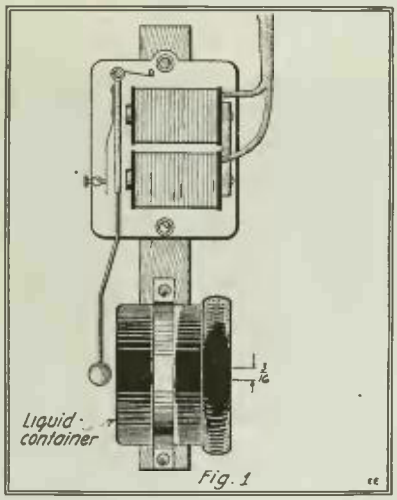
The box should be made water tight. As may be seen in the drawing the agitator consists of a strong electric bell with the gong removed, and the leads taken directly from the coils. The bell should be well impregnated in paraffine or other insulating compound so that it may be submerged without danger of short circuit. The bell should be so placed that the striker will strike the center of the diafram a forceful blow when the magnets are energized. The best position for the striker can only be determined by actual experiment.

When the projector has been completed, if the experimenter wishes to use red colored rings, the liquid container should be filled with a solution of Sodium Hydroxid, and Phenolphthalein. Be sure that all the air has been expelled, as any air in the container causes the rings to be irregular. The gun is then lowered into the tank, and the magnets energized by means of batteries, controlled by a telegraph key. Rings will be seen to issue from the aperture, and traverse the length of the tank intact. If the water is slightly acidulated with Sulfuric Acid the rings will immediately disappear upon breaking up. If the experimenter wishes to make milk-white rings, an emulsion of Silver Chlorid can be used that will become colorless in a weak solution of Ammonia. To make such an emulsion a tablespoonfull of gelatin should be dissolved in about a liter of hot water. About 15 grams of Silver Nitrat previously dissolved in water should be added. Then stirring well, add a weak solution of Hydrochloric Acid until the Nitrat is all precipitated as a chlorid. This milk-white solution should be diluted with equal parts of water before using. Rings of this solution shot out into a weak solution of Ammonia, will hold their form until broken, and will then completely disappear. The amount of current necessary for each gun can only be determined by practice, and the nature of the rings wished. After some practice, the key can be so manipulated as to produce swiftly, or slowly moving rings. Two guns should be constructed, as it is necessary in some experiments to connect them in series, and shoot rings towards each other. The guns should be so arranged on handles that it is possible to shoot rings from all angles under the water. When the guns have been adjusted and the tank filled, the experimenter is ready to begin his experiments.

The kinetic energy of these rings is considerable, as shown by several rather interesting experiments. If a light watch chain be suspended in the path of a ring it will be noticeably deflected by the impact of the ring striking it, altho the ring itself is broken. If a piece of light tissue paper is tightly stretched on a frame, and held in the path of the rings, the rings will break thru the paper, but in turn are broken up by the impact. A pretty experiment is to similarly stretch a piece of chiffon cloth and hold it before the gun. *The rings will pass thru it without being broken or disturbed in their motion.*

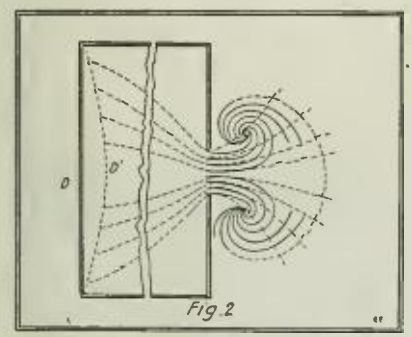
If two guns are placed opposite each other, and rings be projected simultaneously, it will be observed that if they strike each other fairly, both will be broken up. If, however, their path is such that they would merely have touched on their edges, they will bend out of their course and will pass each other without injury. This phenomenon of the mutual repulsion of the rings is in accordance with the modern idea of the electron; namely, that they are like charges of electricity, which repel each other. These vortex rings, of course, are not supposed themselves to have any electric charge, tho acting like an electron; they are simply clever illustrations of *what an electron is supposed to be.*

If a ring is shot towards the surface of the water in the tank, it will be noticed that at certain angles, it is reflected from the surface and *continues in a new path* the same as the angle of incidence. At other angles the ring will not be reflected but will jump out of the water with a spurt. Besides being reflected it can be shown that these vortex rings can be refracted. The tank should be half filled with water, and a dense solution of Sodium Chlorid siphoned into the bottom of the tank, so as to make a layer of denser liquid underneath the water. If a swiftly moving ring be shot so as to pass into the salt solution at an angle it will be noticed that the ring will pursue a slightly downward course, curving slightly.



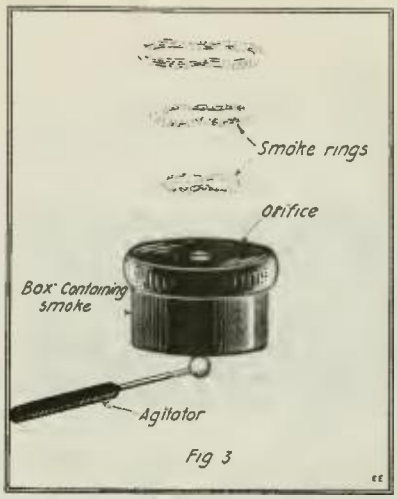
One Way of Making the Liquid "Gun" for Shooting Vortex Rings Thru Water as Shown in the Illustrations On Opposite Page.

There are many more experiments in this line, which space does not permit us to enumerate. We will, however, name a few extremely interesting experiments. The aperture can be cut in all manner of forms, thereby imparting to the ring various vibratory movements, or two holes can be cut near each other, thus projecting two rings at the same moment. Rings can also be shot into a lighter layer of oil, which is poured over the surface of the water, and interesting results may be obtained. If it is desired to procure actual models of the rings, the gun should be filled with melted paraffine, and the ring shot from a layer of hot water into a layer of cold water beneath. *The rings will harden upon coming into the cold water, and may thus be saved.*



The Formation of the Vortex Rings. When the Diafram is Moved from D to D', the Stream Lines of the Liquid Outside the Aperture Will Be Somewhat as is Indicated By the Full Lines. The Liquid Bends Into Spirals, Each Particle Moving Towards the Place Where the Pressure is Diminishing, and the Ring Formed Continues to Rotate Around a Circular Center.

A word as to the formation of the rings by the gun will doubtless be necessary. Referring to Fig. 2 it will be noticed that when the diafram D is moved from D to D' the stream lines of the liquid outside the aperture will be somewhat as is indicated by the full lines. After the liquid has issued from the aperture it would be expected that the liquid would move as the broken lines indicate. Instead it bends into spirals, each particle moving towards the place where the pressure is diminishing, and the ring formed continues to rotate around a circular center.



The Vortex Ring Smoke "Gun." Every Time the Bottom or Diafram of the Box is Struck, a Smoke Ring Issues from the Small Opening in the Top of the Box.

Water is one of the best mediums for producing vortex rings, because it is incompressible. It has, however, a great viscosity, and internal friction, which prevents their being permanently formed. According to the mathematician, in a perfect fluid, such as ether is supposed to be, a vortex ring could never be created, but if once formed could never be destroyed. Thus an electron, if it were an ether vortex ring, as is surmised, would be indestructible. This accords with the theory of matter as accepted today.

TESTING THE QUALITY OF MILK.

By means of two simple tests it is possible to determine with a reasonable degree of accuracy the quality of milk. A qualitative test to show whether the milk contains water or not is made in the following manner. Take a perfectly clean steel hatpin and immerse it point down into the milk. If on withdrawing it a film of milk covers the same, there is no free water present. On the other hand the presence of water in small quantities will prevent the milk adhering to the pin.

Should the above test show the presence of water the percentage of the same can be obtained in the following manner:—Take an ounce of plaster of Paris and wet it with the milk under test till a smooth paste is formed. Allow the paste to dry, determining the length of time that elapses before it hardens. The percentage of water can then be obtained from the following table:

Time	% Water	Time	% Water
20 min.	75	5 hrs.	12½
30 min.	50	6 hrs.	10
1 hr.	40	7 hrs.	7½
2 hrs.	25	8 hrs.	5
3 hrs.	20	9 hrs.	2½
4 hrs.	15	10 hrs.	0

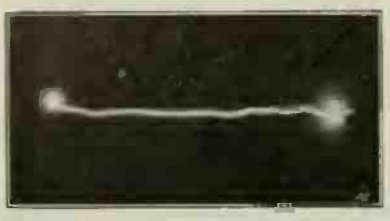
This test depends on the fact that the cream in the milk retards the hardening.

Contributed by T. W. BENJAMIN.

"Ball Lightning" Experiments

By SAMUEL S. WEISIGER, Jr.

IN the January, 1916, issue of the ELECTRICAL EXPERIMENTER you publisht a discourse on "Ball Lightning," and gave instructions for the experimental production of it. Thru the kindness of Mr. Porter, Instructor in Physics at the



This Is Another "Freak" Discharge. The Ball Travelled In a Very Crooked Path to the Positive Electrode, and Here Exploded. The Force of the Explosion Was So Great that a Part of the Spark-Ball Was Thrown to the Other Side of the Positive Electrode, from Whence it Continued to the Positive Electrode.

Allegheny High School, I have been able to make the several photos accompanying this letter. Under each photo there is given a short description of the circumstances under which each discharge was made and the phenomena connected therewith.

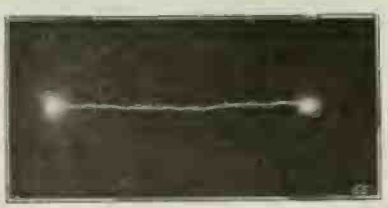
In making these photos a 75,000 volt Toepler-Holtz static machine was used. The distance between the sharp metal points was from 5.5 to 6 centimeters. This distance must be found by experiment, and altho it is absolutely essential to have the correct distance between points, it will nevertheless differ with the capacity of the static machine.

Much trouble will be encountered if the sharp points, used to produce the discharge, are not free from grease and highly polished. The best way to polish the points is to take a little powdered chalk (blackboard chalk which has been scraped to a fine powder with a knife) and put it on some kind of cloth and turn the point of the electrode, at the same time giving considerable pressure to the cloth where the point is being turned.

The best connection for the electrodes was found to be obtained by means of two brass chains.

Two large-sized, sharply pointed darning needles suitably mounted form admirable electrodes. It is practically impossible to use blunt needles.

There will be much trouble in finding the correct spacing for the electrodes and it will probably require some experimentation. In any case the spacing is dependent on the power of the static machine.



Some Trouble Was Encountered In Getting this Spark-Ball to Form. Evidence of This Is Shown By the Plate Being Exposed By a Tiny Charge Or Burst of Light On One Side of the Negative Electrode. The Uneven Course of the Spark-Ball Is Clearly Defined.

When the plate is put under the electrodes be sure to get the emulsion side up, as the discharge occurs better when the plate is placed in this manner.

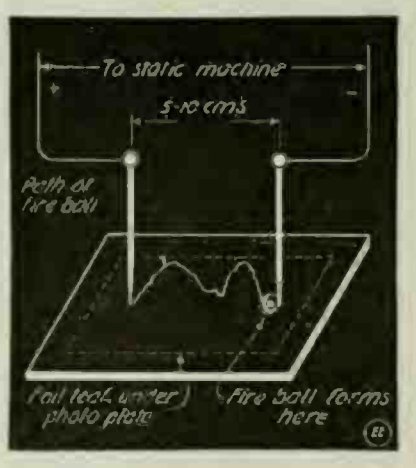
When the plate is under the electrodes and the static machine has been started, the spark ball should form very quickly. After the ball has detached itself from the electrode, turn the machine very slowly in order to expose the plate longer. The rate of travel of the spark ball is proportional to the speed of the static machine.

Should the machine be stopt before the spark ball reaches the other electrode, the plate will only show the path of the ball to that point.

* * * *

Knowing that there is considerable interest in these "Ball Lightning" experiments we have republisht below the original directions for producing ball lightning in the laboratory as outlined by the famous French scientist—M. Stéphane Leduc. His experiment makes possible the production of a slowly moving globular spark not easily obtainable in any other way, in so far as we know.

To produce this imitation ball lightning it is necessary to employ two very fine highly polished metallic points, each of which is in connection with the positive and negative poles, respectively, of a static machine of small or medium size. These

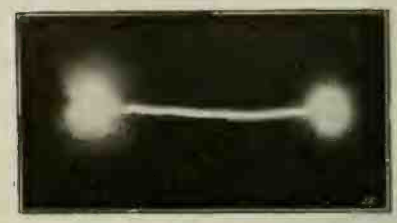


Scheme for Producing Ball Lightning In the Laboratory with Static Machine, Photograph Plate and Two Needles.

two metallic points must rest perpendicularly, as our illustration indicates, on the sensitive face of a gelatin bromid of silver photographic plate, which is placed on a metallic leaf, such as tinfoil. The two metal points are spaced about five to ten centimeters apart. When the static machine is operated an effluvium is produced around the positive point, while at the negative point there is formed a luminous *fireball* or *globule*.

Now, when this globule has reached a sufficient size, it will be seen to detach itself from the metallic point, which then ceases to be luminous, and the globule will begin to move forward slowly over the surface of the plate, taking various curved paths and eventually it will set off in a direction toward the positive metal point. When it reaches this electrode the effluvium is extinguisht and all luminous phenomena ceases. Further, the static machine acts as if its two poles were short-circuited, or, in other words, united by a conductor.

The velocity acquired by the luminous globule as it travels is quite slight, it taking from one to four minutes for it to traverse a path of six centimeters in some cases, and before reaching the positive electrode the globe bursts into two or more luminous balls which individually continue



This Is Probably the Best Photo of the Set, the Spark-Ball Being the Largest Obtained. You Will Notice the Manner In Which the Ball Broke Into Two Parts and Each Part Proceeded to the Pole. The Effluvium Around the Positive Pole Shows Signs of a Violent Explosion As Will Be Noted By Closely Examining the Tree Formation Made By the Bursting Spark-Ball.

their journey to the positive electrode. On developing the photographic plate (which, of course, should be placed under a ruby light while the foregoing experiment is conducted) there will be found a trace on it of the exact route followed by the spark globule—the point of explosion, the routes resulting from the division, and the effluvium around the positive electrode point. Also, if one should stop the experiment before the globule's arrival at the positive electrode, the photograph will only give the route to that point. The fireball takes for its course the conductor, which apparently short-circuits the static machine. If sulfur or some other powder is thrown on the photographic plate while the experiment is being conducted, and also while the ball is moving, its path will be marked by a line of aigrettes, looking very much like a luminous rosary.

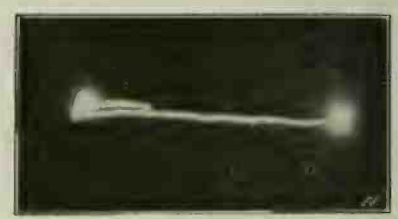
[*The Editors will be glad to hear from any of our readers who have made experiments in this direction. Photographs are particularly welcome.*—ED.]

HORSE-POWER OF WIND MILLS.

Below is given a table showing the actual useful horse-power developed by a windmill working under different conditions.

HORSE-POWER OF WINDMILLS

Diam. of Wheel in Feet	Velocity of Wind, Miles per hour: 8	10	12	16	20	25	30
	Actual useful Horse-Power Developed						
12	0	⅛	¼	½	1	1⅔	2
16	⅛	⅜	¾	1½	2¼	3½	4
20	¾	1¼	2	3	4	5½	7
25	1¼	1¾	3	4½	6	8	10
30	2	3	4	5½	7	9	12



This Is One of the "Freak" Ball Lightning Discharges. The Spark Ball Formed At the Negative Electrode and Travelled Straight for the Positive Pole, But Did Not Reach It. It Disappeared Without Exploding. The Machine Was Kept Going and for Some Unknown Reason Another Ball Formed and Backed Away from the Negative Electrode, and Broke Into Two Pieces Before It Reached The Positive Electrode.

A Useful Electrical Laboratory Switch-board

By H. DANNER

A SWITCH-BOARD is a valuable accessory to any Experimenter's electrical laboratory. The switch-board here described is intended for use on an *alternating current* circuit of 110 volts, 60 cycles frequency. But if the switch-board is to be used on a *direct current* circuit the only changes necessary are the substitution of D. C. instruments and the removal of the low voltage transformer.

The marble or slate panel is 3 ft. 10 in. long, 2 ft. 6 in. wide and 1 or 1¼ in. thick. It is supported by two angle iron uprights, 2 x 2 inches, and 6 ft. 4 in. long, plus four inches which is bent back as a foot as illustrated in Fig. 4. To make this bend saw off one side of the angle four inches from the end and after heating it red bend at right angles by putting it in a vise. Use a hammer to make a square bend. The panel is fastened to the angle irons by six ⅜ inch bolts as shown in Fig. 1. The weight of the marble or slate is supported by a piece of angle iron across the bottom of the switch-board fastened as shown in Fig. 5 (a bolt can be used instead of a rivet). The top of the board is braced to a wall by means of a flat piece of iron bent on one end to permit it being bolted to the wall.

A marble drill should be used in drilling the marble, but an ordinary drill will serve the purpose. Water will help to drill either marble or slate.

We are now ready for the instruments and switches. The voltmeter is preferably a Weston model 151, 0—150 volt scale range. The ammeter is the same model, 0—150 amperes scale range. Both instruments are 9½ inches in diameter. All connections are made at the back, conforming to standard switch-board practise.

The main line cut-out is of 100 amperes capacity and is located between the instruments. The main line switch, 100 amperes, connects the bus-bars to the line. The ammeter is connected in series with the switch (see Fig. 1). The volt-meter is connected to a small, double-pole, double-throw knife switch, one side of which is connected across the main bus-bars and the other side across the step-down transformer outlet.

The upper set of (copper) bus-bars are ⅝" x ⅛" x 24" and are spaced two inches apart. The bars leading from the main line switch to the second set of bus-bars are of the same size. The lower or second set of bus-bars are ½" x 3/64 x 24".

The bus-bars are fastened by No. 8—32 copper or brass machine screws (⅛" in diameter). All connections must be well made. The bars are insulated by bending them up and over the other bars. The switches are connected to the bus-bars by short pieces of copper bars.

The upper row of switches consist of two 60 amp. D.P.S.T. switches placed in the center and two 30 amp. D.P.S.T. switches on each side. All the switches have fuse clips attached of proper capacity.

The four switches in the lower row are 15 amp. D.P.S.T. switches.

Below this row are placed three plug receptacles, two *polarized* and the other unpolarized, located as shown in the drawing. A double-pole double-throw 15 ampere switch is placed in the middle with a small charging rheostat on the right. This switch connects the storage battery to the motor-generator and to the discharge outlet. The plug receptacle on the right is connected directly to the motor-generator and affords a source of direct current. The one to the left of the switch is connected to the storage battery and is of use in many experiments. The plug on the left side is connected to the step-down transformer.

The service to which the individual switches are put depends upon the needs of the experimenter. The two 60-amp. switches are intended for the arc, electric furnace, or for a 5 K.W. step-up transformer and other apparatus requiring over 30 amperes. The switch for the arc is connected to the stage plug at the bottom of the switch-board. A variable resistance is connected in series with the stage plug.

The first switch on the left-hand side, second row, connects the primary of the step-down transformer to the line. The next switch to the right is for a high voltage transformer. Then comes the hand wheel or knob of a small field rheostat for the motor-generator. The field rheostat is mounted behind the board in such a position as not to interfere with the other apparatus. To the right of this comes the motor-generator switch, and on the right is the switch for the lights.

The transformer slide at the lower left-hand side consists of a ¼" square brass rod 14¼" long. Over this rod a ¼" square hollow tube, 1 inch long is fitted, with a handle and spring contact large enough to cover only one contact point at a time. The contacts can be made from ⅜" round brass rod and fastened and connected in the same manner as starting box contacts. Use your judgment in all of this work. There

(*Continued on page 753*)

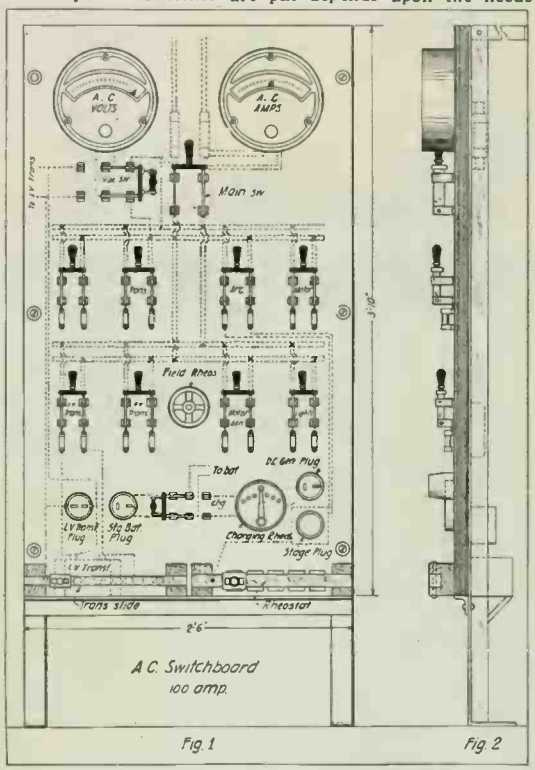
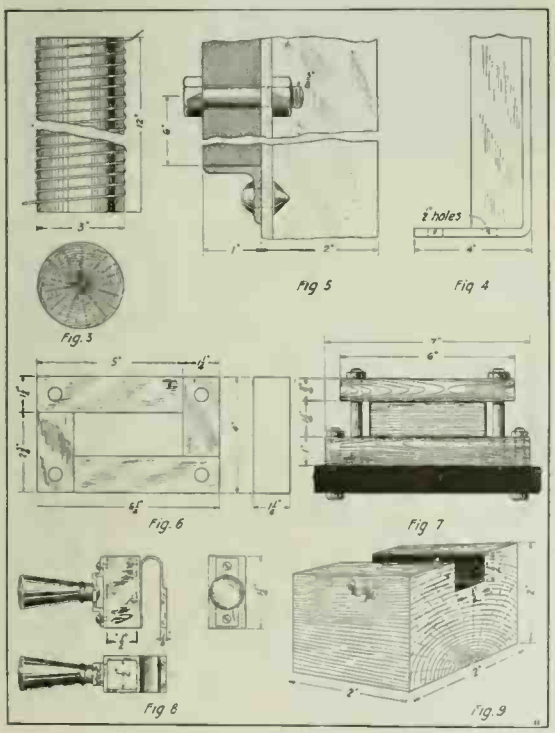


Fig. 1 Fig. 2

The Experimenter Desiring an Attractive and Efficient Switch-Board Will Find the Design Here Suggested an Excellent One. It Is Fitted with A. C. Low Voltage Transformer and D. C. Battery Charging Rheostat, as Well as Volt and Ammeter.



Details of Transformer, Sliding Switch, Switch-Board Support and Other Parts Used in Building the Laboratory Switch-Board.

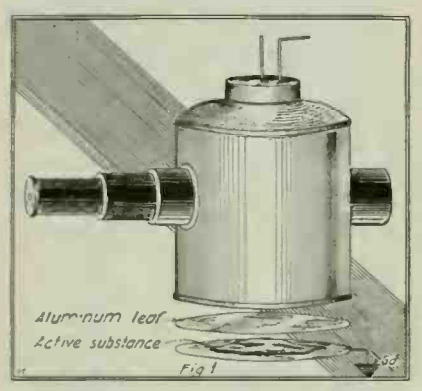
Experiments in Radio-Activity

By IVAN CRAWFORD

PART II—Ionization (Continued)

IN the first installment the construction of a super-sensitive electroscope was outlined, and the conduction of electricity thru gases partially discust.

Before going further into the mysteries of radio-active phenomena it is fitting that further experiments with this electroscope should be given. Another method



Home-Made Telescope-Electroscope For Use In Studying the Retardation of Alpha Particles By Aluminum.

for the detection of *ions* will also be given.

The retardation which an alpha particle experiences in its course thru matter, depends entirely upon the atomic weight of the atoms thru which it passes. Bragg and Kleeman found that the retardation of the alpha particle was approximately proportional to the square root of the atomic weight of the substance. In the case of metals, their weight per unit area, required to completely overcome the alpha radiation, is proportional to the square root of their atomic weight.

It was found that the retardation of the alpha particle by complex molecules was an *additive* property. For, consider that a molecule is composed of N number of atoms of atomic weight W, together with N^1 number of atoms of atomic weight W^1, etc. Then the retardation of the alpha particle is $N\sqrt{W} + N_1\sqrt{W^1} \ldots$.

Sir Ernest Rutherford has determined the specific retardation of alpha rays in metals both by observation and calculation. A few of his results with the commoner metals are given below: s is the observed stopping power of the atoms in terms of air as unity; w is the atomic weight. It will be noticed that the quotient $s/\sqrt{w}$ is approximately equal in all cases.

Metals.	Al.	Fe.	Cu.	Pb.
s	1.495	2.29	2.46	4.27
$\sqrt{w}$	5.2	7.48	7.96	14.35
$s/\sqrt{w} \times 10^3$	287	307	309	298

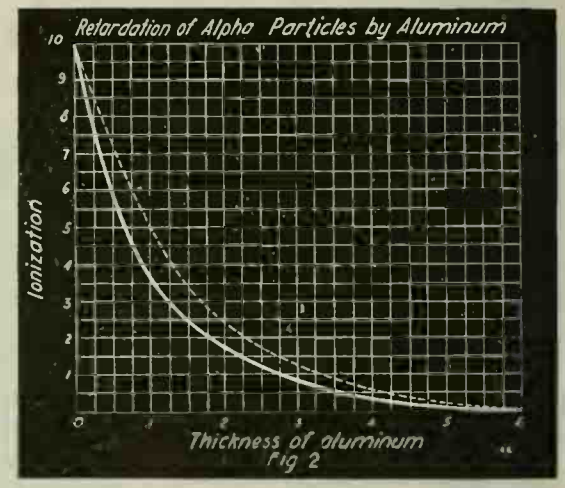
By a series of simple experiments the reader may determine the retardation of alpha particles by thin sheets of the commoner metals. On a grounded metal disc a quantity of radium bromid is placed. See Fig. 1. Thin sheets of aluminum, brass, copper, iron and lead should then be interposed between this active material and the electroscope. The discharging current should then be measured as outlined in the previous paper. The sheets of the various metals should be of the same thickness to allow comparison. It will be noticed that the experimental results will compare very favorably with the calculated values.

A very interesting experiment is to interpose successively various thicknesses of aluminum between the radium bromid and the electroscope. With the electroscope empty the gold leaf past over five divisions on the scale in 412 seconds. The time with uncovered radium bromid was 15 seconds. Upon placing a sheet of extremely thin aluminum leaf over the ionizing agent the electroscope discharged in 25 sec., showing that a portion of the alpha radiation was stopt by the aluminum leaf. When a sheet of aluminum foil about .001 of an inch thick was interposed, the electroscope was discharged in 137 sec. A sheet of aluminum .01 of an inch thick cuts off the entire radiation, and the ionization caused by beta particles, which easily penetrate this obstacle, is very small, discharging the electroscope in about 380 sec. A sheet of lead cuts off the entire radiation, the electroscope discharging the same as when empty.

To determine the retardation of alpha particles by aluminum the following experiment may be performed. The radium bromid is covered by successive layers of aluminum leaf and the discharging current measured in each instance. For radium the ionization falls off in geometrical progression as the thickness of the aluminum is increased. Thus, as Makower has shown, where I_0 is the intensity of the active substances uncovered, then I is the intensity when a thickness of aluminum, t, is interposed.

$$I = I_0 e^{-\lambda t}$$

Where e is the base of the Naperian logarithms and λ is an absorption constant which has a different value for each substance. It is proportional to s in the preceeding table. This law holds true for homogeneous radiations, but when using ordinary radium bromid as an ionizer, four sets of rays are given off, each having a different penetrating power. Until the thickness of the aluminum is great enough to cut off one set of rays the law given above will hold true. The author has found that about 6 thicknesses of aluminum are sufficient to cut off the first set of radiations. In the accompanying graph Fig. 2, the full line indicates the successive stopping powers up to 6 thicknesses of aluminum leaf for radium as determined by Rutherford. These results were obtained by the author and experiments by the reader should be proportional to these.



Graphic Chart Showing the Effect of Different Thicknesses of Aluminum In the Retardation of Alpha Particles.

That the radiations given off by radio-active materials ionize the air into positively and negatively charged carriers can be readily proven by the following experiment: Connect a spark gap with an induction coil and with a vacuum tube as indicated in Fig. 3. A large Geissler tube will give excellent results, the larger the better. The spark gap should be capable of fine and delicate adjustment. The coil must not give too strong a discharge, but the discharge must be very steady. Arrange matters so that the coil gives a steady discharge at the spark gap and then draw the electrodes apart until the discharge just passes thru the vacuum tube, only an occasional spark crossing the gap. A small quantity of radium bromid is then brought into the vicinity of the spark gap. When this is done the Geissler tube will be partially dimmed and the discharge will pass by way of the spark gap. The greater the amount of radium bromid used the more the tube will be dimmed. This is caused by the ions formed by the radiations from the active radium bromid. If care is taken that the conditions named above are secured the experiment will always be successful.

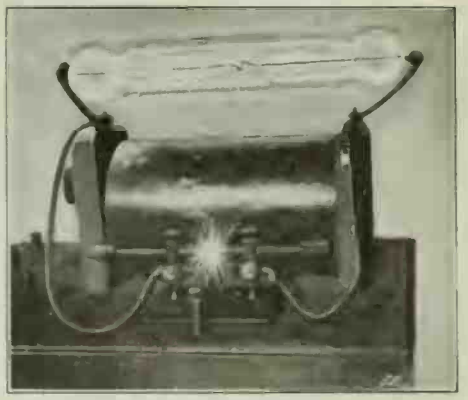


Fig. 3.—A Very Interesting Experiment Can Be Conducted With a Geissler Tube and Spark Gap, Excited By a Spark Coil, In Connection With Some Radium Bromid. The Radium Will Dim the Tube, the Spark In the Gap Becoming Heavier.

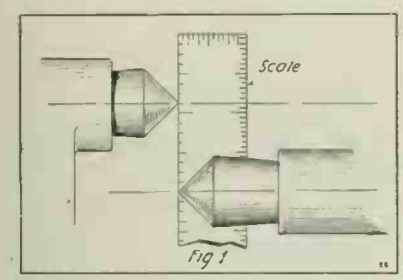
(To be continued)

Experimental Mechanics

By SAMUEL D. COHEN

LESSON X

ANOTHER valuable feature that the lathe possesses is the cutting of tapers. Standard tapers are rated at the amount with which the diameter changes in a foot's length. We will take as an instance the standard Brown and Sharp taper, which is one-half inch per foot, and how it is turned in the lathe.



Measuring Off the Required Distance Between the "Live" and Tail-Stock Centers, Preparatory to Turning a Taper in the Lathe.

First, it can be turned by the use of a taper attachment on the saddle of the machine, or else by offsetting the tail-stock from its regular central position to give the required rate of change in the diameter. In all taper attachments the settings are graduated to read direct. Thus it is easy to set the tool for cutting the prescribed taper. The second method of offsetting the tail-stock is not as simple as the first. If the distance of the center points enter the work, or the mandrel is ignored, the mandrel length can be considered as the distance between the central points. In order to determine at what length the centers shall be offset for a given taper, a simple arithmetical calculation will be required. This is done by multiplying the length of the work or mandrel in feet by one-half the required taper in inches. To turn a Brown and Sharp taper on a piece of work nine inches long, the problem would work out in the following manner. This particular calculation refers to the one-half inch taper per foot specified in the opening paragraph of this lesson:

$$\frac{\frac{1}{2}}{2} \times \frac{9}{12} = 0.1875 = \frac{3}{16} \text{ inch.}$$

The value of 3/16 inch would be the required amount necessary to offset the center of the tail-stock. The off-centering is accomplisht by unscrewing the set screw on the base of the tail-stock and shifting it towards the cutting tool 3/16 inches away from its original center-line position. Fig. 1 illustrates the simplicity of accurately figuring the exact position of the respective centers by the use of a steel scale or rule.

It will be noticed that in the above illustrative problem that both the length and amount of taper are given. However, at times it happens that the amount of taper is not given. Let us suppose that a piece eight inches in length is to be turned on one end. The taper portion should be four inches in length. The difference in diameters of this four inch section is to be one-half inch. The problem is, how much must the tail-stock be offset? If the taper is ½ in 4 inches, it would be 1½ inches in a foot or three times as great. and the tail-stock would be moved over one-half of 1½ inches or ¾ inch. This calculation holds good were the piece a foot long, but as it is 8 inches. or ⅔ of a foot, the tail-stock should be moved over ⅔ x ¾, or ½ inch. Should the piece be twenty inches long, the tail-stock would be moved 1⅔ x ¾, or 1¼ inches.

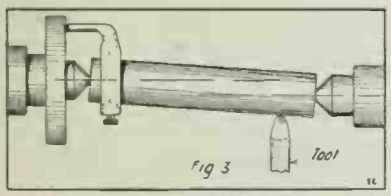
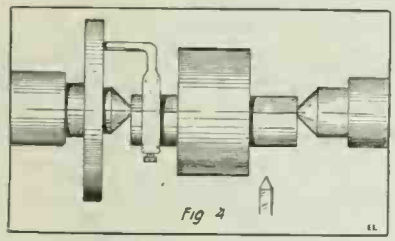


Diagram Showing Plainly How a Piece of Stock Is Placed Between Off-Set Lathe Centers When It Is To Be Turned On a Taper.

The above problem was assumed for simple calculation, the lathe centers merely touching the ends of the working piece, thus making the length of the piece the same as the distance between the centers. In actual practise the depth of the centers in the work must be considered. The calculation should be as accurate as possible to avoid continually changing the tail-stock in order to get a reasonably good taper fit. The necessity of considering the exact distance between centers depends somewhat upon its length. If the piece is very long the actual taper will differ considerably from the calculated taper. If each center enters the piece ¼ inch they would enter a total of ½ inch. The length of the piece should thus be reduced by ½ inch in the calculation. While turning the taper, the calipers should be used frequently so that it may quickly be determined whether or not the tail-stock is correctly placed for the job in hand.

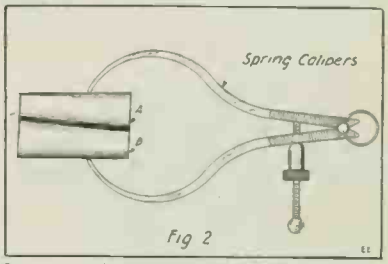


Eccentric Discs For Steam Engines and the Like Are Bothersome Jobs To Turn. This Diagram Shows How An Eccentric Is Readily Centered On An Arbor Having Off-Set Centers.

In order to test the accuracy of the taper as it is turned it should be prest lightly into a standard tapered hole and worked back and forth sufficiently to mark the places where bearings points occur. If the work has been lightly covered with some marking pigment (chalk), the bearing points will be more distinct. However care must be taken that the coating is not too heavy, as it will be liable to deceive the amateur. Adjust the taper setting until a correct fit is obtained.

Another very good method of testing the exactness of the taper is to obtain another taper mandrel or form of standard size, having the same taper pitch. and placing its surface against the one cut, as shown in Fig. 2, where either A or B can be the *standard*. Then set a pair of calipers on one side, and run over the entire surface with the same setting of the calipers. If no indication is shown of surface irregularity the taper is said to be true; if high or low marks are present, the taper is not true and a readjustment of the tail-stock setting is necessary to correct it.

In turning down a taper the centers must be employed. This work must be turned down with the aid of the face plate and dog shown in Fig. 3, which illustrates the position of offset work for taper cutting. A lathe chuck cannot be used for this class of work, as the piece to be turned down is kept rigidly in place in a central position, thus preventing its position from being offset. The chuck is used only when a taper attachment is employed. It should never be used otherwise. At times in cutting a very short taper or conical point and when a compound rest is at hand the compound rest is turned to an angle equal to the angle of the taper to be cut. However it is advisable to adhere to the simple method of cutting a taper and as soon as the novice feels quite safe with this method he will then be at liberty to try those more difficult.

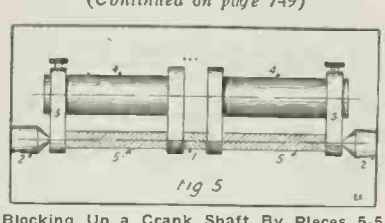


One Method of Testing the Accuracy of a Tapered Piece By Placing It Alongside a Standard Taper, and Running the Calipers Over Them.

The experimenter who is mostly familiar with the use of the lathe for turning concentric objects will now see that the lathe is just as useful in turning objects of eccentric shape. The most common of such objects is the eccentric which operates the valves of a steam engine. If the work has a hole thru it, as in the above example, the hole is first finished to the required dimensions and then a mandrel is used for carrying the work on the lathe centers. While the mandrel has been built on one set of centers exactly true with its axis, for concentric turning, it has a second set of centers which offset the amount required for the eccentricity specified. In the case of eccentrics made solid with the shaft, there are two sets of centers, one for turning the shaft—and the other for stabilizing the opposite end of the shaft. Fig. 4 shows how such an eccentric is arranged in the lathe for proper turning. Note the position of the central axis of the object with respect to the *live* and *dead* centers of the lathe. At certain times the specified eccentricity is too extreme to allow both pairs of centers coming within the limits of the diameter of the shaft. Special ends may be cast, forged (or clamped) on the ends of the work, and can afterward be machined off. In crank-shaft turning, special attachments should be provided for the ends of the shaft, or special chucks for eccentric turning may be made to hold the work.

The turning of crank pins on shafts is

(*Continued on page 749*)



Blocking Up a Crank Shaft By Pieces 5-5, and Clamps 3-3, So As To Make It Rigid While the Bearing 1 Is Being Machined In the Lathe.

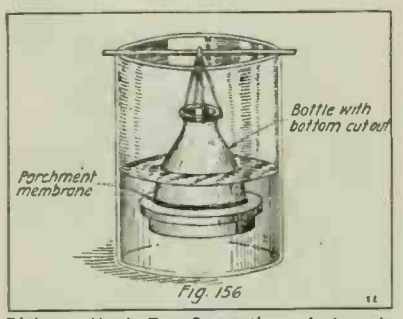
Experimental Chemistry

By ALBERT W. WILSDON

Thirty-third Lesson

ARSENIC: History.

THE ores of Arsenic, in the form of its two sulfids, *Realgar* and *Orpiment*, were known to the Alchemists. Geber was familiar with the oxid, and Mangus refers to the metal; but Brandt, in 1773, first showed that white arsenic was obtained by burning the metal.



Dialyzer Used For Separation of Arsenic Prior to Applying the "Marsh" or Other Test For the Element.

Occurrence.

This metal is quite widely distributed in nature, while in the free state it is occasionally found in distinct crystals. It is more abundantly distributed in the combined stated, as *Arsenolite* [As_2O_3], or the sulfids, as *Orpiment* [As_2S_3], and *Realgar* [As_2S_2], or in the form of the metallic arsenids. *Arsenical iron* [$FeAs_2$], and *Arsenopyrit* [FeAsS]. It is also found in reducing ores of Nickel, Cobalt, etc., being obtained as a by-product of *Cobalt Glance* [CoAsS] and *Nickel Glance* [NiAsS].

Preparation.

Metallic arsenic is prepared by subliming the native mineral or by reducing arsenous oxid with charcoal:

$$As_2O_3 + 3C = 2As + 3CO.$$

Probably the largest quantity is prepared by subliming arsenical pyrits:

$$2FeAsS = 2As + 2FeS.$$

In the first process above mentioned, the arsenical pyrits are oxidized by roasting, that is, heating with access of air. This gives the oxids of the three elements, Fe_2O_3, As_2O_3, SO_2. The first remains behind in the retort, SO_2 escapes as a gas, and As_2O_3 sublimes. It may be purified by resubliming. The metallic arsenic is obtained by reducing the oxid with charcoal.

$$As_2O_3 + 3C = 3CO + 2As.$$
$$2As_2O_3 + 3C = 3CO_2 + 4As.$$

Some Arsenic can be obtained by excluding air and heating FeAsS.

$$FeAsS = FeS + As.$$

Properties.

Arsenic appears usually in the form of a steel-gray, brittle, crystalline mass, of metallic luster.

It is a good conductor of electricity.

It is easily volatile, then possessing a garlic odor.

It hardens lead when alloyed with it; hence its use in shot manufacture.

When roasted in air, it forms As_2O_3. When air is past over it in a hot combustion tube, it burns with a blue flame.

It has great attraction for chlorin, burning in it like antimony, to form the chlorid, $AsCl_3$.

Like its salts it is poisonous when taken into the stomach.

At a temperature higher than 180°C., it unites directly with most elements.

It unites with metals to form arsenids, analogous with the sulfids.

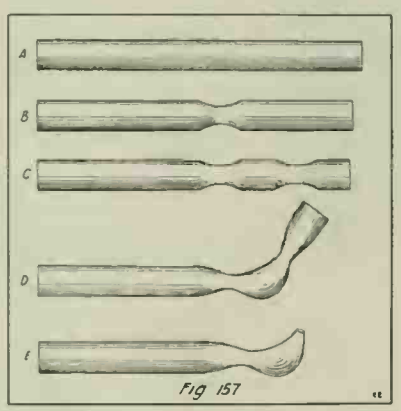
Oxids.

Two oxids are known Arsenious Oxid (As_4O_6) [usually written As_2O_3 and called arsenic trioxid, Arsenious Acid, Arsenic, White Arsenic, etc.], and Arsenic Oxid [As_2O_5]. The former only is important, being the most important commercial compound of the element. From this other compounds of the metal are formed. It is a white substance, sometimes amorphous and sometimes crystalline, which resembles flour when pulverized. It dissolves very slightly in cold water, upon which its particles seem to have a repellent action, but on boiling for a long time more dissolves. The best solvents are Hydrochloric Acid and Alkalies. With Hydrochloric acid it forms:

$$As_2O_3 + 6HCl = 2AsCl_3 + 3H_2O.$$

Salts.

There are two classes of salts, the *—ate* and the *—ite*, of which Sodium Arseniat [Na_3ASO_4] and Sodium Arsenit [Na_3AsO_3] are examples. In the former, the valence of Arsenic is 5, in the latter 3. The *—ite* salts are more frequently met with. The



Successive Stages In Preparing a "Marsh Tube."

Sulfid [As_2S_3] is a permanent and brilliant yellow pigment made by passing Hydrogen sulfid gas into a solution of an *—ite* salt. Scheele's Green [$HCuAsO_3$] and Schweinfurt or Emerald Green [$Cu(AsO_2)_2.CuAsO_3C_2H_3O_2$] both go under the name of "Paris Green," and are much used as pigments, especially for green window blinds, shipping tags, silks, etc.; also extensively employed by farmers to exterminate the potato beetle. Wall papers at one time almost always contained Arsenic, but now—owing to better substitutes and legislative prohibition—they rarely contain it. Scheele's Green is made by adding a solution of copper salt, as $CuCl_2$, to an arsenious salt solution, as HNa_2AsO_3. If these are nearly neutral, a precipitat of $HCuAsO_3$ is obtained, but if strongly acidified with Hydrochloric acid or alkalized with NH_4OH, no precepitat falls, which is the same as saying that Scheele's Green is soluble in either of the reagents. Fowler's Solution —used in medicine—is Potassium Arsenit.

Tests.

There are Four important tests, *Marsh's, Reinsch's, the Carbon,* and the *Hydrogen Sulfid*. Besides these there are *The Modified Gutzeit Test, Bettendorff's,* etc.

MARSH'S TEST.—This is the most delicate and interesting, and consists in first forming Arsin [AsH_3], then decomposing it and subliming the arsenic. Any soluble arsenical compound in presence of nascent hydrogen forms Arsin, which is readily decomposed by heat, when the arsenic sublimes. By this process a quantity far too small for the most delicate balance, can be detected,—in fact a mere trace of the element.

Explanation.—Suppose the compound to have the composition AsX_3, in which X is any nonmetallic monad. Hydrochloric acid gives this reaction:

$$AsX_3 + 3HCl = AsCl_3 + 3HX.$$

Nascent Hydrogen decomposes $AsCl_3$ and combines with both elements.

$$AsCl_3 + 6H = AsH_3 + 3HCl$$

The Arsin passes out and is burned together with the excess of hydrogen.

$$2AsH_3 + 6O = As_2O_3 + 3H_2O.$$

A Bunsen flame decomposes the Arsin.

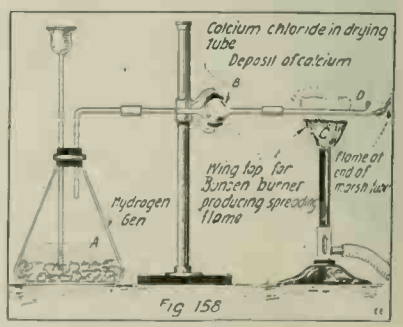
$$AsH_3 = As + 3H.$$

when the metal sublimes in the capillary tube. The question arises whether any other element than arsenic would act in a similar way. Antimony acts almost exactly like it, forming gaseous and combustible Stibin [SbH_3], which likewise decomposes and sublimes as a metallic mirror. Several tests serve to distinguish the sublimed Arsenic from Antimony, the best being the solubility of Arsenic in Sodium Hypochlorit [NaClO] and the insolubility of Antimony. The quantity of Arsenic can be determined by comparing the depth of shading of the deposit with that of tubes containing a known quantity.

REINSCH'S TEST.—This consists of depositing Arsenic on copper, then oxidizing the Arsenic and subliming the As_2O_3 formed.

The compounds of Arsenic will first change to $AsCl_3$ by Hydrochloric acid. The copper in the heated acid will withdraw the arsenic and deposit it, leaving copper chlorid in solution. Heat will vaporize the arsenic, which at the same time will combine with the oxygen in the tube to form As_2O_3, and this in turn will sublime as a white solid on the cold sides of the tube. Identification is then made by examination under a microscope, when a portion of it

(*Continued on page 750*)



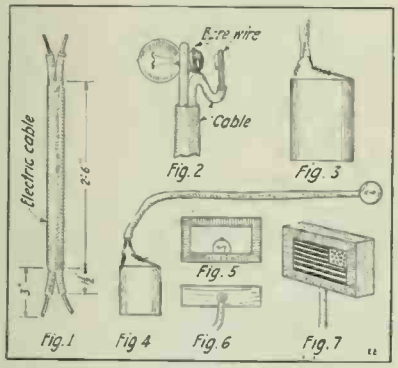
Apparatus Utilized For Performing Marsh's Test For Arsenic.

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

AN ELECTRIC FLAG FOR THE LAPEL.

The materials necessary for this are: 3 feet of electric cable, a flashlight bulb, a flashlight battery, a small U. S. (or



An Electric Lapel Flag Which Anyone Can Make from a Piece of Twin Cord, a Pocket Flashlight, and a Small Paper Flag.

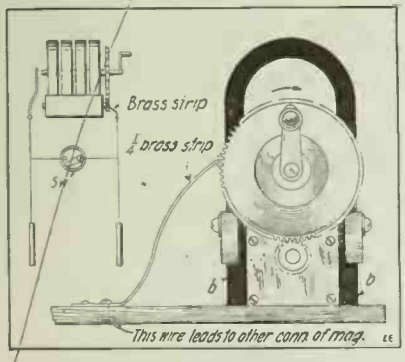
service flag) paper flag and some cardboard. Fix the cable as shown in Fig. 1, and then bend both wires on each end, as shown in Figs. 2 and 3. Make a cardboard box an inch larger each way than the flag and ¾-inch thick. On the front cut out an oblong opening ⅛-inch smaller all around than the flag. Paste the flag over this.

Contributed by FRANCIS V. SLAGT.

INTENSIFYING THE SHOCK FROM MAGNETOS.

Most people are aware that the "mag" out of an old-fashioned telephone makes a fine "shocker." My "rig" will increase its shocking capacity tremendously, as all who try it will be fain to believe.

Cut a piece of thin brass of suitable size to rest against the driving wheel when it (the brass) is secured to the base. No



The Addition of a Simple Spring Greatly Intensifies the Strength of Shock Obtainable from a Magneto.

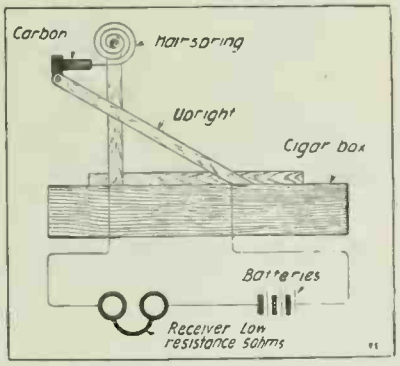
dimensions are given as the mageto-ringers vary in size.

Contributed by L. G. S. TROREY.

SECOND PRIZE, $2.00

THIS MICROPHONE MAKES AUDIBLE THE FLY'S FOOT-STEP.

This microphone, when properly constructed, is capable of making audible the footfall of a fly, the drawing of a thread across the instrument, the slightest touch on the table on which it is placed, the blowing of one's breath upon it, etc., etc. To construct this instrument first take a cigar box and remove the lid. Next hunt up a discarded alarm clock and remove the hair-spring. Secure a piece of wood, 4"x1½" upon which to fasten the uprights, and a piece of copper sheeting or any other suitable metal for the uprights. Connect these as in the diagram. From an old flashlight battery obtain the necessary carbon. Fasten the hair spring onto one upright, and the carbon to the other, first hollowing out a



A Supersensitive Microphone Made from a Cigar Box, a Piece of Carbon, and a Low Resistance Telephone Receiver.

place in the end of the carbon to receive the end of the hair spring; about 3/16 to ⅛ inch deep is sufficient. The right pressure of the spring upon the carbon must be obtained before the instrument will transmit properly. The spring must touch the carbon at all times. Connect up a battery (dry cell) and a low resistance (5 ohm) receiver, ascertain the correct pressure, and the microphone is complete.

Test it by gently touching the cigar box; a whirring noise will be heard if everything is all right. Blow gently upon it; it again whirrs. If placed in the open it will indicate when the wind is blowing, and by the amount of noise, the velocity can be judged. Under certain conditions, it will transmit speech, whistling, and so forth.

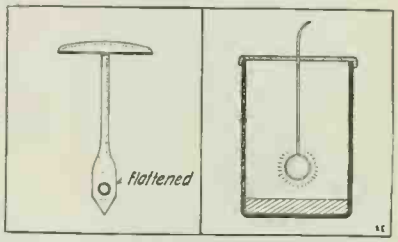
Contributed by FRED C. DAVIS.

THIRD PRIZE, $1.00

CONTACT POINT FROM UPHOLSTERY NAIL.

An ordinary upholstery nail is flattened with a hammer and a hole punched thru it with a set punch, as shown in sketch. The hole serves to thread and hold the wires. This is a cheap and practical contact point.

Contributed by BERT O'LEARY.



At Left—Contact Point Made from Upholstery Nail. At Right—The Platinum Ring That Becomes Red Hot in the Presence of Alcohol.

WHAT MAKES THE PLATINUM RING HOT?

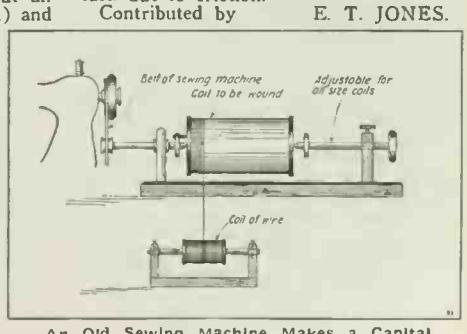
If a platinum ring (or even a piece of platinum wire) is warmed gently for a few moments and then suspended in a glass, having a small amount of alcohol in the bottom, the platinum will become red hot. The glass had best be covered with a piece of pasteboard having a hole in the center. The phenomena may be explained by the fact that platinum has the peculiar property of causing certain gases to condense on its surface. The condensation of alcohol fumes is so rapid as to cause the platinum to become incandescent.

Contributed by S. S. GARRETT.

SEWING MACHINE MAGNET WINDER.

Herewith is illustrated a wire-winding machine which is easily constructed. Most all wire winding machines are turned by hand, but by using this scheme you can both wind faster and easier. The pulley of the machine is brought against the belt of the sewing machine and the same is caused to turn due to friction.

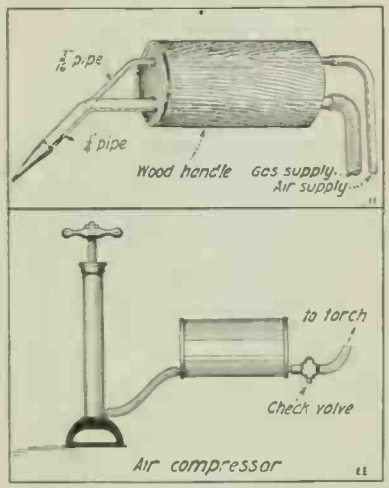
Contributed by E. T. JONES.



An Old Sewing Machine Makes a Capital Magnet Winder.

A HOME-MADE GAS TORCH.

As I needed a gas torch I set about to make one. I first procured two pipes, one



To Make This Gas Blow Torch You Will Require a Bicycle or Other Small Pump, a 1 to 5 Gallon Can, and Two Lengths of Rubber Tubing to Lead the Gas and Compress Air to the Torch Handle.

3/16 and one ¾ inch in diameter and about 8 inches long. I then drilled a hole in the quarter inch pipe and bent it as shown in drawing and set the other pipe into it. The handle is of oak with the edges rounded and two holes drilled thru it to fit each pipe. The air and gas supply come thru rubber hoses. A very good air compressor is made out of a bicycle pump and a one gallon can; the gas may be taken from the gas service pipes or from a carbid generator.

Contributed by HERBERT PEHRSON.

HINTS ON DRILLING GLASS.

Drilling glass is a difficult proposition and very few amateurs possess tools suitable for this purpose. The following apparatus will drill holes, varying in size from the smallest up to an inch or more.

First procure a brass tube the outside diameter of which measures the same size as the desired hole. Revolve this on the surface of the glass, either by hand or better by means of a small hand drill. The drilling must be started by allowing the lower end of the tube to be guided by a wooden block, with a hole cut in it the size of the tube. After the tube has past thru the glazing this guide can be removed. An excellent abrasive for this drill is emery dust and turpentine. It is an excellent idea to drill from both sides, since this results in a clean, smooth hole.

Contributed by PAUL G. EDWARDS.

COINS FOR WEIGHTS.

In an emergency, ordinary coins can be used as weights. The weights given in the following table are near enough for all the usual purposes.

Dime weighs	40 grains
Cent weighs	50 grains
Nickel weighs	80 grains
One-quarter Dollar weighs	100 grains
One-half Dollar weighs..	200 grains
One Dollar weighs.....	400 grains

By simple addition and subtraction a great many different weights can be made with these coins. For instance, to obtain a weight of 20 grains, place a nickel on one side of the scales and a quarter on the other, and then add enough of the chemical to balance it.

Contributed by HUGO J. ENGEL.

A RELIABLE HYDROGEN SULFID GENERATOR.

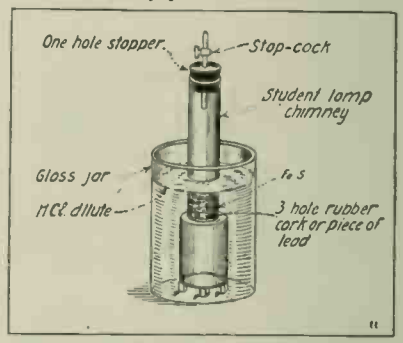
Herewith is a plan and description of a simple and cheap hydrogen sulfid generator.

This hydrogen sulfid generator has given very satisfactory service to the author. It can also be used for generating hydrogen, carbon dioxid, etc.

The necessary parts are:

1. Student lamp chimney.
2. Glass or porcelain jar (a large fruit jar will do).
3. Glass stop cock.
4. Rubber stoppers, three hole and one hole.
5. Iron sulfid (FeS).
6. Hydrochloric acid (HCl).

Contributed by JOHN R. BUXTON.



A Simple Yet Reliable Hydrogen Sulfid Generator Made From a Few Odd Pieces of Apparatus to Be Found About the Laboratory.

THE PREPARATION AND USE OF BLUE-PRINT PAPER.

The following describes the manufacture of blue-print paper in terms that can be easily understood by any one. No difficulty should be experienced in either the making or the use of the paper.

In order that the best results be obtained it is necessary that good material be used. All vessels in which the solution is made should be kept clean and when not in use should have water in them as far as possible. Do not use soap when washing the trays, as the least trace will do harm to the solution.

Where ordinary work is to be done, any kind of well sized paper will answer, if tough enough to be washed. Different grades of unsensitized papers can be bought at engineers and photo supply houses.

The following formula is for a good solution that will give excellent results to the amateur; this solution is made up of two salts, dissolved in water and applied to the surface of the paper:

Solution No. 1.

Ferrocyanid of potassium.... 1 oz.
Pure or distilled water..... 6 oz.

Solution No. 2.

Ammoniocitrat of iron..... 1 oz.
Pure or distilled water..... 6 oz.

When solutions are to be used mix equal parts of 1 and 2 and filter thru cotton or filter paper. This solution we will call No. 3.

The solutions should be applied to the paper in a dark and dry room with a very subdued light—just enough to barely see by.

Small sheets of the paper may be best covered by floating upon the surface of No. 3. This is done by taking a sheet by two diagonal corners and laying it gently on the surface of the solution. This method does away with the possibility of air bubbles forming.

One minute or less will be sufficient for sensitizing. Remove the paper by drawing over the edge of the tray to remove any surplus liquid. Take care to prevent any solution from getting on the back of the paper.

Large pieces are best sensitized by tacking down upon a smooth table with thumb tacks and painting the solution on with a wide camel's hair brush. Take care to get it on quickly and evenly. Dry the paper by hanging up by its corners to a wire so that it will swing free. Before sensitizing a batch of paper it would be best to make a trial sheet and print it. The solution may not be mixed properly or the paper may be too absorbent, in which case the solution will go into the paper and will not come out when washing, thus causing the print to fade in a short time.

After the paper has dried hard and without the slightest trace of dampness it should be rolled up and put into an airtight (tin or cardboard) tube and kept in a dark and dry place.

Printing is the exposing of the sensitized paper to the action of a powerful light with the copy to be printed placed over the paper. The direct rays of the sun are best for printing, but the electric arc is nearly as quick and has the advantage of being always constant—regardless of weather.

The drawing, tracing or negative is placed in the frame next to the glass with the paper under it, having its sensitive side up. Exposure will vary from two to ten minutes, according to the light and tracing. The correct time is only found by experience.

After the paper is sufficiently exposed, it is taken from the frame and immersed in a bath of clean running water. A print should be washed for not less than fifteen minutes or it will fade when placed in the light.

Excellent prints may be made in the following manner: Slightly expose the print so that when it is washed the white lines are not clear but appear bluish. Take the print out of the bath and lay it on a table and sponge it with a solution made up of one pound of bichromat of potash and two gallons of water. The lines will come out pure white and the background an intense blue. Wash print thoroly and dry.

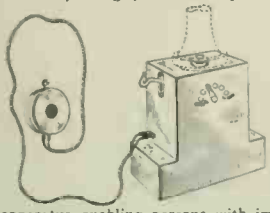
White lines may be added to blue prints by the use of a solution made of soda and water to which a small quantity of prepared chalk has been added to thicken it. This solution may be applied with a ruling pen. Engineers generally use a white, red or yellow pencil for making corrections.

Contributed by RUSSEL MERRELL.

Telephone Amplifier.

(No. 1,280,556; issued to Louis Scher.)

A telephone amplifier providing a loud-speaking portable telephonic

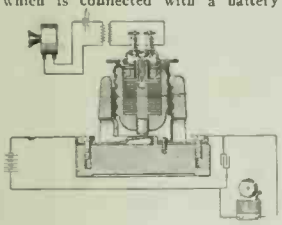


apparatus enabling persons with impaired hearing to satisfactorily use the ordinary telephone. The usual Bell telephone receiver is placed on top of the cabinet in which there is an opening communicating with a dictaphone transmitter. The transmitter in turn is connected from a rheostat and battery as well as switch-hook to a low resistance, loud-speaking telephone receiver.

Signaling Apparatus.

(No. 1,280,705; issued to Fulton Gardner.)

An ingenious signaling apparatus comprising an electromagnet in a receptacle, together with a coherer form of armature, the whole arrangement operating an alarm bell when actuated by voice or other sound waves. It is intended for bank vault protection and the like. The sound waves impinge on the microphone which is connected with a battery

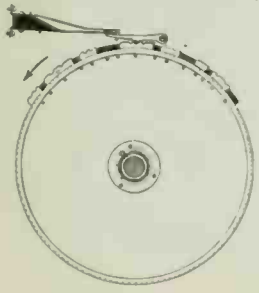


and primary of an induction coil. The secondary of this induction coil connects with the electromagnet of the relay shown in cross-section. This electromagnet acts on an iron filing armature, causing the filings to cohere, and thereby closing the bell signal circuit. A condenser is shunted across the bell in order to provide a more steady current by virtue of its charging and discharging action.

Telegraph Transmitter.

(No. 1,280,566; issued to John J. Sherry and John L. DuFrane.)

A clever mechanical arrangement comprising an automatic machine for sending out dots and dashes, either on a telegraph or radio circuit, by means of which one unskilled in the art or unfamiliar with the code may send a distress message from a ship, etc. The device should prove a fine auxiliary in all ship radio rooms, especially in case of fire, etc., as the transmitter could keep the radio ap-

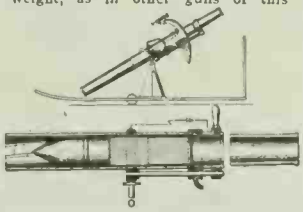


paratus sending out distress calls with location and name of ship, even tho the operator had to abandon the wireless room. There is provided a circular disk with a groove around its perifery, and in this groove there can be placed various telegraph character slugs and spaces. Thus the notched slugs corresponding to dots and dashes actuate a pawl member, opening and closing electric contacts in the manner apparent.

Non-Recoil Gun.

(No. 1,280,576; issued to Andrew J. Stone and William Shuker.)

A novel form of non-recoil gun intended for use on aircraft, etc., in which the recoil of the shell charge is minimized by the discharge from the gun of an "inertia mass," in a direction opposite to that in which the main projectile is shot. The inertia mass in this design is a small affair, and the reduction in its weight, as in other guns of this

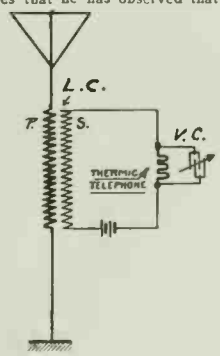


type, is made up for by the increased friction encountered by the mass, owing to the reduced bore of the barrel thru which it is simultaneously discharged with the main projectile. The inertia shell may be a copper disc or cup. The charge of explosive is fired by an electrical primer as shown, or by other means. The design of the gun is so computed that the inertia due to the heavy weight of the effective projectile plus the light frictional resistance of the projectile in the gun barrel, shall equal the inertia effects of the lighter weight of the disc plus the heavier frictional resistance of the said disc in the barrel.

Thermic Radio Detector and Telephone.

(No. 1,281,742; issued to Hendrik Zwaardemaker.)

This novel invention comprises a new form of thermic telephone and detector combined, and is suitable for use in wireless telegraphy and telephony. Prof. Zwaardemaker states that he has observed that the

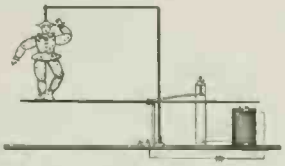


sensitiveness of the thermic telephone, serving simultaneously as detector, can be considerably increased when it works with polarization, i. e., by pre-heating it by means of a constant current such as that supplied by a battery as shown in the diagram. The battery may have a tension of two to four volts, and for increasing the sound, a variable and tunable condenser is connected in parallel to the thermic telephone element.

Dancing Toy.

(No. 1,280,307; issued to Harry Rust.)

This is an interesting electric toy and comprises a jointed doll or other figure suspended at the top in the manner shown. Underneath the fig-

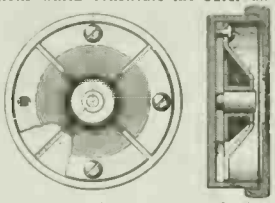


ure there is a spring platform, one end of which is provided with an electric contact, and also an electromagnet to attract it. The action is as follows: When the switch is closed, the magnet attracts one end of the spring armature, but immediately the circuit is broken and it flies back. These rapid vibrations of the spring over the magnet, transmit similar impulses to the opposite end of the armature which forms the tread under the figure, and which results in many curious and grotesque steps being evolved for the amusement of the children.

Novel Telephone Receiver.

(No. 1,283,304; issued to Thomas Rhodus.)

The receiver as shown is of the monocoil type, and the central iron core is secured to a flat base plate. In the improvement here shown, this base plate is formed with radial slits in its marginal portion to provide a series of integrally connected sectors corresponding in number with the series of independent sections which constitute the outer an-

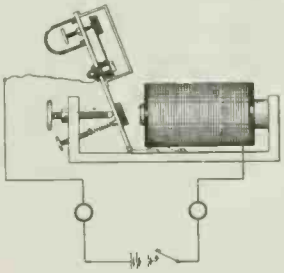


nular pole-piece. This pole-piece comprises a series of radially disposed iron sections. The resistance of the coil is 75 ohms for telephonic work.

Electromechanical Interrupter.

(No. 1,282,388; issued to François de Cannart d'Hamale.)

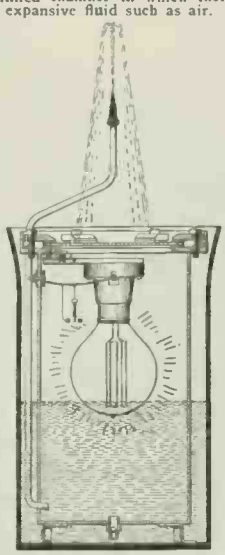
A unique electromechanical interrupter wherein the circuit is made and broken, not by virtue of an electromagnet acting on an armature and pulling it away from a stationary contact screw, but by means of a weighted auxiliary spring placed in a hermetically sealed compartment and acting by inertia. The weight supported at the top of the contact spring tends to keep on moving when the armature itself is suddenly stopt by striking against the magnet core, thus providing a very sudden break, which is highly desirable for operating induction coils.



Electric Lamp Fountain.

(No. 1,280,784; issued to Matt Luckiesh.)

An electric lamp fountain operated by the heat radiated from an incandescent lamp placed in a confined chamber in which there is an expansive fluid such as air. The

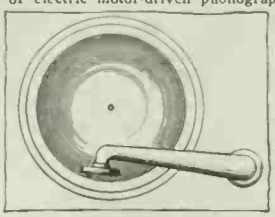


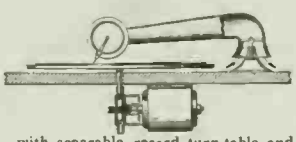
inventor mentions that a 150-watt lamp has worked the apparatus. The liquid sprayed out thru the small capillary tube falls back into a second chamber, thru which the water can reach the inner chamber again thru a check valve. A thermostat may be used to make and break the circuit intermittently when desired. The cover of the fountain may be of glass and colored when preferred for the purpose of transmitting upwardly thru the fountain spray a portion of the light from the lamp.

Electric Phonograph.

(No. 1,281,282; issued to Hans Brockmüller.)

The idea is to provide a simple form of electric motor-driven phonograph





with separable record turn-table and tone arm, so that for economical and other reasons it is not necessary to have a large special cabinet about the house. Any table can be quickly converted into a first-class phonograph by this scheme, the motor and a vertically driven shaft being secured underneath the table. The turn-table has a shaft which passes thru a hole in the top of the table, so as to engage the driving shaft frictionally. The tone arm has a special suction foot which does not require any screws, and the sound emanates around this foot.

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 prize each month for the best photo. Address the Editor, "With the Amateurs" Dept.

"Amateur Electrical Laboratory" Contest

THIS MONTH'S $3.00 PRIZE WINNERS—F. L. BROOKS and W. P. CECIL

THE accompanying photos are views of our Electro Chemical Laboratory and Radio Station (which is now closed). We have quite a number of electrical apparatus such as Oudin and Tesla coils, motors, spark coils, 12 volt storage battery, Leyden jars, electrolytic-interrupter Einthoven galvanometer—which was described in the ELECTRICAL EXPERIMENTER several months ago, 50 watt step-down transformer, also 200 watt transformer located behind switch-board and controlled by a five point switch, ammeter and voltmeter also on switch board, arc spot light which will throw a beam of light over a mile, small step-up transformer, condenser and spark gap. Our Chemical "Lab" consists of about 85 chemicals and about 15 pieces of apparatus such as test tubes, Florence flasks, delivery tubes, hydrometer and other apparatus for carrying on experiments on a small scale. Last of all comes our work bench where everything has its beginning. We have a vise, gasoline blow torch, pliers, screw-drivers, twist drills and numerous other accessories. We also have a good supply of binding posts, screws, magnet wire, copper, brass and all such junk as is found in a red-headed bug's "Lab" like my pal's, not saying anything of myself.—FLOYD L. BROOKS and WM. P. CECIL, Ardmore, Oklahoma.

HONORABLE MENTION (1 Year's Subscription to the "ELECTRICAL EXPERIMENTER") T. C. QUAYLE

MY Chemical "Lab" consists of over 150 chemicals and reagents, also apparatus such as pipettes, burettes, retorts, test tubes, thistle tubes, delivery tubes, crucibles, casseroles, condensers, a Centigrade-Fahrenheit thermometer, chemists' scales, and many other pieces of laboratory glassware and apparatus, with which I carry on many interesting experiments in quantitative, qualitative and spectrum analysis. I also have gas, a Bunsen burner and a spigot for water in the "Lab". I have over 100 pieces of apparatus in my electrical "Lab", and have made a storage battery as described in the 1917 (Nov.) issue, also an arc searchlight, experimental arc furnace, magnetless buzzer, selenium cell (Bidwell type), Wheatstone bridge, electroscope, electrophorus, (sensitive) coherer, electrolytic rectifier and interrupter, Leyden jars, and many other pieces of apparatus described in the ELECTRICAL EXPERIMENTER. I also have an Oudin coil which is operated by an E. I. Co. half kilowatt coil and a rotary spark gap of my own design, also 110 volt and battery motors, hand generator, hot wire ammeter, small storage cell, switches, fuse blocks, Geissler tubes, etc.

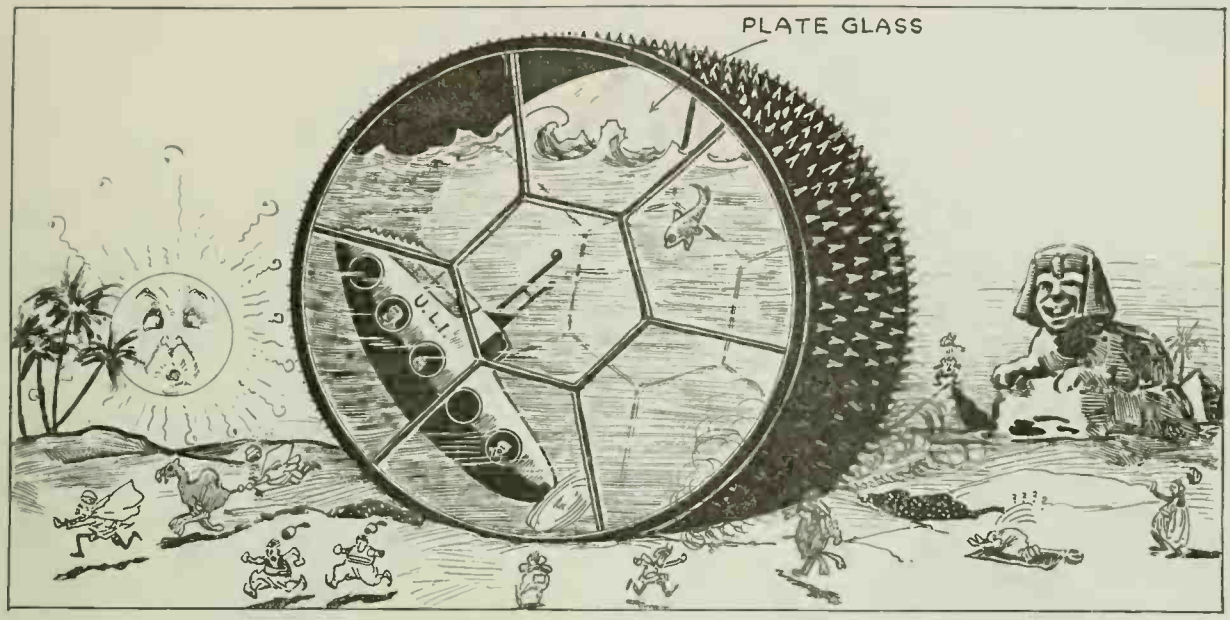
My work-shop is complete in tools for both wood and metal working and here is where I made the articles described in the "E. E." I have drills for both wood and metal, braces, chisels, files, saws, wrenches, planes, pincers, levels, two sets of taps and dies, one for small rods, the other for pipes; also an emery wheel and bench lathe, which I designed and built.—THOMAS C. QUAYLE, Berkeley, Cal.

Phoney Patents

Under this heading are publisht electrical or mechanical ideas which our clever inventors, for reasons best known to themselves, have as yet not patented. We furthermore call attention to our celebrated Phoney Patent Offizz for the relief of all suffering daffy inventors in this country as well as for the entire universe.

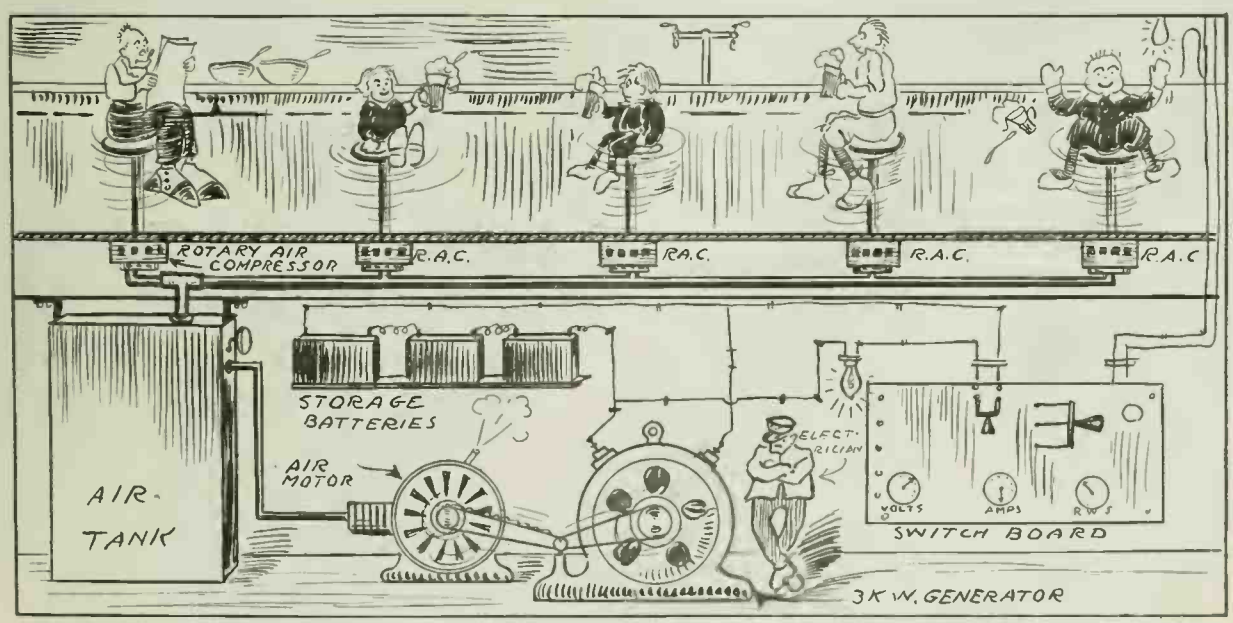
We are revolutionizing the Patent business and OFFER YOU THREE DOLLARS ($3.00) FOR THE BEST PATENT. If you take your Phoney Patent to Washington, they charge you $20.00 for the initial fee and then you haven't a smell of a Patent yet. After they have allowed the Patent, you must pay another $20.00 as a final fee. That's $40.00! WE PAY YOU $3.00 and grant you a Phoney Patent in the bargain, so you save $43.00!! When sending in your Phoney Patent application, be sure that it is as daffy as a lovesick bat. The daffier, the better. Simple sketches and short descriptions will help our staff of Phoney Patent Examiners to issue a Phoney Patent on your invention in a jiffy.

HUN U BOAT UTILIZER

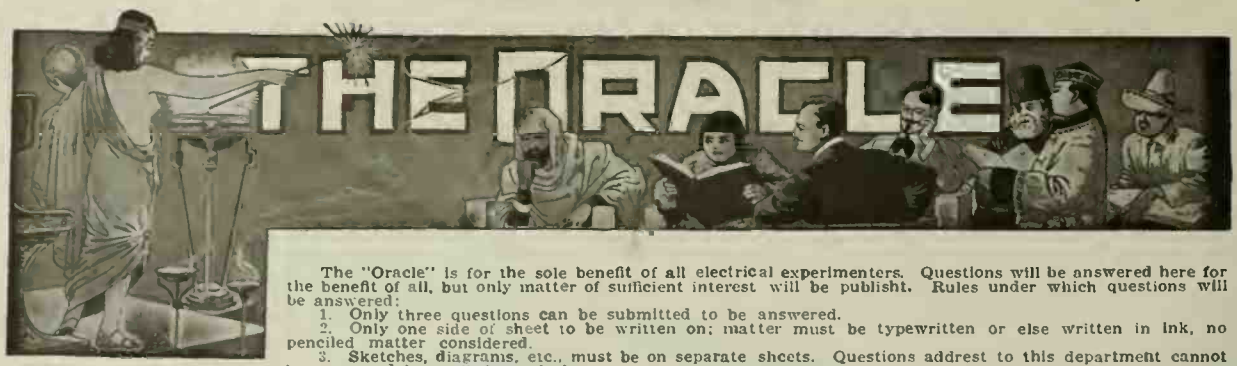


Prize Winner: HUN U-BOAT UTILIZER. Particularly Adapted for Traffic Over Deserts. Take One Gyro Electric Destroyer a la Gernsback, Knock Out All Machinery, Axles, etc., and Mount Plate Glass 16-Inches Thick in Framework Covering Both Sides. Make Waterproof and Fill Cruiser with Pure Prohibition Liquid; Also one Hun Submarine. Weight of Submarine Pressing Against Sides, as Shown, Navigates Cruiser at Rate of 25 Knots an Hour with a Fair Zephyr Breeze Nor' by West. Inventor, Jose Matz, 300 Baker St., San Francisco, Cal.

I'SCREAM GENERATOR



I'SCREAM PARLOR GENERATOR. In Order to Save Tremendous Energy Now Going to Waste In All Ice-Cream Parlors, Due to Rotating Seats, My New Patent Provides Extending Shaft to the Rotating Seat, Which Shaft Operates Rotary Air Compressor. This Control Operates Air Tank, Air Motor, Dynamo, etc. The Great Advantage to this Scheme Is That the Device Works Better the More Ice-Cream You Eat Because of the Added Momentum. Separate Patent Application Provides to Charge Customers an Extra Nickel for Allowing Them to Spin Around. Hoover says Economize, Hence no Free Rides. Inventor, Garrett W. Lewis, Yuba City, Cal.



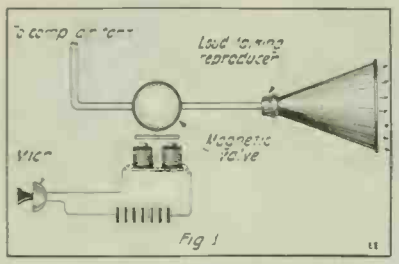
The "Oracle" is for the sole benefit of all electrical experimenters. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be publisht. Rules under which questions will be answered:

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

HURLING THE VOICE ONE MILE.

(979) W. J. M. asks:

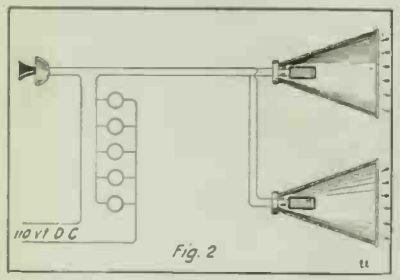
Q. 1. Is there any practical way of enormously amplifying the human voice so that same can be distinctly heard for a radius of, say, a mile, the atmosphere being comparatively free of other disturbances at the time?



Comprest Air Loud Talker Such As Used On Phonographs, and Susceptible of Development For Hurling Voice Waves a Distance of One Mile.

I understand that there are telephone transmitters now made for handling heavy currents of electricity. It occurs to me that possibly the above could be accomplisht by using such a transmitter in connection with a mammoth receiver and a suitable horn.

A. 1. One of the leading phonograph companies have developed a very clever and powerful form of comprest air amplifier which we believe might be worked up on a sufficiently large scale to answer your requirements. In this system a low power aural or electrical voice signal is caused to act, by means of a relay or other appropriate device, on an extremely sensitive valve, which permits successive puffs of comprest air from a tank or bellows to pass out thru a large amplifying horn and reproducer. We also believe that the de Forest amplifier might solve your problem, as one model is capable of amplifying 1,000,000 (one million) times. Also their Mr. C. V. Logwood has stated that he believes that your problem of amplifying the human voice so that it could be heard for a radius of one mile can be solved by modern engineering design. He states that by means of microphones suitably connected to a large *Oscillion* bulb that he has actually heard the human voice at a distance of one-half mile in California.



This Diagram Shows the Microphone Circuit For a 110 Volt D. C. Loud Talker, Having a Bank of 110 Volt Lamps in Series With the Reproducers.

The Alexanderson G. E. Co. magnetic amplifier should be of service to you in this connection. This clever and highly efficient magnetic amplifier was described in detail in the April, 1916, issue of the *Proceedings of the Institute of Radio Engineers.*

Several companies manufacture straight electro-magnetic systems of amplifying the voice, which systems are operated from 110 volt circuits. We can supply names of these concerns on receipt of stamped envelope.

Relative to these systems, the Oracle Editor would say that he has heard the loud talkers put out by one of these concerns throw the voice a distance of from 800 to 1,000 feet. The horns used are not over 2 feet long in this system, but the makers utilize special electro-magnetic reproducers which are connected in parallel when two or more are used, and these in turn are connected in series with a special microphone capable of operating on 110 volts D. C. and a bank of incandescent lamps.

ARTICLES SCHEDULED FOR MARCH "E. E."

"My Inventions"—No. 2 of a series by Dr. Nikola Tesla. Written exclusively for the ELECTRICAL EXPERIMENTER.

"A Wonderful New Electric Machine that Sorts Tobacco Leaves by Size," by George Holmes.

"How Powerful Electric Gyros Stabilize Ocean Ships"—Illustrated with excellent photos—by J. W. Harvath.

"Multiplex Telephony and Telegraphy and How It is Done," written by a Telephone Engineer.

"Exploring Polar Regions and the North Pole by Airplane."

"Locating Ore Bodies Underground by Electricity—A New Method."

A New Talking Motion Picture Invention.

"How Jimmy Saved the Bank"—A cracker-jack electrical story, by F. W. Russel.

"Experiments in Radio-Activity—Part III," by Ivan Crawford.

A Wavemeter and Decremeter Design for Radio Students, Operators and Inspectors. With data on Inductances, condensers, etc., by H. Winfield Secor, Assoc. I. R. E.

Practical Electra-plating, by Joseph Haas.

"Efficient Radio Transmitting," by Donald H. Hassell.

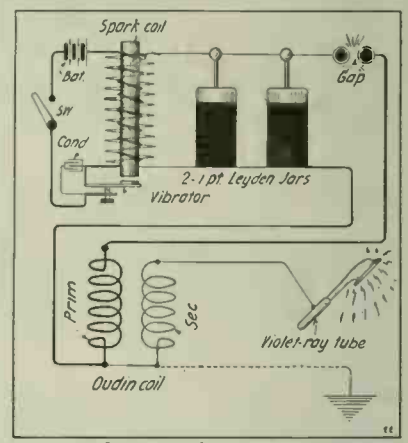
"Experiments With Ultra-Violet Light, for Amateurs," by J. C. Morris, Jr.

OUDIN COIL CONNECTION.

(980) Forrest A. Miller, Shelbyville, Kentucky, writes:

Q. 1. Asking several questions about Oudin and Tesla coils.

A. 1. By means of high frequency Tesla or Oudin currents you can charge the body so as to emit sparks and charge other bodies or persons, etc., and you will find the apparatus and method of doing this completely described in the book you are securing, viz.: "The Experimental Electricity Course"—which contains a special chapter on high frequency currents, with diagrams and full description of the apparatus used.



Hook-Up For Spark Coil, Leyden Jars, Spark Gap, Oudin Coil and High Frequency Electrode For Giving So-Called Violet Ray Treatment.

We can also very highly recommend a book by Transtrom, entitled "Electricity at High Pressures and Frequencies" which our "Book Department" can supply at $2.15 prepaid.

The diagram herewith shows how a spark coil, Leyden jars, spark gap and Oudin type of high frequency coil are properly connected. The ground connection is optional, but usually intensifies the unipolar discharge for electro-therapeutic requirements.

SIX-INCH SPARK COIL DATA.

(981) Marshall M. Wrenn, Baltimore, Md., asks the Oracle:

Q. 1. For data on six-inch spark induction coil.

(*Continued on page 726*)

THE ORACLE.

(*Continued from page 724*)

A. 1. We give you herewith necessary information for constructing a six-inch jump spark coil:

Primary, 220 ft. No. 13 D. C. C. wire.

Secondary, 7 lbs. No. 36 double silk covered wire (or enameled).

Core, 1¼ x 14" soft iron wire (thoroly annealed).

The primary condenser to be connected across the vibrator should comprise 4,500 sq. in. tinfoil, cut in suitable size sheets and interspersed between slightly larger paraffined paper sheets. If an electrolytic interrupter is used on 110 volts A. C. or D. C. then no primary condenser is necessary.

There should be a hard rubber insulating tube between the primary and secondary coils. The dimensions of this tube are 14¾" x 13¾" outside diameter by ¼" wall. The secondary consists of thirty-eight pies, each $^3/_{16}$th" thick, having an outside diameter of 4½". There should be placed between each section six pieces of well-soaked paraffin paper.

An excellent book dealing exclusively on spark coils building can be procured from our "Book Department" for $3.00. The title of this book is "Design and Construction of Induction Coils," by Collins. In this book there is given all the details for the construction of spark coils such as core dimensions, size of wire, length of primaries, etc.

DATA ON WIRELESS POWER TRANSMISSION.

(982) John Verrge, Detroit, Michigan, writes the "Oracle":

Q. 1. The sketch herewith shows my idea on the wireless transmission of power. Where can I find engineering data on the design of such a system? How can I figure the voltage required to transmit a given kilowattage over a certain distance? etc., etc.

A. 1. We have examined your query, together with diagram showing your ideas for the wireless transmission of power to electric railway cars, etc.

We regret to say that there is at the present time no engineering data available for solving the problems you outline, as while Nikola Tesla has successfully lighted lamps and operated motors by the one wire and no-wire wireless system for distances of 15 miles in his famous Colorado experiments, this branch of advanced alternating current engineering has not been made available in text-book form as yet.

You would do well to visit your public library and look up Dr. Tesla's book, entitled "Experiments with Currents of High Potential and Frequency".

PRACTICAL ARMATURE AND MAGNET WINDING, by Horstmann & Tousely. Leather covers, 252 pages, 128 illustrations, size 4½ x 6¾ inches. Price $1.00 in cloth; $1.50 in leather. Publisht by Frederick J. Drake & Co., Chicago.

This is a handbook for the practical electrician, especially those performing shop work and engaged in dynamo and motor repairs. The authors give the principles with special and clearly drawn illustrations of the elements of armature design, armature windings and the mechanical features such as balancing and ventilation of different types of armatures, etc. The section on armature windings is quite complete and gives all necessary information for laying out drum and lap windings, and for different numbers of field poles. The authors then give a discussion on armature troubles and testing for faults in the windings, armature calculations with wire tables, alternating current windings, et cetera. One of the most interesting sections of the work is that on field magnet winding, and of course this applies to magnet windings of any type. The special formulas and tables given greatly facilitate and simplify the calculation of field and other magnet windings, and it is written so clearly that any electrician or student can grasp the simple arithmetic involved after once reading it. An appendix of useful tables is given at the end of the book which will prove of great value in conjunction with the work treated upon.

PRACTICAL FLYING, by Flight Commander W. G. McMinnies, R. N. Cloth covers, 246 pages, profusely illustrated, size 5½ x 8¼ inches. Price $1.50. Publisht by George H. Doran Company, New York, N. Y.

An excellent course on flying instruction which is very ably illustrated by comprehensive sketches in plan and perspective, showing all of the parts of modern battle and scout 'planes, and giving from start to finish all of the necessary elements, including the reading of maps and the determination of location while in the air. This book, contrary to most semi-technical or technical treatises, is one that any aviator or flying enthusiast can read with extreme pleasure and at the same time greatly improve his understanding of the heavier-than-air flying machine. The author has the title of Flight-Commander of the British Royal Navy and knows whereof he speaks.

The chapters are subdivided under departmental heads, so that the book forms a very excellent reference work, as well as a class-room and general reading volume. Flight-Commander McMinnies treats the subject in a very broad way and covers such points as—"which men make good pilots"; in this chapter he evidences a good grasp of the subject of applied psychology. As we pass along thru the elementary studies of the airplane and its component parts, we find the text and drawings so interesting, that it does not tire us at all.

Some very excellent diagrams and drawings are given, showing the various accidents in landing and how they occur, also how all the fancy "stunts" are performed progressively in the air. The sections treating on cross-country flying and the determination of altitude as well as orientation, are clearly written and treated on in a manner following that found most efficient by the Allied fliers on the Western front.

GENERAL LECTURES ON ELECTRICAL ENGINEERING, by Charles Proteus Steinmetz. Cloth covers, 242 pages, 50 illustrations, size 6¼ x 9½ inches. Price $2.50. Publisht by McGraw-Hill Book Company, Inc., New York, N. Y.

This volume contains some of the most interesting lectures given by Dr. Steinmetz, and forms a most valuable work which will find a welcome in the library of every engineer, electrical man and student. Dr. Steinmetz is a speaker and writer of articles which possess great expanse of viewpoint. When he speaks of the incandescent lamp, for instance, in lecture 16 of this series here presented, the reader will be surprised at the wide range of topics he discusses. Practically every important type of lamp and their relative operating efficiencies and characteristics are treated upon in this lecture, even down to the modern gas-filled Mazda tungsten lamp. The several other lectures, of which there are 18 in all, cover such interesting and important subjects as electrochemistry, the alternating current railway motor, electric railways, lightning protection, direct current regulation and control, hunting and synchronous machines, high frequency oscillations, surges and impulses, higher harmonics of the generator wave, long distance transmission, arc lighting, modern power generation, etc., etc.

STANDARD WIRING FOR ELECTRIC LIGHT AND POWER, by H. C. Cushing, Jr. Leather covers, 360 pages, profusely illustrated, size 6¼ x 4¼ inches. Price $1.50. Publisht by H. C. Cushing, Jr., 1918, New York, N. Y.

One of the most widely read and also one of the most clearly written and easily understood works available to electrical men in all branches of the industry. Mr. Cushing's manual has been useful for many years. Each year a new edition is brought out covering the latest changes in the Fire Underwriter's rules. The author follows the Underwriter's rules and describes with the aid of simple formulas, numerous tables, and special illustrations, the exact meaning of the various clauses in the wiring code, so that this book becomes very valuable to electricians, architects, superintendents and engineers. Some of the simplest tables and methods of using them for calculating both light and power distribution wiring ever given are included in this manual, and any electrical man can understand them easily. A number of diagrams of electric motor connections, including series, shunt and compound machines, are given as well as instructions for the proper installation of all such machinery. House wiring receives special attention all the way thru the work, and electrical wiremen will find this manual a most useful and authoritative companion. It settles all wiring disputes.

Famous Scientific Illusions

(*Continued from page 694*)

The earliest trials were made by Dalibrand in France, but Franklin himself was the first to obtain a spark by using a kite, in June, 1752. When these atmospheric discharges manifest themselves today in our wireless station we feel annoyed and wish that they would stop, but to the man who discovered them they brought tears of joy.

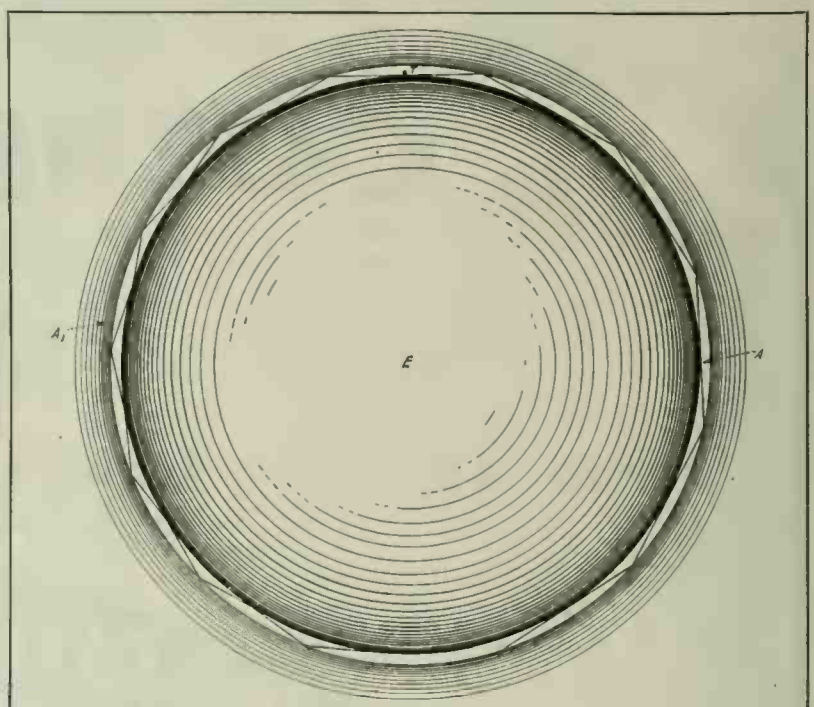


Fig. 7

The Theory Has Been Seriously Advanced and Taught that the Radio Ether Wave Oscillations Pass Around the Earth by Successive Reflections, as Here Shown. The Efficiency of Such a Reflector Cannot be more than 25 Per Cent; the Amount of Energy Recoverable in a 12,000-mile Transmission being but One Hundred and Fifteen Billionth Part of One Watt, with 1,000 Kilowatts at the Transmitter.

The lightning conductor in its classical form was invented by Benjamin Franklin in 1755 and immediately upon its adoption proved a success to a degree. As usual, however, its virtues were often exaggerated. So, for instance, it was seriously claimed that in the city of Piatermaritzburg (capital of Natal, South Africa) no lightning strokes occurred after the pointed rods were installed, altho the storms were as frequent as before. Experience has shown that just the opposite is true. A modern city like New York, presenting innumerable sharp points and projections in good contact with the earth, is struck much more often than equivalent area of land. Statistical records, carefully compiled and publisht from time to time, demonstrate that the danger from lightning to property and life has been reduced to a small percentage by Franklin's invention, but the damage by fire amounts, nevertheless, to several million dollars annually. It is astonishing that this device, which has been in universal use for more than one century and a half, should be found to involve a gross fallacy in design and construction which impairs its usefulness and may even render its employment hazardous under certain conditions.

For explanation of this curious fact I may first refer to Fig. 3, in which s is a metallic sphere of radius r, such as the capacity terminal of a static machine, provided with a sharply pointed pin of length h, as indicated. It is well known that the latter has the property of quickly dissipating the accumulated charge into the air. To examine this action in the light of present knowledge we may liken electric potential to temperature. Imagine that sphere s is heated to T degrees and that the pin or metal bar is a perfect conductor of heat so that its extreme end is at the same temperature T. Then if another sphere of larger radius, r_1, is drawn about the first and the temperature along this boundary is T_1, it is evident that there will be between the end of the bar and its surrounding a difference of temperature $T - T_1$, which will determine the outflow of heat. Obviously, if the adjacent medium was not affected by the hot sphere this temperature difference would be greater and more heat would be given off. Exactly so in the electric system. Let q be the quantity of the charge, then the sphere—and owing to its great conductivity also the pin—will be at the potential $\frac{q}{r}$. The medium around the point of the pin will be at the potential $\frac{q}{r_1} = \frac{q}{r+h}$ and, consequently, the difference $\frac{q}{r} - \frac{q}{r+h} = \frac{qh}{r(r+h)}$. Suppose now that a sphere S of much larger radius $R = nr$ is employed containing a charge Q this difference of potential will be, analogously $\frac{Qh}{R(R+h)}$. According to elementary principles of electro-statics the potentials of the two spheres s and S will be equal if $Q = nq$ in which case $\frac{Qh}{R(R+h)} =$

(*Continued on page 730*)

FAMOUS SCIENTIFIC ILLUSIONS.

(*Continued from page 728*)

$\frac{nqh}{nr(nr+h)} = \frac{qh}{r(nr+h)}$. Thus the difference of potential between the point of the pin and the medium around the same

Fig. 4, Tesla Explains the Fallacy of the Franklin Pointed Lightning Rod, Here Illustrated, and Shows that Usually Such a Rod Could Not Draw Off the Electricity in a Single Cloud in Many Years. The Density of the Dots Indicates the Intensity of the Charges.

will be smaller in the ratio $\frac{r+h}{nr+h}$ when the large sphere is used. In many scientific tests and experiments this important observation has been disregarded with the result of causing serious errors. Its significance is that the behavior of the pointed rod entirely depends on the linear dimensions of the electrified body. Its quality to give off the charge may be entirely lost if the latter is very large. For this reason, all points or projections on the surface of a conductor of such vast dimensions as the earth would be quite ineffective were it not for other influences. These will be elucidated with reference to Fig. 4, in which our artist of the Impressionist school has emphasized Franklin's notion that his rod was drawing electricity from the clouds. If the earth were not surrounded by an atmosphere which is generally oppositely charged it would behave, despite all its irregularities of surface, like a polished sphere. But owing to the electrified masses of air and cloud the distribution is greatly modified. Thus in Fig. 4, the positive charge of the cloud induces in the earth an equivalent *opposite* charge, the density at the surface of the latter diminishing with the cube of the distance from the static center of the cloud. A brush discharge is then formed at the point of the rod and the action Franklin anticipated takes place. In addition, the surrounding air is ionized and rendered conducting and, eventually, a bolt may hit the building or some other object in the vicinity. The virtue of the pointed end to dissipate the charge, which was uppermost in Franklin's mind is, however, infinitesimal. *Careful measurements show that it would take many years before the electricity stored in a single cloud of moderate size would be drawn off or neutralized thru such a lightning conductor.* The grounded rod has the quality of rendering harmless most of the strokes it receives, tho occasionally the charge is diverted with damaging results. But, what is very important to note, it invites danger and hazard on account of the fallacy involved in its design. The sharp point which was thought advantageous and indispensable to its operation, is really a defect detracting considerably from the practical value of the device. I have produced a much improved form of lightning protector characterized by the employment of a terminal of considerable area and large radius of curvature which makes impossible undue density of the charge and ionization of the air.* *These protectors act as quasi-repellents and so far have never been struck tho exposed a long time.* Their safety is experimentally demonstrated to greatly exceed that invented by Franklin. By their use property worth millions of dollars which is now annually lost, can be saved.

III. The Singular Misconception of the Wireless.

To the popular mind this sensational advance conveys the impression of a single invention but in reality it is an art, the successful practise of which involves the employment of a great many discoveries and improvements. I viewed it as such when I undertook to solve wireless problems and it is due to this fact that my insight into its underlying principles was clear from their very inception.

In the course of development of my induction motors it became desirable to operate them at high speeds and for this purpose I constructed alternators of relatively

*Refer to the October, 1918, issue of this journal wherein Dr. Tesla's new form of non-pointed lightning rod was fully described and illustrated.

(*Continued on page 732*)

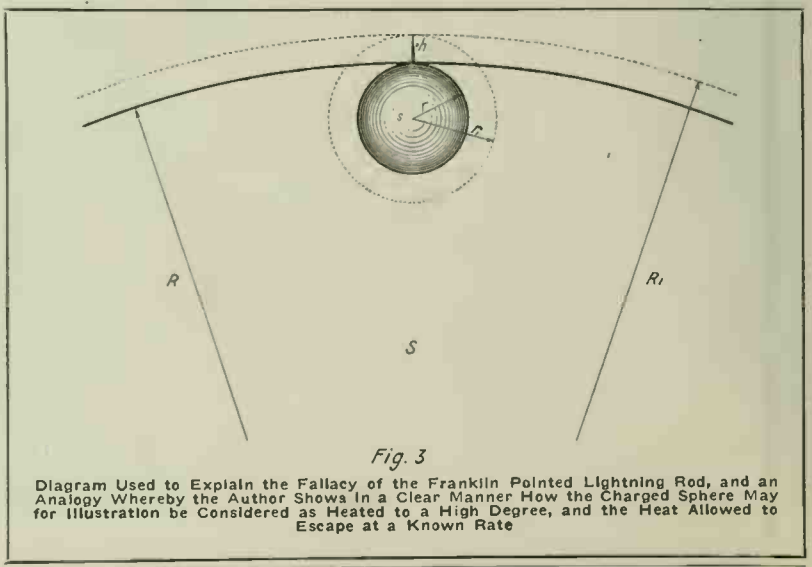


Fig. 3

Diagram Used to Explain the Fallacy of the Franklin Pointed Lightning Rod, and an Analogy Whereby the Author Shows in a Clear Manner How the Charged Sphere May for Illustration be Considered as Heated to a High Degree, and the Heat Allowed to Escape at a Known Rate

FAMOUS SCIENTIFIC ILLUSIONS

(*Continued from page 730*)

high frequencies. The striking behavior of the currents soon captivated my attention and in 1889 I started a systematic investigation of their properties and the possibilities of practical application. The first gratifying result of my efforts in this direction was the transmission of electrical energy thru *one wire* without return, of which I gave demonstrations in my lectures and addresses before several scientific bodies here and abroad in 1891 and 1892. During that period, while working with my oscillation transformers and dynamos of frequencies up to 200,000 cycles per second, the idea gradually took hold of me that the earth might be used in place of the wire, thus dispensing with artificial conductors altogether. The immensity of the globe seemed an unsurmountable obstacle but after a prolonged study of the subject I became satisfied that the undertaking was rational, and in my lectures before the Franklin Institute and National Electric Light Association early in 1893 I gave the outline of the system I had conceived. In the latter part of that year, at the Chicago World's Fair, I had the good fortune of meeting Prof. Helmholtz to whom I explained my plan, illustrating it with experiments. On that occasion I asked the celebrated physicist for an expression of opinion on the feasibility of the scheme. He stated unhesitatingly that it was practicable, provided I could perfect apparatus capable of putting it into effect but this, he anticipated, would be extremely difficult to accomplish.

I resumed the work very much encouraged and from that date to 1896 advanced slowly but steadily, making a number of improvements the chief of which was my system of *concatenated tuned circuits* and method of regulation, now universally adopted. In the summer of 1897 Lord Kelvin happened to pass thru New York and honored me by a visit to my laboratory where I entertained him with demonstrations in support of my wireless theory. He was fairly carried away with what he saw but, nevertheless, condemned my project in emphatic terms, qualifying it as something impossible, "an illusion and a snare." I had expected his approval and was pained and surprised. But the next day he returned and gave me a better opportunity for explanation of the advances I had made and of the true principles underlying the system I had evolved. Suddenly he remarked with evident astonishment: "Then you are not making use of Hertz waves?" "Certainly not," I replied, "*these are radiations.* No energy could be economically transmitted to a distance by any such agency. In my system the process is one of *true conduction* which, theoretically, can be effected at the greatest distance without appreciable loss." I can never forget the magic change that came over the illustrious philosopher the moment he freed himself from that erroneous impression. The skeptic who would not believe was suddenly transformed into the warmest of supporters. He parted from me not only thoroly convinced of the scientific soundness of the idea but strongly exprest his confidence in its success. In my exposition to him I resorted to the following mechanical analogues of my own and the Hertz wave system.

Imagine the earth to be a bag of rubber filled with water, a small quantity of which is periodically forced in and out of the same by means of a reciprocating pump, as illustrated. If the strokes of the latter are effected in intervals of more than one hour and forty-eight minutes, sufficient for the transmission of the impulse thru the whole mass, the entire bag will expand and contract and corresponding movements will be imparted to pressure gauges or movable pistons with the same intensity, irrespective of distance. By working the pump faster, shorter waves will be produced which, on reaching the opposite end of the bag, may be reflected and give rise to stationary nodes and loops, but in any case, the fluid being incompressible, its inclosure perfectly elastic, and the frequency of oscillations not very high, the energy will be economically transmitted and very little power consumed so long as no work is done in the receivers. This is a crude but correct representation of my wireless system in which, however, I resort to various refinements. Thus, for instance, the pump is made part of a resonant system of great inertia, enormously magnifying the force of the imprest impulses. The receiving devices are similarly conditioned and in this manner the amount of energy collected in them vastly increased.

The Hertz wave system is in many respects the very opposite of this. To explain it by analogy, the piston of the pump is assumed to vibrate to and fro at a terrific rate and the orifice thru which the fluid passes in and out of the cylinder is reduced to a small hole. There is scarcely any movement of the fluid and almost the whole work performed results in the production of radiant heat, of which an infinitesimal part is recovered in a remote locality. However incredible, it is true that

the minds of some of the ablest experts have been from the beginning, and still are, obsest by this monstrous idea, and so it comes that the true wireless art, to which I laid the foundation in 1893, has been retarded in its development for twenty years. This is the reason why the "statics" have proved unconquerable, why the wireless shares are of little value and why the Government has been compelled to interfere.

We are living on a planet of well-nigh inconceivable dimensions, surrounded by a layer of insulating air above which is a rarefied and conducting atmosphere (Fig. 5). This is providential, for if all the air were conducting the transmission of electrical energy thru the natural media would be impossible. My early experiments have shown that currents of high frequency and great tension readily pass thru an atmosphere but moderately rarefied, so that the insulating stratum is reduced to a small thickness as will be evident by inspection of Fig. 6, in which a part of the earth and its gaseous envelope is shown to scale. If the radius of the sphere is 12½", then the non-conducting layer is only 1/64" thick and it will be obvious that the Hertzian rays cannot traverse so thin a crack between two conducting surfaces for any considerable distance, without being absorbed. The theory has been seriously advanced that these radiations pass around the globe by *successive reflections*, but to show the absurdity of this suggestion reference is made to Fig. 7 in which this process is diagrammatically indicated. Assuming that there is no refraction, the rays, as shown on the right, would travel along the sides of a polygon drawn around the solid, and inscribed into the conducting gaseous boundary in which case the length of the side would be about 400 miles. As one-half the circumference of the earth is approximately 12,000 miles long there will be, roughly, thirty deviations. The efficiency of such a reflector cannot be more than 25 per cent, so that if none of the energy of the transmitter were lost in other ways, the part recovered would be measured by the fraction $(¼)^{30}$. Let the transmitter radiate Hertz waves at the rate of 1,000 kilowatts. Then about *one hundred and fifteen billionth part of one watt* is all that would be collected in a *perfect* receiver. In truth, the reflections would be much more numerous as shown on the left of the figure, and owing to this and other reasons, on which it is unnecessary to dwell, the amount recovered would be a vanishing quantity.

Consider now the process taking place in the transmission by the instrumentalities and methods of my invention. For this purpose attention is called to Fig. 8, which gives an idea of the mode of propagation of the current waves and is largely self-explanatory. The drawing represents a solar eclipse with the shadow of the moon just touching the surface of the earth at a point where the transmitter is located. As the shadow moves downward it will spread over the earth's surface, first with infinite and then gradually diminishing velocity until at a distance of about 6,000 miles it will attain its true speed in space. From there on it will proceed with increasing velocity, reaching infinite value at the opposite point of the globe. It hardly need be stated that this is merely an illustration and not an accurate representation in the astronomical sense.

The exact law will be readily understood by reference to Fig. 9, in which a transmitting circuit is shown connected to earth and to an antenna. The transmitter being in action, two effects are produced: Hertz waves pass thru the air, and a current traverses the earth. The former propagate with the speed of light and their energy is *unrecoverable* in the circuit. The latter proceeds with the speed varying as the cosecant of the angle which a radius drawn from any point under consideration forms

with the axis of symmetry of the waves. At the origin the speed is infinite but gradually diminishes until a quadrant is traversed, when the velocity is that of light. From there on it again increases, becoming infinite at the antipole. Theoretically the energy of this current is *recoverable* in its entirety, in properly attuned receivers.

Some experts, whom I have credited with better knowledge, have for years contended that my proposals to transmit power without wires are sheer nonsense but I note that they are growing more cautious every day. The latest objection to my system is found in the cheapness of gasoline. These men labor under the impression that the energy flows in all directions and that, therefore, only a minute amount can be recovered in any individual receiver. But this is far from being so. The power is conveyed in only one direction, from the transmitter to the receiver, and none of it is lost elsewhere. It is perfectly practicable to recover at any point of the globe energy enough for driving an airplane, or a pleasure boat or for lighting a dwelling. I am especially sanguine in regard to the lighting of isolated places and believe that a more economical and convenient method can hardly be devised. The future will show whether my foresight is as accurate now as it has proved heretofore.

SHIP RADIO OPERATORS ASK INCREASED WAGES.

Increased wages and the fixing of a standard wage scale for radio operators on vessels operating under Government direction was asked of the Shipping Board recently by a delegation representing the Marconi Radio Telegraphers' Association. The radio operators included in the request made of the Board are those on vessels operating in transatlantic and Gulf waters. Assurances were given the radio representatives by Board officials that their request would be taken under advisement for immediate consideration.

ALEXANDER WIRELESS BILL, AMENDED.

(Continued from page 707)

"Seventh. It shall be lawful for the Government to deputize owners of private or amateur stations at a nominal fee for the purpose of having the radio rules and regulations enforced in such localities as the number of stations so warrants such a proceeding.	No fundamental objection to this phase. It was already done in a silent way by tacit agreement among the amateurs before the war. It was very common for the Editor of this as well as other publications to receive letters from amateurs complaining of fellow amateurs who had infracted the law. A letter to such violators from the various publications devoted to wireless usually brought speedy redress. Apparently no law was necessary.
"Eighth. The Government shall have the right to permanently revoke any license held by a private or amateur station as an extreme penalty for disobeyance of the radio rules and regulations set forth by this Act and any previous Acts concerning radio telegraphy.	We have no objection against this either. An amateur should have his license revoked if he does not play the game fair. In the five years that the 1912 Radio Act was in effect, however, we have not heard of a single case where a license was revoked.
"Ninth. It shall be lawful for the Government to provide technical schools and State universities with radio stations for the benefit of science and the training of radio operators.	No objection to this.
"Tenth. It shall be lawful for the Government to require all private or amateur stations to use inductive coupling between the antenna circuit and the circuit which includes the power transformer for damped radiotelegraphic communication.	No objection.
"Eleventh. It shall be unlawful for any private or amateur station to use a spark coil operating on direct current for the sending of radio disturbances into the ether.	We fail to see the wisdom of this. An amateur with a spark coil, we admit, can cause a lot of disturbance, but it should be remembered that a Government or commercial station can readily tune out such an amateur station without any trouble whatsoever even if it operates a block away. Furthermore, if no spark coils could be used, the amateur would naturall resort to a transformer, and there is no such apparatus made today which uses less than 100 watts. Most of the spark coils use less than 30 or 40 watts, consequently send out less disturbance than would be the case under the new measure.
"Twelfth. It shall be unlawful, except by special license, for any private or amateur station to use more than one hundred and twenty-five watts as measured in the antenna circuit, for the sending of radiotelephonic communications.	We believe that 125 watts is not sufficient. In a few years there will be thousands of radio telephone stations operating all over the country, and they will be as common as the telephone is today. Ours is a country of vast distances. This law would work especial harm to our western states where there are often no settlements a hundred miles apart. One hundred and twenty-five watts as measured in the antenna circuit we believe is insufficient to bridge such distances. We believe 250 watts should be the minimum.
"Thirteenth. The Government shall have the right to suspend the sending of radio disturbances into the ether by private or amateur stations for definite periods of the night or day in such zones as may become necessary, but nothing in this article shall be construed to mean that the sending of private or amateur stations shall be permanently suspended.	Yes, every bill must have its usual joker, and it is right here. If this clause becomes a law then any officious Government operator can take it into his head to prohibit sending in his district between the hours of 4 P. M. and 12 A. M. This period would be considered night. You said it, "GOOD Night." It would, of course, blot out all the sending stations with one stroke. If we must have a time limit, let it be stated in the law so there will not be any "ifs" and "buts"—at best such a clause as this would tend to create eternal friction between amateurs and Government officials. We believe such a clause is unjust and only at best reflects on poor and inadequate Government apparatus and still more inefficient Government radio operators.
"Fourteenth. The owner of the license of any private or amateur station must display in his station a copy of the rules and regulations of the Government regarding radio stations and failure to do so shall be punishable by a fine not exceeding $100, such rules and regulations to be furnished by the Government at a nominal cost."	No objection to this, altho every amateur operator before the war was only too proud to display his Government license once he had gone thru the trouble to get one.

RADIO AMATEURS DISCUST OFFICIALLY.

During the hearings of the Alexander Bill, H. R. 13159, before the committee on the Merchant Marine and Fisheries on December 12, 1918, many interesting points were brought out.

Lieut. J. C. Cooper, Jr., U. S. N. R. F., had been intrusted with drafting the amateur amendment, printed elsewhere in this issue. Lieutenant Cooper, who calls himself an "amateur naval officer", undertook the thankless job of drafting an amendment which would satisfy both the Navy and amateurs. In fairness to Lieutenant Cooper, let us state that he tried hard to be fair to both interests. But it is our opinion that neither Navy Department nor Amateurs are fully satisfied with the compromise amendment.

Lieutenant Cooper's statement before the committee follows:

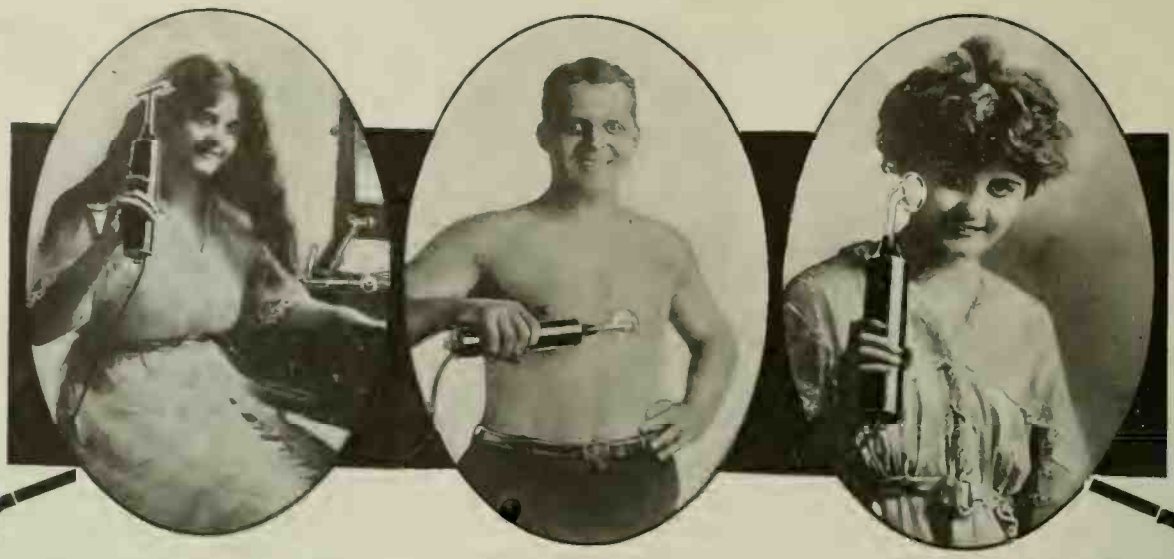
Statement of Lieut. J. C. Cooper, Jr., United States Naval Reserve Force.

Lieut. Cooper: Gentlemen, I am an ex-amateur radio operator and "amateur naval officer," as I am soon going back to civil life to take up the practise of my profession again. As many other amateurs, when the war broke out, I offered to do what I could for the service, and have had some duties in connection with radio work which have given me an opportunity, I hope, to be able to see the point of view of the Navy and the point of view of the amateur operator to some extent at the same time.

Several days ago there was a meeting called in Capt. Todd's office—without knowing how many men would be present—of all of the ex-amateurs who happened to be on duty in the naval service in Washington. There were about 25 or 30 men present. The question of the operation of amateur stations after the war was very liberally discust, and a memorandum was prepared and sent to each of those men and other men in the naval service in Washington who had been amateurs that we could locate, with the request that the questions be answered and sent back as soon as possible, with an idea of drafting an amendment to the present law which would, as far as possible, meet the combined view of themselves as previous amateurs, knowing amateur operations and knowing what the amateur desires to do and what he has done, and also with their experience since the war as part of the Government's service that has controlled radio. I had the unfortunate responsibility of having to say the final word on collating those opinions and putting them into the form of an amendment. There is no body of men, I believe, who disagree more violently among themselves on every subject that concerns them than do the amateur radio operators. I am convinced that from now on, as these hearings are going to be printed, my name is going down in radio history among the amateurs to some as guilty of high treason, to others as being foolish, to others as deserving some credit if this amendment goes into law. I do not expect all the amateurs to agree with it all. It is the collective judgment, however, of a certain number of amateurs who have seen both the Navy point of view and the amateur point of view, and I, myself, with the approval of the department, and it is offered as an amendment to the bill.

The present law states that the amateur who does not hold a special license is authorized within 5 miles of a Government station to use a transformer input of one-half kilowatt, elsewhere 1 kilowatt,

(Continued on page 737)



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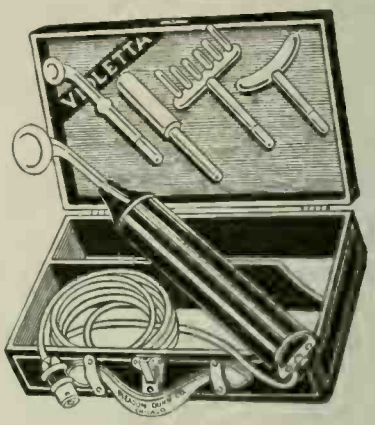

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Chilblains	Insomnia	Skin Diseases
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Corns	Nervousness	Sprains
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Dr. Bert H. Rice, of Vinton, Iowa, says: "I have good results with the Violetta High Frequency Instrument in all cases of neuralgia. Almost instant relief in Facial Neuralgia."

K. L. Allen, D. C., 205 Boone National Building, Boone, Iowa, says: "I have had very good results with the application of High Frequency Current in cases of Paralysis, Rheumatism and Neuritis, and think it a great help in drugless healing."

Dr. Daniels, Lisbon, North Dakota, says: "Have used the VIOLETTA in such cases as Goitre, Bronchitis, Pleurisy, Neuritis, Neuralgia, and Lumbago, and find it very beneficial. In fact, I would not be without it in my office."

Frank Borzone, Seattle, Wash., says: "I purchased the VIOLETTA for my wife who was suffering from an acute attack of Sciatica. From the very first treatment it induced peaceful rest and she is entirely well now."

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RADIO AMATEURS DISCUST OFFICIALLY.

(Continued from page 735)

and to use a maximum wave length of 200 meters. All amateurs are agreed that you can not properly tune an efficient amateur station quite as low as 200 meters; that an extension in wave length is desirable. The consensus of opinion of those I have talked to is that the limitations of this amendment—that is, not to exceed 250 meters—will greatly increase the efficiency of amateur stations and will enable the amateur to further fulfill his real function, which is to train him as an operator for any national emergency that may arise, and to possibly train him as a further developer of the radio art. The amateur has no place in the scheme of things if he is not useful. The ether is a means of communication which must be put to the use of the community as a whole for the advancement of the community. Unless the amateur operator advances the art, or advances the community, the amateur has no right to exist. I, personally, as a naval officer, have had many operators under me. I have found that of the new men under me the easiest trained, the most adaptable to the new apparatus, and the most efficient men I had were ex-amateur operators.

I took two of my best men the other day and put them on the President's ship to receive official messages from Washington. They were both ex-amateur operators; and I think that I speak for Capt. Todd and the Navy when I say that no one more than the Navy realizes the value that the amateur operator was to the Navy when the war first broke out. I, personally, of course am prejudiced in favor of the amateur, because I am praising myself when I praise the amateur, because I am an amateur operator.

This amendment also licenses receiving stations without requiring a license of the operator. In other words, the jeweler who has a receiving station simply for the purpose of receiving the Arlington time signals and checking up his chronometer will not require to be a radio operator to operate his receiving station. Likewise, the amateur who is only learning to send, who is just starting, will not have to have any license in order to operate a receiving station.* We do not think, on the other hand, that any amateur ought to have a right to touch the key and to cause possible blundering interference by his lack of ability as an operator unless he can receive and send what is usually called 15 words per minute; that is, 75 letters per minute, in the ordinary standard of 5 letters to the word, which is what we use in averaging an operator's speed. I personally do not think that that limit is too high. Others may disagree with me. I personally think that no operator ought to touch a key and ought to be allowed to interefere with this medium of commerce, which is the ether, unless he has that degree of skill. If he is required to have that degree of skill, it will be an incentive to him when he is first learning the art to get up to that degree of skill as soon as he can, so that he can have a transmitting license.

This amendment includes a clause authorizing the Government, where it is found expedient—as, for instance, in large centers or elsewhere—to limit the transformer input of amateur stations to one-half kilowatt if within 100 miles of the seacoast or within 5 miles of a Government receiving station to one-fourth kilowatt. I am frank to say that those powers are higher than the consensus of opinion of these written documents from which I compiled the amendment. Those powers are more liberal than the great majority of the men who compiled these memorandums thought proper, but after talking with Capt. Todd and Commander Hooper, and with especially this idea in view, namely, that there are many amateur stations which will have to apply for license before they can again reopen, who, if the input is cut down very much from the present law, will be required to remodel a part of their apparatus or give up their apparatus if we change the power limits very much. Personally, I think that those limits are as reasonable as can be safe from the point of view of non-interference with the real business of radio, which is sending official and commercial dispatches, and that those powers are ample to provide full experimentation that an amateur ought to have occasion to do and all communication that he may have occasion to make. Mark me, it does not say that a license can not be issued up to 1 kilowatt under those limitations. It says that the Government may in its discretion put those limits on.

For example, we will take on the peninsula of Michigan or on parts of the more or less uninhabited coasts of the Gulf, there is no reason why there would be stations near enough or ships working near enough so that 1 kilowatt would necessarily cause interference by what we call "forced oscillation." The amendment leaves it in the discretion of the licensing power to cut down to those limitations amateur stations which are near the centers of commerce, where other stations are using radio for its real purpose, and still it allows the amateur to work.

There are a lot of amateur operators here, some of whom I have known personally; some I have met since I have been here to-day; some I have had correspondence with before the war. A lot of them are going to disagree with me; some of them are going to think these limitations too low and some are going to think these limitations too high. That will be for the committee to decide. This is submitted by the Navy as a measure to assist in the future development of amateur radio.

*The amendment, printed elsewhere, fails to show this.—EDITOR.

(Continued on page 738)

Mr. Saunders: I want to ask you a few questions about the amateur. You have read the bill that is under consideration by the committee?

Lieut. Cooper: I have read it, sir.

Mr. Saunders: Aside from your amendment you have been discussing, there is no provision in the bill whatever relating to amateurs, is there?

Lieut. Cooper: I understand, sir, it was the intention of the department to license amateur operators.

Mr. Saunders: Under the bill that has been introduced there is no provision for the amateur?

Lieut. Cooper: Not under the name "amateur."

Mr. Saunders: Is there under any other name?

Lieut. Cooper: I think, sir, there would have been no reason why amateur stations should not have been licensed under the term "experimental stations."

Mr. Saunders: Suppose it is just a single individual. I understand a great many of these people who are amateurs took up this thing before the war—just young men who took up the business themselves?

Lieut. Cooper: I did so myself.

Mr. Saunders: That would not be called a station, would it?

Lieut. Cooper: Oh, yes, sir.

Mr. Saunders: Do you think, under the language "experimental stations," that any little individual amateur operator in the wilds of my district, I will say, who has been working on the thing himself as an intellectual improvement, could be described as "experimental station"?

Lieut. Cooper: I think so. But I say it is a moot point in view of the amendment.

Mr. Saunders: I do not see how that could be done with respect to the provision as to who is to be licensed as an amateur. Under that, necessarily, before any man could start out as an amateur, he must have had the opportunity to take some training at some school.

Lieut. Cooper: Very frankly I think that very few amateurs ever went to a training school.

Mr. Saunders: You require them to possess certain capacities by your amendment; they have got to have a certain facility.

Lieut. Cooper: The amateur can learn that by using the buzzer. All amateurs do the same thing, all operators.

Mr. Saunders: Can he experiment enough with the wireless apparatus to acquire that facility without having a trainer?

Lieut. Cooper: May I suggest, sir, that the process would be something like this: That by listening in, as we call it—and you will note that no license is required for receiving—a man can become accustomed to using the receiving apparatus, and he can become accustomed to the sending with a key hitched to a little buzzer, which is not a radio operator, and he can be taught to send up to any speed he can ever attain.

Mr. Saunders: He can teach himself, in other words, can he?

Lieut. Cooper: Teach himself, or be taught by other amateurs.

Mr. Saunders: He can pick that up by his own efforts, and by his own ingenuity and application at home and can acquire the facility which you have imposed upon him before he can receive a license?

Lieut. Cooper: I think any of the amateurs here will agree with me on that.

Mr. Saunders: With respect to this amateur, after he has attained that speed, and then is given the license that you contemplate, all of his operations would be controlled by the terms of his license?

Lieut. Cooper: They are at present, under the present law.

Mr. Saunders: Do you contemplate any difficulty in that connection if he operates according to the terms of his license, with the commercial operation of the Government system, or any other commercial system?

Lieut. Cooper: The limitation of wave lengths, sir, and the limitations of power in the present law of 1912, as amended by this amendment, are designed to prevent the amateur from causing interference with commercial stations.

Mr. Saunders: But you can see no danger of interference with the wireless system in the hands of private enterprise or Government control?

Lieut. Cooper: It was my view, sir, in drafting the amendment as it is, that these limitations on power and wave lengths would prevent such interference.

Mr. Saunders: So that in considering the general problem with respect to the necessity of having this entire business under Government ownership and control, we can eliminate any factor of danger from amateur operators?

Lieut. Cooper: I think so, sir, with the exception of the fact that adequate inspection of amateur stations must be had in the future if the amateur is to maintain the dignified position in the radio world that he should.

Mr. Saunders: That is by regulation?

Lieut. Cooper: Yes, sir.

Mr. Saunders: As I said, you eliminate the amateur experimentors as a factor in determining this policy, because they will operate in a field outside of the field that this policy is designed to control?

Lieut. Cooper: That is the idea of the amendment. There is one coming factor in radio work which may adversely affect amateur operating which should be looked forward to at the present time. The fleet—and this is not disclosing military secrets—is using for intercommunicating purposes very short wave length, shorter than the one hundred fifty meters mentioned here as the minimum length that an amateur should use. Aircraft are also using various wave lengths, some of which are almost

(Continued on page 742)

PATENT ADVICE

Edited by H. GERNSBACK

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

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

Readers' attention is called to the fact that due to the great amount of letters to this department it is quite impossible to answer them all thru these columns: The inquiries answered in this issue date as far back as August, and if readers wish speedy service they should carefully note the announcement appearing in the preceding paragraph.

Combination Carriage and Sled.

(299) Peter E. Sparri, Detroit, Mich., sends us a description of a combination foot-power carriage and sled. This apparatus works by means of a paddle that can be raised or lowered at will. When converting the sled into a carriage, the runners are taken off, the back wheels are placed on the paddle axles and are pulled down and locked.

A. This idea is very unique and should find favor particularly in our northern states where there is a good deal of snow. We think a patent might be obtained on this device.

The same inventor also submits what he terms a "desk telephone," which is to do away with hanging up and taking down of the receiver. The idea is to have a stand which when lifted up makes the connections, while the entire combination is similar to the hand telephones, which incorporate a receiver and microphone combined.

A. This is a good idea, but we cannot offer much encouragement as to the patent phase, for the reason that a great many such devices are on the market and hundreds more have actually been patented. Somehow or other, there does not seem to be a very widespread demand for this apparatus.

Diving Device.

(300) Jess F. Perrin, Rapid City, S. D., writes as follows: "I have two ideas on which I would like to have your opinion as to practicability, usefulness and demand on the market. The first one is a small rubber device which fits in the nostrils to exclude the water when diving. It is thought that a device of this kind would be of great service to amateurs in learning how to swim. It could be retailed at 10c."

A. Without seeing the details and construction of this device, it is impossible for us to say whether it has any merit. We think, however, that there might be a demand for a device of this kind.

"The other device is an automatic printer for printing pictures. An automatic counter keeps the operator apprised as to the number of prints being taken. The prints are run thru all the necessary solutions and run out on a belt to dry. This machine could be made at an expense not exceeding $20.00. Your advice on this would also be appreciated."

A. There does not seem to be anything fundamentally new to this idea, and there are several printing machines of this kind on the market at the present time.

Automatic Airplane Control Stabilizer.

(301) Edward R. Young, Covington, Ky., writes: "Most airplanes are controlled by a 'joystick,' a lever on a universal joint arranged so that by moving it from side to side the airplane is steered and by moving backward and forward the elevation is changed. My idea embraces two levers, one to move forward and backward and the other to move from side to side. At the top of each of these levers, which are connected to the regular control wires just like a double control 'plane, is an iron rod. At the ends of these iron rods are magnets so that when the magnet at either end is excited it draws the iron rod, and joystick, a few inches in that direction, thus controlling the 'plane. Another magnet when excited will draw the rod still farther. The same applies to the other end of the iron rod and the other "joystick."

The principal part is the means for telling when these magnets should be excited. Just as we have tubes in our heads to tell us when we are off balance (literally) so is this apparatus intended to tell the airplane when it's off balance. A closed tube, longer than it is wide to prevent electrolyte from splashing, is fitted with a main contact in the bottom and contacts at each end so that if the 'plane dips forward (for example) the electrolyte runs forward, makes circuit with the first contact, excites first magnet and by the magnet drawing the "joystick" forward the level of the 'plane is corrected. If the 'plane continues to dip, the second magnet is excited which draws the "joystick" forward still farther. A large number of small magnets may be used so as to affect the 'plane very gradually and thus prevent jerks and strains. The other "joystick" fitted the same way only crosswise of the 'plane warps the wings or moves the aerofoils (at ends of wings) to control the direction of the 'plane and keep the two wings on a level.

The "brain" unit is made of porcelain, with a number of ridges on the inside to prevent the rather thick oily electrolyte from moving too freely, has a main contact to the battery and the other contacts (as many in each end as there are magnets at each end of "joystick") at each end of the tube. This is only a few inches long, the magnets are not heavy, and the whole apparatus does not take up much room and does not call for extensive changes in the airplane.

When the aviator changes the level of the 'plane he also changes the level of the porcelain tube so that when the airplane gets off of that level the device automatically corrects the position. The position of the magnets change when the aviator changes the level of the porcelain tubes so that when the airplane is on the correct level the magnets are at the ends of the iron rods at the tops of the "joysticks" ready for business. The aviator puts the 'plane on a certain level and this apparatus automatically keeps it there."

A. This is a highly ingenious idea, and Mr. Young deserves much credit for his invention. As will be noted Mr. Young has tried to design an "electro-mechanical brain" for the airplane. It is well known that the human brain has a device of this kind to keep us in an upright position. Fine tubes have a liquid which runs back and forward in these tubes and we thus stabilize ourselves. Mr. Young has tried to make use of this principle by using an electrolyte in a closed vessel and arranged to close various contacts so as to energize certain control magnets, substantially as set forth above.

While the idea is good, we have only one fault to find, viz., that the vessel containing electrolyte must be very small, as any abrupt lurching of the airplane would tend to throw the entire mechanism out of order, as can be readily imagined. If the contacts can be arranged in relatively fine, long

tubes where a displacement of the liquid will take place gradually, we believe that the device will function with a greater degree of success.

Automatic Air Hose Coupling.

(302) James Witkowski, Albion, N. Y., submits a drawing of an automatic air hose coupling with drawing, and wishes our opinion whether it is patentable and if it would be of any value if a patent could be obtained on it.

A. It is impossible to figure out on paper whether the brake would work satisfactorily. Indeed, we are not sure that the device is at all new. We would advise our correspondent to have a search made in the patent office thru one of the patent attorneys to ascertain what has been done previously in the art.

Electric Heater.

(303) Gottlieb Samuel Leventhal, Elmira, N. Y., submits a drawing on an electrical idea for heating water. The device is of the usual type whereby it can be attached to any faucet, the water started running and the current turned on. As the water runs thru this device and over the heating wires, the water is heated.

A. There is nothing fundamentally new to the device as submitted, except for the attractive form that our correspondent has given it, which is in the shape of a round ball. Outside of this, there is nothing new shown, and we are quite certain that no patent could be obtained.

Mechanical Brake.

(304) Emilio R. Salazar, Havana, Cuba, writes as follows: "I am enclosing blue-print and description of a contrivance to apply brakes on railroad cars with a request for you to publish it with your advice on the idea in your Patent Advice Section. Will you kindly let me know the possibilities of this invention?"

A. This is quite a complicated apparatus, and without seeing a model we think it is almost impossible for anyone to give an intelligent opinion. A brake of this kind looks all right on paper, but it is difficult to predict in advance if it will work out in practise. We would earnestly advise that before applying for patent on this apparatus that a model should be built.

BOY BURNED WHEN WET KITE STRING TOUCHES WIRES.

While Wm. Oliver of Port Stanley was amusing himself recently flying his kite he was severely burnt on both hands, when the flying string came in contact with the high voltage wires of a local railway. While flying his kite a strong wind sent it to the ground, and the wet cord came in contact with this power wire, as it fell over it. The victim got the full benefit of the voltage. This was much too strong for the string as it burnt it in two, for which William is very thankful as it saved his life. The only other small boy there ran away when he saw what had happened so he was alone when all was over. The burnt hands healed up all right, but Master Oliver, for one, will keep clear of all overhead electric wires hereafter, when he goes kite flying. It is remarkable that he was not killed outright, the high resistance of the kite string probably being the factor that saved his life.

RADIO AMATEURS DISCUST OFFICIALLY.

(*Continued from page 738*)

down to 250 meters. There may be trouble in the future, sir, between aircraft operating overland and working with their receiving or transmitting stations, and amateur stations. That is a possibility of the future that I will call the attention of the committee to at this time, because this thing may come up here at another time under some future law, and, I simply want to warn the committee that this is a new field that we know nothing about. Aircraft radio was not in existence to any extent when amateurs last operated. There may be interference between amateur operators and aircraft radio stations, but it is hoped that there will not be.

Mr. Saunders: Government ownership has nothing to do with that problem?

Lieut. Cooper: Except the Government would probably be operating the stations for aircraft.

Mr. Saunders: The possibility which you speak of which may arise hereafter is a thing that will be met by appropriate regulations, is it not?

Lieut. Cooper: It might be, sir, if this amendment is past, that it might have to be met by legislation again reducing the wave length back to where it is now.

Mr. Saunders: Appropriate legislation?

Lieut. Cooper: It might be legislation and not regulation.

Mr. Saunders: Legislation is just that much more authoritative than regulation.

Lieut. Cooper: I usually think of "regulation" as a regulation of a department.

Mr. Saunders: I admit that is so in general, where you think of something issued by some department head or some Bureau Chief.

PRESIDENT WILSON ALWAYS IN TOUCH WITH WASHINGTON—VIA RADIO.

(*Continued from page* 708)

Lyons Station, France, was established long before the *Pennsylvania* was beyond communication range of the United States.

The *Pennsylvania* has six receiving booths, which were able to receive on eight different tunes simultaneously as follows: One booth guarded Annapolis or New Brunswick tunes 16,900-13,000 meters; one booth guarded Lyons tunes 15,500 meters; one booth guarded Tuckerton's tune 9,200 meters; one booth guarded 4,000 meters (the Standard arc calling tune); one booth guarded 450 meters for the U. S. S. *George Washington* vacuum tube transmitter tune and one booth guarded 297 meters (the radio telephone tune). One additional operator guarded 600 and 952.

The radio stations at Otter Cliffs, Maine and Lyons, France, were used to receive messages from the President, transmitted by the U. S. S. *Pennsylvania's* arc.

The *George Washington's* radio equipment consisted of the following: One low power spark transmitting set, one 16,900 long wave receiving set, one short wave 600 meter spark receiving set, one short range radio telephone transmitting and receiving set, one vacuum tube 450 meter transmitting and receiving set. The U. S. S. *George Washington* was able to intercept messages transmitted by the Annapolis or New Brunswick stations and guard 600 meter (commercial calling, and emergency tune and the radio telephone and vacuum tunes) simultaneously. Messages for the President transmitted from the United States by the Annapolis, New Brunswick, Tuckerton and the Lyons station were received by the U. S. S. *Pennsylvania* and relayed to the *George Washington* by means of radio telephone and vacuum tube transmitting sets simultaneously.

The messages from the President destined to United States or France were sent from the *George Washington* to the *Pennsylvania* by the vacuum tube or radio telephone set and were relayed by the *Pennsylvania's* high power arc transmitter direct to the United States, Lyons or Brest, France.

The radio communication was directed by Commander H. W. McCormack, U.S.N., Fleet Radio Officer. Lieutenant S. V. Edwards is in charge of the radio of the *Pennsylvania*.

NIKOLA TESLA AND HIS INVENTIONS.

(*Continued from page* 697)

nerve-racking spectacle. Then, inevitably, in the stillness of night, a vivid picture of the scene would thrust itself *before* my eyes and persist despite all my efforts to banish it. Sometimes it would even remain fixt in space tho I pushed my hand thru it. If my explanation is correct, it should be possible to project on a screen the image of any object one conceives and make it visible. Such an advance would revolutionize all human relations. I am convinced that this wonder can and will be accomplished in time to come; I may add that I have devoted much thought to the solution of the problem.

To free myself of these tormenting appearances, I tried to concentrate my mind on something else I had seen, and in this way I would often obtain temporary relief; but in order to get it I had to conjure continuously new images. It was not long before I found that I had exhausted all of those at my command; my "reel" had run out, as it were, because I had seen little of the world—only objects in my home and the immediate surroundings. As I performed these mental operations for the second or third time, in order to chase the

appearances from my vision, the remedy gradually lost all its force. Then I instinctively commenced to make excursions beyond the limits of the small world of which I had knowledge, and I saw new scenes. These were at first very blurred and indistinct, and would flit away when I tried to concentrate my attention upon them, but by and by I succeeded in fixing them; they gained in strength and distinctness and finally assumed the concreteness of real things. I soon discovered that my best comfort was attained if I simply went on in my vision farther and farther, getting new impressions all the time, and so I began to travel—of course, in my mind. Every night (and sometimes during the day), when alone, I would start on my journeys—see new places, cities and countries—live there, meet people and make friendships and acquaintances and, however unbelievable, it is a fact that they were just as dear to me as those in actual life and not a bit less intense in their manifestations.

This I did constantly until I was about seventeen when my thoughts turned seriously to invention. Then I observed to my delight that I could visualize with the greatest facility. I needed no models, drawings or experiments. I could picture them all as real in my mind. Thus I have been led unconsciously to evolve what I consider a new method of materializing inventive concepts and ideas, which is radically opposite to the purely experimental and is in my opinion ever so much more expeditious and efficient. The moment one constructs a device to carry into practise a crude idea he finds himself unavoidably engrost with the details and defects of the apparatus. As he goes on improving and reconstructing, his force of concentration diminishes and he loses sight of the great underlying principle. Results may be obtained but always at the sacrifice of quality.

My method is different. I do not rush into actual work. When I get an idea I start at once building it up in my imagination. I change the construction, make improvements and operate the device in my mind. It is absolutely immaterial to me whether I run my turbine in thought or test it in my shop. *I even note if it is out of balance.* There is no difference whatever, the results are the same. In this way I am able to rapidly develop and perfect a conception without touching anything. When I have gone so far as to embody in the invention every possible improvement I can think of and see no fault anywhere, I put into concrete form this final product of my brain. Invariably my device works as I conceived that it should, and the experiment comes out exactly as I planned it. In twenty years there has not been a single exception. Why should it be otherwise? Engineering, electrical and mechanical, is positive in results. There is scarcely a subject that cannot be mathematically treated and the effects calculated or the results determined beforehand from the available theoretical and practical data. The carrying out into practise of a crude idea as is being generally done is, I hold, nothing but a waste of energy, money and time.

My early affliction had, however, another compensation. The incessant mental exertion developed my powers of observation and enabled me to discover a truth of great importance. I had noted that the appearance of images was always preceded by actual vision of scenes under peculiar and generally very exceptional conditions and I was impelled on each occasion to locate the original impulse. After a while this effort grew to be almost automatic and I gained great facility in connecting cause and effect. Soon I became aware, to my surprise, that every thought I conceived was suggested by an external impression. Not only this but all my actions were prompted in a similar way. In the course of time it became perfectly evident to me that I

was merely an *automaton* endowed with power of movement, responding to the stimuli of the sense organs and thinking and acting accordingly. The practical result of this was the art of *telautomatics* which has been so far carried out only in an imperfect manner. Its latent possibilities will, however, be eventually shown. I have been since years planning self-controlled automata and believe that mechanisms can be produced which will act as if possest of reason, to a limited degree, and will create a revolution in many commercial and industrial departments.

I was about twelve years old when I first succeeded in banishing an image from my vision by wilful effort, but I never had any control over the flashes of light to which I have referred. They were, perhaps, my strangest experience and inexplicable. They usually occurred when I found myself in a dangerous or distressing situation or when I was greatly exhilarated. In some instances I have seen all the air around me filled with tongues of living flame. Their intensity, instead of diminishing, increased with time and seemingly attained a maximum when I was about twenty-five years old. While in Paris, in 1883, a prominent French manufacturer sent me an invitation to a shooting expedition which I accepted. I had been long confined to the factory and the fresh air had a wonderfully invigorating effect on me. On my return to the city that night I felt a positive sensation that my brain had caught fire. I saw a light as tho a small sun was located in it and I past the whole night applying cold compressions to my tortured head. Finally the flashes diminished in frequency and force but it took more than three weeks before they wholly subsided. When a second invitation was extended to me my answer was an emphatic NO!

These luminous phenomena still manifest themselves from time to time, as when a new idea opening up possibilities strikes me, but they are no longer exciting, being of relatively small intensity. When I close my eyes I invariably observe first, a background of very dark and uniform blue, not unlike the sky on a clear but starless night. In a few seconds this field becomes animated with innumerable scintillating flakes of green, arranged in several layers and advancing towards me. Then there appears, to the right, a beautiful pattern of two systems of parallel and closely spaced lines, at right angles to one another, in all sorts of colors with yellow-green and gold predominating. Immediately thereafter the lines grow brighter and the whole is thickly sprinkled with dots of twinkling light. This picture moves slowly across the field of vision and in about ten seconds vanishes to the left, leaving behind a ground of rather unpleasant and inert grey which quickly gives way to a billowy sea of clouds, seemingly trying to mould themselves in living shapes. It is curious that I cannot project a form into this grey until the second phase is reached. Every time, before falling asleep, images of persons or objects flit before my view. When I see them I know that I am about to lose consciousness. If they are absent and refuse to come it means a sleepless night.

To what an extent imagination played a part in my early life I may illustrate by another odd experience. Like most children I was fond of jumping and developed an intense desire to support myself in the air. Occasionally a strong wind richly charged with oxygen blew from the mountains rendering my body as light as cork and then I would leap and float in space for a long time. It was a delightful sensation and my disappointment was keen when later I undeceived myself.

During that period I contracted many strange likes, dislikes and habits, some of which I can trace to external impressions while others are unaccountable. I had a

violent aversion against the earrings of women but other ornaments, as bracelets, pleased me more or less according to design. The sight of a pearl would almost give me a fit but I was fascinated with the glitter of crystals or objects with sharp edges and plane surfaces. I would not touch the hair of other people except, perhaps, at the point of a revolver. I would get a fever by looking at a peach and if a piece of camphor was anywhere in the house it caused me the keenest discomfort. Even now I am not insensible to some of these upsetting impulses. When I drop little squares of paper in a dish filled with liquid, I always sense a peculiar and awful taste in my mouth. I counted the steps in my walks and calculated the cubical contents of soup plates, coffee cups and pieces of food,—otherwise my meal was unenjoyable. All repeated acts or operations I performed had to be divisible by three and if I mist I felt impelled to do it all over again, even if it took hours.

Up to the age of eight years, my character was weak and vacillating. I had neither courage or strength to form a firm resolve. My feelings came in waves and surges and vibrated unceasingly between extremes. My wishes were of consuming force and like the heads of the hydra, they multiplied. I was opprest by thoughts of pain in life and death and religious fear. I was swayed by superstitious belief and lived in constant dread of the spirit of evil, of ghosts and ogres and other unholy monsters of the dark. Then, all at once, there came a tremendous change which altered the course of my whole existence.

Of all things I liked books the best. My father had a large library and whenever I could manage I tried to satisfy my passion for reading. He did not permit it and would fly into a rage when he caught me in the act. He hid the candles when he found that I was reading in secret. He did not want me to spoil my eyes. But I obtained tallow, made the wicking and cast the sticks into tin forms, and every night I would bush the keyhole and the cracks and read, often till dawn, when all others slept and my mother started on her arduous daily task. On one occasion I came across a novel entitled "Abafi" (the Son of Aba), a Serbian translation of a well known Hungarian writer, Josika. This work somehow awakened my dormant powers of will and I began to practise self-control. At first my resolutions faded like snow in April, but in a little while I conquered my weakness and left a pleasure I never knew before—that of doing as I willed. In the course of time this vigorous mental exercise became second nature. At the outset my wishes had to be subdued but gradually desire and will grew to be identical. After years of such discipline I gained so complete a mastery over myself that I toyed with passions which have meant destruction to some of the strongest men. At a certain age I contracted a mania for gambling which greatly worried my parents. To sit down to a game of cards was for me the quintessence of pleasure. My father led an exemplary life and could not excuse the senseless waste of time and money in which I indulged. I had a strong resolve but my philosophy was bad. I would say to him, "I can stop whenever I please but is it worth while to give up that which I would purchase with the joys of Paradise?" On frequent occasions he gave vent to his anger and contempt but my mother was different. She understood the character of men and knew that one's salvation could only be brought about thru his own efforts. One afternoon, I remember, when I had lost all my money and was craving for a game, she came to me with a roll of bills and said, "Go and enjoy yourself. The sooner you lose all we possess the better it will be. I know that you will get over it." She was right. I conquered my passion

then and there and only regretted that it had not been a hundred times as strong. I not only vanquished but tore it from my heart so as not to leave even a trace of desire. Ever since that time I have been as indifferent to any form of gambling as to picking teeth.

During another period I smoked excessively, threatening to ruin my health. Then my will asserted itself and I not only stopt but destroyed all inclination. Long ago I suffered from heart trouble until I discovered that it was due to the innocent cup of coffee I consumed every morning. I discontinued at once, tho I confess it was not an easy task. In this way I checked and bridled other habits and passions and have not only preserved my life but derived an immense amount of satisfaction from what most men would consider privation and sacrifice.

After finishing the studies at the Polytechnic Institute and University I had a complete nervous breakdown and while the malady lasted I observed many phenomena strange and unbelievable.

(*To be continued in our March issue*)

TEN TELEPHONE OR FORTY TELEGRAPH CURRENTS OVER ONE CIRCUIT.

POSTMASTER GENERAL BURLESON on December 12th made public a letter from Theodore N. Vail announcing the invention and development by the technical staff of the Bell system of a practical method of multiplex telephony and telegraphy, which is expected to revolutionize long-distance wire communication.

Mr. Vail, who is President of the American Telephone and Telegraph Company, explained that there can be a combination of telegraphy and telephony under this invention by which a pair of wires, i.e., one full metallic circuit, will be available either for *five simultaneous telephone conversations* (*ten voices*) or for *forty simultaneous telegraph messages*, or partly for one and partly for the other.

With this new system four telephone conversations over one pair of wires are simultaneously carried on *in addition to* the telephone conversation provided by the ordinary methods. Thus, over a single pair of wires a total of five telephone conversations are simultaneously operated, each giving service as good as that provided by the circuit working in the ordinary way.

Heretofore the best telephone methods known to the art provided only one telephone conversation at a time over a single pair of wires. A number of years ago there was developed the *phantom circuit* arrangement, by which three telephone circuits were obtained from two pairs of wires, an important improvement, of which extensive use has been made commercially. Now, by the multiplex method we are enabled to obtain *five telephone circuits* over one pair of wires, that is, *ten simultaneous telephone conversations* from the two pairs of wires which formerly could be used for only three simultaneous telephone conversations. This represents an increase of more than threefold in the telephonic capacity of the wires, as compared with the best previous state of the art.

Some proposals made by the earlier workers in this particular field have naturally proved suggestive in the successful solution of the problem, particularly a suggestion made by Maj. Gen. George O. Squier, Chief Signal Officer of the United States Army, about ten years ago, and which at the time attracted very general attention.

Furthermore, while working in entirely different fields and with a different objective, Dr. Lee deForest a number of years ago invented a wireless device known as the Audion, which by improvements and adaptation has been made an important part of the Bell telephone system.

CURING SOLDIERS' ILLS WITH ELECTRICITY.

(*Continued from page 695*)

were 3,000 shell-shock victims; the day the armistice was signed 2,000 of them recovered, showing what a peculiar and baffling mental ailment this is.

The photograph, Fig. 2, was taken at the American Red Cross War Hospital, located at Paignton, Devon, France, which is one of the finest and best equipt in the Red Cross service. This hospital has a staff of 150 nurses under the direction of Army medical officers. The photograph shows a soldier undergoing an electric bath treatment for rheumatism. This treatment is given in the massage room at the hospital, where multifarious other electrical machines and appliances are to be found, including electrical massage vibrators, electric heating pads, etc.

In some of the larger base hospitals, very elaborate electrical equipment has been made available. In some of the American Army hospitals in the United States, where the returning wounded are being carefully attended to, so as to make them as well and strong as they were when they went overseas to fight the Boche, there are some of the very latest instruments and apparata about which little is known outside of the medical profession. This equipment includes among other things the *Electro-cardiograph*, which comprises an extremely sensitive electrical galvanometer, capable of recording the beats of the heart on a photographic film, so that the exact condition of the heart with regard to its manner of beating and its strength, can be minutely and accurately studied by the physicians.

At one of the large New York debarkation hospitals everything is done by electricity—even to the cooking. This hospital has one of the largest X-ray laboratories in the world, each of the 26 X-ray rooms being equipt with a special dark room for rapidly developing and finishing the X-ray plates. The X-ray in itself has undoubtedly saved thousands of lives in the great conflict, in many cases when the victims of bullet and shell wounds would certainly have died, had it not been for this wonderful scientific machine. Owing to the terrific fragmentation (splintering) of the shell now used, which often causes small steel splinters to penetrate parts of the body where they would never be suspected, and which, if they were not quickly discovered by the X-ray, would be quite liable to affect the heart, lungs or blood vessels at some unexpected time and cost the victim his life. For this reason the returning wounded are most minutely examined and X-rayed, especially in the abdomen and chest regions, where many of these shell splinters, and even bullets, are fond of lodging and camouflaging themselves for long periods, only to cause trouble at some later date, with possibly fatal results.

THE UNKNOWN PURPLE.

(*Continued from page 690*)

last act, in which scene the hero is visible to the eye in flesh and blood but slowly and gradually fades away into nothing, leaving only the purple glow. This was quite impressive and, of course, was done by the usual magician's mirror effect, whereby the hero was not on the stage at all, but below it, thus casting his reflection on a fine screen on the stage; then by manipulating the lights in a certain manner the picture would dissolve into emptiness.

Altogether the stage technique is very cleverly arranged with an absurdly simple effect which in a similar attempt would be very elaborate. Outside of that the plot and theme of the play is quite out of the ordinary and is deserving of mention.

To show just how different this play is from others, reference must be made to a note in the program over which audiences puzzle themselves until the play itself makes the meaning clear. To wit: "The first epi-

sode of the last act occurs before the last episode of the preceding act." It simply means that at that critical time the action is going on in two places at once: and because the stage cannot jump back and forth in a flash like the motion picture, part of the story has to be postponed until the scene shifters catch up.

The illustrations which we present herewith are, of course, doctored up for the reason that if they were not nothing at all would be seen. It is very necessary to show the pictures in this manner, otherwise we would revert back to our camouflaged front cover,—the blank space showing nothing,—and as the Editors must show pictures—well you know how it is:

A little camouflage here and then
Is often mightier than the pen!

EXPERIMENTAL MECHANICS.

(*Continued from page 717*)

much more difficult than the ordinary run of lathe work. Fig. 5 shows how a crank pin, 1, with its rods, is set to be revolved between centers 2, 2, of the lathe. This is made with provisions for attaching to the crank rod 4, 4, temporary support plates 3, 3, on the ends of the crank shaft, and drilling center holes in the plates in line with the *center of the crank pin to be turned.* The main portions of the crank shaft D, D, must first be turned, tho not necessarily to their finished size. The plates 3, 3, must be bored out to be a tight fit on the ends of the crank shafts, to which they are further secured by a set screw as indicated. The crank shaft is then laid on a surface plate or on the lathe bed, which will answer this purpose very well, and the centers of the crank pin, 1, determined and carefully marked on the supporting plates, 3, 3, so that when mounted between lathe centers the axis shall pass thru the central axis of the crank pin. The center holes should be drilled and countersunk in the usual way at these points. The crank shaft may then be mounted in the lathe on its centers, and one end secured to the face plate with a dog and the crank pin then turned to proper size.

It will be found in turning crank shafts that the work as a whole is very much out of balance, and will require a counterbalance weight on the opposite side to the driving of the lathe. This work will be of interest to those building engines, etc.

(*To be continued*)

PRODUCING RAIN BY ELECTRICITY AND X-RAYS.

(*Continued from page 687*)

valve rectifiers, is used to produce the high potential current for operating the X-ray tube, and this current is fed to the tube thru the two wires leading up to the balloon. The X-ray tube itself is placed in a light water-proof compartment suspended from a spar just below the balloon, as the illustration shows. As will be seen, the Röntgen-ray tube is so hung that its rays are directed upward, so as to impinge upon the metallized surface of the balloon, which, as will be remembered, is charged at a very high potential. Suitable high voltage, strain insulators are placed in the lead wires at all the points shown. A recording instrument such as hot-wire ammeter is connected in series with the high tension lead wire. If the ground switch is closed, then any static charge in the neighborhood of the balloon is conveyed to earth, an indication being obtained on the instrument. When the ground switch is opened and the power circuit closed, the air surrounding the balloon for a radius of several hundred feet is endowed with conductive qualities as a result of the emanations from the X-ray tube. When the ultra-high voltage

charging circuit is closed and the metallized balloon surface electrified, then the air in the vicinity of the balloon receives a powerful electrostatic charge, which acts on the aqueous particles suspended or floating in the air in the manner aforementioned. The inventor has elaborately cared for many problems which might arise in the application of his apparatus, and among other things he describes various forms of high tension uni-directional current generators and means for application against lightning discharges.

The inventor mentions that two or more operating stations for rain production may be used in cooperation, depending upon the observed meteorological conditions, these stations being located at greater or lesser distances apart. In operating multiple stations the degree and sign of the charges used therein, respectively, may be varied as required. The use of ultra-violet rays instead of Röntgen rays for ionizing the atmosphere is discust by Mr. Balsillie in the description of the apparatus, but they are of little practical use, as he points out, for they produce practical ionization effects only when reflected from a fluorescent surface.

EXPERIMENTAL CHEMISTRY.

(*Continued from page 718*)

will contain crystallin deposits. Some of the sublimat will be amorphous.

THE CARBON TEST.—In this the Arsenious Oxid [As_2O_3] is reduced by Carbon [CO being formed] to metallic Arsenic, which sublimes as in Marsh's Test.

HYDROGEN SULFID TEST.—The hydrogen sulfid preciptates arsenious sulfid [As_2S_3] [Yellow] from an acid solution of any arsenious salt

$$2AsCl_3 + 3H_2S = As_2S_3 + 6HCl.$$

Physiological Effects.

Like other arsenical comounds, the oxid is very poisonous, the lethal dose being about 2½ grains, or $^1/_6$ gram. It is called an *Irritant* poison, and acts rather slowly, as the digestive fluids have to transform it before absorption. The antidote is freshly prepared ferric hydrat [$Fe[OH]_3$], together with Magnesia.

$$2FeCl_3 + 3Mg[OH]_2 = 2Fe[OH]_3 + 3MgCl_2.$$

This forms a compound of arsenic insoluble in the fluids of the body, and precipitated in the stomach, etc. An overdose may act as an emetic.

For evidence of arsenical poisoning in post-morten examination of the liver, the stomach, etc., these organs and their contents are sometimes dialyzed before the Marsh and other tests can be applied, in order to separate the arsenic from the viscera and food products. After being treated with Hcl, $KClO_3$, etc., the finely divided substances are put into a dialyzer [a parchment membrane, see Fig. 156], and suspended in water, when the arsenic compounds, being more diffusive, pass thru the membrane in to the water of the outer vessel, leaving the other substances behind. This outer solution is then concentrated and tested for arsenic. Generally, however, the contents with the arsenic are dissolved in aqua regia and then tested by Marsh's or Reinsch's test.

Uses.

It is employed in shot manufacture to give a globular form to the grains.

Cobalt Glance, a compound of Arsenic and Cobalt, has considerable use as fly-poison under the name of *Fly-stone*. Arsenic also finds use in many rat poison compounds.

TESTS FOR ARSENIC.

Marsh's Test.

Experiment No. 148.

Make two constrictions in a tube of hard

glass [about 25 cm. long, and 8 mm. diameter] by the use of a blast-lamp flame. The first capillary should be 5 or 6 cm., from one end, or as near the end as is convenient to hold in the flame; the second one 5 or 6 cm. from the first. These capillaries should not be less than 4 or 5 mm., in diameter at the narrowest part. Between the two constrictions bend the tube upward at an obtuse angle [D]. See Fig. 157. The opposite end of the tube is next fire-polished. When all the parts are cool lay the tube down and draw a file gently across the middle of the constriction nearest the short end, and break it at this point, thus leaving a small opening and completing the tube E. A drying tube 10 or 12 cm long, 8 mm. diameter at each end, with bulb, is filled with calcium chlorid, but not so full as to clog and prevent the gas from passing. This is attached to an Erlenmeyer flask of thick glass [about 125 or 250 cc.] and to the arsenic tube. See Fig. 158. The two-hole stopper of the flask carries a thistle tube. The flask may be raised on an iron ring stand or other support, so as to allow a Bunsen flame, flattened by use of a "wing-top" to heat the arsenic tube, the latter being also supported. Not over 5 grams of arsenic-free [or C. P.] zinc are put into the flask and covered with distilled water. Thru the thistle tube are poured small successive portions of C. P. hydrochloric acid. After letting the hydrogen escape for a minute, to expel all the air from the apparatus, test the gas in the usual way, using the utmost caution to prevent an explosion. When sure that all the air is expelled, ignite the escaping hydrogen. Hold the concave side of a porcelain dish in this flame a minute to test the purity of all chemicals. If no deposit is made, pour into the flask not over 5 cc. of a solution of arsenious chlorid [$AsCl_3$] or of sodium arsenit [Na_3AsO_3]. Put the Bunsen burner under the combustion tube, having the top of the flame near the capillary, but on the side towards the flask. Keep the hydrogen burning well at the end of the tube, adding more hydrochloric acid as needed.

Look for any change of color in the hydrogen flame, and in the event of noting any, try to explain it. Hold a dish against the flame as before. What is the effect, and its explanation. Observe any deposit in the capillary; describe and account for it.

When there is no further deposit near the capillary, and the flame becomes yellow, blow out the hydrogen flame, and when the tube is cool, detach it [*avoid inhaling the fumes*] and pour 3 or 4 cc. of sodium hypochlorit into the arsenic tube, closing the capillary end with the finger. See whether the deposit dissolves. This test serves to distinguish an arsenic deposit from one of antimony, which is insoluble in sodium hypochlorit [NaOCl]. Write reactions for:

1. The action of HCl on zinc.
2. $AsCl_3$ on nascent hydrogen, forming the DEADLY gas arsin [AsH_3].

(*Continued on page 758*)

POPULAR ASTRONOMY.

(*Continued from page 701*)

thruout the equatorial segment of which A-B is a cross-section.

It should be borne in mind in connection with Fig. 1, that space, so far as we know, is without limits. Strictly speaking we should set no boundary for the universe such as is implied when we place a circle around the system of globular clusters. The region beyond A-B is unexplored. The extent of the Galaxy in the direction A-B may be even greater than is represented here. The limits in Fig. I are simply those set by the systems of globular clusters. When the distances of some of the spiral nebulae have been determined it is con-

ceivable that the limits of the celestial sphere may be still further extended or modified. At present our tentative diagrams of the universe must be in accord with the extent of our knowledge at this time, just as the maps of the world and of our solar system drawn several centuries ago were representative of the state of man's knowledge in that age.

The theory that the structure of the Milky Way resembles a spiral nebula we have considered in a recent article on the *"Spiral Nebulae."* The laws governing the motion of bodies in a spiral formation are not yet known, but the star streams that exist within and parallel to the galactic plane may be manifestations of the workings of such laws. New methods of attacking the complicated problem of the structure of the universe and the movements of the stellar bodies are constantly being devised and perfected. The advance of astronomy in this direction has been very great in the past few decades, and a rapid increase of our knowledge in this direction is to be expected.

The center of the complete galactic system has been located according to Dr. Shapley's investigations of the globular star clusters in the direction of the richest star clouds of

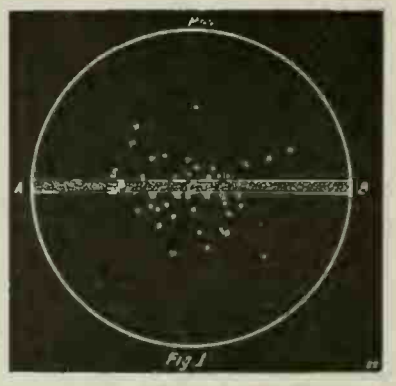

Fig. 1, Above, Shows a Section of the Celestial Sphere made by a Plane Perpendicular to the Plane of the "Milky Way." The Crosses Represent the Positions of Some of the Globular Star Clusters Projected Upon this Plane. The Equatorial Section A-B is 12,000 Light Years in Width and 300,000 Light Years in Diameter. Midway Between its Upper and Lower Limits Lies the Plane of the "Milky Way," the Pole of Which is at P. C Marks the Center of the Entire System, and the Globular Clusters are Distributed Symmetrically with Reference to this Point

Sagittarius, near the boundary of *Scorpio* and *Ophiuchus*. If there is a central nucleus of the Galaxy, it is to be looked for in this general direction which is also the center of the system of globular clusters, which are symmetrically distributed around this position (marked C in Fig. 1) above and below the plane of the Milky Way. In this direction also lies the vertex of one of the two star streams, the majority of the loosely-formed star clusters, the planetary nebulae and the peculiar Wolf-Rayet stars. It is also the region most conspicuously avoided by the spiral nebulae.

Our own solar system is situated well within the equatorial segment of the universe. It is to be found about half way from the center to the edge of the Galaxy (see S in Fig. 1) and is fully *sixty thousand light years* distant from the center of the complete system situated in Sagittarius, and only thirty light years above the central plane of the segment. It is simply one of the stars of the Milky Way, one of the numberless units of the universe. The nature of its journeyings to and fro within the limits of the equatorial region, granted that its travels are thus limited, will not be known until more is discovered regarding the details of the structure of the Milky Way and the laws that control the motions of its various members. Why the great majority of all the stars, as well as the

gaseous nebulae, remain closely confined to these equatorial regions, leaving to the immensity of undefined space beyond, vast and complicated systems such as the Magellanic Clouds the globular clusters and the spiral nebulae, is a problem still unsolved as is also the cause of the tremendous velocity, averaging a thousand miles per second, that is characteristic of all objects beyond the immediate vicinity of the Milky Way.

Whatever may prove to be the form and structure of the Milky Way, it is, according to all that has so far been discovered, of fundamental importance in the plan of the universe and exerts an influence over vast and massive systems situated far exterior to it.

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

A USEFUL ELECTRICAL LABORATORY SWITCH-BOARD.

(Continued from page 715)

are fifteen contacts and they should be spaced about ⅛" apart. The construction is shown in Fig. 8. The rods in both the transformer slide and the rheostat are mounted on a hardwood or fiber block, the dimensions of which are shown in figure 9. The rod is fastened to the block by means of screws or by a long pin thru the entire rod and block. The handle is fastened by bending a piece of brass as illustrated in the side-view. The contacts are six in number and are ⅛" thick 1" long and ¾" wide. Fasten to the marble with No. 8—32 flat-head machine screws countersunk into the contacts. Make them extend far enough behind the board to serve as connections. Therefore the heads must fit snugly because they will have to carry 60 amperes of current.

Next we will take up the construction of the transformer. The dimensions are given in Fig. 6. The core is built of No. 28 sheet iron or stove pipe iron will do. The pieces are cut 5" x 1¼" and 2¾" x 1¼". Use enough to build a core 1¼" thick when compress. The primary for 110 volts consists of 580 turns, 290 turns on each leg, of No. 18 D.C.C. magnet wire

The secondary consists of 180 turns of No. 14 or better No. 12 D.C.C. Taps are brought out for 1 volt at the fifth turn and at every additional five turns until the tap for 10 volts is brought out. Then bring out taps at the 60th turn, the 90th, 120th, 150th, and 180th turns. These are connected to the transformer contacts and the beginning of the coil is connected to one side of the plug receptacle. The other side of the plug receptacle is connected to the brass rod. But the transformer must be mounted first. Figure 7 shows how this is done.

The rheostat is made by winding No. 18 iron wire on 6 wooden cylinders three inches in diameter and 12 inches long. Wind 29 ft. of wire on each. Use nails or screws to start and end the winding. Connect in series and immerse in water. Tap the iron wire connections between each coil by using a heavy copper wire and be sure to let the copper wire make connection below the water. If the water gets too low the wire will almost instantly melt if it is carrying full load of 50 or 60 amperes. The connections are much the same as those of a starting box. Connect one side of line to rod and the other side to the 50 ampere stage plug. Then connect other terminal of stage plug to last lead of rheostat and connect the first terminal or beginning of first coil to contact No. 1, beginning of second coil to second contact, etc.

The main-line wires must be No. 1. This wire is expensive, therefore the switchboard must or rather should be near the entrance cut-out.

A 100 ampere current at 110 volts is 11 K.W., and this means the transformer supplying your house must be of that capacity.

MT. WILSON'S HUNDRED-INCH TELESCOPE.

(*Continued from page 703*)

detailed description of the process of figuring the mirror. Roughly speaking it may be divided into two stages. In the first stage the mirror was brought to a spherical figure; in the second this spherical form was charged to paraboloid. The second process tho requiring much less time than the first involved very great care and frequent optical tests to avoid the introduction of zonal errors. The largest deviation of the paraboloid from the sphere in the case of this mirror is only one-thousandth of an inch. All of the optical work, with the exception of the first rough shaping, was carried on with wooden tools of various sizes and forms, and the use of rouge and distilled water as the polishing material.

After the completion of the mirror a series of photographic tests was made to determine the accuracy of its figure. These showed a remarkably high degree of perfection, every portion of the surface having the same focal length to within one part in about 90,000.

A few figures may be of interest in this connection. The finished mirror weighs *4½ tons*, about one ton of glass having been removed in the process of shaping and figuring. Its diameter is closely 101 inches, and its thickness at the edge 13 inches. The depth of the curve at the center is about 1¼ inches. The focal length of the mirror is five times its aperture, or 42 feet. A direct photograph of the moon at this focus, accordingly, would have a diameter of 4.4 inches. As in most modern reflecting telescopes the 100-inch reflector will be provided with two small convex mirrors to be attached to the upper end of the tube, either of which may be utilized to increase the focal length in much the same way as telephoto lenses are used in ordinary photography. With these mirrors focal lengths of 134 and 251 feet may be obtained and the magnification correspondingly increased.

As soon as the optical work upon the mirror disk was fully under way the design of the telescope mounting was begun. In view of the great size and the immense weights involved the "closed fork" type was finally adopted. In this form of mounting the telescope tube is hung in the center of a rectangular frame of massive steel girders, the bearings providing for north and south movements of the tube being built into the two side members. The entire rectangle is mounted on bearings at top and bottom, which furnish the east and west motion of the telescope. To relive friction the system of *mercury flotation* used most successfully for the 60-inch reflector is employed, there being two large steel floats and corresponding mercury tanks, one at either end of the rectangular axis. These floats carry about 98 per cent of the moving parts of the telescope, or some 90 tons, the remaining two per cent being carried by two large spherical defining bearings. The instrument is controlled by electric motors, which provide for three rates of speed in both north and south and east and west directions.

The driving clock which moves the telescope at a uniform rate corresponding to the rotation of the earth is placed within the concrete pier which supports the instrument and near the south end. The driving shaft extends from the clock and meshes with a worm wheel 17 feet in diameter, which is attached to the telescope axis.

The building and dome which enclose the telescope form a steel structure 100 feet high and 95 feet in diameter. The walls and roof are double thruout to admit of the free circulation of air, and thus help to equalize the temperature within the building. The shutter is of the double section type, divided in the center, and when fully open provides an aperture 20 feet wide. Like the observing platform, the crane hoist and the dome mechanism, it is operated by electric motors. The dome is mounted on 24 four-wheeled trucks running on specially ground rails, and power is applied by two driving trucks at opposite sides. When rotated the motion of the dome has been found to be remarkably smooth and free from vibration in spite of the great weight involved, which is approximately 600 tons.

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Continued on Page 758

EXPERIMENTAL CHEMISTRY.

(*Continued from page 751*)

3. The burning of hydrogen.
4. Burning of arsin.
5. Breaking up of arsin by heat. The solution of arsenic in sodium hypochlorit gives.

6. $2As + 5NaOCl + 3H_2O = 2H_3AsO_4 + 5NaCl$.

In the same manner as above, test some solution imagined to contain arsenic.

Experiment No. 149.

Perform an experiment using $SbCl_3$ solution in exactly the same way as the $AsCl_3$ was used, and compare the results. Pay particular attention to the difference between Sb and As in position of deposit, in color, and in solubility in NaOCl.

Reinsch's Test.

Experiment No. 150.

Pour into a dish 3 or 4 cc. of a solution of arsenious chlorid [$AsCl_3$] or sodium arsenit [Na_3AsO_3] acidified with hydrochloric acid. In this solution place a strip of bright copper foil [about 3 cm. x 4 cm.] and boil the liquid for three or four minutes,—longer, if no discoloration of the copper appears.

What is the color? No change in the copper indicates absence of arsenic. In that case add more HCl and boil again. If the copper is finally discolored, take it from the liquid with the forceps, rinse it carefully, and press it lightly between the folds of filter paper to remove moisture. Then cut it into small strips with scissors; drop these strips to the bottom of a long and narrow test tube, and slowly heat the lower part of the tube.

See whether the copper changes color. Look for a sublimat. State its color; its position. Is it in color and appearance like the sublimat in Marsh's test? Compare it with metallic arsenic, arsenious oxid, etc. Examine the sublimat under a microscope, breaking the tube and scraping off a little for this purpose. Is it crystallin or amorphous?

Experiment No. 151.

Make arsenious sulfid [As_2S_3], wash it free from impurities, dry it and put it away for future use.

Experiment No. 152.

Ascertain by experiment a solvent for arsenious sulfid [As_2S_3]. Try [NH_4]$_2$ CO_3.

Experiment No. 153.

Make Paris Green [$Cu_3[AsO_3]_2$], wash, filter and dry, and put away for use.

Experiment No. 154.

Make arsenious oxid [As_2O_3], using not over ½ gram.

Experiment No. 155.

See whether As_2O_3 is at all soluble in water.

Examine the various compounds of arsenic with special regard to colors—red, yellow, green, and white—and attach names.

(*To be continued*)

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