EXPERIMENTAL · SCIENCE ·

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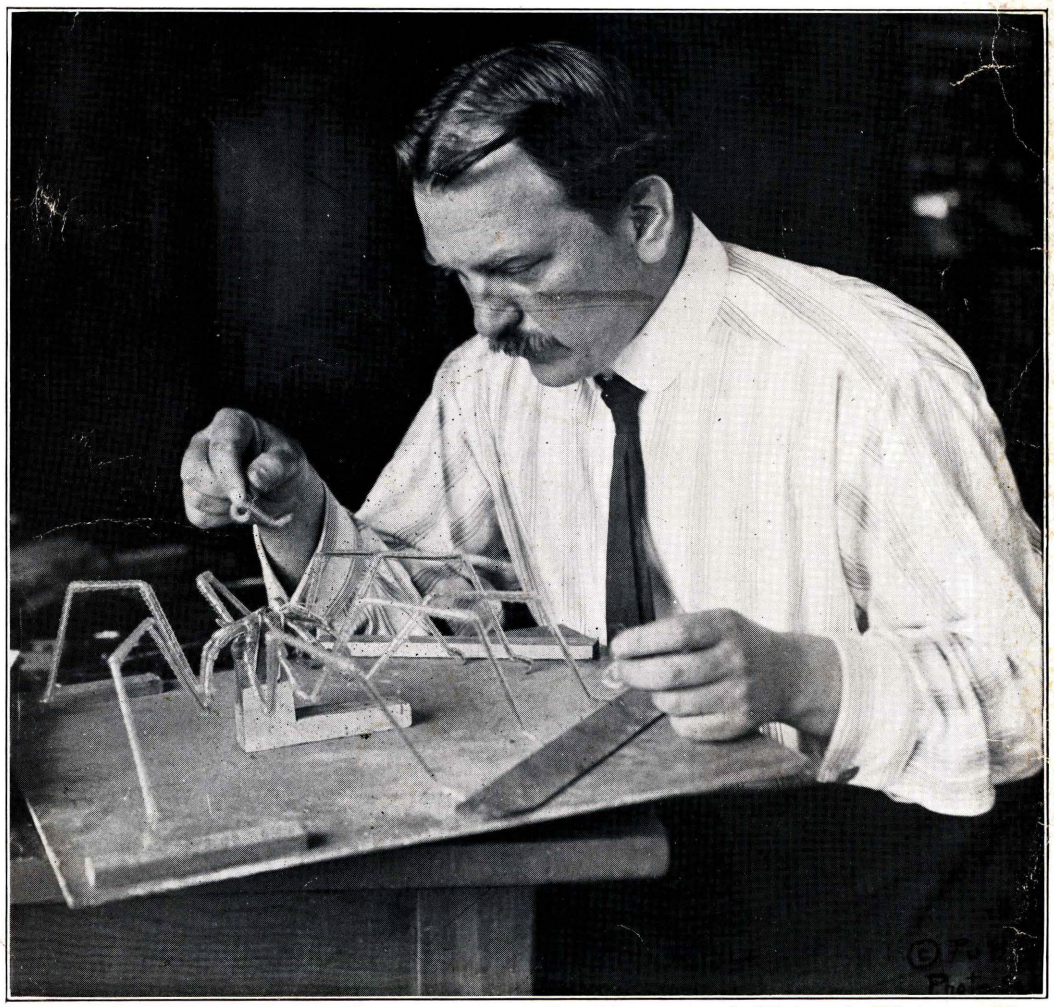
RADIO

JUNE, 1921 15 CENTS

FROM THE HEART OF THE SCIENTIFIC WORLD



Making a glass model of the *Pycnogonid* at the Museum of Natural History, New York. The tropical water spider shown is twenty-five times natural size.

The glass blowers' art is one of individuality. This issue contains the rudimentals of glass working.

EXPERIMENTAL · SCIENCE ·

· CHEMISTRY · · PHYSICS · RADIO

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VOLUME 1 JUNE, 1921 NUMBER 9

MONEL METAL

The craze among machinists is Monel metal rings. We often see this silver like metal upon their oily and greasy hands, as they reach out for their seemingly outrageous fee for putting the family Lizzie in shape. Note how bright the metal seems, never tarnishing like silver, and itself almost as cheap as dirt.

Monel metal is an alloy of 67% nickel, 28% copper and about 5% iron, manganese, or silicon, but no zinc or aluminum.

Monel metal is non-corrodible, strong as steel, and tough and ductile. It is an individual alloy, having many uses, and supplanting many metals heretofore used in commercial and manufacturing circles. It has been used as electrodes for spark plugs for many years, standing up nobly under the strain and heat to which it is subjected. Most of the carburetors of today have their needle valves of Monel metal. Fountain pens have parts made of Monel metal to prolong their life against corrosive ink. Fishing tackle is made of Monel metal to protect it from salt water. Propellors for battleships, turbine wheels for hydroelectric plants, pumps for handling caustic or acid materials, dyeing vats, artificial limbs, incinerator and sewage handling machinery, all can be made more serviceable if constructed with the wonder metal, Monel.

Nature took a hand in providing us with this most useful Monel metal. When the Canadian Pacific Railroad, in 1884, was under process of construction, a copper deposit was discovered during the excavating. During the course of working the metal it was found that it was not pure copper, but one containing both copper and nickel. Various devices made of the copper-nickel alloy, were, in 1905, found to be vastly superior to certain types of noble metals and high-strength steels.

Upon further investigation, it was found that if the natural copper-nickel alloy was not refined, and when this operation of removing the nickel was not carried out, the superior metal, Monel resulted.

Thus it can be seen that nature gave us a wonderfully useful metal, even mixing the metals to the correct proportion in her underground laboratory to await the time that man would shape it into his needs.

Raymond B. Wailes.

EXPERIMENTAL SCIENCE MAGAZINE is for sale on the 15th of each month at most news stands. Published by EXPERIMENTAL SCIENCE PUBLISHING COMPANY, INC., 1311 G Street, Washington, D. C. Subscription price, $1.50 a year. Foreign, $2.00. Single copies 15 cents. Entered as second-class matter April 25, 1920, at the postoffice at Washington, D. C., under the act of March 3, 1879.

Contents for June

What kind of articles are YOU interested in? Let us know, old man.

A MONTHLY MAGAZINE DEVOTED TO RADIO, CHEMISTRY, PHYSICS AND GENERAL SCIENCE.

EXPERIMENTAL · SCIENCE ·

· CHEMISTRY · · PHYSICS · RADIO

FOR THE LAYMAN AS WELL AS THE SCIENTIST OF TO-MORROW—THE EXPERIMENTER OF TO-DAY.

From The Heart Of The Scientific World

VOLUME 1 JUNE, 1921 NUMBER 9

THIS RADIO

By P. F. GEAGAN

This radio, this wireless stunt, how did it start, who bore the brunt, of sleepless nights, of wearied days, devising schemes and sundry ways, to pluck from out the atmosphere, etheric waves lain hidden there. Who spent the money and the time, who first doped out the proper line, of using coil and spark and code, to send our thoughts a hiking far, o'er land and sea in this new mode. Who, think you, was the nervy guy, who told the world the reason why, the ships at sea, no more need be, alone, cut off from shore since he, now had the proper dope. Before that time there had been men, who noticed something happened when, a spark was made, but there they stopped, they did not see how to apply, this sparkling stunt, nor reason why, and so the matter dropped. A young Italian won the fame, Marconi was the dreamer's name, with vision wide he looked ahead, he saw what others missed and said, "We'll use the spark and waves it makes, to telegraph. It will not take, great wealth I'm sure to find a way, to use them and to make it pay." At first 'twas tough you may be sure, his lire were few, his junk was poor, encouragement he did not get, in copious gobs, nor even yet, results to bring him cheer. He stuck along, this fighting wop, he said, "I'll get you yet, old top," and then at last the thing was done, by sticking to it he had won, some signals he was getting through, which demonstrates the good in glue. He then moved in The Hall of Fame, and started out to make the game, successful from the point of view, of those who needed it and knew, the value of the same. The progress made at first was slow, a million things they didn't know, we have with us today. That 1900 stuff they had, was sure superlatively bad, a bucking broncho or a mule, or any union labor fool, has nothing on those one horse shays. Marconi, the first one up to bat, had made a hit, and showed them that, the game was there to play. And so the others straggled in, to add their voices to the din, of patent claims to try and win, some of the kale and pay. Advancing then with rapid strides, the game became the hectic bride of those with dollars in their jeans, those with the dough that makes things go, but little in their beans. New companies, a score or more, sprang up, and then there sprang some more, each one was absolutely sure, they had the stuff required to cure, all wireless pains and ills. The patent office was a fright, they struggled hard both day and night, to try and glean from out the mass, of patent claims of this new class, some dope on what was right. Lawsuits and infringement suits, went into court, there to dispute, the money of the mob away, the mob who always has to pay. At last the truth began to leak, stockholders started out to seek, a way they could unload. This did the game a world of good, it showed the companies where they stood, it told them they must hit the ball, or failing they would hit the wall. Improvements started to arrive, from those of them who still survived, the old time junk, and all the punk soon disappeared not to revive. Marconi's dream was realized; we had the thing he visualized, when he started on its way, the radio game we have today. Improvements still come thick and fast, we wonder how they worked in past, no amplifiers, no undamped waves, no ground reception, what crude jays. We smile whene'er we see the cuts, in literature of what those mutts, of early days used for results. And so we work along each day, and wonder what tomorrow may, bring forth in way of beaucoup stunts, and who can say, it doesn't pay, to follow up a hunch. Marconi followed his a mile, the wise ones smiled the while he toiled, they pitied him a pile. But when he showed this small town bunch, the value of a hectic hunch, they flocked around and clawed the air, and tore their hair in their despair. Too late, alas, they realized, that this young kid who they'd despised, was bringing home the lunch. The moral is, this radio biz, is still yet infantile, so glance around, until you've found, an idea worth while. Then stay with it through thick and thin, remember you must stick to win, there's much to do, there's far to go, in this young game, this radio.

TALKING MOTION PICTURES
USING AUDIO-FREQUENCY CURRENTS

Audio frequency currents have just come into their own sphere. We have heard much of their wonderful possibilities, and seen the results of many experiments in ship controlling and guiding, radio telephony, etc.

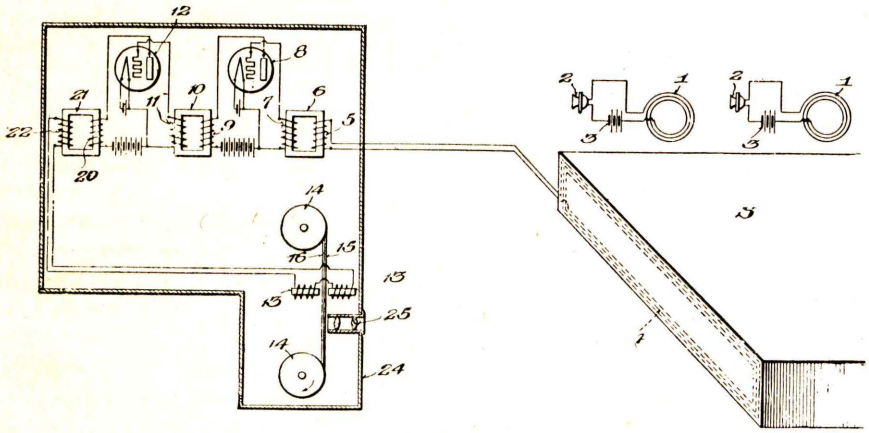


Fig. 1. The transmitting end of the Audio-Frequency Talking Motion Pictures. The stage, or studio, is at S.

A late use of audio frequency currents is in talking motion pictures. The system is simple, and gives absolute synchronism between the film and the amplifying device used to reproduce the voice.

In our illustration, figure 1, the stage or the motion picture studio is shown at S. Beneath or running along the sides of this stage is a loop of wire 4, connected to the amplifying transformer 5, and the audion system, the output being transmitted to the magnets 13, 13.

The actors appear as inhabitants of a strange race when they place the loops of wire 1, over their shoulders, and adjust the telephone receivers 2, upon their brackets so that they are in proximity to the mouth. The loops of wire are composed of ten turns each, and the battery is an ordinary flashlight cell.

The process is simple. When the actor speaks, the current through the coils 1-1, is modified by the transmitter, and an induced current is set up in the coil 4, beneath the stage. The current thus set up is magnified by the audion apparatus, and is finally led into the magnets 13, 13.

Spool 14 contains the sensitive film, and also an iron wire which has the same length as the film, and unwinds in perfect cadence with the film. The light from the actors is transmitted through the lens of the camera, 25.

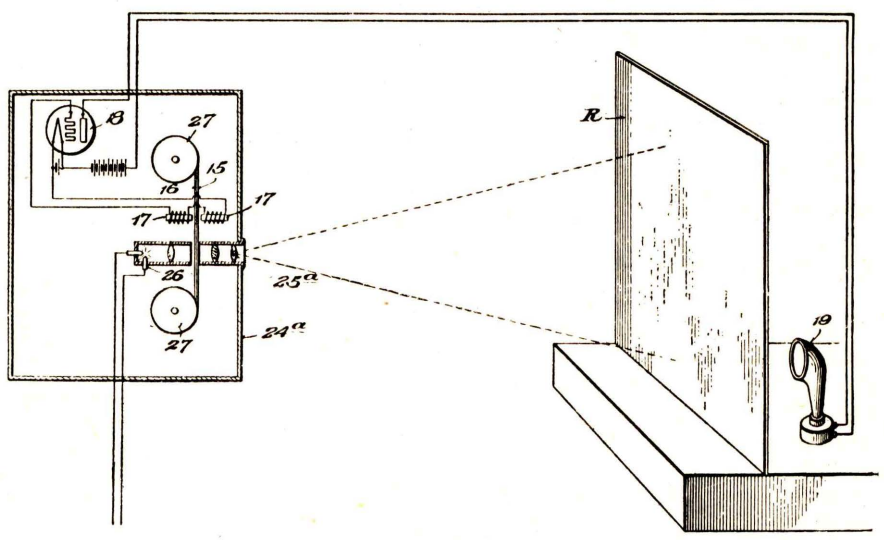


Fig. 2. The reproducing system. It is by this apparatus that the audience listens to the speech of their favorite player canned on the steel wire in Mr. Hanson's system.

As the film passes by the lenses, the exposure is made, and ordinary motion picture film results. The iron wire passing through the space between the magnets at exactly the same rate as the film becomes permanently magnetized, strongly or weakly, according to the strength of the current produced by the variation of the inflection of the actor's speech. *The speaker's voice is recorded magnetically, upon a steel wire.*

The reproducing system is a reversal of the recording process. It is shown diagramatically in figure 2.

The film and the steel wire impregnated with the actor's voice is unwound and the film image thrown upon the screen R. The steel wire unwinds in perfect synchronism with the film, and passes through magnets 17, 17. Being magnetized, the wire creates a current in the magnets, which is amplified by the audion 18, into many times its original strength, and finally passes through the loud speaker, or horn, 19, placed at the rear of the screen R.

One feature about this audio-frequency is certainly commendable. As the actors withdraw off the stage, the voice at the reproducing end gradually dies out, or recedes with the actor.

Extraneous stage noises have absolutely no effect upon the reproducer, as these extra noises do not affect the diaphragm of the transmitter worn by the actors. Another feature with this system is, that as the actor turns his back upon the audience, his voice reproduced at the picture theatre acquiesces accordingly.

Of course, the curses and hisses of the villain are reproduced very plainly—much to the satisfaction of the audience.

An Audio-Frequency Wireless Telephone

By EDWARD T. JONES

Those of you who were interested in Mr. Hanson's system of audio-frequency, telegraphy and telephony described in a late issue of Radio News are in line for a great treat.

Since that time Mr. Hanson has devised a method by which it is possible to increase the distances possible with audio-telegraphy.

By having reference to the diagram it will be clear to the reader that the current is amplified and then impressed upon the antenna.

A transmitter in series with a small battery supply is connected to the primary of a telephone transformer. The secondary goes to the input of a vacuum tube and thence to the primary of the tuning transformer which is fitted with a variable iron core. The secondary of this transformer connects in the aerial-ground circuit. Amateurs who are complaining about the expensive apparatus required to install an ordinary radio frequency transmitting set or modulated radio telephony should give considerable study to this system.

Mr. Hanson is to be congratulated and thanked a thousand times for his valuable contribution to the boys. I do not want to have my readers believe that this system is confined to amateur work, but it can only be used for experimental purposes; therefore the expostulations of glee!

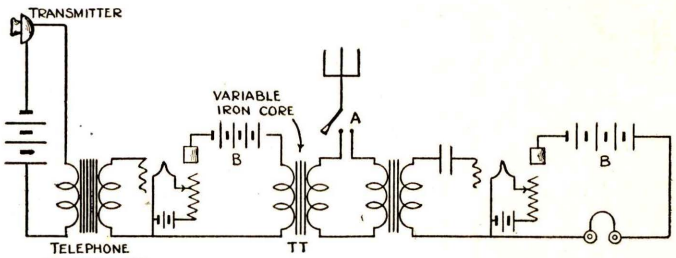
For the receiving equipment an ordinary amplifying transformer should be connected in the antenna ground circuit. The secondary to the input of the audion and phones and B battery in their usual places.

Everyone should join in and begin experimenting with this type of telephone. It is very low in cost, very efficient in operation and does not interfere with commercial land stations equipped with detecting devices for radio frequency currents.

Large power tubes can be put to good use and with a little moderation of the tuning transformer large currents at audio-frequency can be transmitted over considerable distances.

Audio-frequency is an entirely new field and Mr. Earl C. Hanson seems to be alone working ahead on devices employing these currents which will prove of great value in the very near future.

Experimenters should exchange their views through the columns of Experimental Science as we are going to push this audio-frequency apparatus to the limit. Write to us, describing your results in detail. We are willing to help you along—ask us questions—Let's Go—Thank You, Mr. Hanson.



AUDIO FREQUENCY PHONE

Note the simplicity in this Audio-Frequency hook-up.

Try 'er out, Fellers!

CURIOUS MERCURY EXPERIMENT

All liquids have a surface tension, or a tendency to pass into the gaseous state and permeate the air. Mercury at room temperature gives off some mercury vapor.

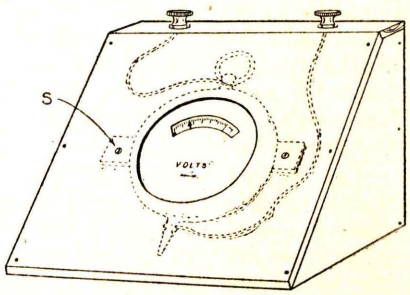
A curious experiment in surface tension can be performed as follows: Take a drop of mercury and cover it with sulphuric acid, one of strong acid to ten of water. Drop a very minute crystal of potassium bichromate in the acid to color it a slight lemon yellow color. Note that the mercury globule is flattened out. Now cautiously touch it on its side with a bright iron wire. The drop will immediately hump up, and form a ball, only to flatten out again and come into contact with the wire (if it is held near enough), and upon coming into contact with it, humps up again, only to fall back again. The process continues for quite a while, and is a very curious action to watch.

Demonstration of Unique Magnetic Field.

Remember the first lesson in electricity you had? It was in magnetism, and pretty magnetic lines of force were made by holding a magnet under a paper containing iron filings.

A very weird magnetic field can be shown by dropping some iron fillings, of rather a coarse texture, in some dilute sulphuric acid in a test tube, and holding a strong magnet on the outside of the tube. The hydrogen bubbles coming from the filings, together with the persistency of the filings to obey and "Fall In" the magnetic field, make it an interesting sight.

TABLE TYPE METER



We all have tried using a pocket type ammeter or voltmeter in a permanent circuit, without soldering, and know what unsatisfactory service it gave us when connected this way. A pocket type ammeter or voltmeter can be converted into a table type instrument very easily.

The instrument can be held in this position by means of a metal strip screwed on the underside. The wires to the terminals should be soldered.

WIRELESS TELEGRAPHY

By E. T. JONES, A. M. I. R. E.

LESSON NUMBER FIVE---MOTOR GENERATORS

We learned from lesson two that by revolving a copper loop between the poles of two powerful electromagnets, so that the loop cut the magnetic lines of force created by the magnets, currents of electricity would be generated in the loop. It is necessary then to provide some form of driving force for turning this loop of copper wire around in the magnetic field. Use is generally made of an electric motor, or some form of steam or gas engine. It is the electric motor with which we are to be presently concerned. There is no essential difference between an electric motor and an electric generator than that the former is a machine for the conversion of electrical energy into mechanical work, while the latter converts mechanical energy into electrical energy. The same structure can be used for either service.

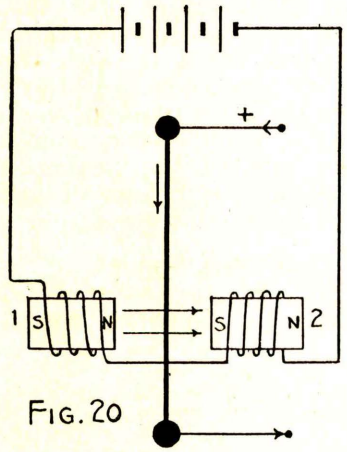


FIG. 20

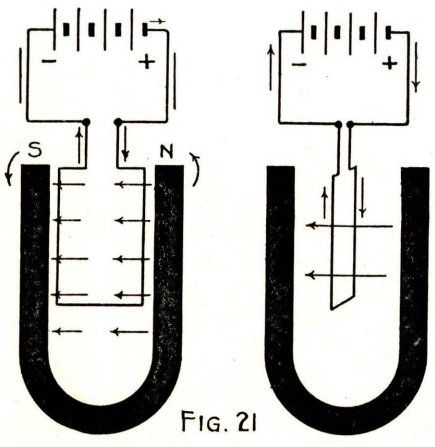


FIG. 21

Fig. 20.—Wire Carrying a Current, in a Magnetic Field Caused by a Current from Battery.

Fig. 21.—Coil in Magnetic Field as Shown Moves Its Left Side Toward the Reader. To Make Coil Rotate Continuously, a Commutator is Required.

The study of the electric motor then requires a general knowledge of the fundamental principles of the generator.

Principle of the Electric Motor.

If a vertical wire 3—4 (See figure 20) is made to pass between the poles of electro magnets in the manner shown and an external source of current—for example, a dry cell battery—sent through it in the direction shown by the arrows; from 3 to 4. The wire 3—4 will be found to move through the mercury, into which its lower end dips. It will move towards the reader, that is, at right angles to the direction of the current flow and at right angles to the magnetic lines, which are also depicted by arrows going from left to right between the two electro magnets. The battery supply creating the magnetic field is shown at 5. This experiment proves that A WIRE CARRYING A CURRENT IN A MAGNETIC FIELD TENDS TO MOVE AT RIGHT ANGLES, BOTH TO THE DIRECTION OF THE FIELD AND TO THE DIRECTION OF THE CURRENT. It is clear from the foregoing that if we were to take an ordinary generator and pass current through its armature windings, maintaining a strong electric field at its field poles, the former would revolve in a direction depending upon the method of connection adopted. From left to right or vice versa, i. e., clockwise or counterclockwise respectively. From the above it is also clear that the motor does not differ in construction at all from the generator or dynamo.

Having further reference to figure 21a, if a current is sent through the coil as shown, i. e., entering at the right hand side of the coil and out of the left side, the wires on the left side of the coil will be urged toward the reader. The coil begins to rotate. After making a half revolution as shown at 21-b if

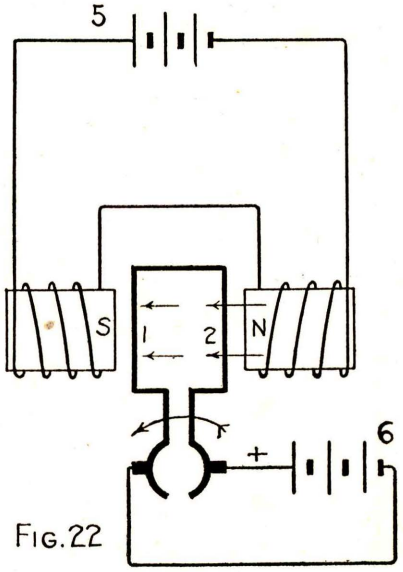


FIG. 22

Showing the Purpose of the Commutator, the Heart of the Motor.

the current is not changed in the loop it would be urged to return to its former position; although no arrangements here are shown for that purpose in the commercial type of motor, a device known as a commutator is employed for this very purpose. A very simple form of commutator is shown in figure 22. It comprises two semicircular strips of copper mounted on the same shaft as the armature windings and connected to the latter. In the drawing it is clear that external current supply 6 is passing through the loop through the right hand side and returning through the left hand side. The magnet poles are arranged as shown, North pole to the right and South pole to the left. In

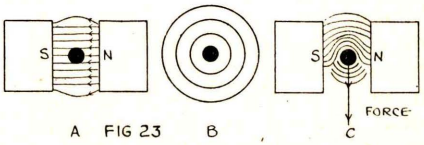


FIG 23

Effect of Magnetic Field on Wire Carrying and not Carrying a Current.

this position the armature or loop will revolve counter-clockwise, i. e., from right to left, as shown by the large arrow. The commutator acts to change the current flow in the loop just at the point when the loop reaches the position shown in figure 21-b. This forces the loop to continue revolving at all times.

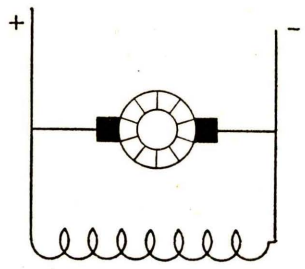


FIG. 24

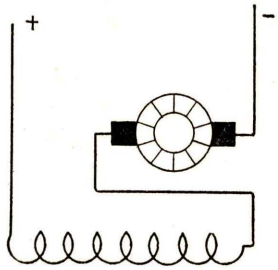


FIG. 25

Fig. 24—Shunt Motor.

Fig. 25—Series Motor.

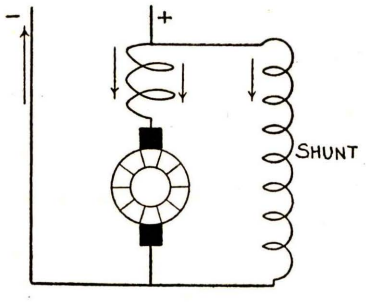


FIG. 26

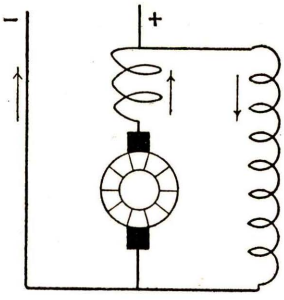


FIG. 26-A

Fig. 26-A—Compound Differential Motor.

A much better understanding of the principle of the electric motor will be obtained from the following description and illustrations. At figure 23-a is shown a copper wire (black dot) placed between two powerful magnets. In this case there is no current flowing through the copper wire. At 23-b is depicted the electric field which is created around a copper wire when current is sent through it. Now then, 23-c clearly describes what takes place when current is sent through the conductor placed in the strong magnetic field. When the current is flowing through the copper wire it sets up a magnetic field of its own and this field distorts the original field in which the conductor lies (see 23-a) making the magnetic lines denser on one side and less dense on the other side. Magnetic lines endeavor to straighten and shorten themselves. This results in a force upon the wire pushing it downwards in the direction of the arrow (23-c). It is also clear that if we were to reverse the current flowing through the copper wire that the arrow would be pointed up rather than down. This would change the direction of rotation.

Classes of Motors.

1. Shunt Motors.
2. Series Motors.
3. Compound Motors.

Shunt Motors.

In the shunt motor we find that *while running* the field connections are shunted across those of the armature windings. See Figure 24. In this type of motor the field strength is constant and the torque* varies directly as the current through the armature.

When an extra load is placed on a shunt motor while running, the motor tends to slow down. The armature windings which are of very low resistance tend to rob the fields of some current because the armature provides the least path of resistance. However, when the motor slows down and the field is weakened the motor endeavors to speed up to increase its Counter-electromotive force* thereby maintaining a constant speed with variable loads. In order to change the direction of rotation of the shunt motor, it is necessary to reverse either the field or armature connections, but not both.

Series Motors.

Since the field and armature coils are in series (see figure 25) the same current passes through both. They are employed where a strong starting torque is required without the necessity of constant speed. A series motor will run in the same direction no matter which direction the current is sent through it; for reversing the armature current reverses the field current and the rotation is unchanged. If a load is put on a series motor the armature slows down and more current flows from the line through it. Since the increased current also flows through the fields they are strengthened and the speed is again reduced, while the torque will increase enough to take care of the increased load. With every change of load we have a different speed.

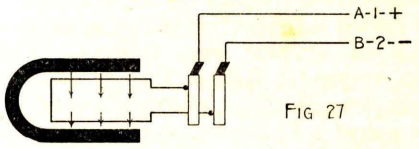


FIG 27

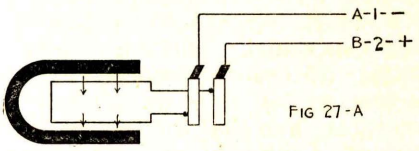


FIG 27-A

Principle of the Alternating Current Generator.

Compound Motors.

In figure 26 we view the connections of a compound wound motor. In this case we have what is termed a differential motor. The current through the series coil S, opposes the magnetizing effect of the shunt current, so that the field is weaker than if the shunt were used alone. The motor field is progressively weakened as the armature current increases, and this naturally results in an increase of speed. The speed of

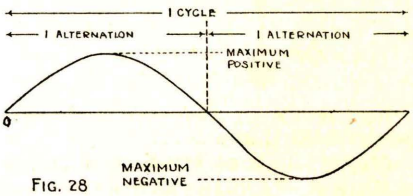


FIG. 28

A Typical "Cycle" of Alternating Current.

*The torque of a motor is defined as the turning movement or twist exerted upon the shaft. By grasping the pulley of a small motor firmly in the hand, and closing the switch, a strong twisting action will be experienced, which will set the armature in rapid rotation when you release it.

*Counter-electro-motive force: Since the wires of the armature are rotating in an electric field as is the case of the generator previously described current is generated in them but in opposite direction to the current which is causing the motor armature to revolve.

our shunt motor would decrease under similar conditions. By accurately designing a series field it is possible to obtain a motor whose speed will vary very little with any and all variations of load. If the current through the field is reversed so that it assists the shunt winding the machine is then called a cumulative compound motor. (See figure 26-a). These motors are coming into wide use aboard ship where constant speed is absolutely necessary.

Alternating Current Generators.

The original current generated in the dynamo is alternating. By alternating currents we mean those which alternatively change or reverse the direction in which they flow, flowing for a certain time in one direction and continuing for an equal length of time in the opposite direction.

A simple alternating current generator is diagramatically shown in figure 27. Here we have an ordinary loop of wire revolving between the poles of a permanent magnet. Magnetic lines of force are streaming across the poles of the magnet from North to South as shown by the arrows. Bear in mind that whenever the copper loop—*no matter what portion of it*—passes under the north pole it generates a certain polarity of current in the loop, let's say, positive. Then, whenever the copper loop passes the South pole of the magnet, currents of negative polarity are generated in it. Since the poles of the magnet are permanent and the loop revolves, and furthermore since the loop has two sides, 1 and 2; it is impossible to maintain a direct flow of current into the outside circuit. The sides of the loop 1 and 2 are alternately connected to the outside circuit mains A. B. In figure 27 we have A connected to side 1 of the loop and is positive in polarity and B connected to side 2 of the loop which gives it a negative polarity. Now then refer to 27-a where the loop has made one-half revolution and note that side 1 of the loop is now near the South pole and side 2 at the north pole. It is very clear then that the current flowing in the outside circuit will be changed. Line A while still connected to side 1 of the loop has changed in sign from positive to negative; and main line B has had its polarity changed even though it is still connected to side 2 of the loop.

From the above we find that in one complete revolution of the loop there are two alternations or one cycle. Refer to figure 28. We find that the current gradually builds up from the zero base line to maximum; positive in polarity, then returning to zero current flow and builds up gradually to maximum in the opposite polarity. Two complete *alternations* equal one *cycle*. The ordinary house lighting alternating current circuit is rated at 60 cycles. The number of cycles per second is called the *frequency*. In the 60 cycle house lighting circuit we have one hundred and twenty alternations per second. The current actually drops to zero one hundred and twenty times per second and there is no current flowing in the circuit during these periods. Owing to the fact that they are of such short duration it is not possible to detect them with the human eye in the case of lamps illuminated by the passage of current through them.

In wireless telegraph transmitters for spark transmission we deal with frequencies ranging from 60 to 500 cycles, the latter predominating.

Questions for Lesson No. 5.

1. What is the essential difference between a motor and a generator?
2. Tell what you know about the generator as explained in this lesson.
3. Why is it necessary to understand the fundamental principles of the generator before studying the electric motor?
4. How many classes of motors are there?
5. Describe the series motor and give connections.
6. Describe the shunt motor and give connections.
7. Describe the Compound motor and give connections.
8. Describe a simple alternating current generator.
9. Define alternations, cycle, frequency.
10. What frequencies are common in spark transmitter use?

CODE INSTRUCTION

There is not very much to be said about telegraphing at this stage of the course. It is only necessary for the Student to continue practicing every day for one or two hours.

Do not try to send faster than you can receive. This results in the forming of characters which are not what they should be. Operators, more advanced, will call your attention to these facts. When receiving endeavor to copy the words apart. Most beginners do not know how to recognize spacing between words. It is absolutely necessary for the beginner to pay strict attention to the sender or sending instrument and space each word he puts down on paper. Running words together increases the length of time allotted to the Student and he generally takes from one quarter to one-half period longer.

Twenty words per minute should be the goal for the beginner. After you have obtained your license and have made arrangements to proceed to sea as a Commercial Operator then a little more speed will come in handy. The radio Inspector does not send more than 20 words per minute when conducting the examination.

Sending from books is a very good method of learning to properly "make" the characters and permits you to correct your own sending.

The best method is to get one of your friends interested in Telegraphy and run a small line to his house. He will lose no time in telling you how "rotten" you send and you will do likewise.

SOME OF OUR READERS

WHAT OUR READERS THINK OF EXPERIMENTAL SCIENCE

" * * Your CLEVER MAGAZINE". W. Lawrence, Paterson, N. J.*

" * * Your magazine, EXPERIMENTAL SCIENCE, must say that you are handing out the right dope, and I like it." A. Senick, Lincoln Place, Penna.*

" * * Liked your first issue fine." H. Hendrick, Paris, Texas.*

" * * Like it great." A. Leverage, N. Y. C.*

Short Course in Glass Working

By RAYMOND B. WAILES

A knowledge of glass blowing and glassworking is very essential to experimenters in the sciences. Many pieces of apparatus can be constructed, and many broken parts can be repaired. A slight knowledge of this art can be used to advantage, in building the various experimental apparatus as described in the issues of Experimental Science.

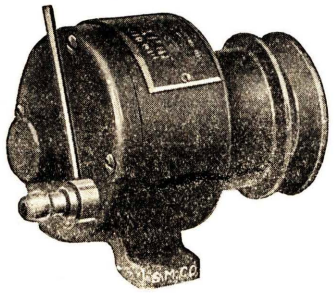


Fig 1
Motor Driven Blower for Air Blast.

The production of the gas and blast for glassblowing will be described in this part of the Short Course. A source of gas is required, although a small amount of work can be done with yellow illuminating flames.

Three types of flames are required for glassworking,—yellow, pointed Bunsen, and wide Bunsen flames. The pointed

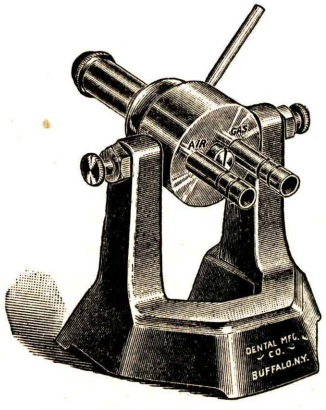


Fig. 2. The Blast Lamp—the Glass Blower's Chief Tool.

flame is used for welding, the wide blue flame for melting and shaping preparatory to blowing, and the yellow flame for annealing glass after the above operations are finished. This latter process is nothing more than covering the parts which have been heated with a film of soot, and allowing to cool slowly.

The rotary blower as shown in figure 1 is an inexpensive apparatus for obtaining a blast of air. It is driven by a motor. It will not compress into a tank. It is used with the blast lamp, figure 2.

The blast lamp can be regulated to give the three types of flames required. Adjustable tips are furnished, so that different sizes of pointed flames can be secured. The blower and the blast lamp should be secured wherever possible, as excellent work can be done with them.

The foot blower, figure 3, can be used to furnish air or blast for the lamp, but why not let the motor do the leg work?

The author has done some very good glassworking with a Micro Burner, as shown in figure 4. This is a small Bunsen burner about three inches high, and

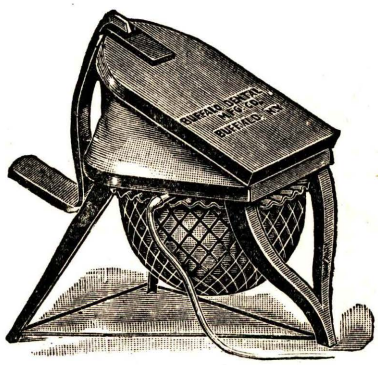


Fig. 3. The Obsolete Foot Blower.

gives a pointed flame about two inches high. Glass T, U, and Y tubes can be made with ease, using this burner. No blast is required, as it has the Bunsen principle. They are often used by dentists, and are suitable for small glass working, such as to be described in the second series of this course.

Fig. 4. A Micro Burner—Every "Lab" Should Have One.

If gas is not available, the makeshift blowpipe, fig. 5, can be used. This is suitable with a Bunsen burner, but if gas is not available, a kerosene or other yellow flamed lamp can be used

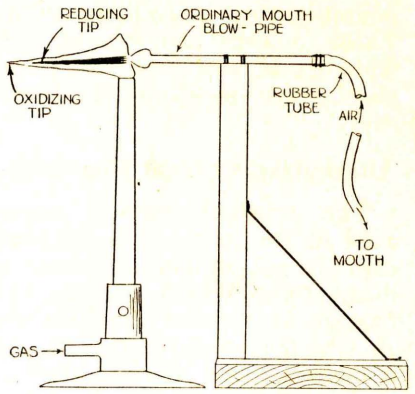


Fig. 5. Home Made Blast Lamp.

instead of the Bunsen burner.

This simple blast lamp consists of an ordinary mouth blowpipe, straightened and supported to the upright which is in turn fastened to a suitable base. A piece of rubber tubing connects to the blowpipe and this tubing is led to the mouth. This support leaves the hands free for turning the work, pulling, etc. The blast lamp can be used with the air pump described in the June, 1920, issue of Experimental Science. The lamp can also be used in charcoal assay of metals, minerals, ores, hand soldering, etc.

The highest temperature which can be produced in the laboratory without the use of a supply of air kept under pressure, or furnished by lung or mechanical power, or otherwise, and using gas as the fuel is with the Meker burner.

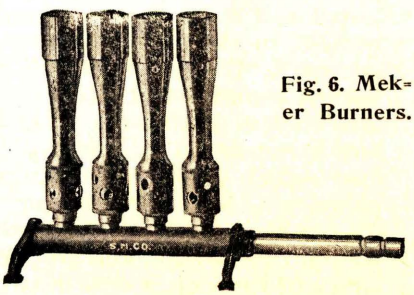


Fig. 6. Meker Burners.

A row of Meker burners is shown in figure 6. These burners operate on the Bunsen principle, air being sucked in at the

(Cont'd on Page 158, 3rd Column)

Sensitive and Easily Constructed Galvanometer

By MARK STEELE

A very sensitive galvanometer can be constructed from the odds and ends about the lab., using a permanent magnet from an old shocking machine as the field.

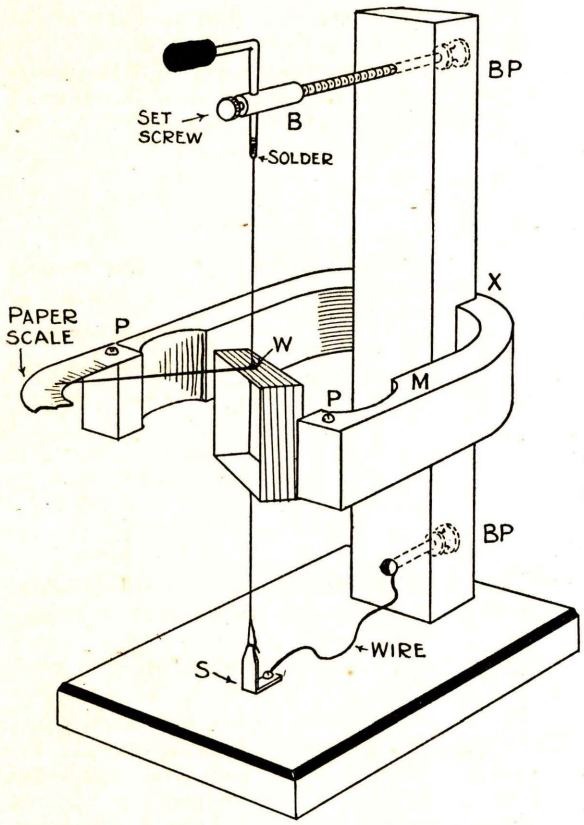
The illustration clearly shows the instrument, and in much detail.

The armature is made of thin, but stiff paper, shellacked, and wound with about fifty or so turns of wire obtained from the secondary of an old spark coil. The pointer should be fastened on the card armature after it has set, and lightly coated with shellac and dried. The wire is then wound on evenly, and brought up to a lever L, which is used to raise or lower the coil, and set the coil at zero on the paper scale which may be fastened on by screws through holes PP.

The lower end of the wire from the moving coil should be soldered to the strip S, and connection made to binding post BP, likewise the top suspension wire.

The magnet needs no drilling of holes, as it is drilled at all places needed. It is fastened to the upright post by means of a metal strip at the back, X.

B is an ordinary binding post on threaded rod, the rod being used as lead to upper binding post BP.



A Sensitive Galvanometer should be in every Experimenter's Hands.

Make this one for use with future articles in Experimental Science.

The moving coil should be built so that it will almost rub the inside of the magnet when it revolves. The wide space shown is for clearness of construction, and should not be followed in respect of distance.

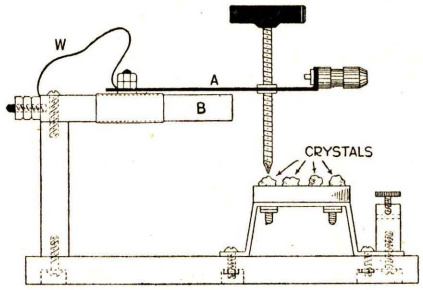
If a milli-ammeter can be borrowed, the galvanometer can be calibrated to read milli-amps, and the usefulness of the instrument will be twofold.

Pointer W should be of aluminum, to make the coil light as possible. It is merely bent on the paper coil. The suspension wire and the wire on the coil is all a continuous length of wire. Solder all connections.

JONES CRYSTAL DETECTOR

A unique and very all around detector having a very critical adjustment can be made from parts about the lab. and shop.

The feature of this detector is the adjustability of the cat whisker. The arm A slides along the bar B, which is of wood. The arm A can also be varied with a sidewise move-



A Good Idea in Crystal Detectors.

ment, and together with the knob, which is adjustable for height or pressure on the desired crystal, a detector of the most exacting requirements of adjustability results. A flexible wire connects A with the binding post on the left. Among the crystals suggested are, two galena, a silicon and an iron pyrite crystal.

TAP WATER BATTERY

Perhaps the most simple wet cell which can be made is from a copper wire previously heated in a blue gas flame, and a silver wire, both held in running tap water. The copper wire in the gas flame becomes coated with a film of copper oxide.

A varied effect can be produced by separating the copper and silver wires by blotting paper and wrapping them with the same material, and then pouring one of the common electrolytes upon the whole.

Sal ammoniac or sulphuric acid can be used.

Theory and Construction of Amateur Phone Set

By ZEH BOUCK

I use the word "Amateur," advisedly. The inability of the majority of experimental fone stations to operate (efficiently) on a two hundred meter wave, has given rise to unfavorable comment in executive circles. The set which I shall describe will give excellent radiation and marked constancy of minor adjustments on waves even under the legal allowance.

The instrument was originally installed at station 2PI, where, in consideration of four watts output, I experienced commendable results. Daylight communication has often been carried on in excess of fifteen miles and 2PI has been reported, heard, in Philadelphia, some ninety miles south of New York. A similar installation, in this city, has recently been effected at 2WN, who consistently works the DeForest experimental station at Ossining, (2XX).

The hook-up shown in figure 1, varies slightly from that employed by the British Government during the War.

The main antenna inductance, designated by L-1 is wound with No. 18, spaced or insulated, to thirty-five turns and is tapped at every fifth convolution. The grid feed back coil, L-2 consists of twenty-five turns of the same wire, wound over the main winding, or alongside of it, and should be tapped every other turn, though simply scraping the wire at these points and using slider will suffice. Four to five inch cardboard or bakelite forms may be used and if desired, L-2 may be wound on separate tubing and merely placed in inductive relation to L-1.

The condensers are fixed and I found their capacities, by experimentation to be .003 mf. and .0005 mf. for C-1 and C-2 respectively, mica dielectric being used for both condensers. However, as the set is in no way critical, a fair approximation of these capacities will be sufficient. The leak resistance, shunted across C-2 will, for W. E. VT2's, be found about eight thousand ohms and for other tubes will be much higher, its mean value lying above fifteen thousand ohms.

The modulation choke, X-1 is wound with No. 28 enameled or cotton covered, and with a core of one square inch cross section area, two thousand turns will be about right. X-2 obstructs the path of radio-frequency currents to the modulating circuit and should be an L150 Honey Comb coil or its equivalent.

The essential meter is the radiation instrument AA, scaled to one ampere, while the plate mi-am-meter, reading to about 200 mils, though not necessary, will assist greatly in obtaining correct adjustments.

The bulbs, one and two, respectively oscillator and modulator, may be almost any tube which will stand the applied plate potential, in my case being Western Electric VT2's.

The high voltage source has not been indicated but may be any available D. C. supply. Using less than eighty volts from dry batteries, a radiation of one-tenth amp has been secured. Low wave antenna current at four hundred volts should be in the neighborhood of six-tenths of an ampere, and in the case of a generator or rectified A. C. the

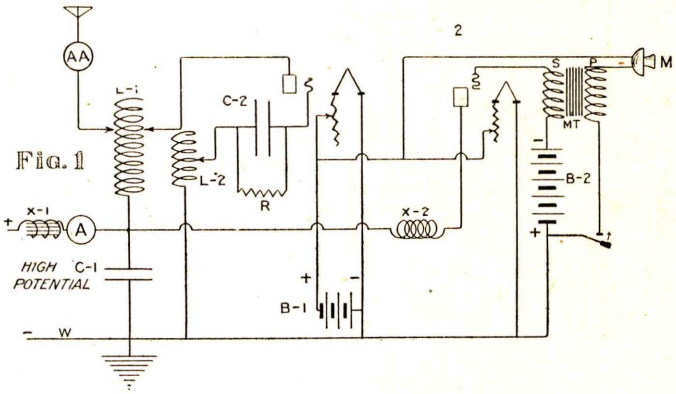


Fig. 1

The Heising System of Modulation. A Good, Efficient Phone Set.

B-1, a six volt filament battery, may, at the option of the maker, be discarded in favor of a step down transformer, (fig. 2), scientifically designed for fifty watts and its secondary tapped in the middle. Twenty-five wire should be used in a hundred and ten volt primary, while the secondary, delivering five amperes at ten volts is safely wound with No. 12, the number of turns being governed by the core and frequency. The center tap joins the negative of the high potential supply (w) and the filaments are in *no other way* connected to the apparatus; this arrangement absolutely eliminating the possibility of an A. C. hum. When using the transformer, the microfone *must be separately excited by direct current.*

The modulating circuit comprises the modulation transformer, MT, the conventional microfone, M, and the C battery B2 which adds to tube safety and clarity of speech.

filter system must, of course, come on the source side of reactance X-1.

In actual operation the preliminary tuning is as follows: The leads, from the grid condenser and antenna, should be placed on about the fifteenth turn of their respective inductances, counting from the bottom

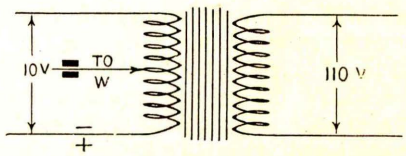


Fig. 2

Tap the Secondary in the Middle.

up. On applying the high potential, after first bringing the filaments to incandescence, the lead from the oscillating plate should be adjusted to that tap on L-1 at which the greatest radiation is secured, and there soldered. If the plate meter reads in excess of sixty mils and at no adjustment is antenna current evi-

(Cont'd on Page 159)

·HEARD·
·BUT NOT SEEN·

·BY·THE·BLACK·CAT·

The hospital smell from Bakelite is carbolic acid. This, together with formaldehyde, both disenfectants, and a catalyzer, or "chemical hastener," makes the condensation product, Bakelite. Can you imagine it * * * two bug killers making a bee-you-ti-ful Bakelite panel?

We have been asked—Who puts the BLACK CAT out at night?

You can deaden the noise from your shop anvil, by mounting it on a barrel filled with sand.

The Tropical Radio Telegraph Company through its President and General Manager, Mr. George S. Davis, has acquired a minority holding in the Radio Corporation of America. Both companies will benefit by the transaction which spells closer cooperation.

The Jahncke Dry Dock and Ship Building Company of New Orleans are in the market for two complete wireless telephone equipments. One for their Tug Bayside and one for their land station which is to be erected near the site of the present plant. Communication over a distance of 100 miles is desired.

Why not a balloon antenna, using a Weather Bureau type of balloon, which is easily purchased from the Goodyear people? Fill it with hydrogen. For hydrogen see a commercial welder in your city.

Did you know that the condensed rays from a magnifying glass are not hot? They evolve heat when they fall upon an opaque object. It is a case of transformation of radiant energy into heat energy.

It's almost time for Mars to begin signalling again. Sounds like the yarns about the death of the Czar, Kaiser and Villa. Guess it will be a regular annual affair. We hope the listeners go deaf so they won't bother us again on this subject.

It was once said that Marconi employed wet macaroni for his tuning helix. Can you believe that one? If so———well.

What has become of the operators who copied long distance with ye good old piece of stone coal or carborundum as it was called by some early radio engineers?

Speaking of the present theories of wave propagation one need but take the following into consideration and give a second thought. No one has been further than eight miles off the earth's surface in a lighter than air machine or any kind of machine equipped with radio. We do know that signals have been picked up half way around the earth—on its surface. This is something like 12,500 miles. By drawing a circle with a diameter of 12,500 miles using 1,000 miles to the inch we will have a circle 12.5 inches in diameter. Then try if you can—to represent an airplane but EIGHT MILES off the earth's surface. This represents the airplane or air machine equipped with radio which furnished us with as much as we know about the waves reaching out and upwards into the unknown regions. Which theory are we going to accept? In the long run we will be forced to accept the ground or conduction theory because it holds true in every respect.

If you radio fans are looking for a real treat on Radio subjects purchase a copy of "Radio Engineering Principles" by Lauer and Brown. Nothing has ever appeared in print so comprehensive and so well handled. It is nothing short of the best to date.

FOR YOU!

EBONY ASBESTOS WOOD is the title of the booklet issued by Mitchell-Rand Mfg. Co., 18 Vesey St., New York City. "A substitute for Bakelite panels, etc."

Mono Corp., 25 W. Broadway, New York, has bulletin on Duplex Mono instrument for analyzing flue gases.

An Oxide Film Lightning Arrester bulletin is issued by General Elec. Co., Schenectady, N. Y.

Remember when you spilled the acid from the cup of the old electrolytic detector, and got your sleeve in the stuff?

GALVANIC BATTERY WHICH PRODUCES ALTERNATING CURRENT

Many of us, if asked what a battery is, would reply "A cell producing a direct current from chemical reaction, two electrodes of which are two dissimilar metals."

A cell which produces an alternating current, and consequently explodes the brilliant definition above, can be made in about five minutes, and the AC which it produces, be shown in less time than that.

Mix strong sulphuric acid with water in proportion of 1:5 (1 acid, and 5 water), by volume. Make a saturated or maximum strength solution of potassium bichromate,and mix the acid and the bichromate solution in equal proportions. This is the electrolyte of the AC cell. It is a strong oxidizer, and has an abundance of oxygen available for chemical reaction.

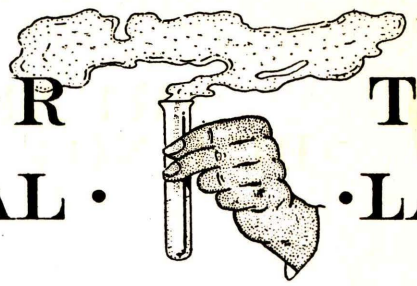
Place two clean iron electrodes in the red electrolyte thus formed, and connect with a galvanometer.

The needle will move slowly at first, then rapidly, to a maximum point. It will hang there for an instant, and then move back to zero, past zero, hang there, up to zero, and then to the maximum point again. This queer action of the needle will continue for hours. The maximum point of deflection is about 0.4 volt, the minimum about 0.4 volt.

If a galvanometer cannot be had, use a *sensitive* ammeter or voltmeter, with a scale from O to maximum. In this case, use *two dissimilar iron electrodes*, such as a nail and an iron slug. This couple will produce a slight positive EMF, which will cause the needle to be *at zero* somewhere up the scale, thus making the minus motion of the needle visible.

Use that blank on page 159!

· FOR THE · · CHEMICAL · · LABORATORY



By Raymond B. Wailes

AMMONIUM AMALGAM

The radical ammonium, NH_4 has never been isolated. Ammonium amalgam, the nearest compound to the free or uncombined ammonium radical, can be made thusly: Warm gently a small piece of sodium with a few drops of mercury, a flash will follow and sodium amalgam is formed. An amalgam is a combination of mercury and another metal. When the NaHg amalgam has cooled, add a solution of ammonium chloride (sal ammoniac). The amalgam will swell up considerably. Sodium chloride is in solution, and the sponge-like substance is ammonium amalgam. Keep in tightly stoppered bottles. It decomposes into NH_3, H, and Hg.

Qualitative Analysis Chart

The below scheme for analysis is offered as a simple and clear method of ordinary qualitative analysis of a substance. It should be remembered that an alloy or a metal should be dissolved in acid in order to determine its components.

· SCHEME FOR QUALITATIVE ANALYSIS ·

· DISSOLVE · THE · SUBSTANCE · IN · WATER. ADD · FEW · DROPS · HNO_3. COOL. ADD · HCl ·

1. IF WHITE PRECIPITATE FORMS IS EITHER LEAD, SILVER OR MERCUROUS CHLORIDE OR ALL. FILTER. WASH. SAVE FILTRATE. USE IT AS DESCRIBED IN 2. POUR BOILING WATER THREE TIMES ON THE PPT. WHICH IS IN FILTER PAPER. $PbCl_2$ WILL DISSOLVE.

A. SOLUTION (FILTRATE) DIVIDE INTO THREE PARTS. 1 PART ADD H_2SO_4. BOIL. WHITE PPT = Pb. SECOND PART ADD $K_2Cr_2O_7$. YELLOW PPT = Pb. THIRD PART PASS IN H_2S. BLACK PPT = Pb.

B. TO PPT. (ON FILTER PAPER) ADD NH_4OH IF IT TURNS BLACK Hg_2 (OUS) IS PRESENT IF Ag IS PRESENT. THE Ag Cl WILL DISSOLVE AND RUN THROUGH. ADD HNO_3 TO FILTRATE WHITE PPT. MEANS Ag IS PRESENT

ABBREVIATIONS
SLT. ALK. — SLIGHTLY ALKALINE.
PPT. — PRECIPITATE.
SOL. — SOLUTION.
T.T. — TEST-TUBE
CONC. — CONCENTRATED.
MIXT. — MIXTURE.
1:4 — MEANS ONE PART OF SUB. TO FOUR PARTS OF H_2O.

NOTES.
SODIUM COBALTINITRITE CAN BE MADE BY DISSOLVING 5 GMS. $NaNO_2$ (ITE) IN 10 C.C. H_2O AND ADDING 3 C.C. OF 35% ACETIC ACID AND ½ GM. OF $Co(NO_3)_2$. SHAKE. LET STAND OVER NIGHT. FILTER. DILUTE TO 20 C.C. WITH H_2O. REAGENT FOR POTASSIUM.

IN 2. THE $(NH_4)_2S$ CAN BE MADE BY PASSING H_2S INTO NH_4OH FOR SOME TIME AND ADDING SULPHUR TO THE SOLUTION. KEEP IN AMBER BOTTLES.

TO FILTRATE FROM 1.

2. PASS IN H_2S FOR 20 MINUTES. IF PPT. FORMS, 2ND. GROUP METALS ARE PRESENT. IF NO PPT FORMS PASS ON TO 3.

FILTER AND WASH PPT. CALL IT "A". SAVE FILTRATE FOR 3. POUR WARM (NOT HOT) $(NH_4)_2S$ ON PPT. 3 OR 4 TIMES. WASH WITH WATER 4 TIMES. TO FILTRATE (OF ALL WASHINGS) PROCEED AS IN 2B BELOW.

2A. (PPT) POUR BOILING DILUTE HNO_3 ON SAME PB, Bi, Cu, Cd WILL DISSOLVE. IF PRESENT, AND PASS THROUGH AS FILTRATE. PROCEED WITH THIS FILTRATE AS BELOW. IF A BLACK PPT. IS LEFT ON FILTER, UNDISSOLVED, IT IS PROBABLY Hg (ic) WASH. POUR BOILING AQUA REGIA OVER IT. IF Hg IT WILL DISSOLVE. BOIL UNTIL Cl IS NO LONGER GIVEN OFF. ADD $SnCl_2$. A WHITE PPT. WHICH SOMETIMES TURNS BLACK SHOWS = Hg PRESENT.

TO FILTRATE FROM 2A. ADD STRONG H_2SO_4. EVAPORATE (HOOD) UNTIL DRY. COOL. ADD WARM H_2O. WHITE PPT. INDICATES PRESENCE OF Pb. FILTER IT OFF. TO FILTRATE ADD NH_4OH TILL IT SMELLS OF NH_3. A WHITE PPT. INDICATES THAT Bi IS PRESENT. FILTER. IF FILTRATE IS DARK BLUE, Cu IS PRESENT. ADD KCN (POISON) UNTIL BLUE COLOR DISAPPEARS. IF COLOR IS PRESENT (IF NOT, PROCEED) PASS IN H_2S. AFTER ACIDIFYING WITH $HC_2H_3O_2$ (ACETIC). A YELLOW PPT IND. THAT Cd IS PRESENT

2B. TO FILTRATE. ADD HCl (As, Sn, Sb WILL PPT. AS SULPHIDES). FILTER. DISSOLVE IN CONC. HCl (Sn AND Sb WILL DISSOLVE) TO SOLUTION INSERT A PIECE OF Zn AND BIT OF PT IN CONTACT WITH EACH OTHER. BLACK DEPOSIT ON Pt. MEANS Sb PRESENT. TO RESULTING SOLUTION AFTER ACTED ON BY H BUBBLES FROM Zn ADD $HgCl_2$. WHITE PPT MEANS Sn PRESENT. DISSOLVE PPT. (ABOVE) IN AQUA REGIA. BOIL OFF Cl. NEUTRALIZE WITH NH_4OH. ADD MAGNESIA MIXTURE. WHITE PPT MEANS As IS PRESENT

3. ADD NH_4OH TO FIL. FROM 2 AND PASS IN H_2S. FILTER. WASH. PROCEED WITH FILTRATE. AS IN 4. POUR HCl (1:4) ON PPT. IT IS EITHER $BaCO_3$ $SrCO_3$ OR $CaCO_3$. FILTER, TEST FILTRATE AS IN 5.

TO PPT ON FILTER BROWN BORAX BEAD = Ni. PRESENT. BLUE BEAD = COOR. DISSOLVE THE PPT. IN AQUA REGIA EXPEL ACID. MAKE ALKALINE WITH NH_4OH. DIVIDE INTO 2 PARTS. ADD DIMETHYL GLYOXIME TO 1 PART (ALCOHOLIC SOL.) RED PPT. WILL FORM. TO 2ND PART ADD $C_2H_3O_2H$ (ACETIC) AND POTASSIUM NITRITE. YELLOW PPT. SHOWS PRESENCE OF CO. RUB SIDES OF T.T. IF PPT. DOES NOT FORM AT ONCE

TO FILTRATE: ADD A FEW DROPS OF HNO_3 AND BOIL. TO OXIDIZE Fe. THEN ADD EXCESS OF NaOH. BOIL. FILTER. WASH.

INSOLUBLE PPT. $Fe(OH)_3$, $Cr(OH)_3$ $Mn(OH)_2$ (AND SOME $Ni(OH)_2$) DISSOLVE IN HCl. ADD NH_4Cl, NH_4OH. FILTER. WASH.

FILTRATE SOLUBLE $Zn(OH)_2$, $Al(OH)_3$. ADD HCl FOLLOWED BY NH_4OH.

PPT. $Fe(OH)_3$ $Cr(OH)_3$ DISSOLVE A BIT IN HCl. ADD KCNS. A BLOOD RED COLOR INDICATES Fe. FUSE A BIT OF PPT WITH $Na_2CO_3 + KNO_3$ ON Pt WIRE. GREEN COLOR SHOWS PRESENCE OF Cr.

FIL.: CONCENTRATE. ADD PbO_2 (BROWN) + CONC HNO_3. BOIL. AT FIRST SETTLING, A VIOLET COLOR INDICATES Mn. IS PRESENT

PPT. $Al(OH)_3$ PLACE A BIT ON CHARCOAL BLOCK. ADD DROP OF Co. Cl_2 BLOW PIPE. BLUE COLOR SHOWS Al PRESENT

FILTRATE: ADD $HC_2H_3O_2$ UNTIL IT IS ACID. PASS IN H_2S. A WHITE PPT. WHICH IS INSOLUBLE IN HCl MEANS THAT Zn IS PRESENT

4. FILTRATE FROM 3 MAY CONTAIN Ba, Sr, Ca, Mg, K, Na. ADD NH_4OH, THEN $(NH_4)_2CO_3$. IF A WHITE PPT. FORMS IT IS EITHER $BaCO_3$ $SrCO_3$ OR $CaCO_3$. FILTER, TEST FILTRATE AS IN 5.

DISSOLVE PPTS. IN $HC_2H_3O_2$. ALL WILL DISSOLVE. DILUTE WITH H_2O. ADD K_2CrO_4. A YELLOW PPT. SHOWS THAT Ba IS PRESENT. IF Ba IS PRESENT, FILTER PPT. OFF AND REJECT PPT. TO THE FILTRATE, WHICH MUST BE YELLOW (IF NOT YELLOW, ADD MORE K_2CrO_4) ADD A FILTERED (CLEAR) AND SATURATED SOLUTION OF $CaSO_4$. WHITE PPT INDICATES PRESENCE OF Sr. LET IT STAND IF PPT. DOES NOT FORM AT ONCE. IF PRESENT, FILTER. TO FILTRATE (OR TO SAME SOLUTION IF Sr IS NOT PRESENT) ADD $(NH_4)_2C_2O_4$. A WHITE PPT INDICATES Ca.

5. ADD NH_4OH AND Na_2HPO_4 TO FILTRATE. A WHITE, SANDY OR GRITTY PPT. INDICATES PRESENCE OF Mg.

6. FILTER. DIVIDE INTO 2 PARTS.

HEAT IN AN EVAPORATING DISH UNTIL A SOLID FORMS AND IT NO LONGER FUMES. THEN ACIDIFY 1 PART SLIGHTLY ADD $Na_3Co(NO_2)_6$ (SODIUM COBALTINITRITE). A YELLOW PPT. INDICATES K IS PRESENT. RUB SIDES OF T.T. WITH GLASS ROD TO HASTEN PPT.

TO NEUTRAL OR SLT. ALK. OTHER PORTION. ADD POTASSIUM PYROANTIMONATE ($K_2H_2Sb_2O_7$). A WHITE CRYST. PPT. INDICATES Na. IF A Pt. OR CLEAN IRON WIRE BE DIPPED IN THE ORIGINAL SOLUTION AND HELD IN BUNSEN FLAME AND A DEEP YELLOW COLOR SHOWS AND STAYS FOR 30 SECONDS Na. IS PRESENT

TEST FOR NH_4 BY BOILING THE ORIGINAL SOLUTION WITH NaOH. IF NH_3 IS GIVEN OFF, THE NH_4 RADICAL IS PRESENT.

The Qualitative Analysis Chart shown above is the last word in chemistry, for the amateur chemist. Correct in every detail, and with the simplified wording, it should prove invaluable to those interested in chemistry.

Beware of the tin top reagent bottle. It will soon rust and contaminate your chemicals.

ORIGINAL STINK BOMB.

If a mixture of egg albumen and solid KOH be heated, or fused, a very fecal odor will be obtained.

A commercial stink bomb was found to contain a solution of sulphur in carbon disulphide, colored red with dye.

Fill out that blank on page 159!

MELTING POINT OF WAX, PITCH, TAR, ETC.

To determine the melting point of a wax or tar, etc., cut a cube of the material ½ inch square, and suspend it on a wire hook in a beaker of water (600 c.c.) at a distance of 1 inch from the bottom of the beaker. A weighted piece of paper should be placed on the inside bottom of the beaker. Allow the sample to remain in the beaker 5 minutes before making the test. After 5 minutes, heat the beaker with a Bunsen very slowly. The instant the substance begins to melt, and the FIRST drop touches the bottom of the beaker, the thermometer, which is placed in the beaker, should be read, and recorded as the melting point. If the pitch or sample melts above 77 degrees C, cotton seed oil should be substituted for the water. This is the standard Barrett method for M. P.

Blue glass from a Bromo Seltzer bottle is a good substitute for cobalt glass in flame tests for potassium. It cuts off the yellow Na and allows the lilac K flame to pass. A clean and bright iron wire can be used with some success in flame tests.

Many medicinal substances claim to contain H_2O_2. Test for this oxidizer as follows: Take 2 cc. of 5% (5 grams tartaric acid in 100 cc. H_2O) tartaric acid solution and 2 drops of a 5% solution of ammonium sulphate $(NH_4)_2SO_4$. Add 1 or two cc. of a *cold* solution of the substance to be tested. Mix. Add 5-6 drops of sodium hydroxide, NaOH and shake. A violet color forms if H_2O_2 is present. Hydrogen peroxide is inexpensive. If a manufacturer claims that it is in his preparation, and it is not found, it has probably been decomposed, as it is very unstable. Concentrated hydrogen peroxide will explode if heated. The drug store and commercial bottle is a 3% sol.

(Cont'd from Page 159)

The current flowing through the plate circuit of the oscillating tube, and incidentally part of the inductance, L-1, rises from zero to its maximum value *slowly*, due to the counter-emf, (of self-induction). L-2, in inductive relation to the main coil, has induced in it as the plate current rises, an emf in a direction opposed to that of the inducing current, which, the grid coil being connected in the correct direction, will place a negative potential upon the grid. This negative charge repels the electrons traveling from filament to plate, thus reducing the space current and causing the magnetic field around L-1 to fall. As this flux contracts it cuts the grid coil in the direction opposite to that when building up and the grid current is necessarily reversed. The reverse in direction positively charges the grid and the plate current, again rising to maximum completes the cycle of the antenna current which is generated by the rise and fall of the flux surrounding L-1. This of course occurs at extreme rapidity, the frequency of which is governed by the permittance (capacitance) and inductance of the circuit and on a two hundred meter wave this operation will be repeated 1,500,000 times per second.

Speaking into the microfone varies the charge upon the modulating grid causing the plate current in tube two to increase or vice versa with different words. But as the joint current to both tubes is kept always constant, by reactance X-1, a decrease in plate consumption in the second tube will send an increase through bulb one with a corresponding greater oscillatory output. When, with other syllables, the juice through the modulator is increased, the current to the oscillator and its output, will suffer.

The above will be instantly recognized as the Heising system of modulation and anyone listening in to stations employing it, will, I think, vouch for its excellence.

More bulbs may be added in view of increased range and power. The new additions should be placed in parallel to the original tubes with a suitable reduction of grid leak resistance in the power circuit. However, in virtue of its theory, the modulation circuit must consume approximately half the total plate current and in most cases this will necessitate an equality of modulating bulbs.

(Cont'd from Page 153)

base just as in the ordinary Bunsen burner. The area, horizontal cross section, of the flame is as much as one inch in diameter in some sizes of Meker burners. They are useful for the attainment of rapid high temperatures. As much as 1,000 degrees C. has been measured with one burner, in the laboratories of Experimental Science. *(The next lesson deals with the tools, and manipulations of the glass worker).*

(Cont'd from Page 155)

denced, the connections to L-2 should be reversed. Having determined the correct values in L-1, the grid inductance is varied (by moving the condenser lead across the scraped wire) until again maximum radiation is indicated, when the connection is made permanent.

Variation of wave, by means of the antenna taps in the main inductance, may now be secured without any alteration in the grid or plate circuit.

Battery B-2 will be about forty volts and variable until tube two takes slightly less current than the oscillating bulb. This is the only adjustment required to obtain perfect and efficient modulation and it is altogether unaffected by any other change in the set.

The theoretical action of the apparatus is probably as follows:

(Cont'd on Page 158)

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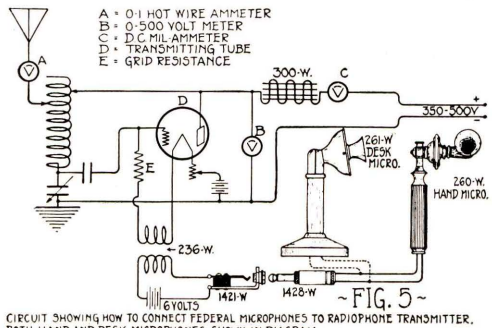

~FIG. 5~

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