August 1924
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25 Cents

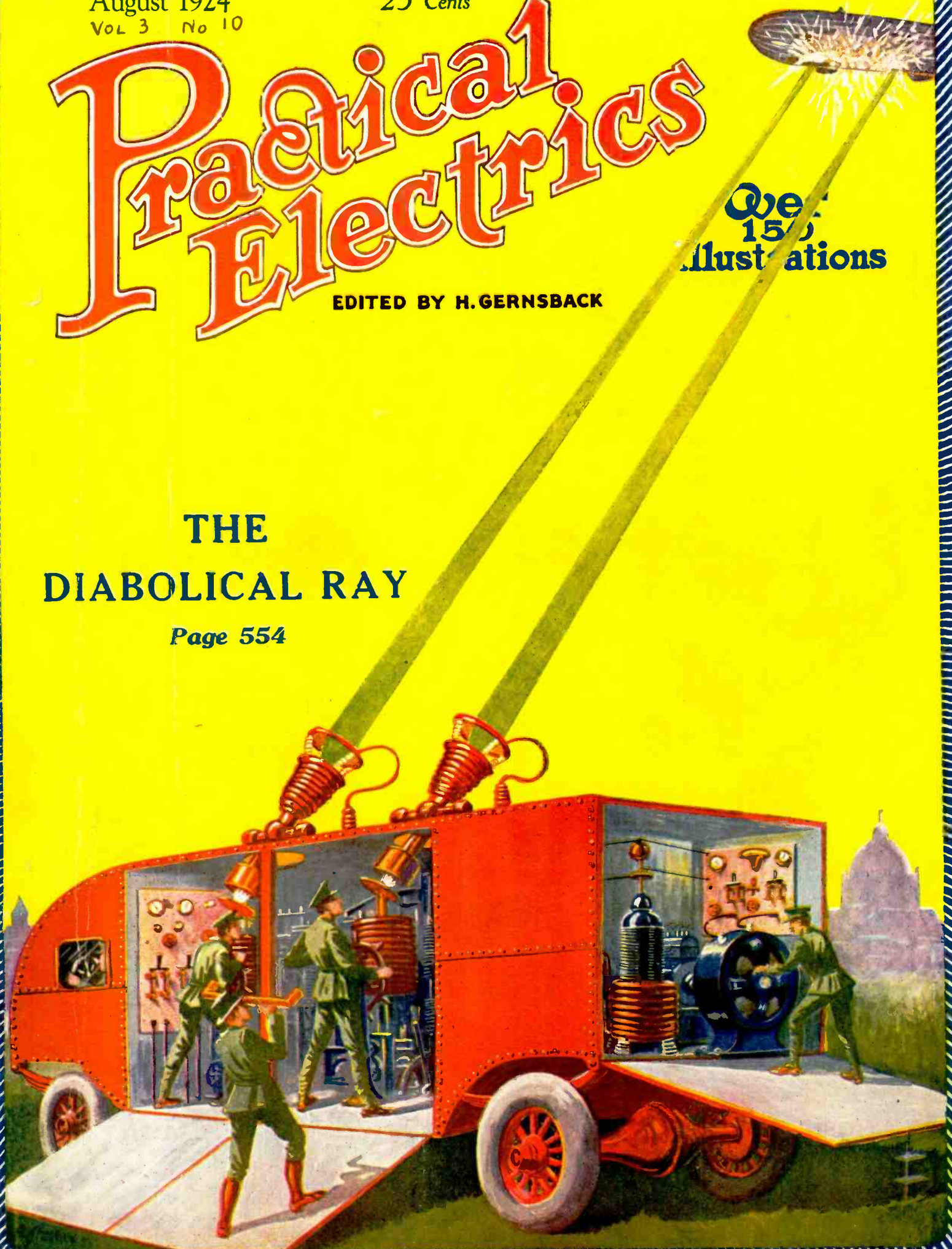
Practical Electrics

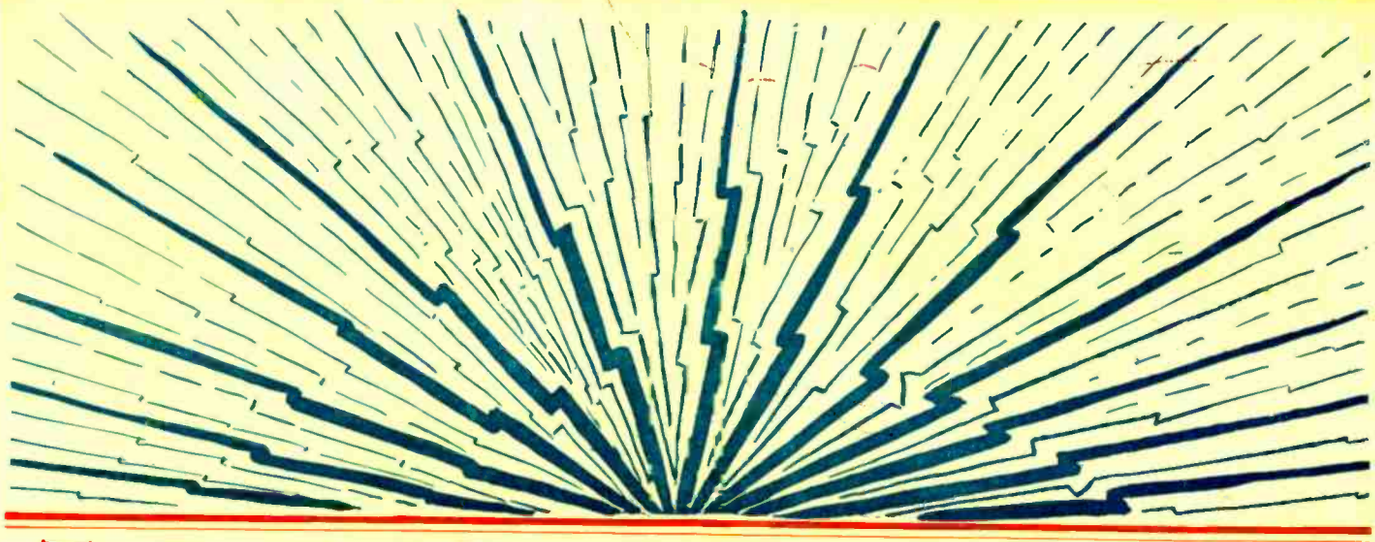
Over 150 Illustrations

EDITED BY H. GERNSBACK

THE DIABOLICAL RAY

Page 554





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Also Alternating Current Calculations in finding Impedance, Reactance, Inductance, Frequency, Alternations, Speed of Alternators and Motors, Number of Poles in Alternators or Motors, Conductance, Susceptance, Admittance, Angle of Lag and Power Factor, and formulas for use with Line Transformers.

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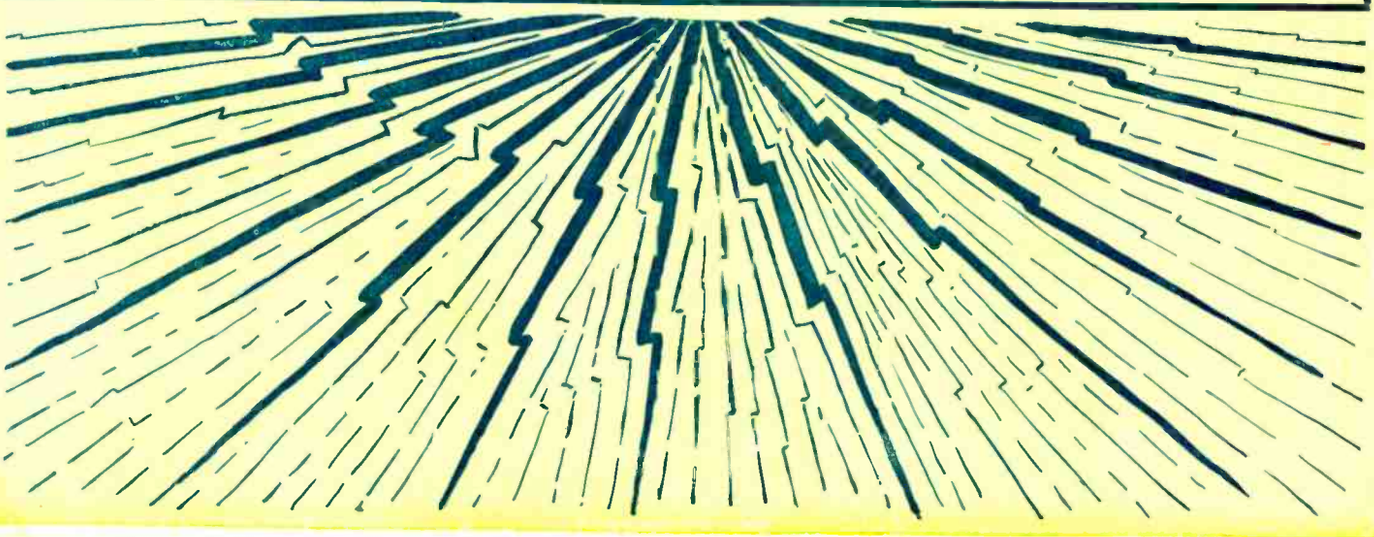

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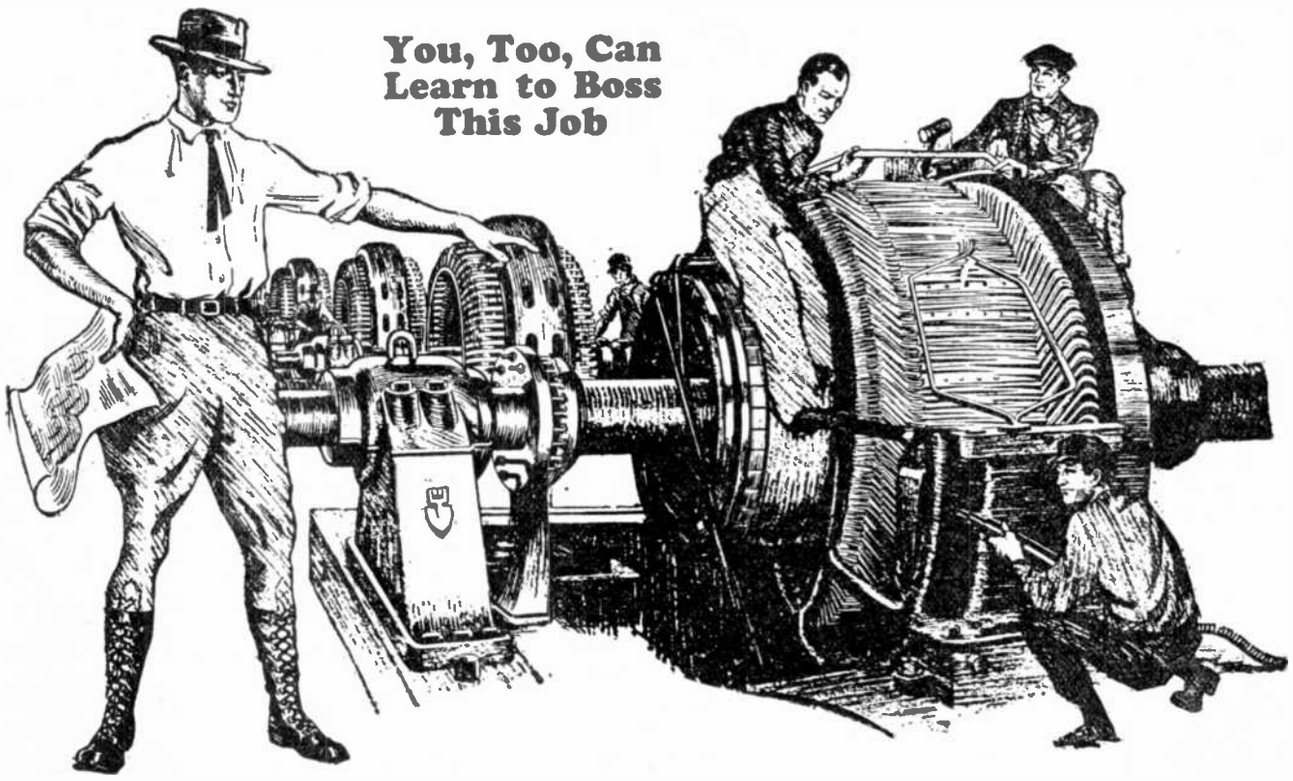

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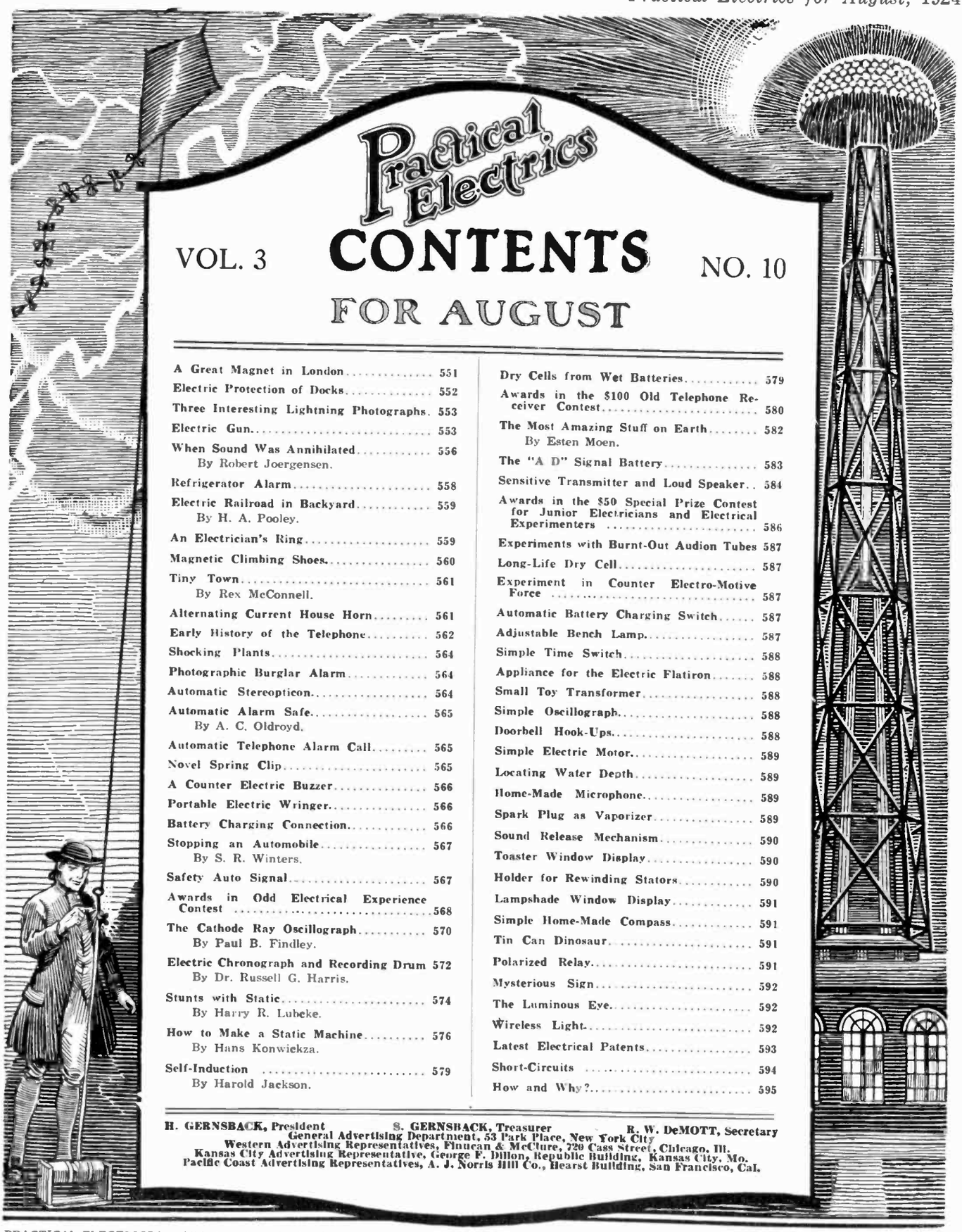

Practical Electrics

VOL. 3 **CONTENTS** NO. 10

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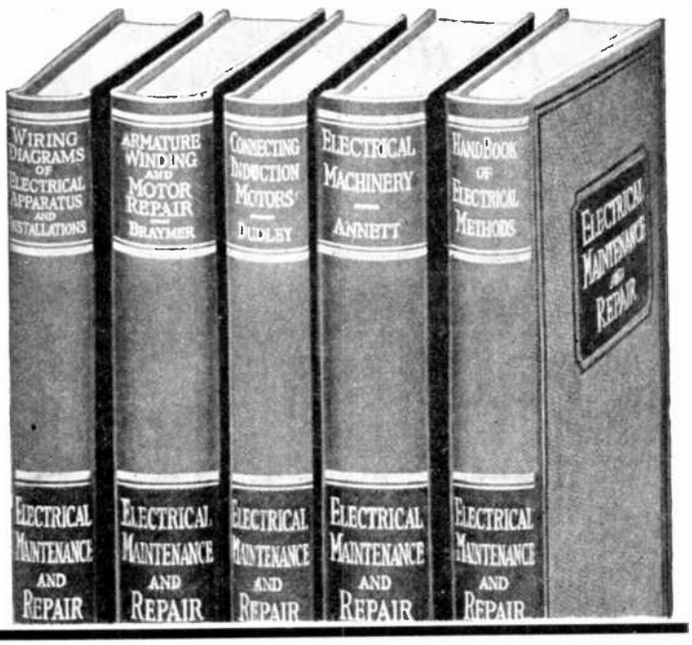

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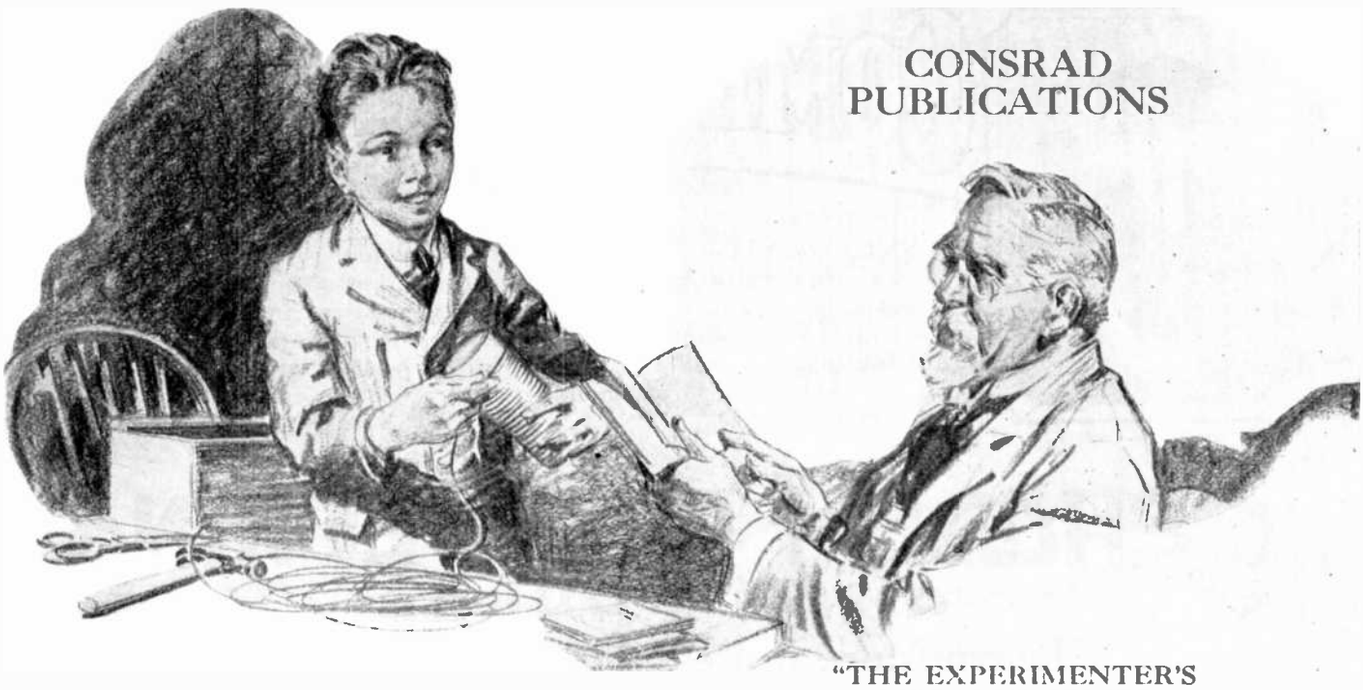

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Volume 3
No. 10

Practical Electrics

August
1924

H. Gernsback, Editor and Publisher T. O'Conor Sloane, Ph.D., Associate Editor

A Great Magnet in London

Tricks of a magnet; umbrellas are stolen, nails drawn out of a box, a dog is tethered by his iron chain, even a watch is attracted for some mysterious reason—presumably because it has an anti-magnetic iron case. Below will be seen the extract from the daily press, on which this picture is based.

WHEN Professor Joseph Henry constructed his large electrical magnets, which in those early days were miracles of electrical accomplishment, he supported weights of many pounds. The spectators would stand upon the armature and public lecturers used them in their demonstrations before audiences.

The Stevens Institute of Hoboken, as one of its great achievements, had one of the largest electromagnets of the world constructed to give a widely distributed field, so that it would attract objects from a considerable distance. It would hold them with great force once they were brought metal to metal.

The writer well remembers inspecting this magnet once, and neglecting the warning to look out for his watch, departed with a pretty thoroughly magnetized timepiece. A clipping from a recent paper which we give here tells of the great magnet in London at the Wembley Exposition

BIG MAGNET STEALS
BRITISH EXHIBITION
VISITORS' UMBRELLAS

LONDON, June 6 (A. P.).—Visitors to the engineering section of the British Empire Exhibition being held at Wembley must take great care of their umbrellas and any other articles containing steel or iron, for one of the exhibits is a giant magnet weighing nearly 6,720 pounds.

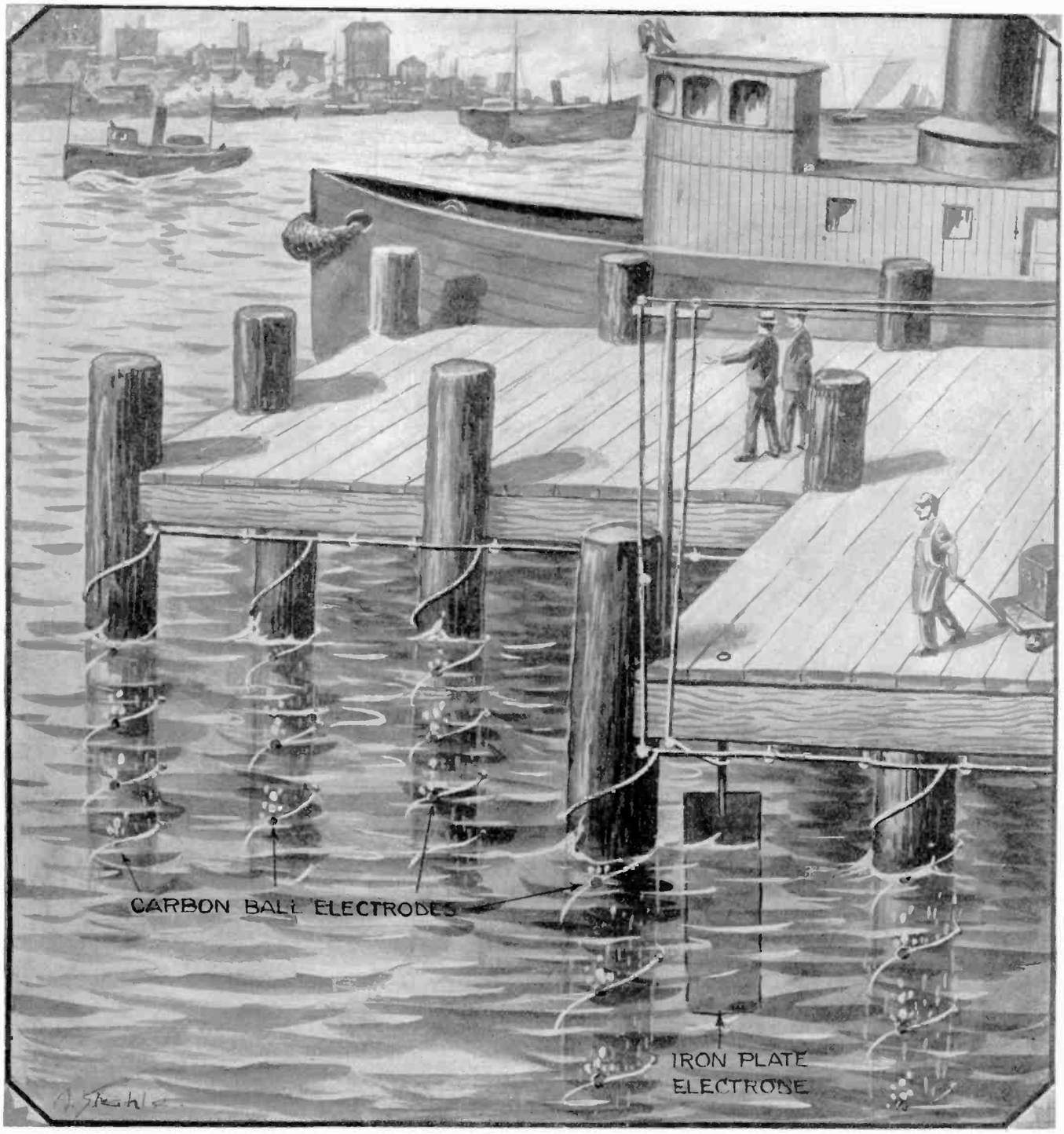
The magnet has several times stolen souvenirs from visitors. A woman carrying a handbag apparently of silver had it drawn from her grasp, and several umbrellas have been snatched from the hands of their owners. The magnet can lift 80,600 pounds of metal.

and describes the tricks which it is supposed to have played upon unsuspecting spectators.

Our artist has given way to the range of his fancy in the illustration above and shows a great magnet attracting all sorts of objects of iron and steel, wrenches, umbrellas, and the like. A man has the end of a crowbar held rigidly to it, a boy with a box full of spikes finds them flying through the air; a supposititious gold or silver watch is mysteriously attracted, indicating that in its case or works there is iron or steel.

Lines of force from a magnet inevitably and always form a circuit; they cannot exist as straight lines, except for a limited distance. If there were any way of sending magnetic lines of force straight out into space the powers of the electromagnet would be wonderfully increased. As it is the attraction of a magnet for an iron or steel object diminishes at a very high rate with increase of distance.

Electric Protection of Docks



The protection of wooden docks in salt water has been a very serious problem. Above we see electricity applied to drive away or kill the teredo principally, which is the great enemy of submarine woodwork. The wires wound around the piles are insulated and carbon electrodes are exposed at intervals. The iron cathode is seen immersed in the vicinity.

THE destruction of docks in salt water by the teredo has been a source of great loss. A wooden dock represents a considerable investment of capital, and the teredo and other boring creatures are always ready to wreak destruction upon the submerged portion of the woodwork piling.

A recent patent proposes to apply electricity for the protection thereof. We illustrate the method here.

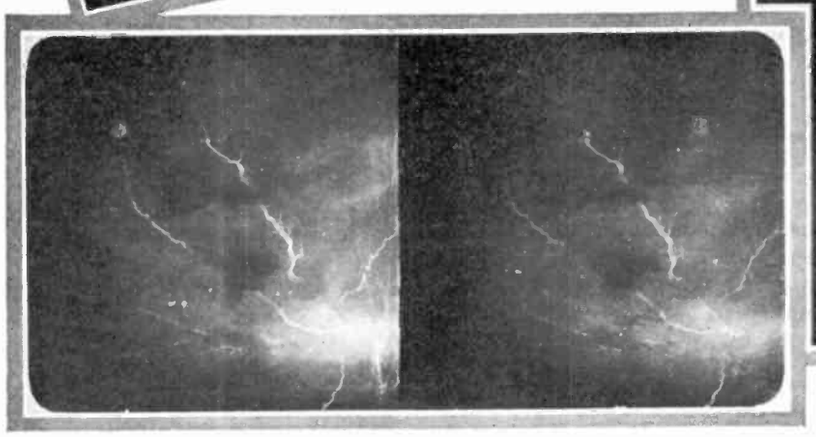
A heavy current of electricity is passed through the water surrounding the submerged woodwork; one of the terminals of the circuit is carried to an iron plate electrode of large area, submerged in the vicinity of the part to be protected. The other lead of the wire runs to the different piles and is wound around them, so that the spiral lines surrounding the wood are in parallel with each other.

On each of these wires there are several carbon balls, the wire being insulated except through these. This refers to the wire which is wound around the wood. As the current passes, the water acts as an electrolyte and the action of the current in decomposing water is relied on to protect the structure from the teredo.

The iron plate is the cathode and the numerous carbon balls are anodes. Stress is laid on the importance of passing current in the right direction to insure the desired result. If the iron is made the anode, it is claimed that the result will be futile as far as the teredo is concerned. It is essential, too, that direct current be employed.

Owing to its salt contents, sea water is a fairly good electrolyte and the decomposition of the salt by the current is relied on to kill the little shipworm. The electrodes on the wires operate to give distributed action which will go to protect the whole surface of the timbers.

Three Interesting Lightning Photographs



Three examples of lightning photographs. The one on the left dates back to the early days of these achievements and was taken in 1885 after the photographer had tried in vain for three years to get a result.

On the right is the top of the famous William Penn tower of the Philadelphia City Buildings, surrounded with a perfect glow of light, the statue being hidden thereby.

Below is a stereoscopic photo of a lightning display. It was taken with two cameras 100 feet apart.

IN the past we have shown many photographs of lightning, but the three which are reproduced on this page are of especial interest, each one having its own peculiar features.

The photographer who took these views states that after trying for three years to induce Jove to write his autograph on a photographic plate, he succeeded in capturing it on August 5, 1885. The photographic emulsion of those days was too slow to record an ordinary lightning flash. This was an unusually vivid discharge.

When Franklin flew his famous kite, he was playing with fire, as the old time expression has it; here his predecessor like Ajax is defying the lightning, and a view of Jove striking "Billy Penn," the bronze statue on the top of the City Hall Tower, Philadelphia, is shown.

During a thunderstorm, just before the release of the electric tension, there will often be noticed the formation of a "brush" discharge, when the ring of electric lights on the tower gradually disappears and becomes lost in a bright fog. This is instantly cleared up when a lightning discharge occurs in the vicinity of the tower.

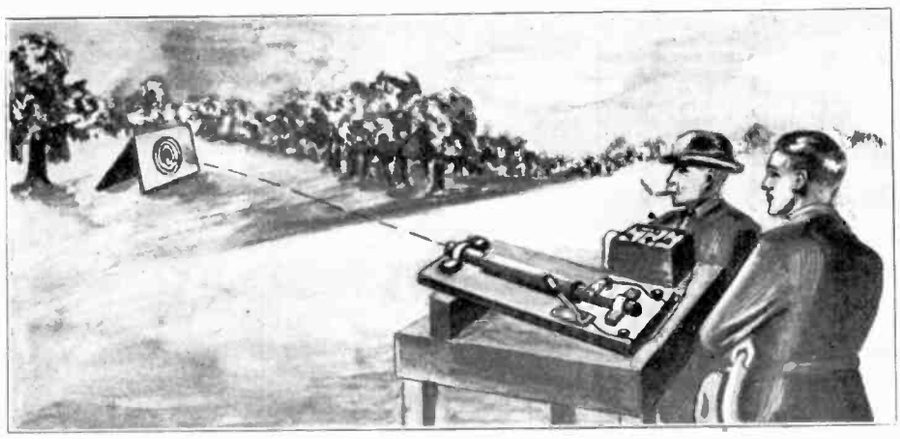
We also show what the photographer believes to be the first stereoscopic photograph of lightning ever taken. Two cameras were placed at open windows, about 100 feet apart, and an arrangement was devised for opening the lens shutters before and closing them after a flash of lightning in front of the cameras.

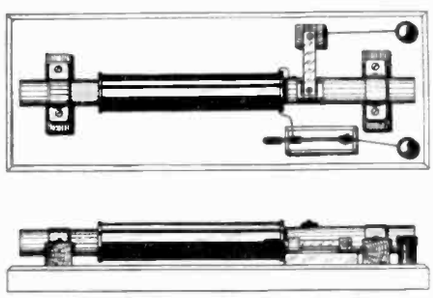
If one looks at this photograph and allows the eyes to be directed toward an imaginary distant point, it will be noted that the lightning is not on a flat plane, but that the branches approach and recede like the branches of a tree. The photographer states that he was the first to term this form of lightning "tree lightning."

Contributed by W. N. JENNINGS.

Electric Gun

By FRANK W. GODSEY, JR.





An electric gun operating by solenoid action and whose action in the way of opening the circuit is affected by the projectile itself.

AN electric gun to be used for demonstration purposes was recently made for the third biennial engineering show of the Rice Institute. Such a gun is easily made and provides a very interesting experiment.

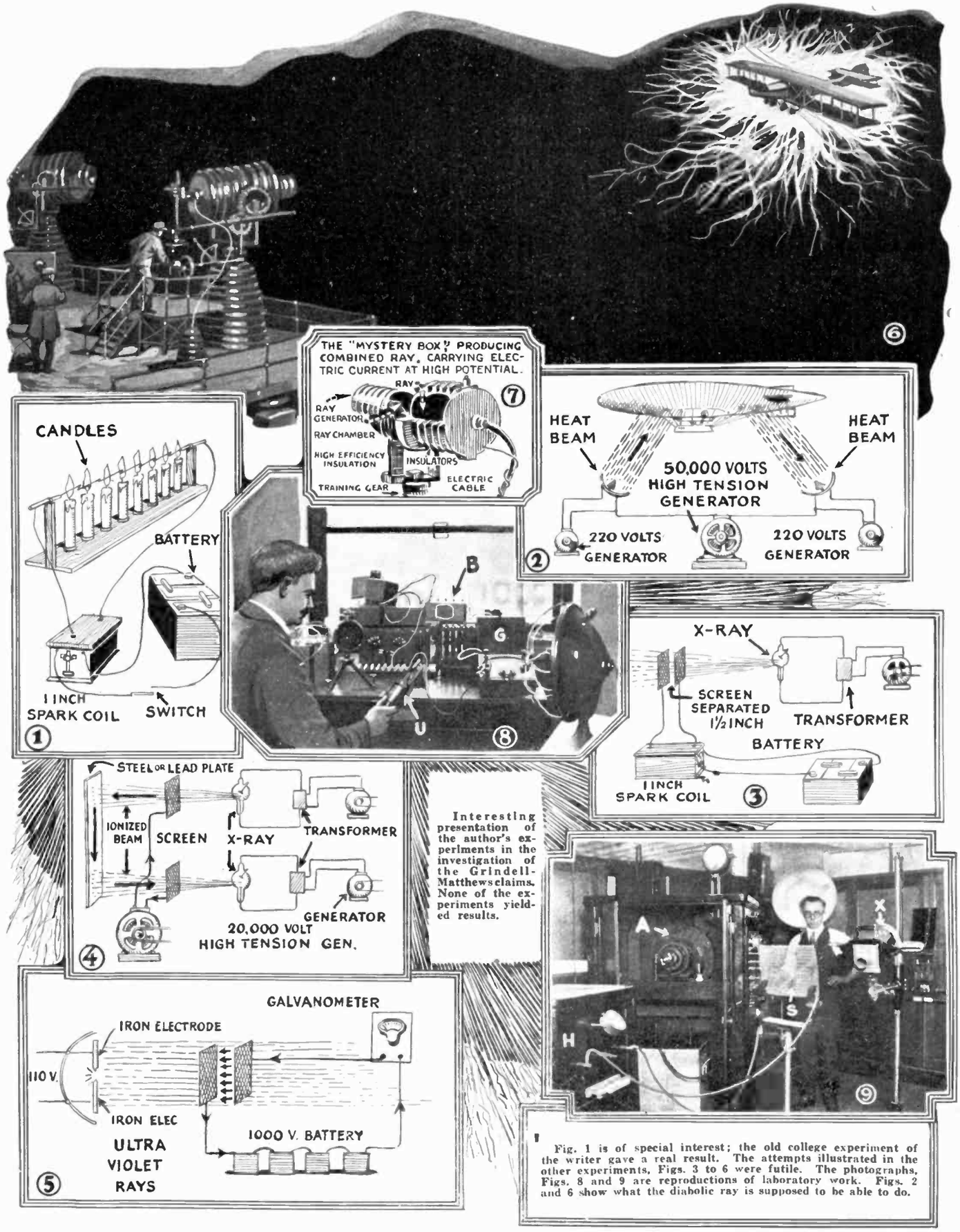
A one-inch brass tube about fourteen inches long is the gun barrel: a solenoid consisting of about 240 turns of No. 18 D. C. wire is wound into a coil seven inches long and is placed about three inches from one end of the tube.

A wooden base, six by sixteen inches, is made and two wooden blocks with semicircular segments cut from their upper edges are fastened a few inches apart on the base. The brass tube and coil is then clamped in the slots in the top of these blocks. The recoil will not be serious.

A block of carbon one-quarter inch square is fastened to the end of a small, flat spring by means of a countersunk screw through the center of the block, and the spring is mounted on a small wooden block fastened to the base in such a way that the carbon block projects through the slot in the brass tube to a point about five-eighths inch from the bottom of the tube. The carbon block must not touch the tube at any place.

The Diabolic Ray

By Hugo Gernsback



Interesting presentation of the author's experiments in the investigation of the Grindell-Matthews claims. None of the experiments yielded results.

Fig. 1 is of special interest; the old college experiment of the writer gave a real result. The attempts illustrated in the other experiments, Figs. 3 to 6 were futile. The photographs, Figs. 8 and 9 are reproductions of laboratory work. Figs. 2 and 6 show what the diabolic ray is supposed to be able to do.

The Diabolic Ray

By Hugo Gernsback

Member, American Physical Society

AS our readers are aware, an English electrician named Grindell-Matthews has recently made himself heard from one end of the world to the other in connection with his so-called "Diabolic Ray." From what we are expected to believe in reports from eye witnesses, Mr. Grindell-Matthews was able to electrocute a rat from a distance of 15 feet by this mysterious ray. He is also credited with having stopped a motorcycle with it at a distance of about 50 feet. It is, however, quite significant that when the British Government asked him to duplicate the experiment in the British Laboratory, substituting their own motorcycle, Mr. Grindell-Matthews refused the offer, although his government gave every assurance that he could keep the invention secret. This of course does not speak well for the invention.

Let us go back and see what has been done in the past in connection with so-called "death" rays. Mr. H. G. Wells in his book the "War of the Worlds" was probably one of the first to make use of the problematic death dealing ray.

The present writer in his story, the "Magnetic Storm" which appeared in the ELECTRICAL EXPERIMENTER, November, 1918, outlined a scheme whereby the entire German Army was made to capitulate by highly induced Tesla currents, the underlying idea of the writer's scheme at that time being to surround the entire battle front from the North Sea down to Switzerland with a highly charged electrical "fence." This "fence" was the *primary* of a number of titanic Tesla coils. Curving around in a huge semi-circle, the fence was so highly charged that any electrical mechanism for miles around that had any electrical winding would become the *secondary* to the Tesla coil, and would immediately become burned out the instant a current was started in the primary.

While purely fantastic, the idea is, nevertheless, sound and Dr. Nikola Tesla endorsed it as feasible, at least within the range of a few miles.

In trying to determine if Grindell-Matthews really has an invention or a hoax, it is best to enumerate all possibilities of the case, for even if Grindell-Matthews has not at present the death-dealing ray, such a ray will be found sooner or later. It is all in the realms of physics and just because we do not actually know how to produce it today is no reason why it will not be produced tomorrow. The case for us to decide is if Grindell-Matthews has a new ray, or whether he is making use of the already well-known properties of present-day rays and the laws of present-day physics.

On the table shown in this page we see a list of vibrations. We may dismiss octave 1 to 15 which embrace sound waves. We do not think that by means of these low vibrations electrical currents can be super-posed on such sound waves. The 20th octave is known to us. Its properties are hidden from us. The same is the case with the 40, 45, 51, 57 and the 62nd octaves. Has Grindell-Matthews discovered a new ray that comes within any of these unknown frequencies, one composed of any of these unknown vibrations? Frankly we do not believe that he has; as a matter of fact, he says so himself. *In other words he has discovered no new ray*, no new physical principle, but he does claim to make use of present-day devices and present-day facilities to achieve his ends. But let us see if this holds forth any promise. What can any good scientist do with present-day means? The writer asked himself this question and he performed a number of experiments as will be indicated below.

Refer to illustration No. 1. This is an old college experiment of the writer's. Eight candles were placed on a board so that they almost touched. At each end candle there was a wooden support upon which electrodes were fastened which reached into the flame of the first and last candles. By means of a coil giving a one-inch spark when energized by a battery, it was possible to make the spark leap over a distance of about five or six inches.

What does this experiment mean? Just this—that if you have a sufficient amount of hot gases or hot air it is possible to make an electrical discharge leap over a large gap, which it would be unable to do in free air. As everyone knows, a spark coil giving a one-inch spark cannot

TABLE OF VIBRATIONS

Octave	Number of Vibrations per Second	
1st	2	
2nd	4	
3rd	8	
4th	16	Sound
5th	32	
6th	64	
7th	128	
8th	256	
9th	512	
10th	1,024	
15th	32,768	
20th	1,047,576	Unknown
25th	33,554,432	Electricity
30th	1,073,741,824	
35th	34,359,738,368	
40th	1,099,511,627,776	Unknown
45th	35,184,372,088,832	
46th	70,368,744,177,644	Heat
47th	140,737,468,355,328	
48th	281,474,976,710,656	
49th	562,949,953,421,312	Light
50th	1,125,899,906,842,624	Chemical Rays
51st	2,251,799,813,685,248	Unkown
57th	144,115,118,075,855,872	
58th	288,230,376,151,711,744	X-Ray
59th	576,460,752,303,423,488	
60th	1,152,921,504,606,846,976	
61st	2,305,843,009,213,693,952	
62nd	4,611,686,018,427,387,904	Unknown

be made to give more than that one-inch spark in the open air. By using heated gases we can increase the distances.

Now consider Fig. 2. Here we have the actual experiment of Fig. 1, duplicated in a hypothetical death-dealing ray. Imagine two large reflectors with two enormous electric heating elements, built along the lines of our electrical parabolic heaters, such as we use to heat our bathrooms on a chilly morning. These heaters are to be so powerful that they will throw a hot beam over a mile. We admit that they would have to be "some" heaters to do this, taking into account cold air currents, winds, etc., which would most surely affect the operations of the heat beams. But let us suppose the beams were sufficiently hot and powerful. We attach to each one of the heaters a 50,000-volt high tension generator or if you think that this is not sufficient we can step it up with transformers to a million volts if necessary. We can now see that if everything works, we could direct the two beams on an airship or airplane as shown and the high tension discharge would go via the parabolic reflectors, would follow the path through the heat and the ionizing heat beam up to the airship and down through the other heat beam. The high intensity current would burn out all electrical windings and thus stop the machinery and cause fires, bringing down the machine.

A beautiful theory, but we do not think that it will work out very well over a distance of a mile or so. To be sure such results can be had over comparatively small distances, maybe 50 or 100 feet, but it would be far too expensive for the results that it would accomplish.

So much for heat rays. We next turn our attention to the most powerful ray known to science today. This is the X-ray. X-rays, as is well known, have the power of ionizing air, in other words, make air conductive to the electric current. For instance if you turn an X-ray on a charged electroscope, it will discharge almost immediately, proving the conductivity of the air. When Grindell-Matthews first brought out his death-ray the writer thought to duplicate it and he rigged up the apparatus shown in Fig. 3. The photograph, Fig. 9, shows this apparatus of the experiments along similar lines.

Refer to Fig. 3. Here we have a powerful X-ray tube sending out its usual intense X-rays. In addition to this we have also a spark coil giving a one-inch spark, the high tension posts of which are connected to two pieces of metallic screening separated about 1½ inches. The spark coil was now energized by the battery and of course no spark jumped between the screens for the reason that the coil could only give one-inch sparks and no more. The idea behind this was to find out if the air between the screens could be sufficiently ionized to make the spark clear a gap of 1½ inches. The logic recalls the experiment shown in Fig. 1, in which we have a one-inch spark actually leaping over a distance of about five inches, so if the X-ray was as good an ionizer as were the gases of candles, we should not only get 1½-inch sparks between the screens, but a six-inch or seven-inch spark. But the writer was very much disappointed to find out that the results from this experiment were entirely nil. Evidently the ionizing, as powerful as it is, fails to make the air conductive enough, or otherwise a different kind of a current than that given by an induction coil must be used. Right here it may be stated that several other electrical currents were tried out with the same negative result. Not only did the spark refuse to leap the maximum distance, but no increase of the air gap could be bridged at all, not even one-sixteenth inch over the one inch.

Then the experiment shown in Fig. 4 was tried. Two large and powerful Coolidge tubes were connected as shown, the two screens were put in position, while a 20,000-volt generator was connected to the two screens. The idea here again being to have the current go as shown by the arrows from one screen to the steel or lead plate, down the lead plate, then leaving the lead plate pass over the ionized beam to the lower screen and back to the generator. Nothing at all happened. There was no spark of any kind and as far as we could tell, no energy went over the beam. Then we attached the high tension generator direct to each one of the poles of the X-ray tubes with the hope that this might prove more successful, but with no result.

(*Continued on page 601*)

When Sound Was Annihilated

By Robert Joergensen

PALE with rage, with flaming eyes and clenched fists young Zerno sprang to his feet. Suddenly he seized his wine glass and threw it across the table, so that it broke in Captain Migel's face. This was his answer to the captain's insulting words. The young officers who sat around the table sprang to their feet and looked in alarm at Ilja Zerno. What had he done? Ruined his future, his coming career as an officer, put his young life in the balance by an ungoverned action. The prince had forbidden under penalty of death all dueling, but could no other solution for this situation be found than a duel? No. Then the result of such might for young Zerno be either death or exile.

The only one who in the general commotion kept perfectly quiet was Captain Migel. With a cold smile he remained sitting in his place and wiped off the red wine which sprinkled his face and uniform; now he rose, his face became severe, and with a voice cold as steel he said: "I shall kill you for this Mr. Ilja Zerno and I will do it as quickly as possible. Can my friends meet you within an hour to arrange time and place?" He threw a contemptuous glance of inquiry at Lieutenant Zerno, who for answer mechanically bowed his head, and with slow steps Captain Migel left the room.

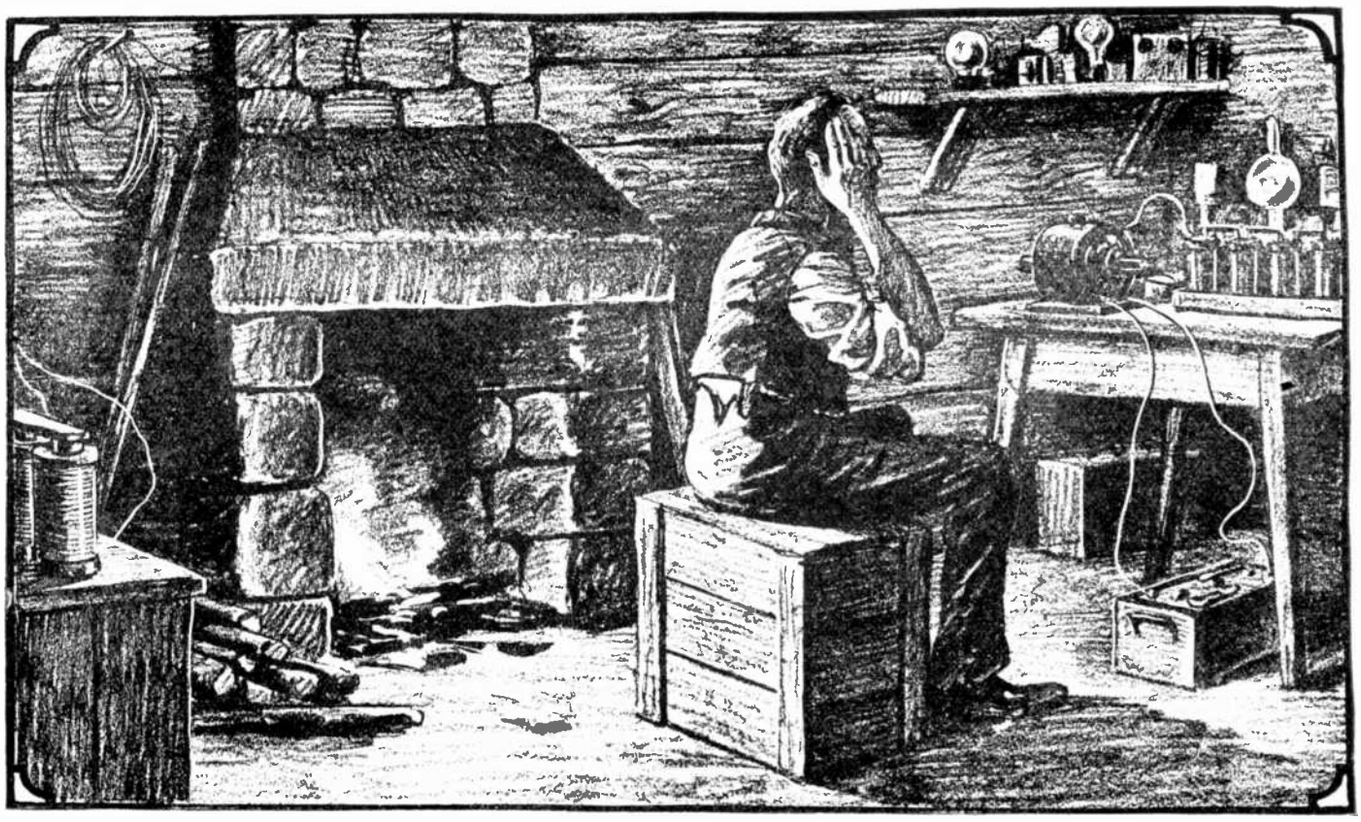
Zerno remained standing at the table with hard staring eyes; it was as if the full meaning of what he had done only now stood clear before him. But as his comrades began to flock around him inquiring, warning and wondering, he suddenly roused himself, drew a deep sigh and hastily passed them on his way out of the room.

The Duel

The morning after, while the air was still cold and the morning sun shone white and dreary, a little assembly of men met in the Bernetz Forest and disappeared among the trees. Now, before the dew had disappeared from field and tree, one of them lay cold and dead on the grass and another was fleeing to a strange land.

The next morning Ilja Zerno awoke in the capital of a foreign country. There he remained for a long half year; it was known that he had vainly sought for occupation and then he suddenly disappeared from the city without telling anyone. Rumor told that he had been seen in the great commercial port but nothing positive was known. He had disappeared out of the world in which he had lived hitherto. But whether that was to go to a better or a worse, no one tried to determine with any degree of certainty.

And so year by year, the memory of Ilja Zerno grew fainter and fainter.



"Poor as the hut was, a quantity of electrical apparatus was contained within it. . . . Weird sounds were produced in his experiments which excited the fears of the passers-by and which the experimenter himself could not endure."

A Mysterious Being

The heath was awe-inspiring, deserted and cold. And the man who lived out there in the hut was alone, alone and mystical as nature that surrounded him.

Who was he? No one knew. Where did he come from? No one knew. No one knew his name, what he was doing, how he supported himself, nor why he lived so lonely out there in the deserted heath.

Superstition had deep roots in the souls of these people. For them the supernatural and unexplained was worse than death. The effect of it all was that they went in a wide circuit around the house on the lonely heath, and hastened away to the adjoining village.

The heath was awe-inspiring, deserted and cold. The man there was unknown and charged with secrecy; the hut he lived in was wretched and ready to fall into ruin. A fire burned in the great open fireplace; out of the darkness the fantastic contours of machines, glass vessels, working tools and instruments of physics emerged. The man himself sat bent over and meditating by the fire; the flames cast a mystic glow over his old and energetic features, was reflected from his deep, luminous eyes, lighted up his whole form, and then would suddenly go down to disclose no longer the poverty that came into view.

He stared into the fire with a dreaming, seeking look; he thought and murmured half aloud to himself, in the way common to those who live much alone: "Home again; home; but no one must know it, not even those nearest to me. I must always live alone; but it is home in my own land with my own people; it is my own language which I hear spoken on the streets of my city. When I wish, I can visit the places where I lived as a child and a young man.

The Soliloquy

"What might I not go through in a foreign city—struggle, in need of everything, and living in poverty. And it is not yet over; the hour of relief is not yet near. It is as far away today as on the morning when the victim fell. But one must be patient; one must set his teeth and make the best possible out of circumstances, even if all appears hopeless.

"What a hell was that, the wharf I worked on! An inferno, not of smoking fire, but of noise and sounds, the shriek of steam whistles, the hammering of riveting machines, clangor and noise everywhere, and everywhere and on all sides the hammering of the riveting machine.

"Could anything be found which would so enslave a man, dull his brain and split his nerves, like a constant abode in such a hell of noise. If the thought came to one: 'I am unhappy!' the riveting ma-

chines would rivet that fast into the heart and close it in.

"And if the noise in the machine shop and workshop could be abolished, if all the men could work without sound, what a paradise such a place would be in comparison with this where I worked. The workmen could sit in quiet and at peace at his bench, his nerves would be spared and he could find quiet to think out his own thoughts, without being deafened by the clangor of the machine.

"Is anything of this sort unthinkable? No, surely not. What is sound but a vibration of the air and as a weak light disappears before a stronger obscurity, a weak noise is unheard over a louder one. If one could now produce a tone so strong that it deafened all other sounds, and without weakening it any, let it rise into higher and ever higher frequency until it reached over 60,000 cycles per second, then all sound would disappear. All would be still as death. No human ear could perceive the least sound. . . . but then it would also be impossible for men to communicate with each other except by signs. Men who worked in such a place, where there was no sound, might as well be deaf and dumb, and that might be still more dreadful. . . ."

The speaker's voice dropped to an inaudible murmur. Thinking and sighing he sat long and stared into the fast expiring fire.

auditory nerve, to be carried out by high frequency oscillation of audions. Those of us who have heard, and who have not, the piercing sounds that can be produced by the little bulb of the radio apparatus will realize how powerful an agent is at hand in it for throwing the air into vibration. Audion bulbs can be made to produce any desired note but here the pitch was to be raised far above the range of the human ear. Weird sounds were produced in his experiments, which excited the fears of the passers-by and which the experimenter himself could not endure.

Distress in His Home Country

Distress spread over the country. Slowly it wormed its way in, insinuated itself everywhere, and obtained firm foothold, sometimes in one, sometimes in another district. From an intangible suspicion spreading everywhere, it quickly rose to frightful reality. War in a neighboring country, reducing exports and the operations of commerce and factories, which had to be closed, threw thousands and more thousands out of work, and they wandered back and forth through the streets in small groups, gathered on the street corners and great squares, discussing the latest news about home and foreign conditions. The voices were yet quiet, for the populace were spiritless, depressed and troubled over the sudden change in their life; they were unaccustomed to governing themselves and had no leader to guide them. Silent and passive they awaited the further development of affairs, but they did not have to wait long.

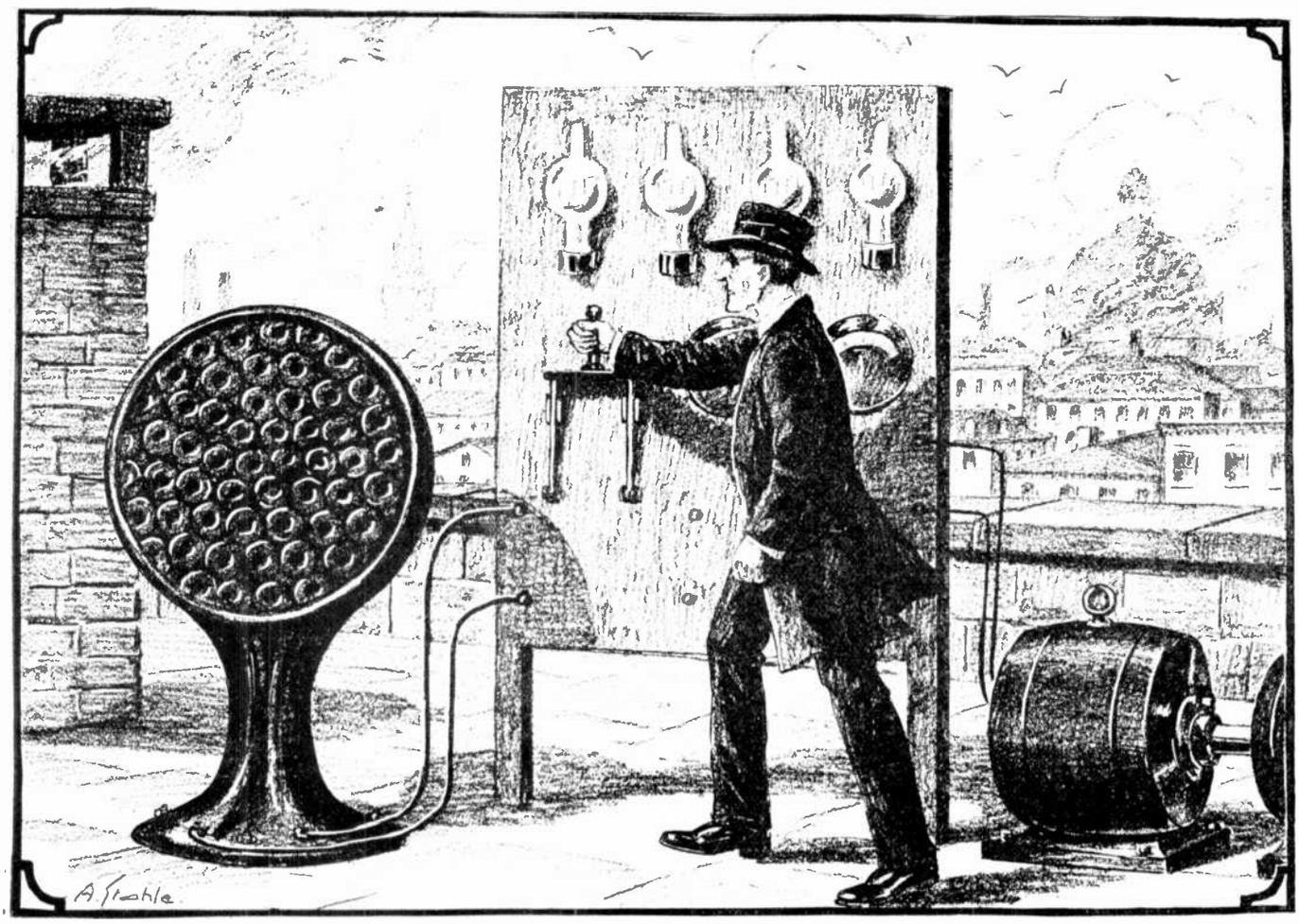
The country was soon cut off from importing the necessities of life and turned to their own insufficient harvest fields. This year the harvest failed; conditions became alarming. Ever greater crowds of pale shadows strode day and night through streets and market places, hungry and distracted. Here and there a voice was lifted up over the general murmur and the grey shadows willingly gathered around it to hear the story of their own need and poverty and to listen to hate inspired attacks upon those who controlled the government.

Conditions became alarming. The authorities saw with anxiety how it began to ferment in the people's mind, but still managed to keep in control of the situation. But they were anxious lest the day would soon come when hunger and need would drive the people out of themselves, and they were frightened lest the slight force of police and troops at the disposal of the city would be unable to hold back a revolution.

They were afraid that the day would come soon, only too soon.

The Impending Revolt

Colonel Becker, Commander of the City Military Forces, sat in his office in the castle and turned over the pages of his journal. He was not satisfied either with the general condition of things nor with the excitement in the city which was in his charge. What could he do, with his twelve hundred men, against the hundred thousand excited devils in men's form who had taken control and got it into their heads that they could only get bread, money, work and happiness by overthrowing the present government. What was he to do, he asked himself with a bitter smile. He could get no increase of troops, he could get together the little body of



"The Colonel saw him. On the roof was installed the apparatus which had produced such a startling effect. A generator operated a bank of enormous audion bulbs connected to a reflector full of high pitched telephones, especially constructed to correspond with the ultra-audible frequency."

His Work in Electric Sound Production

Poor as the hut was, a quantity of electrical apparatus was contained in it, a noticeable feature of which were audion bulbs, induction coils, evidence of the idea of enforcing silence by the production of air vibrations beyond the range of the

men who occupied the Castle and fight to the last man to hold it as long as possible. The Prince might withdraw to the innermost rooms and into those Colonel Becker asserted no one should come save over his dead body. A knock on the door was heard and at the Colonel's "Come In" his Adjutant stepped into the room.

The Adjutant's Report

"Is there anything new."

"Only that Lieutenant Jerko and his comrades have come back, Colonel."

"Let them come in."

Lieutenant Jerko and his two comrades had gone out into the city in disguise to find out how the people felt. It was now just darkening and they returned to give their report.

"Lieutenant Jerko," said the Colonel, "I have seen with pleasure that you undertook this little reconnaissance. Tell me now what you have seen."

"It is perfectly clear that the situation is ready to come to a head.

"I rambled over the city today and everywhere felt the general disquiet and threatening atmosphere; there has not as yet been any actual outbreak—it is known that a man was plundered in the open street, that a few shops in the smaller streets had their windows broken in, food was stolen and men went around into the houses and begged in a threatening manner, but there is no great violence ensuing as yet, and even if it were wished for by them, the groups on the market place were all dispersed by the police. It is as if men were wandering around and awaiting final orders to break loose."

One of the Leaders

"If you will give me permission," said one of Jerko's companions, "I can give you the latest news. Today when I stood on a corner and looked over the square I saw a man who went from group to group, stopping a moment with each of them and then going on. When he completed his circuit through the square and went down to the eastern side of the city, I decided to follow him. First it was very easy, there were so many people in the street. But it became more difficult as the man began to reach comparatively empty streets and lanes. He never stopped or realized that he might be followed; at last he stood still and turned around, but as he did this I sprang back into a doorway so that he never saw me. At last the man reached a poor little shop with a sign which announced that there was a cafe there. Here he knocked and at once the door opened. As I stood by his side I nodded to him as if I knew him, and went in before him. He looked somewhat astonished but as the doorkeeper said nothing he thought I was all right and as I was seen entering in known company he made no trouble.

"The place we came into was full of poorly dressed men; the air was full of bad tobacco smoke and of the odor of sour beer. The man I had followed seemed to be at home here and greeted everyone to right or to left and I went along with him and tried to appear to be in his company and I nodded to all that he greeted. He went through the crowd and knocked upon an inner door and disappeared therein, but as I didn't dare to repeat my maneuver, I cast myself down on an empty chair and tried to seem as stolid and uninterested as possible, while with tense attention I listened to the conversation around me.

A Conference of the Leaders

"I couldn't make much out of it; no one seemed to know anything definitely. There, thought I, it is best to wait until something or another happens that can give me some enlightenment.

"After I had waited for about two hours a party of men came out of the inner room. From the dead silence which fell as they emerged, I understood that they were the leaders of the impending revolution and that the crowd were expecting an important announcement. But they went directly through the room and out to the street; only the man I had followed stayed behind. He sprang up on the table, as all crowded around him, and began to speak.

An Interruption and a Letter

"Comrades," said he, "soon the day . . . ." A loud knocking at the door broke off the story. Lieutenant Jerko hurriedly unlocked the door and one of the sentinels stood there. "A letter to the Colonel," he announced. "It was brought down to the guardhouse by a workman who asked that it be taken to you immediately. He said that it referred to the revolution."

The Colonel hurriedly tore the letter open. It was very short. "Revolution is at the door. It can break out any day. The first step will be an attack on the Government Building and this you cannot prevent. But I can take care of everything and I will do so on one condition. No shot must be fired and no man's life must needlessly be put in peril. If you will accept my offer withdraw all sentinels in the city and all the soldiers in the castle and let them be prepared to go out at the critical moment and clear the market place. This they will be able to do in a few minutes without spilling a drop of blood.

"You will recognize the moment the critical time has come."

Signed ILJA ZERNO.

The Exile Returned!

The Colonel stared nonplussed at the name signed to the letter. He could easily remember Iljo Zerno, an accomplished but hot tempered and temperamental man. How could he, the exile, be here in the capital city? What did he mean by saying that he was the only one who could hold up a revolution. Was he in with the leaders? Hardly. Had he men enough to encounter the populace, so that they would understand that a revolution was impossible to carry out, so that each one would go to his own home without a blow? Hardly. Perhaps he had found a frightful weapon—the Colonel remembered that he had been interested in problems of this sort. Perhaps an explosive material that would destroy a whole swarm of men in one blow. But no, that could not be the solution; there in the letter it stood that not one human life was to be needlessly endangered. We must get in touch with Ilja Zerno and get better acquaintance with his plan, and if he was not to be found—then there was nothing to be done but to follow the advice in the letter—assemble the troops in the castle and await the results. If he only knew when the revolution would break out! If he only had time. Suddenly the Colonel remembered that the young Lieutenant had not told the whole of his adventures so he asked:

End of the Lieutenant's Story

"And now what did the man say?"

"Tomorrow at one o'clock the revolution is to break out. . . ."

The next day opened gray and gloomy. The sun was hiding behind thick, dark clouds; the mist hung dark and impenetrable over the roofs of the houses. The red banners which were carried through the streets seemed damp as though they had been dipped in blood.

Red Banners in the Square

Up and down the streets the red banners were borne, the crowds following them grew larger and larger, dark forms emerged from lanes and houses, joining the crowds and swallowed up by them. Weapons which they had hitherto concealed under their garments they no longer took the trouble to hide. They were now strong enough to show their intentions. Like a great deluge the mob swarmed through the streets, shrieking, howling, dragging with them everybody whom they met to show that it was hopeless to stand against their numbers.

The sea of humanity spread over the field of battle—the square before the Castle. If those in advance had the least doubt or fear they could not give an expression; those who were behind forced them on, and what any individual desired counted for nothing. The mass could only be treated as a unity, driven on by those who stood over them, the leaders of the riot.

The Leader's Speech

The square was filled with the cries of the multitude; now the leader appeared. The man who led the people and controlled them, mounted the pedestal of the statue in the square. He spoke and his voice carried over the whole crowd, ex-

(*Continued on page 598*)

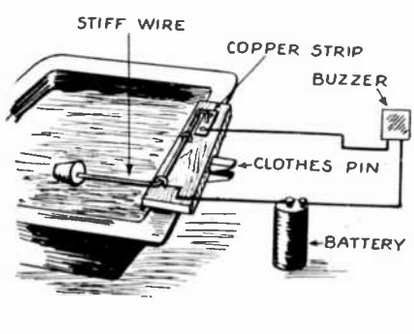
Refrigerator Alarm

THE occupant of the kitchen becomes preoccupied occasionally. As a result, the kitchen floor looks like a reproduction of the flood.

After escorting a flood out of the back door one day I contrived a reminder. It's easy and simple to make and takes about ten minutes to complete.

Get a small piece of wood a little wider than the edge of the drip pan. Cut a slot half the thickness of an ordinary clothespin in the bottom of the wood piece. Take the clothespin apart and mount half of it in the slot with a screw.

Bend a piece of stiff wire as shown, put a cork on the end and fasten down with a couple of carpet tacks.



Place a small piece of copper strip under the other end of the wire so that contact will be established when the float rises.

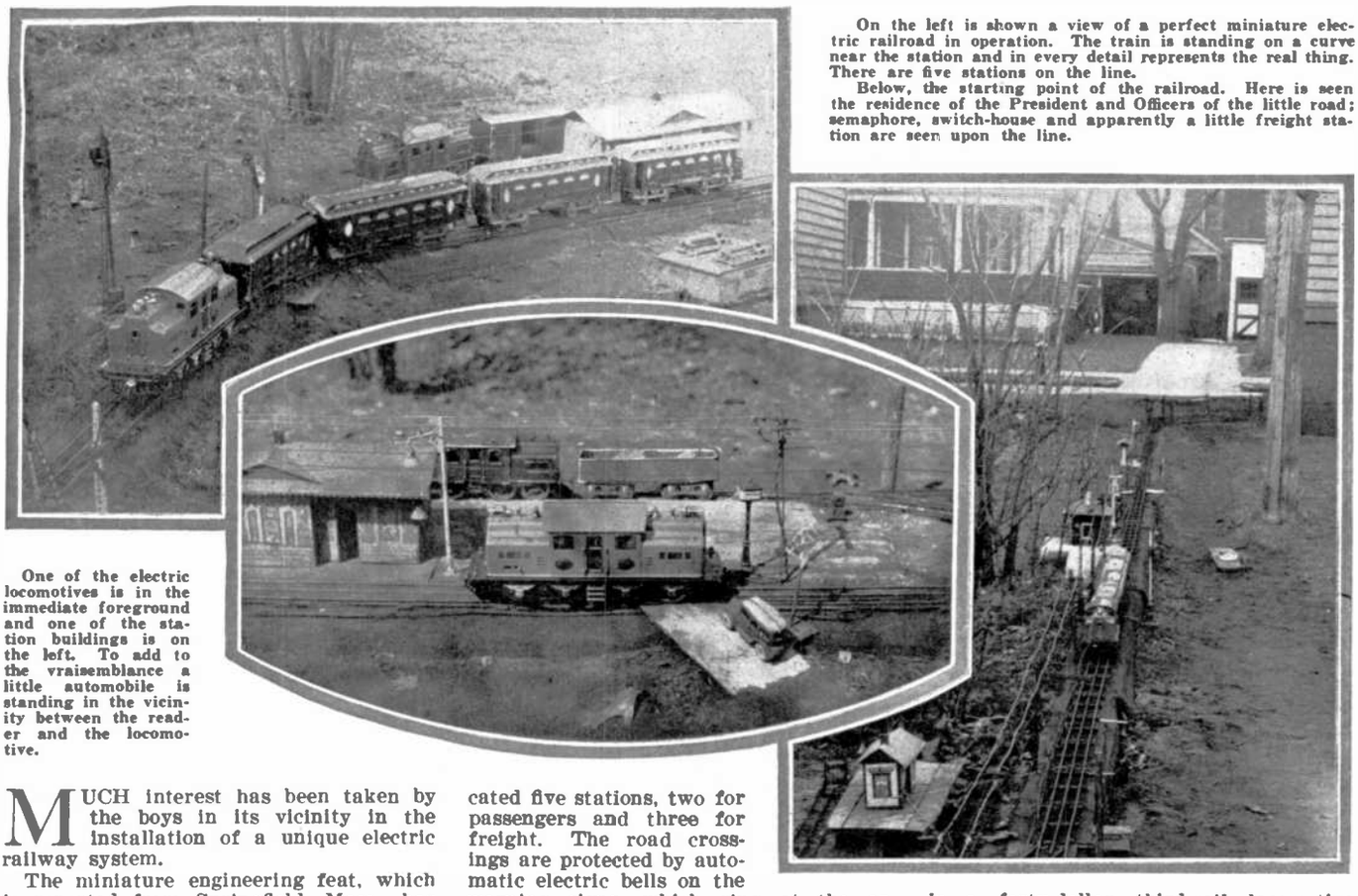
A simple water alarm adapted for any receptacle which is liable to overflow, such as a refrigerator drip-pan.

Reassemble the clothespin and clamp the outfit to the edge of the drip pan. Run wires from the bell and battery to the copper strip and a carpet tack. Bend the wire so that contact will be made when the water has risen to the danger level.

Contributed by PERRY D. WILSON.

Electric Railroad in Back Yard

By H. A. Pooley



On the left is shown a view of a perfect miniature electric railroad in operation. The train is standing on a curve near the station and in every detail represents the real thing. There are five stations on the line.

Below, the starting point of the railroad. Here is seen the residence of the President and Officers of the little road; semaphore, switch-house and apparently a little freight station are seen upon the line.

One of the electric locomotives is in the immediate foreground and one of the station buildings is on the left. To add to the vraisemblance a little automobile is standing in the vicinity between the reader and the locomotive.

MUCH interest has been taken by the boys in its vicinity in the installation of a unique electric railway system.

The miniature engineering feat, which is reported from Springfield, Mass., has a total length of about 220 feet of track of the third-rail type. Suspended over this track is a trolley line which enables the boys to use both third-rail locomotive and trolley rolling stock at the same time. As these have separate controls consisting of Lionel rheostats, they can be run without interfering with each other. The controls are located at two positions, outside for summer operation, and an inside controller for winter. In winter weather it is often necessary to chop the ice from the rails and treat the switches, which are electrically operated, with salt. The boy owners say that traffic has not been stopped for two winters, excepting for one or two days.

The trackage consists of two loops and a straightaway. Upon the lines are located five stations, two for passengers and three for freight. The road crossings are protected by automatic electric bells on the warning signs, which ring at the approach of the train. The crossing protections also include solenoid-operated crossing bars which are down until after the passage of the train. As the train is invisible at the curves in the winter, electric buzzers have been installed, which warn the operator at the inside of the curve.

The stations, trackway and crossings are lighted by miniature lights, twenty of which are used. A few statistics have been gathered by the boys, each of whom owns a system; which may interest not only the electrical boy experimenter but the grown-up boys.

The rolling stock consists of three large locomotives, two of the third-rail type and one of the trolley type. A new addition is a forty-dollar third-rail locomotive. Other rolling stock is composed of four passenger and two freight cars and one gondola car. The current consumed at starting is four amperes and three running, with a pressure at the source of fifty volts. The loss in voltage when remotely controlled is about five volts. The electric switch is an original idea employing an ordinary bell interior and a pivoted metal piece connected to a lever operating the movable piece of track. The metal armature when attracted by one coil pulls the track into one position and the other magnet reverses the operation; the two coils are actuated independently.

Much spare time and effort have been put into the many details of this double system.

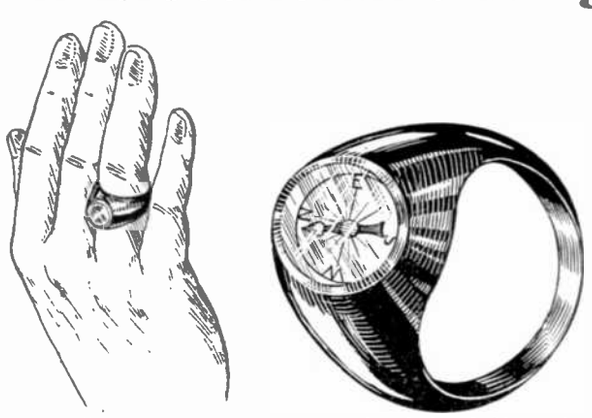
An Electrician's Ring

VARIOUS ways of using a compass in jewelry, generally as a watch charm, have been devised and carried out.

We illustrate here a very handsome ring of the contour of a seal ring, which in place of the stone or jewel, carries a compass needle under its glass.

There are two ways of constructing a compass; the simplest method is to have the needle poised upon its center on a pivot.

The other way of mounting it is that adopted in the seaman's compass. Here the compass needle moves upon its pivot as just described, and attached to it is a circular card marked with the regular points of the compass or perhaps in degrees, which turns with the needle.



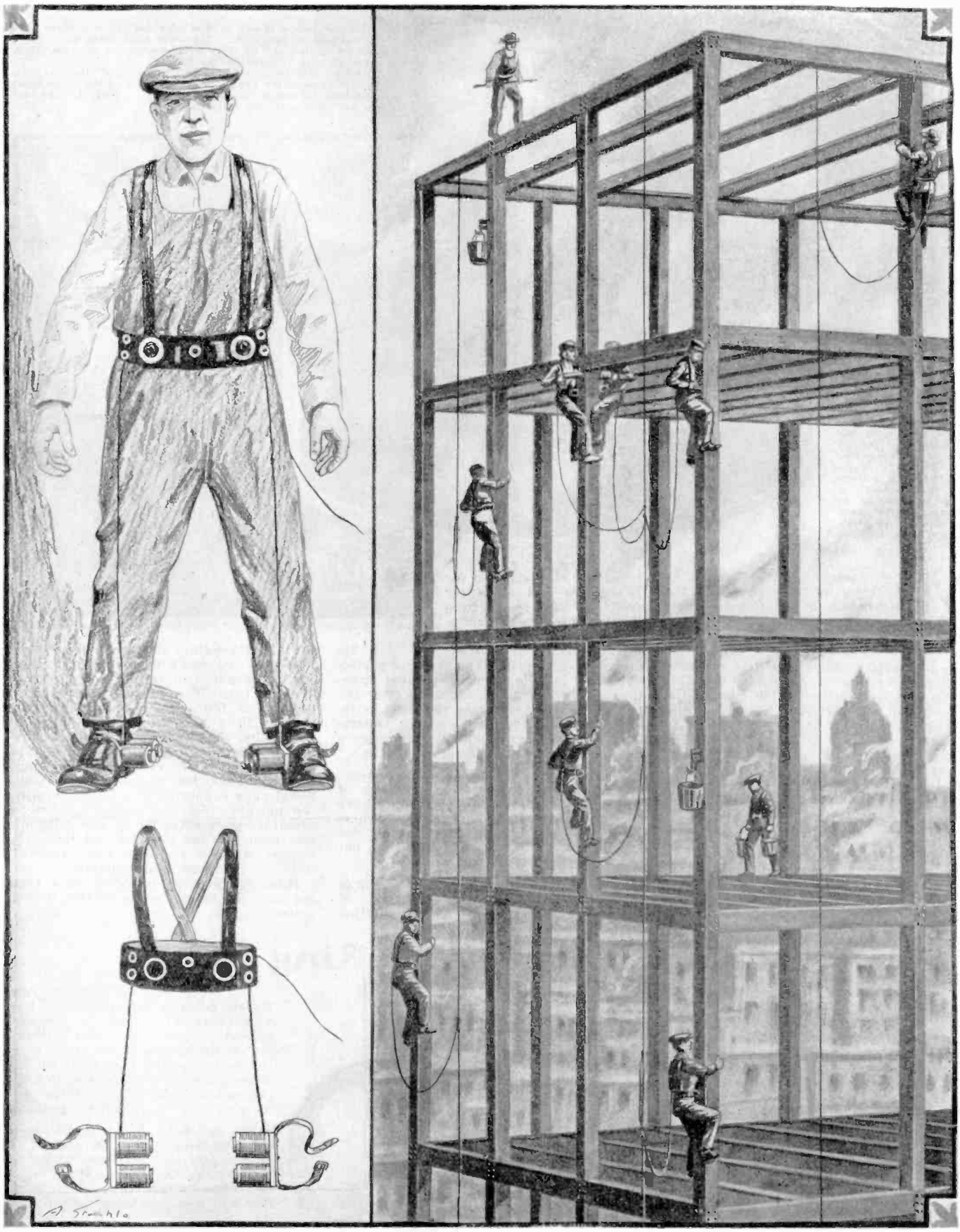
An illuminated dial compass mounted seal ring fashion, primarily for electrician's use. The magnetic needle is a detector of currents and the illuminated dial feature makes the ring useful in obscure corners and dark places.

The object of this compass from the electrician's standpoint is to test wires, especially in out of the way and dark places. The card is illuminated by radium so as to show in the dark. A wire may be in an obscure place and the operator by simply thrusting in his hand can see whether there is a current passing.

The action of the needle will also show in which direction current is passing, due regard being given to the position of the compass with reference to the wire, which position will normally be below the conductor.

We have spoken of it especially from the standpoint of the electrician, but it forms a very pretty ring and will be an interesting bit of jewelry for any of us.

Magnetic Climbing Shoes



This is an odd suggestion for the use of electromagnets by workers on steel frame buildings who are enabled to climb up as if they were using climbing spikes. The illustration is suggestive of many things which can be accomplished with electromagnets. The reader's imagination can be exerted to develop the theme.

Magnetic Climbing Shoes

IN working on steel frame buildings and various other lofty structures, where the workman comes in contact with iron surfaces, the suggestion is made that his work might be facilitated by the use of electromagnets.

A compact electromagnet can take a very strong hold upon an iron surface. If to the workman's feet magnets were attached in a manner analogous to the spikes of the telegraph lineman, when current was turned on they would give his feet a hold upon an iron upright that could easily carry his weight. They might be termed electric climbing spikes.

This would not be all. A belt might carry other magnets so that he could attach his waist to the iron beam, and have his hands perfectly free for painting, etc. If he had a rivet can or tool bag to accompany him, this could be provided with a small magnet, so as to be attached anywhere, just like a trouble light on an automobile. A painter would be provided with a hook with its magnet on which to suspend his paint pot. The current could be taken by a single lead, the frame of the building giving ground for the return.

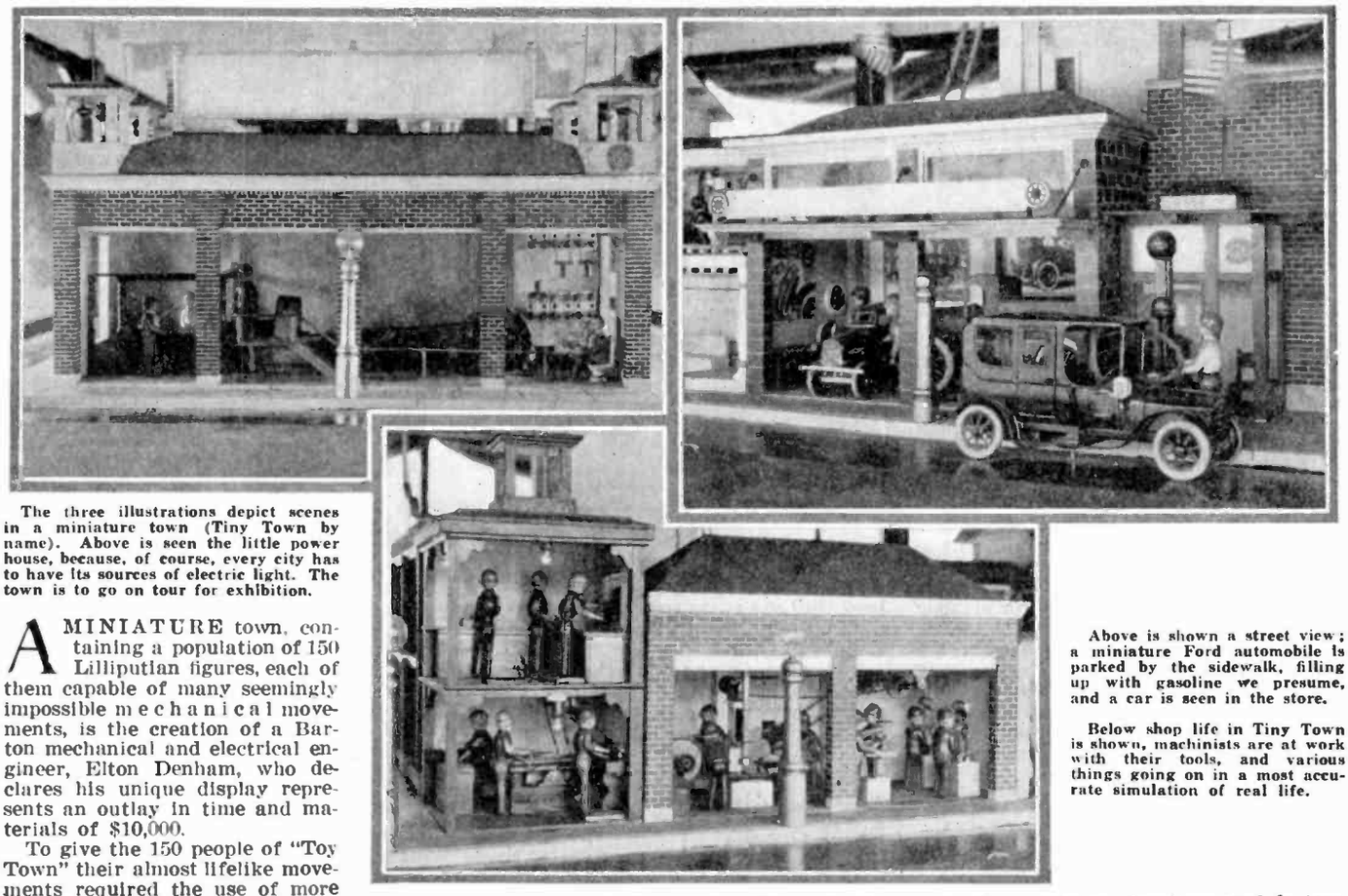
On his belt there would be push buttons so that he could free one or the other foot magnet or the waist magnet could be depolarized, enabling him to climb just as if he were climbing a tree.

If the current were cut off from all these magnets simultaneously he would of course have a fall to his death. But the switches should be so arranged that it would be impossible to cut current off from the magnets except in proper order.

The suggestion may seem a strange one, but it is not a particle stranger than the principle of many other things that are now done by electricity, and it is in avoiding the trial of strange things that invention and progress are cut off.

Tiny Town

By Rex McConnell



The three illustrations depict scenes in a miniature town (Tiny Town by name). Above is seen the little power house, because, of course, every city has to have its sources of electric light. The town is to go on tour for exhibition.

Above is shown a street view; a miniature Ford automobile is parked by the sidewalk, filling up with gasoline we presume, and a car is seen in the store.

Below shop life in Tiny Town is shown, machinists are at work with their tools, and various things going on in a most accurate simulation of real life.

A MINIATURE town, containing a population of 150 Lilliputian figures, each of them capable of many seemingly impossible mechanical movements, is the creation of a Barton mechanical and electrical engineer, Elton Denham, who declares his unique display represents an outlay in time and materials of $10,000.

To give the 150 people of "Toy Town" their almost lifelike movements required the use of more than 4,000 gears, according to the inventor who has been working practically all of his time for three years on the novel creation. The miniature city is mounted on the running gear of a wagon and the activities of its citizens are visible to spectators from all sides.

The town has its own tiny light plant and many factories or shops in addition to a garage, dance hall and a church.

There is a miniature pipe organ in the church, which organ is 22 inches wide and 14 inches high, the church being built of stone on a similar scale. Chimes in the steeple are operated by the pipe-organ.

Other music is provided by a tiny piano on a dance floor, the instrument being played by a combination pianist and trap drummer, his drum being less than an inch in diameter.

There are miniature electric generators, motors and transformers furnishing power to operate all the figures and to illuminate the tiny town's street and buildings. The generator is of one-sixth of one horsepower.

Perfect miniature furniture and factory equipment is contained in the houses and buildings. On the veranda of one home is an old woman who calmly smokes a pipe. In a sun parlor of another is a mass of pretty flowers with an attractive girl tending them.

The constructor formerly was on the stage as a magician, having traveled with many shows in this and foreign countries.

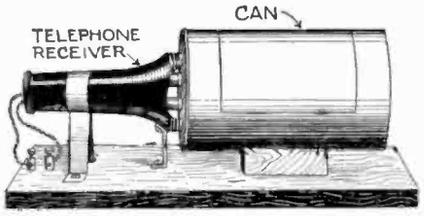
It is so constructed that it can be knocked down within a short time and transported from place to place.

A. C. House Horn

By Merle C. Biskeborn

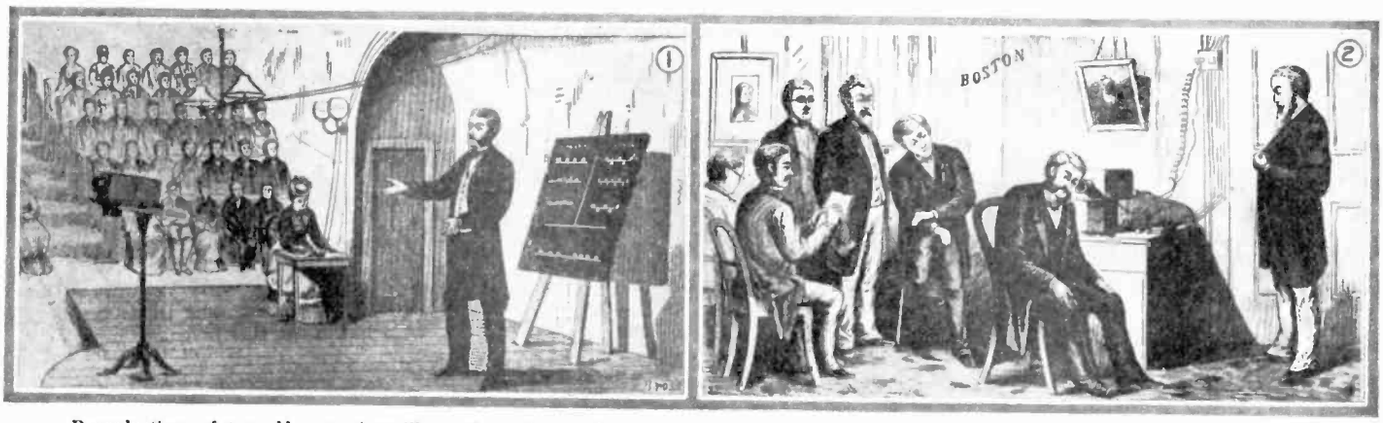
THE illustration shows an old telephone receiver used in the construction of an A. C. horn. It consists essentially of a thin diaphragm placed near the receiver. In this instance, the bottom of a tin can is used for the diaphragm.

The receiver must be rewound with heavier wire, the size of which depends upon the strength of the current supplied to the apparatus. Other points are shown in the diagram. We have termed this a house horn because it is adapted for alternating current only or interrupted current, and alternating current is so extensively used that the title is justified.



If you have a tin can and an old telephone receiver, try to build this horn and see what result a good alternating current will give.

Early History of the Telephone



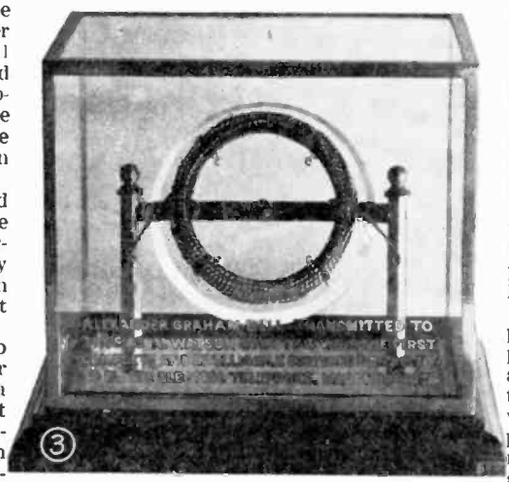
Reproductions of two old engravings illustrating a famous lecture by Alexander Graham Bell delivered at Salem, Mass. As an exhibit in the lecture, speech was transmitted between Salem and Boston, a distance of some 12 miles.

IT is not many months since the death was chronicled of Alexander Graham Bell, the inventor of the Bell telephone. He and his father had long been interested in the deaf mute problem, that of enabling the deaf to receive communications mechanically or in some way better than by any method used in those days.

Again, for many years physicists had studied sound and its manifestation in the production of harmonics, vibrations, overtones and discords, and it is fair to say that the production of vocal or speech sounds mechanically was always present in the minds of such investigators.

If we look at the keyboard of the piano we cannot realize the enormous number of sounds which it can produce, for a sound is not limited to a single note, but chords or discords may be struck in endless number. In all analyses of the human voice it is fair to say that even the number of sounds produced in ordinary speaking have never been counted. No two people pronounce any vowel sound or syllable precisely alike.

Two great strides were made in the direction of reproducing the enormously complicated human voice when all elaborate machinery was done away with. One simplification was the mechanical Edison phonograph, the other the electric bell telephone, both striking instances of what simplicity can do. Bell, without any backing amounting to anything, experimented in the transmission of sound produced by the voice. After endless trials he succeeded in getting a sound over a wire. Not a word, but a sound produced originally by the voice, effected an electrical disturbance, which was transmitted a short distance. This was in 1875. He was working with the idea of causing a membrane, if possible, or other similar material to vibrate in exact unison with the human voice. At last he did get enough of a result to feel justified in applying for a patent, and he took his invention to the Patent Office.



A piece of the wire over two miles of which articulate speech was transmitted for the first time. Bell was at one end of the line, and Watson, his associate, at the other. This was on October 9, 1876.

It consisted of two electromagnetic telephones, in a rough way similar to our present receiving instrument, but whose action by change of current passing through the coils of an electromagnet was supposed to set into vibration a simple membrane, parchment or paper, it might be, to which an armature plate was attached. In those days inventors frequently applied for caveats, a really unsatisfactory procedure and much in disfavor now. Two hours after Bell's application reached the office Elisha Gray's representative filed an application for a caveat on a telephone system. The two hours' delay is said to have cost him his patent, but of course it is not the date of application so much as the date of

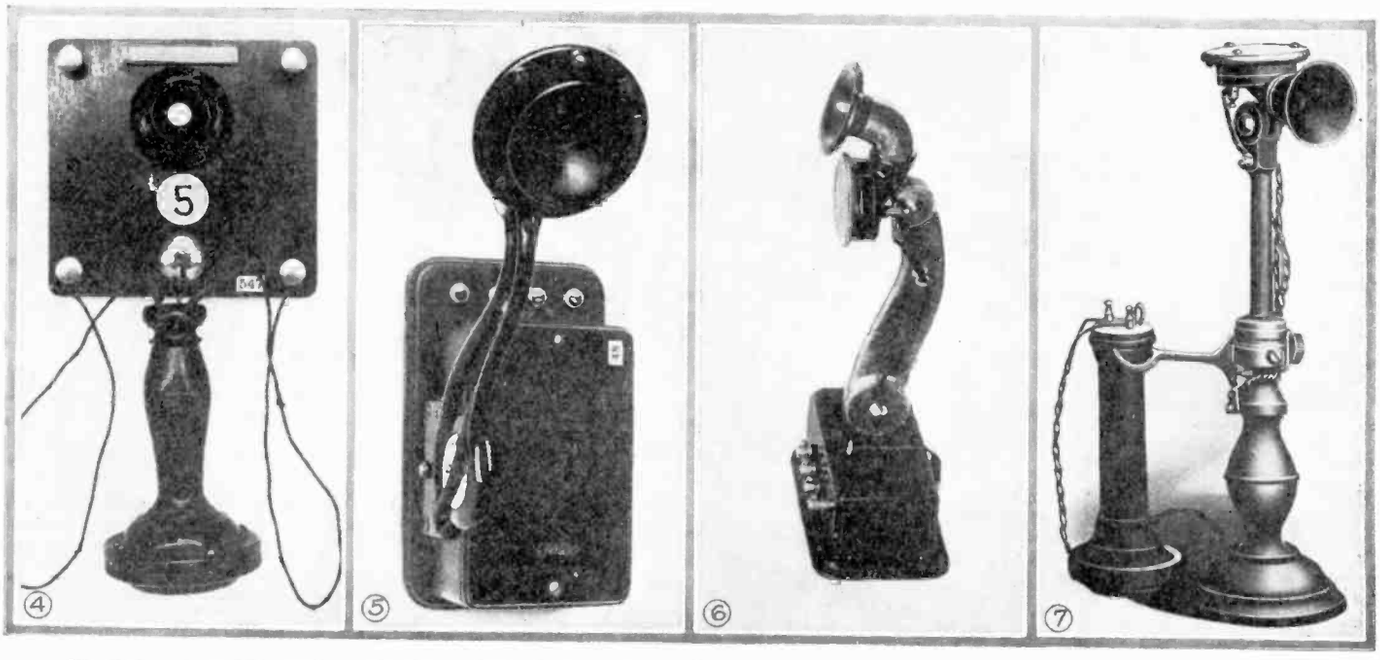


Fig. 4 shows a wall box magneto transformer dating back to 1878 which was used in Meriden, Conn., in which town the second commercial station in the world was installed. Fig. 5 shows the Edison carbon transmitter of 1881. Coming down to 1886, Fig. 6 shows a long distance transmitter, and Fig. 7 the desk stand of those days.

invention that is involved, but the case is so odd that it is often cited as an instance of the danger of delay in prosecuting applications for patents.

Bell's patent shows an identical instrument for transmitting and receiving. In practice this has been pretty generally given up except in special cases, and the microphone is used for a transmitter and an electromagnetic instrument for a receiver. The curious point arises here that Gray's instrument showed a species of liquid resistance microphone at one end and an electromagnetic receiver at the other, really making an approximation to present practice. Some of Bell's early developments with the telephone followed out the lines of the Gray receiver.

The present writer remembers well going over to the Stevens Institute in Hoboken, N. J., many years ago to see the telephone. It seemed as if considerable use of the imagination was necessary to get anything out of it. A prominent scientific editor of New York told the writer that he had been offered, presumably for some very nominal sum, a half right of the telephone for the city of New York, and had refused to accept it because the telephone required shouting for transmission and gave no results when spoken into with a low voice.

A great step in advance was made when the carbon microphone was invented. This element, carbon, has a very definite property of changing its resistance by change of pressure, and so far has proved to be generally the one and only substance available for telephone transmission.

Enormous sums of money were spent over a long term of years in defending the original Bell telephone patent in the Federal courts, and the lawyers formulated a convenient theory by which to protect it from infringement, to the effect that continuous control was exercised upon the diaphragm, which now was a plate of iron, as it is today. To the unprejudiced observer it seems as if Gray should have received some recognition, for his invention was certainly enough different from Bell's to have deserved a separate patent.

It is even claimed that the instrument of Bell's patent never conveyed articulate speech. The date of the patent was March 7, 1876, and the famous conversation with Bell and his associate, Watson, took place on the evening of October 9, 1876. The transmitter was a liquid transmitter, not the transmitter of his patent. It was such an instrument as shown in the Gray patent, and was essentially a very crude microphone. In our columns we have often had occasion to illustrate carbon rheostats and liquid rheostats. A microphone is plainly and simply a carbon rheostat, so the equivalence of a conductive liquid and of carbon is exactly in line with what we have so often shown and illustrated.

We show here two reproductions of the drawings of the Bell patent and of the Gray caveat. The inventor of the sewing machine needle threaded it at the point which made the sewing machine possible, yet he never obtained recognition because the invention was made practical by an improvement by Howe in the way of grooving the side of the needle. So also Gray never received any reward for his ingenious work.

The illustrations on the opposite page illustrate the early history of the telephone. One shows the inventor lecturing on his telephone to an audience in Salem, on which occasion speech, or attempted speech, was transmitted to Boston. This lecture is one of the incidents much stressed in the annals of the invention.

Fig. 3 shows a carefully preserved coil of wire. It is over this wire that speech was first transmitted on the evening of October 9, 1876. Interesting examples of the development of the telephone are shown in Figs. 4 to 7. Fig. 4 is from the Meriden, Conn., system, which had the second commercial exchange in the world. Three years later the Edison carbon transmitter appeared, which is shown on Fig. 5.

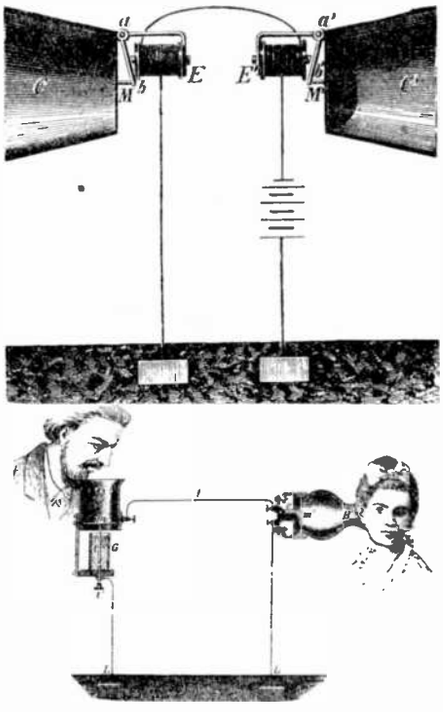
Next, efforts were made at long distance transmission and the instrument of 1886 is shown in Fig. 6. Fig. 7 shows what was called a desk stand with granular carbon transmitter and the familiar hook switch. This also dates to 1886. The telephone pole lines on West Street, New York, which did not disappear until 1904, are shown above in Fig. 8.

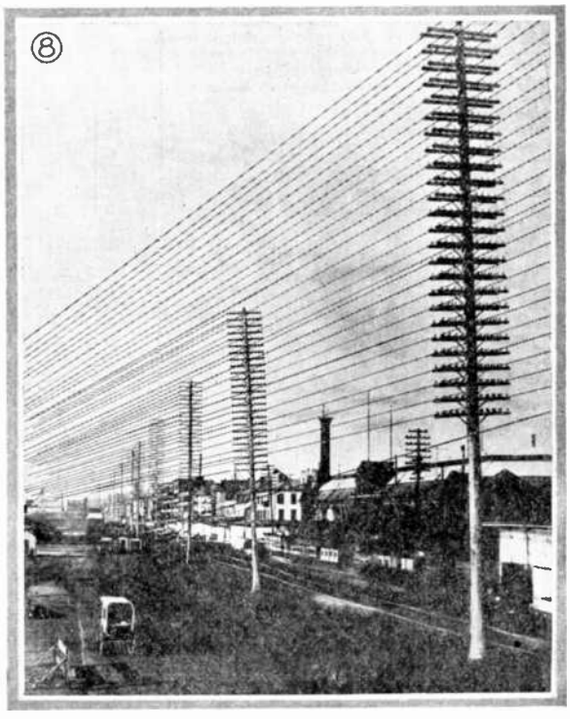
Bell's patent was applied for on January 20, 1876, and was granted on February 14 of the same year, a period of a little over three weeks, which now would be regarded as an astonishingly short delay. It is probable that articulate speech was never conveyed by the telephone of this patent.

On the evening of October 9, 1876, a conversation destined to become famous in the annals of telephony took place. At one end of the line was the inventor and at the other end was Thomas A. Watson, his associate and co-worker. The line was a short one and belonged to the Walworth Manufacturing Company. It extended from Boston to Cambridgeport, a distance of two miles. Quite a consecutive conversation was carried on with question and answer. At each end of the line the observer, Bell or Watson, took notes of what he said and of what he received, and the notes were compared by the double column method. In the *Scientific American Supplement* of November 25, 1876, about six weeks after the conversation had taken place, a verbatim report was published. This conversation marked a veritable epoch in the history of the telephone, yet it was regarded with so little interest at the time, that it was given a rather insignificant presentation of less than a column length.

It is claimed that articulate sound had been produced many years before the days of the Bell patent. The German inventor, Reis, had endeavored to transmit speech by electricity, but his contact which was supposed to do the speaking, was a make-and-break contact, whereas for the transmission of speech a current with no abrupt breaks seems to be essential. But it is claimed that in 1865 by placing a drop of dilute acid between the contact points of the Reis telephone, the experimenter, Yeates, succeeded in transmitting some speech because he had the change of resistance and not the make-and-break. It was never carried out any further.

In the contest for the maintenance of the Bell patent, great stress was laid on the undulatory current as it was then called as the vehicle for telephonic communication. It is true that when an undulatory current passes through a line, a multiplicity of zero points may be reached, which, of course, imply the opening of the circuit. But this opening is not a sudden break. The current runs down consecutively, its intensity grows less as it falls to zero but the process is a graduated one, and the click heard in a telephone when a circuit is broken, is not produced.





The upper left-hand illustration is a reproduction of the drawings of the Bell patent of 1876. A stylus was attached to the center of a membrane stretched tightly across a funnel-shaped drum and one end of a lever, pivoted at the other end, was secured to this stylus. The lever carried a piece of iron or might be itself of iron, so as to be attracted by the electromagnet placed directly in front of it. The idea was that talking into one of the drums would set the membrane into vibration, which would induce current corresponding in its form to the sound waves of the voice, and would reproduce the sound in the other instrument. It is claimed that this telephone never spoke, although the patent was awarded on it.

Below, on the left, is shown the Elisha Gray telephone, which has a sort of liquid microphone at one end as a transmitter, and an electromagnetic receiver at the other end.

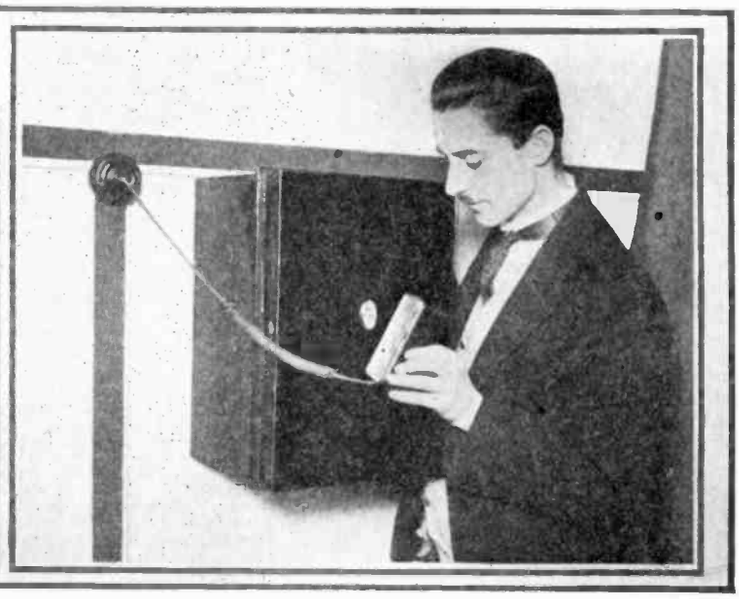
On the right is shown a view of West Street, New York, upward of twenty years ago, when the telephone lines were above ground, carried on poles. There are twenty-five cross-arms on the poles, and 300 wires were sometimes carried. The overhead lines were a great deformity and measures were taken over twenty years ago to put them underground. It can readily be seen that with the present number of subscribers it would be hardly practicable to maintain overhead wires in our larger cities for telephone service.

Shocking Plants

Photographic Burglar Alarm

Below. Shocking plants from a high voltage circuit. A proper amount of treatment of this character is supposed to improve the growth of plants. Too much is not advisable.

Right. An odd device for trapping burglars. The idea is that it will photograph the intruder so as to give his identification.



INDUCED electric discharges have long been utilized in medical treatment of invalids with more or less success. We have also had occasion to illustrate in our columns various applications of electricity for helping plants to grow.

The illustration shows a new method, however, where the induced current, as it may be called, or discharge, is applied to stimulating growth. It is said that the enthusiastic gardener electrician shown is "shocking" the plants. This is claimed to be one of the most efficacious means in existence for speeding up their growth.

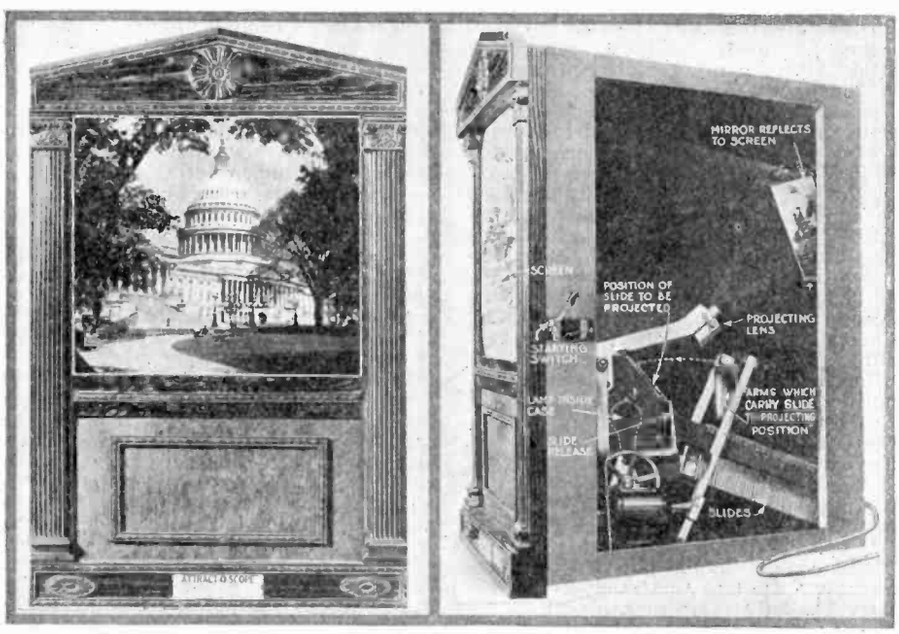
This is one of several interesting applications of electricity to plants and individuals, which we have had the opportunity of presenting to our readers.

THE burglar alarm shown above is supposed to be placed within a safe or elsewhere in connection with an electric circuit, so that when a safe protected by it is opened or tampered with in any way the circuit is closed, igniting a flashlight, ringing bells all over the building and taking a photograph of the thief.

The device is an English invention, the subject of a patent, and it is said that the police authorities of the famous Scotland Yard, London, are very favorably impressed by it.

Many accounts have been given of arrangements for photographing intruders. One always feels a doubt as to the efficacy of the arrangement; it seems as if the intruder might quite possibly be out of the range of the instrument. But whether the photograph were a success or not, the ringing of the bell would be a certain deterrent for the thief.

Automatic Stereopticon



Two views of an automatic miniature projection apparatus. One shows the front view of the structure exhibiting the great Capitol at Washington. The illustration immediately adjacent shows the mechanism of the apparatus, the long row of slides which are picked up one by one for projection, the incandescent lamp, and the mirror, from which the light is projected upon the screen, on which screen it comes to the true focus.

WHERE there are light, color and motion, there is attraction for the eye. The machine pictured here, called "Attractoscope," combines all these, through the medium of lantern slides, which change automatically, quickly and quietly.

This device is used for window display advertising, and exhibits of all kinds. It is a compact cabinet, standing about 40 inches high, having a simple mechanism, which carries the slides by means of "arms" one by one in front of the lens through which they are projected on a mirror, which reflects the rays to the screen so as to bring them to a focus thereon.

Its motive power, a 1/30th horsepower universal motor, is used either on A. C. or D. C. current. The lamp used is a 400-watt steropticon lamp, which gives a brilliant image, which can be seen in bright daylight. The speed of changing slides is regulated by a rheostat.

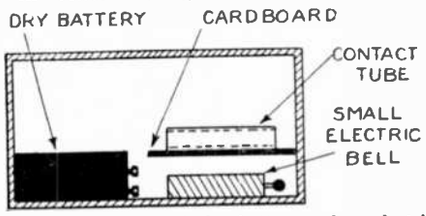
Contributed by GEORGE MILLER, JR.

Automatic Alarm Safe

By A. C. Oldroyd
Barrow-in-Furness, Eng.

As soon as the safe illustrated here is lifted up an alarm bell begins to ring, warning the owner that some unauthorized person is tampering with his property.

Automatic alarm safes have been made before, but they suffered from the disadvantage that the contact was made by a projecting pin which protruded through an aperture in the bottom of the safe. As soon as the weight of the safe did not act —in other words, when the safe was



Mercury switch with dry battery and an electric bell, to be enclosed in a portable safe. If the globule of mercury holds a central position and keeps the circuit open, the least disturbance will close the circuit, ringing the bell.

lifted—a spring connected to the projecting pin closed a contact.

Such alarms are useless for all practical purposes, for thieves are quite well versed in electricity nowadays; alarms of this type can be silenced by simply pressing the pin back into the hole and wedging it there with a small piece of wood, such as a match.

With the safe shown here things are different; there are no projecting pins, etc., and the alarm cannot possibly be silenced until the box is forced open.

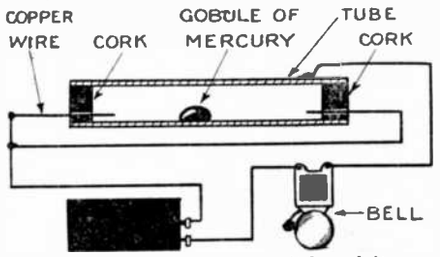
Fig. 1 shows a section through the lower part of the safe. On the left is a small dry battery, as used for portable hand lamps, on the right an electric bell, the hammer of which is close to the steel side of the safe, so that it drums on the safe wall when current passes through the bell. Above the bell, mounted on a piece of

View of interior of safe, containing the alarm apparatus, showing the mercury switch or contact tube, alarm bell and battery.

cardboard, is the contact tube, the secret of the alarm gear.

Fig. 2 shows a sectional elevation of this tube. The tube itself is of brass, three to four inches long and about one-half inch in diameter. Through corks cemented into the ends a short, stout copper wire passes into the tube, close to the bottom of the latter. Between the wires, at least as long as the safe is strictly horizontal, is a small globule of mercury.

The two copper wires are connected to one pole of the battery, the tube itself, through the bell to the other. As soon as the safe is lifted the globule of mercury will roll over to the lower side and make contact with one of the wires and the tube, so that the bell will begin to ring.



Sectional view of mercury switch and its connections to battery and bell. Whichever way the mercury goes it will close the circuit.

Inclined to the other side, the globule of mercury will connect the circuit between the other wire and the tube. As it is impossible to carry the safe absolutely horizontal, even for a second, and as the motion of walking is sufficient to cause the mercury to travel to one of the contact wires it is out of the question to steal an auto alarm safe unnoticed.

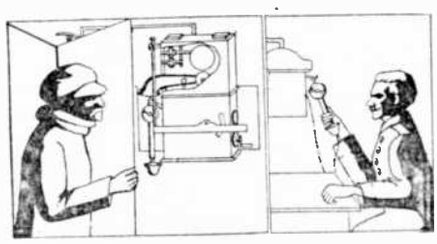
To set the tube horizontally, the cardboard, to which the contact tube is tied, is first depressed on one side and then on the other, until the globule of mercury is in its central position.

The brass tube must be carefully cleaned on the inside, so that a good contact is assured.

Automatic Telephone Alarm Call

In case of the entrance of a burglar or other dangers the inmates are not always able to reach the telephone to call up and notify the police. A new invention is designed to cover this case, which automatically announces any attempt at burglary over the telephone line and gives the alarm. The apparatus works on the following lines:

An electromagnet by a disturbance of the alarm switches starts the arm and sound box of a phonograph. The needle at once falls into the spiral on the disc and the movement closes the circuit of an electric motor. The electric motor drives a record in order to actuate a lever.



The burglar, by an automatic alarm call, starts a phonograph which telephones the message to the police. The burglar is seen on the left. On the right the police officer is taking down his receiver in the distant station.

The latter as it is moved lifts up the receiver from the hook and sets free the apparatus for pressing down a push-button and also for connecting the induction coil into the circuit, so that the alarm signal is given. The apparatus and operation are shown on the diagram.

In case of a breaking-in of the house the phonograph record is started, the receiver is lifted off the hook and the signal is given to the telephone and goes over the line to the police station. Our illustration shows how in case of a burglary the alarm is transmitted and shows the police officer taking down the receiver so as to get the message.

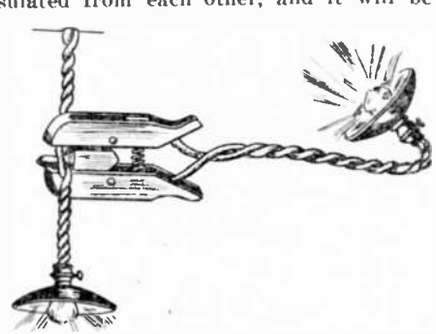
Novel Spring Clip

THIS is a French product; it is an electric spring-clip and our readers undoubtedly are very familiar with this convenient accessory for the laboratory or wireless practitioner.

The one we illustrate goes a point beyond; it is a substantial spring-clip with a double flexible cord connected to it, and between the jaws there is a central rod whose purpose is, when the clip is in use, to go between the two leads of a twisted pair of conductors.

When inserted thus, so as to separate them, the clip is allowed to close upon them, and there are sharp points on the inner surface of the jaws which puncture the insulation of the two wires and come in electric contact with such wires, so that one can take current from the circuit.

The two portions of the clip are insulated from each other, and it will be



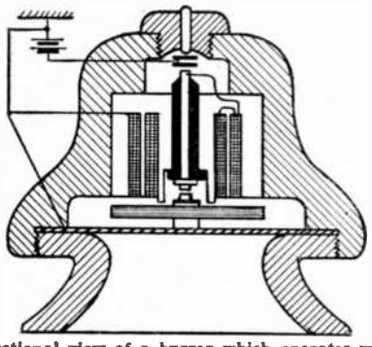
Spring clop provided with sharp points so that connection can be made with a flexible cord, the points penetrating the insulation.

seen that by using the rod to go between the wires of the circuit one will be connected to the upper and the other to the lower member of the clip. A small lamp or other appliance can be connected to the flexible cord; and this clip enables current to be taken from many places and gives a very convenient way of establishing a temporary branch circuit.

One especial place for which its use is recommended is for the automobilist for attaching his trouble light to any desired and accessible line of wire on the machine.

The points, it will be observed, are liable to become dulled by use, possibly even broken off. To overcome this trouble they are made detachable and new ones can be obtained which are easily put in position. The whole thing is thoroughly practical.

A Counter Electric Buzzer



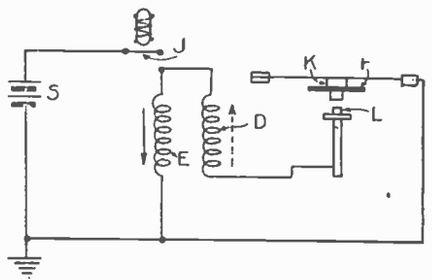
Sectional view of a buzzer which operates without breaking the main circuit. The interruption of current is substituted by a depolarizing circuit which is so wound as to take all the power out of the magnet.

A VERY ingenious buzzer has been devised by the Thompson-Houston Company, which operates on a peculiar principle as far as appliances of this sort at least are concerned—that of counter electro-motive force.

There is the socket or case of ebonite or other material with its cap which screws down and holds in place the sound diaphragm. It contains also an electro-magnet in its axis, which has differential windings (DE), of opposite polarity relations. The arrangement avoids the production of sparks generally produced at the make-and-break points in an electric circuit of this type.

The connections are arranged according to the diagram. If a push button is pressed or if the switch (J) is closed, so as to close the circuit comprising the buzzer, the current is sent to one of the differential windings of the magnet, so that it attracts the armature. The contact (K), one part of which is attached to the armature, comes in contact with an adjustable contact (L), and it is by the closing of a circuit by these two points that the other coil of the magnet is brought into an active circuit. When this takes place and the second circuit is closed, as the coils are differentially wound, the polarity of the magnet core is at once reduced to zero, the elasticity of the diaphragm now free to act alone, draws back the armature, and opens the circuit in doing it, so that the magnet is again excited and once more attracts the armature. The cycle thus described is continuous in action as long as the circuit is closed.

The description makes it clear that as



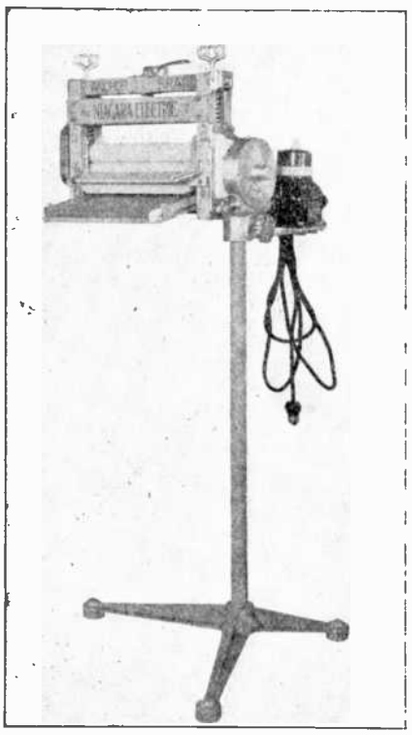
Details of the buzzer. (S) is the battery, (D) and (E) the two coils of the magnet, at (K) and (F) are the armature, diaphragm, and contact, (L) is the magnet core, (J) is the switch.

the field of the electro-magnet is reduced to zero when both contacts are closed, there is no spark to be seen between the contacts, on the opening or closing, so that the apparatus can be used on circuits of quite high voltage.

The case of the apparatus and its cap are of insulating material and the diaphragm is preferably of thin steel and carries a laminated armature to be attracted by the magnet, only when a current is sent through one of the coils, but not through both.

Portable Electric Wringer

A PORTABLE electric clothes wringer designed for use with washing machines not provided with power wringers and as an auxiliary in laundry equipments



A portable wringer which can be moved about on a stand of proper height for the ordinary electric washer. It may be used away from the regular place and be available for special work. It can be detached from the stand and be attached to the side of the washtub.

for homes, hotels, clubs, schools, etc., has been recently placed on the market.

The wringer, which is mounted on a tripod, has a swivel hanging, permitting it to be swung to any position over a washer or stationary tub. For permanent use on stationary tubs or boilers the wringer is built without the stand and provided with clamps to hold it in place.

Power for turning the rolls of the wringer is supplied by a Westinghouse heavy duty electric motor built for operation on either direct or alternating current at 110 volts on a 10-ampere fuse. The motor is reversible electrically and will operate without stalling under all loads. A snap switch in a convenient position on the top of the motor controls the operation of the wringer. A 10-foot cord and connecting plug are provided for connecting the motor to a lamp socket.

The new wringer is of the safety type and has been made with durable rubber rolls to handle the heaviest household articles.

Battery Charging Connection

IN charging a storage battery, the rate at which current is being delivered to it should be known; there is a proper rate for each one, determined by experience, subject of course to modifications according to the condition of the battery.

The appliance we illustrate does two things; it indicates the amperage of the current and contains within its case a rheostat whose resistance can be changed so as to obtain any desired diminution of current. This change is produced by changing the pressure to which the material of the rheostat is subjected.

At the top there is a clamp for attaching it to the bus-bar; at the other end there is a spring-clip by which it is attached to one pole of the battery. The other pole of the battery may be attached to the other bus-bar. The rate at which

A compact battery charging control. The ammeter shows what current is being taken and the intensity of the current is regulated by turning the knob directly below the dial. This operates upon a pressure rheostat.

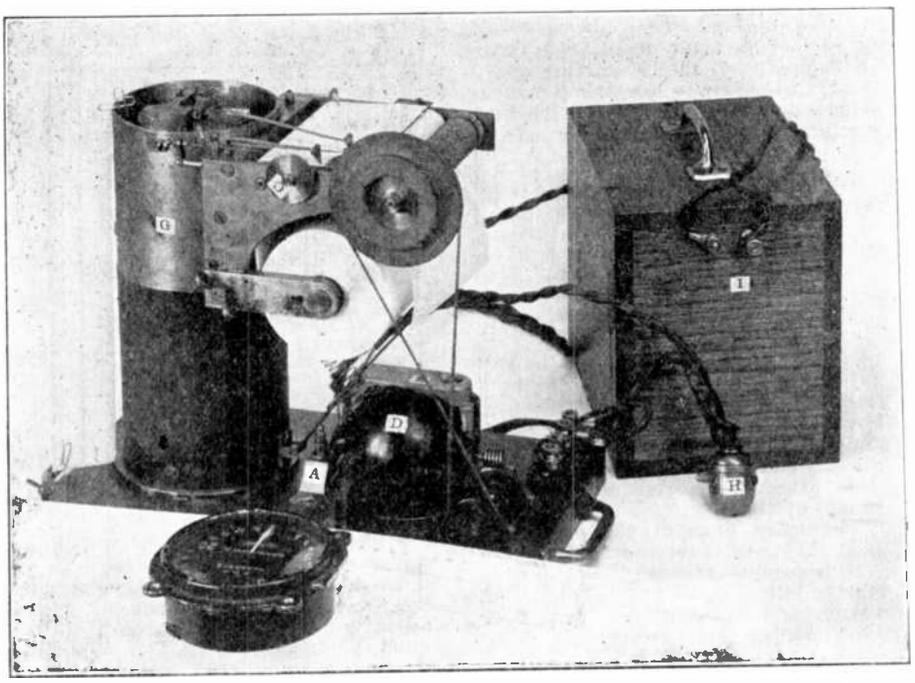
current is passing is shown by the ammeter; below the face or dial there will be seen a large button, which when turned compresses or releases the pressure on the rheostat, as spoken of above.

The latter is made up of a pile of carbon plates and is contained within the case of the instrument. Diminution of the pressure increases the resistance, cutting down the current, and increase of pressure operates in the opposite way. Thus, within the little case are provided the measuring instrument for letting the operator know just what he is doing, and the pressure carbon rheostat for controlling the current.

Motor Electrics

Stopping An Automobile

By S. R. Winters



An apparatus for investigating the action of automobiles when coming to rest or starting. (D) is a motor actuated by the battery (I); drawing a sheet of paper continuously under markers carried on arms. Within the cylindrical case (G) there is a weight carried on the upper end of a flat spring-tempered piece of steel, and it is the motions of this which through the arm and pencil are recorded on the sheet of paper. (H) is the switch and (A) is the ammeter.

HOW quickly can you stop an automobile and how far will it go after the brakes have been applied, are questions answered automatically and autographically by an instrument recently designed by the Automotive Section of the Bureau of Standards, United States Department of Commerce. Technically described as a "decelerometer," this apparatus is so compactly arranged that it can be contained in a small wooden case placed on the floor of an automobile responsive to every change.

The device consists of a heavy weight mounted on the upper end of a stiff spring, with a pen and multiplying mechanism for recording the movement of this weight on a strip of paper. It is exactly comparable to a seismograph or earthquake detector. As the brakes are applied to an automobile the inertia of the weight causes it to swing forward, the extent of such movement being in proportion to the rate at which the automobile is losing speed. The curves recorded show the force administered to the brakes in order to bring the vehicle to a standstill, and this graphic record also reflects the manner in which this force varies throughout the period in which the automobile is being stopped.

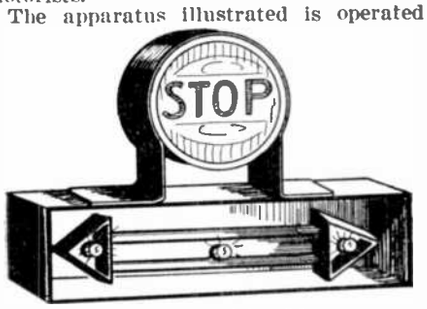
Another pen on this decelerometer, which pen is operated by a motor to which the tachometer is attached, records on the chart a scale of time; while still another pen permits of the recording of the time at which the driver is given the signal to stop. For instance, tests have indicated that an appreciable interval elapses between the giving of a stop signal and the beginning of the braking action, such periods varying with the type of automobile, the driver, and what the latter is doing at the moment this signal is given.

The average indication of many tests with the decelerometer showed that fourtenths of a second elapsed while applying the foot brakes, during which time the automobile would have gone twelve feet if traveling at a rate of twenty miles an hour. The intervals varied from 0.15 to 0.6 seconds. If the driver happened to be shifting gears when the signal to stop was given there was considerable delay in obeying this signal. The same condition applied if the driver had his foot on the "gas" at the time. Tests indicated that there was greater delay in heeding the stop signal when applying the hand brake than when putting on the foot brake.

Safety Auto Signal

ALMOST any device which will help reduce the growing number of automobile accidents is welcome to motorists.

The apparatus illustrated is operated from the steering wheel. Inasmuch as in making a turn to right or left in busy streets, or in darkness, the driver reaches far around the perimeter of the wheel, in order to gain sufficient purchase on the wheel to make a turn; the operating buttons which light the signal lamps are so placed as to come directly under the hand when a turn is about to be made.



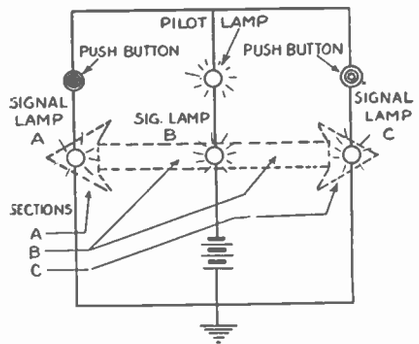
Stop light, a right turn and left turn, and a Go Ahead signal for use on the rear of an automobile.

Mounted directly on the wheel, at the proper point, operation is practically automatic when the driver's hand grasps the wheel at the relatively advanced point along its perimeter. Grasp of the wheel manipulates the push button, at the same time indicating to those in cars behind that a turn is actually being prepared for, and about to be executed.

The push buttons mounted on the wheel are not of the ordinary circular form, but are made from short strips of stiff spring brass or steel with brass or copper contacts inserted. A sleeve of leather, sufficiently loose to allow the contacts to separate by their plasticity is adjusted over the push button devices, thus protecting them from damage and preventing the possibility of parts catching on driver's gloves or clothing.

In operation, the manipulation of a given button lights not only a lamp fixed in the central section of the rear signal housing (see (B) below), but also lights the corresponding section (A) or (C), corresponding with the desired result.

If it is sections (A) and (B) which are lighted, the third section, partitioned off by sheet metal, remains dark, and the visible signal shows an arrowhead and



Full diagram of the layout, connections and details of the signal. (A) and (C) are left hand and right hand indications respectively and the center lamp at (B) indicates go ahead.

(*Continued on page 600*)

Awards in Odd Electrical Experience Contest

First Prize, $20.	Second Prize, $10.	Third Prize, $5.	Fourth Prize, $2.50
V. W. Lemmon, Furnald Hall, Columbia University, N. Y.	G. A. Hughes, 1022 Haight St., San Francisco, Calif.	Cecil H. Render, Hartney, Man., Canada	Sheldon P. Krieger, Metamora, Michigan

First Prize

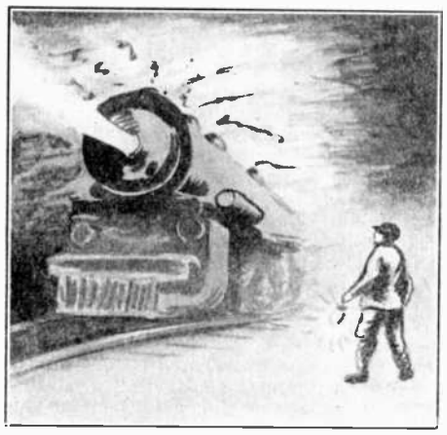
Electric Smoke

By V. W. Lemmon

SOME time ago the Pennsylvania train on which I was riding was delayed for a while in the yard just outside the Philadelphia station. In this yard a number of the tracks have overhead trolleys carrying 11,000-volt circuit alternating current for the electric trains of the Philadelphia-Paoli division.

While I was watching, a steam switching locomotive came along on one of these tracks, and, stopping just under a signal bridge, belched forth a great cloud of steam and smoke. Through some queer trick of the wind this cloud did not rise straight up, but eddied around until it filled the space between the trolley and the ground.

Immediately a very strange thing happened. The cloud of smoke became luminous; the light was not very bright, but pulsated in time with the 25-cycle alternations of the current. It looked very much like an Aurora Borealis display on



A curious electric discharge witnessed in a trackyard, illuminating a great quantity of steam and smoke between a trolley and the ground.

a small scale. A man who worked on the railroad said that he had never seen the phenomenon before, but thought it might be a "silent" electrical discharge between the trolley and the ground, through the wet smoke.

Second Prize

Desert Static

By G. A. Hughes

ONE bright day the field gang of a power company started out for Mr. Willis' property, which included many acres of ranch land and long stretches of desert sand, with tall, clumsy cactus plants. Mr. Willis, a rancher, had the reputation of being "impossible," where automobiles were concerned, because he thought them "tomfoolery" and far inferior to his live, breathing horses he prized so.

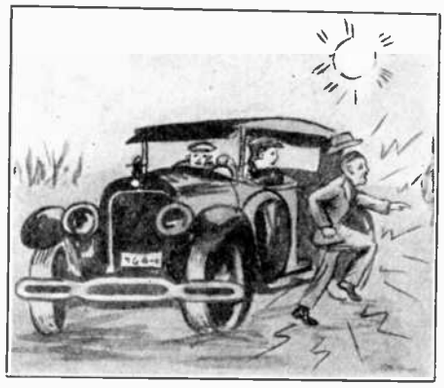
On arriving at the Willis home it was necessary for the power company men to take Mr. Willis along to assist them in locating the incoming lines across his property. It was not easy, because our husky friend rebelled against riding in the "automobile contraption," as he called it. He said: "They are no durn worth and mean no good." After much persuasion he entered the car. Then off the outfit started.

In the course of the trip it was necessary for the car to traverse about three miles of desert sand, which swirled about and was blown against the car in the warm wind and sun's heat. On arriving at the edge of the sandy plain, some three and a half miles from the starting point, the party proceeded to disembark, and it so happened that Mr. Willis was the first to step out of the car, perhaps due to his uncontrollable desire to be out of the "pesky thing."

One foot on the running board and both hands on the car body—one foot on the ground—then old man Willis jumped three feet in the air and roared out expletives of indignation, accompanied by violent gesticulations, equal only to the before breakfast daily dozen. His disgust for the automobile was complete and unquestionable, intensified by the shock he had just received: as you can imagine the car was blamed. He was so disturbed that his temper caused him to retrace the three and one-half miles to his home, on foot, repeatedly cussing out the auto. Later, when the field gang returned and attempted an explanation, all he would say was, "If it was 'lectricity it came from that there 'tin divil'—it's no d——n good, nohow."

Even if Mr. Willis had been receptive to the explanation the field gang were anxious to give him, it is very reasonable to believe that he would not have understood the phenomena which had transpired.

When an automobile crosses a desert such as described above, the wooden wheels insulate the metal body and frame from the ground. The particles of sand blow against the metal body, and deposit their



A hater of automobiles got a bad shock on leaving one. The desert sand had charged the body of the car with static electricity. The car was not to blame.

small electric charges, which accumulate after several miles and raise the body of the car to a static potential above ground, similar to a condenser. When Mr. Willis stepped from the running board to the ground he discharged this accumulated static charge which gave him a severe jolt or shock.

Until Mr. Willis understands the true cause of the shock he received, the automobile must carry the blame, and once again we see one unjustly convicted, the automobile in this case, upon circumstantial evidence.

$37.50 IN PRIZES

We take pleasure in offering a series of prizes for letters giving odd and unusual electrical experiences.

First Prize	$20.00
Second Prize	$10.00
Third Prize	$5.00
Fourth Prize	$2.50

Nearly every one of us has had an odd or unusual experience in electricity, sometimes humorous, sometimes pathetic, sometimes puzzling, and it would appear that our readers should let us have some of their personal experiences for the benefit of all.

The more unusual the experience, the more chance you have.

Illustrations are not necessary, but the letter should be either typewritten or written in ink. No penciled matter can be considered. Contest closes on the 15th of month of issue.

If two contestants should send in the same winning experience, both will receive the same prize. In the event of two or more persons sending in the same as best, second best, etc., each tying contestant will receive the prize tied for.

Prize winning letters will be judged as follows: The first prize will be awarded for the letter giving the oddest or most unusual experience. The second prize to the one considered next best, and so on.

Communications to this department should be addressed *Editor, Odd Electrical Experiences,* care Practical Electrics, 53 Park Place, New York City, N. Y.

Third Prize

Telephone on Strike

By Cecil H. Render

Before the days of celluloid rimmed spectacles the old lady accidentally short-circuited the telephone system every evening, by putting her silver rimmed spectacles behind the clock where the telephone wires had lost their insulation.

SOME years ago in a rural district the country telephone line refused to work after 10 o'clock each evening, which meant that in case of serious sickness during the night a doctor could not be called. This deficiency and the curiosity of the subscribers resulted in calling out the tele-

phone repair man. He examined the line carefully, but was unable to offer any explanation as to its actions.

As this was continued each evening an expert from headquarters was finally called upon. At 10 o'clock that night a detailed examination of main wires and lead-ins revealed the source of trouble to be in an old dwelling which had employed phone service for a number of years.

The lead-in, which was insulated, entered the house by the kitchen, ran along the wall, behind a small shelf, and from that to the phone.

Mice playing on the shelf, behind a clock which had not been disturbed for some time, had destroyed the insulation on the wire. The mistress of the house, an old lady who kept regular hours, was in the habit of placing her silver-rimmed spectacles behind the clock, which was about two inches from the wall. This, of course, caused a short circuit and suspended all further operations until she arose the following morning.

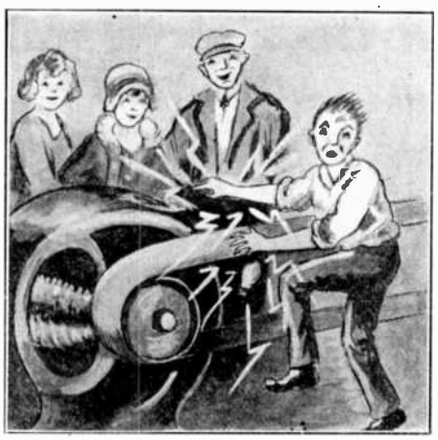
Fourth Prize

Shock from Glass Bulb

By Sheldon P. Krieger

THE writer was employed in an electric light and power plant. One of the young men about town always pretended to know a little more about electricity than the average person, although he had never made a study of it. One night he brought two or three of the fair sex into the light plant to show them all about the big electric machines.

"They're all 'dinimos'," he said with a flourish of the hand as they stepped inside the door. Of course, the girls were all greatly impressed at the sight of the big machines. I laughed a little up one sleeve and thought I would try and play a little joke on him.



Bad shock received through an electric bulb held near a charged driving belt.

I got a 60-watt light bulb and began drawing sparks to it from the exciter belt. I pretended to make it light from the sparks that were jumping into it from a distance of about an inch from the belt. The girls were greatly amused at the sparks and wondered why I didn't get a shock. I explained that the sparks were produced by the belt going through the air so fast, and said it was static electricity and didn't give any shock.

About this time our budding electrician noticed my seeming familiarity with the girls and decided it was about time for him to do something smart.

So he said, "Give me that lamp; I can make it light." I had been holding it by the base and the sparks were jumping into the glass part. He said I was holding it the wrong way around to make it light. I handed it to him and he, of course, grasped it by the glass part.

Bang! He received a bad shock and scare as he touched the glass. He gave a yell and dropped the bulb, which burst as it struck the floor, further adding to the commotion. After it was all over the girls laughed and he shook like a leaf. They soon got out and he never showed up to do any more Elec-Tricks again.

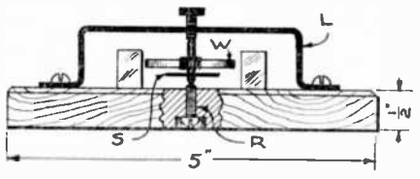
Voltmeter

By William Meagher

THE construction of this voltmeter is quite simple, as the field of a toy motor is used to make the field of the voltmeter. The construction is as follows:

Secure a hardwood board about 5 inches long and one-half inch thick; give this two coats of varnish and when dry proceed as follows: Remove the field from an old toy motor; take the wire off the bobbin and rewind it with No. 28 cotton covered wire. Drill four holes in the board so that bolts can be used to fasten the field to the board; washers should be used between the board and the field as required to make them perfectly parallel with each other.

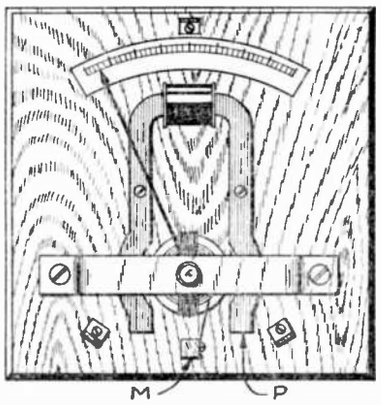
From an old clock take the balance-wheel with hairspring and the adjustment screws. Next make a support to hold



Support for the needle and coil of a voltmeter. The wheel (W) comes from a clock and carries the coil of the rotor.

the balance-wheel between the field poles. This is made of sheet brass one-sixteenth inch thick, bent into the form shown in the illustration; it is 4½ inches long over all and stands one inch above the board. A hole is drilled in the center of the top and tapped to take one of the adjustment screws. Now center-punch for a hole midway between the pole pieces; drill this to take a threaded bushing the same diameter as the adjustment screws. The bottom of this screw hole is countersunk so that the head of the screw will not protrude.

The next step is to file off all the projections on the perimeter of the balance-wheel, except two pair opposite each other in order to hold the wire which is to be wound on. After winding on the same, take a stiff piece of brass wire to form an index hand. Solder one end of the wire to the shaft of the wheel, and to the other end fasten a small wooden pointed match stick. This should be painted black, as it gives a better effect. We will now start to assemble the instrument. Loosen both adjustment screws so that the shaft of the wheel can be placed between them; see that the pointer is pointing upward toward the top. Now screw down the adjustment screws so that the shaft will turn freely between them. The binding post (K) is used to convey the current to the spring (P). After seeing that the wheel works easily, remove it from the bearings to be wound.



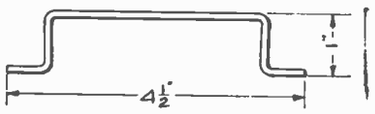
General view of the voltmeter showing the balance wheel, its coil, the index and other parts.

First remove the spring attached to the shaft; glue pieces of tissue paper between the four projections, give them a coat of varnish and start the winding. I used No. 36 silk covered wire. About 15 turns were wound on each side of the shaft. Be careful to wind the coils in the same direction so they will not oppose each other. We now have two wires projecting from the fine wire coil; one of these is soldered to the wheel; this will throw the wheel out of balance, but can be overcome by filing off some metal.

Next to the connection over the long end of the shaft put a fibre tube that will fit tightly over the shaft; varnish or shellac the shaft before putting it on, so as to hold better. Fasten the inside end of the spiral spring to the fibre tube; the other end of the coil is placed under the spring, making a firm connection.

The next step is to put the field in place. Put flat-head screws up through the four holes bored in the board and on these screws place as many washers as will be necessary to elevate the field magnet a good distance above the board. Be sure to place the same number on each screw or the field magnet will not be parallel with the board. After this is done, bolt the magnet down tight, place the armature in between the screws, "pointer up," and screw them down.

To connect up our voltmeter, one wire goes to the field coil of the field, and the



Exact dimensions of the supporting brace, which supports one end of the balance wheel shaft.

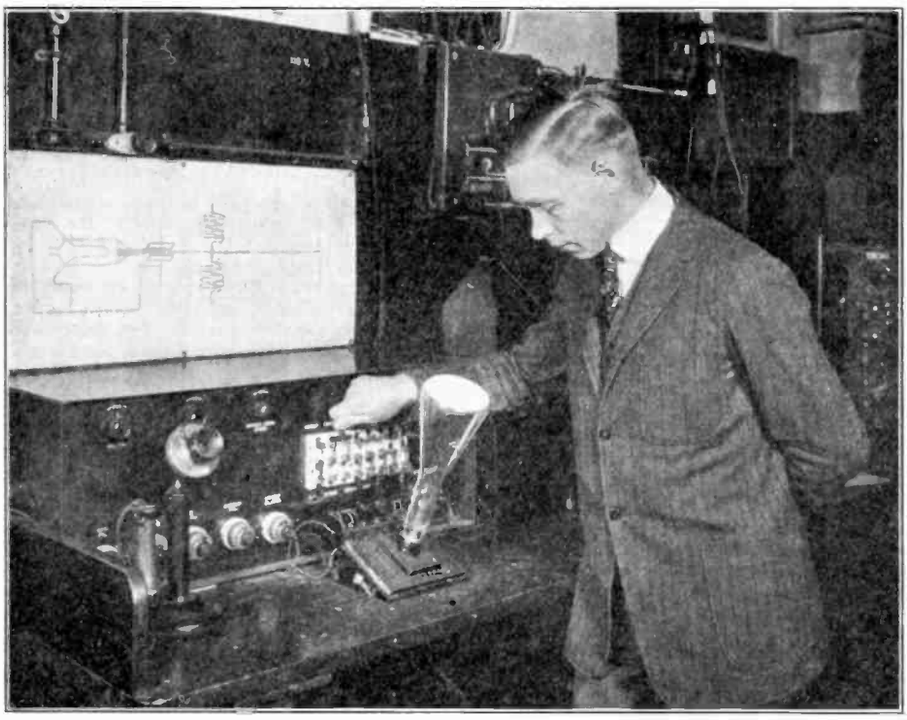
other end is connected to the brass support (L). The other terminal wire of the field coil is run to a binding post not shown in diagram. The binding post (K) used for adjustment is connected to the other binding post.

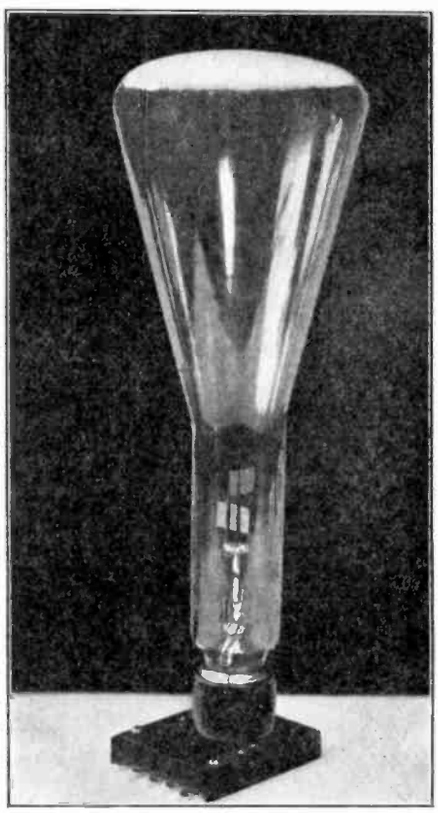
To calibrate the voltmeter compare it with a standard voltmeter. It may be calibrated by varying the tension on the spiral spring. If this cannot be done, a rougher method is to take four new dry cells, connect them to the instrument, and where the vane stops mark 6 volts; as this is not accurate it should never be used where a voltmeter is obtainable.

A further refinement would be to place a clock case over it, with the glass that comes with it. The brackets (1, 2, 3) are used to fasten such a case to the instrument.

The Cathode Ray Oscillograph

By Paul B. Findley





The oscillograph in use. The experimenter is Dr. J. B. Johnson, who developed this most interesting apparatus. At the right is shown an enlarged view of the same. The curves are seen upon the almost flat end of the bulb, when it is in action.

THE principle of the cathode ray oscillograph was discovered by Braun 25 years ago and the tube has always been known by his name. In Braun's tube, however, the electrons were produced by a high voltage discharge, between the metal terminals through the remnants of gas left in the tube. Some of the electrons went through a tiny hole in the terminal plate and struck the end of the tube making a spot of light where the stream of light ended. If an electric voltage was applied between the plates the stream would be deflected toward the positive plate and the spot would move across the screen.

The Braun tube had two major limitations. The air left in it became gradually exhausted and had to be renewed while the voltage required to operate it was from 10,000 to 50,000 volts direct current. The apparatus necessary to generate a current at this voltage and its maintenance was expensive and it was also dangerous for the operator to handle. In addition the tube was not stable. The electrical characteristics varied with the amount of gas in the tube and the electron stream was falsely deflected by negative charges collected on the glass walls of the tube. These charges collect on the walls of the tube because the pressure of the gas is not high enough to dispose of them. For these reasons the Braun tube was never used as much as it deserved when its advantages were considered.

The development of the vacuum tube, however, opened up a way to obtain the stream of electrons more easily by the use of the heated filament. In the drawing (F) is the filament which is heated by a six-volt battery as in the ordinary vacuum tube. Another battery built up of small radio B cells provides 300 volts between the filament and the other electrode (A). This electrode is in the shape of a little tube. The voltage at which it is maintained draws off the little electrons from the filament. They pass through the hole in the plate (S) and down through this tube. From there they shoot on down between the plates (Px) to the end of the vacuum tube where they strike the chemical coating of the screen making a bright dot. To simplify matters only one pair of plates is shown in the diagram. The other pair is at right angles to the first and is used to swerve the beam at right angles to the motion produced by the first pair of plates. One plate of the pair (Px) has a lead which passes through the glass to a terminal and the other is connected to the tubular terminal (A) and from there to a terminal outside the tube. In this way when a voltage is put across the two plates the stream of negative electrons will be swerved toward the positive plate.

When it is desired to measure a current instead of a voltage, two small coils of a few turns of wire are placed on opposite sides of the tube. The magnetic effect of the current deflects the electron stream in a direction parallel to the plane of the coils and the luminous spot will be moved as before.

In the cathode ray oscillograph as developed by Dr. J. B. Johnson of the Western Electric Company the disadvantages of the Braun tube have been overcome. The adoption of the heated filament did away with the necessity of maintaining a very high voltage between the filament and the other electrode. The elements were so designed that the electrical characteristics of the tube were maintained independent of the pressure of the gas in the tube. It was found in the development of this tube that when it was exhausted to a very high vacuum the individual electrons of the stream separated. This stream of electrons shooting out through the tubular electrode resembles very much the stream of water with which the small boy was drawing his designs on the board fence. The electrons separate just as the globules of water did making the stream wide where it strikes the end of the tube.

Of course the boy when making his figures on the fence doesn't care whether the pencil he is drawing with is an inch in diameter or a foot. However, when you are going to calculate the action of an electric current you must use a sharp pointed pencil. So a way had to be found to focus a stream of electrons down to a very fine point.

Consequently, Western Electric engineers made up a tube containing a small amount of argon, an inert gas. First they

exhausted the tube of all the air possible, even to baking the glass while it was being exhausted, so as to release all the gas from the glass which would be freed by the heat generated during operation. Then the argon gas was introduced. Now every gas is made up of separate molecules, each of which has a comparatively large nucleus positively charged with electricity which is surrounded by a number of negatively charged electrons held to it by electric attraction. The free electrons shoot down the tube at a velocity of 6,000 miles per second and when one of them hits one of these molecules which is moving at the rate of only one-quarter of a mile per second the force of the collision knocks off one or more electrons from the molecule. Formerly the positive charge of the nucleus was neutralized by its ring of negative electrons but when some of the electrons are knocked off, the nucleus, now positive begins to attract free negative electrons. As these nuclei are heavy as compared to the flying electrons they are simply buffeted around by the latter and they stay in the line of the electron stream where they are formed. Therefore, there is along the whole length of the electron stream a line of positive nuclei which attract the free electrons and hold them in the straight and narrow path in spite of the repulsion between electrons which tempts them to spread out. Further, the dislodged electrons shooting off in all directions soon fill the space outside the stream with negative charges which repel the flying electrons, keeping them in their own path. In addition the pressure of the gas in the tube is high enough to denude the glass walls of the tube of negative electric charges.

In order to prevent the bombardment of the filament by positive ions which destroy its oxide coating and thus render it inactive the filament is sealed in the glass-mounting tube, and to prevent the ions from striking the filament, when they come through the hole in plate (S), the filament is bent in a circle. The filament is made of ribbon instead of wire which leaves only an edge exposed to these ions.

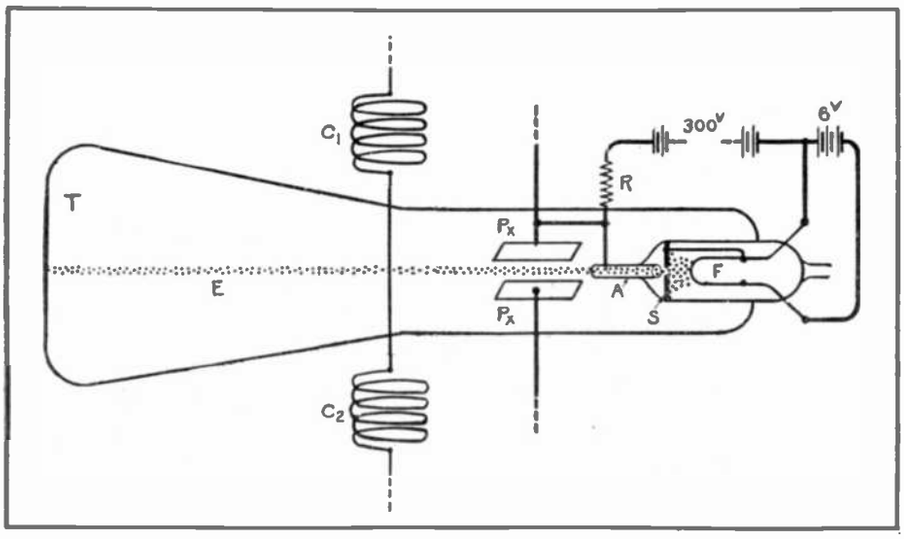
The great advantage of the cathode ray oscillograph lies in the fact that the stream of electrons forms a nearly weightless pointer whose movement will accurately follow the changing conditions in the circuit to which it is connected. By avoiding mechanical inertia, as it does, it is capable of recording frequencies up to millions of cycles per second.

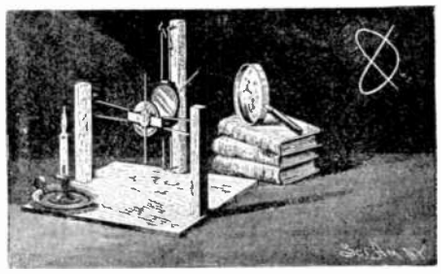
This interesting instrument can be used in many ways. When one set of deflector plates alone is used the electrical potential to be measured causes the luminous spot to become a bright line whose length is proportional to the amplitude of the voltage wave. If now another voltage varying with time is applied to the other pair of plates, placed at an angle with the first pair, the beam will be swept across the field and its wave-form can be seen. Thus, by speaking into a telephone transmitter one can "see himself talk."

The familiar "hysteresis loop" can be shown most vividly with this oscillograph. The magnetizing current moves the spot "from side to side" and the resultant magnetism in the sample moves it "up and down." In the Western Electric laboratories of the Bell System, such a set-up has been made by winding the magnetizing coil on a fibre tube, into which is slipped a thin strip of the material. The tube is so placed that the end of the sample comes up to the oscillographic tube where its magnetism can swerve the flying electrons.

By connecting each set of deflecting elements to alternating currents of different frequencies, the spot will trace out Lissajous figures. If the frequencies are steady and one is an exact multiple of the other the pattern will be stationary, otherwise it will change as the phase relation of the current changes. There is shown here a comparison of 100 and 400 cycles, but the ratio between the two may be much greater. For two currents differing widely in frequency, the pattern may be too long for its ends to appear on the coated end of the tube; but the fact that it is steady shows that one frequency is an exact multiple of another. Thus the carrier wave of a broadcasting station may be amplified on one set of deflector plates, while a locally generated frequency impressed on the other set of plates is adjusted to a match with it. The local wave is then matched with another local frequency at say, 1/100 its frequency and this in turn is "stepped down" to a frequency which can be measured easily.

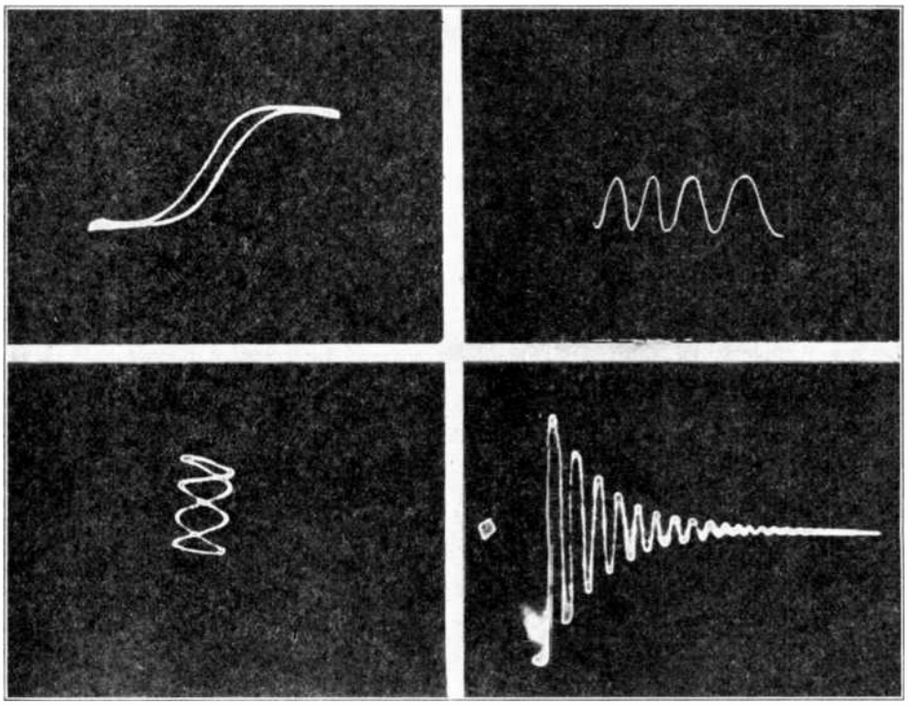
The chief value of this cathode ray oscillograph is to get quick indications. Hysteresis loops can be taken very rapidly on one sample after another as against a half day each by the more accurate "point-by-point" method. Also for demonstrations before classes up to about 20 persons, this device shows what is happening with a convincing clearness.





The old and the new. On the left is shown the construction of the electric oscillograph operating by the cathode ray, giving a virtually weightless index to be affected by the current and producing the figures, seen as such by persistence of vision upon the end of the tube.

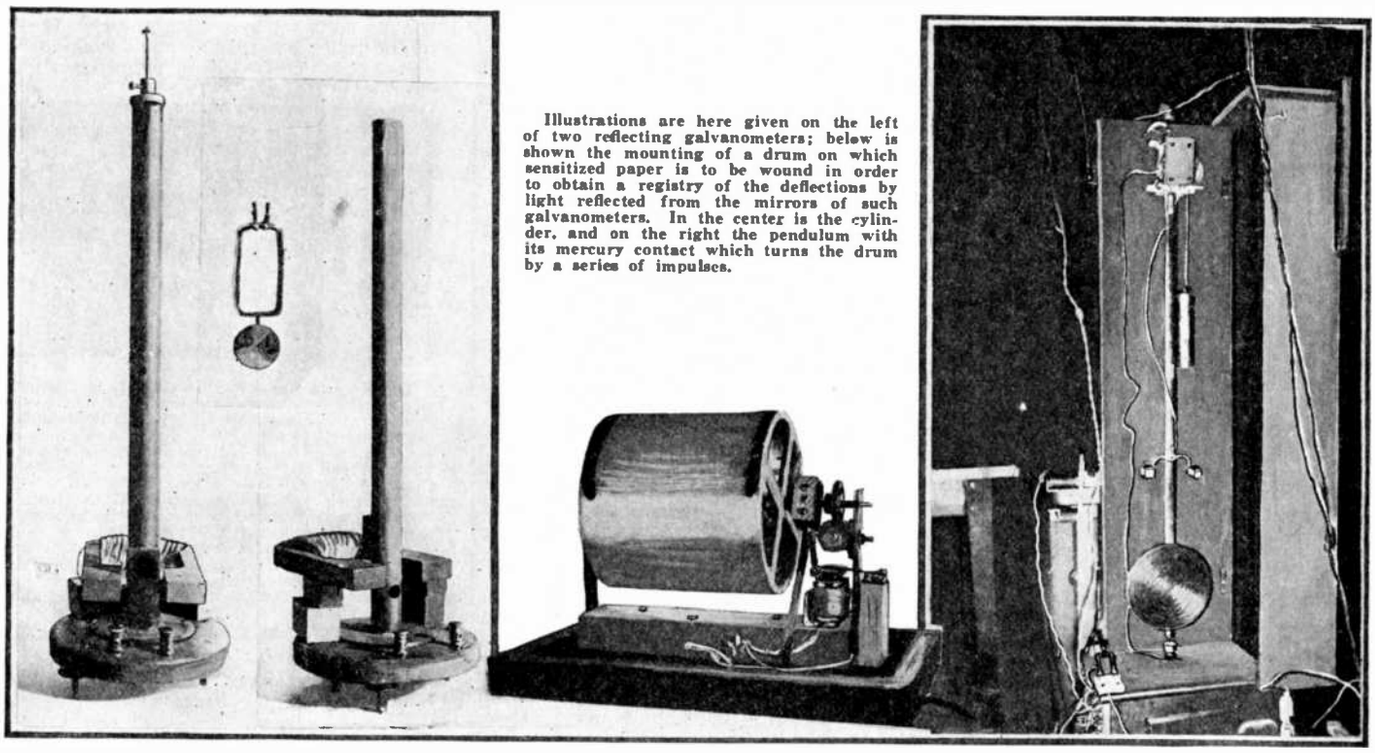
Above is shown the production of the Lissajou figures; a very simple apparatus with mirrors so mounted as to oscillate about axes at right angles one to the other quite rapidly. By a simple lens the light spot is projected upon a screen, giving various interesting figures, which illustrates the oft repeated story of electricity supplanting mechanics.



Various examples of curves seen upon the end of the oscillograph. Beginning at the upper left we have the familiar hysteresis curve; then a curve of alternating current; below at the left is a curious little effect produced by the special excitation; the lower right curve shows a dying or dampened oscillation.

Electric Chronograph and Recording Drum

By Dr. Russell G. Harris



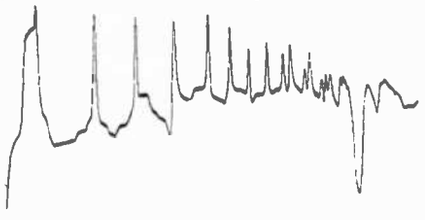
Illustrations are here given on the left of two reflecting galvanometers; below is shown the mounting of a drum on which sensitized paper is to be wound in order to obtain a registry of the deflections by light reflected from the mirrors of such galvanometers. In the center is the cylinder, and on the right the pendulum with its mercury contact which turns the drum by a series of impulses.

IN preceding articles we have described instruments which give their readings in terms of the motion of a beam of light reflected from a mirror connected to their moving systems. In any extremely sensitive device it is necessary to use this method, as a pointer made of a material substance would be too heavy to respond quickly. The beam of light is essentially a rigid weightless pointer, which may be made of any length desired within limits.

In many cases, where we are not measuring separate quantities, it is desirable to take readings continuously in order to see how the thing being measured is varying. Thus suppose the radiomicrometer is set up to measure the radiation from the sun, as was suggested; in order to get any sort of a record over a long period of time it would be necessary to take a reading every second or so. The writer recently had occasion to take 3000 readings an hour for a period of several hours, and as this proved considerable of an eye strain if continued, the recording device to be described was built. It may be used with all the instruments so far described, and in addition will be found useful with several others to be mentioned later.

The illustrations show the apparatus as used with the various galvanometers. This differs from the usual form as no motor is required to drive it, and it moves by jerks or intermittently instead of continuously, which has several advantages. A sheet of photographic paper is wrapped around the drum, which turns slowly, and the spot of light from the moving mirror, swinging at right angles to the motion of the drum, traces out a curve as its deflection changes. Such a curve is shown on this page. The average experimenter is apt to shake his head at this point, as photographic paper is rather expensive to be used in large quantities. As ordinarily purchased this is true, but by buying it in rolls a six months' supply may be had for a couple of dollars. The writer uses a single weight slow chloride or bromide paper, and rolls of this thirty feet long and twenty inches wide are bought for slightly over two dollars. These are easily cut up into sixty strips, twenty inches by six, and will do for sixty complete records. In fact, the developer costs more than the paper, if the ordinary MQ tubes are used: for that reason a formula is here given which can be made up once and for all, and will keep six months. In this way the total cost of a complete record containing several thousand readings is only a few cents.

Get a large bottle such as the ordinary six pound acid bottle to store the developer in, and also a smaller bottle holding just enough to fill a small tray three-quarters of an inch deep. Mix the following chemicals, obtainable at photographic supply stores, in the order given:



Example of a curve produced upon the sensitized paper on the drum indicating the deflections of the galvanometer. These deflections are primarily horizontal but are most conveniently studied when the paper is held across the page.

Distilled water	6 lbs. or	2.7 liters
Metol or Elon	.11 oz. or	3.15 grams
Sodium Sulfite ...	1.68 oz. or	47.7 grams
Hydrochinon	.5 oz. or	14.0 grams
Potassium Bromide	.07 oz. or	2.0 grams
Sodium Carbonate.	2.64 oz. or	75.0 grams

This mixture should be stored in a tightly stoppered bottle and kept in the dark, when it should last for six months or over without turning deep brown. For immediate use, the small bottle should be filled half full of developer, and then completely filled with distilled water. This can be used several times if kept stoppered when not used but should be thrown away as soon as it gets very dark brown. The coloration is caused by contact with the air more than by use, and the life of a given batch can be much prolonged by keeping the bottle full to the top and well sealed.

The paper, after exposure, is run through the developer tray exactly like a roll of film, and the black lines should stand out visibly in less than a minute. Just before the background of the paper begins to turn dark, remove it and wash for an instant, then fix it in a saturated solution of hypo, which need not contain any hardener. The hypo can be bought very cheaply in bulk several pounds at a time.

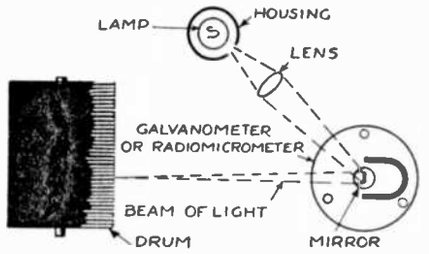
If the record line appears weak, or does not show at all the trouble is more likely to be in insufficient exposure than in the developer, and the light should be made stronger, or else the galvanometer mirror should be closer to the recording drum. In general it will be found that the deflections are so large that the recording drum must be brought to within a couple of feet of the galvanometer in order to compress the maximum deflection into the six inches of the paper on the drum.

On many types of record sheet we desire to know just when a certain point on the curve occurred; thus, in using it to measure the growth of a house-plant during the night, it showed that a sudden increase of growth occurred at 4 A.M., indicating that the janitor was right on the dot in starting his furnace. For this reason we will have the drum driven by a standard clock instead of a motor; indeed, this method is most convenient in other ways. A pendulum clock is desirable, as being the simplest and easiest to handle. The average experimenter is quite capable of tinkering with an alarm clock, and an old pendulum clock is even simpler. These can generally be picked up in junk shops very reasonably, and as it is not necessary that it keep accurate time, we should not

have much trouble in getting one which could be fixed up.

If the pendulum of the clock is over twenty inches long, it will need no modification. If it is less than this a wooden rod, preferably hardwood, should be rigidly fastened to the pendulum, and a metal bob weighing several pounds be fastened to the bottom of this. The length should be such that one complete swing is made in two seconds; the weight of the bob will not affect this.

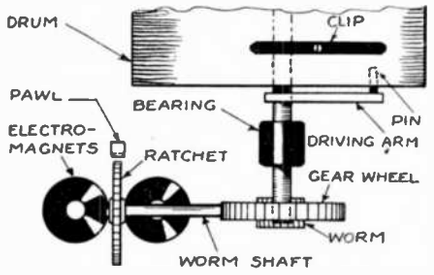
If the clock has not been running for some time, it should be taken apart and the bearings and shafts cleaned with kerosene or benzine, then reassembled, using a tiny bit of good oil on each bearing. It should stand so that when the pendulum



The reflection from the mirror of the galvanometer upon the surface of the drum on which the bromide paper or other sensitized paper is secured.

hangs straight down, the escapement is in the proper position for releasing. There is a small screw which may be loosened to adjust the position of the escapement; this can be used to set the shaft of the latter so that the release occurs at the right time, and the proper drive is given to the pendulum. The clock will have a healthy tick when the proper position is found. A little oil should be placed on the teeth of the escapement, and on the ways where the drive arm touches the pendulum shaft.

The clock must be mounted rigidly; preferably fastened to a wall. Above all, the pendulum weight driving the clock should never start swinging of its own accord; this would indicate that the clock is loose. On some jewelers' watch-boards, watches may be seen swinging from side to side, due to the reaction from their balance wheels. No timepiece can be accurate while doing this. In Figure 3



The ratchet drive for operating the clock by an electro-magnet which is in circuit with the mercury contact at the foot of the pendulum.

is shown an old clock which was rescued in this manner, made to run again, and which now serves admirably to drive recording drums, to release shutters and to do other things at definite intervals.

To the bottom of the pendulum a copper wire is fastened, fairly stiff, and projecting about half an inch below the point. This continues, insulated, up the pendulum shaft, and at the top of the clock is soldered to a loose coil of perhaps twenty turns of No. 30 wire, so that the stiffness is not sufficient to affect the clock. This in turn leads off to the rest of the circuit. Below the copper wire, at the point where the pendulum hangs when at rest, place a piece of flat iron, with a shallow half-inch hole hollowed out in it. In this cup place a large drop of mercury, and adjust the length of the pendulum wire until it passes through the mercury enough to make an electric contact, but not enough to stop the clock. If, now, we complete the circuit outside with a battery and telegraph sounder, we get a click every second; once on the forward swing, and once on the backward. These clicks should be even; if they are not, the position of the mercury cup must be changed until they are.

In the clock illustrated there are three mercury contacts, one at the bottom, and two half way up the sides, which only make contact once in two seconds.

Where the clock circuit itself is used to drive the drum, as is most convenient in cases where slow motion is desired, a magnet and pawl arrangement is used, as in the illustration. In this case it was desired to have the drum make about one revolution an hour. To attain this, a worm drive was used. This can be picked up from an old piece of apparatus, or can be bought very cheaply. The large gear, placed on the drum shaft, has fifty teeth, and there are thirty teeth on the ratchet wheel. The exact numbers are unimportant, except that if we multiply the first number of teeth, times the second, times the number of seconds between clicks, we get the number of seconds required for one revolution of the drum. In the case above, fifteen hundred clicks, one every two seconds, caused the drum to rotate once in 3000 seconds, or 50 minutes.

The ratchet wheel can be taken from an old clock, phonograph motor, or anything that requires winding. The pawl to pull it down when the electromagnet gets an impulse can be filed from a piece of strap iron. The various springs, indicated in Figure 4, are cut with tin shears from the springs of an old alarm clock. The bearings are made by drilling holes in brass, and should not be too tight.

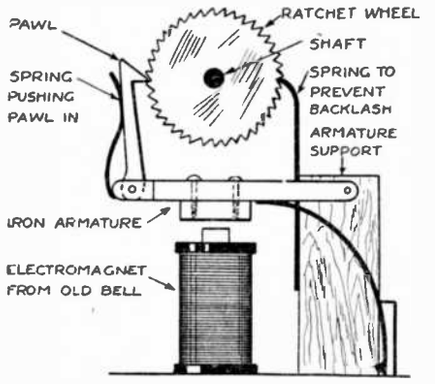
The drum illustrated in the figure was cast from aluminum especially for this purpose, but an old coffee can will do as well. It should have a good lid, which should be soldered on so as to make the can rigid. Solder on two end plates of fairly thick brass or sheet iron, about two inches in diameter, and after carefully finding the centers, bore holes which fit the shaft rather loosely. In the end of the can nearest the magnet bore a hole which loosely fits the pin in the end of the driving arm. The can may then be slid along the shaft, disengaged from the pin, and rotated to put on the paper without turning the shaft. Then, when the paper has been put on, it is slipped into place, and a positive drive is afforded.

If the room is not to be darkened it is necessary to have a cover over the drum. It should be easily removable, so that the drum can be loaded and unloaded in a dim light. The drum and driving mechanism are mounted on a base giving a half inch clearance all around, and a strip is fastened all around the edge. A box large enough to slip right over the whole arrangement, and fit into the border around the base is then made. Along the front of this box, and level with the center of the drum shaft, cut a half inch slit the whole length.

Now take two desk rulers and mount these by means of round headed screws so that they make a slit about the thickness of a dime. The screw holes should be very loose or oblong, so as to allow for adjustment. When the screws are tightened the jaws should be parallel to each other and to the shaft.

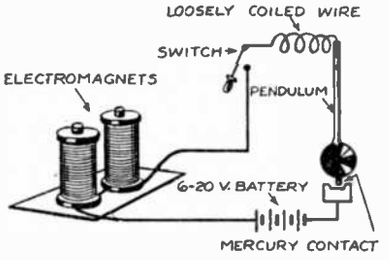
Probably the most difficult part of the whole arrangement is to get the pawl to pull the ratchet wheel around by one tooth, and only one, for each click. Some adjustment in the spring and position of the armature arm will be necessary for this, but once the proper adjustment is found, it should not need adjustment for a long time. The proper adjustment can often be found by moving the spring which prevents back motion.

After all has been assembled, cut a strip of the bromide paper about six inches wide, in a darkened room, or one provided with a red light, and mount it on the drum. The paper is held in place by two clips made of spring brass or copper. These are screwed in the center to the drum. The can should be slightly over six inches long, and slightly less than twenty inches in circumference. Fold about half an inch of one end of the paper under, and insert it under the clips.



Elevation of the ratchet drive. The pawl secures regular action in conjunction with the spring opposite to it.

Then turn the drum, wrapping the paper tightly against it, being sure the emulsion side is out, and after folding the other end under, insert it under the clips. These should take a positive hold, as it is very aggravating to spend an hour making a run, and then find your paper has come undone in the beginning, and curled up in one corner of the box. The housing is now put in place, and the slit closed with a hinged flap. The whole outfit is then put on a stand of suitable height and placed the proper distance in front of the galvanometer mirror. The lens should then be adjusted so that the light spot is focussed on the slit of the housing. A nice finish to the job is made by painting base and housing with a thin mixture of lamp-black in dilute shellac.



General layout of the whole driving apparatus omitting all details not required for explanation.

By using a narrow spot of light the record line will be broken up into a large number of small spots, and by counting these and reckoning from the first one it is possible to tell when any change in deflection took place. On the other hand, if an unbroken line is desired, the spot may be made wider so that successive images overlap on the paper, and the time may be marked by having another lamp and lens system, which traces a straight line on the paper beside the record line, but is interrupted at any desired interval by a shutter operated by a second electromagnet controlled by the clock circuit. Several measuring devices can be made to record their deflections simultaneously on the same sheet of paper, by properly arranging them.

Stunts With Static

By Harry R. Lubcke

THE phenomena produced by static electricity are, in the main, mystifying to the average person. Crackling of the hair when combed on a dry day or the fabled sparks produced by rubbing a cat's fur backwards in the dark are familiar to all.

For the experimenter static electricity offers a new field of endeavor. It is electricity in its "natural" state and a study of its actions will aid to a thorough understanding of current electricity. Current and static electricity are near relatives. Static electricity is of great voltage but of infinitesimal amperage, while current is the more moderate, useful variety of comparative low voltage and high amperage.

To illustrate, the potential of a glass rod which has been rubbed with silk may rise to several thousand volts with only a few micro-amperes of current, whereas the ordinary dry cell develops only 1½ volts but furnishes from 10 to 20 amperes.

To conduct the experiments a few pieces of apparatus will be necessary which can easily be made. To start, procure a smooth glass rod and a piece of silk. The rod need not be solid but should be about one to two feet long and one-half inch or so in diameter. Next make a stand and suspend two pith balls with a silk thread as shown in Fig. 1. If the real pith from the center of a cornstalk is not available some very thin tissue paper lightly pressed into balls can be used. Do not press them too tightly because they should be as light as possible.

Now warm the rod and silk so that they will be free from moisture. Rub the rod briskly with the silk rag and when it is working right both should warm up and give forth a slight crackling noise. Then bring the rod near the pith balls. It will first attract them, but when they touch the rod they will be strongly repelled. Now take the glass rod away and the two pith balls will stand apart from each other. Touch them with your hand and they will fall together again. Evidently the glass rod charged them with electricity and your hand discharged them, exactly what has happened.

Next provide yourself with a rod of hard rubber or sealing wax and a piece of flannel or fur. Rub the rod with the rag and test as before. The action is the same; first attraction and after contact, strong repulsion. Charge the pith balls with the glass rod. They will mutually repel each other as before. Then rub the hard rubber rod with the fur and bring it near the pith balls. It repelled them? No, it attracted them! By this we see that there are two kinds of electricity; one kind generated by the silk on glass and the other by the fur on hard rubber. When we touched the pith balls with one rod we gave them the same kind of charge as was on the rod and they were repelled. When we brought the other charge near them they were attracted to it. Thus, like charges repel and unlike attract. This shows the experimental proof of one of the most fundamental laws of electricity. The electricity produced on glass by rubbing with silk has arbitrarily been called positive and the other, produced with hard rubber and fur, negative. By charging either the glass or hard rubber bits of paper, thread, etc., can be made to cling to them.

However, the potential we produce on the rods by rubbing does not exceed about 2,000 volts. Some of the more advanced experiments require a higher potential. When we consider that it takes a potential of 30,000 volts to make a spark jump one centimeter (about three-eighths of an inch) through air it can be seen that a more powerful generator is needed. This is easily obtained with a device called an "electrophorus." It consists of a pan of rosin and a metal disk provided with an insulating handle as shown in Fig. 2. Two tin pie plates of different sizes can be used. The larger one, preferably about 9 inches in diameter, should be heated and enough rosin put in to make a cake about one-half an inch thick. Heat till the rosin smokes so there will not be any air bubbles. The smaller one (seven inches) is provided with an ebonite, bakelite, or hard rubber handle at least a foot long. It should not project through on the side that touches the rosin. If the handle is not sufficiently long or of good insulating material the charge will leak off through it to the hand. The author has used four pieces of silk thread tied to small holes equally spaced around the rim and extending up about a foot with fine results although it is more difficult to place the plate on the rosin cake. The handle or thread should be grasped at the extreme end.

To operate the electrophorus secure a piece of fur, thoroughly dry it by heating slightly and rub the rosin briskly for a full minute or more. Then put the top plate down firmly on it and touch your finger to some point on the upper plate. Take off the finger and then the plate without touching the bottom plate that holds the rosin. Then approach the top plate with your knuckle and a spark will jump to it. You have now discharged the plate and to charge it again it is only necessary to put it on the rosin, touch with your finger and take off again. This can be repeated many times before the rosin has to be rubbed again with the fur.

The spark should be at least one-half inch long for an apparatus of this size. If this is not secured at first rub the rosin thoroughly again with the fur and be sure the handle is well insulated. With a small electrophorus only 5 inches in diameter the author has secured sparks over one-quarter of an inch in length which indicates a potential of about 20,000 volts. Because of the low amperage, however, they are harmless and produce only a slight tickling sensation.

If the experimenter desires he can attempt the construction of the new double electrophorus described in the October, 1923, issue of this magazine on page 546. Great claims are made for this type—a voltage of 50,000 and a spark of 2½ inches.

To detect extremely small potentials an *electroscope* is used. This consists of two very thin "leaves" suitably mounted and protected from air currents by a glass container as shown in Fig. 3. The leaves should be made of one piece of thin gold or aluminum leaf about one-quarter inch wide and 2½ inches long. This is bent over a piece of No. 12 copper wire which extends through a rubber stopper and is provided with a polished metal knob on the top. An Erlenmeyer flask is used in the commercial types but an ordinary bottle can be used with good results.

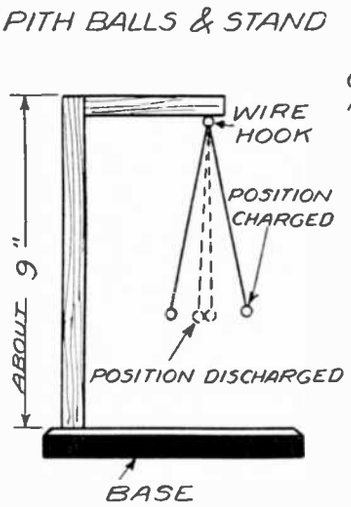


FIG. 1

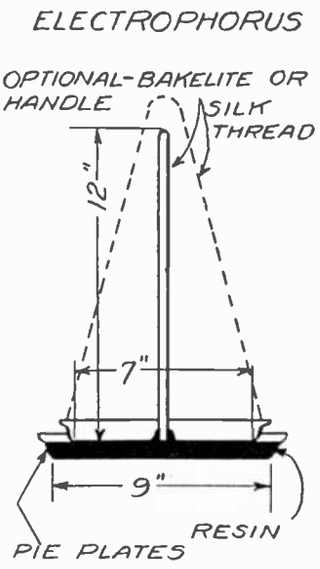


FIG. 2

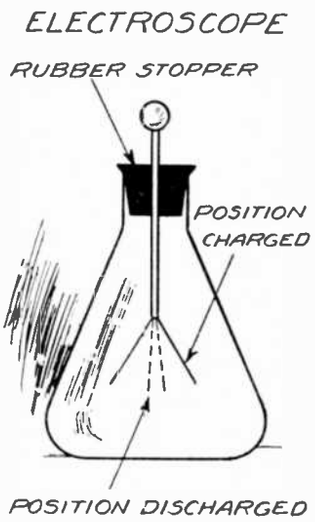


FIG. 3

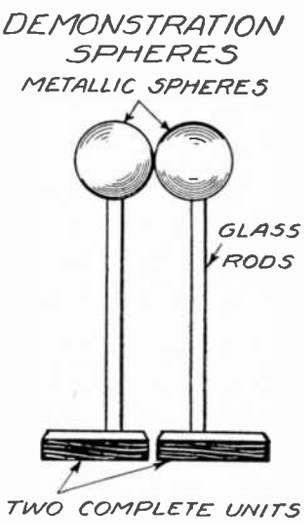


FIG. 4

Experiments with pith ball electroscope and other classic appliances, used for demonstrating the action of so-called static electricity, which is electricity of high potential held as a charge.

When the electroscope is brought near to or given an electrical charge by contact the leaves diverge; the larger the charge the greater the effect. This is because both leaves have the same kind of charge and therefore repel each other. With a sensitive instrument the charge on a glass rod can be detected at a distance of from 2 to 3 feet. If it is given a positive charge by contact so that the leaves stand out about half way and a negatively charged body is brought near it slowly, the leaves will fall. An external positive charge will spread them further apart.

When the electroscope is charged by an electrified body at a distance it is said to be charged by "induction." This sort of a charge is of a temporary nature and the leaves fall together when the body is removed. When a charge is induced into a neutral body by another charged one, the end away from the charged body has the same charge as it and the end near the opposite charge. Thus if a positively charged rod is brought near an oblong object the further end would be positive and the near end negative. After the rod is removed the charges flow back and neutralize each other. But if we separate the body while under the influence of the charge we trap the positive charge on one part and the negative on the other. This can be proved by charging an electroscope and determining which body causes the leaves to rise or fall.

By knowing this fact we can perform a trick that will puzzle the most sophisticated "scientist" in any audience. Provide yourself with a glass rod and silk, two insulated metal spheres (Fig. 4), and an electroscope. Electrify the glass rod and charge the electroscope positive with it by contact. Then place the two metal spheres in contact and touch them with the glass rod. Demonstrate to the audience that they both cause the leaves to diverge further when they are brought near the electroscope. Next bring the charged rod very near the spheres and take the further one away before you remove it. Show that it will also cause further divergence. Then ask the audience what the other one will do. Undoubtedly they will say the "same thing." Wrong! You fooled them by taking the spheres apart and it is charged negative and will cause the leaves to fall. Before they have recovered (?) charge the rod again and bring it near the spheres as before. Touch them at one end with your finger for an instant and remove the rod. Take the one closest to the rod over to the electroscope where it will cause the leaves to fall. Then ask them what the other will do. If they are not entirely dumfounded by this time they'll guess that it will cause the leaves to spread further apart as before. Wrong again! It causes them to fall just as the other one did. This is because the positive charge is repelled as far as possible by the glass rod and when you put your finger on them it goes up through it and into your body. Because you removed your finger before the rod it cannot flow back and hence the charge on both the spheres is negative. The spheres can be touched anywhere and to further baffle them you can touch them at the end opposite that which you touched before. The electroscope may need to be recharged with the glass rod during the experiment.

Another mystifying effect can be produced by bringing the charged glass rod near the electroscope and putting the finger on the knob. The leaves will first diverge and then fall when the finger is applied. Now remove the finger and then the glass rod and the leaves will unexpectedly jump apart showing the 'scope is charged. In this case the positive charge on the rod induced a negative one on the electroscope and when you touched your finger to it you made a path for the positive charge to escape, thereby leaving the whole electroscope negative.

If a static machine is at hand or a double electrophorus has been constructed several more interesting experiments can be carried out. The discharging effect of sharp points can be demonstrated by the "electric whirl." This consists of a few pieces of pointed wire fastened together with a bearing in the center (Fig. 6a). This is connected to one pole of the static machine. When the machine is started the little wheel will revolve rapidly. This is due to the fact that at sharp points the electrical charge is very concentrated. The charge leaks off into the air and gives a reaction effect on the wheel similar to that which makes a garden sprinkler rotate. This experiment is the basis for many tricks. You can tell the audience you have invented a new sort of motor without a field, that you have discovered perpetual motion (?) (as long as the crank of the static machine is turned), or simply ask them what makes it go and save the answers for a joke book!

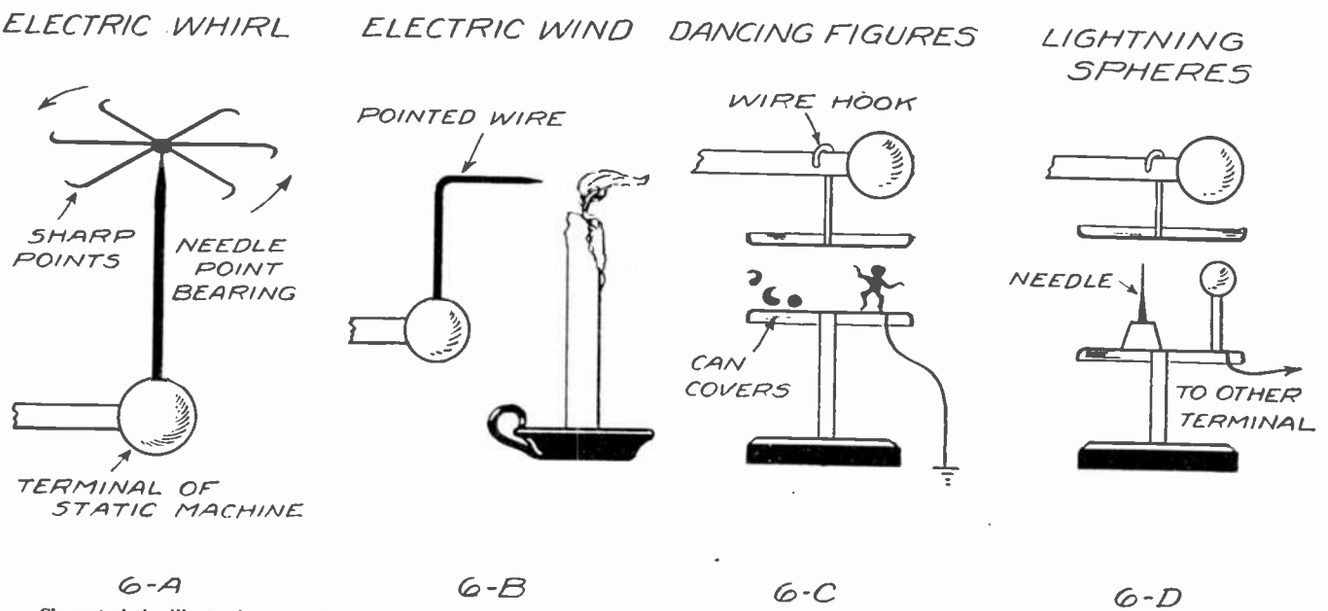
Another trick along this line is called the "electric wind." In this case only one point is needed (Fig. 6b). Place a candle near the point and start the static machine. The disturbance in the air caused by the charge leaking off will blow the flame over as shown.

The "dancing figures" are also interesting. Procure two metal plates (tin can covers) and place them about 2 inches apart (Fig. 6c). One is connected to a terminal of the machine and the other to the ground or your hand. Then place pith balls, bits of paper, or light dolls made of pith or paper on the lower plate and start the machine. The figures will bob up and down as long as the machine is operated. This is the same phenomenon as was shown by the pith balls and the electrified glass rod. The plates have opposite charges and when figures touch one of them they receive that charge and are immediately repelled by it and attracted to the other, which results in the bobbing.

To make the demonstration educational you can explain the action of the lightning rod. Use the two plates of the preceding experiment, a sphere with a metal support, and a sharp pointed needle with a supporting base (Fig. 6d). First leave the needle out and adjust the plates so that a spark will just jump from the top plate to the sphere. Then place the needle as shown and no sparks will jump even though the top plate is brought quite a bit closer. The needle causes the discharge to take place quietly even though it may not be as high as the sphere. In this experiment the top plate represents the charged cloud, the sphere a house, the needle the lightning rod, and the bottom plate the ground.

To the experimenter and magician who will follow the field of static electricity a vast amount of experiments and tricks are opened. Any work expended will be amply repaid by the results, whether it be an explanation of some electrical phenomenon, or a new trick with which to mystify the public, who, as Barnum said, "always like to be fooled."

While these experiments may be familiar to many of our readers, they represent the good work of former investigators and cover a field which is perhaps being somewhat neglected at the present time, when so much is being done in high frequency work. By following out static action and the incidental reaction due to its excitation, there is scope for much ingenuity in devising interesting experiments, some more serious than others, and some leading to the construction of what may be termed electrical toys and games.



Characteristic illustration of interesting experiments in static electricity, some of which may be familiar to our readers, but which are well worth reproduction and description.

How to Make a Static Machine

By Hans Konwickza

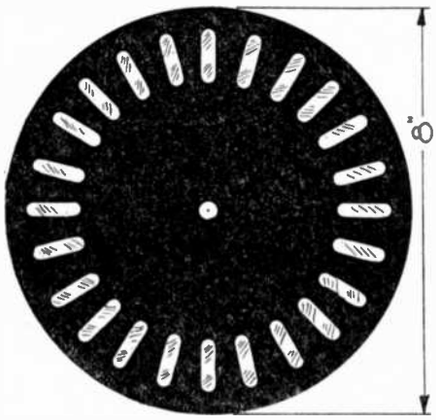


FIG 2

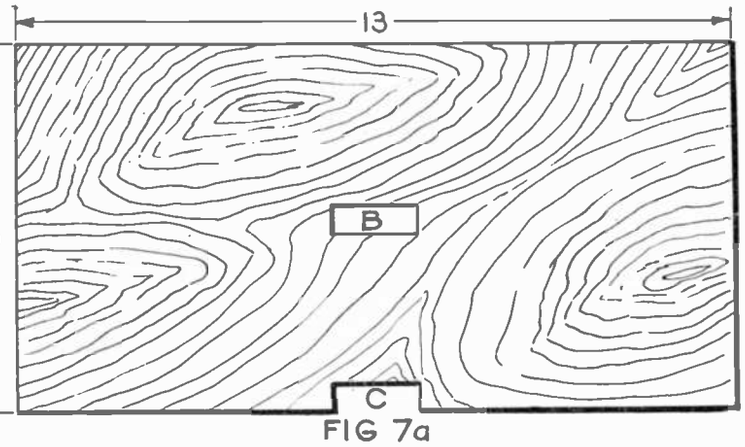


FIG 7a

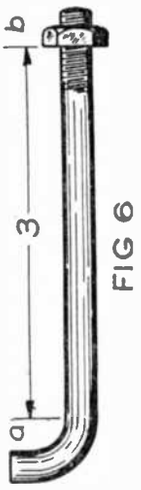


FIG 6

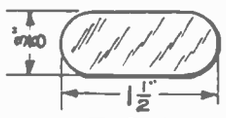


FIG 1

One of the plates of the Wimshurst influence machine with its tinfoil segments; diagram of a segment; the base and the shaft of the influence machine. It may have phonograph discs or glass ones.

WHEN we have completed the construction of a glass plate frictional machine we may take up a much more difficult affair, the building of an influence machine. With this machine we can produce sparks four inches and more in length. Although the construction is not so simple, the satisfaction derived will be much greater. Such a machine can be used for X-ray work and for many beautiful experiments.

Procure from the owner of a gramophone or from a dealer in such apparatus two damaged records and the rest will be simple. We will need some hardwood boards for the base, other pieces for the standard, cigar-box wood, sheet brass, brass wire, 80 to 120 mils thick, two narrow high battery cells, tinfoil, two small file handles and good sealing wax, a few screws, six small brass balls, and pieces of lametta, such as is used to ornament Christmas trees (tinsel). When we have all the principal materials we can proceed with the construction. We now may summarize the parts needed:

The rotating discs with central hole, the shaft, baseboard, standards, collector, equalizing conductors, Leyden jars, discharger, rotating apparatus.

1. The Rotating Discs

We select two discs each of eight inches diameter. As has been said, discarded phonograph records can be used very satisfactorily. Tinfoil pieces are pasted radially near its circumference on one side of each plate. The circumference of each disc is laid off into 24 equal divisions and, radial lines are drawn for a guide. From tinfoil there are to be cut 48 exactly similar strips in the form shown in Figure 1, three-eighths inch wide and 1½ inches long. These pieces are glued to the marked side of the discs so that each disc has 24 of them as shown in Figure 2. Common shellac dissolved in alcohol is used for the cementing. Each plate has to be provided now with its hub, shown in Figure 3; the hubs are drilled for the shaft to fit tightly; each hub is one inch long. The disc-shaped extension (I) serves for cementing the hub to the glass.

(U) is a drive pulley, grooved to receive a round belt, and it will be understood that all this will be made of one piece of wood. Figures 4 and 5 show very clearly how the discs (A) and (A) are cemented to the hubs (N) and (N). The tinfoil pieces are on the outside of the discs and face the equalizers (G) and (G), Figure 4. The portion (S) of the hub operates to prevent the plates while being turned from approaching each other closer than .2 inch. If the holes in the center of the plate are too small, they can be reamed out; this requires the utmost care, because some records break with great readiness.

The flanges (I), if not of the same pieces of wood, must be very securely fastened to the hub and be set perfectly true with the shaft.

2. The Shaft

This consists of a piece of brass wire that passes easily through the holes in

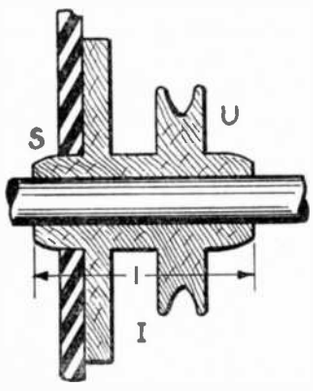


FIG 3

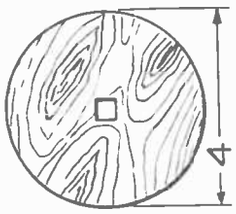
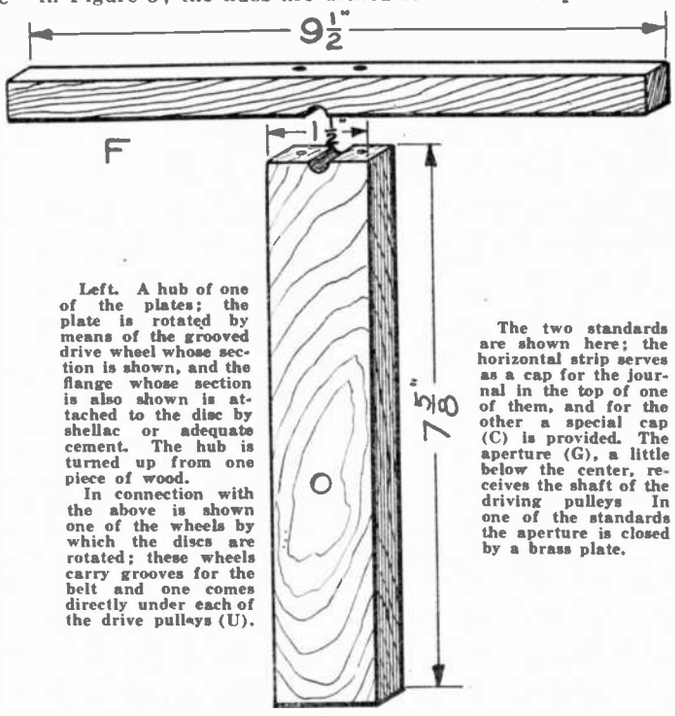


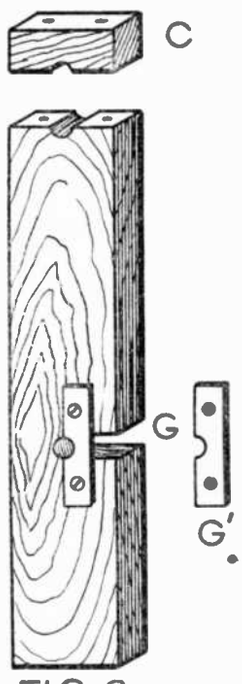
FIG 16



Left. A hub of one of the plates; the plate is rotated by means of the grooved drive wheel whose section is shown, and the flange whose section is also shown is attached to the disc by shellac or adequate cement. The hub is turned up from one piece of wood.

In connection with the above is shown one of the wheels by which the discs are rotated; these wheels carry grooves for the belt and one comes directly under each of the drive pulleys (U).

FIG 7



The two standards are shown here; the horizontal strip serves as a cap for the journal in the top of one of them, and for the other a special cap (C) is provided. The aperture (G), a little below the center, receives the shaft of the driving pulleys In one of the standards the aperture is closed by a brass plate.

FIG 8

the driving hub, yet without too much play. The wire, about 3¼ inches long, Figure 6, is bent at the end (A), and at the other end (B) is threaded to receive a nut and washer. Next comes

3. The Baseboard

This is made of one-inch board 13 inches long, 6 inches wide, notched out at (C), Figure 7a, 1½ inches long, one-half inch deep; in the center of one of the long sides the hole (B) of identical size with the notch is morticed out. The distance between the two is two inches and in these we have to glue

4. The Standards

One standard shown in Figure 7 is one-half inch thick, 1½ inches wide and 7⅝ inches high. It carries a cross piece (F) of equal thickness, of square section and 9½ inches long. It is screwed fast to the standard and the hole for the shaft is divided between it and the cap or cross-piece of the standard as shown. The other standard, Fig. 8, is of the same dimensions as the first, and has a small block (C) screwed to its top, but has no cross arm. These have at the top the bearings for the shaft and a second hole (G) notched out 2½ inches above the upper curves of the baseboard. The little plate of brass (G¹), about 1¼ inches long and one-half inch wide, is screwed on as shown to close the sides of the hole. The hole is about one-quarter inch in diameter. A hole corresponding to this in height and size will be seen in the other standard. These receive the shaft of the driving pulleys.

5. Collectors

Two collectors shown with dimensions in Figure 9 are cut out of 1/50 inch brass plate; each has two tongues separated about one inch from each other, the dimensions being quoted on the drawing. Two screw holes (i, i) are used for screwing it down to the cross arm of the first described standard as shown in Figure 5. Teeth are filed on the inside of the tongues and must be so far apart that the discs will turn with their surfaces a little over one-fifth inch from the teeth without touching them. The space between the discs is taken as one-half inch.

6. Equalizing Conductors

Out of sheet brass three sixty-fourths inch thick are cut two strips three sixteenths inch wide and 6½ inches long, Figure 10. In the middle of each strip there is a hole that fits very snugly on the main shaft, Figure 4, so that while each can be adjusted by hand, it will not rotate with the discs. On the end of these strips little brushes of very thin brass wire or of so-called lametta or tinsel are soldered. These brushes should be about three-eighths inch long; the equalizers are bent in the shape shown in Figure 10, or Figure 4 (C C). All parts can now be put in place. The standards are supposed to be glued to the baseboard and the cross-piece screwed down to one of them. The shaft is then thrust through the hole, receiving first one of the equalizers (C), Figure 4, then comes one of the discs with its tinfoil plates facing the equalizer, then the other disc with its uncoated side facing the first disc, then the second equalizer. The brushes on both equalizers face the discs, then the shaft is thrust through the second upright and the nut is screwed thereon. The collectors (D, D), are now screwed down on one end of the cross-piece, Figure 5, care being taken that the teeth do not touch the discs.

7. Leyden Jars

are pieces of apparatus which are sometimes used independently, and are necessary constituents of our influence machine. They must be made with the greatest care to act well. We use two round battery jars about 5¼ inches high and 2 to 3 inches diameter, Fig. 11. Cement over the interior of the glass tinfoil to a height of about 3½ inches; the tinfoil must be pressed

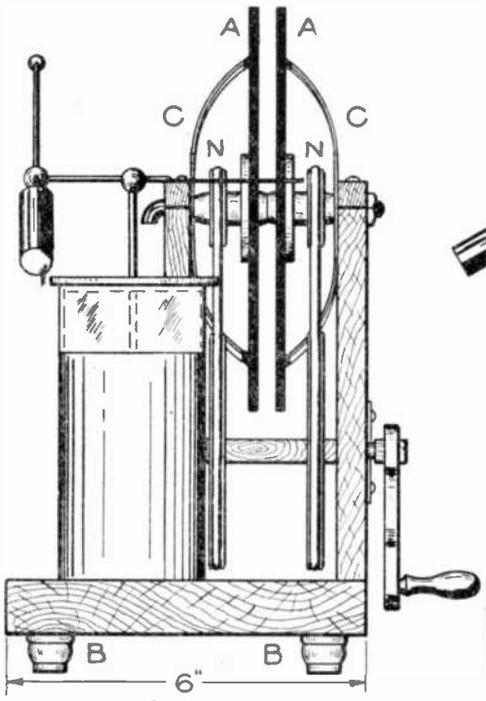


FIG 4

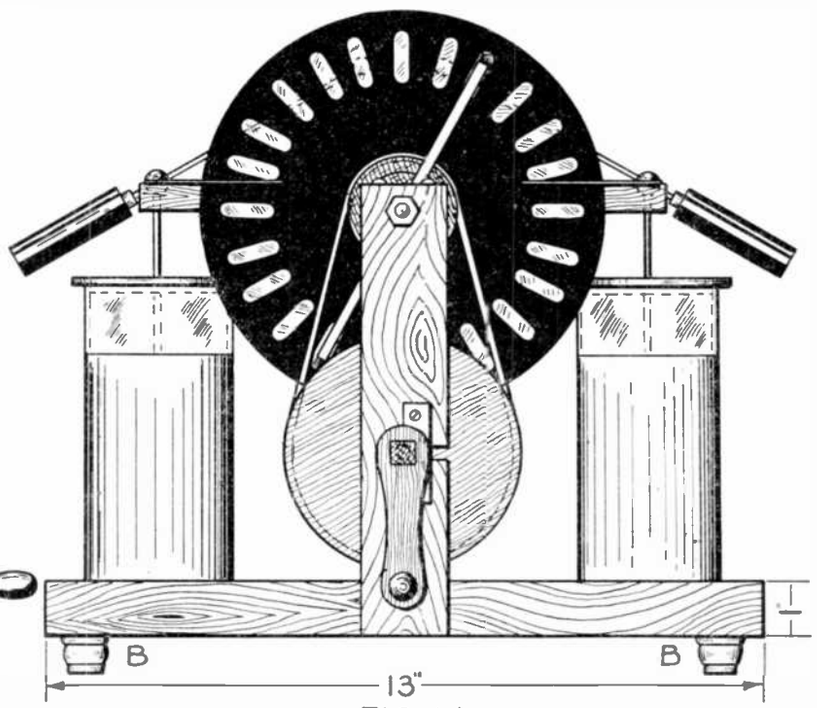


FIG 14

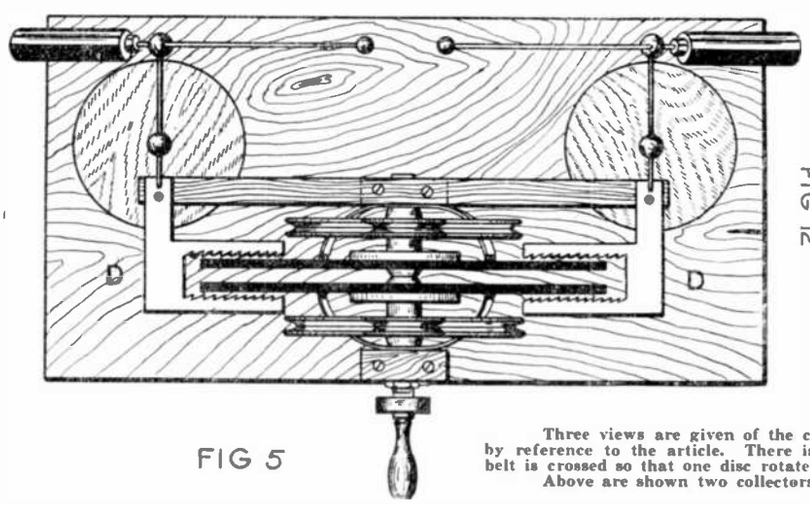


FIG 5

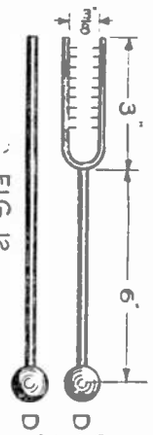


FIG 12

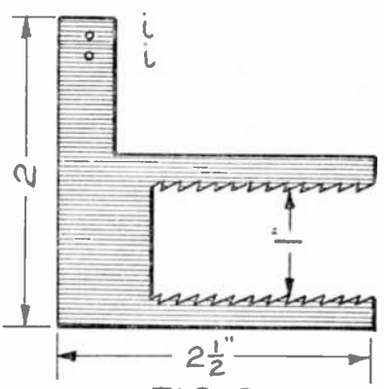


FIG 9

Three views are given of the complete influence machine, which will be clearly understood by reference to the article. There is a drive belt pulley on each side of the machine and one belt is crossed so that one disc rotates in one direction and the other in another. Above are shown two collectors, all fully described in the article.

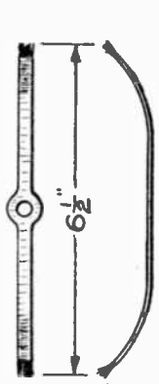


FIG 10

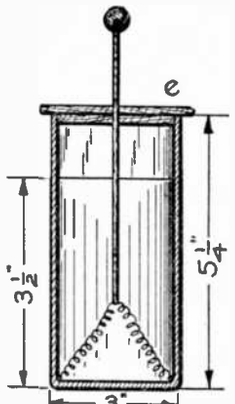


FIG 11

Fig. 10 shows a light piece of metal which carries tinsel brushes on its end which sweep against the tinfoil discs on the rotating plates.
Fig. 11 shows a Leyden jar; these must be constructed with the greatest care; even the quality of the glass has important bearing on their action.

tightly against the glass everywhere and must be absolutely continuous; the bottom of the jars is also to be coated with tinfoil. The outside is coated with tinfoil to the same height and the tinfoil must project below the lower edge and be bent over the bottom. A disc of tinfoil is cemented thereon. This is all done with shellac solution. The jars must be perfectly dry before they can be used and the very material of the glass is of importance, as poor glass will not act well. Before putting on the cover the interior must be perfectly dry; the cover (e), Fig. 11, is made of two discs of cigar box wood, glued one upon the other, the upper one slightly larger so as to rest upon the edge of the cell, while the other one fits the interior tightly. Through the center of the cover a brass wire 12 mils in diameter and about 6 inches long passes, to whose top a brass ball is soldered, while to the lower end pieces of very thin soft brass or copper wire of spiral shape are soldered. To secure still better contact, some strips of tinfoil can be attached to the spiral. None of the wires except the spiral should touch the tinfoil coating; the strips of tinfoil of course must also touch it.

The cover is now given a thick coating of sealing wax, is cemented to the glass with the same material, and the uncoated exterior of the jar can be advantageously coated with the same. A test can be applied to both the Leyden jars by bringing their terminal bulbs in contact with the conductor of the machine, which is now completed and which we are supposed to be turning. We should not let the charging last too long, if we are going to make the discharge by the knuckle. Of course, if we use a regular discharger we can bring them up to as high a tension as they will receive. A simple discharger, Fig. 12, is to be recommended highly for those experimenting with electric machines, to avoid repeatedly taking shocks through the body.

It can be very simply made. The handle is made of a piece of our glass rod about four inches long. Such a piece as we used for the standard of the conductor is the right material. A 1¼-inch piece of round wooden rod of the same thickness of the glass is bored as shown in Fig. 12 and is attached to the glass by a bit of brass tubing cemented with shellac. Through the hole in the wood a piece of brass wire 80 mils in diameter and about 8 inches long, bent as shown and with balls soldered on the end, is thrust tightly. We can use the discharger for either charging or discharging the Leyden jar; to charge, one of the terminals of the discharger is held against the conductor and the other against the terminal of the Leyden jar. For outside experiments we can make any number of Leyden jars we desire, but for our machine we must have two of this particular construction and size as given. There is no need to state that for ordinary use we can use glass as large as we wish and of any dimensions. It is important for the jar to have a wide enough neck, however, to give a good insulating space between the wire terminal and the outside of the jar. We now come to

8. The Discharger

A short piece of pointed brass wire (L), Fig. 13, is thrust into a wooden handle (K); a black polished tool handle is recommended and on its end a metal ball is soldered with a hole to receive the horizontal wire (M). As an extension of the first wire, a second wire four inches long (H), is soldered, and this has a ball (S) on its outer end. The horizontal wire (M) which makes contact with the ball terminal of the Leyden jar is 1¼ inches long and has a thread cut on its end so as to screw into the ball (J). The balls (S) and (S), Figs. 13 and 14 can thus be brought as close together or as far apart as desired.

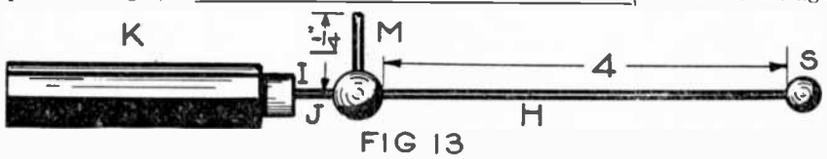


FIG 13

One of the electrodes. When the machine is running sparks will fly across from one electrode to the other. These rods are shown in the figures on the preceding page.

MARS!

On August 22 the planet Mars will be nearer to the earth than it will be for very many years to come. It will be the most conspicuous object in the evening skies.

This event again leads to speculation if Mars is inhabited or not, and if so, what sort of looking people are the Martians?

All of this is speculated upon in an article entitled "Evolution on Mars," by H. Gernsback. The problematical Martian is depicted in SCIENCE AND INVENTION for August, with discussions.

Electrical Articles in August "Science and Invention"

The Diabolic Ray—Results of Tests Made by the Editors.
The Radio Knife—Newest Aid to Surgery.
Artificial Animals — Operated by Electricity.
Dr. Hackensaw's Secrets — The Dream Machine.
By Clement Fezandie.
The Ten Most Needed Inventions.
By Raymond Francis Yates.
An English Ossiphone—New Sound Detector for the Deaf.
Electric Power from Earth's Heat.
Electroplating Baby's Boot and Other Small Objects.
By C. A. Oldroyd.
Latest Patents.
Patent Advice.
Latest Radio Inventions and Construction Articles.
Complete Revised List of Broadcasting Stations.

9. The Rotating Apparatus

This part comes directly under the shaft of the discs. The shaft, Fig. 16, is made of a wooden rod about ½-inch square and nearly 3½ inches long, and has two rounded portions, (z) and (y), which fit the journals of its standards, shown in Figs. 7a, 8 and 14. The crank arm (L), Fig. 15, is cut out with a compass saw from wood and has a square hole to fit the shaft to which it is glued and if necessary wedged. A nicely smoothed handle (O) is secured by a screw in the other end of it. The two belt wheels (F) and (F), Fig. 16, can be sawed out of thin wood and a groove must be filed all around their periphery so as to receive the belts. These wheels have a diameter of about 4 inches and are ¼ to ⅜-inch thick. Each must come exactly under the corresponding belt wheels on the shaft of the discs. The piece thus made is dropped into its bearings and all is ready for the belts.

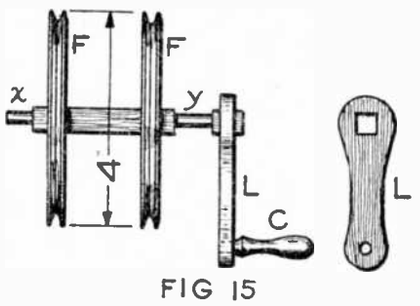


FIG 15

The two drive wheels (F F); it will be noticed that the crank has a square aperture for fitting the square end of the shaft of these wheels. The belt going around one of these wheels is crossed so that a slightly longer belt will be required for one than for the other.

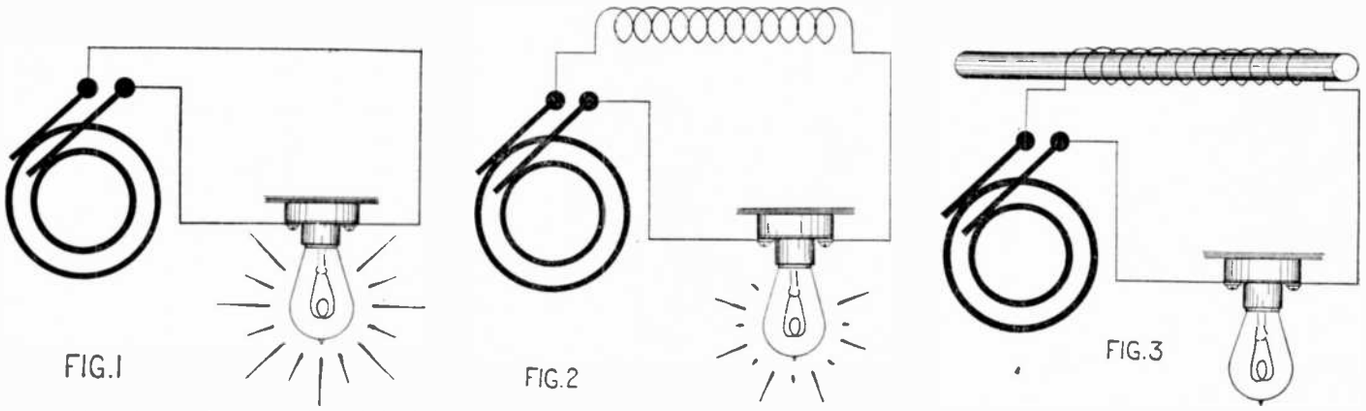
These belts, which are put on as shown in Fig. 4, are passed around each drive wheel, and then over the corresponding drive pulleys attached to the disc shaft, Figs. 4, 5 and 14. The ordinary sewing machine belt can be used for driving and one of them is crossed so that when the handle is turned one disc will rotate in one way and the other in the opposite. The Leyden jars are now placed on the baseboard so that the wires soldered to the balls (M) will come directly under the collectors (DD) and after being screwed therein, the end if it protrudes is hammered smooth, so as to constitute a riveting. To hold the jars more securely on the base plate, holes can be cut in pieces of cigar box wood just large enough to tightly receive the jars and are glued in place. The upper end is held steady by the wire, see Fig. 4. Finally, we attach to the baseboard four short feet (B), Figs. 4 and 14, about three-quarter inch high. We now have to bring the equalizer in its proper position; each must be set against the direction of rotation of its own disc and the brushes must lightly touch the tinfoil pieces; the best position will be found by trial. The angle from the perpendicular should be about 30 degrees as shown in Fig. 14.

The machine will now work even in wet weather and give four to six-inch sparks. For this we need an induction coil which alone would cost more than the whole apparatus.

The machine may be taken as acting well when a half turn of the hand wheel will start it to working; even after a quarter turn one should perceive the characteristic rustling noise associated with electricity which is especially observable with influence machines.

Self-Induction

By Harold Jackson



Three figures show, 1, a lamp lighted from an alternating current circuit with no inductance, giving full illumination; 2, the same lamp giving diminished light because of a coreless coil of wire which produces a comparatively weak inductance; 3, an iron core inserted in the open coil increases the inductance so as to make it a choke coil and to extinguish the lamp.

BY definition. self-induction is the effect produced by the action of electric current upon itself during variations in strength. In alternating current wiring this is a feature which must be considered. Self-induction is sometimes called electromagentic inertia and is analogous to mechanical inertia in ordinary matter. The three illustrations show the effect of self-induction upon the incandescent lamp, which is connected in series in the alternating circuit.

In Fig. 1, which represents a non-inductive circuit, the whole of the pressure or voltage is available to cause current to flow through the filament of the lamp, which results in the maximum brilliancy of the lamp. In a non-inductive circuit such as shown in Fig. 1 the whole of the power generated by the alternator is available to do work, in other words, the pressure is in phase with the current. In this case the power factor is said to be unity. However, even with a small amount of inductance in the circuit the pressure is caused to lag, which causes the power factor to become less than unity. In Fig. 2 an inductive coil has been placed in the circuit which, on account of the self-induction of the coil brings the power factor below unity which results in the lamp being but dimly lighted. The mutual induction arising between the separate turns of the coil give rise to an opposing potential, which partially chokes down the main current resulting in the reduced output of the alternator, consequently in the dimming of the lamp.

The self-induction of the coil may be greatly increased by inserting an iron core in the coil as shown in Fig. 3. Here the circuit becomes highly inductive and can be intensified to such an extent as to extinguish the lamp entirely. In Fig. 3 the lamp receives hardly any current; although the electrical circuit is as complete as in the other cases, the alternator is generating potential as before, but the potential is not available for any useful work in the external circuit. The self-induction of the coil exactly balances the electromotive force generated by the alternator which causes the current to merely play back and forth in the circuit without flowing through the lamp filament at all and therefore it exerts no energy. This is sometimes called a wattless current. In the case of the wattless current, the pressure lags ninety degrees behind the current giving a zero power factor.

Alternating current wiring, when done in metal conduits, must always be arranged so that both wires of the same circuit are in the same pipe, otherwise trouble will be encountered due to self-induction. The effect of the induction is nullified by the currents of opposite direction in the two wires. Sparking at the brushes of a dynamo is caused by the self-induction of the induced currents in the armature winding. It is necessary to give the brushes a little additional lead, that is, to advance the brushes in the direction of rotation beyond the neutral plane, in order to prevent the sparking at this point due to self-induction as just noted.

The current in a circuit cannot be instantly stopped by breaking the circuit. The self-induction will cause the current to continue to flow a short time after the circuit is broken, causing a bright spark at the point of rupture. The current jumps the air gap due to its "momentum." Thus one coil can be used for low-tension ignition.

Dry Cells from Wet Batteries

By C. A. Oldroyd

Barrow-in-Furness, Eng.

WITH the introduction of the new "dull emitter" audion bulbs for wireless work, the cumbersome storage battery is no longer necessary and primary batteries can be used instead. Dry batteries have been greatly improved during recent years, but naturally, their current-hour capacity cannot equal that of a wet battery.

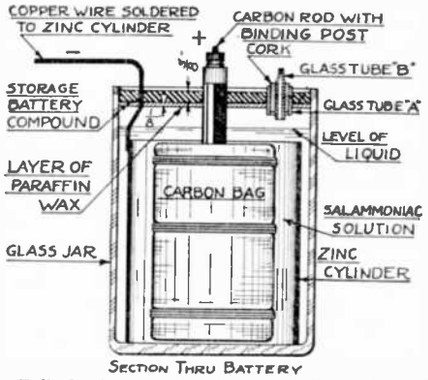
The wet cell has the advantage that the liquid is easily spilled and might damage instruments or furniture, furthermore, the liquid has a habit of crystallizing and "creeping" over the rim of the container.

As far as safety and ease in handling are concerned, a wet battery can quickly be converted into a "dry" one, while still retaining the advantages of more enduring currents and possibilities of recharging peculiar to wet batteries.

The illustration shows a vertical section through a standard wet cell of the Leclanché type, employing a carbon bag and a zinc cylinder immersed in a salammoniac solution.

To prevent an escape of liquid, a layer of melted sealing compound, as used for storage batteries, is cast within the top of the glass container. Provision for the escape of gases and for recharging is made by fitting a vent consisting of two concentric glass tubes.

The larger tube (A) has an inside diameter of three-quarter inch and is about 1½ inches long. A second glass tube (B) having a diameter of about three-sixteenth inch, is supported within the larger one by a cork. The end of this tube is drawn out to a fine point, similar to that of a fountain pen filler. This tube is about two inches long.



Full details of what is practically a dry cell made up of wet-battery parts. Observe how it is sealed with the asphaltic sealing compound.

For recharging, the inner tube and cork are withdrawn, when the exhausted liquid can be emptied out through the larger tube. To cast the sealing layer into the top of the glass jar, place the container on a perfectly level surface, after assembling the battery. Next fill the jar with cold water up to about five-eighth inch from the top of the jar; dry the inside rim carefully, and temporarily support the larger tube (A) in position with a strip of wood. The bottom of the tube should be about one-half inch below the surface of the water. After melting some paraffin wax or Christmas candle ends, pour this on top of the water. At the beginning of the pouring the melted wax should run down at the inside of the rim, so as not to disturb the water level.

This layer, which should be about one-eighth inch thick, serves to protect the sealing compound layer from the chilling effect of the cold water, so as to get an

(*Continued on page 600*)

Awards in the $100 Old Telephone Receiver Contest

First Prize

Telephone Amplifier

By Jack Bront

MANY and varied are the schemes attempted for the amplification of telephone signals by the use of a microphone attached to a watch case receiver. Many are fair but many useless.

The best found by the writer is that type described here—where the input current manipulates the diaphragm of a telephone of the watch case variety, which in turn varies a second current traversing a microphone arrangement, a local battery

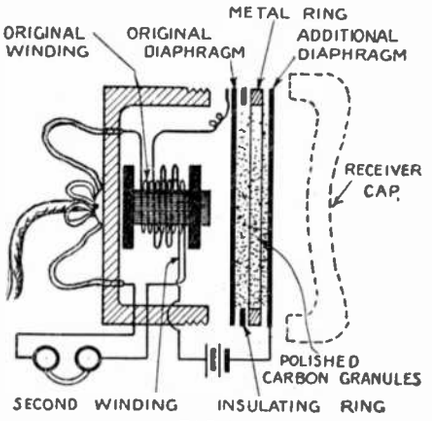


FIG. 1

A telephone with double diaphragm with carbon granules in the space between, to act as a sort of microphone and amplify the sound.

and a secondary winding on the watch case receiver magnet.

Instead of placing the recording telephones in the local battery circuit, they are connected in the line circuit where their resistance does not affect the low voltage battery current.

Incoming currents vibrate the diaphragm of the watch case receiver, traversing the main receiver winding, the recording telephone windings, thence back to the line.

Actuation of the watch case telephone diaphragm varies the local battery current, which induces, through its separate winding of few turns, a high voltage back in the "line-recording telephones" circuit —thus acting in the role of a repeater, or relay——

Amplification is accomplished at the expense of the battery energy.

The apparatus was built at the "de

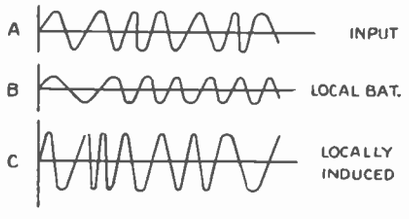


FIG. 2

Curves of the input and also of the relay current and of the combination of the two in this amplifier.

Souge" artillery and air field near Bordeaux, France, several years ago—and the model is not available, as it, I believe, was taken to "F L" by one Sergeant Chevigny of the 8ième Infantrie.

The telephone used in the apparatus was one taken from a German field tele-

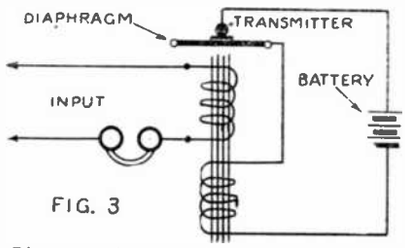


FIG. 3

Diagram of connections for the telephone amplifiers.

The $100 Old Telephone Receiver Contest

OUR $100 Old Telephone Receiver contest was a great success. From all quarters we received ingenious suggestions for using old telephone instruments, and we publish in this issue the names of the prize winners with illustrations and descriptions of their devices, and also of one to whom Honorable Mention has been awarded.

There is something quite fascinating in the utilization of such things as the discarded telephone receiver, which may figure as the higher grade article, down to such things as the homely plug fuse or discarded spark plug.

What is published in this issue certainly carries out our ideas as here expressed. The various uses shown are most ingenious, and the variety of things done with the receiver is quite impressive. The great number of contributions sent in included a number of almost equal interest with that of the prize winners, so that it became no easy task to select from the many those to whom prizes should be awarded.

Ingenuity has been displayed by our readers in a number of such subjects and reference to previous numbers will show how much can be done with this class of electrical appliances.

In old times, when there was a general lack of such articles, such contests would have been impossible. But modern life has brought to the front so many things which supply what the Wagnerites would call a *motif* for ingenuity, that we never institute contests of this sort without a full conviction that the results will be most interesting.

From time to time we shall publish a selection from the others. We are sure that our readers will be greatly interested in them.

First Prize, $50
Jack Bront,
2179 East 35th St.,
Cleveland, Ohio

Second Prize, $20
B. J. Brunsink
530 Michigan St., N.E.,
Grand Rapids, Mich.

Third Prize, $15
A. Melvin Skellett,
4722 Vernon Avenue,
St. Louis, Mo.

Fourth Prize, $10
Roscoe Betts,
Arcadia, Nebraska

Fifth Prize, $5
Roscoe Betts,
Arcadia, Nebraska

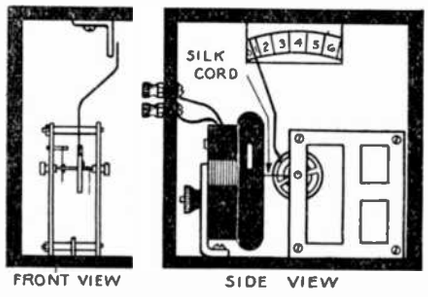
phone buzzer, and an additional winding was placed over the original. Although not exactly calculated, I presume the telephone winding resistance was in the neighborhood of 4,200 ohms. The original winding on the telephone was about No. 32 wire (B. & S.). The added winding was of wire about the same size, although silk covered, whereas the original was enameled.

The other winding in the apparatus was the "secondary" of a very high frequency buzzer of German design of approximately No. 40 wire and a resistance of probably 5,000 ohms. The "secondary" here mentioned was attached in the original buzzer to telephone lines employed for buzzer telegraph work—trench to command post.

Second Prize

Voltmeter

By B. J. Brunsink



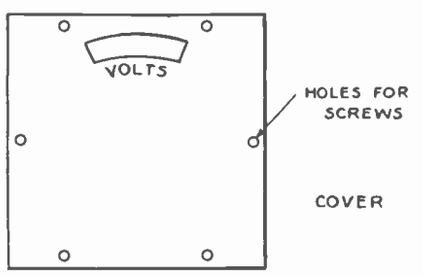
Voltmeter whose controlling element is a telephone receiver. The motion of the diaphragm is multiplied for the indications of the needle.

A VERY serviceable voltmeter can be made from an old telephone receiver. It is constructed in the following manner. In the center of the diaphragm pierce a small hole. Through this thread a silk cord and secure it by a knot.

From an old alarm clock remove all parts except the balance wheel and hair spring. These should be left in their bearings on the frame. Wrap the other end of the silk cord around the balance staff once or twice and tie to the rim.

To the edge of the wheel solder a small wire (about No. 30) four or four and a half inches long. The other end of this wire moves over a dial and indicates the voltage, constituting the index hand.

A piece of fairly thick magazine paper is cut in the form of a ring and placed under the diaphragm to keep it a little farther than normal from the pole pieces. The cap should be screwed on loosely.



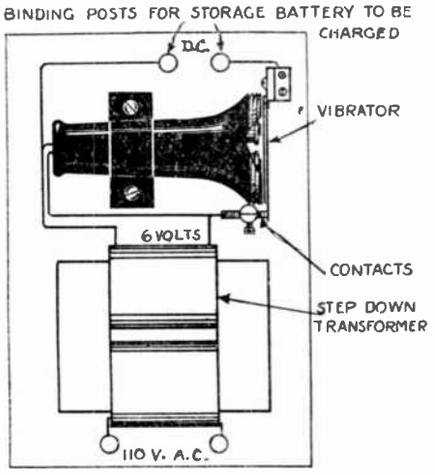
How the telephone receiver and voltmeter is to be mounted; the layout of the panel.

I am using a 75 ohm watch case type receiver and get a reading of one to six volts. A resistance in series with the receiver will enable one to measure higher voltages. A higher resistance receiver will make a good instrument for extremely low voltages.

Third Prize

Battery Charger or Rectifier

THE rectifier shown here was constructed from an old telephone receiver and the author has used it to charge a radio battery for over a year.



A telephone receiver connected with a step-down transformer acting as a current rectifier for charging a small storage battery.

A vibrator and contact may be purchased from one of the companies who makes battery chargers. A new set of contacts should be procured. It is advisable to purchase these two parts as it is rather difficult to construct a pair having so high a period as 60 cycles. However with a little experimenting one may be made from parts of a Ford vibrator. The author has used both purchased and "Ford" parts with good results.

The illustration is self-explanatory and data for the transformer may be obtained from back numbers of this magazine. A toy transformer may be used for small storage batteries such as those used with dry cell audions.

All of the telephone receiver is used except the cap and diaphragm as shown.

Fourth Prize

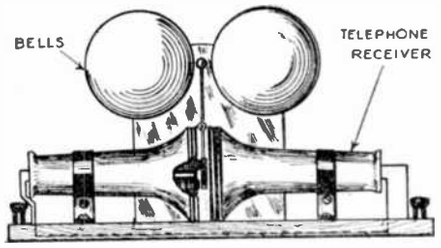
Alternating Current Bell

By Roscoe Betts

THE bell is for use with an alternating current, such as that produced from telephone generators, and is constructed as follows:

Remove the caps and diaphragms of two telephone receivers and mount the receivers on a baseboard as shown, leaving a small gap between the two electromagnet poles.

An upright piece is mounted also on the baseboard to hold the two gongs and the pivot for the clapper to swing on.



A pair of telephone receivers are made to ring two gongs in rapid succession.

The receivers are connected in series and a little experimenting here will be necessary to obtain the best results, i. e. since the magnets are permanent the coils should be so connected that the cycle will increase the magnetism of one and at the same time counteract the magnetism of the other, the next cycle, of course, doing the same but in the reverse sense.

It will be seen that in this way one magnet will be stronger than the other every other cycle, thus causing the armature to vibrate back and forth and to strike the gongs alternately.

Fifth Prize

Sensitive Relay

By Roscoe Betts

THE illustration shows how to make a sensitive relay from a telephone receiver.

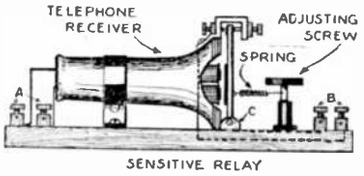
The cap and diaphragm are removed and the receiver is mounted as shown on the baseboard.

On the top of the receiver case is attached a brass strip, bent twice as shown, and with an extension to accommodate the case. It carries the two adjusting screws, one makes contact with the armature, and the other which must have an insulating tip serves as a back stop.

The armature is attached to a strip of iron, thick enough so that when soldered thereto the armature is very close to the magnet poles. The armature is pivoted at (C). The spring serves to pull the armature away from the magnet, the tension or pull being varied by the adjusting screw.

The telephone magnets are connected with the binding posts at (A), while one post at (B) is connected with the brass strip, and the other with the pivot at (C).

When the relay has been set up, the magnet, as it is a permanent one, will attract the armature and if the attraction



A relay of great sensitiveness using the magnet of a telephone receiver to operate the vibrating bar.

is sufficient will cause the same to make contact at the contact point. To prevent this tighten the spring slowly until the magnetism is overcome, but not too tight. The object is to so adjust the tension that a small current will cause the armature to make contact.

It will be seen that the relay is of the polarized type and while more sensitive than the ordinary type, it will only respond to currents flowing in one direction, this being due to the fact that a current flowing in the wrong direction tends to neutralize the magnetism of the permanent magnet so that it will not attract the armature. How the instrument should be connected in the circuit may be determined by experimenting and after the connections have been found, the posts are marked positive or negative.

As a telegraph instrument the relay can be used to some advantage since most lines require a relay of 75 to 100 ohms, the ohmage of most telephone receivers.

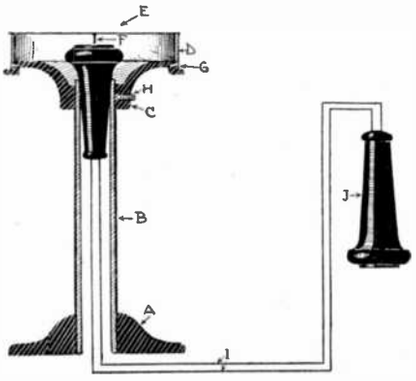
1st Honorable Mention

Telephone Rain Alarm

By Jacob E. Raible

A RAIN indicator which operates by telephone consists of a steel pipe screwed into a round iron base, and a circular cast-iron spider with a brass hoop and bronze diaphragm and stud at its upper end.

A telephone receiver is placed inside the upper end of the pipe and the cast-iron spider is set so that the stud fastened to a bronze diaphragm will just touch the center of the receiver diaphragm. The bronze diaphragm may be seven or eight inches in diameter. When the rain beats down on the large diaphragm the drumming will be transmitted to the receiver under it and from it to the indoor receiver.



This is a most ingenious rain alarm which never need be turned off, in which there is no salt to be replaced and no strip of paper to be put in clamps. Its advantageous features are stated in the article by the writer thereof.

The good points about this indicator are these:

It is prompt in action.

The amount of noise in indoor receivers is proportional to the severity of the storm.

It becomes quiet when rain stops.

No battery is required.

2d Honorable Mention

Telephone Receivers as Induction Coil

By Belgrave Gostin

A SUBSTITUTE for an induction coil for telephonic transmission can be made up of two old telephone receivers.

Referring to the illustration, two such are shown, facing each other; it is essential that the north pole of one magnet face the south pole of the other.

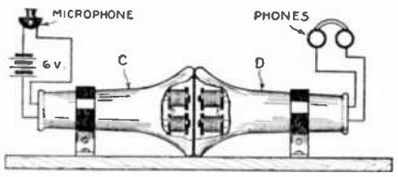
(A) is a microphone transmitter with a six-volt battery (B) in circuit with one of the receivers (C). The latter is of 75 ohms resistance. The receiver (D) which faces (C) is rewound to about 2,000 ohms resistance, the idea being to have it identical in that regard with the head-set (E).

This equivalence of resistances is necessary for the best results.

We have said that the north pole of one receiver should be opposite the south pole of the other. This, however, is not necessary if a diaphragm of iron is secured between the two receivers.

This connection has been tested out and has been found to give excellent results. It will operate very well on a radio set.

This is quite an elegant combination of

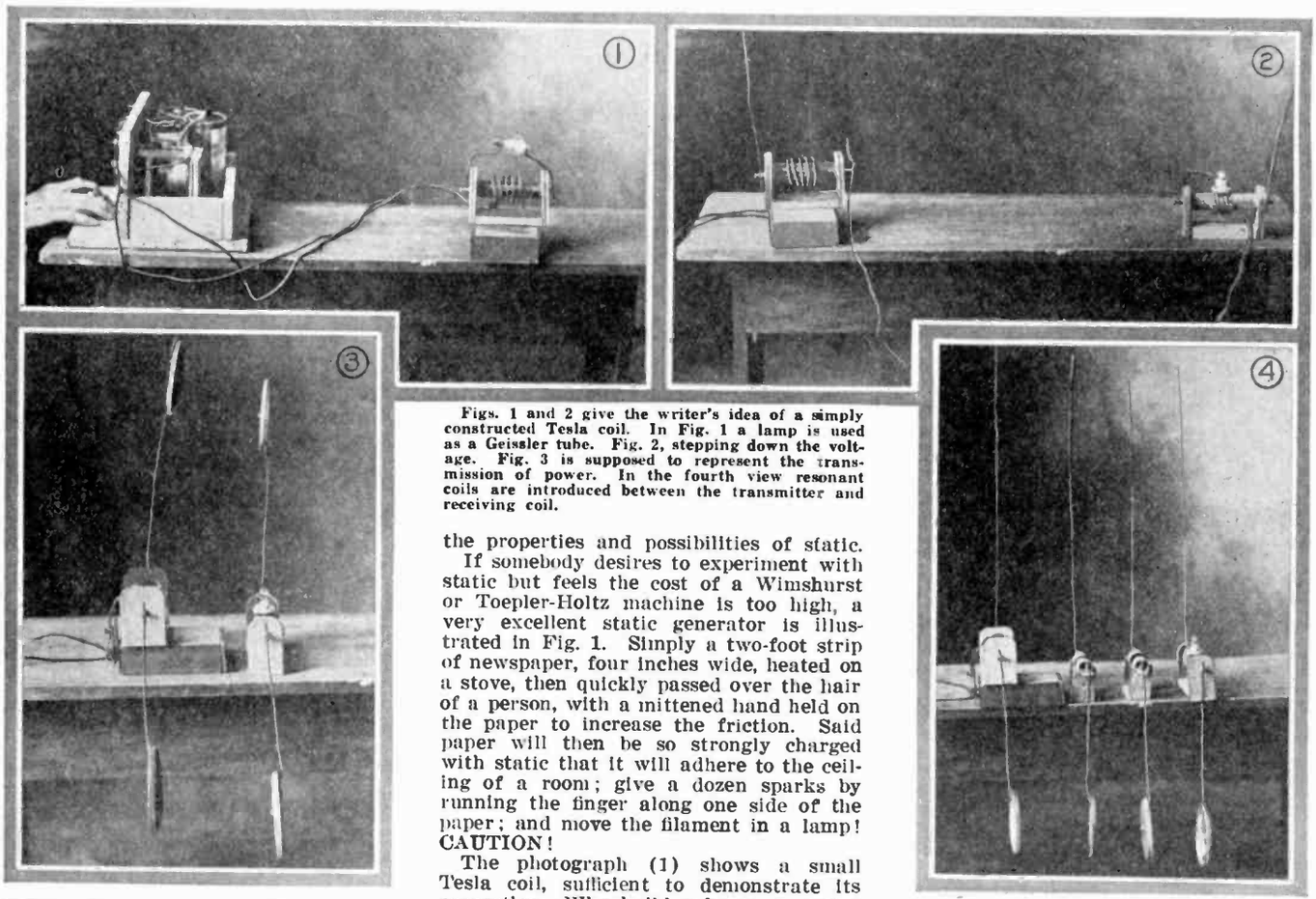


Current modulated in the left-hand receiver by the voice induces a corresponding current in the right-hand receiver, and the conversation is received by the phones as shown.

old telephones. It is not impossible that by placing the poles in metallic contact one with the other interesting results might be obtained. It certainly suggests a field for experimentation.

The Most Amazing Stuff on Earth

By Esten Moen



Figs. 1 and 2 give the writer's idea of a simply constructed Tesla coil. In Fig. 1 a lamp is used as a Geissler tube. Fig. 2, stepping down the voltage. Fig. 3 is supposed to represent the transmission of power. In the fourth view resonant coils are introduced between the transmitter and receiving coil.

STATIC electricity is difficult to understand. Sometimes it seems as if static is very "different" from electricity; you know, the high voltage from a spark coil does not "act" on an electroscope as strongly as does a genuine charge of static.

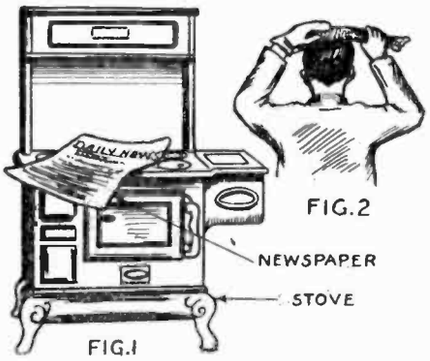


Fig. 1, the kitchen stove on which the newspaper is warmed to dry it. Fig. 2 shows the experimenter rubbing it against his hair as he presses it with a mittened hand to produce static excitation.

Then again, static and electricity may seem very much alike; in the light that both "radiate hairs." Hold a piece of paper, charged with static, close to your cheek or hand; it "feels" as if there are some very fine "hairs" on the paper. The same "feeling" is manifested at the terminal of a Tesla coil. Indeed, the "fine hairs" become visible in the dark; as purple brushes of fire at the terminals of a large Tesla coil, and also from the more popularly known "Violet Ray Machine."

But theorizing in this fashion will not get us anywhere. Suppose we investigate the properties and possibilities of static.

If somebody desires to experiment with static but feels the cost of a Wimshurst or Toepler-Holtz machine is too high, a very excellent static generator is illustrated in Fig. 1. Simply a two-foot strip of newspaper, four inches wide, heated on a stove, then quickly passed over the hair of a person, with a mittened hand held on the paper to increase the friction. Said paper will then be so strongly charged with static that it will adhere to the ceiling of a room; give a dozen sparks by running the finger along one side of the paper; and move the filament in a lamp! CAUTION!

The photograph (1) shows a small Tesla coil, sufficient to demonstrate its properties. Why build a large expensive one?

The makeshift Geissler tube (an auto headlight bulb) shows quite strikingly the "hairy feelers" mentioned above.

Now the question may arise; if the "static electricity" from the spark coil is stepped up in voltage, might it not be stepped down again? Photo (2) proves this can be done. Now examine the picture closely and you will see that it is possible to send power over one wire and furthermore, no ground whatever is needed! Just two short aerials will serve as the "ground" (via air!). Indeed, an earth connection will completely destroy the effect of transmission. The phenomenon will have to be seen before its significance can be appreciated!

Coming to photo (3), behold a successful attempt to accomplish radio transmission of power! The disappointing truth confronts us, however; the distance is limited. But we may honestly hope for an early solution of the problem, because—

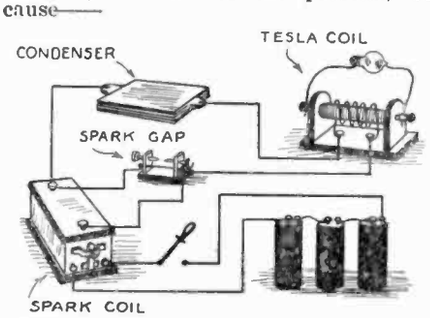


Fig. 3. Diagram of the connection for Mr. Moen's Tesla coil, showing the distribution of spark coil, spark gap, condenser, battery and the coil proper.

Now let's see photo (4). You see?—experiment solves any problem! Could anything be more simple than inserting resonant coils between sender and receiver? From this simple beginning, some-

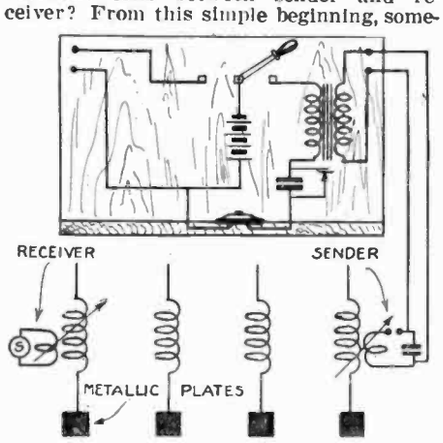


Fig. 4. Connection for the transmission of power by means of the Tesla coil limited unfortunately as to distance.

one must discover the correct solution for the problem of the sending of power by radio.

Here are some data about the apparatus in the photographs:

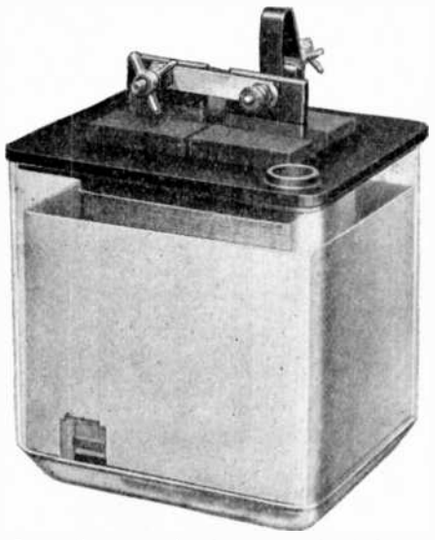
The connections for the power unit (dry cell, spark coil, push button, etc.) are given in Fig. 3. Take the hint, brother, and make one. You will find hundreds of uses for it.

The condenser consists of four sheets of copper foil, 3 inches by 4 inches, separated by five glass photo plates. The spark gap is perhaps 1/32d inch. The

(*Continued on page 600*)

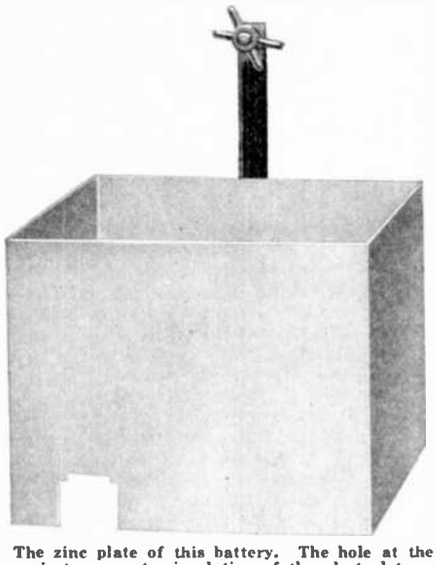
The "A D" Signal Battery

THE French have never lost their devotion to the carbon-zinc-ammonium chloride combination, for



Interesting example of an open circuit battery of French origin, recently introduced into this country for heavy railroad service. It is depolarized by the atmosphere.

the production of a primary cell. A battery of such elements with an adequate depolarizer has been found to be admirable for open circuit work. In the Le-Clanché combination a depolarizer consisting in great part of manganese dioxide or sesquioxide is used.



The zinc plate of this battery. The hole at the base is to promote circulation of the electrolyte.

The next development of this combination was in the direction of using air as a depolarizer. If a couple is made up with a concentrated solution of ammonium chloride, with one carbon and one zinc electrode, polarization soon ensues, unless the hydrogen produced by the electrolysis can be oxidized.

The battery which we describe here, the A. D. (adsorption), effects this depolarization by the oxygen of the air. The carbon plates are very porous in the interior so that they will absorb air, and the surface is so constituted that water cannot pass through it. Thus the carbon is constantly supplying oxygen to the couple.

When the battery is set up a considerable area of the dry carbon above the liquid is exposed to the air; this is to enable the carbon "to breathe," as it is expressed, in other words to absorb the oxygen which in the operation of the battery combines with the hydrogen and produces depolarization.

It is found that the inside of the carbon element remains dry at all times and once the battery reaches its true voltage it holds it for a very long period. When a new battery is put at work there is what is called a peak voltage, but this diminishes quite rapidly during the first day's use, and eventually what is termed the working voltage, varying from 0.95 to 0.75 volt, is maintained during the ampere hour life of the cell.

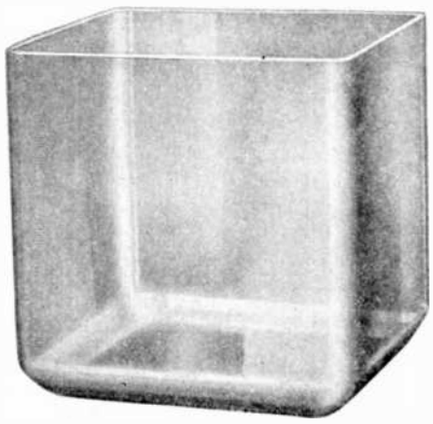
One of the important uses of the battery is for railway signal service. An enormous number of primary batteries are used for this work throughout the country, and this battery can deliver quite a heavy current in intermittent service.

At a constant discharge of 250 milliamperes the cell is rated at 600 ampere hours, which it will be observed is over three months. In intermittent service, it will develop 750 ampere hours.

A peculiarity of the cell is that the carbon element is not of perpetual duration; it has to be replaced from time to time, but one plate wears out three zincs before it becomes useless.

It is absolutely essential that the ammonium chloride shall be pure.

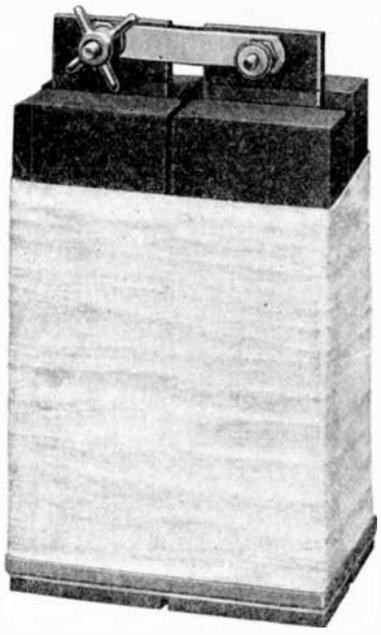
Recharging the cell is very simple; after the first 800 ampere hours the zinc will probably be full of holes; the cell is then dismantled, washed, and the carbon element is cleaned by detaching one of the layers of linen which are wrapped around it, and scraping the bottom with a stick



The battery jar with nicely rounded corners.

or knife. Those who have had experience in taking care of a copper sulphate battery, gravity or Daniell, will realize that getting rid of the perpetual attention, which they require, will be a very great relief. The writer has had his experience with a fair sized gravity battery and knows whereof he speaks.

The illustrations show very clearly the interesting features. The zinc is an open



The carbon element wrapped with linen in several layers. Each time the battery is to be recharged a layer of linen is removed from the carbon.

rectangle like a box with no bottom, with a notch in the bottom to admit free ingress of the solution. The carbons are bunched together and wrapped with linen cloth, and they fit inside the zinc; the linen cloth prevents any possibility of contact and short-circuiting.

The jar is a glass one and there is a hard rubber cover with openings for the introduction of solution and for the passage of the zinc terminal. The final illustration shows how it is put together, the rubber cover not yet being dropped down to its seat.

It is highly recommended for use as an A battery in radio work. It avoids the perpetual buying of new dry cells and lasts for many seances.

Interesting Articles to Appear in September Practical Electrics

Inter-Poles.
By Harold Jackson.

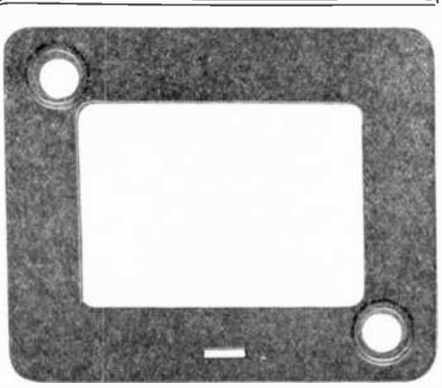
Stray Current Action on Water Pipe Lines.
By Prof. P. Medinger, Luxembourg.

Construction of Electrolytic Rectifiers.
By Leon Magron.

Electro-Static Experiments.
By Frederick Von Lichtenow.

Laboratory Appliances.
By Richard Merolle.

Internal Resistance of Cells.
By F. S. Yamamoto.

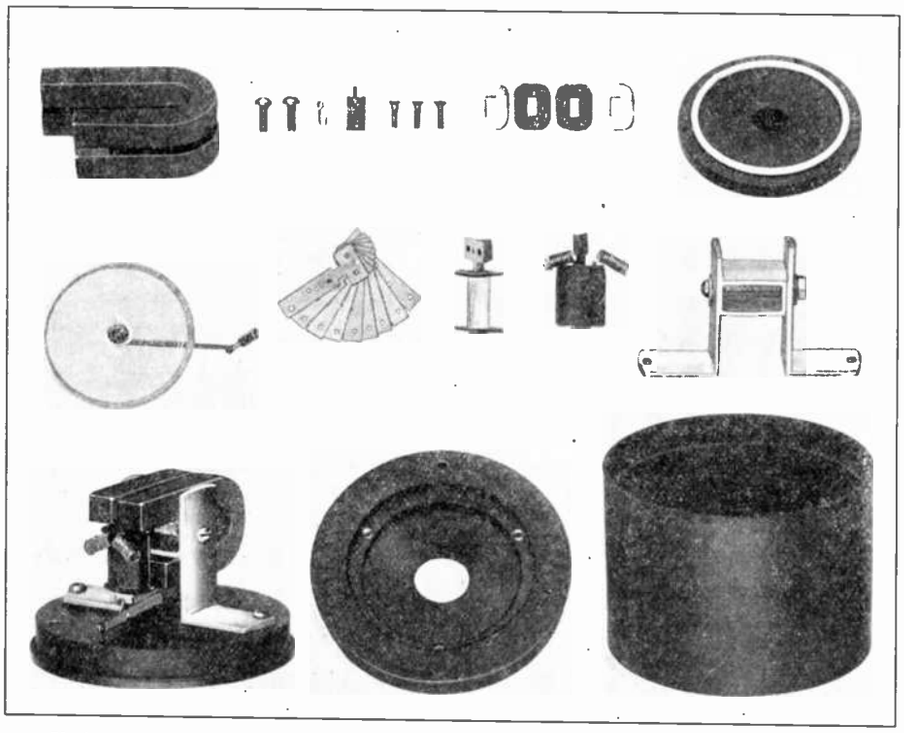


The cover gasket with the two round holes for pouring in solution and a rectangular one for the passage of the zinc terminal.

Sensitive Transmitter and Loud Speaker

FOR some years a great deal of interest has been excited by appliances which increase the range of the speaking or receiving telephone, so that its speaking can be heard a considerable distance. It has been tried in railroad stations for announcing at different points of the building the hours of departure of trains.

In the present great popular interest taken in radio telephony still more attention is being given to loud speakers, where the desire is to receive from broadcasting stations the almost inconceivably weak electric waves and convert them into sound waves of intensity sufficiently high to be heard by a comparatively large roomful of people, or even by a great audience.



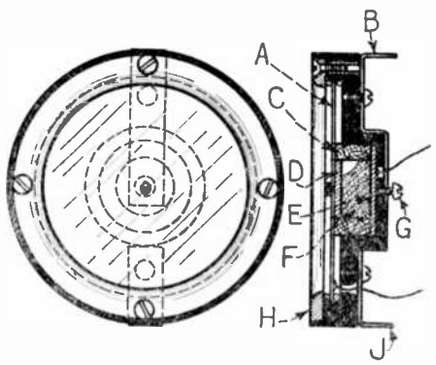
Various parts out of which the loud speaker is constructed; the bakelite case in its three parts; the laminated core is shown, fanned out to illustrate its construction, and immediately at its side it is shown closed; next thereto it is within the coil. The magnet is shown in the upper left hand corner the magnet and support, the coil, and the armature are shown in the lower left hand corner.

All sorts of ideas have been expended on these loud talkers. The loud talker generally comprises a horn, and experimentation has been devoted to the material of the horn to secure the utmost resonance. The finish of the inner surface has also been considered, with the idea of smoothing out, as it were, the sound waves in order to obtain the best possible effect.

We are pleased to illustrate a loud speaking telephone which really produces remarkable results, in all its details. The great point is to secure distinctness of utterance. Mere magnification of the sound, if it confuses the emanations, will be disastrous and render it useless. The different parts of this receiver, which is the loud-speaking instrument, represent, when assembled, a telephone with lever connections so as to increase the amplitude of vibration of the diaphragm.

A very interesting point about the ordinary telephone receiver is that the vibrating plate, always made of iron, forms the armature of a magnet. The voice impulses, with frequencies from 30 to 40 to the second up to perhaps several hundred, cause the plate to vibrate. At the transmitting station the original voice impulses by a microphone, have been converted into exactly corresponding electrical variations, and these it is which, affecting the magnet of the receiver, cause the diaphragm to vibrate in exact correspondence with the original voice.

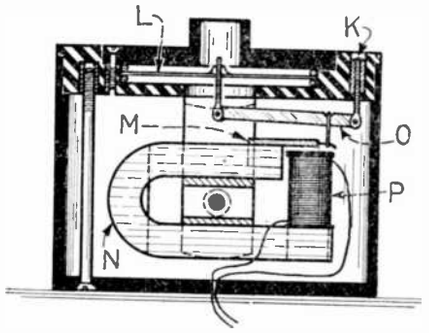
A plate supported in any definite way has a natural period of vibration. The diaphragm of the ordinary telephone, clamped firmly around its periphery, can only respond to one single note if it vibrates as a whole. We can hardly avoid thinking that the vibration of a telephone diaphragm is strictly comparable to that of a Chladni plate. The magnet with its periodic excitations, corresponding to the distant voice, forces the disk, however, unnaturally to vibrate in synchronism; so that it is probable that the disk is divided up into many small areas, varying in number according to the note.



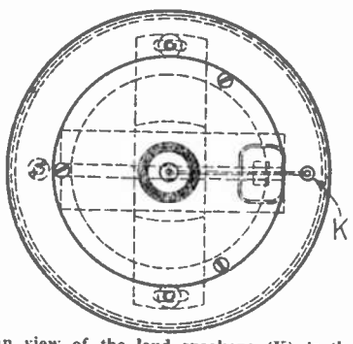
Front view and section of the microphone; (A) is the diaphragm;; (B) the supports; (C) the side of the carbon case; (D) the front of case; (E) the elastic rear of the case; (F) the carbon granules; (G) the regulating screw; (H) the clamp.

In the instrument we are describing quite a departure is made from the ordinary telephone. A peculiar shaped permanent horseshoe magnet carries a prismatic laminated core attached to one of its poles. The material of this core is a very special steel, with very low hysteresis coefficient—a material which can change its polarity over a thousand times a second. Around this laminated core the speaking coil of the telephone is wound. Very close to the core but never touching it the armature—a little plate of soft iron—is supported, free to vibrate.

It is carried by an arm pivoted to one side of its center, so that the distant end of the arm for a given motion of the armature moves over a range about twice as great.



View of the interior of the loud speaker. (K) is the adjusting screw; (L) the mica diaphragm; (M) the armature; (O) the lever; (P) the speaking coil; (N) is the horseshoe magnet. The laminated core is within the coil (P).



Plan view of the loud speaker; (K) is the adjusting screw by which its loudness is controlled. The small rectangle with rounded corners on the left of the screw is the speaking coil.

So far we have not spoken of the diaphragm, and the ordinary iron diaphragm, as we have already stated, is omitted. The parts so far described are contained in a cylindrical case of bakelite, and one end of this case is closed by a diaphragm of special mica. This is selected to be of the highest quality as regards elasticity and absence of flaws and seams. To the center of this diaphragm the end of the arm carrying the armature is secured. This end is the one which moves the longer distance, representing the end of the long arm of the lever. After the diaphragm is in place a cover with a central opening is screwed on to the end of the cylinder, shutting everything up in a neat cylindrical case.

The permanent magnet is of very specially selected steel, and small as it is, can sustain three pounds of iron.

The operation of the receiver is now clear. The magnet armature vibrates in exact synchronism with the talking current. The vibrations of the armature, magnified by the lever, are communicated to the center of the disk of mica, and force it into vibration. Here again we must think of the Chladni plate, and for high notes may picture to ourselves the division of the mica disk into areas varying in size with the pitch of the note, comparatively large areas for the low notes and small ones for the high notes.

The principle, it will be seen, is very simple, but the greatest care has to be exercised in every detail of construction and in the selection of the materials. The core of the magnet is almost a true prism,

and in the illustration, to show its lamination, it is opened up like a fan, but this is merely done as a demonstration. Directly to the right of this fan, as we may term it, the core appears in its real state. The little extension seen on the top is used for riveting it to the pole of the magnet.

The magnet (N) of horseshoe shape has one long and one short leg. To the short leg is secured one end of the armature (M) and this faces the core of the speaking coil. The core is rectangular so that the speaking coil is also of rectangular contour. From the end of the armature a little bolt runs to a lever (O). The long end of the lever is connected to the center of a mica diaphragm (L) by a bolt. The short arm of the lever can be adjusted by a small screw (K) which regulates the distance of the armature (M) from the pole or end of the core of the speaking coil. It will be observed that this is a distinct departure from the ordinary telephone receiver as there is no iron diaphragm. By screwing the adjusting screw (K) in or out, the loudness of the instrument is regulated, so that it is in each case adjusted to suit the customer or he can do it for himself. The little laminated core, it is said, has a wider oscillatory range than that of any diaphragm and the electrical voice is said in this instance to be identical with the natural. The sound chamber is of heavy bakelite, and a mica diaphragm (L) is clamped and held in position between rubber gaskets around the periphery. It will be seen that the instrument gives mechanical amplification and the laminated armature and general construction are said to give magnetic amplification also.

The operation of this receiver is wonderfully good; the natural voice of a distant speaker issues from it almost as if he were present. Seated at a table or desk, one of these instruments at the other end of the room will give you its message, just as if the person communicating with you were there in *propria persona*.

In line with the loud speaker which embodies the level arm principle we have described, and which depends also for its action upon the selection of material of which it is constructed, a transmitter in the shape of a very sensitive microphone is constructed. This is a granulated carbon microphone with a very large diaphragm and of very great power.

The transmitter is a microphone whose sensitiveness is extreme. The carbon granules (F) are contained in a resilient ring (C). At the center of the back of the instrument there is an adjusting screw (G), which adjusts the pressure on the back (E) of the carbon capsule. A resilient ring presses on the center of the diaphragm (A). When the screw is withdrawn to the extreme limit there is less than one-tenth of an ounce pressure on the diaphragm. A whisper 30 feet distant is sufficient to cause it to act and the voice can be heard at the distant end of the circuit. The diaphragm (A) is dished about one thirty-second inch, and this is said to add considerably to the sensitiveness of the instrument. The microphone is said to have been known to pick up the tick of a clock 40 feet distant. (B) and (J) are the fasteners to secure it in place.

After having attended several demonstrations of this system, the opinion was formed that the system is distinguished by the clarity of its enunciation. A great many loud speakers have been deficient in this point. Of course, poor enunciation does not matter so much for music or singing, but when it comes to the imparting of absolute words and sentences in messages, it is all important. As the outfit is supplied, for commercial uses it would seem to present the luxury of telephoning. The apparatus can be placed on top of a bookcase, back of a desk or anywhere desired, and the conversation can be carried on in a natural tone of voice, with a person who is miles distant and with replies coming back in a natural voice, as if he were only across the table.

The sensitiveness of the instrument can be adjusted by a screw, and at the limit of sensitiveness the smallest sound can be heard. As an experiment the microphone has been shut up in a burglar-proof safe and the receiver which was connected to it would repeat sounds made outside the safe. This gave a suggestion that to protect safes, microphones should be shut up in them, and any attempt of a burglar to open them, by hammering or chiseling the door, working on the lock, or the noise of a drill, would be transmitted at once to any desired place and notify the guardian that a robbery was being attempted.

The system embodying these instruments has been worked out for police use. It is proposed to have transmitting boxes throughout the city, the opening of the door of which closes the circuit and leaves all ready for telephoning. There would be no instrument to unhang, no receiver to be held against the ear; it will all be done in the open.

Another rather curious suggestion, yet one that seems very practical, is to place in a figure of a man a receiver and transmitter. This figure can be used for giving information in department stores and the like. If anybody wishes to know on what floor of a great store he can find any given article, he would address the manikin exactly as if it were a human being, and the attendant at a distant office will at once respond.

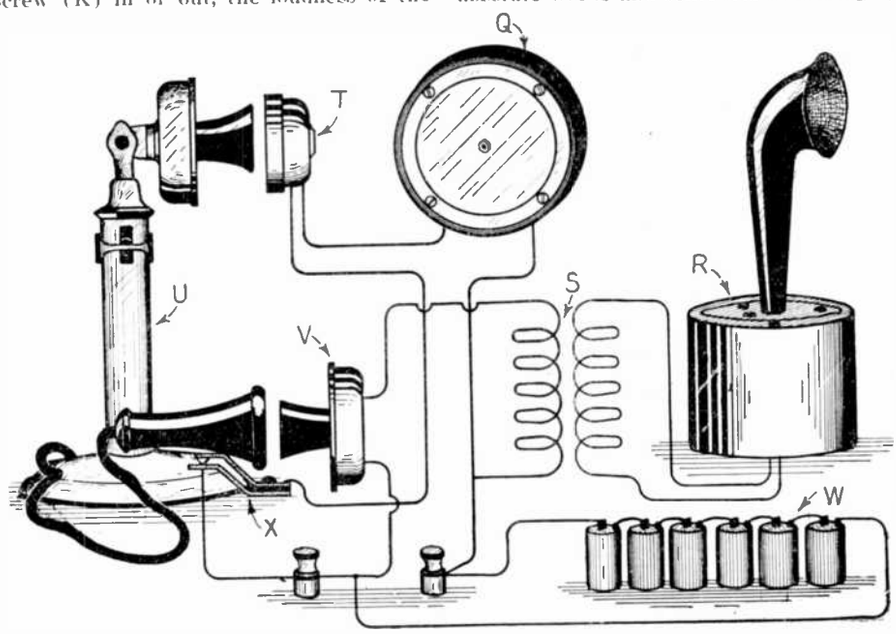
In the figure now used for demonstration purposes the transmitter is placed in an opening of the vest in lower end of the scarf, so that it is almost invisible. The flat microphone blends in with the silk of the tie so that it is hardly noticeable. The loud speaking receiver is placed in the hat; the idea eventually is to have a papier mache head and have the receiver within it, but this, of course, is a mere matter of detail. Quite a striking dummy of a man was secured, and gives a very good exposition of this use of the loud speaker. It would certainly seem that a speaking figure would be a very impressive advertisement.

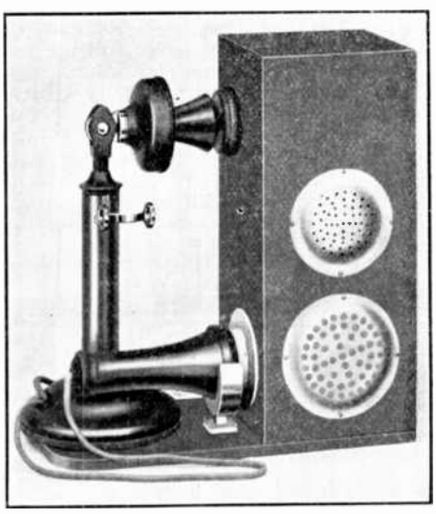
Another idea is to utilize it in subway trains for announcing to the occupants of the car the approach of stations, and, of course, the regular depot service is provided for.

An interesting application is a case with two openings containing the apparatus, a transmitter and receiver. It is so constructed with openings at the end that a regular telephone transmitter can be placed on a table or desk with its mouth facing the mouth of the transmitter. Lower down is the loud speaker and the telephone receiver has its message delivered as if by a person speaking, so that it can be heard 20 or 30 feet away.

But this is not all. For by the adjustment of any screw we have alluded to the loudness can be changed so that the voice will be heard only two feet away, if it is desired to keep it private. The same case or box can be spoken into, and the microphone will transmit the voice through the ordinary telephone system.

The adjusting feature alluded to above is a very nice addition; it is a very small screw which would escape notice, but by which any desired degree of loudness can be obtained. In one of the illustrations the very accessible position of the screw is indicated by an arrow pointing at it.





Left. Connections of supersensitive microphone on loud speaker; (Q) is the microphone; (T) is a receiver which talks into an ordinary transmitter (U); this takes the voice to the distant person spoken to. When the answer comes it is received by the telephone shown at the bottom of the standard (U), resting on a spring switch. This talks into a microphone (V) and by the induction coil repeats into the loud speaker (R). (W) is the battery.

Above. View of the microphone and telephone mountings.

Awards in the $50 Special Prize Contest
For Junior Electricians and Electrical Experimenters

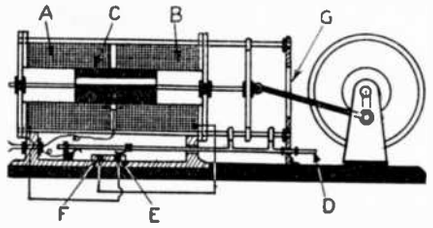
First Prize, $25.	Second Prize, $15	Third Prize, $10	1st Hon. Mention	2nd. Hon. Mention
R. A. Marshall, 4005 Northrop St., Richmond, Va.	Philo Farnsworth, 47 W. Seventh North, Provo, Utah.	Roscoe Betts, Box 4, Arcadia, Nebr.	William Meagher 4216 Third Ave., New York City	George A. Zwald, 1333 Crease St., Philadelphia, Pa.

First Prize
Solenoid Motor
By R. A. Marshall

THIS type of solenoid motor is an original idea.

The motor has two coils (A) and (B) which operate as follows: Coil (A) pulls core (C) in a reverse direction until the ring on the slide rod strikes the ring on rod (D), which slides back and opens the circuit in coil (A) and closes the circuit of coil (B). Coil (B) then pulls the core (C) in a forward direction until the ring on the slide rod strikes the ring on the rod (D) and opens the circuit of the coil (B) and closes the circuit of the coil (A). This explains one revolution.

The circuit of the motor is clearly shown.



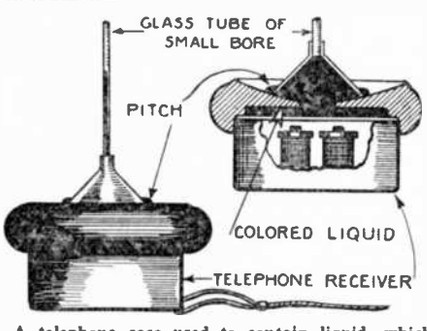
Very ingenious reciprocating engine operated by two solenoids, one giving the forward and the other the back stroke.

Second Prize
Liquid Milliammeter
By Philo Farnsworth

ELECTRICAL experimenters frequently have use for a milliammeter. The diagram shows a very sensitive and easily made instrument.

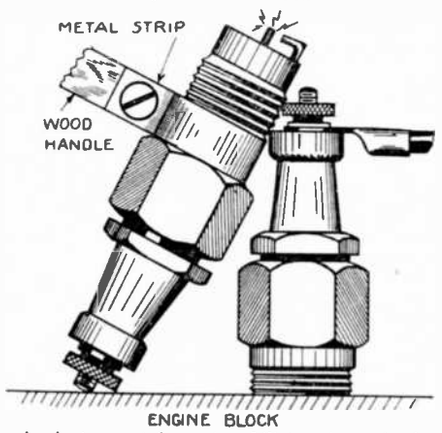
The material needed is a watchcase telephone receiver, a glass tube of very small bore (the smaller the better), and the top of a small funnel tube. The diagram shows clearly how they are assembled. The diaphragm of the telephone receiver should be sealed with pitch to the cap of the receiver case.

When the magnet is excited it attracts the diaphragm, which bends downward, enlarging the space filled with the liquid, so that the column thereof sinks in the tube. With more current it sinks more, with less current it rises. It must be calibrated by comparison with a correct instrument.



A telephone case used to contain liquid, which rises in a capillary tube and changes its height of column according to the attraction exerted on the diaphragm by the telephone magnet, which diaphragm forms the bottom of the liquid receptacle, so as to give readings of current strength.

Third Prize
Spark Plug Tester
By Roscoe Betts



An instrument for automobilists. A spark plug mounted in an insulating handle of wood or fibre, is used to test the condition of plugs mounted on the engine.

A CONVENIENT spark plug tester may be constructed by fastening a small wooden handle to a spark plug by means of a metal strap and a small stove bolt.

When testing an engine spark plug merely place the tester plug as shown in the illustration and if the engine plug is working a spark will be seen at the gap of the tester plug.

The instrument is cheap and small and may be easily carried in the toolbox.

$50 IN PRIZES

A special prize contest for Junior Electricians and Electrical Experimenters will be held each month. There will be three monthly prizes as follows:

First Prize	$25.00 in gold
Second Prize	$15.00 in gold
Third Prize	$10.00 in gold
Total	$50.00 in gold

This department desires particularly to publish new and original ideas on how to make things electrical, new electrical wrinkles and ideas that are of benefit to the user of electricity, be he a householder, business man, or in a factory.

There are dozens of valuable little stunts and ideas that we young men run across every month, and we mean to publish these for the benefit of all electrical experimenters.

If in any way possible, a clear photograph, should be sent with the idea; but if that is not possible, a good sketch will do.

This prize contest is open to everyone. All prizes will be paid upon publication. If two contestants submit the same idea, both will receive the same prize.

Address *Editor, Electrical Wrinkle Contest,* in care of this publication. Contest closes on the 15th of each month of issue.

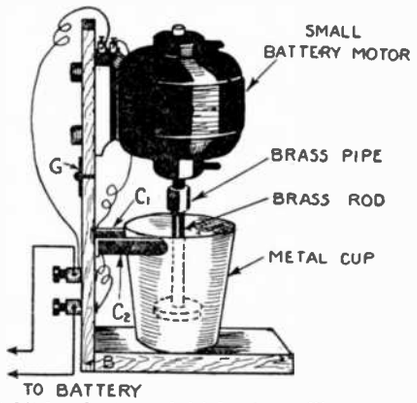
1st Honorable Mention
Kitchen Beater
By William Meagher

THIS kitchen beater is for use where electric power cannot be had, as it will operate with a battery.

A small battery motor is fastened to the upright board (B). A round brass rod the same size as the shaft is fastened to (S).

A good way to do this is to take a piece of small brass pipe about one-half inch long and slip it on the ends of the motor shaft and the brass. Now solder it on and it will hold them firmly together.

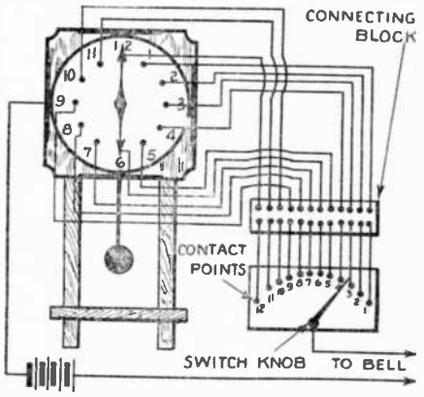
The two pieces of copper (C^1) and (C^2) serve the purpose of holding the metal cup in place. They also act as a switch which turns on the current when the cup is placed under the motor and between them, and stops it when it is taken away. The cup simply closes and opens the circuit between the two pieces of copper. To make it easier to put the cup under, the upright board should be sawed in half and two small hinges (A) fastened to it.



A kitchen beater and drink mixer. We presume the drinks will only be milk shakes. The metal cup containing the liquid when pushed between two springs closes the circuit.

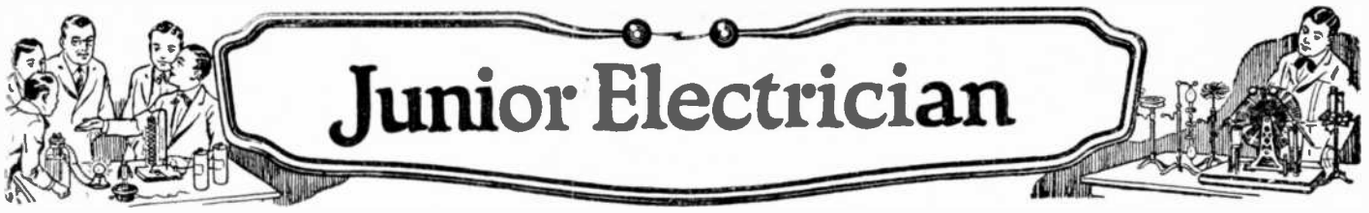
2d Honorable Mention
Electric Alarm Clock
By George A. Zwald

A SIMPLE electric alarm clock made from an eight-day clock is being used successfully by the writer.



An electric alarm clock the time of whose alarm is fixed by setting an outside and separate twelve-point switch.

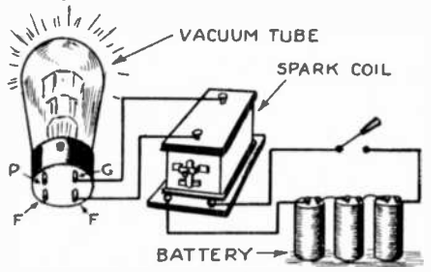
(Continued on page 600)



Experiments with Burnt-Out Audion Tubes

BURNT-OUT audion tubes can become very useful as Geissler tubes, window display lights, or other entertaining ways of displaying static electrical phenomena.

No socket should be used as this externally shorts the tube. The secondaries



Burnt-out audion tube used as a vacuum tube or Geissler tube illuminated by an induction coil discharge.

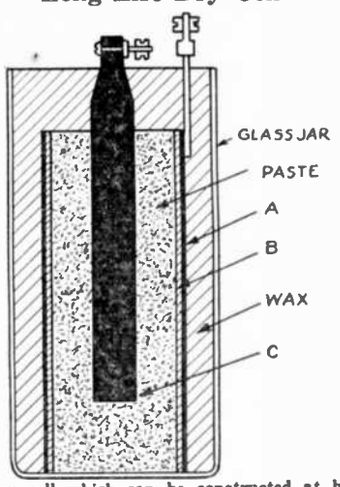
of a small spark coil (a Ford coil will do) are connected to the grid and the diagonal filament connection, respectively, of the burnt-out tube, by means of two small wires (about No. 24) twisted around the prongs.

Care should be taken that the wires are not near the brass jacket as this externally short circuits the tube, just as the socket would do. It is sometimes (though seldom) necessary, that a small piece of glass be held between the prongs to prevent sparking.

In the tube (a Cunningham C. 300) used by the writer, the inner surface of the glass was covered by a vivid bluish-green while on, and inside, the plate was a reddish-orange glow; this two-color effect was very marked, and produced a mysterious, ghostly effect.

Contributed by LEO J. SCHULTHEIS.

Long-Life Dry Cell



A dry cell which can be constructed at home, and which owing to its size and general features of construction will last a long while and can be refilled after the zinc is perforated and partly dissolved.

THIS cell is contained in a glass jar and on account of its size may be expected to last much longer than the ordinary dry cell purchased in the stores.

The container is fairly large, three inches in diameter and six inches high. A zinc cylinder made out of reasonably heavy sheet zinc, 2⅛ inches in diameter and 5⅛ inches high, sits inside it.

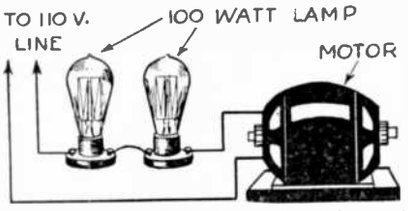
Within the zinc cylinder and against it there is a lining of thick blotting paper to prevent the paste from coming in contact with the metal. In the center of the jar there is a carbon from a discarded dry cell. When the paste is in position and the sealing compound poured on, the carbon will be held fixed in place.

The paste is made as follows: Hydrochloric acid is diluted with three volumes of water. Next measure out with a cup or even with a teaspoon or tablespoon four parts of crushed charcoal, two parts of flour, and one part of plaster of paris. After the dry powders are well mixed, the acid solution is added thereto, and all is thoroughly stirred, and holding the carbon in a central position, the mixture is poured into the jar. There must be sufficient to fill it up nearly to the top of zinc. After it has set, the sealing compound is melted and poured over the contents so as to come up practically level with the top of the jar.

The writer claims that this cell will last a long time, because it is unaffected in operation, even if the zinc is perforated through and through.

Contributed by LESTER THOMAS.

Experiment in Counter Electromotive Force



An interesting and simple experiment in counter electromotive force. This is the element which governs the field of rotation of an electric motor.

A PECULIAR experience with 110-volt D. C. may interest the reader. Hook two 100-watt lights in series with a small motor as shown in the illustration, throw in the switch and the lights will light. Give the motor a spin and the lights will go out, and the motor will continue to run until a load is put on it; then the motor will stop and the lights will light again.

This simple experiment illustrates very strongly the purpose and use of starting boxes for starting large motors. When the motor is idle, a large current passes which may injure it unless a resistance, the starting box, is connected in the circuit.

As the motor speeds up, it acts as a generator and generates a counter e. m. f. that opposes the applied e. m. f. and limits the current, after which the starting box resistance is disconnected from the circuit.

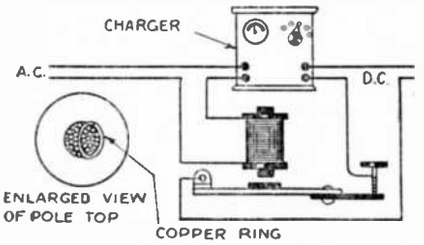
Contributed by DILLARD S. WRIGHT.

Automatic Battery Charging Switch

WHEN charging storage batteries from the lighting current, the current may just happen to be turned off at the power house, thus causing the battery to discharge. The writer has designed an automatic switch which will prove quite helpful.

The switch is made on the order of a relay, the coils being wound with heavy wire and with as few turns as possible. Just enough wire is used to give the magnets the desired pull. The contact point is fitted with a screw for regulating its relation with the iron armature, which latter forms the switch. An insulating handle is placed on the armature as shown. The switch is wired with the charger, battery, etc., as shown.

When operating, the current is turned on and the armature is thrown towards the magnet so as to draw it to them, thus completing the circuit. If the current should be shut off, the magnet will lose its pull on the armature and it will return to normal position, thus breaking the circuit.



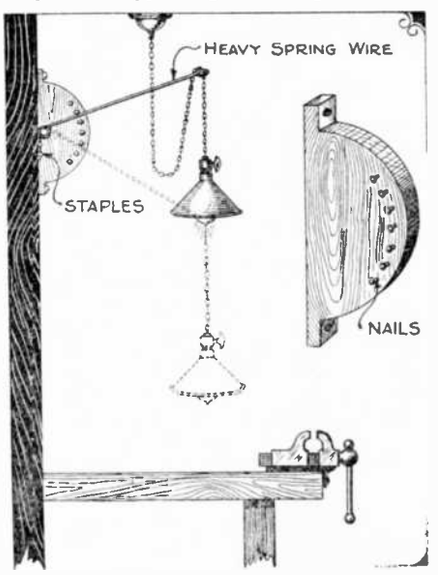
A switch for charging a storage battery. If the current ceases, the switch opens, so as to prevent the battery discharging. A copper ring surrounds the magnet pole to prevent contact of armature with iron.

Contributed by EVERMONT FISEL.

Adjustable Bench-Lamp

A NOVEL and extremely efficient adjuster for the lamp over the workbench is shown in the accompanying illustration.

A semi-circular block is cut from a one-inch pine board and this is nailed upon the wall above the work-bench in the position shown. Beside it a length of heavy spring-wire is fastened with staples, the portion close to the wall being made into a double loop to support the wire at the angle shown. A loop at the other end of the wire provides for attachment of the drop-cord supporting the lamp.



Very simple and exceedingly effective adjustment bracket for a burner so that its height above a workbench or table can be regulated.

Several nails are driven into the board along the outer edge so that the lamp can be moved up or down and supported at any desired height by swinging the wire against the board and beneath one of the projecting nails.

Contributed by G. E. HENDRICKSON.

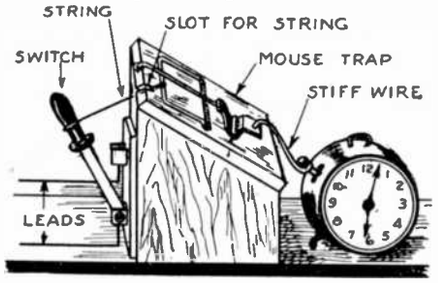
Simple Time Switch

By PERRY D. WILSON

A TIME switch is something that comes in handy for the performance of numerous tasks. The switch described is easily constructed, is simple to operate, and will last as long as the clock, and then some.

It can be used to wake you up in the morning by merely adding a bell and battery. It lifted the writer from slumber every morning for two years in time to take the milk away from the cow.

You can put a light out in the hen-



The old story of a clock operating a time switch, but to make the action sudden, a mouse trap is used and a good knife switch gives a first class contact.

house, connect it up with the time switch, set the clock for three in the cold A. M., and jolly the hens into laying more eggs. Note that I only suggest this. I have no desire to become entangled with the S. P. C. F. (Society for Prevention of Cruelty to Fowls.)

To make the switch, secure the following properties: One clock, one single pole single throw switch, and one first class, A No. 1 mouse trap.

Mount the switch on a short post, the top of which has been cut with a slant. Mount the post on a shelf or in some other convenient place. Cut a narrow slot in the mouse trap about an inch long. Cut a corresponding slot in the top of the post. Mount the trap on top of the post as shown in the illustration.

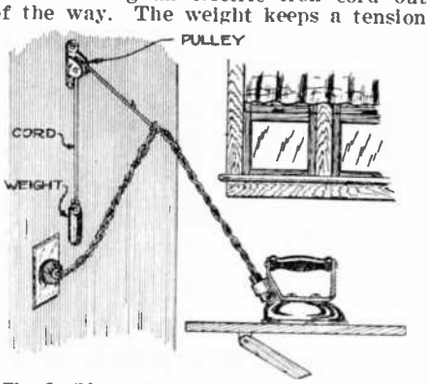
Remove the bell from the clock and solder a short, stiff wire to the hammer. Set the clock near the switch and bend the wire until it will trip the trigger on the trap. Tie a short piece of heavy cord to the handle of the switch and also to the deadly part of the trap. The switch should not work too stiffly. The string must be short enough to allow the trap to jerk the switch closed.

That's all; go to it, fellows.

The point is that the switch is closed with a jerk, not in a slow and undesirable way.

Appliance for the Electric Flatiron

THE illustration shows a simple method of holding an electric iron cord out of the way. The weight keeps a tension



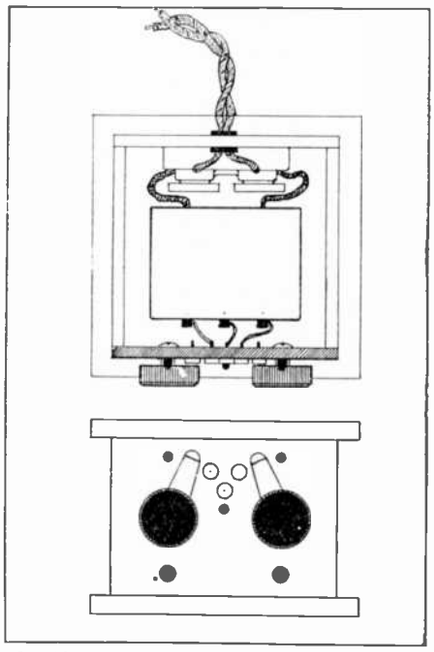
The flexible cord of an electric iron is held up out of the way by a string passing over a pulley with a counterweight on its end. The weight of the iron takes care of the counterweight.

on the cord and holds it up and out of the way of the user.

Contributed by W. T. MARKOWSKI.

Small Toy Transformer

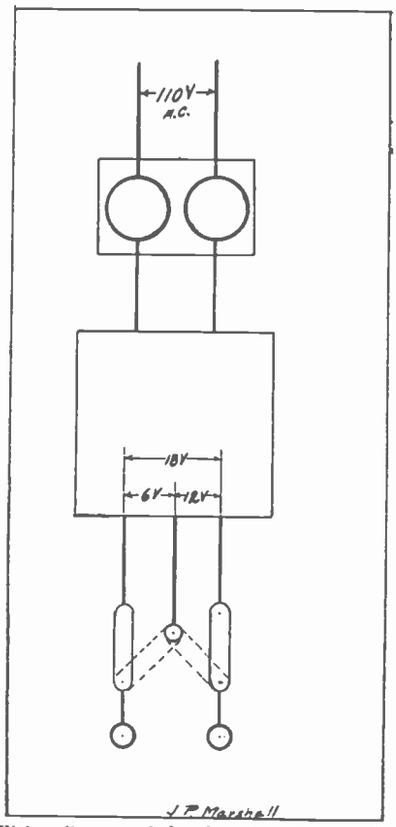
THIS toy transformer can be constructed from odds and ends picked up in the shop. It consists of a good sized bell transformer, a fuse block, two rotary



Outside view of a miniature transformer made of simple appliances; the construction can be undertaken by anyone of ordinary mechanical ability.

switches, five contacts, three stops, two hard rubber binding posts, a bushing for the cord, and the cord with an attachment plug.

The switch mounting was made from a small section of formica, but a piece of hard wood may be substituted in its place.



Wiring diagram of the above transformer, elucidating clearly its construction.

After being assembled the whole was given two coats of mahogany stain, and constructed thus presented a very neat appearance.

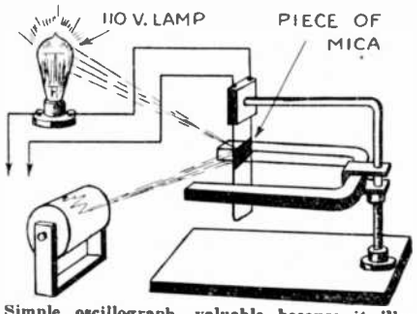
The arrangement of parts is evident, from the drawing and wiring diagram. No dimensions are given, as any bell transformer may be used and different makes vary widely in size.

By changing the positions of the rotary switches three different voltages may be obtained. Use three ampere fuse plugs in the fuse block.

Contributed by JAMES P. MARSHALL.

Simple Oscillograph

A CURRENT is passed through a wire hanging between the poles of a permanent magnet.



Simple oscillograph, valuable because it illustrates the construction of what is often considered a very recondite apparatus, but which is here shown to be of real simplicity.

A beam of light focused on a piece of mica or glass attached to the center of this wire will be reflected on a piece of paper or any other suitable surface, and will show the oscillations of the wire.

The wire will oscillate according to the frequency of the current. The lamp which is put in the line with this apparatus to keep the fuses from burning out may also be used as the source of light.

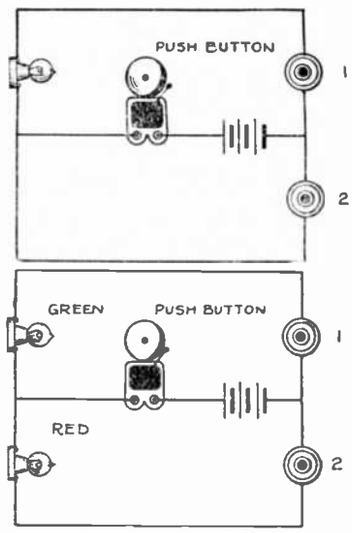
Contributed by W. A. PETERSON.

Door Bell Hook-Ups

ONE way of distinguishing the point from which a bell was rung is by means of one or two lamps. In the first connection a lamp lights and tells the story. Only one lamp is on the circuit. When the bell rings one can tell from which source it was rung by simply looking at the light. If the bulb lights, button No. 1 was pressed. If not, button 2 was pressed.

If the telephone bell sounds like the doorbell the bell may be wired as in lower diagram. Here the color of the lamp tells which button was pressed. When the green bulb lights, button No. 1 was pressed; when the red bulb lights, button No. 2 was pressed, and if none lights the telephone bell rang.

Contributed by EARL F. RUETER.

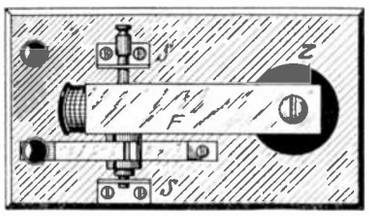


Two connections for a door bell, using an indicating lamp or a pair of them to tell which bell is being rung.

Simple Electric Motor

A VERY simple motor to be constructed from parts that have been discarded or found around the workshop, may be easily made by carefully studying the following description. While this motor has little power, it is very interesting and instructive.

A straight electro magnet is secured, or may be wound, using a large iron bolt

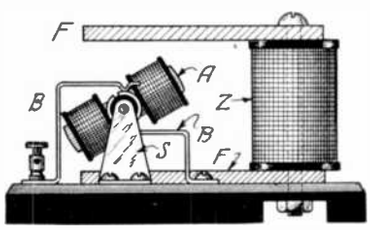


Plan view of a simply constructed electric motor on a miniature scale, which will give good speed rather than power.

to form the core. On each end of the magnet are placed, on the ends of the bolt, which is the core as stated above, two iron bars, holes having been drilled so that they will fit on the bolt, and they are held solid with a nut. These are pole pieces. This nut also helps to hold the magnet and the two pole pieces to the base. Referring to the two illustrations (Z) is the magnet, and (F, F) the iron pole pieces.

The next part to make, and probably the most difficult, is the armature. A threaded shaft is secured and on this is slipped a small iron bar with a hole drilled in the exact center. This bar should be of such length that it will rotate freely between the poles of the magnet. Also a solid wood or fibre cylinder, with hole through the center, is slipped on the rod, or shaft. The cylinder is held solidly to the shaft with lock-nuts. A section of copper or brass tubing of the same length as the wood cylinder is secured, and split in half. This is placed over the cylinder so the two separate pieces of tubing do not touch each other. They may be secured solidly to the cylinder with a good glue, and a silk thread wrapped around each end as shown in the drawing, (A) denotes the iron bar, and (C) the commutator, as the cylinder with the tubing is now called. The iron bar is wound with cotton covered magnet wire, and connected to the commutator bars, which are the two separate pieces of tubing, as described.

Two supports are made from metal and mounted, as shown, at (S) in both figures. These are arranged so that the armature will rotate between the pole pieces of the magnet. Two brushes (B) are made of spring brass and placed as shown, so that



Elevation of a simple electric motor, showing the relation of parts and arrangement of brushes.

they will make contact with the commutator pieces. The two binding posts are arranged for connection to the current circuit. The magnets may either be connected in series, or parallel with each other; however, it would be best to experiment by connecting them in different ways.

Contributed by EVERMONT FISEL.

Locating Water Depth

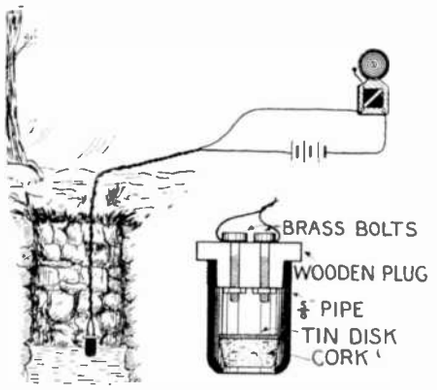
A SIMPLE and accurate method of locating the surface of water in a well is shown in the illustration.

A length of ordinary flexible lamp cord is connected at one end to a bell and dry cell, two cells being used if the lamp cord is very long. At the other end the lamp cord is connected to an automatic switch which operates when striking the water.

The switch consists of a short length of ⅝-inch pipe with a wooden plug at the upper end and a cork with a tin disk tacked on top inserted at the other end, the lower edge of the pipe being hammered over to keep the cork from falling out.

Two small-diameter brass bolts are passed through the wooden plug and the ends of the lamp cord are connected to them. The bolts are disconnected electrically. As soon as the cork rises in the pipe and pushes it against the bolts (the tin disk making the contact), the circuit is closed, the bell is rung, indicating that the surface of the water has been reached.

Contributed by W. J. JACKSON.

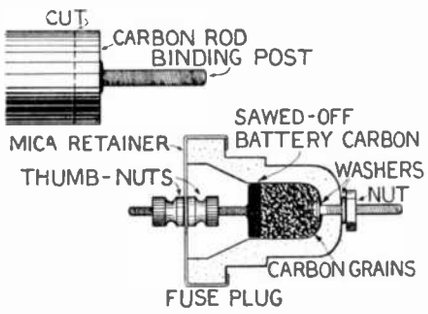


Very simple and ingenious electric apparatus for determining the depth of a well; when the little capsule reaches the water level, the bell rings.

Home-Made Microphone

THIS microphone differs from the type generally constructed, as it is adjusted by two dry battery terminal nuts instead of by taking out or adding carbon grains.

A burnt-out fuse plug with a thread in it is required. Remove the threaded part from the plug. Next bend up the flange that holds the mica in place and remove it. The center contact is next removed. It can be taken out easily by drilling a hole through it. The drill used should be smaller than the hole in the porcelain.



A very nice home-made microphone, using a plug fuse case for the body, with carbon granules.

Slip a washer over a small brass bolt and place it in the hole with the head on the inside. Put another washer over the bolt, place a battery nut upon it and screw up as shown in the diagram. This forms one connector on the transmitter.

Secure the positive post and carbon rod of an old unit dry cell. This kind of battery has a longer binding post than the ordinary type. Cut a disk from the binding post end with a hacksaw, at the same time cutting through the post where it extends into the carbon. Reduce the diameter of the disk with a grindstone or file until it fits inside of the fuse plug loosely. With a knife split the mica window into a thin diaphragm. In the center make a hole for the binding post on the carbon disk.

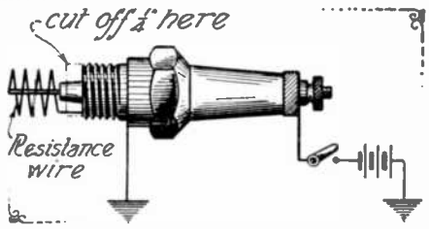
A battery nut is next placed upon the binding post and screwed up part way. The binding post is then put through the hole in the diaphragm and another nut screwed on behind it. The hole in the fuse plug is now partly filled with carbon grains. The microphone is then assembled as shown in the diagram.

Contributed by WILLIAM F. CLARKE.

Spark Plug as Vaporizer

THE spark plug fitted with a heating coil as shown in the illustration can be used as an electric vaporizer, water heater, cigar lighter, etc. The spark plug shown was used as an electric vaporizer, which was installed on a gasoline motor manifold.

This electric vaporizer consists of an old spark plug with six inches of No. 22 German silver wire coiled and brazed as shown. When the current is turned on



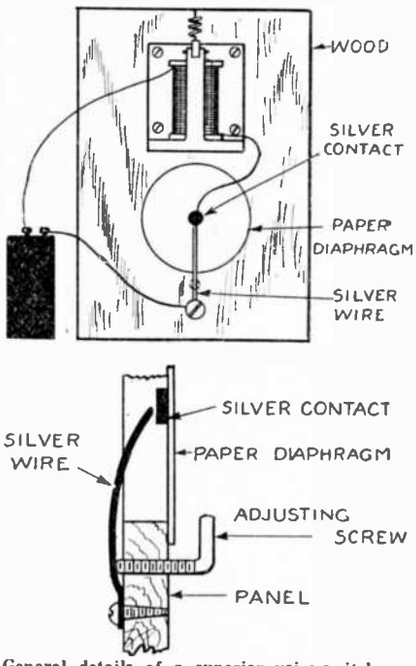
Spark plug employed to vaporize gasoline for starting an automobile engine. When the engine starts the plug is thrown out of action. It is placed near the carburetor in the manifold.

the resistance wire becomes red hot. This will vaporize the fuel and make the motor easy to start. The current may be turned on by a switch on the dash a few seconds before stepping on the starter, or cranking. After the engine is started and warmed up turn off the switch to the vaporizer.

Contributed by M. SKAER.

Sound Release Mechanism

WHEN we read of the President or other official starting an exposition from a distant point by pushing a button, we marvel at the mechanism which makes possible this control. To utter a single word and cause a piece of mechanism to start in operation also appears a most uncanny and difficult feat. This is far from difficult, however, and the veriest amateur in electricity can make up a simple mechanism which, on the sound of a voice or at the sound of hands or books being slapped together, will operate a release gear or throw a heavy electric contact and put mechanism into operation.



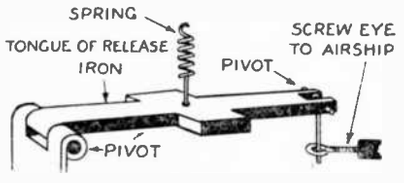
General details of a superior voice-switch, one which is released by the ejaculation of a word, so as to start any electric motor into action.

The diagram appended shows the simple parts and connections which will serve as a basis for some interesting and enlightening experiments. The materials required are, mainly, one or more dry batteries, a magnet or bell coil, a small spring, some contacts and a simply made diaphragm.

The assembly is made on a plain board for convenience, and the several parts comprising the trip mechanism are mounted adjacent to this.

The diaphragm is made by cutting out a circular opening in the board about seven inches in diameter, and stretching over this any tough paper, such as parchment, while wet, and securely gluing the edges down.

When this is dry a small piece of silver is glued to the center with a small strand of copper wire soldered to it at one edge and used to make a circuit with the other parts. A small and delicate contact is made from drawn silver wire bent to rest lightly over the center contact and secured outside the diaphragm.



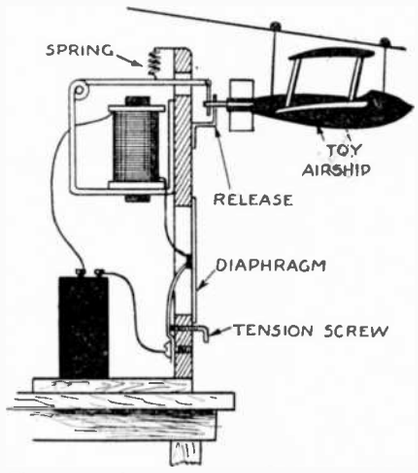
Details of a release for an airship to be actuated by the switch just described.

The magnet or bell coils are secured to the panel and a hinged tongue, to make contact with the center bars of the magnet coils, is also mounted on the panel. Under this tongue a small flat or coil spring is placed so that it will push out when the magnets are not excited and do not draw it down.

Under the silver wire contact to the center of the diaphragm is a small screw for varying the pressure of the contact. The battery is connected into the circuit so that the current will flow through the contacts on the diaphragm, through the coils and to the battery. Inasmuch as the break of the circuit is slight when the diaphragm is vibrated by the voice, it will be necessary to maintain a very light contact, and the wire making it will bound off altogether, or momentarily, when the disc vibrates. At the same time the spring behind the tongue or release must be sufficiently active to thrust the tongue back before the magnet reacts at the succeeding contact.

It is advisable to include in the gear small adjusting screws to increase the spring tension as suggested for the contact. Now as to the operating device for release, a single wire extension can be made from the tongue, which will pull out of release when the diaphragm acts, or the tongue can be made part of an electric switch, and the upper end will throw over and make up another contact.

In connection with the release gear described, a small airship was mounted on a thin wire across a room, the wire inclining downward, so that the toy airship would glide across the room when set free. The wire extended from the tongue engaged a screw eye in the bow of the ship, so that a person could step up near the release and at the word "Start" the ship would start on the journey. This only demonstrates one of the various applications of this most simple but highly interesting device which converts sound into motion.



The toy airship suspended by its wire and of which the release mechanism and general connections are shown.

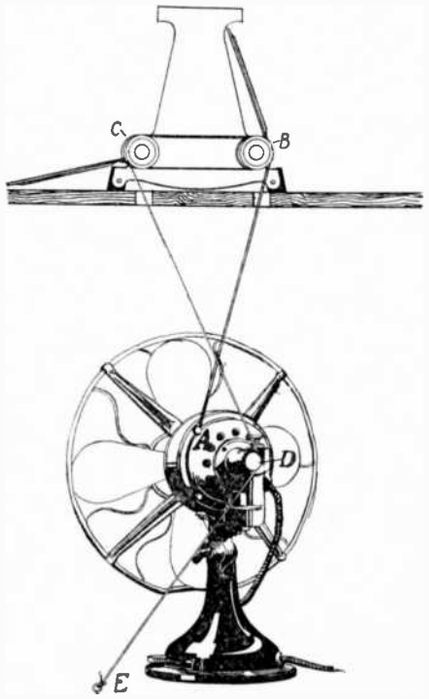
Contributed by G. A. Luers.

Toaster Window Display

ONE of the twentieth century improvements in electric toasters is a construction in which the turning of its handle reverses the piece of toast, exposing the other side to the heat.

Our illustration shows a way of exhibiting the device in a show window. The toaster is supported on a shelf over a 10-inch oscillating fan in a good position as regards spectators. The fan blades and guard are removed, and as thin a belt or cord as will do the work is carried around the knobs (B) and (C), and wrapped around one of the knobs two or three times to give it a grip.

One end of the cord is fastened to the frame of the fan motor; this point appears on the illustration on the left; then after the cord has passed over (B) and around (C) three or four times, the other end is fastened to the table on which the fan stands, and is carried around the oscillating part of the fan at (D). As the fan wriggles back and forth, it will keep the toaster in operation and illustrate clearly its advantages.



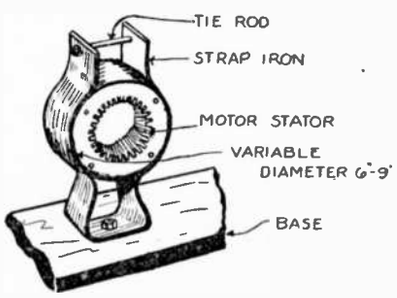
The concealed electric fan is used as a motor to actuate an electric toaster which turns the toast so as to expose first one side and then the other to its heat. A good window display.

Holder for Rewinding Stators

A MASSACHUSETTS electric service company uses an interesting device to facilitate holding motor stators during rewinding operations.

The device consists of a flexible metallic holder constructed out of a piece of strap iron. This piece of iron is about 28 inches long and is bent into the shape of a U-clamp, with upper ends held in place by adjustable rods and bolts. The lower end is bolted to the bench.

The whole outfit forms a receptacle with adjustability to a wide variety of motor frames ranging from 6 inches in diameter to 9 inches. The strap iron used is 2 inches wide and ⅛ inch thick. The tie rod at the top is ⅜ inch in diameter and a ⅜-inch bolt fastens it to the bench. The device stands about 11 inches high.



Simple stop arrangement for holding motor fields, adjustable for a considerable variety of sizes.

The flexibility of the band of steel is the reason why it will fit so many diameters of stators as said above. The classic way of making such a clamp fit a large range of cylinders is to put two sharp bends in it, so that the cylinders are gripped by straight portions of the strap which come in contact with the cylinder in only four places.

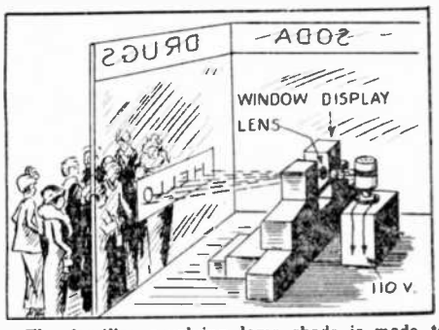
Contributed by R. Franklin Mundorff.

Lampshade Window Display

THE revolving lampshade revolved by heat is more or less common, but this adaptation of it is original.

The vanes, as may be seen, are merely "figure seven" cuts in the top of the oatmeal box, with the flaps bent up. This provides a method of propulsion, since the heated air rising from the electric light passes up through the vanes, acting upon them as wind on a windmill.

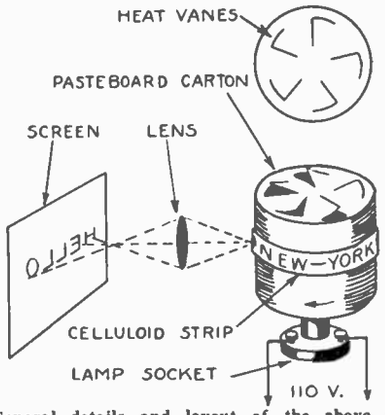
A strip of clear celluloid is substituted for cardboard around the cylinder.



The familiar revolving lamp shade is made to project words or other things upon a screen in a window so as to attract attention.

Upon this are written words, in a single line, continuing clear around the cylinder. The light inside the box projects the characters written on the celluloid through the lens upon the screen. As the box rotates slowly, one word after another moves across the screen, producing a novel and unique effect.

This is best suited for advertising in a show window, etc. If this apparatus is installed in a store window, concealed except for the lens, behind the other articles on display, and a semi-transparent screen is pasted on the window, people passing by will see nothing but the words on the screen in front of them and will be im-



General details and layout of the above apparatus showing relation of revolving shade, projection lens and screen.

pelled by curiosity to stop and read them. This disturbs the window display in no way.

In the illustration the words are seen reading backward. This is because people outside will see the words through the screen, not upon it.

Contributed by ROBERT NEWMAN.

Simple Home-Made Compass

A VERY simple compass may be constructed from parts found lying around almost every home. The building of the compass will no doubt afford much amusement and the apparently primitive instrument may even prove quite useful.

The main part of the compass is the index needle or pointer. This may be cut from an old clock spring or razor blade with an emery wheel, care being observed that the steel does not lose its "temper." After cutting the pointer in the shape shown, the temper is removed from the center so that it may be bent, etc. This is done by heating it at this point but keeping the two ends cool. To ensure this the ends may be pushed into small potatoes and the center heated in the flame of an alcohol torch. After the temper is removed, it is bent as shown. A small dent is made in the central crease with a nail.

A cork is procured and a brass pin is pushed through it, with its point in an upright position. Some pins are made of steel and such would not answer. If desired a small dial may be made and placed below the needle.

One end of the pointer is painted blue or black and the needle is magnetized by rubbing it on the poles of a magnet. One of the points is rubbed on the north pole and the other on the south pole. The pointer is placed on the upright pin so that the dent in the needle fits over the point of the pin. The painted end of the needle should point to the north.

We Pay One Cent a Word

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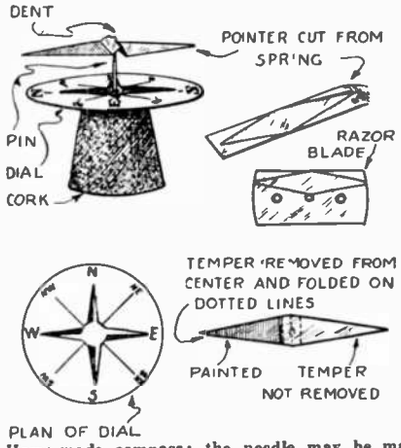
To secure balance a little more steel may be ground off one of the points to give it equilibrium. It is well to magnetize the pointer and try it out before painting one of the points, in order to be certain that the right one is colored.

Contributed by EVERMONT FISEL.



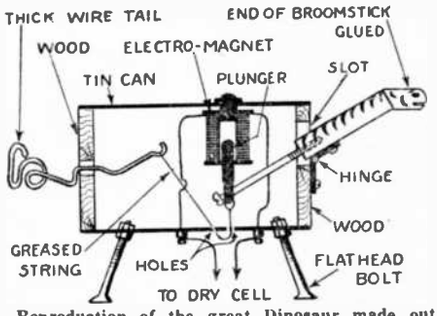
Home-made compass; the needle may be made from a safety razor blade. It will be found to be a very delicate instrument.

Tin Can Dinosaur

CHILDREN usually like to have a toy that moves by itself, especially if the actions caused by that toy resemble those of some living thing. The tin can dinosaur will move its long neck and head up and down, and at the same time raise and lower its tail simultaneously. These antics will amuse any child, especially if he can control the movements from some distant point. Closing the switch causes the tin can dinosaur to raise his tail and lower his head. When the switch is opened it promptly raises its head again, at the same time lowering its tail.

An ordinary tin can is used for the body of the toy. A piece of broomstick makes a very fine neck; a thick piece of wire can be bent into a comical tail; four long, flat-headed bolts or nails make the legs of the toy.

On the inside of the body a hollow solenoid is mounted. When current from a dry cell flows through this coil it pulls up the iron plunger which is attached to the long screw extending from the neck. This lowers the head. A greased cord is attached to the end of the wire tail and is then slipped through two small holes in the bottom. These act as a pulley. The cord is then attached to the plunger.



Reproduction of the great Dinosaur made out of a tin can, nails, broomstick, and wire. As the body is made of tin, perhaps it ought to be called a Tinosaur.

The binding posts should be insulated from the tin can, and the feet filed flat for the beast to stand squarely on the floor.

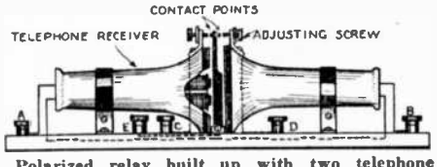
The toy may be decorated to suit the person building it. The tail and plunger must be heavy enough to overbalance the head and neck in order that it should return to its natural position.

Contributed by L. DRIBIN.

Polarized Relay

THIS relay is constructed from two telephone receivers, minus caps and diaphragms, mounted on a baseboard as shown.

On the top of each receiver case is mounted a brass strip carrying a contact and adjusting screw. One of these is



Polarized relay built up with two telephone receivers facing each other and the armature between them, the diaphragms being removed. It acts like a polarized relay although the armature is of soft iron and not polarized.

wired to the post at (C) and the other to the post at (D).

The armature is made of iron, and swings on a pivot between the two receivers, also carrying contact points at the upper end. The armature is connected with the post at (E), which serves as a common post for circuit through (C) or (D).

The receivers are connected in series and a little experimenting will be necessary in order to get the receivers connected in such a manner that when the current is passing in one direction through the coils, one electro-magnet will tend to aid its permanent magnet, but at the same time the other electro-magnet will tend to counteract the magnetism of its permanent magnet.

Thus it will be seen that when the current is flowing in one direction through the instrument it will cause the armature to make contact at the one post, and at the other post when the current flows in the opposite direction.

With four of these instruments two separate telegraph circuits may be made over a single wire line.

Contributed by ROSCOE BETTS.

Elec-Tricks

IN this department are published various tricks that can be performed by means of the electrical current. Such tricks may be used for entertaining, for window displays, or for any other purpose. This department will pay monthly a first prize of $3.00 for the best electrical trick, and the Editor invites manuscripts from contributors.

To win the first prize, the trick must necessarily be new and original. All other Elec-Tricks published are paid for at regular space rates.

Mysterious Sign

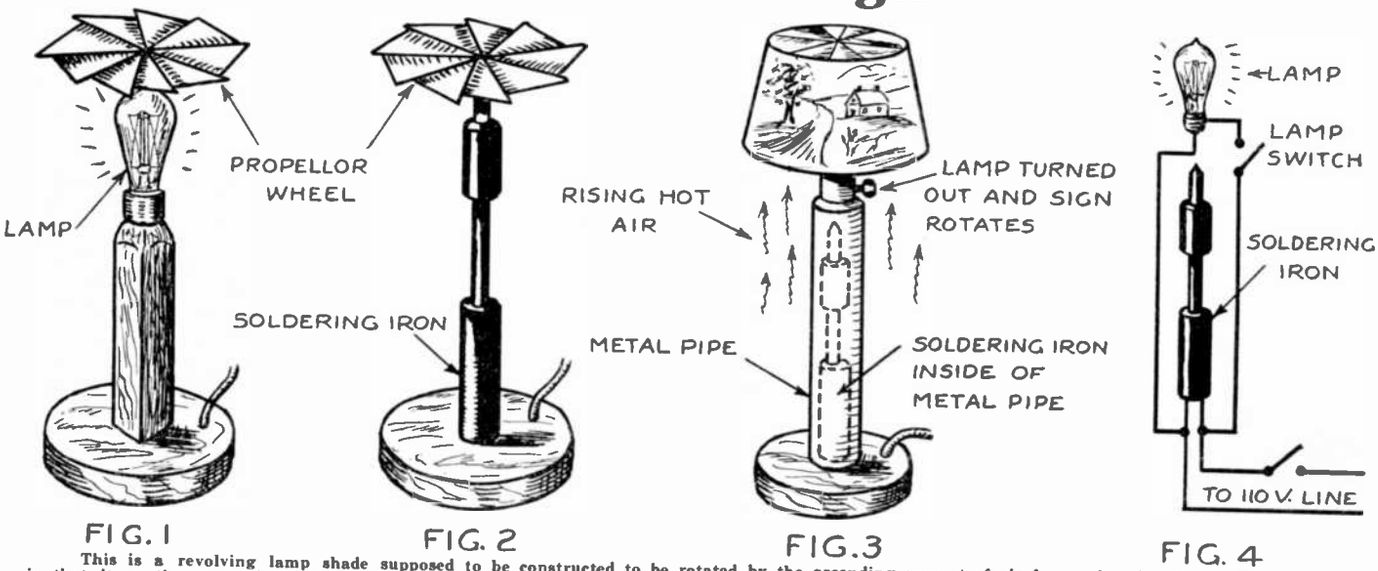


FIG. 1 FIG. 2 FIG. 3 FIG. 4

This is a revolving lamp shade supposed to be constructed to be rotated by the ascending current of air from a burning lamp. The mystery is that it continues turning when the lamps are extinguished. Within the stem a soldering iron is concealed, and this, heated by the current, produces sufficient up-draft to rotate the shade in a mysterious manner.

MOST of us are familiar with the advertising signs in vogue for store windows which consist of a propeller wheel of paper rotated by the rising current of hot air from an electric light bulb. Figure 1 shows the simplest form of this device. Many styles have been produced, some of which are placed inside of a translucent glass globe and cast figures on the globe as the light shines through the rotating screen.

Practically everyone knows how these devices work, but would be baffled if the lamp were turned out and the sign still rotated. This is precisely what the device illustrated will do. The secret is explained in Figure 2. Instead of using a lamp to heat the surrounding air, an electric soldering iron is used. This in itself would make a good attraction in an electric retail store window.

In Figure 3 is shown a combination of the two. The soldering iron, however, is concealed in the lamp standard, so that everyone will think that only the heat of the lamp rotates the sign. But when the lamp is turned out and the sign still rotates, the mystification increases. Figure 4 shows how the connections are made, so that the lamp can be turned off without turning off the iron.

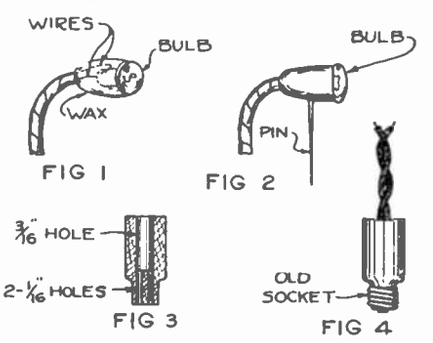
It is an excellent way of puzzling the alleged electrician.

The Luminous Eye

By FRANK C. FLINT and ARTHUR SUTCLIFF

THE materials needed are a flashlight and battery, one yard of small, double wire, one burned-out flashlight bulb, sealing wax, a needle, and a bit of ingenuity.

Tools employed: pliers, soldering iron, solder and drill.



An electric eye to be worn at the neck, so that when the current is turned on from a pocket battery a light will appear near the collar button.

Take the lens and bulb out of the flashlight, solder the end of one wire to the plug on the end of the good bulb, and the end of the other wire on the brass receptacle of the same bulb. When this is done cover the whole up with sealing wax leaving the glass at the extreme top of the good bulb (as in Fig. 1) uncovered.

Before the wax hardens push the head of the needle into the wax (as in Fig. 2).

When this has been done break off the glass of the burnt-out bulb and dig out the contents of the brass receptacle, being careful not to break the end off.

It is then essential to make a wooden plug (as in Fig. 3, cross-section). Insert one of the wires in each of the small holes, pulling the insulated part well down into the larger hole.

Bore a small hole in the lead plug of the old socket. Insert one of the wires and solder it in place. Solder the other wire to the brass base of the socket. Put a drop of shellac in the socket and pull the socket on over the end of the wooden plug (as in Fig. 4).

All that remains to be done is to get a piece of translucent paper, paint an eye on it and paste it over the glass part of the good bulb, screw the socket that is on the end of the wooden plug into the flashlight in place of the bulb and manipulate the switch.

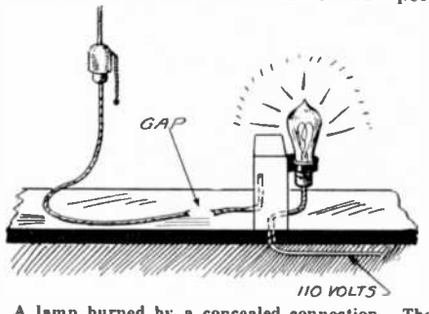
A coat of shellac may be put on the wooden plug to give it a finish.

This may be worn in the following manner: place it behind your tie, push the pin into the tie and hide the wire behind your shirt. In this way you can, by pushing a button in your pocket, turn a light on at your neck.

Wireless Light

TO make a wireless light which apparently remains lighted when the wire has been cut, fasten a socket of any sort on an upright panel. The wires are run down about two inches and through a hole, but not through the back. They are run down slanting through the panel and out at the bottom.

A false wire is connected and put in through the back and knotted. To operate, connect real wires to a 110 volt line and turn on the switch. Then cut the false wire and the light will remain on, apparently jumping the gap. The real wires should go down through the table or floor, out of sight.



A lamp burned by a concealed connection. The ostensible connection is cut and the gap exposed so as to mystify onlookers.

Contributed by LESLIE CARPENTER.

Latest Electrical Patents

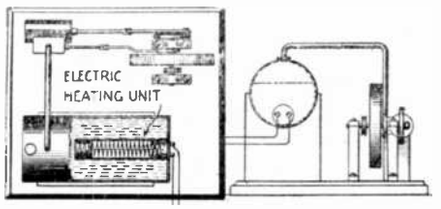
Magnetic Toy

Two horseshoe magnets, fastened together as shown, are twirled above a star-like armature, which is also permanently magnetized. The armature has a small turning point on the under side so that it will spin like a top. Although a simple toy, it demonstrates the laws of magnetism.
Patent 1,481,256, issued to Theodore Dols.

Electrode

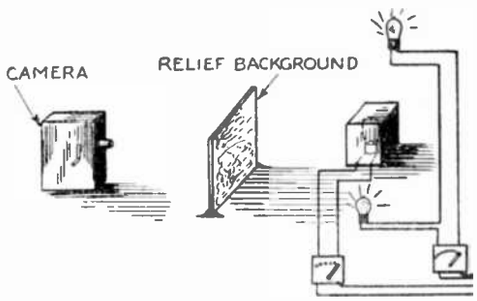
This electrode is devised of such a shape and curvature that it will readily adjust itself to almost any curvature of the body. It is used for applying the electric current to the person of the subject.
Patent 1,487,998, issued to Milton Woolf.

Toy Electrosteam Engine



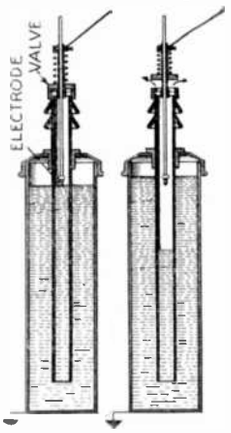
This toy steam engine has a boiler containing an electric heating unit. Steam is quickly generated with this arrangement and the pressure is easily controlled.
Patent 1,480,445, issued to S. D. Horlacher and W. E. Horlacher.

Motion Picture Apparatus



Artificial scenes are brought out in relief by cutting or forming fixed objects of plastic material on a glass plate relief background as illustrated. By means of various lights different effects are brought out. The apparatus is especially adapted for cloud and sunset scenes.
Patent 1,487,862, issued to Archie La Freniere.

Current Interrupter

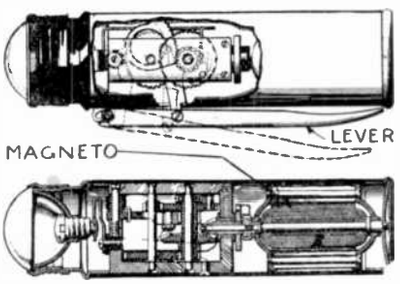


In a grounded tank containing an electrolyte is placed an insulating tube and electrode which dips into the electrolyte inside the tube. When a heavy current passes, heat is generated, producing vapor, which increases the pressure inside the tube and forces the electrolyte down, breaking the circuit. A valve at the top allows excess vapor to escape.
Patent 1,479,276, issued to C. E. Bennett.

Display Device

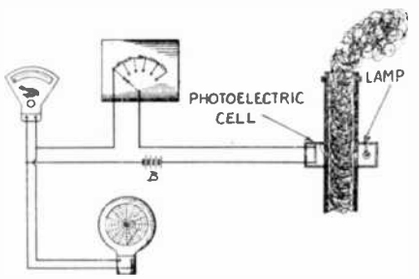
By projecting multi-colored light rays on an intaglio of opaque material many harmonious illussive effects are produced. The colored lamps are arranged around the periphery of the intaglio and the intensity and color of the lamps are varied automatically.
Patent 1,480,375, issued to Charles C. Cristadoro.

Magneto Flashlight



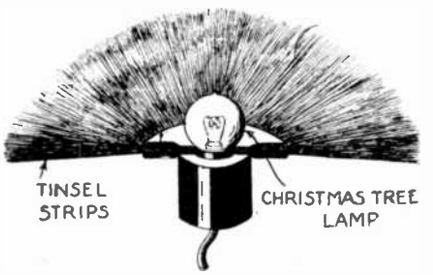
This is a very compact mechanical arrangement whereby the magneto in a flashlight case is spun by gripping the lever. Thus the life of the instrument depends upon the mechanical wear of the parts and duration of the lamp.
Patent 1,487,502, issued to J. J. Wood.

Smoke Indicator and Recorder



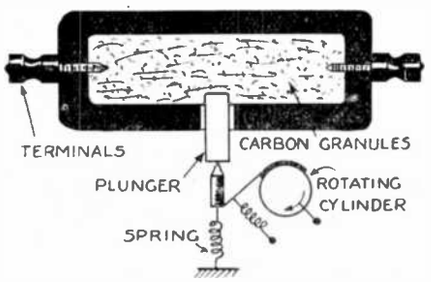
A lamp and selenium cell or other photo-electric cell are placed on opposite sides of a smoke flue so that the light passes through the smoke and affects the cell. The resistance of the cell is therefore varied in accordance with the amount of smoke passing and this varies the current, which is recorded by the measuring instruments.
Patent 1,487,898, issued to Roy C. Stolp.

Tinsel Reflector



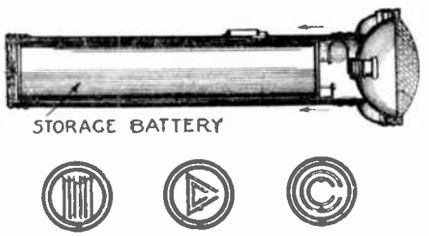
Thin strips of shiny tinsel are used for the reflector of this Christmas tree light. A special arrangement is provided to prevent the tinsel from shorting the circuit and at the same time to make the manufacture of the device as simple as possible.
Patent 1,479,037, issued to Bernard E. Franke.

Microphonic Amplifier



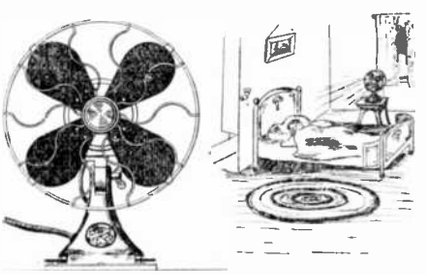
This microphonic amplifier has a chamber containing carbon granules in which a plunger vibrates, thus changing the resistance between the two terminals in accordance with the vibrations. The plunger is attached to a metal sheet lying over an agate cylinder which is rotating and pulls on the plunger in accordance with the electrostatic attraction between the sheet and cylinder.
Patent 1,491,170, issued to K. Rottgardt.

Flashlight Storage Battery



By using a storage battery in a flashlight the lamp may be used as long as the filament lasts, as when the battery is run down it is easily charged. This battery is very compact and several methods of arranging the electrodes may be used, as shown in the illustrations.
Patent 1,481,226, issued to H. P. Rhodes.

Automatic Fan



A clock in the base of this electric fan opens the circuit and stops the fan at any predetermined time, thus allowing a person to retire at night and leave the fan running, to stop when desired.
Patent 1,480,906, issued to J. G. Heitzman.

Short-Circuits

THE idea of this department is to present to the layman the dangers of the electrical current in a manner that can be understood by everyone, and that will be instructive, too. We have given monthly prizes of $3.00 for the best idea on "short-circuits." Look at the illustrations and send us your own "Short-Circuit." It is understood that the idea must be possible or probable. If it shows something that occurs as a regular thing, such an idea will have a good chance to win the prize. It is not necessary to make an elaborate sketch, or to write the verses. We will attend to that. Now let's see what you can do!

Here lies Bill Snodgrass,
Stingy though rich.
His screwdriver slipped
While repairing a switch.
—CARL A. FANTON.

Sad was the day
When Willie Vail
Made a target
Of a charged third rail.
—EDWARD C. KOZEM.

Here lies the body
Of Rastus Tuson.
Who doused the motor
With the juice on.
—E. R. DAVISON.

Resting in peace
Lies Hazel De Vaughn.
She washed the toaster
With the current turned on.
—CARL A. FANTON.

MAN KILLED BY ELECTRIC SHOCK

David Trone, 30, Steps Against Bus-bar and 2,200 Volts Pass Through Body.

David Trone, 30, chief electrician of the Adams Axle Company, Inc., 435 North Franklin Street, was killed instantly yesterday afternoon when he stepped against a bus-bar carrying 2,200 volts. He was found by other electricians who searched for him when he did not answer their calls at 4:45 o'clock.

Dr. L. P. Ransom, factory surgeon, pronounced Trone dead, and notified the county morgue. The body was taken there to await relatives believed to live in Findlay, Ohio. An investigation this morning by Coroner Crane showed death to be accidental.

Trone was clutching tightly a broom with which he had been sweeping. He evidently backed against the bus-bar, not realizing how close he was. The shock threw him to the floor nearby.

Company officials say Trone was electrician with them for several years before the factory was brought to Syracuse. He lived at 321 West Genesee Street. Trone was a member of Findlay Lodge 75, B.P.O.E. He wore a Masonic ring at the time of his death.

The candles burn in requiem
For what was once old Joseph Kamp.
While calling on the telephone
His bare arm touched the office lamp.
—WILLIAM RASIKAS.

THIS department is conducted for the benefit of everyone interested in electricity in all its phases. We are glad to answer questions for the benefit of all, but necessarily can only publish such matter as interests the majority of readers.

1. Not more than three questions can be answered for each correspondent.
2. Write on only one side of the paper; all matter should be typewritten, or else written in ink. No attention can be paid to penciled letters.
3. Sketches, diagrams, etc., must always be on separate sheets.
4. This department does not answer questions by mail free of charge. The editor will, however, be glad to answer special questions at the rate of 25 cents for each. On questions entailing research work, intricate calculations, patent research work, etc., a special charge will be made. Correspondents will be informed as to such charge.

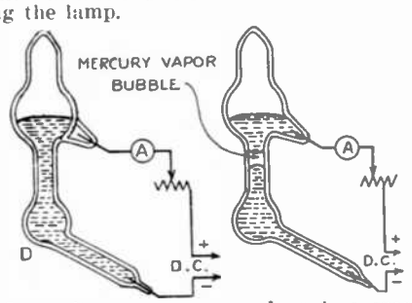
Kindly oblige us by making your letter as short as possible.

Low Voltage Mercury Lamp

(447)—W. L. Wesley, Williamsburg, Pa., asks:

Q. 1.—Have any low voltage mercury lamps been developed recently and if so please give a short description of them?

A. 1.—The illustration shows an experimental lamp recently developed. This lamp is constructed of pyrex glass with tungsten lead-in wires. It operates on direct current and the lower electrode must be negative. To start the lamp the circuit is first completed through the unbroken column of mercury and a Bunsen flame is applied to the point (D) until the mercury boils. This will cause bubbles to rise that break the mercury column and also furnish the necessary vapor to carry the current. A "hot spot" is also formed on the negative electrode when the column is broken by the bubble and this maintains a sufficient supply of vapor. The discharge is very concentrated and intrinsically brilliant. The lamp draws from .5 to .8 amperes at a potential of 20 to 30 volts. A rheostat is included in the circuit which is found convenient when starting the lamp.



Low voltage mercury vapor lamp in a quartz glass or pyrex container.

Musical Lamps

(448)—Harold A. Lower, San Diego, Calif., writes:

An article in the February issue, on the subject of "Musical Lamps," recalled a rather interesting occurrence.

One evening, as I sat reading by the light of a 200-watt tungsten lamp, I became conscious of a peculiar, high-pitched musical note that seemed to come from the ceiling.

On investigating, I found that the filament of the lamp had burned out, and that the current was arcing across the space between the two ends. The arc was about one-sixty-fourth of an inch in length when first noticed, and emitted a very high, clear note. To prove that the sound actually came from the lamp, I touched the globe lightly with my finger nail, and could feel the vibration very distinctly.

In the course of about five minutes the filament melted back far enough so that the arc broke and the lamp went out. As the arc increased in length, the pitch of the note became lower.

The lamp was operating on 110 volts, 60-cycle A. C., but the pitch of the note was from about the upper limit of audibility, down to about that of the E string on a violin, so it was at all times much higher than a 60-cycle note.

Q. 1.—I would like to know if this phenomenon has been noticed before, and if so, what the explanation is?

A. 1.—We know of no instance where this phenomenon has been observed before. A similar condition takes place when a large-sized lamp is slowly unscrewed from the socket, in which case the arc forms between the base of the lamp and the socket.

The reason that the note of the arc is high-pitched and lowers as the length of the arc increases may be explained with reference to the illustration. The full-line curve shows the 110-volt 60-cycle sine wave. The effective voltage is 110 and the maximum is $\sqrt{2}$ times 110, or 155.5 volts. But when the arc is very short in length it breaks down at a much lower voltage, say 50. Therefore, as soon as the voltage rises from zero to 50, the gap breaks down and the voltage drops to such a low value that the gap resumes its normal condition and the arc stops. Instantly the voltage rises again, only to break down the gap again, and the action is continually repeated. As the gap becomes longer a higher voltage is necessary to break it down and more time is required for the voltage to build up. This accounts for the lower note emitted from the longer arc. Since the electrodes were in a partial vacuum the discharge was more in the nature of a spark than of an arc. The electrostatic capacity of the line also has some effect on the discharge.

Insulator Query

(449)—L. G. Moore, Chihuahua, Mexico, asks:

A. 1—Are there any electrical insulators which can sustain a temperature of 2,500 degrees centigrade without becoming conductors and without melting?

A. 1.—We know of no such insulator. Fused silica or quartz is probably the best insulator known which stands high temperatures, but this becomes soft at the temperature mentioned and the resistivity decreases about 90 per cent.

Tesla Coil Query

(450)—David Thomas, St. Louis, Mo., asks:

Q. 1.—I would like to know if an eight-inch spark coil could be used with a Tesla coil with good results.

A. 1.—You should obtain excellent results from a Tesla coil operated from an eight-inch spark coil. With this combination a very low capacity condenser should be used and it must be well insulated or it will break down. It should consist of two heavy glass plate condensers immersed in oil. The condensers are connected in series so as to decrease the strain on the glass plates.

Q. 2.—Please give the dimensions of the Tesla coil and also the length of spark that may be obtained from it.

A. 2.—We would suggest that you look in the May, 1923, issue wherein complete details of a powerful Tesla coil were described. The spark obtained was from two to three feet in length.

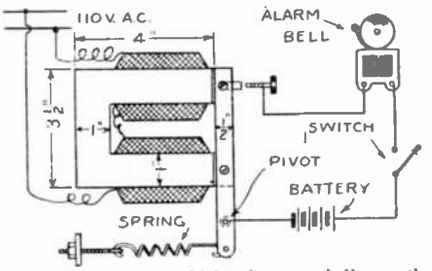
Incubator Alarm

(451)—TKV, Lodi, Calif., writes:

I have need of a constant circuit A. C. magnet for use with a local bell ringing circuit to give an alarm when the voltage is turned off the main line supply. I have an electrically heated incubator system supplied with auxiliary kerosene lights which can be used in case the line voltage is turned off, and no harm is done if the change-over is effected at once. The thermostat type of alarm is not satisfactory as it allows the temperature of the incubators to fall quite a lot before the alarm is given. I am enclosing a rough sketch of the system that I would like to use.

Q. 1.—Please furnish all the data necessary for making the magnet. It must be designed so as to be very economical as to the watts used.

A. 1.—We have reproduced your sketch and have added the size of the magnet on the drawing. The core should be built



Incubator alarm which rings a bell on the voltage of the supply line being turned off. Early notification is necessary.

up of laminated transformer steel and should have a cross-sectional area of one square inch. On this core wind 800 turns of No. 24 D. C. C. magnet wire, 400 turns placed on each leg. The armature should be of laminated steel also. On account of the high reactance of this magnet the current consumed will be extremely low. To prevent humming and vibration the method described in connection with the battery charger relay described in these columns may be employed.

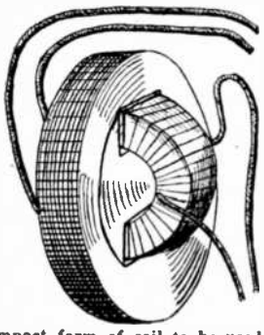
Compact Transformer

(452)—Arthur Harsley, Nashville, Tenn., asks:

Q. 1.—I have noticed some fairly heavy duty transformers of exceptionally small size, whereas all those described in PRACTICAL ELECTRICS are comparatively bulky. How is it that manufacturers can make them so small?

A. 1.—Some of the manufactured transformers are made according to the connections in the illustration. The main core is ring-shaped and built up accurately of steel laminations punched out by machine. The windings are wound on another stack of laminations accurately punched out so as to fit tightly into the center of the ring shaped core as shown. This construction

gives the transformer a very efficient magnetic circuit and at the same time makes it very compact. In order not to have objectionable air gaps in the magnetic circuit it is absolutely necessary to have the punchings accurate, and it is practically impossible to cut them accurate by hand. This is the main reason why manufacturers can build transformers much smaller than home-made ones.



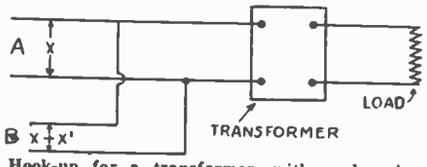
Very compact form of coil to be used as transformer. The peculiar shape of the laminated core will be observed, notched out for the inner coil.

Transformer Query

(453)—E. C. Judson, Willimantic, Connecticut, writes:

Q. 1.—If two alternating current lines (A) and (B), (A) having a voltage of x and B a voltage of (x + x'), but the source of current from (B) being limited so that it is less than that from (A), are connected together to a transformer as shown in the illustration, how will the secondary output compare with that obtained from the same transformer when connected to a line giving a voltage of (B) and current of (A)?

A. 1. — You are somewhat confused about the action of a transformer. If the two lines are connected together, one line having a higher voltage than the other, current will flow from the line having the higher voltage into the one having the lower voltage, and the amount of current depends upon the resistance of the lines and upon the difference of voltage. The resultant voltage will be somewhat less than the voltage of the higher line. The current flow into the transformer depends upon the capacity of the transformer and the amount of current withdrawn from the secondary. In your case if the source of current from (B) is limited by the resistance of the lines or some other cause, its voltage will drop the instant current is withdrawn. Your problem therefore depends upon the size of the transformer and if this is very small and draws very little current the secondary voltage will be higher when it is operated on the higher voltage line.



Hook-up for a transformer, with explanations of its action to elucidate the question asked.

Violet Rays

(454)—Leonard Hesse, Plymouth, Wis., inquires:

Q. 1.—How is a violet ray made?

A. 1.—The term "violet ray" is sometimes used for ultra-violet light. Ultra-violet light is beyond the range of vision and cannot be seen by the human eye, although it is recorded on a photograph film. It is present in sunlight, but it is doubtful if any reaches the earth, as it is absorbed by the atmosphere. An arc light emits a large amount of ultra-violet rays, especially if an iron electrode is used. To produce a small amount a spark coil with a spark gap having iron electrodes may be used. A mercury vapor lamp is also rich in ultra-violet light, but the lamp must be of quartz as this light does not pass through glass.

Q. 2.—How large is the current produced when a piece of aluminum and some other metal is touched to the tongue?

A. 2.—The current depends upon the area of the contact. It is very small, in the neighborhood of a few milli-amperes.

Q. 3.—Explain why a lamp is illuminated to a green color when connected to the secondary of a Ford spark coil.

A. 3.—The lamp, similar to the well-known Geissler tube, emits light when connected to a high tension line. The color of the light depends upon the nature of the rarefied gas within the bulb, and the light is due to an ionic discharge of electricity.

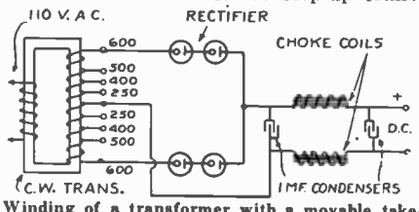
The term violet ray may be considered a popular name for one of the manifestations produced by high frequency electric discharges. If a vacuum tube is connected to the terminals of an Oudin coil or of a Tesla coil, the gas contained within it will be rendered incandescent with a bluish color and has been more or less extensively used with the idea that it has therapeutic value—something which perhaps is open to question.

It gives a certain degree of excitation and warmth and many people have derived considerable satisfaction from its use.

C. W. Transformer

(455)—Anton J. Moravec, Chicago, Ill., writes:

I wish to wind a C. W. step-up transformer for radio transmission with a ratio of about 5 to 1. This instrument is to be operated from a 110-volt 60-cycle circuit and the secondary is to be tapped 250, 400, and 500 volts, the end being about 600 volts, each side of the center tap.



Winding of a transformer with a movable take-off on the secondary so as to give different voltages.

Q. 1.—How is the secondary wire wound? Are all the windings in the same direction?

A. 1.—The windings should all be in the same direction, as shown in the diagram. In other words, the secondary coil should be one complete winding with one tap in the center and four on each side, including the end connections, making nine connections in all.

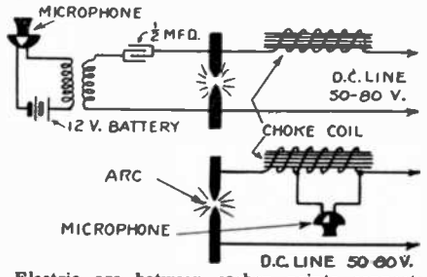
Talking Arc

(456)—J. E. Ragsdale, Pasadena, Cal., asks:

Q. 1.—Please give diagrams showing how to reproduce music from a talking machine across two rods of a carbon arc light.

A. 1.—We are giving two diagrams which you may try when experimenting with this apparatus. One shows the arc supplied by direct current through a large choke coil connected in series with the line. The microphone current, which is varied by the sound waves from the phonograph, is passed through a step-up transformer, the secondary terminals of which connect across the arc through a one-half microfarad paper telephone condenser. Sound waves striking the microphone vary the current passing through the arc and the arc reproduces the sound. It will be necessary to experiment with different sizes of choke coils and arc lights in order to obtain satisfactory results.

The other diagram shows the microphone shunted across a portion of the choke coil connected in the line. This is the simplest arrangement. The choke coil should contain several hundred turns of No. 16 wire on an iron wire or laminated steel core 12 inches long and having a cross-sectional area of about two or three square inches.



Electric arc between carbon points connected so as to operate as a telephone receiver. A very interesting experiment.

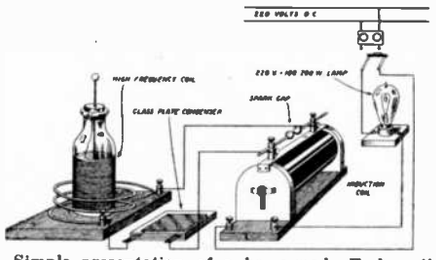
Battery Charger Relay

(457)—S. D. Rogers, Jr., Birmingham, Ala., writes:

Q. 1.—I noticed an error in your September, 1923, issue. On page 606 is illustrated a battery charger with a relay. This relay is not suitable for A. C. work.

A. 1.—If the relay is properly constructed it should not lower the A. C. voltage. If connected in series it should have a few turns of a large size wire. If it lowers the voltage then this can easily be remedied by connecting it across the line, in which case the relay should have many turns of fine wire. In regard to vibrating, if the armature is rather heavy and sluggish and has a springy contact in the D. C. side, the vibrations should not be objectionable. Vibration in A. C. magnets is greatly reduced by employing a short-circuited copper ring on the pole tip, as shown in the illustration. This passes around a portion of the pole tip only. The currents induced in this ring are out of phase with the line current and the magnetic pull is therefore extended over the dead points. The relay magnet should have an iron wire or laminated sheet core. Telegraph relays, as sold by manufacturers of these instruments, will not work in this case because practically all of them are polarized and the vibration will be too great.

Tesla Coil



Simple presentation of a home-made Tesla coil with complete hook-up.

(458)—John Bade, Jersey City, N. J., asks:

Q. 1.—Please give the construction of a simple Tesla coil that can be operated on the 220-volt D. C. line. If necessary a spark coil may be used.

A. 1.—Our diagram will tell how this may be accomplished. The coil is wound on a milk bottle as shown. No. 30 wire is used for the secondary. The spark coil is operated from the line in series with a 220-volt 100 or 200-watt lamp. If a 220-volt lamp is not available two 110-volt ones connected in series may be used.

(*Continued on page 598*)

"BUILD YOUR OWN" WITH "RASCO" PARTS!

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"RASCO" Double Acting Snap Switch

25c

At last a REAL radio switch constructed for radio purposes, not just a battery switch that may be adapted for radio. The RASCO switch is the only switch with a POSITIVE DOUBLE spring action. No more guess work if the circuit is open or closed. A push of the finger and the current is on. A slight pull and THE HANDLE SNAPS BACK of its own accord. An internal coil spring pushes the handle back when a little pull is applied. This switch is intended as a battery switch to disconnect your "A" batteries.

Only one hole to drill. **No tools required to mount except your finger and thumb.** Also this switch takes up a minimum of room, much less than other switches, the base of the switch measuring only 1¼"x½". All metal parts nickel plated. A switch you will be proud to possess.

No. G 4850—RASCO Snap Switch, each..... $0.25

5c

G-4870

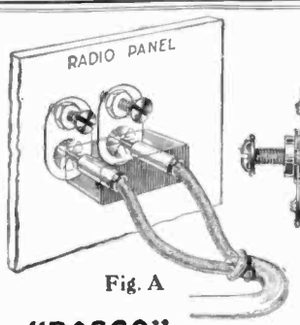


Fig. A

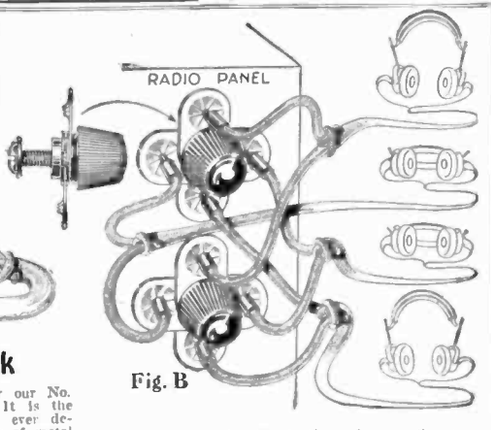


Fig. B

"RASCO" "Jiffy" Cord Tip Jack

This jack has been specially designed for our No. G-4860 cord plug shown on this page. It is the simplest and most efficient cord tip jack ever designed. It is stamped from a single piece of metal and it grips any style cord tip of any make phone or loud speaker. The "Jiffy" Jacks take but a minimum of room. All you are required to do is to drill two small holes in your panel and mount the "Jiffy" Jacks with screw and nut furnished. No soldering is necessary as the wire goes right under the nut. Our X-Ray view, Fig. A, shows how two of the "Jiffy" Jacks are used in conjunction with our cord plug. Note that Jacks go on back of panel; only the screws show in front. The illustration, Fig. 4870 of the "Jiffy" Jack is full size. They take practically no room at all when mounted and will not extend more than about ⅛" from back of panel. Made of best spring brass, that will not wear out, even through extended use.

We also show a few illustrations of some other uses for the "Jiffy" Jack. Eight of them can be mounted on two binding posts as shown (Fig. B) which will make it possible to connect 4 pairs of phones to your outfit. The same system can be used by mounting eight of the jacks behind the panel by drilling a few simple holes; then the cord tips may be pushed through these holes, making it possible to connect one or more phones in the circuit.

We will pay $1.00 for every new use for Jiffy Jacks.

No. G-4870 RASCO Jiffy Jack, complete with nut and screw, each **$0.05**

No. G-4871 RASCO Jiffy Jack, without nut and screw, two for **$0.05**

"RASCO" Phone Cord Plug

Again RASCO leads with a small but important radio novelty. Here is a bit of semi-hard rubber into which the tips of your phones or radio speaker are pushed. This makes positively the cheapest and simplest radio jack ever designed. Its small size and neatness has made it famous over night. Illustration is full size (1" long, ½" wide, ⅜" thick). **No tools of any kind are required to attach,** just wet the metal cord tips and push them through the openings, where they will be held firm until you wish to withdraw them. This plug can be used with any standard cord tip jack, but preferably with the new Jiffy RASCO cord tip jacks shown on this page. (See also Fig. A.). For experimental purposes The RASCO cord plug is finished neatly in a good grade of black rubber and will last for years.

No. G-4860 RASCO Plug, each....$0.10

10c

(Patents Pending)

Wanted

THIS Company is always in the market for new ideas. Any small specialties in demand by the radio fan will be highly welcomed by us. Some of the articles shown on this page originated with our customers, whom we paid well for the ideas. Send your sketch or model addressed to Research Department, c/o this Company.

Dealers and Jobbers

WRITE or wire for territory that is still open on the specialties described on this page. These articles are widely advertised and you will have a demand for them almost immediately.

We shall be glad to send samples to responsible and rated concerns. Address all wholesale inquiries to

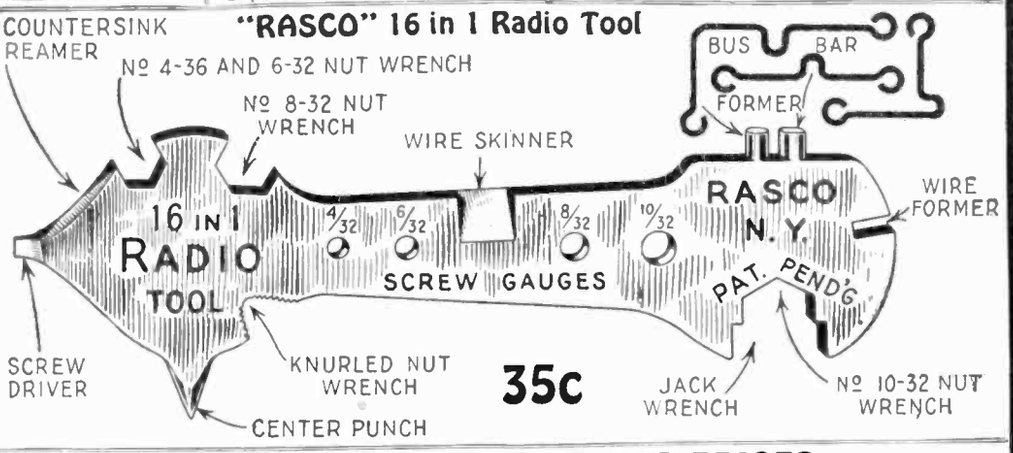
RADIO SPECIALTY COMPANY,
Wholesale Department,
25A West Broadway New York City

"RASCO" 16 in 1 Radio Tool

Here it is! The radio tool that will bring happiness to all radio experimenters and constructors. Here is a tool that does 16 different things and does them well. A tool that does practically everything required in building your radio set. The tool is built of hardened steel, size exactly as per illustration, highly finished. Here are some of the uses: 1. Screwdriver. 2. Center punch. 3. Countersink. 4. Bus bar wire bender. 5. Bus bar and wire bender for 8/32 screw. 6. Bus bar and wire bender for 6/32 screw. 7. Socket wrench for jacks. 8. Socket wrench for 4/36 nuts. 9. Socket wrench for 6/32 nuts. 10. Socket wrench for 8/32 nuts. 11. Wrench for knurled nuts. 12. Screw gauge for 4/36 screw. 13. Screw gauge for 6/32 screw. 14. Screw gauge for 8/32 screw. 15. Screw gauge for 10/32 screw. 16. Knife for wire skinning.

These are only the important uses of the tool, but many other uses will readily suggest themselves to every radio experimenter. You will wonder how you have gotten along before without the 16 in 1 radio tool. Get one of these happiness tools. You will never again be without it.

No. G-4800 RASCO 16 in 1 Radio Tool, each **$0.35**



35c

NEW THINGS FROM CATALOG No. 11 AT CUT PRICES

Dial Marker

The big little thing you have been waiting for. Just drill a hole in the panel and mount the marker above the dial. Very neat, nicely nickel plated and polished.

G7788 Dial Marker, each ..... $.05

Vacuum Tubes

Only best make tubes carried in stock. All tubes guaranteed to work or exchanged if filament lights.

G201A 5 v., .25 amp. $2.50
G199 3 v., .06 amp. 2.50
G12 1½ v., .25 amp. 2.50

Three-Gang Socket

Aluminum shells, genuine heavy bakelite base, 3 brackets for mounting, 12 nickel binding posts. Length 7¼".

G5995 Three-gang socket $1.50

Cockaday Coil

Guaranteed best make. Three windings of No. 18 D C C Magnet wire. Has brass brackets for panel or base mounting. Results guaranteed or money back.

G2750 Cockaday coil $1.50

Neutralizing Condenser

Latest pattern. Genuine bakelite base. Fahnstock connectors, hard rubber composition knob, easiest to regulate. Size 3⅝" long, 1" wide and 1" high.

G1202 Neutralizing condenser ..... $.40

Neutro-Transformer

Can be used for all neutrodyne circuits, also for all tuned radio frequency circuits. Made for usual broadcast waves. Secondary has one center tap. Two genuine bakelite tubes. Two nickel mounting brackets.

G6909 Neutro-transformer $1.65

Sponge-Rubber Cushions

Get rid of tube noises due to vibration. Softest sponge rubber made. Also used under cabinets to absorb shock and vibration. Size 2½"x3", ⅜" thick.

G8989 Sponge-rubber cushions, each ..... $.12

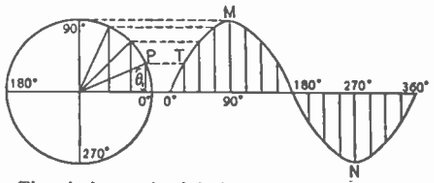
RADIO SPECIALTY CO., 985 Park Place, New York City

Factories Brooklyn, N. Y. Elkridge, Md.

(459)—Roland Fuhrer, Baltimore, Md., asks:

Q. 1.—What is the meaning of the term Vector Diagram?

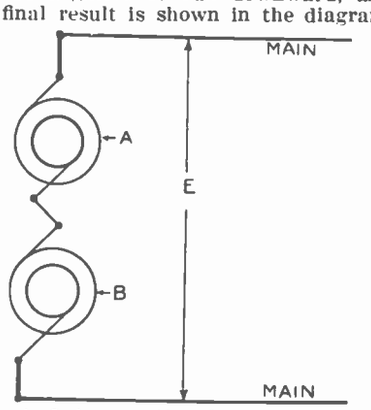
A. 1.—A Vector Diagram is a way of representing the action of an alternating potential or resulting A. C. current in a circuit. Ordinary alternating current follows what is known as a sine curve. If on a straight line we lay out a set of divisions to represent the circumference of a



The circle on the left is the generating circuit of the sine curve going towards the right. The lengths of its radii and their angular positions express the curve. Such radii are radius vectors.

circle, generally given as 360 degrees, and erect on each division a vertical line extending upward for each of the first 180 degrees, and make each line equal to the sine of the angle on whose degree mark it stands, and pass a line through the terminations of these lines (ordinates), we shall have what is known as a sine curve for one-half a cycle.

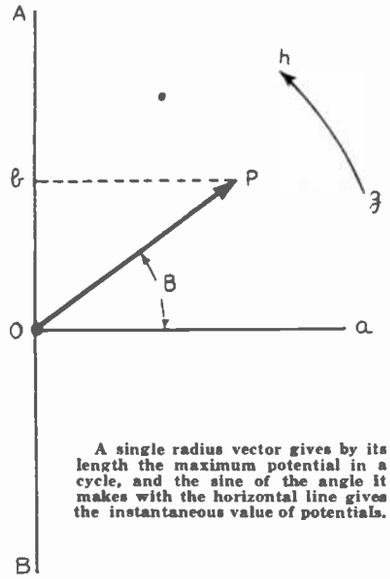
We now must do the same for the other 180 degrees, but this time our ordinates will be negative or run downward, and the final result is shown in the diagram.



Two A. C. dynamos (A and B) may impress exactly similar sine curves on a circuit—one curve lagging behind the other; the brushes are sets in the diagram to produce this result.

What is known as the generating circle is shown on the left of the curve. Each of the vertical lines is equal in length to the sine of the angle on whose designation it is erected.

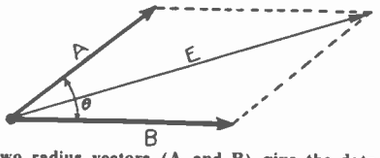
The next illustration shows a vector



A single radius vector gives by its length the maximum potential in a cycle, and the sine of the angle it makes with the horizontal line gives the instantaneous value of potentials.

diagram. The vector (O P) is the radius of a circle and represents in length the maximum value of the potential as the case may be. The sine curve of the electromotive force or potential or of the corresponding current of any part of the cycle corresponding to the angle (B) is proportional to the sine (Ob). This is the simplest vector diagram.

Suppose now that two generators of alternating potential or alternating current are operating on the line simultaneously, one behind the other in phase. Two sine waves will be produced, one of which is said to lag behind the other; the vector diagram next given shows how these two waves are represented by vectors. (B) is the vector representing the maximum potential produced by the A. C. generator (B), and (A) the same as produced by the A. C. generator (A). The angle (θ) is the phase difference or lag, and to get the resultant of the two quantities they are resolved by the parallelogram of forces into the resultant vector (E). It will be seen that all sorts of complicated cases may arise to be treated by vector diagrams. These give the elementary notions.



Two radius vectors (A and B) give the data of two potentials, one lagging behind the other (out of place); the combined effect is shown by the resultant (E) of the parallelogram. This sort of summation is called vector addition.

When Sound was Annihilated

By Robert Joergensen

(*Continued from page 558*)

horting and driving them on. He spoke and shouted with great wild gestures. He governed the wills of men with his overpowering spirit; he hypnotized them and drew them along with himself. The road which he pointed out was the right one which they must follow, with the power of a great avalanche, as it thunders down the steep mountain-side, overwhelming everything in its path.

Cries of assent sounded louder and louder all around him; the excitement grew; he saw that now he had them in his hand. Now was the time to do his work. He shook his fist towards the castle.

"Comrades, within those walls are our oppressors, our blood-suckers, our murderers. There dwell those who are the cause of our misery; there they live and live well year after year, while the people slave for them. But today we cast off the chains of our oppressors; today there will not remain one stone upon another of that house which we are going to level to the ground, and our enemies shall go down with it. On, comrades, on to freedom!" From the thousands the cries rose like deafening thunder; the clamor increased in strength, it rose and re-echoed over and over again, back from the walls, and swinging their weapons the rioters started into motion and drove forward with that instinctive madness, which melted them all into one being. . . . Now the decisive moment had come.

A Strange and Overpowering Sound

But now through the air was heard a frightfully strong hum as of a hundred great steam whistles. It overcame all the cries of the mob, all noises. It went through bone and marrow and penetrated every corner and hiding place. Even the air became charged with it. And now it rose in pitch. It suddenly mounted from

a deep bass to high notes which whined like a siren, piercing the ears, and overcoming the senses, then went up to a treble, more and more penetrating, until it took away the hearing. Suddenly it was over; all was still; there was a sigh of relief. The great crowd that stood as if overcome by the wonderful inexplicable noise, turned again to their leader for him to give a new command to inflame the mob still further. He still stood by the statue gesticulating, tearing his hair, pointing to the castle, but—not a sound was heard! The men looked in astonishment at each other. Why doesn't he speak? They spoke to each other, but could get no audible answer. Each one was isolated from his neighbor and could not communicate with him except by touch or gesture. The mass of humanity who a moment ago were like a single being in their strength, were all isolated from each other, and their strength disappeared. No one can express his lust of blood, no one can draw the other along with him, when he cannot speak. Their power as a unit was gone.

The Silence

Overcome with amazement, the men looked on one another, shook their heads and got a corresponding shake of the head for answer. They looked up to the castle, and saw—what? That formerly deserted and apparently unguarded place, had now altogether another aspect.

The Mob Is Dispersed

Soldiers streamed out of every gate; they formed in ranks and put their bayonets on their rifles. And at a sign from the officer they moved slowly and noiselessly on against the mob. After them comes a body of cavalry; they too without noise, the beat of the horses' feet against the stones were inaudible, the tinkling of the spurs and the rattling of the sabers now drawn out of their sheathes could not be heard. Slower and slower, worming their way along as it were, the troops approach the mass. It was as if death itself approached them. How long shall they wait upon it? Uncertain, they looked upon each other; one single shout, one single word, and they would instinctively have overwhelmed the soldiers; but not a sound was heard; no voice called them to action.

Slowly they began to work their way back over the square; they were driven into the streets that led into it, and soon after the square was empty, and so. . .

The troops with their bayonets now wheeled to one side and the cavalry patrols filled the square in rapid motion. All doubt was over; every one of the rioters ran away as quick as his legs could carry him; a few minutes after the boulevards were empty, the people had disappeared and again quiet reigned in the city.

Colonel Becker had followed the drama on the market place with anxiety and tension. He had heard the strange noise; like all the others he was overcome by a wonderful feeling, as the noise suddenly ceased; but he had also instantly understood that now was the critical moment. He had hastily sent down his orders in writing to the troops.

Now all was over, the square was empty, the crisis was past, quiet again prevailed, but still there was no noise. The humming which had been heard as the noise was disappearing seemed to begin now and again from the upper air, and Colonel Becker ran his glance over the roofs, to see if he could discover the source of the discord.

Zerno's Apparatus

He saw it. On a roof was established the great apparatus which had produced such a startling effect on the infuriated

crowd. A generator operated a bank of enormous audion bulbs, which were connected in turn to a reflector—full of high pitched telephones, especially constructed to correspond to the ultra-audible frequency. Here the sometimes almost unendurable sounds of the little radio bulb were multiplied thousands of times by the great bank used by the inventor and an inconceivable volume of sound produced electrically, for no mechanism could do it, was poured out over the astonished crowd.

The power of the ultra-audible air waves was so great that the auditory nerves of those in the vicinity of the generator were deadened to sound waves of lower frequencies and conversations could not be carried on.

The same noise as before was heard, but now it began like a sharp whistle and ran down the scale until it sounded like gigantic low pitched steam whistles and ended in a low humming. The Colonel did his best to locate the source of the sound and suddenly made a discovery. "There he is, Ilja Zerno, on the roof over there," he cried out, "Hurry and catch him; do not let him escape!" The officers seemed startled as they heard a human voice but ran off at once to obey the command. There upon the roof they found a man lying overcome by the side of a machine, whose like they never had seen before. He was carried up into the Castle and laid upon a bed; everything was done to bring him back to life again, but the physicians who were called in had to work long before they could restore him.

The Reward

When Ilja Zerno finally opened his eyes after his long swoon, Colonel Becker stood bending over him with a friendly look in his eyes, naturally so severe. "The Prince sends you his greetings and this Order," said he, and pinned the great cross of the Order of the Sun upon his chest, "and when you get back your strength he wants to see you to personally thank you for the service you have done your country today."

Ilja Zerno tried to speak but could say nothing; he only sighed—so deeply as if he only now could breathe after all his past struggles and suffering. All grew black again before his eyes and he went off in a second swoon.

Safety Auto Signal

(*Continued from page 567*)

shaft pointing to the left, and indicating that a left turn will be made.

However, if the lamp (C) is lighted (and automatically (B) also by virtue of the wiring employed), the (A) lamp remains dark, and the visible signal shows an arrow head and shaft directed toward the right and indicating a right turn.

A pilot dash light may or may not be carried to indicate the positive action of the device.

The signal housing may be easily constructed of sheet metal, without skill, and may be varied to suit individual requirements.

If the device is mounted near or on the lower side of the "stop" signal now in common use, it will be conspicuous to following cars, the drivers of which are more or less alert to indications of the "stop" light on cars ahead.

It is recommended that the cover of the housing, to the rear, be constructed either of ground glass, or of glass stained red.

Contributed by JACK BRONT.

Dry Cells from Wet Batteries

By C. A. OLDROYD

(*Continued from page 579*)

even distribution and thickness of the latter layer.

After again thoroughly drying the inside rim of the jar, pour on a layer of melted sealing compound three-eighth inch thick, so that it will be nearly flush with the rim of the jar.

When set, this solution will hold the vent tube firmly, so that the wood strip can be taken away. After pouring out the water and refilling the glass container with salammoniac solution and assembling the small vent tube, the battery is ready for use; a wet battery with all the advantages of a dry cell!

The Most Amazing Stuff on Earth

By ESTEN MOEN

(*Continued from page 582*)

Tesla primary consists of five turns of heavy copper wire, two inches in diameter. The Tesla secondary is one inch in diameter and four inches long wound compactly and evenly with gauge No. 24 enameled wire. However, the Tesla primary for the receiver must be smaller in diameter, than that on the sender. (In wireless lingo, the receiver coils must be "closely coupled.")

Here is an easy way to make tubes one inch in diameter and four inches long:

First get a cardboard tube or piece of broomhandle (or a test tube obtained from the chemistry teacher at school). Then cut a strip of newspaper four inches wide and about two feet long. Wrap the paper evenly and gently around the broomhandle (or test tube), and gently slide it half way off. Then dip the free end of the paper roll into a cup of molten wax; allow wax to soak into the paper, then withdraw and allow to cool. When hard, immerse the other end of the tube in the wax; likewise withdraw and cool. A few more dips and you have a cheap, quickly made, strong and insulated tube. Don't be afraid of using wax. It's cheap and the best thing.

The incandescent lamp used in the experiments was a three-volt flashlight bulb.

Electric Alarm Clock

By GEORGE A. ZWALD

(*Continued from page 586*)

Take 12 brass-headed upholstery tacks and solder about 2 feet No. 25 B. S. gauge magnet wire on the under side of each tack. Beneath each numeral, one inch away, drive each tack into the face of the clock far enough to allow the hour hand to touch without stopping the clock. Embed each wire in the face of the clock and drill a small hole in the outer edge; run the wires around the side so they will not be seen. A connection block as shown will fit over the top of the clock and the wires are fastened to the same.

The regulating switch can be placed anywhere desired, also the bell and batteries. The connection block is made from a suitable piece of fibre, with 12 holes drilled along each side, making 24 holes about one-half inch apart. A thin piece of brass or copper one-half inch center to center will do between the screw holes. The under side of each hole is countersunk and six-thirty-seconds machine screws are used. A ground wire runs from the battery to the frame of the clock.

The Diabolic Ray
By HUGO GERNSBACK
(*Continued from Page 555*)

The writer then came to the conclusion that the effect of the X-rays, powerful as they are, is not adapted to be used to carry a current at high tension. The writer does not wish to say that someone else might not do it with a different arrangement and perhaps some different form of electric current than the one at his disposal. Also perhaps the voltage of the circuit used in these experiments was not sufficiently high. Perhaps a voltage of 100,000, 200,000 or 300,000 may be necessary. It is not very probable however.

As a last resort the writer took to the only other ionizing arrangement of which scientists know and that is ultra-violet rays. Here we have also a ray that ionizes air quite powerfully, although not as strongly as X-rays.

The ultra-violet ray machine was rigged up by using an electric arc composed of two iron electrodes. This as known gives powerful ultra-violet rays. This also is shown in Fig. 8, the letter (U) pointing to the ultra-violet arc. The arc was put in operation and a strong beam of ultra-violet rays were sent out. Again two screens were used through which the rays passed, ionizing the air between the screens. In the circuit was included the galvanometer, shown in Fig. 5, and also under the letter (G) in Fig. 8. A direct current at high tension with actuating potential of about 1,000 volts obtained from radio "B" batteries was included in the circuit. This is also included in the Fig. 8, letter (B). The sensitive galvanometer however failed to give any response whatsoever, and no current could be made to flow between the two screens, no matter how close together. In other words, all of the experiments came to naught.

Summing up we have seen therefore that the heat beams as well as X-rays and ultra-violet rays are all insufficient to conduct an electric current produced by high tension. Therefore as far as the writer is concerned he does not accept Mr. Grindell-Matthews' diabolic ray.

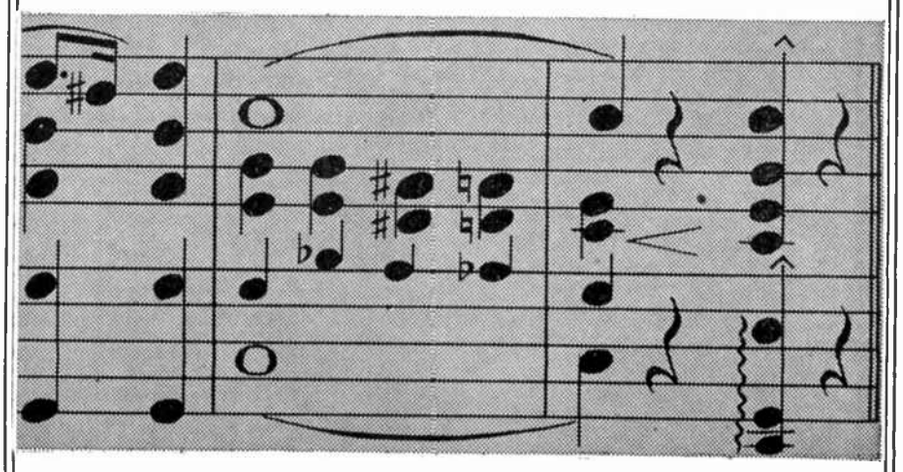
If Grindell-Mathews achieves the results which he claims, he probably uses an entirely different means than the ones described in this article.

Transporting Generator to Canadian Rockies

IN filming a motion picture on the edge of Lake Louise, Canada, an interesting and somewhat unusual feat was performed recently to supply the electrical energy necessary for the production of the picture. Central station power was not available, and the Louis B. Mayer studios, under whose direction the picture was made, procured a compact, portable motor-generator equipment and transported it by rail and sled to the location in the far North.

A 50-kilowatt, 125-volt, direct-current Westinghouse generator was direct connected to a 6-cylinder, 160-horsepower Mercedes aeroplane motor, and the equipment mounted on a frame for transportation. It was first shipped as near as possible by rail and then hauled on a heavy sled to its destination by teams of horses. The deep snow and severe cold made the work difficult, but the task was accomplished and the generating outfit was finally installed and put into operation. Although it was not even housed in a shed the equipment functioned satisfactorily throughout the filming of the picture.

The picture was a Reginald Barker production, "The Eternal Struggle."



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Individual Electric Plants in Britain

INDIVIDUAL electric plants are not very widely used on farms in Great Britain, but are found to a considerable extent on large country estates and are becoming increasingly popular for use in small country bungalows. As a rule they could be arranged to furnish power for pumping or for other industrial purposes, but in practice are rarely so used. They are probably most popular in Scotland, the American Consul at Glasgow estimating that there are from 6,000 to 7,000 in the whole of Scotland.

They are reported to be extensively used also in the Birmingham district, and in goodly numbers in the Leeds, Sheffield and Bradford districts—which would indicate that their use is more general in the Midlands than in any other parts of England. It is reported that in the Plymouth district they are quite common on large country estates and farms, from 4,000 to 5,000 having been sold in the County of Devon. They are not generally used in Ireland, and the few that are in operation are employed for large country homes and hotels.

Estimates from London agencies and dealers indicate that the use of individual lighting plants is steadily increasing. It has been found impossible to obtain exact figures as to the number of such plants in use. One American firm distributing these plants in this country estimates that they have about 2,000 of their own make in Great Britain and Ireland.

Muscle Shoals

THE War Department of the United States has just placed with the General Electric Company an order for four 32,500-kv-a vertical waterwheel generators, each with direct-connected exciter, for the Wilson Dam hydroelectric project at Muscle Shoals. There is other apparatus bringing it up to 25,000 kilowatt units.

The 25,000 kilowatt units will comprise a part of the proposed installation of eighteen units which will have a total ultimate generating capacity of approximately 444,000 kilowatts.

The Muscle Shoals area is described as a fifty-mile stretch in the Tennessee River between Florence and Sheffield, in Alabama, and Brown's Island, near Decatur, also in Alabama. This part of the river is not now navigable during months of low water, or approximately one-half of each year.

The Muscle Shoals development, which was originally started for the purpose of improving navigation conditions, rapidly became of supreme interest because of the hydroelectric possibilities.

When our entrance in the World War became imminent an appropriation of $20,000,000 was made in the National Defense Act of 1917 for the purpose of taking necessary steps in the development of a plant for the fixation of atmospheric nitrogen. Because of the length of time required to utilize the water power a steam plant was constructed to supply current for operating nitrogen fixation plant No. 2 at Sheffield, Ala.

All the Muscle Shoals plants, with the Tennessee River unregulated, will supply approximately 7,000,000 kilowatt hours of primary power (available every hour of the year) per annum, and 1,490,000 kilowatt hours of secondary power per annum.

The only hydroelectric project which approaches the capacity of Muscle Shoals is as yet hardly past the visionary stage. At Priest Rapids, on the Columbia River, in the state of Washington, a project has been outlined with an estimated capacity of 525,000 kilowatts. The largest power plant at Niagara will have an ultimate capacity of 385,000 kilowatts.

Lead Storage Cells

ALTHOUGH the substance of the following introductory note may be common knowledge to the student of electricity, we beg leave to say something on the elements of the subject first of all, in order that the general reader may the more readily appreciate and understand the account of our experiences with the old battery about to be described.

The ingredients, comprising an active lead storage cell, are metallic lead, one of its oxides, sulphuric acid, water and a containing vessel of insulating material. There are three oxides of lead, all of which enter into the process of construction of a lead storage battery. They are lead monoxide, chemically called lead protoxide, because lead is one of the metals that forms several oxides. Its formula is PbO, in which Pb stands for the lead, and O for the oxygen, and it is therefore a combination of one atom of lead and one of oxygen. It is commercially called "litharge," and is a yellowish-white powder. Then we have lead dioxide PbO_2, or one atom of lead to two of oxygen. It is chemically known as lead peroxide, and it is quite unstable in the second atom of oxygen, and is easily convertible to one of the other oxides. It is the lead oxide which forms the principal part of the active material of the external positive plate of a lead storage cell, and its color is a fairly dark chocolate-brown. Finally, there is the best-known oxide, which is a chemical combination of the above two. It is made up of two parts of litharge and one of the peroxide, and is expressed $2PbO + PbO_2$, and therefore its proper formula is Pb_3O_4, or three atoms of lead to four of oxygen when in combination. It is called "minium," or more generally "red lead," and as its popular name implies, is of a bright red color, almost vermilion. (It is not vermilion, however, as this color is a salt of mercury.)

The Active Lead Sulphate

The most active constituent in a lead storage cell, as well as the greatest hindrance if allowed to get the upper hand, is lead sulphate. Chemists write it $PbSO_4$, which means one atom of lead, one of sulphur and four of oxygen. It is formed superficially, both outside and in (which requires describing), upon both plates by the decomposition of the sulphuric acid of the cell when it is discharging. The acid is written H_2SO_4, which means two of hydrogen, one of sulphur and four of oxygen, and during the decomposition the hydrogen is set free, and the SO_4 combines with the lead of the plates to form the lead sulphate mentioned above.

Some Points on How a Lead Cell Works

We will start by assuming that we have the two *charged* plates, one, the external positive, made up of a lead grid filled with cellular peroxide of lead of a dark chocolate color, and the other, the external negative, also a lead grid filled with cellular lead. This combination, if in a solution of pure sulphuric acid and pure water, of specific gravity about 1.2, not touching each other, and in a charged condition, should have an open circuit voltage of 2.2 to 2.3, and a closed circuit voltage of about 2.0 to 2.1.

Two statements here require elaborating—one, we speak of the external positive. The external positive of an electrolytic cell is always the internal negative, and vice versa. To complete the circuit, when discharging, the current flows, as with all batteries, from + to — externally, whereas it flows from the so-called — to the + internally. Therefore, internally, in the case of a lead cell, the lead is positive to the peroxide.

(To be continued)

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