Science and Invention

TOTAL ECLIPSE OF THE SUN SEPT. 10th
See Page 430

IN THIS ISSUE

Articles by

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Of the U.S. Naval Observatory

Professor Vladimir Karapetoff

Professor Harold F. Richards, Ph.D.

E. B. "Farmer" Dunn

Clement Fezandié

Dr. Ernest Bade

Professor Joseph Dunninger

Ray Cummings
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Signed:
J. H. KILLIAN,
George Dobrusin,
Stanley Berger,
Kenneth E. Jones,
Joe Londo.
## Table of Contents for September

### POPULAR SCIENTIFIC ARTICLES

- **EDITORIAL.** By Radio Now Possible. By Edward H. Landus, 431
- **HYPOTHESIS.** By Radio Now Possible. By Joseph F. Dammer, 432
- **HYPOTHESIS.** By Radio Now Possible. By Joseph F. Dammer, 432
- **HYPOTHESIS.** By Radio Now Possible. By Joseph F. Dammer, 432
- **HYPOTHESIS.** By Radio Now Possible. By Joseph F. Dammer, 432

### ASTRONOMY ARTICLES

- **LARGEST AND SMALLEST PLANETS.** By Charles Swets of Holme, 432
- **MOON.** By Charles Swets of Holme, 432
- **VARIOUS STARS.** By Robert O. Best, Jr., 433
- **STAR CLUSTERS.** By Robert O. Best, Jr., 433
- **HIGH POWER TELESCOPE FOR YOUR GARDEN.** By Robert O. Best, Jr., 433
- **RIGID CELESTIAL TELESCOPE MOUNT.** By Robert O. Best, Jr., 433
- **EINSTEIN'S RELATIVITY EXPLAINED ON A MODEL.** By Robert O. Best, Jr., 433
- **HOW TO FORECAST THE WEATHER.** By Robert O. Best, Jr., 433
- **SPECTROSCOPES-HOW TO BUILD THEM.** By Robert O. Best, Jr., 433
- **MAN AND THE STARS.** By J. S. Dow, 434
- **TANTALUM-ALL ABOUT IT.** By J. S. Dow, 434
- **BIRDS THAT HAD TEETH.** By John Lane, 435
- **ENCEPHALOPATHY OF THE PRESENT.** By John Lane, 435
- **CAMERA OBSCURA FOR PUBLIC USE.** By Louis Yeager, 435
- **LIQUID AND SOLID HYDROGEN IN QUANTITY.** By Louis Yeager, 435
- **OXYGEN APPARATUS FOR MOUNTAIN CLIMBERS.** By Dr. Albert Schmoller, 435
- **WEIGHING OF PRECIOUS STONES SUPPORTED.** By S. R. Winter, 435
- **SPEED-UP 4.** By Harold F. Richards, Ph.D., 436
- **LUMINOUS WATER SIGNS.** By Harold F. Richards, Ph.D., 436
- **PARACHUTE FOR MOUNTAIN CLIMBERS.** By Harold F. Richards, Ph.D., 436
- **FISH LINE INDICATES PLANETS HEIGHTS.** By Harold F. Richards, Ph.D., 436
- **MOTOR CAR LEAPS, LOOPS, AND SKIDS.** By Harold F. Richards, Ph.D., 436
- **SCIENTIFIC PROBLEMS AND PUZZLES-NO. 10 OF A SERIES.** By Ernest K. Chapin, 436

### ELECTRICITY

- **HOW SUBMARINES DIVE AND RISE.** By Lewis F. Webber, late of the U. S. Navy, Submarine Division, 436
- **TANTALUM-MORE ABOUT IT.** By O. Ivan Lee, 436
- **SPEED-UP 4.** By Lewis F. Webber, late of the U. S. Navy, Submarine Division, 436
- **LUMINOUS WATER SIGNS.** By Harold F. Richards, Ph.D., 436
- **SCIENTIFIC PROBLEMS AND PUZZLES-NO. 10 OF A SERIES.** By Ernest K. Chapin, 436

### AUTOMOBILES

- **MOTOR CAR LEAPS, LOOPS, AND SKIDS.** By Harold F. Richards, Ph.D., 436
- **LUMINOUS WATER SIGNS.** By Harold F. Richards, Ph.D., 436

### MAGIC FOR EVERYBODY

- **EXPERIMENTAL ELECTROCHEMISTRY.** By Raymond B. Wiles, 457
- **PRACTICAL CHEMICAL EXPERIMENTS-INTER.** By Raymond B. Wiles, 457
- **LATEST PATENTS.** By P. A. Price, 474
- **BROADCAST STATION PHOTOS.** By Everett N. Curtis, 474
- **RADIO ORACLE.** By Everett N. Curtis, 474

### CONSTRUCTORS ARTICLES

- **A RIGID CELESTIAL TELESCOPE MOUNT.** By George A. Lucas, 441
- **SPECTROSCOPES-HOW TO BUILD THEM.** By S. R. Winter, 444
- **SILICON STAR PHOTOMETER.** By Lewis J. Boss, 460
- **ETCHING WITHOUT COPPER PLATES.** By Harry Dunn, 462

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**Note:** The text contains advertisements and editorial content related to various scientific and technological topics. The content is typical of early 20th-century scientific magazines, focusing on inventions, technology, and scientific discoveries. Some of the articles, such as those on radio and electricity, reflect the rapid developments in these fields during the early 20th century. The text is divided into sections based on different topics and authors, providing a comprehensive overview of the scientific landscape of the time.
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Apparatus and Circuits of Transmitting Apparatus, etc.

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THE average man, and there are millions like him, is apt to regard Astronomy as something unworthy of his attention. To the majority of people, even in this supposed enlightened age, the word Astronomy immediately suggests a shudder, and to most of the others it is a closed book with seven seals.

All these people may be compared to busy ants in an ant-hill who are so engrossed with their universe—the ant hill—that they never find time to see what goes on across the creek. To the ant, a distance of five miles is infinite. He is not even aware that such a thing as a man, who prides himself as being the most glorious thing in creation, is in existence. Billions of ants never even see a man, and know nothing of his puny handwork.

The average man on the other hand, is either too lazy or too self-engrossed to lift his head to the stars and speculate as to what lies behind his mental creek. As for Astronomy, he is not at all interested in it, because it means nothing in dollars and cents to him. He knows there are such things as the sun, moon, and stars, and he is glad to leave well enough alone. If Astronomy could be expressed in dollars and cents, there would not be enough printing presses to print astronomical news. Unfortunately, so far, the money value of Astronomy has been practically nil to the public, but the time is coming when the average man will no longer see the stars as they are, but will see them as gold coins and valuable gems.

Let us therefore enumerate some of the actual everyday uses of Astronomy.

We might first mention that Astronomy has done away with a good deal of superstition that existed as late as 100 years ago. A solar eclipse four or five generations ago was a terrifying event and was looked upon as a vengeance of God, punishment of the devil, and what not. Since then, people know that the solar eclipse is caused by the moon getting between the earth and the sun. By our mathematics an eclipse can be predicted accurately to the day, hour, minute, and second, 100 or 1,000 years ahead, so that is a very natural affair to the astronomer. Astronomy, therefore, has been the cause which has delivered us from some of our superstitions.

We used to kill a lot of people sending them up in balloons that were filled with hydrogen. You will remember the many disasters of exploding air ships. All of this will be soon a thing of the past due to Astronomy, and particularly to spectrum analysis. The gas which is going to save us from death in dirigibles is called Helium. The gas is present in the sun in rather small quantities, and was unknown to earth until the spectroscope showed us its presence in the sun and now it has been found in quantities in the earth. In other words, Astronomy led us to the sun first and back to the earth in our practical quest of knowledge.

We have discovered several other gases in the sun which have not been found on earth as yet, but we know from experience that if a gas exists in the sun, it is reasonably sure that sooner or later it will be found on earth.

Our solar eclipse expeditions of what good are they? Why is so much money expended on them, just to look at the total eclipse for two or three minutes at an expense totaling tens of thousands of dollars? For one thing, there is the mysterious Corona which may be studied on the front cover of this magazine. We also know that in a total eclipse, spectrum analysis shows that there is present in this Corona, a gas termed "Coronium." So far it has not been put to any practical use because we have not been able to demonstrate its presence on earth, but we are getting there by degrees and once we have it, we shall no doubt put it to work making dollars and cents for someone. Also during a total eclipse, we expect to learn something about the mystery, about what keeps the sun hot. Good "Old Sol" has been giving out a tremendous volume of heat for at least a million years and possibly longer. So far, our puny efforts have not succeeded in unravelling the mystery as to just why the sun keeps hot. Its heat is estimated to run above 10,000 degrees C. No new fuel is added, still the titanic heat keeps up century after century, undiminished. Here is a secret that is worth, not thousands, but billions of dollars to the scientist who solves it. Suppose manufacturers could sell a little furnace or stove that would give out a tremendous heat for thousands of years, at no cost whatsoever and without adding any fuel. This is exactly what the sun does today, and some day we hope to wrest this secret from it, and if we do, it will be thanks to Astronomy.

In every factory where optical goods are made, such as your eye-glasses, knowledge of velocity of light is of prime importance. Its velocity was determined by means of Astronomy. So you see that even your eye-glasses have their foundation upon Astronomical knowledge.

Outside of this, however, and the dollars and cents value of Astronomy, it may be said that there is nothing more ennobling and more mind-elevating than the study of Astronomy. It purifies the mind and gives you an entirely different outlook upon the world. Cease being an ant looking across a rivulet of water!
At the Top of This Page the Illustration Shows How 'Radio-Hypnotism' Was Made Possible. Center, Photo of Mr. Joseph Dunninge, the Hypnotist. At the Left of His Photo, Hypnotizing the Subject Preparatory To the Needle Test. At the Right of Large Photo, Needle Test in Detail.

In the Two Photos Immediately Above This Print, the Receiving Set Used For Radio-Hypnotism Is Shown and Is One of Them the Bridge Test Is Reception May Be Seen. In the Other, the Art Pin Is Passed Through the Hand of the Hypnotist's Subject. At the Left Is a Photo of WHN Station.
LONGBED distance hypnotism via radio has been successfully demonstrated by Dr. Duncan, of the newspaper office at WHN, located at Ridgewood, L. I. Never before in the history of radio has an such attempt been made, and that it was, as all those who were present will concede, except one newspaper reporter on the staff of a rival publication, who would have been convinced that the subject was hypnotized, even if she herself had fallen into a trance alongside of him. Nevertheless more than a dozen newspaper reporters, two medical doctors, who would not permit their names to be published, and who arrived incognito, at the SCIENCE AND INVENTION magazine offices, at least as far as the newspaper reporters were concerned, and one eminent hypnotist, besides other spectators were present at the demonstration. All of these were enthusiastic at the success of the experiment.

GETTING READY FOR THE TEST

On Saturday, July 14th, at 10:00 o'clock, in the morning, station WHN, which participated in the first broadcast ever made from a transmitting station at full power, played several test numbers, so that we could tune in for them at the laboratories of SCIENCE AND INVENTION, ten miles from the station. At the Ridingwood station, Mr. Joseph Dunninger, who needs no introduction, as he is already well-known to the readers of this publication by his series of articles on "Magical Science," and by the fact that he is chairman of our investigative board on spiritualistic matters, was at the station.

Lester B. Duncan, the subject, was stationed at the SCIENCE AND INVENTION offices in the presence of the newspaper reporters, physicians, and other spectators. After a short lecture, Mr. Dunninger, speaking into the transmitter at WHN, conveyed his voice to the doctor's patients, had him pair which they particularly impressed, inasmuch as his voice was directed to Duncan only.

THE HYPNOTIST SPEAKS

"Duncan," the command came, "I am speaking to you now. Look directly into the horn of the loud-speaker. You see my eyes looking into yours. You see me here before you. Tell me to move my eyes, and they are watery: they are tired. Your eyelids are drooping. Your body is becoming rigid—very rigid. You will remain standing, your arms at your side."

Then his voice addressing one of the attendants said: "Now, place the subject directly in front of you, his eyes open, and see whether or not his eyelids will twitch when the flame of a match is passed rapidly before them."

This effect was attempted, but it was not entirely successful, as there was a movement of the eye. One of the reporters stepped forward and examining Duncan, stated that his muscles were not absolutely rigid. So word was sent to Mr. Dunninger at station WHN via a private telephone wire, connecting our office with that of station WHN, that the command should be brought out of the trance and the effect tried again. The voice then came through the loud-speaker via radio again.

FIRST ATTEMPT NON-SUCCESSFUL

"To my listeners: I have just been informed that our experiment was an entire success. I will try it again in a few moments. Duncan, I am now speaking to you. I want you to relax."

Duncan did. He fell limply and almost to the floor, were it not for the fact that several forward to hold him. Duncan, by a score of several sharp steps across the floor, he could not be aroused.

DUNCAN FAILS TO RALLY

Needless to say excitement reigned supreme for the moment. Rushing to the phone, Mr. Dunninger was informed by the attendant that Duncan had not come out of the trance, although he had relaxed as commanded. A discussion followed, during which it was discovered that the command to awake had not been given, but only the command of relaxation had passed through the air.

Again from WHN's station, came the words, "Duncan, I am your commander: I command you to awake when you receive a sharp slap on your cheek." Duncan did awake, but was not in a fit condition to undergo the second test for at least five minutes.

Bear in mind that Mr. Dunninger had not even Duncan that the command there was absolutely no prearrangement of this experiment. It was an error that the first signal transmitted from station WHN was a command to relax rather than awake, and it was not until the complete resume of commands was made, that we discovered the proper one had not been transmitted. At first we all thought that Duncan would stay in the trance and continue until the hypnotist arrived at our offices and personally brought his subject back to consciousness.

A HUMAN BRIDGE

Five minutes later the commanding voice from WHN station again directed Duncan to stand straight and to be relaxed. He was again placed in a state of catalepsy, his muscles rigid, and his shoulders on one chair and his feet on another, forming a veritable bridge upon which an individual could sit with ease. This effect is clearly brought out in our photograph, which was taken to Mr. Dunninger's command, and after a short intermission was ready for the demonstration. This test conclusively demonstrated the possibility of long distance hypnotism.

BLOODLESS AND PAINLESS NEEDLE TEST

The subject was placed on a chair, his arm dangling over the side, and went into a state of catalepsy again at Mr. Dunninger's command, the muscles of his arm being perfectly rigid while those of the rest of his body were relaxed. A spot on his arm was sterilized, as was a lady's veil pin, and this was then plunged through the skin of the arm, which skin was lifted for the test. The lady pin punctured only an inch close to one of the superficial veins. In fact it even seemed to puncture the superficial vein and came out of the skin more than an inch of an inch away from its entrance. The subject did not flinch, and when the pin was withdrawn, there was no trace of an incubus had been coming back to mark the spot. SCIENCE AND INVENTION did not like to conduct this last test, but the newspaper reporters were persuaded. They wanted it proved that Duncan was absolutely in a hypnotic trance, and if this test, successful as it was, did not convince all of them, it convinced all but one. Undoubtedly readers of this article have already read the reports which were published in nearly every newspaper throughout the United States.

THE OBJECT OF THE TESTS

The tests proved conclusively that hypnotism may be successfully produced by telephone and that it now becomes possible for a good hypnotist, a medical doctor, to go to the nearest transmitting station and treat thousands of patients at one and the same time, by means of this art. Each of the doctor's patients can have a small receiving set at home and by listening to the voice of the radio, can be treated for insomnia with beneficial results, and by post-hypnotic suggestion, other ailments. The treatment of chronic alcoholism and drug addiction has hitherto been successfully demon- strated by hypnotism, and the treatment of chronic alcoholism and drug addiction has hitherto been successfully demon- strated by hypnotism. Now with hypnotism by radio he be as successful as hypnotism by telephone? Radio has advanced to such a stage that the voice is as clear as the telephone. With a multi-stage amplifier it is many times louder than the telephonic voice. Suppose that a very good hypnotist, internationally known, could travel through the country giving hypnotic treatments and leaving his old patients behind in the cities, through which he has passed. He could then come to administer further treatments from nearby broadcasting stations to his old patients and at the same time administer two or three personal treatments to each new subject. That this treatment may be developed more fully, and may be brought forward through the telephones at one and the same time by an efficient hypnotist, is the next step, the gap to which the subject has been brought about in the SCIENCE AND INVENTION magazine, which has shown how this can be done. Further steps will soon be taken to develop methods of increasing and lasting results following radio administered hypnotism.

This magazine wishes publicize to thank the operators and managers of Radiophone Station WHN for their kind and courteous cooperation in assisting in the first successful attempt at long-distance radio-hypnotism.
How Submarines Dive and Rise

A SUBMARINE, in the most general acceptance of the term, is a vessel designed to operate at pleasure on the surface or submerged. All submarines involve the following principles:

- Surface buoyancy, or displacement is destroyed by the admission of water ballast into specially constructed tanks called ballast tanks. The tanks are so located and of such size that the boat will naturally submerge on an even keel, and when these tanks are full the boat will have a very small percentage of positive buoyancy left, as about 75 per cent of her buoyancy is destroyed when fully flooding the main ballast tanks.

HOW A SUBMARINE DIVES

I will try to describe how a submarine makes a stationary dive.

We are running on the surface on the main engines when the following orders are given by the commissioned officer:

"Rig for diving." Everything about the decks is secured, lines stowed, deck locker and gun secured, the colors taken down, the diving flag put up, and all navigating instruments are sent below.

All hands except the commanding officer and quartermaster, go below to their stations and see that everything is in readiness by actual test.

All hatches are closed, except the conning tower hatchway.

The next orders are:

"Station for trimming down." Everybody stands by for further orders.

The commissioned officer stops engines and goes below, also the quartermasters.

Reports come in from all diving stations "Ready forward," "ready all," etc., and further orders.

"Flood M. B. T." (M. B. T. means main ballast tanks.)

This last named operation occupies less than a minute, when the said tanks are reported full; the air in the tanks has been expelled and replaced by water.

But still we are not ready to run. We still have about 25 per cent of buoyancy which must be cut down to enable us to handle the boat with ease as we flood our auxiliary and regulator tanks, which can be so regulated that the boat will be perfectly balanced at what is called neutral buoyancy.

In other words, the boat now at neutral buoyancy is, as it were, suspended in a sort of indifferent buoyancy. In fact, if it were possible for a man to get outside of and (Continued on page 491)
Important Announcement!

THE October issue of SCIENCE AND INVENTION will witness an important and far-reaching innovation in the magazine field.

In order to give our readers greater value for their money, the October issue, and subsequent issues of SCIENCE AND INVENTION, will contain almost three times as much matter as has been published in any previous issue.

THE editorial policy of SCIENCE AND INVENTION remains unchanged. The same material, only three times as much of it in an entirely new form, will be presented to our readers.

INCIDENTALLY, SCIENCE AND INVENTION will appear in a new make-up which will make its reading far more fascinating and interesting than it has ever been in the past.

THE EDITORS
mortality figures of their policy holders, have found that the death rate of these millions of insured persons was 8.8 per thousand lives in 1922, and 8.7 per thousand lives in 1921. These figures differ from those issued by the Government, but the general proportion is maintained. The reason that this year fell back slightly was because of the higher rate recorded for the early months of 1922, which made the record higher than that in 1921, although the latter half of the year showed the best health record ever made during the past fifteen or twenty years.

There was a sharp decline in deaths from tuberculosis, which eleven years ago was in the lead as a cause of mortality. From this ranking position it has been displaced, so that now it is second in importance to organic heart diseases. The decline in deaths from tuberculosis was not so marked among white individuals as among colored persons. Typhoid fever was lower among insured wage-earners in 1922, and the communicable diseases of children, such as diphtheria, scarlet fever and whooping cough, show a lower death-rate during the year, although the measles death-rate children and in adolescents the rating was normal. Cerebral hemorrhages were slightly higher this year than last year. The diabetes rate increased ten per cent during the year. This is the highest recorded for alcoholism since 1917, but it is still much lower than the rates in the years prior to 1918. These figures would indicate, therefore, that prohibition was of value in causing a marked decrease in the number of deaths due to alcoholism, because from 1917 to 1920 there was an upward trend.

Alcoholism 2.1

DIARRHEA AND ENTERITIS 4.0

"What Do We Die Of?" is a question often heard, and which is not such a simple answer. Except by a study of actual statistics such as those tabulated by the Insurance Companies and Hospitals. The picture here shows all of the more important human ailments which are the causes of deaths, the figures indicating the number of deaths per one hundred thousand people in the United States. We remember reading one medical report some time ago, in which it was stated that probably more people die from a weak heart or a weak stomach than from all other causes combined.

FIGURES INDICATE NUMBER OF DEATHS PER 100,000 IN U.S.

APoplexy and Hemorrhage 8.0
Whooping Cough 12.5
Influenza 7.1.
Pneumonia 13.7
Typhoid Fever 7.8
Nephritis and Bright's Disease 9.2.
Chirrosis of the Liver 5.8
Measles 5.0
Scarlet Fever 6.3.

Diphtheria and Group 15.3
Heart Disease 50.1
Tuberculosis 14.0
Cancer and Tumors 8.3.

What is the death rate for 1920? It was lower than for any year since the publication of annual reports in three of the five items listed. Remember the figures are about the general population, not insured wage-earners alone which occupied our attention in the previous part of this article. These three are typhoid fever, diarrhea enteritis, and tuberculosis. On the other hand, the rate from diphtheria, group and cancer is higher.

Very interesting information is given by the John Wiley publication, "Vital Statistics," by George Chandler Whipple, a standard text work on the science of demography. It would be well for anyone interested in living long to read this most excellent work. We find that the ideal family, according to the author in question, would consist of a father, a mother, three children and an occasional grandfather, grandmother, aunt or uncle. As the average number of persons per family in the United States is only 4.3, it is evident that our nation's families are much smaller than the ideal. It is surprising to note the number of persons about 14 per cent who really do not know their own age, and also that the population of the United States is increasing in spite of the rather difficult times. For instance, in 1918 there were seventy-three deaths for each one hundred births, but this was a high rate of mortality, effected by the influenza epidemic, which reigned in that year. In 1919 there were only fifty-eight deaths per one hundred births in the United States. In England the figure for 1917 was sixty-two, and seventy-three for the two years, respectively, whereas in Vienna and France the death-rate was appalling. High. In the non-influenza portions of France there were one hundred and ninety-eight deaths per one hundred births for the year 1918, which means that the population of France is decreasing rapidly, and in Vienna two hundred and twenty-nine and one hundred and sixty-two were the figures, respectively, for the two years mentioned per one hundred births.
No doubt you have all read of the sudden rise in fame of Miss Evelyn Lyons, the "Michigan Marvel," from Escanaba, Michigan. Miss Lyons was called "the girl with a temperature of 114°." On May 7th physicians were baffled with the abnormally high temperature of 114°, and is graduated beyond that point, although it will require a temperature of approximately 114° to cause the mercury to reach the end of the capillary tube. When Miss Lyons placed the thermometer under her arm it lasted a few seconds, and was then cracked by the expanding mercury. The Weather Bureau had to come to the physician's assistance, furnishing longer-range thermometers for the tests.

Medical men from all over the country were making guesses as to why her fever was so high. She had an unusually good appetite, was able to remain in bed, and reports would have it that she even ran out and lay down in a snow bank in order to cool off. The proper cooling procedure would have been for Papa Lyons to have turned young Miss Evelyn over on his knee and administered a little additional heat, because Evelyn was found cooling the hot water bottle. The miniature hot water bottle was concealed under her arm, so physicians, who had figured that pressure on the thermal center, or that peritonitis, or that a thousand and one other causes were responsible for the fever, returned home baffled.

What Temperature Can We Stand?

By JOSEPH H. KRAUS

STAFF MEDICAL EXPERT

Significance of High Temperature

One often desires to determine what the effects of high temperatures in the body or on the body would actually be. The normal temperature of the human body is 98.6° F, which varies a few tenths in either direction in different climates. Should there be a persistent elevation or depression in the temperatures above 99.5 or below 97.3, both in degrees F, one may be quite certain that a diseased condition is present. The average temperature of the human body is 1° higher in the tropics than in temperate regions. This increase of 1° generally increases the pulse beat, so that the pulse averages ten more beats per minute.

In cases of ague, the temperature of the body begins to rise and after the disease has been practically cured, this temperature is still found to be quite high. As long as it remains above normal, the patient is not entirely cured.

Supposing that a person of good habits and who only a few hours ago was perfectly healthy, develops a temperature of 104° F. It is an almost positive sign that he has developed an attack of ephemeral fever, or that ague is coming on. This temperature may further increase to 106°.

(Continued on page 495)
Solar prominences of incandescent hydrogen 80,000 miles high rising from the chromosphere. It is now possible to photograph these great eruptive prominences without the aid of a total eclipse. The dark disk is this photograph is NOT the moon, and this was NOT taken at time of total eclipse, though such may appear to be the case.

Another view of the partial eclipse which is ever less than last illumination.

Total eclipse of the sun May 28th, 1900, photographed by Yerkes. The white streamers are the corona. Note short polar streamers and bottom.
UPON the tenth of September the United States will be visited by a total eclipse of the sun, the first to be visible in this country since the astronomers recognized the probability of the event in June 8, 1918, crossed diagonally from Washington to Florida. To be sure, the path of totality of the coming eclipse will not much more than graze our shores in Southern California, but it will be at the most favorable part of its course when the sun is high in the heavens early in the afternoon and when the duration of the total phase is near its maximum value.

The Santa Barbara Islands, off the coast of Southern California, lie directly in the path of total eclipse, the island of San Clemente being on the central line. Point Conception and San Diego on the mainland are also well within the path of totality. The Mt. Wilson Observatory lies only thirty miles or so outside of the shadow path and ninety-eight and one-half per cent of the sun's diameter will be covered by the lunar disk at that point at the time of greatest obscuration. Plans are being made to observe the eclipse on Mt. Wilson and within the path of total eclipse, and it is expected that some interesting results may be obtained with the aid of the powerful astronomical equipment of this observatory which is second to none in the world. It is hoped that the fifty-foot interferometer may be completed in time for use at this eclipse.

TIME DURATION OF ECLIPSE

At San Clemente Island the total phase of the eclipse begins at about 12:55 p.m., Pacific Standard Time, and the duration of the total phase will be 3m 3s, which is within one second of the longest duration at any point on the central line. This compares very favorably with the scant two minutes, at the most, afforded observers of the 1918 eclipse. The Lick Observatory expedition to Wallal, Australia, which so successfully observed the eclipse of last September and obtained such striking confirmation of the Einstein prediction, was favored with a duration of a little over five minutes. The duration for the coming eclipse is about that of the event of 1918. The possible duration of a total eclipse is 7m 58s, and this occurs only under very excep-

Popular Astronomy

By ISABEL M. LEWIS, M.A.

OF THE U.S. NAVAL OBSERVATORY

The Total Solar Eclipse of Sept. 10th Visible in the United States and Mexico

There are many excellent points of vantage for the observation of this eclipse not only among the Santa Barbara Islands and in the vicinity of San Diego, but also in Mexico. Here the shadow path passes over Lower California and across the mainland from the Gulf of California to Yucatan. The Mexican National Government, the Council of Mexico City, the Governor of San Luis Potosi, the Director of the National Observatory at Tacubaya, Prof. Gallo and the Mexican National Railways have offered many courtesies and offers of assistance to astronomers of other countries who are planning to observe the eclipse in Mexico.

All necessities of expeditions going to Hermosillo, a point on the central line midway between Cuencame and Tampico, will be provided by the Governor of San Luis Potosi and all facilities will be granted to the visitors. The National Railways are also offering a discount of fifty per cent to Mexico City and other points where the eclipse will be observed.

The Lick Observatory Expedition will locate in the neighborhood of Ensenada, Lower California, with an extensive equipment, through no further attempts will be made to obtain plates to test the Einstein effect, owing to the nearly perfect agreement between observation and theory that was obtained by his expedition last September at Wallal, Australia.

Certain other expeditions will attempt to obtain photographs of the star-field surrounding the sun, however, for the purpose of detecting this Einstein effect, due to the bending of the rays of light from the stars upon passing near the sun which causes the stars images to appear displaced on the photographic plates from the positions they would normally occupy, not only away from the sun, but by an amount varying with distance from it.

An expedition from Germany will observe the eclipse in Mexico at the invitation of the Mexican government and the test of the Einstein effect will be part of the program of observation.

At Cuencame, Mexico, there will be an expedition from the Sprout Observatory of Swarthmore College, which is planning to obtain plates to test the Einstein effect, as well as to photograph the solar corona with lenses of 65 feet, 104 inches and 38 inches respectively, to photograph the flash spectrum, which appears just preceding and following totality, and to test the corona for rotation with the interferometer.

The Mexican Government will send out two expeditions, one to occupy a station near Cuencame and the other a station at Hermosillo. Photographs and drawings of the corona will be made and moving pictures of the eclipse will also be taken.

An expedition from the Steward Observatory of the University of Arizona under the leadership of Director A. E. Douglass will locate on the central line south of Hermosillo in Mexico. Amateur observers are also showing great interest in this eclipse and a group of Arizona amateurs are planning a pilgrimage into the wilds of the Sonora desert to the central line by automobile, a distance of 160 miles. Other amateurs interested in observing the eclipse are invited to join the expedition which will start from Douglas on the border. The equipment will consist of whatever astronomical instruments may be obtainable. The artists of the expedition may try their skill in making drawings of the coronal streamers and many of the details of form and structure which may be caught even better by the human eye than by the photographic plate. All members of the expedition, if the weather permits, will be afforded a view of one of the grandest spectacles that nature has to offer.

On Catalina Island there will be several expeditions. The Yerkes Observatory expedition will be stationed here with an extensive equipment, and also an expedition from the Washburn Observatory of the University of Wisconsin which will measure the displacements of the corona by means of the photo-electric cell. The Goodsell Observation (Continued on page 484)

Map Showing Path of Total Eclipse in United States and Mexico and Local Standard Times of Beginning of Total and Greatest Eclipse With Per Cent of Obscuration for Various Cities in the United States.

Map Showing Path of Total Eclipse Over Santa Barbara Islands, and Southern Most Favorable Points Will Probably Be Santa Catalina Island and Vicinity of Ensenada.
The Planet Mars

By Prof. WILLIAM H. PICKERING

HARVARD COLLEGE OBSERVATORY, MANDEVILLE, JAMAICA, B. W. I.

T

HE year of Mars is about twice as long as that of our Earth, consequently in our path around the Sun we are continually overtaking it in a period of a little more than two years. At such times, since the path of the planet is quite eccentric, we occasionally pass comparatively near to it, that is to say within 35,000,000 miles, which seems near in astronomy. This will happen on August 22d of next year, when we shall be nearer to Mars than has been the case for over 120 years. Nor shall we be as near again during the present century. The planet will then appear very large and red in the sky, so that anyone can easily recognize it. But it is not merely that it will be nearer to us than usual next year, but also that it will be near us for a very long time, which is much more important. We therefore hope to secure many interesting observations of it. The season on Mars will be the middle of November for its northern hemisphere, or late spring for its southern. The south pole of the planet will therefore be turned towards the Earth, and we shall be able to study the whole of the southern hemisphere to great advantage.

The drawings illustrating this article were made in 1920, when the northern hemisphere was turned towards us, and they show that hemisphere very clearly. Like all planetary drawings north is placed at the bottom of the picture, and the northern snow cap is distinctly shown in each of them, thus locating the pole of the planet. The Martian month was late July and early August, though most of the drawings were made in our April and May. At that time the Earth was once and a half as far from Mars as we shall be next year.

HOW MAPS OF MARS WERE MADE

These drawings were all made by expert observers belonging to the international society devoted to the study of Mars. This society includes in its membership all of the best known planetary astronomers throughout the world. Under each original drawing is the name of the observer, and the longitude of the planet's central meridian at the time the drawing was made. Referring to the drawings individually, it may be said that Dr. Maggini believes that he should draw everything that he sees, or thinks that he sees. Some of this detail is so faint that in order to show it at all he has to greatly exaggerate its density, so that, as he himself admits, his drawings for this reason really do not look like the planet, but are more nearly analogous to a map. The other observers insist on drawing only those things of which they are absolutely sure, feeling that it is better to omit some real detail than to draw something else that is not there.

Since the drawings were not all made on the same night, or even during the same week, and since the surface of Mars is continually changing, we should not expect them to be all exactly alike. At the same time they should bear a very close resemblance to one another.

These facts will explain why there are two distinct schools of observers of Mars—the more radical, and the more conservative. The former is the only one which will decide Dr. Maggini's drawings show innumerable canals, lakes, and several of the famous double canals of Mars. That some of these canals exist as canals there is no manner of doubt. The only question is as to whether their sides are darker than their middles. Most of the observers apparently think not. It is hoped that this matter may be definitely decided next year.

SURFACE CONDITIONS ON MARS

We will now discuss some of the better ascertained facts relating to the surface conditions on the planet. The most important one, on which most of the others depend, is that the force of gravity there is only two-fifths as great as it is on the Earth. A man weighing 150 pounds here would weigh but 60 pounds if transported to Mars. Consequently the density of its atmosphere must be considerably less than that of ours, probably about one-quarter as great. Also there is very much less water on the planet, hardly as much as would be contained in one of our great lakes. There are no permanent water areas as with us, and water is only seen in the liquid form temporarily, at the edges of the melting polar caps. Those large dark areas on the planet which temporarily turn a bright blue, indicate, it would seem, like the green maria, merely a process of vegetation.

(Continued on page 482)
The Largest and the Smallest Planets

By CHARLES NEVERS HOLMES

Eight planets constitute the planetary membership of our Solar System. Of course, these planets are Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune. There may exist other planets, besides these eight, but astronomers have not as yet discovered a ninth planet. In order of respective size, these eight planets are Jupiter, Saturn, Neptune, Uranus, Earth, Venus, Mars, and Mercury.

Accordingly, the largest planet of our Solar System is Jupiter; the smallest is Mercury. Both Jupiter and Mercury vary in their distances from the Sun and from our Earth. Jupiter revolves at a mean distance of 483,000,000 miles from the Sun; it may approach as near as 370,000,000 miles to our World or recede as far as 600,000,000 miles from us. Its mean distance from the Sun is, therefore, not quite 1/6th that of Neptune, the farthest planet from our Sun. Mercury is not only the smallest of the eight planets but it is also the nearest to the Sun. It revolves at a mean distance of 36,000,000 miles from the Sun, and its distance to our Earth varies from 50,000,000 to 136,000,000 miles. At its nearest distance to us, Mercury approaches 1/7th of Jupiter’s nearest distance to us.

The “year” of the planet Jupiter is almost twelve times as long as our Earth’s. The “year” of Mercury only about 1/4th that of the World’s. As we well know, our Earth’s year is approximately 365 1/4 days of length. The reason for Jupiter’s longer year and Mercury’s shorter year is owing to Jupiter’s greater orbit and Mercury’s shorter orbit around the Sun and to their relative speeds. Around our Sun, the latter planet speeds with a velocity of 23 to 35 miles per second, the former planet with a velocity of only 8 miles per second.

The density or solidity of Jupiter is estimated to be even a little less than that of our Sun. There have been a number of estimates respecting the density of Mercury. Whereas Jupiter’s solidity approximates only about one-quarter that of our Earth, Mercury’s density has been estimated from 85/100ths of the terrestrial density to a density comparable with our Earth’s. Now, our Moon is almost 2/3rds as solid as our Earth. In other words, our Earth’s density is about 3/5 times that of water, Jupiter’s density a little greater than that of water, whilst Mercury’s has been estimated, upwards, from 4 7/10ths times the density of water.

All the eight planets vary respecting the so-called “weight” of bodies at their surfaces. The weight of a body on the planet Jupiter is about 2 65/100ths times the weight of such a body, were it weighed upon our Earth’s surface. That is, one of us who weighs 150 pounds here, would, were he transported to Jupiter’s surface, weigh almost 400 pounds. Of course, Mercury is smaller than either Jupiter or our World, so that we should expect a 150-pound body to weigh less there than what it would on either of the other planets. A good estimate would perhaps be about 60 pounds. Compared with these respective weights, a 150-pound body would weigh about 23 pounds on the Moon and more than 2 tons on our Sun. These calculations leave centrifugal force out of consideration.

There are many other interesting facts about the largest planet and the smallest planet of our Solar System. We know that it takes our Planet about 24 hours to rotate once around its axis. Now, Mercury takes about 88 days to complete one of its axial rotations, and Jupiter only about 10 hours. That is to say, the planet Jupiter rotates more swiftly around its axis than any of the 7 other planets. Respectively, its moons or satellites, Mercury possesses no known moon, whereas Jupiter has 9 known moons revolving around it. One of Jupiter’s moons, Ganymede, is larger than the planet Mercury, and another one, Callisto, is almost as big as Mercury.

And, now, how large is the largest planet in our Solar System and how small is the smallest planet?

The diameter of Jupiter is more than 86,500 miles, our Earth’s diameter being about 7,918 miles. Accordingly, Jupiter’s circumference is more than 10 times that of the earth, and this giant planet’s volume is over 1,309 times greater than our own planet’s volume. With respect to some of the other planets, Jupiter is about 1 7/10ths times as large as Saturn and nearly 9,000 times as large as Mars, and approximates the volume of 1,400 Mercuries, combined in one planet. It is 64,000 times as large as our moon.

As for the planet Mercury, its diameter is about 3,000 miles, or nearly 39/100ths the diameter of our World. Accordingly, this pigmy planet’s volume is only about 1/18th of our Earth’s volume. The planet Saturn is some 14,000 times as large as Mercury, and the planet Mars almost 3 times as big. Mercury is larger than our Moon, but only 2 3/4ths times as large.
Around the Universe

By RAY CUMMINGS

THIRD INSTALLMENT

Eastern Time—shortly after the First Meal, as time chanced to be on Mercury, Tubby, Sir Isaac and Ameena gravely faced the white-haired King and his aged dignitaries who were seated around a huge table.

The Sky Travelers Were Greatly Impressed Upon Their First View of the Landscape and Buildings on Jupiter. The Buildings Were Erected in Great Terraces.

...in the Audience Room. The place was crowded; its gallery above, open to the public, was thronged with those curious to see these strange visitors from another world.

Sir Isaac, who, fortunately, was fairly fluent in the Mercurian tongue, explained their mission. He was earnest and eloquent. And when he had finished, having done his very best, the King, after a whispered conference with his councillors, made his speech of condolence!

Sir Isaac was agast. He translated the King's words briefly to Tubby and Ameena.

"How dare they?" the girl cried. "It is inhuman. Tell him I say!"

Sir Isaac interrupted her, in a whisper, for the Audience Room was intensely quiet.

"Your position is not so important, Ameena. Your own people refused to mix up in this inter-planetary war. How can you expect——"

"My people have no weapons of war," she defended passionately. They know nothing of fighting. Never has voice been raised in anger to us world. What could they do to help, if they would?"

"You let her alone," Tubby whispered vehemently to Sir Isaac. "Don't get the right idea. You tell this King he can help. Ain't he got that Light-ray? Make him lend it to us!"

Sir Isaac then requested the use of the Light-ray—a sufficient amount of its apparatus which they could set up on Earth for defense.

At this a stir ran over the assemblage. The King's guards, squat little men in leather jackets and wide, knee-length trousers, shouted for order. Several young girls flapped their long red-feathered wings—only the women had wings, it seemed—and one fluttered across the roof near the ceiling, until commanded by the guards to cease.

The King looked exceedingly grave at Sir Isaac's request; his whispered conference with his advisors lasted several minutes. At last he shook his head.

Sir Isaac translated his answer. "He says he is sorry. They could not trust their Light-ray to another world. He claims the Earthmen would then learn its secret and some day might use it against Mercury.

"He's a fool!" shouted Tubby angrily. "Ain't they got it on Mars already? An' maybe on Jupiter!"

TUBBY SASES THE MERCURIAN KING

He turned toward the King. "Say listen here you——"

Thirty feet separated Tubby from the King at that moment, but he encompassed it in one bound, for on so small a planet as Mercury even Tubby weighed hardly sixty pounds! He landed beside the King's chair.

"Say, listen here you——"

As Tubby's fat little body went hurling through the air pandemonium broke out in the room. Girls were fluttering about; the guards were pushing and shoving the crowd. One or two of the older women fainted. A little joy broke into terrified screaming.

The King, finding he was not hurt, ignored Tubby's fist in his face, and with rare presence of mind rose to his feet, shouting reassuringly to the assemblage. Three of the nearest guards, their faces dark with anger, were making for Tubby belligerently; one of the aged councillors put a restraining hand on his shoulder, but he shook it off.

Sir Isaac bawled:

"Come back here, you fool! They'll kill us all!"

It was Ameena's pleading voice, rising above the tumult, that brought Tubby to his senses. He stopped abruptly his abuse of the King, and with another prodigious bound leaped over the heads of the intervening people, and landed back beside his friends.

"Come on, let's get out of here," she gasped. "This here Mercury ain't gon' to get us nothin'!"

SYNOPSIS OF TWO PRECEDING INSTALLMENTS OF "AROUND THE UNIVERSE"

WHILE watching a game of cards "Tubby"霍uddenly finds himself out in the open under the stars. He also finds that he has been endowed with a power of wishing and has his wishes come true. He wishes that he could know all about the stars and astronomy and there appears before him a man who introduces himself as Professor Isaac Swift DeFoe Wells Verne. The Professor tells "Tubby" that he will teach him all about astronomy. Tubby then wishes that he could travel everywhere in the universe and before them appears a space flyer which Sir Isaac says is his invention. They start for Venus. Landing on Venus, they meet a young lady whose name is Ameena. She tells them that the earth is in danger. Her people have found out that the Martians are about to descend upon the Earth and conquer it. Emigrants from both Mars and the Twilight People of Mercury, as the latter are going to assist the Martians, have been to Venus and tried unsuccessfully to enlist the aid of the Venusians. She says that the armies of Mars and Mercury have already conquered the Moon and placed outposts there.

The Professor declares that they must go for help to the Light Country located on Mercury, as its inhabitants are not going to enter into the war. At 7:30 p.m. Professor "Tubby" and Ameena land upon the surface of Mercury.

CHAPTER V

IN WHICH THE MERCURIANS PROVE THEMSELVES UTTERLY SELFFISH TO THE DISAPPOINTED VOYAGERS, PURSUED BY THE ENEMY, HASTEN TO JUPITER

HOW selfish is human nature the Universe! After a voyage of some thirty million miles, the travelers might quite as well have remained on Venus! The Mercurians of the Light Country were sorry—indeed, they greatly deplored the action of their neighbors of the Twilight Country in joining with the war lords of Mars against the unoffending Earth—but they would do nothing about it! How simple all human problems become, when viewed in that detached spirit! How human nature does repeat itself, wherever in the Universe it may be found!

The audience with the ruler of the Light Country took place at 9:40 p.m., Earth's
Sir Isaac, with true diplomatic suavity, waited until order was restored. He then paid his respects to the King, apologizing for Tubby's conduct, and stating with curt dignity that the Earth would solve its own problems and look after its own safety in its own way. After which, escorted by the King's guards to protect them from the increased populace, the three visitors coldly departed.

As they left the room, a young girl—surely a beauty of the other girls in the room as to mark her of another nation—climbed from the balcony into one of its outer windows. Posing there a moment, she launched herself into the air, spread her wings and flew away.

Sir Isaac, Tubby and Ameena were on the palace steps when this girl flew past, just over their heads. She shouted something venomously at Sir Isaac, and rising higher, flew rapidly toward the Narrow Sea and the Twilight Country.

Sir Isaac did not mention this incident then to Tubby or Ameena, who had not noticed the girl. Indeed, he forgot it in a moment, though afterward it was brought upon his mind unpleasantly to his memory.

FLYING THROUGH SPACE ONCE MORE

It was 11:45 p.m., Earth time, when the vehicle was again launched into space. When they had passed over the Dark Country and had left the atmosphere of Mercury—headed this time away from the Sun, back toward Venus and the Earth—the three interplanetary adventurers sat down quietly in the instrument room to determine what should now be done, in the face of this unexpected disappointment.

"An' here we went an' wasted all day," Tubby moaned. "We could have been almost anywhere while we was foolin' around here with them selfish, pin-headed—" He trailed off into abuse of the Mercurians.

Sir Isaac, more practical, summed up the situation as it now stood. "We have, of course, no means of knowing whether the inhabitants of Jupiter are against us or not," he said. "But at all events, at the next opposition of Mars with the Earth we may expect their attack."

"Less'n two months from now," Tubby put in gloomily. "In fifty-six days and eighteen hours," Sir Isaac corrected. "I assume their method will be to mass their army first upon the Moon. From that point of vantage, always close to the Earth, they can launch their successive attacks at will."

"That is what they will do," Ameena cried. "From the Moon, of course."

Sir Isaac added: "What will they do to the Earth? You say they're goin' to kill us, but you ain't never said how."

Then Sir Isaac, his voice trembling in spite of himself, explained the horribly destructive power of the Mercury Light-ray—that beam of red-green light-fire, which from giant projectors ignited everything within its range over a distance of fifteen miles! And the tremendous war-machines of the Mar-
Doctor Hackensaw's Secrets

By CLEMENT FEZANDIE

No 20
A Car for the Moon!

author's note. Will man ever be able to travel to the moon or to the nearest planets? The problem is one of perennial interest, and many fiction writers have attempted to solve it. Numerous fantastic schemes have been proposed, but I have endeavored to show in the following story that the sending of a passenger to the moon is by no means an impossibility.

Doctor Hackensaw's Secrets

By Clement Fezandie

No 20
A Car for the Moon!

View of the Gigantic Machine Designed by Dr. Hackensaw for Projecting His Moon Car on Its Journey Away From the Earth. The Passengers Are Placed in the Car Itself, and As the Huge Wheel Is Rotated by a Giant Electric Motor, the Chain Is Fed Into the Hub of the Wheel and Causes the Radius of the Swing to Be Increased. When the Velocity of the Car Has Reached a Certain Point, It Is Suddenly Released and Leaves the Earth.

"Doctor," said Silas Rockett, "Did I understand you to say that you intended to send a car to the moon?"

"You certainly did, Silas," replied Doctor Hackensaw. "The moon was in a condition to support life hundreds of thousands of years before the Earth. Hence there may be intelligent creatures on the moon with inventions far in advance of our wildest speculations. Think what it would mean to open communication with them and learning what it would otherwise take us a hundred thousand years or more to learn! It would be a triumph such as no man has ever achieved before me!"

"I understand that," said Silas, "but what I don't see, is how you are going to send your car of specimens to the moon. Many fiction writers have tackled the problem of communication with other worlds, but I confess that none of the methods I have read about seems to me to have any scientific basis. But tell me first, straight out, whether you really believe it is possible, at the present day, to send a car of any sort to the moon?"

"Not only do I believe it possible, Silas," replied Doctor Hackensaw, "but my conviction is so strong that for the past few years I have been secretly at work on the preparation necessary for sending a car full of specimens to the moon."

"What?" cried Silas in amazement. "You have already started making preparations for the trip? Is it possible that you have discovered some new force, some new means of locomotion?"

"No, Silas. The forces I shall use are all well known."

"But how in the world will you accomplish it? None of the schemes I have read about seems to offer the slightest possibility of being put into practice."

"What schemes have you read of?"

Silas and the Doctor discuss various schemes.

"First of all there was the idea of being carried to the moon by birds. If I remember correctly, it was Cyriano de Bergerac who made the journey in that way. Such a method is of course impossible."

"True. No bird could fly to the moon. I'll admit that."

"Next, Edgar Allan Poe sent Hans Pfaal to the moon in a balloon. That, too, was impossible."

"I am ready to admit that also. Understand me; I am not a believer in the ether theory of light. Consequently I do not believe the heavens are filled with the so-called 'ether.' Nor do I believe there is an actual vacuum in space. My idea would be rather that there is a highly rarefied atmosphere between us and the planets. But, regardless of the question as (Continued on page 502)
Variable Stars

By RUFUS O. SUTER, Jr.

The average person is little affected when he considers that if Aristotle should come to life today a casual observation of the heavens would reveal no change in the brilliancy of the stars. We have grown to look upon the sky as the paragon of constancy; but, as is often the case, we do not realize that this constancy is one of the greatest marvels which Nature presents. Every star is an incandescent mass so huge that if the earth were dropped into its seething depths, the catastrophe could only be compared to the dropping of a marble into a roaring steel-mill furnace. Nevertheless, each of these suns has poured into space for countless ages energy on the average amounting to 100,000 horse-power per square meter. Throughout the ages this unbelievable output has continued, unimpaired, and without fluctuation. Fortunately, everybody does not regard matter-of-fact phenomena indifferently. Few discoveries would be made if this were the case, because curiosity often leads to the most successful investigations. Astronomers have been so impressed by the proverbial constancy of the stars that they have searched the sky for ages to find some exception. The ancients discovered the well-known Algol, which undergoes fluctuations; and Mira, which every ten months drops from a luster rivaling that of the North Star to invisibility. Eighty years ago Argeinder, the great German astronomer, cataloged eighteen stars which he believed were inconstant. Today scrutinizing observation has revealed that out of the 125 million stars visible through the most powerful telescopes, only 5,000 change in brilliancy. Thus, peculiar as it may seem, irregularity of energy-production in the Sidereal Universe is the exception rather than the rule. These variable stars are a class by themselves, governed by laws with which we are largely unfamiliar. Professional and amateur astronomers the world over have united forces in obtaining systematic observations, with the hope that in time data enough may be secured to solve the mystery which surrounds them.

Observation already has revealed the fact that variables fall into five distinct classes:

1. The nova, or new stars, which sud-
Star Clusters

By BASIL NEWCOMB

OF THE HARVARD COLLEGE OBSERVATORY

Single stars, quite free from close alliances, are apparently not in the majority in our universe. Very frequently stars occur in groups of two and three. Sometimes a score or two associate together, and occasionally we find them in aggregations of a hundred thousand or more.

The ancients gave mythical names to the familiar groups of bright stars, and these constellation names are used to this day. But the constellations in general are chance and often imaginary arrangements; their stars are seen near to one another by projection only. The real grouping or clustering tendency mentioned above is something different. It signifies actual association in motion, origin, color and distance, indicating that the stars of any one group or cluster are physically related to one another.

A few constellations of the ancients, however have been proved by modern research to be clusters in the true sense of the word.

(Continued on page 498)
High Power Telescope for Your Garden

A New Six-Inch Diameter High-Powered Reflecting Telescope Suitable For the Garden Or Other Locations Has Been Brought Out By An American Manufacturer. There Has Been a Long Feeling For a Telescope of This Type Which Should Cost Neither Much Nor Little, But Be Capable of Fairly High Magnification. The Man At the Left Is Telling the Time By Focusing the Telescope On the Sun and Reading the Dial Settings. As Given In the Instruction Book Furnished With the Instrument. The Center Picture Shows Details of the Telescope, Including the Six-Inch Diameter Mirror, Refracting Prism and Eye-Piece. The Right-Hand Photograph Shows How the Telescope Appears In the Garden and How Convenient It Is For a Person To Look Into the Eye-Piece, Which Is Placed At the Side of the Telescope.

This garden telescope is as useful by day as by night. It may be placed on the lawn or a pedestal, or may be set up on the porch for viewing distant objects. If the city dwellers have a place available on their roof, it may be equally well placed there—on the verandas of summer hotels, in the mountains or on the shore—always ready for instant use. It requires no care—no more than would be bestowed on a garden sun dial. The mirror is a polished glass concave disk, silvered on its front surface, lacquered to protect its silver coat. The mirror is protected when not in use by a cast-bronze cover with machined edges that fit tightly to the mirror cell. The mirror always faces the object viewed and since the eyepiece can be moved around the end of the blade to any position, the observer may always be comfortable whether the object he is viewing is overhead or on the horizon. There are none of the back-and-neck-breaking attitudes required in some positions of the common telescope.

SIGHTING AND FINDING

On the back of the blade are two pointers, and these are used very much like gun-sights in picking up distant objects. When they are in line with the object, it will be seen in the eyepiece. They constitute a finder. For terrestrial use, then, the declination and base clamping screws are released and the telescope can be swung around and brought to bear on any desired object. No other adjustments are necessary. The mirror and eyepiece may be taken indoors, if desired, when not in use, for safe keeping.

The earth turning over on its axis gives the stars an appearance of moving across the heavens. To follow the stars, therefore, the telescope has one bearing parallel to the earth's axis, thus constituting what astronomers call an equatorial mounting. The other bearing of the telescope, the declination axis, which carries the blade and telescope and it permits pointing or setting on any object in the heavens. A part of the bell is cut away to prevent interference with the blade in certain positions. This is shown clearly in the photograph above.

AS A TIME KEEPER

Like the sun dial, the garden telescope gives us sun-time, but with greater accuracy. One of the photographs indicates how this is done. The telescope is pointed at the sun, not by looking into the eyepiece, but by projecting an image of the sun on a card placed near the eyepiece. The sun-time is then read off on the hour circle on the rim of the bell. Watch or standard time may be found by consulting a table for this purpose in the booklet furnished with the telescope. If the house clock, or your watch, has run down, the time is thus readily recovered on any clear day. This garden telescope is a complete reflector. It comprises a six-inch parabolic silvered mirror of approximately two feet focal length, totally reflecting glass prism, with one-half inch E.P. positive parabolic erecting eyepiece giving fifty magnifications; solid bronze combination mounting.

SCIENCE AND INVENTION aims to be timely, as timely as the news first. SCIENCE AND INVENTION is the magazine to read.

Some Feature Articles in October

SCIENCE AND INVENTION

SCIENCE AND INVENTION has the goods. This magazine is not made up several months in advance, as others are, but very often the forms are held on the presses and new matter is substituted for articles that are of no particular importance at the time.

NEW NAVAL RADIO-CONTROLLED TORPEDO,
By Georges B. Bunnell, Naval Expert.

AERIAL BLOOD-HOUNDS TO CHASE ENEMY AIRCRAFT IN FUTURE WARS,
By Raymond Francis Yates.

SOME REMARKABLE FINGER PRINTS,
By C. B. Bunnell.

REFUELING AIRPLANES IN FLIGHT,
By C. B. Bunnell.

THE MARK VIII TANK—AND WHAT IT CAN DO,
By Ismael Ginsberg.

GOLD FOIL—HOW IT IS MADE,
By Ismael Ginsberg.

HIGHER STORY SKYSCRAPERS NEXT.
By Dr. H. Becher.

A NEW SOLAR POWER PLANT.
By Dr. H. Becher.

AROUND THE UNIVERSE—SCIENTIFIC FICTION.
By Ray Cummings.

DR. HACKENSAW'S SECRETS,
By Clement Fenziadé.

LOADING RECEIVING SETS FOR LONG WAVE LENGTHS.
By Marius Logan.

RUBBER ROSE—BALLS AND OTHER GOODS—HOW MADE.
By Marius Logan.

SPECIAL PRIZE CONTESTS.

439
The Paris Observatory

The establishment of the Paris Observatory goes back to the days of Louis XIV. Richelieu originated it as far back as 1664, Colbert took it in hand, and it is curious to read that the object of it was to rival or to equal the observatories of England, of Denmark and of China. Claude Perrault, celebrated architect of the Louvre, put up the first building and work was begun upon it in 1667. Efforts were made to get the great astronomers of the world, such as Huyghens, Newton and Leibnitz, to come to the observatory. None of these would come and eventually Jean Dominique Cassini from the famous University of Bologne was put in charge, and three generations of Cassini's succeeded each other in conducting the observatory.

It is interesting to read about the old-time instruments of the eighteenth century. The telescopes were of small diameter with long focus lenses. For observations in the regions of the zenith, a building without a roof was used, and there was a long gap or slot made in the northern wall of the building for raising and lowering objectives to different heights. We are told that there was a woman too, whose husband carried on it top an objective of two hundred and fifty foot focus. There was no tube and the astronomer at the base of the tower held the eye piece in his hand, remarkable dexterity being required to make observations under these conditions.

Of course, many discoveries were made in the observatory. It was there that the Danish astronomer Roemer determined that light required from seven to eight minutes to traverse the distance from the sun to the earth, really 8 minutes 20 seconds, basing his calculations on the eclipses of the satellites of Jupiter. In 1657 the catalogue of fixed stars was begun. In the latter half of the eighteenth century, great activity obtained which was rudely interrupted by the French Revolution. Cassini the Fourth, as he was called, objecting to the treatment by the Convention, resigned on the day of an eclipse of the sun, September 6, 1793, and then had to put in six months in prison.

Mr. Jerome de Lalande was the Director of the observatory for some ten years following the Revolution, and he is said to have enjoyed great popularity.

His great treatise on astronomy was used for several generations by students and is still consulted. A curious thing is told about his gastronomic propensities. He was very fond of eating caterpillars and spiders. Every Saturday he used to take supper with a friend, whose wife collected for his benefit a number of these disagreeable creatures and gave him a sauce of them all. He said that the spiders tasted like nuts, while the caterpillars reminded him of peaches or plums.

The great Arago figures among the workers on the staff of the observatory, concerning himself with geodetic operations, laying out the meridians during war time, which involved his being seized as a spy, and captured at sea by a privateer. He eventually reached Marseilles in 1809, after his mother had given him up as dead.

We finally come to Le Verrier. He was said to have been very unpopular, but won world-wide fame when he discovered the planet Neptune. He has been termed "the Giant of Modern Astronomy." Neptune, it must be remembered, was found by pure mathematical calculation, the data leading to its identification being based on the motions of other planets.

Many of the old-time instruments are still preserved in the Museum.

The regular work, of the ever busy observatory, constantly goes on, and the photograph of the heavens has been completed at last.

Many special investigations, such as those of the satellites of Saturn and those of Jupiter with photometric investigations, had been carried on. By using polarized light and the spectroscope, great differences in the luminosity of stars have been observed and have given the base for determining temperatures. Thus the temperature of the sun has been placed at 5,320° C, 9608° F.—far more than that of the electric arc—and these have coincided with other former observations in which polarization was not used.

The temperature of one of the stars in Taurus is given at not less than 40,000° C., 72,000° F., in round numbers.

Time signals are sent from the station on the Eiffel Tower covering a great part of the world so that chronometers can be regulated thereby. These signals give time as determined in the observatory.

There are three clocks of the observatory kept in a crypt. The temperature practically never varies and the clocks are accurate to three tenths of a second in a day. Sometimes no error can be detected. An astronomer can, by observing a star, determine time to one-tenth of a second, but the clocks of the observatory surpass them many times in accuracy. By methods at the disposal of the observatory the geographic positions of the principal points on the earth's surface are now being fixed. Our illustrations show some of the modern apparatus of the famous observatory and a famous old planetarium.

To Study Sun's Eclipse

The afternoon of Sept. 10 next a party of eight men, headed by Dr. John A. Miller of Swarthmore College and Dr. Heber D. Curtis, Director of the Allegheny Observatory, Pittsburgh, will gather at the tiny village of Verbeniz, Mexico, to spend 189 seconds—the length of time the sun will be completely eclipsed by the moon—in important astronomical photography.

After journeying to Verbeniz, which is near Cuencame, halfway between El Paso and Mexico City, the party will spend more than six weeks in setting up intricate and fragile apparatus, weighing more than two tons, which will be used in the making of the pictures.

The camp of the Sprout Expedition, as the party will be known, will be located at an altitude of 12,000 feet. The purpose of the expedition to obtain large-scale photographs of the sun's corona. In the equipment is a telescope sixty-five feet long. The Ein-stein theory will be attacked with a powerful pair of cameras, with lenses eight and a half inches in diameter, each with a focal length of fifteen feet.

Dr. Curtis built at the Allegheny Observatory machine shop an instrument for studying the spectrum of the sun in the 'red' region, a thing never before attempted.
The mounting of a telescope for celestial observation is of utmost importance to obtain a decisive rigidity and avoid the disturbing flexibility, detracting from the exactness of observations.

The observer presses his head with a varying force against the eye aperture and any unsteadiness of the stand or the connections is transmitted as tremors or a flicking of the object across the telescope lens. The magnification of the telescope amplifies the movement and the unsteadiness of the mounting is a pronounced handicap to the observer.

A perfect telescope inadequately mounted will give less satisfaction than a telescope with poor or faulty lens, that is supported with a proper steady pedestal with facilities for shifting the position of the telescope without decisive exertion of the observer while holding his eye steadily on the object. Obviously a jerky movement will carry the observer off the point, because of the limitations of the small field of high power telescopes. To lose the object is disconcerting and probably necessitates a long search that is annoying to the user of the instrument.

In this article a description with fully illustrated drawings for a telescope mount is given.

The construction purposely avoids expense of construction, through the use of available materials, mainly wood, however without sacrifice of the essential features for obtaining the desired stability and adjustment.

Assuming it is desired to mount a telescope of four or five feet in length with a magnification of one hundred to two hundred times, which instrument will meet the general requirements for a modest equipment, the adopted height for the tube of the telescope of five feet will afford the use of a seat for the observer, which detail from the point of time required in observations is essential to some degree of comfort.

The three legs of the tripod are secured with cross braces of lighter wood, while the upper ends terminate and are secured to a circular brass or steel plate. A triangular plate in the midposition serves jointly to brace the legs and as a section of the bearing.

The rotating part of the mount or carrier is also made of wood. A heavy block secures the pivot bearing, while side cheeks are fastened to this, using sheet metal brace plates, which side cheeks have at the upper ends trunnion bearings or bearings for the horizontal axis of the instrument.

A holder for the telescope is made in the form of a saddle, this part being provided with detachable clamps, for convenience in removing the telescope after use. The removable feature is important, as a telescope requires protection from the elements as far as possible. Moisture or sweating of the telescope is avoided by careful storage in a dry box or housing. Dirt and cinders on the lens will dull them through need of frequent wiping. Rain will frequently rust the adjustments inside the tube or make the bronze adjusters stiff.

The detachable saddle is made of wood, with sheet metal braces to hold this solid. Two trunnions or bearings are fitted to the sides for rotating in the horizontal bearing guides of the carrier. The clamps are of sheet metal bent to conform to the telescope.
August Heckscher equal lengths, and importance impossible velocities. Since this by a presented familiar in designed nishes further astronomical expeditions this confirmed his theoretical predictions. Moreover, there are certain physical experiments and phenomena for which Einstein’s theory furnishes the most satisfactory explanation. As time goes on, this theory will either be further established by additional evidence, or else new phenomena may be discovered not in accord with it. Our present problem is to learn to think in terms of this theory.

TIME ON THE MODEL IS REPLACED BY LENGTHS

The theory of relativity furnishes no new evidences at usual velocities which are so small as compared to the velocity of light (300,000 kilometers per second). Even the velocity of our Army rifle bullet is less than 1 kilometer per second. Therefore, a model must be so designed as to show phenomena at very high relative velocities, say 10 per cent, 20 per cent, etc., of that of light. The solution lies in replacing time by distances. Everyone is familiar with this mode of representation of time. For example, fluctuations in the price of a commodity in various years are represented by a curve, we replace time (years) by a length (say 1 cm. = 1 year). With this substitution of distances for time, the model needs no parts revolving at practically impossible velocities. Since the velocity of light in vacuo is a physical constant of great importance in the theory of relativity, it has been selected in the model for units of both length and time. This means that a unit distance and a unit time are represented by equal lengths, and a material point which moves at our assumed velocity of light covers 1 unit distance in 1 unit time.

THE MODEL MAY REPRESENT TIME-SPACE RELATIONSHIPS IN A DIFFERENT WORLD

In order to dodge completely the question as to whether Einstein is right or wrong, we shall simply say that the model shown in Fig. 1 represents the space-time relationships in an entirely different world, where time or may not be similar to ours. We shall make this world logical in itself and should we find that our conclusions, derived from the model, agree quantitatively with certain observed physical phenomena, we may be made to believe that the queer world, represented by the model, may be our own world after all.

To make the conditions as simple as possible, we shall assume that in this fairyland all motion takes place along the same line XX’ (Fig. 2) and that we have two observers, S and S’, who with their platforms and instruments are in relative motion with respect to each other, along the XX’ axis, at a uniform velocity q. This means that to the S observer (who thinks himself stationary) the S’ system is moving at the velocity q to the right.

On the other hand, the S’ observer considers himself stationary and to him the S observer with his platform and instruments appears moving to the left at the same velocity q.

According to a fundamental postulate of relativity, there is no absolute stationary point of reference in the universe and all motion is relative. Hence, there is no logical contradiction in the foregoing views of the two observers. Furthermore, we shall assume that at some time the two observers were stationary with respect to each other and adjusted their standards of length and their clocks so as to agree to a very high degree of precision. Each observer has his own reference (O and O’), from which he measures his distances (x and x’) along O0, and the clocks at O and O’ are set, that at the instant when O and O’ coincide, both clocks show zero (say twelve o’clock). Let A be an event, say an instantaneous flash of light, dependent of both observers, and let each observer be asked to be prepared to watch for it and to find (a) the distance (Continued on page 480).
Cirrus clouds furnish one of the best means of foretelling weather changes. If the weather be fair, no change is likely to take place until these clouds appear. They give a warning of from twelve to twenty-four hours before wet weather sets in. They are the forerunners of all storms and move from a westerly or southwesteir direction, and from three hundred to five hundred miles in advance of the storm. If they move rapidly, the storm is approaching rapidly. If they drift along and the ends of their feathery whips turn down, it is an indication that the weather is likely to continue fair, but if they turn up, rain or snow is to follow within twenty-four hours.

If they form in bands and lose their feathery appearance, it means high winds. If they form and dissolve, fair weather will continue for at least twenty-four hours. Cirrus clouds of “mackerel” formation foretell wind and rain and snow; with long streamers reaching upward, wind alone.

Cirro-stratus clouds usually precede rain or snow from twelve to twenty-four hours. They move from a westerly or southwesteir direction; the same direction from which the rain or snow or general storm centre is coming and are usually accompanied by high winds.

A mottled sky, with light drifting clouds, foretells fair weather.

Cirro-cumulus clouds are termed “fair weather clouds.” In Summer they foretell dry, hot weather. When their small tufts merge into one another, several days of fair weather are due.

Cumulus clouds are considered fair weather indicators, but when they appear the day is generally warm and sultry and the clouds form during or shortly after the hottest part of the day. They are also the clouds that usually precede thunderstorms and are called “thunder heads.”

They start close to the horizon with a low, flat base and grow and expand steadily into the upper air without the least sign of local storm development. They gradually rise higher and higher and become well rounded masses with beautiful domes. Then, if thunderstorms are to develop, there will appear fine, feathery Cirrus clouds distinctly separate from the Cumulus clouds. Soon the Cumulus will turn into a large gray and grow darker as they come nearer. From beneath the Cumulus cloud will shoot out a small, dark, threatening cloud which will rush forward with a great burst of wind and sometimes rain.

If wind comes before the rain the squall will be of short duration. If rain comes before the wind it may last an hour or two. The heavier the rain the quicker the squall passes.

Cumulo-stratus clouds form in the lower air strata. They assume something of a Cumulus formation, with a flat, extended base and a partially rounded, but ragged, broken top. They are Winter clouds and appear in cold, dry weather. They have a dark, threatening appearance, but are really heralds of fair weather. They dissolve in late afternoon or warmer part of the day.

Stratus clouds are the lowest of all clouds and, when resting over the land or water, are called fog.

When fog sets in before midnight the following day is likely to be rainy, but if fog appears in the morning after sunrise, the day will be fair.

Nimbus clouds are those from which rain invariably falls. They are without complete definition; a broken, confused mass being driven by the lower easterly winds.

A general increase of cloudiness at sunset means rain or snow. Tufts of cloud forming a doubled or mottled sky indicate fair weather.

A fog, arising in the morning is the surest sign of a fair day.

Small, inky clouds indicate rain.

In cold weather, a bank of dark cloud forming in the north or east with a southerly or easterly wind indicates rain or snow. An excessive clearness of the atmosphere is an indication of rain or snow to follow within twenty-four hours.

A low, overcast sky, with light northerly wind in Winter, foretells snow. Ragged clouds moving rapidly indicate wind and rain.

Dew indicates a fair day. Wind or cloudy nights prevent frost or dew.

A yellow sunset foretells rain; a bright straw yellow, wind and rain, and yellow blending into orange, fair weather.

A red sunset, a fair day.

A red sunrise, a wet day.

A gray sunset, a wet day.

A gray sunrise, a fair day.

Dark Indian gray sunrise or sunset, rain.

Pale green at sunset, rain.

Combined green and red sunset or sunrise, probably rain.

A red disc at sunset means fair and warmer.

Cool wind over a warm surface or water, or a warm wind over a cool surface or water creates fog.

Sudden fall in temperature causes showers.

Sudden rise in temperature, fair weather.

High temperature and high humidity, thunder-storms.
Spectroscopes—How to Build Them

By C. E. BARNES

Spectroscopes are instruments with which theokeriewve and labor give a thrill of delight not soon forgotten. But it remains for the spectroscope to absolutely dazzle one with a new world of mystery and beauty:

MAKING THE PRISM

A borosilicate 60° prism suitable for a tabletop-spectroscope will cost some twelve or fifteen dollars; but the novice has two alternatives: the purchasing a two-inch blank prism for about three dollars and grinding and polishing it himself, or the construction of one of three evenly matched pieces of thin clear negative glass by binding and cementing together with acetic glue so as to be absolutely water-tight, and filling with distilled water or, better still (at least so far as the increased refractive and dispersive powers go), with carbon disulphide. In the latter case the prism should be well capped and corked, as this chemical is not only volatile and malodorous, but inflammable. If, however, this fluid prism is thoroughly cleaned with a solution of carbolic potash and distilled water affords a very interesting spectrum. Various liquids may also be experimented in a fluid prism.

REQUISITES OF A TABLE-SPECTROSCOPE

The three requisites in a tabletop-spectroscope system are: the prism, the collimator with lens and slit for producing the spectrum, and the telescope for viewing the same. The length of the collimator-tube should be approximately the focal length of the double-convex lens used to magnify the image of the slit at the other end of the tube; and it is well to have the slit-device on a separate adjustable tube so that a clean line of light cuts the prism, is refracted and dispersed, and the emergent beam taken up and magnified by the telescope system placed at such an angle as will insure a sharp view of the famous Fraunhofer lines. When pointed at the sun, these cut through the brilliant bands of color parallel thereto in myriad profusion. But, as the prophet said, "the hairs of your head are numbered," so science has numbered and annotated every line and combination of lines in that vast orderly array—the alphabet of the physical universe. Every one of the ninety-two known elements gives a distinct and separate spectrum, from hydrogen, the lightest, to uranium, the heaviest, in atomic weight when made incandescent in laboratory research and yet all are there in one combined solar blaze! It is well worth while to build a spectroscope just to behold this one amazing phenomenon.

The length of your tubes for collimator and telescope will depend upon the focal length of the double convex lens in the former and of the achromatic lens used in the latter system. It is well to have sliding ends to both so that accurate adjustment is possible—that the slit may cut a sharp image on the spectroscope and that the telescope tube it up sharply beyond. Usually when the telescope is first focused upon some distant object, this is sufficient adjustment, but success demands largely upon a cleanly magnified image of the slit which is seldom more than a hair-line in width. The brighter the source of light the narrower the slit, so that it is necessary to have the jaws adjustable with set-screws in the collimator head. Any pruner will supply you with new inches of new hair-line brass rule which has almost a razor-edge and is even throughout. With this rule the jaws may be made, crossing the center of the hole in the collimator head, which should be small, not over three-eighths of an inch for a one-inch lens at the prism end, nor over three-quarters of an inch for a two-inch lens. This is the size I use with great satisfaction.

The blocks upon which the telescope and collimator are fixed should be bolted to the circular table with a single center bolt so as to turn at will. The prism should be mounted upon a separate circular table that not only turns from right to left, as occa-
Man and the Stars

By J. S. DOW

I T is surely one of the strangest illustrations of the absorption of men in their own small affairs that most people are content to pass their lives without learning the most minute details of the universe. The most brilliant scholars are without curiosity as to the nature of the planets and the fixed stars. My own interest in the solar system was awakened by a chance gift, as a prize at school, of Sir Robert Ball's popular work on "The Story of the Heavens." I was aware that the distance of the sun from the earth approaches a hundred million miles. But it was a revelation to discover that the sun, the most brilliant star in the Heavens, is roughly a million times as large as a man. Was I equally impressed by the discovery that the sun, apart from the rotary motion of the earth on its axis and the motion of the earth in its orbit, is moving through space at a gigantic speed—"that every three days the solar system accomplishes a stage of about two million miles in its journey towards the constellation Lyra." Fortunately the distance of Lyra is comfortably great for the eye to follow, and even at this speed, the journey would take at least a million years! Is there any study more rich than astronomy? The discoveries and predications? Is there anything in science more impressive that the prediction by Halley of the transit of Venus, which he knew he could not live to see, but which he foretold to the minute and commanded the attention of posterity? Again, can one imagine a coincidence (for it can have been nothing else) more strange than the account of the moons of Mars in Guiliéver's Travels? It was narrated that the astronomers in the Island of Laputa had been keen and very powerful telescopes and had detected two moons of Mars. Now this was just 150 years before the existence of two moons of Mars, was ascertained, with the spectroscope, by Professor Schwabe. These two moons have most curious properties. Having escaped detection for so long they are naturally small objects, only about 15 miles and 22 miles respectively in diameter. Interest attaches chiefly to the inner of the two satellites, which is only 4,000 miles distant from Mars, whose bulk must render it invisible during 2/3 of its period in the most favorable circumstances; it is never visible at the poles. The most singular thing about this inner moon is that, whereas Mars, like the earth, rotates on its axis in the direction of the revolution of this moon is only 7 h. 40 min.—a circumstance believed to be unparalled in the solar system. The rapid motion of this moon would be evident to an inhabitant of Mars; it would have a day visible to the naked eye, and the clockwork driven moons occasionally seen on the stage. Strange to say in Guiliéver's Travels it was stated that the period of one of the moons was also predicted, the period being given as about 10 hours—a remarkably close guess!

It is interesting to observe how often scientific discoveries, apparently only of academic interest, eventually make their way into direct and practical bearing on human affairs. Our knowledge of the constitution of distant suns is derived chiefly from the spectroscope which enables us to identify arrangements of spectral lines characteristic of known elements in the sun. The discovery that most of the familiar terrestrial metals are present in the sun. Not only this, but the spectroscope enabled the existence of a new element, helium, to be detected in the sun before it was known to exist on our earth. It is related that when a popular lecturer was enthusiastically describing this incident, a voice at the back interrupted the proceedings by the bored inquiry "Who cares whether there's helium in the sun or not?" Ultimately, as is now well known, helium was discovered by Sir William Ramsay as a minute constituent in the earth's atmosphere, although with great difficulty and in very small quantities. Afterwards it was discovered that helium could be produced in a commercial quantity from natural gas in Canada and the United States. Shortly before the Armistice sufficient was accumulated to fill the envelopes of airships with this "rare" gas, which had the great advantage over hydrogen of being non-inflammable. One picturesque possibility that has arrested the attention of writers of fiction is the sudden arrival in our solar system of a strange planet. Mr. G. K. Chesterton has written a story in which the consequences of such an invasion are graphically told. Some concern was expressed in the daily press a few years ago at the birth of a new star in the Heavens whose growing brightness led to the belief that it was moving rapidly towards the earth. If such an approach of a planet ever came to pass, the Astronomer Royal would be the most important expert in this nation. True he could do nothing to ward off the catastrophe, but he might be able to predict the probable course of events, and at least inform us of the period which was to elapse before serious trouble would be experenced. The immense distance from which such a foreign earth would probably have to travel is a comforting circumstance. Speaking generally it would appear that the incipient threatened invasion of our solar system by a body large enough to have any material effect, would be, in its initial stages, a very gradual process.

The study of the stars confirms the age-long philosophical conviction that time and space are only modes of thought—that to someone in a larger scheme of existence our terrestrial sun and moon, our childhood, and a few thousand years of the earth's history but a flash of time. Throughout the universe dimensions of time and distance correspond. As we have ascertained that bodies and greater distances traversed, so the period of time increases and demands larger units. This was well described a few years ago in a work by Mr. E. Fournier d'Albe, who contrasted the motion of the planets round the sun, with the similar motions, on a far more minute scale, of the electrons that circle round the central nucleus of the atom. The conception of an atom as the smallest particle of matter has of course been greatly modified since the acceptance of the electronic theory of the atom. We know that an atom is itself a complex system. To us the period of revolution of the electron round the atomic centre appears infinitesimal, the distance of the electron from the nucleus is roughly over one thousand times. This smallness may or may not exist also an "ultra-world," to the inhabitants of which our times and distances would seem as infinitesimal as those in the firmament. This leads us to a new conception of space for which there seems to be some scientific justification. In the space occupied by constellations scattered at immense distances and more or less regular intervals, and this condition continues indefinitely as we extend our observation. But the greater refinements of modern astronomical observations suggest that this is not the case, for a space exists an outer void where no more constellations are found but merely uncounted ones. It may therefore be conjectured that our universe is merely an isolated system, separated from other similar universes by distances immensely greater even than those dealt with in ordinary astronomy. When we are thus led to the conception of an ultra-world comprising a multitude of universes—each forming an object as minute in this vast world as the atoms of our own earth. We may also picture an "ultra-ultra-world," in which the ultra-ultra-worlds exist, almost infinitesimal object, and indeed an infinite succession of such worlds, each but a speck in the next greater. Another ingenious speculation by Mr. Fournier d'Albe may be recorded. We, on this earth, can control and rearrange the world. When we perform a chemical experiment, atoms enter into new combinations and their life as elemental molecules comes to an end—that is sudden, according to our notion of time for the change appears to take place practically instantaneously. But to an inhabitant of the ultra-ultra-world the change would not seem sudden at all. It would be a gradual process spread, perhaps over many "centuries" of the infra-scale of time. Similarly in the ultra-world we may conceive a Power bringing about changes in our universe executed in a flash of ultra-time but in our eyes proceeding so slowly as to escape detection. The "end of the world" then would come to us, not as a sudden flash of lightning, but as a slow and almost imperceptible change, which is yet more terrifying, because we cannot imagine the intelligence responsible. Here again, curiously enough, there seems to be some scientific justification for this conception of the ultra-ultra-world. If these minute changes we have the first faint indication of the final destiny of our universe.
Tantalam--All About It
By O. Ivan Lee, B.Sc.

FOREWORD

THE Great War focused the attention of the world upon the trans- scendent importance of the rarer metals and was reflected in the feverish activity to find and produce them so as to confer their marvelous virtues upon alloys for military purposes, ranging from battle tools to armor plate. Today, tungsten, molybdenum and vanadium are almost household words. But tantalum is a stranger to most of us. Your pragmatic chemist friend may recall with some effort that it is indeed a rare metal—of some academic interest—but will shake his head if pressed for details by the curious. No, he doesn't know what it looks like, and it isn't good for much anyway.

Because of the difficulties inherent in its production on a commercial scale in a pure state, metallic tantalum has remained a laboratory curiosity, and little has been available except occasional foreign material of fluctuating composition and variable properties. As a consequence, metallurgists and chemists have had but limited opportunities to explore the possibilities offered by an adequate supply of this remarkable metal.

After several years of intensive experimenting under the capable direction of Dr. Bulke, practical results have been attained and ductile metallic tantalum of great purity is now an industrial reality. Noteworthy results have already been attained, but the technical world is convinced that far more interesting results lie "just around the corner."

Tantalum

THE accompanying article by Mr. Lee, well-known analytical chemist, describes the occurrence, mining, and the latest methods of refining tantalum, one of the rarer elements which bids fair to enter the field of industry to an extent not dreamed of heretofore.

Pure tantalum is one of the heaviest metals introduced into commerce, being 16.5 times as heavy as an equal volume of water, or half again as heavy as lead. It possesses a very high resistance to corrosion, and may be used in the place of platinum for many industrial uses. It is not magnetic, nor is it attacked by nitric acid, and has a high melting point--1805° C. Tantalum is readily made very ductile and can be rolled or drawn into rods, sheets or wire. It may be lead through and sealed in glass like platinum, having the same coefficient of expansion as glass. A tantalum electrode with a lead or other electrode placed in an electrolyte solution, results in an ideal resistance to alternating direct current, the tantalum electrode lasting indefinitely.

By a nomenclature commercial tantalum of a very pure quality is now available, and can be used for making non-rusting pins, fine tools, surgical instruments, and jewelry. In the electrical field tantalum promises to find considerable use as filaments for special lamps and radio vacuum tubes, for use in electric heaters and resistance furnaces, for leads in glass lamp bulbs, for grid and plate electrodes, in radio and X-ray tubes, lightning arresters, electrolytic condensers, as well as for anodes and cathodes, for deposition of metals, such as silver, copper and gold. When alloyed with other metals it yields some very interesting and valuable results.

HOW TANTALUM WAS MADE KNOWN TO THE WORLD AND HOW IT CONFUNDED THE EARLY CHEMIST

It was in the year 1802 that the Swedish chemist Ekeberg announced that while endeavoring to unravel the nature of a queer black mineral from Kimito, Finland, he encountered most discouraging obstacles in his efforts to get it into solution. The metal assumed to be present, although resembling tin, tungsten and titanium, was yet none of these, but a new element, "because even in the midst of acid it was unable to take the liquid to itself." In playful allusion to these tantalizing difficulties, he named the novel substance "tantalum" from that legendary unfortunate, Tantalus, whose thirst, you recall, was only exceeded by his inability to quench it.

TANTALUM MINERALS AND ORES; WHERE THEY ARE FOUND

Today some thirty different mineral species are known to contain tantalum to a noticeable degree, but the great majority of these are merely of scientific interest and found only in public and private mineral collections.

They occur principally in granite rocks, the economically important ores being limited to a scant three or four, and of these, only tantalite is continuously utilized as a source of raw material, particularly the variety manganotantalite. Although of infrequent occurrence, tan-
bright greyish-yellow minutely crystalline powder analyzing 98.5% of tantalum and 1.5% of columbium, and is probably the rarest of all naturally occurring metals. A year later, it was also reported from the Altai Mountains in Mongolia, lacking columbium but, with a trace of gold. One cannot avoid speculating how such material came to exist. Even if one may believe that a meteorite which, melting in the crucible, which, melting, produced was a very crude material and anything but metallic in appearance, being merely a black heavy powder which judging from its low specific gravity (10) contained only about 60% of metal. Nevertheless it was shaped and produce on large scale with tantalum in it, and although the properties of this substance were a miracle of divergence from what we know of tantalum today, yet it gave the world some conceptions of what might ultimately be expected.

MODERN METHODS OF MANUFACTURING TANTALUM

The method just described is still of more than theoretical interest, inasmuch as with certain modifications it may be utilized for making a product of genuine value. The cheap metallic sodium is substituted for the expensive malleable potassium, the tantalum salt being alternated with layers of small pieces of the sodium, an iron crucible, the whole being topped with ordinary table salt, which, melting from the heat of the reaction, serves as a protective covering. The reaction is started by heating strongly at one point, but once on its way, requires no further aid, and the sodium burns vigorously. Oxyhydrogen, and digested out of the crucible, is a very suitable material is found, interspersed with beautiful violet colored crystals of salt, sparkling like little amethysts. Unfortunately, they soon fade on exposure and disappear on contact with water. As fragments of un consumed sodium are apt to be present, the precaution is taken of first dissolving the salt by covering the contents of the crucible with denatured alcohol until disintegrated. When the bubbling has ceased, the crucible is thoroughly washed first with water, then with a mineral acid and water again. In this way, salt and other soluble impurities are eliminated and the tantalum salt is reduced to a dense heavy black powder. In spite of the protection afforded by the molten salt, much of the tantalum finds opportunity to combine with the air since tantalum easily unites with both oxygen and nitrogen; and it is the presence of these omnipotent gases which renders the tantalum made as just described impure and valueless. The greatest importance of excluding air was under estimated by many of the pioneer workers with tantalum, or rather, the extraordinary power possessed by hot tantalum of absorbing or combining with inert and even reducing gases, was not realized. On this account it is more satisfactory and practicable to exclude any and all gases by carrying out the whole operation in a vacuum. The powder thus produced looks like a dusty old redure, but in reality is far purer. It is now strongly compressed and heated, and finally melted in a bath kept at a high temperature of the electric furnace. This treatment not only consolidates the metal, but expels any slight remaining impurities, resulting in tantalum at least 99.5% pure. Such material is capable of being drawn into fine wire, rolled into thin sheets and taking a mirror like polish.

This great advance in the art of producing useful tantalum was announced in 1905 by Dr. Von Bolton, head of the chemical laboratory of the great German electrical firm of Siemens and Halske. Simultaneously, the incentive was revealed with a description of an intense use for electric lamp filaments, in line with the general theory that that filament would give the best economical results which could be maintained for the longest time at the highest temperature. Although eventually superseded by the more efficient tungsten, these lamps have the low energy consumption between 1.5 and 2.5 watts per candle power. In passing, it is well to remember that a pound of tantalum would make many thousands of filament, and that primarily Von Bolton's feat may be taken as marking an epoch in quality rather than quantity production.

The more intricate problem of quantity production was ultimately mastered in 1922 by the Faunsteel Products Company of North Chicago, the purity being greatly enhanced at the same time.

We may now well consider in some detail the very unusual physical and chemical properties of this relatively rare metallic whose devious history we have traced to the goal of making it an article of commerce. It is platinum, the resemblance to the latter being so close that there is little doubt that it could be substituted in jewelry without the wearers ever being aware of the difference. For economic as well as sentimental reasons, however, it is doubtful if tantalum will ever become popular in this rôle. A thin sheet, when rolled and polished, has all the rigidity of hammered platinum foil, it is also hand polished to perfection, and in the purest state unites the hardness of the best medium steel, with a greater toughness and ductility than is known to be possessed by any other metal. Moreover, it can be drawn, rolled, beaten and in general worked by the same processes used with other metals.

Wrought tantalum is one of the heaviest metals ever introduced to commerce, being 16.6 times as heavy as an equal volume of water, or half again as heavy as lead. This coupled to its resistance to corrosion, has suggested it as being well adapted for use in corrosive atmospheres.

Although the melting point is over 1,000 degrees Centigrade higher than that of platinum, it does not fall to the same extent on heating. At 400 C, the metal becomes black, at 600 C, greyish black, and at still higher temperatures slowly oxides and burns, and at the same time. On the other hand, it is almost equally resistant although in divergent ways. It is attacked by hydrochloric acid and mixtures containing this acid, but against this drawback we may balance the astonishing fact that it is quite unaffected by the King of Secrets, aqua regia, which readily dissolves platinum. This renders it very suitable for the determination of gold and platinum by electrolytic deposition since they may thus
FIFTY million years or so, ages, dur-
ing the age of the earth's history, much of North America was covered by broad, shallow seas that were dotted with low and almost barren islands. And upon these islands nested some of the strangest of all the thousands of odd crea-
tures that have lived in past ages—birds that could not walk, and that had long beaks armed with sharp teeth.

These birds, like the other beings of
ancient times, are known from their skele-
tons, which have been preserved and turned into stone in the chalk beds of western Kansas. These chalks once were muddy cozes lying at the bottom of the old sea. Whenever one of the birds died, and its bones sank to the bottom, they were covered by the ooze, and so preserved from destruction. They lay there for millions of years, while the sea disappeared, and the mud be-
came solid rock. Today they are dug up by the collectors in the service of museums and universities, shipped hundreds or thou-
sands of miles, and carefully taken from the rock which surrounds them. Then they are studied by paleontologists, and finally the bones are set up in as nearly as possible the attitude which they had during life.

Hesperornis, the western bird, as this an-
cient dweller of Kansas has been called, measured nearly five feet from the tip of his beak to the tip of his toes. In shape he was a good deal like the black and white Loon, or hell diver of modern rivers and lakes, but unlike that bird, he swam by
means of his legs and feet alone, never trying to use wings. Indeed, he
could hardly have done so, for after ages of disuse, his wings had disappeared entirely, and there remained but a few bones to show where they once had been.

But Hesperornis did not suffer any on this account, at least while he was in the water.

His stout legs and paddle-like feet were all he needed to get along either on the surface of

At the Right Will Be Seen the Hes-
perornis, the "Western Bird" on the
Shore of an Ancient Kansas Island.
This Bird Shows Distinct Teeth as
May Be Seen.

In Photographs at the Left, 1, Shows a
Triangle for Chemical Purposes, 2, a Tube
in Serpentine Form and 3, Various Sizes of
Glass Tubes. All of These Objects Are
Made of a Difficulty Breakable Glass.

Dr. Albert Neuberger.
The elaborate camera obscura at Santa Monica, Calif., is maintained for visitors and has an ideal location. The instrument requires sunshine and scenery and it is surrounded by both. The construction of the camera obscura is founded on the fact that the rays of light, when focused on a plane either by being passed through a small hole or by a converging lens, form an image of the objects from which they originally proceeded.

This may be readily tried by piercing the shade of a dark room with a small hole, and holding a piece of white paper within a short distance of it. It will be noticed the smaller the hole the more distinct is the image.

The discovery of the camera obscura is credited to Porta and strange as it may seem this places it as far back as the seventeenth century. Porta found that if the opening were filled with a convex lens the arrangement would make the image more distinct and far more brilliant.

**HOW THE CAMERA OBSCURA WORKS**

For those who do not know the application of the principle other than seen in the camera we include the following description:

Camera obscura means a dark chamber. As the name implies, it is a closed space from which the light is excluded. There is, however, a small aperture through which the rays of light. The rays proceeding from external objects, and entering by this aperture, form an image on the opposite side of an image of the objects in natural colors.

Since it is often convenient to have the image produced upon a table the lenses are sometimes placed above the structure. To elucidate:

A brass case is at the peak of the roof which is conical or prismatic as a rule, and this case holds the lenses. A triangular prism, which may be cut so as to act as a condensing lens separates a mirror set at 45°—one of the faces may be plane and the other may have such curvature that the combined refractions on entering or emerging from the prism produce the effect of a lens, while the flat side reflects the rays vertically downward on a table.

Those desiring to erect a camera obscura are advised to experiment with lenses and mirrors before finally constructing the parts for the structure.

A visitor at the Camera Obscura at Santa Monica, said to be one of the most complete in the world, and maintained at public expense, enters by a door which is closed after him. This leaves one in a six-cornered dark room a dozen feet in diameter.

The roof of the room is peaked and at its center is the lens which can be rotated so as to point in any direction desired. One does not look in every direction at the same time as the lens only gathers the image from one direction.

One of the visitors turns a wheel arrangement connected by rods and a bevel gear to the lenses in the peak of the roof. This turret turns in any direction. The room is absolutely dark.

The sun then reflects a beautiful image in natural colors on the circular screen which occupies a position in the center of the room. The table may be tilted as desired. Not a detail of a breaker on the shore or of a motor car coming down the street is lost if the sun is bright. The colors are natural and no painter could duplicate the ocean scene, the waving palms, the palisades, the mountains in the distance or a thriving city street scene.
The story of the attempt of the English expedition to climb to the summit of the highest mountain of the world, Mount Everest, tells how these alpinists used oxygen, which they inhaled in the higher regions. In climbing to the 5,000 meter altitude, oxygen has not yet been used, though its grading would often have given great advantage. At a height of 3,000 meters the air is so rarefied and contains, therefore, so little oxygen that many people have suffered from lack of it. The vital forces diminish, the heart has to work harder, and people very often suffer with the so-called "mountain-sickness," whose symptoms are nearly the same ones as those of sea-sickness. After the experiences of the Mount Everest expedition proving the advantage of the use of oxygen, for without inhaling it the climbers never would have reached the height of 8,848 meters, this gas probably will form a part of the equipment of the alpinists of the future.

According to the researches of Dr. V. Schrotter, the relative lack of oxygen will be felt at a height of 4,000 meters and upwards, where the tension of the oxygen in the air is diminished to 125%. At a height of 7,000 meters to 10,000 meters, the tension of the oxygen falls to 6%. In regions exceeding 10,000 meters, the barometric pressure is 217 millimeters, and a sufficient oxygen tension in the lungs is no more attainable. Dr. Schrotter comes to the conclusion that life must cease at 9,000 meters, with a barometric pressure of 240 millimeters.

By the experiences of the Himalaya expedition, the researches of Dr. Schrotter have been fully verified. A member of the expedition, Dr. Kellas, got mountain-sick at a height of little more than 7,000 meters and died. By longer camping at heights of 7,600 meters, the constitution of four other members became accustomed or acclimated to the lack of oxygen, so that they could climb to 8,147 meters without using this gas. But only with the aid of oxygen apparatus did a part of the expedition succeed in climbing to 8,268 meters.

Other researches, recently made, have determined the amount of oxygen which must be inhaled at different heights in order to be able to climb without suffering. The quantities of oxygen, which must be added to the inhaled air, are for a height of 4,000 meters, 2 liters in each minute; for 5,000 meters, 3 liters; for 6,000 meters, 4 liters; for 7,000 meters, 5 liters and for 8,000 meters, 6 liters.

NEW LIQUID OXYGEN APPARATUS

A new apparatus for alpine purposes has now been constructed in Germany. This apparatus is charged with liquid oxygen, which constantly and slowly evaporates, evolving quantities of gaseous oxygen. The apparatus consists of three steel cylinders, which can take up 1.3 liters of liquid oxygen. This oxygen gives 195 liters of gaseous oxygen at atmospheric tension, sufficient for 65 minutes at an altitude of 5,000 meters and for nearly 50 minutes in an altitude of 6,000 meters. The weight of the apparatus is so light that one climber can bear three cylinders, one of them for instance in his knapsack and the other two in a pocket fixed on a waist belt.

The cylinder is connected with a reducing valve and a manometer, by which the pressure in the cylinder can be known. A special hand-wheel serves for regulating the outflow. The oxygen passes through the valve regularly, while the inhalation oxygen is taken in. During the exhalation the gas still escapes from the valve, but it would be wasted if not inhaled. In order to use this oxygen also, there is fixed on the cylinder a bag in which the gas is gathered in order to be inhaled at the next inhaling period. A small check-valve prevents the exhaled air from entering the bag.
THE fact that sound travels at an excessively slow speed as compared with light and radio was turned to very good account during the recent war, and excellent work was done in locating German guns by timing the arrival of the sound of the explosion at three different reporting stations. In certain situations the low velocity of sound is a source of inconvenience, notably in auditoriums, where reflection from the walls frequently gives rise to an overlapping of the sounds uttered by an orator, who is speaking at the rate of two or three syllables per second; but in the war zone it was this very slowness of sound which facilitated the localization of dangerous guns at a distance of six miles or more, for if sound traveled as fast as light there would have been no practical means of detecting a difference in the times required for the sound of the explosion to reach the different reporting stations, no matter how far apart in the field they were situated.

The variation of the velocity of sound with the temperature of the air, however, frequently led to serious inaccuracies in the calculations, and consequently the Subaqueous Sound Ranging Section of the Coast Artillery Corps has recently undertaken an intensive study of the influence of temperature upon the speed with which sound is propagated. The first tests have been designed to furnish the required data for sound waves traveling in water, in order to effect improvements in localizing submarines and in the devices which automatically record the depth of the water through which a vessel is moving; but the method which Mr. E. B. Stephenson has devised for deep-sea measurements, in which he has so ingeniously put radio to a new use, is equally well adapted for determining the velocity of sound in air under different atmospheric conditions, and so we may shortly expect to be able to locate the sources of distant sounds with much greater accuracy than has hitherto been possible.

SOUND AND LIGHT VELOCITIES DIFFERENT

It is by no means a new discovery that sound travels with only moderate rapidity. Many persons of an inquiring turn of mind are accustomed to estimate the distance of a flash of lightning by counting the seconds elapsing between it and the thunder, and allowing five seconds to the mile, and it is a matter of everyday experience that a perceptible lag intervenes between the instants of seeing a pistol-shot strike the pile and of hearing the sound of the impact, or between the instant a distant observer notices the emission of steam and sound in succession, from the whistle of a locomotive. The crack, and the soldiers in the trenches hear the shell whistling above their heads before they hear the sound of the explosion of the charge of the gun, which had sent the missile hurtling towards them.

SOUND VELOCITIES WITH TEMPERATURE

The fact that the temperature of the medium affects the velocity of sound has long been known, and indeed the ratio of the two specific heats of a gas has frequently been determined by calculation based upon the law that the speed of sound in a gas is directly proportional to the square root of the absolute temperature. The rise of a great practical need, however, such as that of locating hostile guns with accuracy, has led to new and more refined methods of determining the influence of temperature and other conditions upon the speed of sound in various media. The most reliable results indicate that the speed of sound in air, at 65°, 70°, and 75° Fahrenheit, is 1,125, 1,131 and 1,136 feet per second, respectively, and while the variation with temperature may at first thought seem too small to require attention, the reader has only to examine Figs. 1 and 2 in order to learn how important it is to take account of this variation when locating a distant source of sound. Station B notes the time at which the sound of the gun, G, arrives, and also receives electric signals indicating the instants at which the same explosion was heard at A and C. The distances of A and C from B are known, and the time-difference of the arrival of the sound at the three stations are recorded photographically, so that by using these known quantities in connection with a chart previously prepared with the aid of analytic geometry, the triangle can be constructed, showing the location of the gun, G. In Fig. 1, the calculator has assumed that a temperature of 65°F. exists throughout the region, whereas, in the case cited, the temperature is greater at the right of the field than at the left, as indicated in Fig. 2, so that the gun is actually 145 ft. farther from B, and 203 ft. farther to the left, than had been calculated neglecting the variation of the speed of sound with temperature. This error is sufficient to cause the gunner at B to miss the enemy's cannon at every shot; for at a distance of 5 or 6 miles, which is of the order we are considering, an expert gunner can place virtually every shot within a circle 100 ft. in diameter.

USING RADIO TO MEASURE SPEED OF SOUND IN SEA-WATER

The method by which radio is used to measure the speed of sound in sea-water is illustrated in Fig. 3. This device, which Mr. E. B. Stephenson has recently described in the Physical Review and in a pamphlet issued by the Engineer School, of Huffman, Va., has already been tested by the Subaqueous Sound Ranging Section of the Coast Artillery Corps at Fort H. G. Wright.
Luminous Water Signs

A FRENCH inventor has recently devised a kind of animated advertisement which is quite novel, and which, in interest and originality seems to surpass all the processes and systems, hitherto employed for attracting the curiosity of papers.

It is based on an optical illusion, which has not yet been fully investigated, and which gives an attractive fashion the impression of water in continuous movement. It comprises a moving transparent object brilliantly illuminated and the animated advertisement apparently in high relief. The transparency which can be placed directly upon the glass of the show window, or even in the interior of the store, consists of a subject painted on glass, or of an advertisement glued thereon, illuminated from the rear by means of a special installation and in front by the general illumination of the store. Some parts of the presentation judiciously selected, are specially lit and given an animated movement, thanks to an exceedingly simple arrangement which will be described below. Finally the whole can be accompanied by illuminated captions, which also can be animated.

The animated advertisement produced in relief is composed of natural objects, whose apparent movements agree exactly with their presumable nature.

It is extremely difficult to describe the impression of motion which such objects give, and it is quite necessary to have seen at least once a picture of this kind in action to really take in the effect produced.

We propose, following the lines of the inventor of this arrangement, M. L. Masson, described in Sience et la Vie, to try to explain this phenomenon by describing its causes. The movement, rather appearance of movement, is obtained without any mechanism. It consists in circulating within glass tubes at a constant speed, what may be called a string of beads formed of drops of water which may be colored or not, with bubbles of air between them of about the same dimensions.

In the illustrations are shown examples of such animated advertisements in relief. The moving parts are contained within glass tubes, but when the system is in action the tube becomes indistinguishable because it is transparent, while the moving heads, as we have termed them, are what the eye sees. The eye follows the movement of the liquid pears, and is attracted by this interesting and graceful spectacle, while the observer is puzzled in his attempts to account for the effect produced. The illusion is so complete that it would seem as if the tube is in constant motion. One has to touch it with his hand to realize that it is stationary. In the other system of transparency a different phenomenon appears, but one just as curious.

The apparatus is composed of a glass screen on which is glued or painted the image, leaving transparent the design which is to be animated. It is placed before a grating built up by a series of horizontal tubes spaced at regular intervals and parallel to each other, through which the water circulates, the heads in each tube moving in the opposite direction to that followed by those in the adjoining ones. At the back of the screen or on the sides, the illuminating system is installed.

The screen being in position, the heads do not show except at the transparent spaces, so that the succession of moving droplets attracts the eye and forces it to follow the movement, until as the heads disappear behind the opaque portion of the panel, others catch the eye; some being in the tube above or below, go in the opposite direction. An optical effect is produced which it is quite impossible either to imagine or to describe. The eye, attracted first by one and then by another of the stream of luminous beads going some to right and some to left, sees a design which seems to oscillate perpetually before it. For accord-

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Fig. 1 Shows How the Water and Air Beads Are Formed. The Action is Obvious.

Fig. 2A Shows How a Luminous Water Sign Operates, But the Water is Wasted. Fig. 2B Shows a Similar Sign Where bottles or Other Reservoirs Are Used to Conserve the Water.

Fig. 3 Shows a Complete Illuminated Transparency Which Utilizes Parallel Glass Tubes Through which the Bubbles of Air and Water Circulate. These Are Visible Through Letters Cut in the Front of the Cabinet Containing the Tubes.

At the Left Is Shown a Luminous Water Sign Used as an Advertisement of Medicinal Iron. Cooled Water Pours From the Iron Press in Streams and Falls Into the Bottles, But the Latter Never Become Full.

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452
Parachute for Mountain Climbers

Quite frequently do we read of mountain climbers losing their lives by falling from a high precipice or being caught in a storm. Then again it has been stated that it is more difficult to descend a mountain than to climb it. All of this danger and difficulty can be eliminated if the alpinist will carry a seventy-pound pack on his back containing one of the regulation U. S. Army parachutes. This parachute opens by merely pulling a cord, conveniently placed with a large ring on one end.

The new parachute is fully opened after a drop of sixty feet, and a man has actually jumped from the low altitude of seventy-five feet from a flying boat travelling at one hundred miles per hour. The breaking of a life line or a fall from a precipice need have no terrors now if one has a parachute. In case of a sudden storm or a perilous descent it will be safer and quicker to get down by means of the parachute.

Contributed by F. E. Louby.

Fire Under Water

At first appearance this suggests a very fantastic idea but it is the result of thirty years of technical experience of a Berlin firm. This firm has put this apparatus called "The Diving Condor" upon the market.

When a heater for a bath tub fails or cannot be used for any reason, this apparatus helps out in an emergency, as it represents a subaqua bath-oven for heating the water. Burning under the surface of the water, it prepares our bath water and helps along with the house washing, replaces the fixed kitchen boiler installation, the big wash boiler, or the portable bath ovens which are perpetually breaking down and needing repairs, etc. It is practical for use for any emergency requiring big tubs. The apparatus requires no expensive installation, is not expensive in the power it consumes and its installation is ten times cheaper than that of an ordinary gas stove.

Fish Line Indicates Plane's Height

Mr. C Francis Jenkins, the well-known motion picture machine inventor of Washington, whose system of movies by radio was described some months ago in SCIENCE AND INVENTION, follows seaplaning as a hobby. He often goes seaplaning at night and he has invented a simple scheme of determining when he is but a short distance above the water, preparatory to making a landing in the dark. This scheme works in foggy or on clear nights equally well. He throws a twenty foot fish line over the side, at the lower end of which is a small sinker or weight, and then heads the seaplane slowly downward. As soon as he feels a tug on the line, he knows that it is touching the water and he then straightens out, preparatory to making a long slow descent toward the surface of the water.

Another novel and simple scheme for determining the height above land or water for aircraft is that involving the use of two searchlights or small spotlights, the angles of one or both of them being variable by means of a calibrated dial control mechanism. Changes in altitude cause the light targets on the water to recede or approach.
Motor Car Leaps, Loops and Skids

By HAROLD F. RICHARDS, Ph. D.

OF THE GRADUATE COLLEGE, PRINCETON, NEW JERSEY

IMPROVEMENTS in aircraft and far-ranging projectiles have done a good
deal to disseize us of the idea that any
body which apparently defies the laws
of gravity is doing something paradoxical and unnatural, and yet one has only to
interesting phenomena, will appear at once
after we have considered three very simple
facts.
The first principle to be noted is that
the tendency of a rigid body to rotate or
turn depends not only on the forces acting,
and on their direction, but on where they
act as well. Everybody is familiar with
the fact that a gate turns most easily if it
be pushed at the point farthest from the
hinge. Experiment has shown that the
rotational effect of an applied force is
proportional to the force multiplied by the
distance between the point of application
of the force and the axis about which rotation
is produced. This product of force times
torque lever arm is called the torque of the
force, and the torque bears the same relation
to the rotation of a body as the force would to
a straight-line motion of that body as a
whole. The importance of this principle in
automobile problems will shortly be made
evident.
The nature of the second principle to be
applied will immediately become clear to
anybody who will tie a bolt or nut to a
string and whirl it around in the air. The
string remains taut, showing that there is a
force acting outwards along the string—
that is, along the radius of the circle
described by the rotating mass—and if the
string in its whirling be allowed to pass
through an intense flame, so as to be seared,
the weight will be observed to fly off at
a tangent to its circular path. The second
fact shows that the body tended to con-
tinue in a straight-line motion, and the
tautness of the string during the original
whirling proved that this tendency of the
body exhibited itself in the form of a force
apparently pulling outwards from the center.

Centrifugal force is merely the Latin for fleeting
from the center, and centrifugal force is
the outward reaction of a body moving along
a curved path. Forces are always twins;
they never occur singly; this centrifugal
force may be considered to be merely the
reaction to the force which holds the body
in a curved path. Which of the forces
comes first is as fruitless a question as the
old one involving the hen and the egg.

One fact further, and we are ready to con-
sider our flying automobile. Tie a rope to
any point of the rear axle and lift the car bodily
into the air. Draw an imaginary line down
through the suspended car, in such a direction
that it will seem to be an extension of the
rope; that is, in the same straight line
Lower the car, and now fasten the rope to
some other point of the car, preferably
at the side, and lift the car again. Draw
an imaginary line, as before, extending
the direction of the rope through the car.
Where these two lines cross, within the car
lies the center of gravity of the car. This
is an important point, for in all problems
the weight of the car may be considered as
acting as a single force placed at this
center of gravity. This holds true even
if the point should lie in empty space, say
an inch or a foot above or below the floor
of the car. If you do not believe it, run the

Fig. 1 Illustrates the Forces Which Tend To Lift the Inner Wheels When an Automobile Rounds a Curve at High Speed. This Diagram Shows the Forces Acting On the Machine If the Same Is Traveling On a Level Surface.

Fig. 2. If a Circular Speedway Is Banked At Such An Angle That the Resultant Centrifugal and Gravitational Forces Are Perpendicular to the Track, the Pressures On the Inner and Outer Wheels of the Car Are Equal, and the Car Does Not Skid.

Fig. 3. A Bicyclist When Rounding a Curve at High Speed Tends to Fall Outwards, and He Must Use His Weight to抵 against the Centrifugal Force. The Reaction Friction Between the Wheels and Road Serves to Hold the Bicyclist at Any Point From Falling Outwards.

car so that the front wheels are on one
platform-scale, and the rear wheels on an-
other; record the readings of the two scales.
then replace the car by a light, stiff beam
resting on two platforms, place a single
heavy weight, equal to the weight of the
car, at that point of the beam where the
center of gravity of the car was previously
located, and see whether after allowing for
the weight of the beam, the indications of
the two scales are not the same as before.

Now drive the car rapidly around a curve,
on a level road. The forces acting are
shown in Figure 1. The centrifugal force
acts outwards, as drawn, and the torque
due to this force—remember my previous
paragraph—equals the centrifugal force mul-
tiplied by the distance A. This torque ob-
viously tends to overturn the car outwards,
and is resisted by an opposing torque which
can be calculated by multiplying the weight
of the car by the distance B. The outer
wheels serve as pulleys, or axis of rotation,
being held in line by the friction at the
road. If this friction is less than the
centrifugal force, the car will skid out-
wards. Assuming a rough road, however,
we can readily see that the inner wheels
will or will not rise, according as the centri-

www.americanradiohistory.com
frugal torque is greater or less than the weight-torque. If the car does start to overturn outwards, it becomes smaller and smaller. The centrifugal force and the weight may be combined into a single force (see Fig. 3), and the angle of the track should be so chosen that this resultant force will be perpendicular to the track. In this case, the forces on the inner and outer wheels are the same, and there is no tendency either to skid or to overturn. Since the centrifugal force depends on the speed, the angle can be exactly correct for a single speed only. Thus, for a circular track, eight laps to the mile, the angle should be 66 2/3 degrees for a speed of a mile a minute, and 84 degrees for 120 miles an hour (84 degrees is just 6 degrees short of the perpendicular). These values, of course, will vary slightly with the latitude and with the altitude above sea-level. In order to allow for varying speeds, the track is usually constructed with an upward curve rather than a straight incline, so that the driver can mount a higher or lower track as his speed increases, and thus pick out the correct angle. No matter how great the speed, however, the car can never hold to a perpendicular wall, when running around it; for in this case both the momentum and the centrifugal force act at right angles to the weight, the one forward and the other outwards, and no force can ever be counterbalanced by one acting at right angles to itself.

The bicyclist secures the effect of banking by leaning inwards when rounding a corner, as shown in Fig. 3. The same reasoning regarding torques applies here, as above. The difference, of course, is that the ground reaction is not in line with the wheel, if the friction is too small, and consequently there is danger of skidding and falling. The common error of considering that an automobile inclines inward when rounding a curve is doubtless due to the drawing of an incorrect analogy from the inward lean of a cyclist. There is not one case in which a car can tend to overturn inwards, and this is where the car, already high up on the side of a banked track, starts to slide sideways down the slope, and tends to incorrect angle and insufficient friction. Then, the car, having acquired lateral momentum in sliding down the slope, a rough spot on the track may catch the inner wheels and cause the car to overturn inwards, due to this momentum.

The centrifugal force is also the important factor in leaping the loop, as shown in Fig. 4. In position 1, the momentum of the car supports it against gravity, and the centrifugal force holds it to the track. In position 2, the momentum is directed at right angles to the force of gravity, but the centrifugal force supports the weight of the car; and in position 3 gravity is augmenting the momentum and, as before, the centrifugal force pulls the car against the track. The driver is at all times subjected to the same centrifugal force, and to the same momentum, as the car, and so he feels no tendency to fall from the car when it is inverted at the top. His pressure upon the seat, however, will vary with the momentum, rather than the centrifugal force, as the important quantity. In considering the mechanics of this feat the reader must remember that a body projected horizontally in free space drops in one second exactly the same distance as a body falling from rest. Thus, for the speed and the gap shown in Fig. 5, the automobile could not possibly leap from one level plane onto the other. The momentum of the car would carry it across the gap, but during transit the car would fall 4 1/2 inches, and even if the front wheels were able to clasp upon the landing plane owing to their curvature, they would in so doing throw the rear wheels still farther down, and the result would be tragic headlines in the newspapers. To allow for the gravitational drop, the projecting plane is curved upwards, and the same upward curve gives another advantage; namely, the rear wheels, which apply the power to the track, are the last to leave, and consequently the car is given a forward tilt which causes it to land flat-footed on the opposite platform.

To pass from rare feats to an every-day experience of motorists, why is it a good plan to turn the front wheels in the same direction in which the rear wheels are skidding? The fact remains that rear skids are often checked by turning the front wheels toward the skid. Figure 6 shows the forces involved. The skid is to the right, and consequently the car tends to twist in the direction shown by the first curved arrow; on turning the front wheels sharply to the right, however, the frictional force F is called into play, owing to the fact that the forward momentum of the car momentarily causes it to tend to continue moving forward, and this force F has one component, namely, R, which is perpendicular to the wheel. This force R combines with the frictional forces opposing the rear skid to produce a torque in the opposite direction to the original turn of the car. If the front wheels also skid, the story is much sadder, as the motorist knows.

The results of a blow-out, to which so many fatal accidents are attributed, are. (Continued on page 483)
A stage magician once excited great astonishment by his feats of superhuman strength. In one of the most spectacular of his performances he would support a huge rock on his head and invite the strongest man in

Would You Smile Under This Kind of Treatment? The Young Man Who Is Kept in Sams to Be Enjoying It Immensely.

the audience to come up and crack it with a sledge hammer. If the efforts of the man were at first fruitless he would urge him to strike harder until at last the stone broke under the blows. Although the man went through this performance as many as seventeen times a day, there was nothing interposed between the stone and the man's head but a small blanket. Do you see how this feat can be possible without resort to trickery of some kind?

THE ENCHANTED RING

A trick which to the unsophisticated bor-

WAXING OR WANING?

Ask the average mortal how he can tell at a glance whether the moon is waxing or waning and he will look at you as if you

The Man in Our Illustration Seems to be Having a Hard Time Trying to Keep Himself from Falling. How Much Force Must He Exert in Order to Do So?

had asked him something about the Einstein theory or the fourth dimension. But ask old Granny Hilton, who believes that all human ups and downs follow the changes of the moon with unfailing regularity, and she will tell you as soon as she can get a peep at it. Can you figure out how she does it?

(Continued on page 503)

OZONE MADE TO ORDER

Ozone, the intangible substance that makes the air fresh and pleasant after a thunder-storm, and that gives the sea-breeze its invigorating quality, is now being electrically produced to aid in solving problems of ventilation and air supply in schools and work places where people are crowded together. Two schools, each housing one thousand pupils, were used throughout the past Winter, and it was found that the school in which the air was impregnated with ozone had less illness among its pupils, that it had only one-third as many absences for illness, and that the absences were shorter. Ozone, produced electrically by a generator installed in the air-duct of the building, is added to the air at the rate of one part of ozone to two million parts of air.

456
Mystery Information or Happy Belief

Crystal Gazing

Yea, it. the days of ancient Egypt, when enchantment and so-called witchcraft was in vogue, the ancient crystal was used by the wizards as old as a mystic mirror in which could be seen the reflection of the things to be. Much of Biblical importance and religious value has been attached in the centuries gone by; to the predictions which have been made by seers from the so-called mystic spheres of mysterious information. With the twentieth century and its many explanations of the many things at one time seemingly impossible, with achievements such as the radio, the submarine, the telephone, etc., has come a disbelief in the probabilities of forecasting through the focus of the mystic sphere, and yet there are many that claim that they can actually see things in the crystal.

Public wonder workers are to some extent using the crystal as a subject of a most delightful form of entertainment, many of the society people whom I have entertained, having a great belief in the crystal as an information bureau. As per the title of my articles "Magic for Everybody," it is merely my intention to offer in this series tricks of a nature, such, as to prove of practical demonstrative value to my readers, and I will therefore not attempt to criticize the believers in the weird art of crystal gazing, nor will I attempt to deprive or destroy the religious value that some have attached thereto.

I offer herewith an original method of crystal gazing which will be found to be of unique value to those caring to put themselves to the trouble of constructing the paraphernalia necessary. It has its advantages over the average so-called form of crystal gazing, inasmuch as the operator or wizard wonder, as you care to term him, has absolute control over the sphere, and therefore can cause his friends to actually see things in the enchanted globe.

How the Crystal Globe is Built

Referring to my diagram one will find that the stand upon which the crystal rests is the responsible item for bringing about the necessary results. Passing over a series of small wheels will be found a roll of spirit pictures. These pictures, which are rather small, should be painted upon a roll of black canvas cloth with phosphorous paint, the purpose of which will be readily explained. A small wheel with a pointed edge is exposed, in the base of the stand, and also is a member of the series upon which the roll of pictures travel. It will not be necessary to explain this, by turning the wheel, the pictures which are traveling upon an endless loop will be brought to view beneath the upper edge of the stand one at a time. The crystal ball being of solid glass (it may be an inverted fish aquarium) has magnifying qualities, and the subject looking into the crystal will therefore see the picture beneath, magnified many times, and as the basis of the cloth upon which the pictures are painted as a doll or dead black, the picture will to all appearances present itself apparently within the center of the sphere.

Magic Candy

Smilingly the magician walks over to a table upon which is the empty candy box, and apparently carelessly opens the cover thereof and eats one, again closing the cover without offering any to his friends.

One of the spectators is sure to comment thereupon, and the magician in so等一系列ing his neglect at once makes his way to the table and offers the box and its entire contents to his friends to take of the candy. The average kind and quality of the candies really consist of but one layer, which are contained in a tray, held to the upper edge of the box by a small wheel Actuated by the Fool. Are Magnified by the crystal ball.

The Cigarette Paper Trick

The Effect: A package of cigarette paper of the average kind and quality is passed about for thorough inspection.

One of the cigarette papers is taken from a package and is secretly marked while the performer has left the room. It is then inserted in the rest so that it's direct location is unknown. The performer places the papers beneath a table, or behind his back, so that his audience is convinced that he cannot possibly see them and immediately draws out the marked one. How is it done?

Inspection will prove that most cigarette papers are cut on the band, that is to say, instead of the corners being square, they are cut at an angle. While one paper is being marked, the performer leaves the room. When the marking has been done, he is recalled and brings with him the balance of the sheets. The performer secretly sees that when the marked paper, which is turned mark side down, so that he cannot see it, is returned to the stack, the package is so arranged that when the paper is replaced two of its corners will protrude slightly. The magician has but to feel for the protruding corners and draw out the marked slip.
GLASS, we have been told and found by experiment, is a non-conductor of electricity. Perhaps the last item of the title of this paper, as given above, would seem misleading. However, the statement relative to the electrical conductivity of glass should be modified with a phrase . . . at normal temperatures. That is, at room temperature glass will not conduct an electric current. But if a bit of glass be heated to redness it will conduct electricity. This can be proved by immersing a Bunsen or other blue flame upon a piece of broken glass until the glass is intense red and soft. Now, by applying to the plastic glass two wires which are connected to a strong battery or other source of current with a suitable indicating instrument in series, the index of the instrument will be deflected, the current flowing through the molten or plastic glass.

Using a fairly high current strength and 110 volts potential, glass can be electrolyzed at a temperature of about 300° Centigrade (572° F.). This temperature is not sufficient to make glass plastic or even red hot. Just how this can be done is disclosed in Fig. 1. Here a test tube containing mercury is inserted into a porcelain crucible containing sodium amalgam. Sodium amalgam, as we have already seen, is an alloy of sodium and mercury, alloys of mercury being termed amalgams. This amalgam can be made by dissolving clean and dry sodium metal in mercury. A 3 per cent sodium amalgam (3 by weight of sodium to 97 by weight of mercury) is adapted for this experiment. An iron wire should be inserted into the crucible and another iron wire into the test tube, one making contact with the mercury and the other with the amalgam. These are the electrodes, the crucible being made the anode and the test tube the cathode. The crucible should now be heated to a temperature approximating 300° C. and a heavy current, preferably from a 110 volt circuit D.C., of course, at about 5-10 amperes for several hours. At the end of this time, the mercury in the test tube should be treated with several drops of water, the liquid falling into a strip of red litmus paper touched to the liquid. The paper will turn blue, showing that sodium has been actually "plated" out on the mercury in the test tube.

The addition of water forms sodium hydroxide with the small amount of sodium in the sodium amalgam which forms by electrolysis, and this sodium hydroxide (NaOH) affects the red litmus paper. So, if the red paper turns blue, we can say that electrolysis of the glass has taken place.

A simple pyrometer which can be employed to secure the proper temperature for electrolysis can be made from a glass tube, sealed at one end and containing pieces of lead (not solder). When this little pyrometer is immersed slowly to prevent cracking by means of a wire into the sodium amalgam, the lead will melt if the temperature is about 320 degrees, which is sufficient for the electrolysis.

MAKING METALLIC SODIUM OR POTASSIUM

An iron crucible containing molten sodium hydroxide or potassium hydroxide sticks heated by a Bunsen burner can be used as the electrolyte. The cathode is an iron wire terminating in a spiral and inserted into the bottom of a porous ignition crucible, made of porcelain or other refractory material. This crucible is inverted and dips into the fused electrolyte and protects the metallic sodium or potassium from combining as fast as it is formed with the oxygen in the air. About 15 amperes should be used for the electrolysis and as fast as the inverted crucible yields the metal, the rod and crucible hanging to it should be removed from the molten caustic bath and given a sudden jerk under kerosene. The sodium or potassium metal will then fall off and be preserved by the kerosene.

The heating should be carried out, keeping the caustic alkali in fason for about an hour before the electrolysis is begun. It must be remembered that the sodium or potassium which is produced reacts with water, forming hydrogen gas and the corresponding hydroxide, this being the reason why an aqueous solution of a potassium or sodium salt such as sodium hydroxide could not be used. The bowl of a clay tobacco pipe can be substituted for the crucible if desired. It should be inverted and the mouth dipped into the molten or fused electrolyte so that air cannot enter and spoil the reaction product. If sodium hydroxide is used sodium will form, and if potassium hydroxide is employed as the electrolyte, potassium will be the product. Fig. 2 shows the apparatus as set up.

AZOBENZENE FROM NITROBENZENE

Important to the dye industry is azobenzene. This substance crystallizing in beautiful red rhombic crystals can be made by the electrolysis of nitrobenezene. This latter substance is made by the action of nitric and strong sulphuric acid on benzene which can be obtained from coal tar distillates.

Nitrobenezene has the formula C₆H₄NO₂. While Azobenzene has the formula C₆H₅N₂ = NCH₆. It can readily be seen that the latter substance is devoid of oxygen atoms. It is by an electrolytic reduction that the two oxygen atoms of nitrobenzene are removed, producing the azobenzene. During the electrolysis hydrogen gas is produced, and this being in the anode or newly born state combines with this undesired oxygen and forms water.

For the electrolysis a beaker or battery jar containing the following solution should be used: 20 grams nitrobenzene (oil of mirbane), 5 grams of sodium acetate and 200 cc. to 75 per cent alcohol. Pure grain or ethyl alcohol should be used, although some (Continued on page 482)

Fig. 1. Glass, Commonly Called a Non-Conductor of Electricity, Can Be Electrolyzed With This Extremely Simple Cell. The Little Pyrometer Shown in Detail Is Used to Judge the Temperature of the Metallic Electrolyte in the Crucible.

Fig. 2. By Electrolyzing Fused Sodium Hydroxide, Metallic Sodium Will Collect in the Inverted Crucible Shown Here. This Prevents the Sodium from Spontaneously Reacting With the Air.

Fig. 3. Azobenzene, Important in the Dye Industry, Can Be Made in the Form of Red Crystals, Using This Electrolytic Cell Containing a Semi-permeable Diaphragm.
Practical Chemical Experiments
By RAYMOND B. WAILES

INTERESTING FACTS ABOUT SULPHUR

We all have in the past few months, come into contact with more sulphur than at any other time of the year. This goes for those who have taken their annual dosage of sulphur and molasses and those who have had their year's sport in the Fourth of July celebrations with fireworks, which contain sulphur in several forms.

But besides being the basis of spring tonics, fireworks, matches, and other everyday commodities, sulphur has found use in many products. The wealth of a nation, it has been said, could be computed by reckoning the amount of sulphuric acid it produces and annually utilizes. A step farther than this can be taken. The wealth of a nation could be computed on the amount of sulphur it uses, for it is with sulphur or a form of sulphur with which sulphuric acid is made, the world's most important chemical.

By Using the Above Arrangement, You May Determine Whether or Not the Gasoline You Use Contains Sulphur: a Silver Coin Turn Black If Sulphur Is Present.

Sulphur is an interesting substance the moment it is mined. This can at once be confirmed when it becomes known that sulphur is first melted in the earth and then pumped from it. This novel method of robbing mother earth of its treasure was developed by Herman Frasch in 1871. Figure 1 shows the method now in use.

and out at the top. Virtually, a foam of steam and air is produced, the whole mixture passing out at the top of the pipe marked C. The larger or 8 inch pipe serves as a protective casing for the three innermost pipes, the air space between C and D (6 and 8 inch) tending to maintain the heat within the pipe and not allow it to escape into the surrounding earth and thus cool the superheated water which is continually being pumped into the sulphur well.

The retort, Fig. 3, contains crystallized sulphur (flowers of sulphur will serve). By heating the bottom of the retort slowly with the Bunsen burner the sulphur will at first melt and then pass over into the neck. Several passages of the burner at the neck will serve to keep it melted at this point and so that it will not crawl the tube. Drops of sulphur will now fall into the cold water in the beaker, and later a stringy rubber-like mass will exude.

Diagramatical View of the Apparatus for Obtaining Sulphur From the Earth. The Action is Fully Described in the Text.

Here, four concentric pipes, 1, 3, 6 and 8 inches respectively in diameter are introduced into the drilled well in the sulphur-bearing region. Hot air is forced down the smallest and inside pipe, and superheated water is forced down the six inch pipe. This superheated water, soon causes the sulphur to melt, and by the aid of the hot air forced in through the inner or 1 inch pipe, the sulphur is forced from the head through the three inch pipe, along its length.

Fig. 3. Making Plastic Sulphur Which Can Be Moulded and Worked Into Various Shapes in Much the Same Manner as Clay.

At Left: High Pressure Pumps Which Force Super-Heated Water Into the Well to Melt the Sulphur, So That It May Be Extracted.

Lower Left: One Hundred Thousand Tons of Sulphur Cooling in a Bin After Extraction From the Earth.

Below: Blasting the Sulphur From the Huge Block After Cooling and Loading It on Cars.
Selenium Star Photometer

By LEWIS J. BOSS

This little device, the latest aid which science has brought to the astronomer to assist him in delving into the depths of the universe, is in itself essentially simple. Briefly, it consists of a sensitive selenium cell connected in the same circuit with a very delicate galvanometer, a variable high resistance and a source of electric energy such as an ordinary battery.

The light-sensitive cell is affixed to the eyepiece of the telescope and takes the place of the observer's eye. It is in fact an electrical eye, which is many times more sensitive to variations in light than is the human eye. Selenium, a non-metallic element occupying the intermediate space between sulphur and tellurium, was discovered in 1817 by Berzelius. Since a Fahlun pyrites of the element tellurium, which was so, it is the selenium photometer for variable star work. Prof. Joel Stebbins, of the University of Illinois, has used selenium cells in astronomical work and we also find that Minkin has used these cells in several ways.

Selenium crystals have an extraordinarily high sensitivity as compared with the ordinary variety of selenium cell. With this fact in view the cells constructed for use in the selenium photometer are so made as to have a crystalline structure. From laboratory research as well as from published data, it appears that a single crystal of selenium 1 mm. in area is one hundred times as sensitive as the best non-crystalline cell.

In connection with a reflecting telescope, carrying a 36-inch mirror, such a crystal receiver could detect the light from a candle at a distance of 350 miles.

The cell is formed by winding two small enamelled copper wires closely together around a flat strip of mica. (Fig. 1) Terminals are brought out from one end of each winding. This gives, in effect, two disconnected coils of wire wound side by side upon the same core. The enamel is now scraped off the top of the coils so that there is left a number of turns of two conductors spaced closely together but not touching. This arrangement is then warmed and a thin coating of the vitreous variety of selenium is spread uniformly over the wires. The strip is then placed in an oven and the temperature gradually increased to 100° Centigrade, when the selenium will rapidly begin to pass into the metallic (so-called) state, the temperature rising to about 217° Centigrade. The modification of selenium thus obtained will change its electrical resistance inversely as the amount of light allowed to fall upon it. The peculiar granular crystalline structure, so essential to the most delicate and sensitive cells, is produced by subjecting the cell to a temperature of 210° Centigrade, for a considerable period of time, finally permitting the cell to cool very slowly.

Selenium appears to have no specific color sensitivity. Recent experiments carried on have shown that the character of the wave-length sensitivity curve of selenium can be controlled by heat treatment. Annealing the cell at 200° C. produces a maximum sensitivity in the red end of the spectrum, while annealing at 150° C. shifts the maximum sensitivity to 0.55 μ. The distance between these crystals is shown by X-ray analysis to be in the neighborhood of 3.7 × 10⁻⁴ μmeters and the thickness of this delicate crystalline layer which is affected by the light action is calculated to be less than 0.000015 inch. From these facts it can be readily seen that in a thin layer of selenium a much higher sensitivity can be obtained than in a thick one. For this reason the photometer cells have an extremely thin coating in order that the change in conductivity may be great in proportion to the variation in light intensity. This change occurs almost instantly, or at most the

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Fig. 1 Shows a Partially Wound Selenium Cell Core and Fig. 2 Shows its Completion. Figs. 3 and 4 Show Another Form of Cell Wound On a Square Core. Twenty Pieces of Thin Copper Sheet Cut As Shown In Fig. 4 Are Necessary For Making the Metal Plate Cell While Eighteen Pieces of Mica As In Fig. 5A Must Also Be Made. The Metal and Mica Plates Are Stacked As Shown In Fig. 6 and Connected As In Fig. 7 and Should Be Clamped Between Two Wood Blocks As Shown In Fig. 8. The Circuit For Testing the Cells Is Shown In Fig. 9. A Mica Sheet Cell Is Shown In Fig. 10.

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The selenium cell, having passed through the several processes outlined above, is now ready to be used at the telescope. It is placed in a suitable bakelite mounting and is affixed to the telescope in place of the eyepiece, by means of a short brass tube. In reality, taking the place of the observer's eye. The three different parts of the cell mounting are shown in the diagram.

Think of it! This small selenium plate detects and indicates changes in light which it emits in the same way that a cell to equal amounts of energy in different parts of the spectrum. While Curve C gives the response of a selenium cell when exposed to a wave-length of light, Curve D represents the response obtained at one-sixteenth the intensity used to obtain Curve C, according to the measurements of Professor P. Thaddeus. For wave-lengths shorter than 0.65, the deflections of the galvanometer are approximately proportional to the square root of the incident energy, while for wave-lengths greater than 0.76, the deflections are approximately directly proportional to the intensity of the incident light.

It is relevant to add that, concerning the peculiar electrical properties of selenium, some hold the view that the increased conductivity of selenium is caused by a resonance of electrons on exposure to light. Others consider it a modification of the crystal structure, assuming that selenium occurs in several allotropic forms of widely different electrical conductivity. The absence of polarization indicates that the conduction is not electrolytic. Experiments at liquid air temperatures, where the light sensitivity is retained, seems to be evidence supporting the electronic hypothesis. The selenium cell may be used as an indicator in the null and the equal deflection methods of obtaining ratio of intensities; for example, the galvanometer deflection might be observed when the cell is exposed, say, for five seconds, to the lower intensity. Then the higher intensity is reduced, by means of calibrated crossed Nicol prisms, a wire grating, an absorption wedge, a variable sector disk, or some other device to give the same deflection. In this manner the ratio of intensities of monochromatic light of the same wave-length may be observed; but the selenium cell cannot be used in this manner to compare accurately the intensities of light of two sources differing in color.

This restriction applies, of course, to all of the photo-electric devices of a like nature, as, for instance, the potassium hydrate or the rubidium cell. In applying the cell to variable star observations, therefore, due care has to be exercised in compensating for the color of the star observed as well as for the clearness of the earth's atmosphere. By examining the spectrum of the star beforehand, and bearing in mind the characteristics thus revealed, the cell may be applied to a much better advantage.

(Continued on page 497)
Etching Without Copper Plates

By HARRY DUNN

The cotter pins, Fig. 12, are strung upon a wire, they make very serviceable card holders. The cards can be removed at any time without much difficulty, and may be replaced again without removing the cotter pins from the line. A clinched eye for locks on chests, doors, or for hooks, is shown in Fig. 13. By bending the cotter pin at right angles and driving it edgewise into a box, it makes a very fine hinge or screw in the cover acting as the pivot point. This is shown in Fig. 14. Repairs for many kinds of springs can be made with the cotter pin if the legs are bent out, as illustrated in Fig. 15. The tension of the spring can be increased by merely turning the cotter pin into the spring for a greater distance. Another card holder, but one which is detachable, is shown in Fig. 16, and last but not least, we find the use depicted in Fig. 17 for preventing jugs from being broken by too frequent extractions with a corkscrew or from being lost. A cord is passed through the cotter pin and tied to the neck of the jug. A tag at this cord will then remove the stopper, the tag being attached to the neck of the bottle by means of the cord, cannot be misplaced. Contributed by C. R. MULLEN.

If you are an etcher and have no copper plates, or if you want to be an etcher and yet dislike to go to the expense of trying out your experimental urge of art on copper plates, just do your etching without the copper. It is being done by several artists in San Francisco, where the method was discovered by Dr. George Lee Eaton, who uses worn out and resharpenned surgical instruments as needles for his etching.

A photographic plate is the substitute employed. An undeveloped plate 5 by 7 inches in size, or larger, is procured, and the picture desired is etched on that plate, the shading of the lines and spaces being accomplished by varying the depth of the cut made by the needle in the emulsion on the plate. Undeveloped plates must be used because the emulsion hardens after development, and the cutting of the lines becomes difficult, sometimes impossible. By varying the depths of the lines, delicate degrees of shading can be made and as full advantage is taken of lights and shadows as in copper-plate etching.

After the lines have been cut in the undeveloped plate, it is developed, just as in photography, except that a darkroom is unnecessary. A t t e r complete development, usually about 15 minutes in any commercial developing solution, the plate is washed and passed into the fixing bath, as in the case of the photographic negative, and then washed and dried when it is ready for printing. The plate, having been fully exposed to the light while the etcher is working on it, becomes impervious to light in the spaces where no lines have been drawn and light passes through only in proportion to the density of the lines etched on it.

When the plate is thoroughly dry, it is placed against printing-out paper, in a printing frame, and printed by electric or sun-light, just as a photographic negative would be printed, except that the average exposure to the light is less than in the case of an ordinary negative. The result is a perfect print of the etching made on the emulsion. Some of the etchings so printed on brown and green printing-out papers have been remarkably beautiful, and, as the new art is still in its infancy, probably other improved coloring methods will be developed.

Uses For Cotter Pins

Many are the uses to which split keys or cotter pins can be put. As a matter of fact very few people realize just how important these little accessories are, primarily because of the fact that they have only attempted to use them in or around machinery. The cotter pins, however, may be employed as hooks for small doors or boxes, by merely clipping off a portion of the pin and bending the other portion around it, we have a miniature snap hook which may be employed in models, or may, in a pinch, even replace snap hooks on harness. A use for cotter pins that is very often overlooked, is illustrated in Fig. 3. The cotter pin is fastened to the wall with a screw; it will hold a spool of cotton when slipped over the legs. For repairing thin chains, the method employed in Fig. 4 will be found of value. It is very difficult to obtain eye bolts when needed, particularly the smaller sizes, but they may be made from cotter pins very easily, as shown in Fig. 5. By placing a nut or coarse washer upon the eye bolt and then spreading the legs, a toggle bolt, Fig. 6, is produced.

Figs. 7, 8 and 9, show methods of making connection clips. Fig. 8 is very serviceable in small receivers where the spread clip will hold itself in the binding post holes without necessitating tightening of the nuts. A method of repairing a buckle by merely slipping a cotter pin over the piece portion is shown at 10, and 11 indicates a line guide for fishing rods or a single sight for 22 caliber rifles. If a number of these cotter pins, Fig. 12, are strung upon a wire, they may be used very serviceable card holders. The cards can be removed at any time without much difficulty, and may be replaced again without removing the cotter pins from the line. A clinched eye for locks on chests, doors, or for hooks, is shown in Fig. 13. By bending the cotter pin at right angles and driving it edgewise into a box, it makes a very fine hinge or screw in the cover acting as the pivot point. This is shown in Fig. 14. Repairs for many kinds of springs can be made with the cotter pin if the legs are bent out, as illustrated in Fig. 15. The tension of the spring can be increased by merely turning the cotter pin into the spring for a greater distance. Another card holder, but one which is detachable, is shown in Fig. 16, and last but not least, we find the use depicted in Fig. 17 for preventing jugs from being broken by too frequent extractions with a corkscrew or from being lost. A cord is passed through the cotter pin and tied to the neck of the jug. A tag at this cord will then remove the stopper, the tag being attached to the neck of the bottle by means of the cord, cannot be misplaced. Contributed by C. R. MULLEN.
The art of glass blowing is comparatively simple, provided one keeps in mind certain fundamental principles of the art.

Glass is a material which is thickly fluid under a high heat. But this heat is so great that it can best be obtained by the blast lamp and rather soon after the glass is removed from the flame of the lamp, it hardens and can no longer be worked properly. The greatest difficulty that the beginner finds in glass blowing is to shape the glass into the different forms he wishes it to assume, while the glass is in the proper pasty condition. If you attempt to blow a cold glass, uneven results are obtained. Furthermore, it is necessary in working with glass that the blowing be done easily and uniformly. It does not pay to lose one's patience and blow rapidly. If that is done, forms are obtained which are far from what are desired. A few tools are used in glass blowing, but generally the glass blowers makes very little use of them. All he needs is a good blast burner and a triangular file for nicking the glass so as to break it off.

In blowing glass in the laboratory for the ordinary uses that arise from time to time therein, the chemist should know how to bend glass tubes so that the bore is not materially diminished in the bending operation, how to blow bulbs, and how to fuse glass at the end of the apparatus, at the side and internally. The rough edges can then be removed by a little grinding or by simply fusing the glass in the flame.

The principal piece of apparatus is the blast lamp. After the flame has been adjusted so that its height is not too great and the inner blue cone is fairly large but well distributed through the mass of the flame, the glass tube, that is desired to bend at right-angles for example, is held in the flame just a little above the tip of the inner cone and allowed to heat up. It is kept in constant rotation while the heating is going on. In this stage of the operation, the position of the hands is of the highest importance. In fact the success of glass blowing depends to a large extent on their correct position.

**A GOOD QUALITY GLASS SHOULD BE EMPLOYED**

The correct position of the hands is such that the left hand grasps the tube lightly with the palm in front. The tube is held between the thumb and the other fingers. The tube can thus be rotated continuously and regularly by a simple movement of the thumb and fingers. The other end of the tube is held between the thumb and the index finger in the right hand with the palm extending away from the glass blower.

In heating glass prior to blowing or formation into various shapes, it often happens that due to an irregularity in the glass, the flame or due to accidental moving of the hands, the heated part becomes slightly deformed; it gets out of shape. The beginner in this case generally tries to correct the fault by continuing heating the glass. But this just serves to complicate things, to accentuate the deformity and finally render the fault so bad that it can no longer be remedied. The only practical thing to do is to continue the heating and gradually draw out the glass to a fine point and then to insert the open end of the tube into the mouth and without twisting the tube to blow gently. The deformation is automatically corrected in this manner.

Another error which novices generally make is to suppose that the joint between two pieces of glass would be more solid if the thickness of the glass were thicker. These therefore tend to accumulate a mass of glass at the joint where the joint is to be made by prolonged heating. But in reality instead of being stronger, the joint is actually more fragile. For in cooling off the inequalities that arise due to the contraction that takes place in the glass mass result in the development of internal forces which act and counteract, and inevitably cause the glass to break. In making a good joint between two pieces of glass, as for example in joining a glass tube laterally to another tube or to a bulb, just a few simple rules must be followed to obtain success.

The two parts that are to be joined together, must be heated rapidly one after the other. The flame of the blast lamp must be large. Then the two pieces are brought together and the molten parts of the glass are allowed to make contact. Only one piece is supported, the other hangs from the first in an unsupported position. Then the pieces are pulled slightly as if they were desired to separate them. Air is blown through the tube while it is being uniformly turned while being heated in the flame. If these directions are followed out assiduously the joint is perfect and indeed in many cases it is impossible to tell where union took place.

**Glass Blowing In the Laboratory**

By ISMAR GINSBERG, B. Sc., Chem Eng.
How to Use Your Camera

By DR. ERNEST BADE

NO. 8. VARIOUS WAYS OF ENLARGING PICTURES

The cameras used by the amateur usually produce only small pictures. It is, of course, possible to enlarge these, but then the negative must be sharp and contrasty. Under no conditions will such an enlargement produce all the fine and delicate details found in the smaller negative. The greater its enlargement, the more will it lose in distinctness, and if the enlarging is pushed too far, then the silver grain of the emulsion will become too pronounced. An enlargement should not be made if it can be avoided, although certain types of artistic photos, which require a soft, half concealed effect, can be thus obtained. In other cases it is far better to take the picture in the desired size at once.

If the bellows extension is not long enough, then an extension can be added, such as was mentioned in the first article. With an exceptionally good lens of wide aperture such hollow extensions, consisting of tubes or sections of square boxes which let light through, can be made to a length of about 8 to 12 feet depending upon the focal length of the lens, or until an enlargement of approximately 12 diameters has been attained. This is also sufficient to take pictures of minute objects directly, such as insects, etc.

On the other hand, an exceptionally great enlargement can be obtained by photographing small objects directly if the lens of the camera is removed and an ordinary well ground hand or reading glass, a double or plano-convex lens being best adapted, is substituted. The most even illumination is obtained by having the source of light immediately behind the microscopic object. Electric light is best, and between light and object, a ground glass is placed which will illuminate the object more uniformly. The exposure is usually less than 1/2 of a minute.

Best results are obtained by using a lens larger than the object to be taken.

ENLARGING WITH A PHOTOGRAPHIC OBJECTIVE

Enlarging with the photographic objective by the aid of one or more bellows extension sections will give quite a little depth, especially if the iris diaphragm is closed down. Such pictures are best taken out of doors in the direct light of the sun, the strong shadows being softened with the aid of a little mirror. With a long extension and with closed diaphragm an exposure of about a minute is necessary.

When light is transmitted through the negative so that an enlarged image is thrown upon the ground glass of the camera—using either the simple lens or the camera objective—the image can be taken directly upon bromide paper which, of course, will give a positive or print on the small negative used. Here the bromide paper is placed in the ordinary plate holder and exposed like a film or glass plate. The process of loading and developing must be carried out in red light. If it is desired to enlarge with reflected light, then a print of the negative must be taken and this must be enlarged upon film or glass plate.


**Cold Soft Solder**

Easily adapted to the distillation of substances that will not boil at the temperature of the solder, this method of soft solder is simple and effective. The solder should be kept in an airtight container, as it will oxidize and harden over time.

**How to Make it**

1. **Prepare the materials:** You will need a mix of tin and lead. The ratio of tin to lead is 60:40. Melting point of this mixture is around 360°F.
2. **Heat the materials:** Place the mixture in a double boiler or a metal pan set over a gentle heat source. Stir until it is completely melted.
3. **Apply the solder:** Use a small brush or a stick to apply the solder to the joint you wish to solder. Be sure to remove any excess solder to prevent a build-up.
4. **Cool the solder:** Allow the joint to cool and harden before using. The solder will cool rapidly due to its high melting point.

**WATER COOLER FOR THE ICE BOX**

**First Prize $150**

A very simple and effective water cooler can be used to cool the ice box. The device consists of a coil of copper tubing which is connected to a galvanometer. When a current flows through the coil, the galvanometer will indicate whether the current is flowing through the coil or not.

**How to Make it**

1. **Prepare the materials:** You will need a copper coil, a galvanometer, and a power supply.
2. **Assemble the device:** Place the copper coil in the water box and connect it to the galvanometer. The power supply should be connected to the opposite end of the coil.
3. **Test the device:** When a current flows through the coil, the galvanometer will indicate the direction of the current.

**SECOND PRIZE $100**

**RESISTANCE FINDER**

A simple device for finding the resistance of a substance can be made using a galvanometer and a coil of wire. The device consists of a coil of wire which is connected to a galvanometer. When a current flows through the coil, the galvanometer will indicate whether the current is flowing through the coil or not.

**How to Make it**

1. **Prepare the materials:** You will need a coil of wire, a galvanometer, and a power supply.
2. **Assemble the device:** Place the coil of wire in the substance whose resistance you wish to measure and connect it to the galvanometer. The power supply should be connected to the opposite end of the coil.
3. **Test the device:** When a current flows through the coil, the galvanometer will indicate the resistance of the substance.
**Simplest Still**

This is a very simple method of making a still which I have found to be quite efficient. The substance to be distilled is placed in an ordinary kettle, and a tumbler is inverted over the spout and held there by means of a piece of wire. Beneath this tumbler another is placed. The spout of the kettle should be preferably directed over the edge of the stove, so that the liquid receiver will not rest upon the stove itself. It is not suggested that alcoholic liquors be distilled in this type of apparatus, because of the inflammable nature of the distillate.

**Shield for Explosive Mixtures**

When experimenting with gases, there is in many cases, the possibility of an explosion. This means that the experimenter, unless he has some means of protection, will have chances out of ten, receive a charge of splintered glass in his face and eyes. It is to prevent such a catastrophe, that the shield described below is designed. This protector consists simply of several layers of clear mica securely fastened to a stiff wire frame. As shown in the drawing, the shield is planed flat or round around the mixing tube or generator. The materials of which it is constructed are very easily workable, and a vast unlimited variety of sizes and shapes can be made. A good clear grade of mica, which can be purchased from any automobile supply house, is wired through holes punched near the edges to the frame, bent to the desired shape. Three or four layers of the mica should prove strong enough to deflect the splinters of a standard weight test tube or burette. The shield should be placed several inches from the apparatus. The illustration shows a shield for use where a partial obstruction of view is not objectionable. It is constructed of heavy fibre, and contains a mica window. When buying the mica, one should be certain that he is getting the genuine mica, and not some inflammable celluloid substitute.

**How to Make a Colloidal Gold Solution**

The study of colloids is an interesting side of chemistry and a subject that is receiving a great deal of attention today. A colloidal gold solution is easy to prepare provided you have some gold chloride to start with. Those who do not have this expensive salt can prepare a very satisfactory substitute by looking around the house for a gold filling that has come from a tooth of some unfortunate member of the household. This small piece of gold is dissolved in aqua regia (1 part Nitric Acid to 3 parts Hydrochloric Acid). The volume of this solution should be about 10 c.c. (Cubic Centimeters), depending somewhat upon the original size of the gold filling.

Add about 5 drops of this gold solution to 50 c.c. an alabaster in a test tube. Test the solution with blue litmus paper and if it turns the paper red add a little baking soda to make the solution neutral.

With our new neutral gold solution it is an easy matter to reduce the gold to a beautiful suspension of colloidal particles. This is done with a dilute solution of Formaldehyde (1 or 2 drops of the commercial formaldehyde to 50 cc. of water).

Heat the solution of gold nearly to boiling and add 1 or 2 cc. of the dilute formaldehyde solution which acts as a reducing agent. The solution assumes a red or purplish color depending upon the size of the gold particles formed. By varying the concentration of the gold solution and the amount of reducing agent used different shades of colloidal gold can be produced.

These solutions will usually last for a long time, especially if the gold used was pure to begin with.

**Loosening Tight Glass Stoppers**

The glass stoppers of certain bottles, especially those containing alkaline substances, often become fastened so tightly that even jarring will not loosen them. However, if the neck of the bottle is heated, it expands, easily loosening the stopper. The ordinary methods of heating are very liable to crack the glass, but if a strong cord, or better, a flat shot glass is used, it will shatter quite cleanly above the neck (see figure) and run vigorously back and forth while the bottle is held firmly, sufficient frictional heat is developed to loosen the most obstinate stoppers with no danger of breakage.

**The Mercury Rain**

This experiment, one of the many devised to show the almost inconceivable pressure of the air, has hitherto been beyond the scope of the average experimenter.

Cover the bottom of a heavy, 500 cc. flask to the depth of a quarter of an inch with water. Support it over a square of wire gauze on a ring stand and heat to boiling. While the water is heating, pour 10 or 15 cc. of mercury into a small, round box, turned from wood. The grain of the wood should run parallel to the axis of the box.

Remove the heat and the instant the water stops boiling, place the box on the rim of the flask. As the apparatus cools, the steam in the flask condenses, creating a partial vacuum. The mercury is forced by atmospheric pressure through the pores of the wood and rains into the water.

**Every Experimental Chemist Should Use One of These Shields When Performing Experiments With Explosive Mixtures.**

**A Mercury Rain Storm May Be Created By Means of a Pill Box and a Partial Vacuum.**

**A Simple Still May Be Made By The Use of Two Cups and a Tea Kettle.**

**A Mercury Rain Storm May Be Created By Means of a Pill Box and a Partial Vacuum.**

**A Mercury Rain Storm May Be Created By Means of a Pill Box and a Partial Vacuum.**

**A Mercury Rain Storm May Be Created By Means of a Pill Box and a Partial Vacuum.**
EVEY startling effects can be produced by combining cartoons with motion pictures. For instance, in one of the Colonel Heezaliar films we see the artist sketching the Colonel. The artist then draws a lake and the Colonel intimates that it is too hot to work, so he dives into the lake and swims around. The artist meanwhile has his attention distracted by a report in the newspaper that a great many vessels have sailed for Treasure Island and expect to find hidden gold there.

The Colonel becomes a nuisance in his efforts to determine what the artist is reading, and is forcibly thrown against the easel from which he has escaped. Desiring revenge he slides from the easel again and makes his way to an open window. By crawling and jumping he disappears through the window and reaches the roof where a radio station and its operator are found. Here he informs the operator that he would like to be placed on a ship near to Treasure Island, and desires to be transmitted there by radio. The operator picks up Colonel Heezaliar, posts him to a cardboard and pushes him into a slot conveniently located in some peculiar part of his grotesque transmitting station, and then presses the key. On the roof of the building one can see a picture of the antenna and the undulating current being emitted therefrom. Suddenly the lead-in commences to swell progressively, and Heezaliar wobbles out through the top of the L-type antenna and runs along the wave.

We cut in now to a scene where a ship is sinking in mid-ocean. Heezaliar, who has been shot into the clouds by the radio wave, decides to leave them, and when the proper bolt of lightning flashes from the sky striking the ship and straightens out to form a very fine sliding pole similar to the ones used by the firemen in their company houses, Heezaliar slides down and lands on the deck of the sinking vessel, which is, by the way, nearest to Treasure Island. On the vessel but a short while, Heezaliar realizes that it is impossible to stay there as the ship is sinking rapidly. He makes his get-a-way in a bottle cast up upon the waves, and is washed ashore on a cannibal island.

One of the cannibals scuttling the beach discovers the bottle, and extracting the cork therefrom, withdraws the Colonel. Throwing him to the ground he attempts to step on him, but Heezaliar eludes the cannibal's feet. Eventually captured, Heezaliar finds himself in a cauldron for the next meal.

Photos courtesy of Bray Productions.
Utilizing Wired Radio for Broadcasting

BY BERT T. BONAVENTURE

It has remained for the present chaotic condition in the broadcasting situation to bring into prominence some of the actual work being done in utilizing the transmission lines of a central power station for radio communication purposes, an idea advanced as early as 1911. Wired radio, as the name suggests, is a scheme of transmitting currents of high frequency along a system of conductors which then serves as the connecting link between the transmitter and the receiver. In space radio, the transmission medium which serves the above purpose is the hypothetical ether.

Wired radio is the invention of Major-General George Owen Squier, Chief Signal Officer of the United States Army. An active interest has been shown by Maj.-Gen Squier in the present as well as in past experiments and tests of his system.

In order to collect the necessary data, before placing the system into commercial use, exhaustive experiments had to be carried out to determine the peculiarities, if any, in the characteristics of wired radio transmission. For this purpose, a series of extended tests were carried out in various cities such as Cleveland, New York and Washington, D. C. The co-operation of the Radio Section of the Bureau of Standards was obtained in the last mentioned city. As a result of these experiments interesting observations were recorded, which proved of considerable value when the commercial project was launched.

Some apprehension was felt from the start relative to the character of the light and power distribution system. The method of distribution of electric light and power generally utilized in most cities where alternating current is used is as follows: Primary generation of current takes place at the central station at voltages ranging from 5,000 to 15,000 volts, three phase, and is distributed to the several substations at this voltage. At the substations this current is transformed to between 2,000 and 3,000 volts, also three phase, and redistributed to the areas where the consumers are located. The various distribution transformers located along the line reduce the voltage approximately 110 volts, single phase, in which form it is finally used. In order that the broadcasting service be supplied to the maximum number of customers with the minimum losses occurring in the intermediate power apparatus connected to the line, it is necessary for the transmitter to operate into the 2,000 to 3,000 volt line.

It had been a relatively easy task to transmit by wired radio over a long transmission line, where an unobstructed path was offered to the high frequency currents from the transmitter to the receiver, the line providing a direct path for the signal.

Furthermore, it was found that with the proper choice of wave-length for any given installation practically all of the energy transferred to the line would be propagated to its destination by conduction and no appreciable amount of energy would be lost by radiation in the form of electromagnetic waves. From a study of the theory, it was expected that with decreasing wave-lengths, the attenuation suffered by the transmitted energy would increase and that abnormally large powers would have to be used to cover a given distance. However, actual tests showed that extremely long wave-lengths gave very poor results and that an optimum wave-length exists at which no appreciable radiation into space occurs, at the same time the wave-length provides good wired radio service. During tests on one line, short wave-lengths up to 710 meters gave considerable radiation as evidenced by reception on an antenna, while 13,000 meters gave poor reception on an antenna and also by wired radio, showing, in this case, that the wave-lengths chosen were ill fitted to be used successfully on that particular line. Excellent wired radio reception, with almost nil reception on an antenna, was obtained when using a wave-length of 3,800 meters.

When using short wave-lengths, the existence of "blind spots" was relatively frequent. At these points no reception could be obtained, due apparently to the fact that standing waves were formed through the reflection of the high frequency currents by the power apparatus on the line. At the nodes of these stationary waves no reception was possible. While maximum signal strength was obtainable at the loops.

At the present time, the Richmond Light and Railroad Company of Staten Island, New York, has a wired radio broadcasting station in operation at the Livingston power house. Special receivers, both crystal and vacuum tube type, have been developed for use on the company's electric light lines.
Radio for the Beginner

XIX. AMPLIFICATION

By ARMSTRONG PERRY

The radio, to the irrepressible occurrence of radio is to purchase as inexpensive an outfit as will enable him to hear something. For a few days he thrills at the voices and melodies that respond like fairies to his touch of the controls. Then, irritated by the necessity of snatchings the phones from his head in order to share his joy with those who stand eagerly at hand, fired by the bold assertions of others and enterprising dealers that he can magnify those sounds 20,000, yes, a million fold, he raises the catalogues for the most efficient amplifier.

Vacuum Tube Best All-Around DETECTOR.

The detector tube of the single-tube set not only detects but also amplifies. The term “detector” really belongs to those phones rather than to the tube, which merely rectifies the oscillating currents received from the antenna, strengthens them with currents from batteries that light its filament and put pressure on its plate, and passes them on in the form of a pulsating direct current that the phones can translate into sound.

The crystal detector is more successful in some respects as a rectifier of radio currents than the tube, but as it can pass on no more than it receives, the tube has the immense advantage given by the comparatively heavy currents from its “B” battery.

Grid current, in an electron tube, is measured in micro-amperes or milliamps of an amperere. The condenser capacities existing between condenser plates, and sometimes between parts of radio apparatus not intended to serve as condensers but nevertheless having capacity, are sometimes measured in micro-microfarads or milliamp of part of a farad. So the man who thinks he has set his dial correctly may be a million of something or other away from the adjustment that he needs for best results.

The amplifier tube can amplify only what reaches its glassed enclosure. It must amplify all the current it receives, regardless of whether it carries songs or squeals. The first step in successful amplification, therefore, is to learn to adjust the detector bulb. A common practice is to crowd it with all the filament current it will take, making it deliver loud results regardless of distortion. The best practice is to adjust it by the finest possible gradations until it delivers only the sounds that are desired and no noises of its own making. Filament voltage and plate voltage both play a part in this, but filament voltage is usually more critical. A rough rule is to turn on the “A” battery current until a hissing noise is heard and then turn it down until the hissing stops.

The curves that radio engineers draw to show the characteristics of electron tubes, and which beginners will do well to learn, explain that an increase in the grid voltage of a tube causes a much greater increase in the plate current than could be produced by increasing the voltage of the plate itself by the same amount.

Radio frequency amplification, which is being used more and more, is essentially different in that the amplification takes place before the current passes through the detector tube. A phone connected in the plate circuit of a radio frequency amplifier tube would bring to the ear no voice or music, if the amplifier is working correctly, for the modulations would be too weak to either stimulate the diaphragm of the phone or make an impression on the diaphragm of the ear. The antenna current, in this case, goes to the grid of the first tube. The plate of this tube is connected with the primary of a transformer, when the secondary is connected with the grid of the next tube. Sometimes, however, a different method of coupling is used, a resistance element being inserted between the plate and the positive terminal of the “B” battery. A condenser between the plate of the first and the grid of the second tube, and another resistance element between this condenser and the negative pole of the “A” battery that supplies the second tube. What is known as tuned impedance radio frequency amplification consists of an inductance coil and a condenser in parallel, connected to the plate of the first tube and the “B” battery. The plate is also connected to the next tube, through a fixed condenser.
A One Tube Regenerative Receiver

By BERT T. BONAVENTURE

Construction of Tuner

Both the variometers and the vario-coupler may be home-made, but it is the opinion of the writer that it is not worth the time and trouble today to make your own, as the market now affords fairly good ones at very reasonable prices. This set was made when the radio boom had just started and prices of radio apparatus were sky high. (Some of the parts had to be replaced by more recent apparatus.) For the benefit of those who would like to try their hand at constructing the tuning units, the table below will furnish the necessary data.

Data on Tuning Elements

<table>
<thead>
<tr>
<th>Instrument</th>
<th>No. of Tuners</th>
<th>Size of Wire</th>
<th>Type of Wire</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plate</td>
<td>82</td>
<td>No. 22 D.C.C.</td>
<td>35/62</td>
</tr>
<tr>
<td>Variometer</td>
<td>76</td>
<td>No. 22 D.C.C.</td>
<td>35/62</td>
</tr>
<tr>
<td>Grid</td>
<td>64</td>
<td>No. 20 D.C.C.</td>
<td>35/62</td>
</tr>
<tr>
<td>Vario-</td>
<td>60</td>
<td>No. 20 D.C.C.</td>
<td>35/62</td>
</tr>
<tr>
<td>coupler</td>
<td>56</td>
<td>No. 18 D.C.C.</td>
<td>45/62</td>
</tr>
<tr>
<td>Primary</td>
<td>30</td>
<td>No. 18 D.C.C.</td>
<td>35/62</td>
</tr>
</tbody>
</table>

How to Wire the Set

There is very little explanation necessary regarding the construction of the set, as the photos and figures practically tell the story. The shelves are held to the panel by means of two brackets on each shelf, as shown in Fig. 1. The brackets themselves are held to the shelf by two 8/32 flat head machine screws through the bottom of the shelf

countersinking the holes so that the heads of the screws will not protrude. Several methods of holding the batteries in place may be used, but a narrow leather strap around the battery will do very nicely. The ends of the strap are held by wood screws with washers under the heads.

A word about the wiring will not be amiss. Experience teaches that the low voltage leads of the set need not be wired with bus bar wire, such as the leads from the A and B batteries. Hence these circuits have been wired with twisted pairs of lamp cord to reduce the labor of wiring. Small brass staples may be used to hold the wire in position on the sub-base, or two small holes may be drilled where it is desired to hold the wire down, and the wire may be tied in place with thin twine or cord. No iron of any sort should be used in the construction. Only the high voltage parts of the circuits have been wired with bus bar wire, such as the grid and plate circuits. The wiring circuits are shown in Fig. 3. Two possible circuits are shown, with the preference to Fig. 3A, as the oscillations of the circuit may be more easily controlled. Fig. 3 is a standard Armstrong three circuit tuner.

Material Necessary

To build the set, the following parts should be used:
1. Bakelite panel, 7 3/4" x 21" x 3 1/2".
2. Vacuum tubes.
3. Potentiometers.
5. D.C.C. 3 1/2" plate.
8. D.C.C. 3 1/2" plate.
11. D.C.C. 3 1/2" plate.
15. D.C.C. 3" plate.
17. D.C.C. 3 1/2" plate.
18. D.C.C. 3" plate.
20. D.C.C. 3 1/2" plate.
23. D.C.C. 3 1/2" plate.
27. D.C.C. 3" plate.
29. D.C.C. 3 1/2" plate.
30. D.C.C. 3" plate.
32. D.C.C. 3 1/2" plate.
33. D.C.C. 3" plate.
34. D.C.C. 7 3/4" plate.
35. D.C.C. 3 1/2" plate.
36. D.C.C. 3" plate.
38. D.C.C. 3 1/2" plate.
41. D.C.C. 3 1/2" plate.
42. D.C.C. 3" plate.
44. D.C.C. 3 1/2" plate.
45. D.C.C. 3" plate.
47. D.C.C. 3 1/2" plate.
50. D.C.C. 3 1/2" plate.
51. D.C.C. 3" plate.
53. D.C.C. 3 1/2" plate.
54. D.C.C. 3" plate.
56. D.C.C. 3 1/2" plate.
57. D.C.C. 3" plate.
59. D.C.C. 3 1/2" plate.
60. D.C.C. 3" plate.
62. D.C.C. 3 1/2" plate.
63. D.C.C. 3" plate.
64. D.C.C. 7 3/4" plate.
65. D.C.C. 3 1/2" plate.
66. D.C.C. 3" plate.
68. D.C.C. 3 1/2" plate.
69. D.C.C. 3" plate.
70. D.C.C. 7 3/4" plate.
71. D.C.C. 3 1/2" plate.
72. D.C.C. 3" plate.
74. D.C.C. 3 1/2" plate.
75. D.C.C. 3" plate.
77. D.C.C. 3 1/2" plate.
78. D.C.C. 3" plate.
New Vacuum Tube With Nine Lives

A NEW model Radiotron tube known as the UV-199 has recently been put on the market and become an instantaneous success. A new tungsten filament has been placed in this tube which consumes only .06 ampere at 450 volts. The total wattage consumed is only 1/27th of the amount used in the UV-201 tube, but the new anode has characteristics which render it better for use in a radio set than the old type of tube. With 80 volts on the plate and a negative bias battery, the watts drawn from the "B" battery are slightly greater than the watts drawn from the "A" battery.

Due to extremely low current consumption of this new tube it can be very economically run on ordinary three cell flashlight batteries. In fact, No. 6 dry cells will last for about a year when used with this tube under ordinary circumstances and usage.

AN EXCELLENT RADIO FREQUENCY AMPLIFIER

This new tube can very well be used in radio frequency amplifiers where it gives exceptional results due to the fact that its internal capacity is very low. It is practically impossible to burn out this tube because when too much current is supplied to the filament, the electronic emission automatically falls off and the tube becomes inoperative. In order to bring it back to a normal state it is necessary to burn the filament of the tube for some time without any plate battery connected in the circuit. The length of time required for recuperation is dependent upon the length of time at which the tube was operated at abnormal voltage.

When interference and static are at a minimum the grid leak should have a value of from six to ten megohms. However, with severe QRM or static the leak should have a resistance of about two megohms. In general a five megohm leak will give very satisfactory results under all conditions.

GRID BIAS NECESSARY

When these new tubes are used as amplifiers it is quite necessary that a grid bias battery be used. This should be inserted in the transformer to filament lead and should have the negative side connected to the transformer. The following values will be found to give good results for various voltages on the plate. With 40 volts on the plate use from 3 to 1 volt grid bias, for 60 volts, 1 to 3 volts bias, and for a plate voltage of 80 use 3 to 4.5 volts between the filament and the transformer.

At the Left Will Be Seen the U. V.-199 in Comparison With Two Standard Raters. Its Small Size Can Be Readily Seen. The Second Illustration Shows How the Connections to the Filament Circuit Should Be Made When the Tube Is Used as a Detector. While the Third Illustration Shows What Changes Should Be Made in This Circuit When the Tube Is Used as an Amplifier. These Connections are Quite Important.
Fig. 1 At Left Shows the Portable Vacation Radio Set Described by Mr. Price in Use on a Pleasure Yacht. This Set Comprises a Detector and Two-Step Audio Frequency Amplifier. This Receiving Set Has Been Designed and Tried Out by Experts and This Article Will, Therefore, Be of Unusual Value and Interest to All of Our Radio Readers.

Fig. 2 Above Shows Front Panel View of the Portable "DX" Receiver. The Controls for Tuning Are Simple, Considering the Fine Selectivity Possible.

Fig. 3 at Left Shows the View From the Right Side or Tickler End of the Portable "DX" Receiving Set. It is a Good Idea to Mount the Vacuum Tube Sockets on a Shelf or Frame Supported on Sponge Rubber or Else on Rubber Bands, to Absorb Any Vibration or Jars. Especially if the Set Is to Be Carried on a Boat or Automobile. Fig. 4 Above Shows the Rear View of the Portable "DX" Set. While Fig. 5 at the Extreme Right Shows a View From the Left or Condenser Side of the Outfit.

Fig. 6, at Left, Shows the Bank of Small Mica Condensers Used in Series with the Antenna in the Place of the Usual Variable Condenser. This Bank of Condensers May Be Substituted by a Variable Condenser if Desired, However, as the Author Points Out. A Switch Enables the Operator to Connect in as Many of These Condensers as Necessary.

Fig. 7 at Right Shows a Top View of the "DX" Portable Receiving Set.
A DX Portable Receiver With Novel Tuner

By P. A. PRICE

VACATION dry battery radio tube set that is easy to make, simple to operate and highly efficient—one, of course, that will work equally well at home—has been evolved for the benefit of the radio fans after a long series of tests to determine just what type of set would be best for the good of the vacation and at the same time he within easy reach of Mr. Radio Fan's pocketbook.

Here is a set which can be used in camp, on auto trips, on motor boats or yachting cruises, at the summer home or back home on the front porch or in the parlor for the stay-at-homes. It has a summer range of 1,000 to 1,500 miles and under ordinary favorable conditions has received California stations at Cleveland, Ohio. Its range for loud speaker use in summer is around 300 miles and most radio fans on their summer outings will be within easy range of broadcasting stations.

NOT A FREAK, JUST A REGULAR SET

This vacation set is not a freak. The circuit used, an ordinary three-circuit hook-up, is tried and tested. It makes use of a primary-secondary-tickler coupler consisting of a secondary stator coil at both ends of which are rotors for the primary and tickler coils. A detailed description of this coupler is given in succeeding paragraphs. The circuit has been used most successfully by amateurs and others and during the test of the model set. Detroit and other stations were tuned in through WJAX, the powerful station of the Union Trust Co., of Cleveland, Ohio.

The detector and two-stage amplifier are mounted on a panel 8x11 inches, the base being 11x71/2 inches and 3/8 inch thick, making it most compact and has a handle away as luggage. It may be fitted with a box-like cover and a handle attached for convenience in carrying.

The batteries, of course, are not contained in the set. For vacation use they may be carried along in a separate box, providing the tubes using dry cells are utilized. The test set contains three UV-199 tubes, which are connected in parallel and controlled by one 10-ohm rheostat. Three dry cells, connected in series, are used to supply the 41/2 volts required for these tubes. It is well to remember that a 25 or 30 ohm rheostat is required for UV-199 tubes when these tubes are used singly on a dry cell battery, and that a 60-ohm rheostat is required when a 6-volt storage battery is used for individual tubes.

Of course if standard 6 volt tubes are used, a 6 volt A battery will be required. With the WD-11 and WD-12 tubes 11/2 volt dry cells will be required for the A batteries. In all cases the B battery voltage remains at 45 volts, although 221/2 volts may be applied to the detector tube if found best.

The recommended aerial for use with this set is a single wire 100 feet long. For an inside aerial it is recommended to use two, three, or four wires, each as long as possible up to 75 feet, the wires being connected at one end and being left free at the other, the lead-in being attached to the end-connecting wire.

The use in camps a single wire aerial 100 feet long can be strung up between trees, as high as convenient. On a motor trip, the 100-foot single wire aerial may be thrown over a tree branch and attached to the set in the auto, the aerial being properly insulated where it touches the tree. It is not practicable to try to use the set in the car while traveling, although by rigging up a proper aerial and ground this might be done.

If it is desired to use the set on a motor boat or on a yachting trip, an aerial string from one end of the boat to the other may be used, any metal parts of the boat which touches the water being used for ground.

ALL UNNECESSARY PARTS ELIMINATED

In submitting this circuit for the use of radio fans all unnecessary parts have been eliminated. The three vacuum tubes are operated from one rheostat, so that the two stages of amplification are always in use when the set is being operated. The test set was made of the highest grade parts obtainable and thus constructed, the parts, without tubes, phones or batteries, should cost not more than $45.00 or $46.00. With tubes, phones and batteries the cost should be around $77.00. This, of course, is exclusive of labor.

It is not necessary to use the same parts as described in the test set. Cheaper parts may be used or parts taken from other sets. The only part described and which is necessary to retain is the P-S-T (or primary-secondary-tickler) coupler, and this coupler may be constructed by the radio fan.

The coupler consists of a bakelite tube 44 inches long, having a 3-inch diameter. This forms the stator or secondary coupling and upon it are wound 75 turns (60 feet) of No. 21 or 22 silk-covered wire. Taps are taken out at the 40th, 50th, 60th, and 70th turns, on the tickler end of the winding. The winding starts about 1/4 inches from the primary end. The 40-turn tap is for 200 meter work. If broadcasting only is desired no taps need be provided and the entire coil is used.

(Continued on page 489)
Pitfalls of the Radio Inventor

By EVERETT N. CURTIS

(MAY NOT FAIL TO READ THIS VALUABLE ADVICE ON PATENTS)

Mr. Everett N. Curtis, the author of this article is the lecturer on patent and trade-mark law at Colum-bia University and is patent solicitor in active practice in New York City. He is the author of Curtis’s Manual of Steel Sherman Law and of a number of monographs. He was graduated from Massachusetts Institute of Technology in 1895, and from the Boston University Law School in 1900.

PATENT LAW IS OLD

The patent law in this country is derived from the English law as it existed at the time of the colonies. Under our constitu-
tion it is provided that the Congress shall have power to promote the progress of science and useful arts by securing for limited times to authors and inventors the exclusive right to their discoveries. The word “dis-
coveries” is unfortunate, but is interpreted in the courts to mean the same thing as inventions. The number of patent acts have been passed by Con-
gress, and the law has become fully crystal-
lized in the Acts of 1870 and 1872 as amended.

The most important provision of the law is Section 466, under which it is provided, among other matters, that any person who has invented any new and useful art, ma-
chine, manufacture, or composition of matter, or improvement thereof, known or used by others in this country before his invention or discovery thereof, may obtain a patent. Thus it is provided that in every application for patent there must be present invention, or exercise of the creative faculty; there must be present novelty or newness; and there must be present utility, or use-
fulness. It is also provided in effect in the same section that a publication, either abroad, two years prior to the filing of the application or a two years public use or sale in this country prior to the filing of the same shall void the issuance of the patent theron. Accordingly under-
lying the validity of any patent, are the prerequisites of invention, novelty and utility and the so-called statutory bars. Even though the patent be issued, no defendant is precluded from showing that such patent is defective or that any of these particulars and accordingly void.

THE RIGHTS A PATENT GIVES TO THE INVENTOR

All that the inventor secures by his patent is the right, in the first instance, to exclude all persons from making, using or selling the invention described by it. This is true is a very substantial right and includes not only the right to an injunction but also the right to damages and profits. It should be borne in mind, however, that this right is negative in character and is only presumptive, and that a patent may be declared void and void by the courts for a variety of reasons, as for example, that the inventor was not the true inventor, that the subject of the invention is unpatentable, or that it involves only mechanical skill, that it is not new, or that it will not operate, etc.

Inventions must be regarded in the light of the prior art of the art, and measured by the advance which they have made. If they are basic in character and performs a function not before known, they are termed “primary” or “pioneer” inven-
tions, such as the Goodyear process for vulcanizing rubber, the telephone, fax, or the Bell telephone, and are construed broadly. If they are improvements upon what has gone before, they are secondary inventions and are narrowly construed. Mechanical skill is not invention, neither is mere aggregation, nor doubling of an old structure, nor duplication or enlargement, nor mere change of form.

Want of novelty may be shown by prior publications in any language or by any prior knowledge or use accessible to the public. Want of utility may be shown by proving that the so-called invention is non-operative, or that it is injurious to the morals, health or good order of society.

One of the first steps to be pursued by an inventor should be to ascertain whether or not his invention is new, that is, if it has patentable novelty. If he is a skilled mechanic, or if he is engaged in a business which brings him into close contact with the art and the trade, he will probably know if there is any commercial product or process on the market which anticipates his inven-
tion. But this tells him little. It is pos-
sible that there may not be any known
invention in the world a prior printed publication accessible to the public showing and describing his invention, which he has not already used. Even though there is such a publication, it is probable there is a copy of the same in the U. S. Patent Office, or perhaps in some public library in any of the great cities. A search therefor at the Patent Office and through technical libraries accessible to the public would probably disclose the publication. In order, however, to be fairly certain there were no prior publications, a very thorough search would be required, which would be expensive and perhaps beyond the means of the ordinary inventor, who would have to be satisfied with his own investigation at a public library. A search of scientific works and copies of domestic and foreign patents might be accessible, or he might have made for him the usual preliminary examination by some resident patent attorney at Washington, who for a small fee would make a cursory examination of the class of U. S. patents where the invention was likely to be found and would send back to him a critique of the patent. Such preliminary examination is often of great advantage, since it will usually disclose any very close inventions; but the inventor must be cautioned from placing too much depend-
ence upon it, as it is at best only a make-
shift and cannot in the nature of things be exhaustive.

(To Be Continued.)
The Photograph At the Left Gives a Comprehensive View of the Aerial and Masts of Station WEAF, of the American Telephone and Telegraph Co., New York City. The Antenna is Located On the Walker Street Building, and the Studio, a Prospective View of Which Is Shown Above, is Located at 195 Broadway.

Above: The Operator at Broadcast Central, Controlling Stations WJZ and WJY, New York City. At Right: The Visual "Check Up" Device Which Gives A Sight Record of All Transmission from These Two Stations.

At Left: Studio of WJZ From Which Classical Selections Are Broadcast. Above: Jazz Studio of WJY.
Radio Oracle

In this Department we publish questions to this Department cannot be answered and answers which we feel are of interest to the novice and amateur. Letters addressed free. A charge of 25c is made for all questions where a personal answer is desired.

LONG AND SHORT WAVE TUNER

Edward Freyer, Holyoke, Mass., requests:

Q. 1. Can you give me a circuit diagram of my type of three-circuit tuner which employs a vario-coupler and two variometers with the necessary additional change over by means of switches to a three-coil honeycomb tuner? I also wish to change my present two-step amplifier to one step of radio frequency amplification and one step of audio frequency amplification. Kindly indicate this in the diagram.

A. 1. You will find the required circuit diagram given in these columns.

VARIOMETERS WOUND INCORRECTLY

Edwin Converse, Pioneer, Ohio, submits a circuit diagram and states that his variometers are wound with 74 turns on the static and 58 turns on the rotor. He says that he is unable to get good results with this circuit and asks:

Q. 1. How can I make this circuit work correctly?

A. 1. Providing that all of the connections shown in your circuit diagram are correct, we cannot see any reason at all why your set should not work with the exceptions that your variometers are not wound correctly. We would advise you to reduce the number of turns on the static coils to 56, so that the two coils balance better.

A small fixed condenser shunted across the phones will generally give better results and we would advise you to employ the same.

MORE TROUBLE

Robert Brandon, Grand Rapids, Mich., says that he has hooked up a set using a hose coupler and an audion detector, but is unable to get any results whatever, he asks:

Q. 1. Can you tell me why my set fails to operate and give me some pointers on the same?

A. 1. The reason you do not hear anything with your audion detector set might be any one of many reasons. For instance, your "B" battery and filament currents may not be adjusted correctly, or your batteries may not be strong enough. Also, be sure that the polarity of your "A" battery is correct. The positive pole must be connected to the plate.

Regarding this set, we would say that you should go over all your connections carefully and solder all those that are not clipped tight in binding posts. Also, be sure that your hose coupler is in good shape, and that the fine wire on the binding posts of your receivers is not broken. Also, try adjusting your grid leak. When you do get signals, a variable condenser, shunted across the secondary of your hose coupler will give much finer tuning.

476

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BATTERY CONNECTIONS

(179) F. O. Grams, Geneva, Ill., mentions a diagram appearing in this magazine in which the negative of the "B" battery is connected to the positive of the "A" battery. He says that he has tried this connection several times and could not receive anything until he connected the negative of the "B" to the negative of the "A." He asks:

Q. 1. Is not the connection you show a mistake?

A. 1. While it is true that some tubes work best with the negative of the "B" battery, connected to the negative of the "A" battery, still other tubes will work best with the negative of the "B" connected to the positive of the "A." It is always best, however, to hook up a set to try both connections to determine which one is best.

The writer personally has a tube which will work equally well with either connection. Therefore, we do not consider that the print which you brought up is an error.

LONG WAVE RECEIVER

(180) A. J. Guertin, Amsterdam, N. Y., asks:

Q. 1. What instruments would you recommend for a receiving set which will tune from 200 to 3,300 meters, using one stage of radio frequency amplification and two of audio frequency amplification?

A. 1. In order to tune from 200 to 23,000 meters, it will be necessary to use honeycomb coils for tuning. We give below a diagram showing how to connect one step of radio frequency, a detector, and two stages of audio frequency amplification to three honeycomb coils, used as primary and secondary and tickler. The first, third, and fourth tubes are amplifiers, and the second is a detector. The first transformer is of radio frequency type, and the second and third are of audio frequency types. An "A" battery potentiometer is necessary for the correct operation of this circuit. A small fixed condenser with a capacity of about 0.01 mf. should be connected across the primary of the first audio frequency amplifier transformer. Two 0.01 mf. variable condensers are used, one divided across the secondary, and one in series with the primary honeycomb coils. The "B" battery must be so arranged that 25 volts or slightly more may be applied to the detector tube, and from 45 to 100 to the amplifying tubes. A single 5-volt storage battery may be used for lighting the elements in this circuit, providing it is of sufficient capacity.

RADIO FREQUENCY TROUBLE

(181) Eugene Rouch, Brooklyn, N. Y., refers to a particular radio receiving outfit employing radio frequency amplification and says that he is unable to get any results when his radio frequency amplification is connected. He asks:

Q. 1. Can you give me any help with this set?

A. 1. It is practically impossible to say just what is wrong with your set, unless we are able to see the same, and hear how it works. It may be that your radio frequency amplifying tubes are inadequate, or that you are applying too much or too little current to them. Also, your potentiometers may not be adjusted to the best positions.

LIGHTNING DANGER

(182) Baird Fellows, Salisbury, Missouri, says that he is contemplating the erection of a radio station and is going to place his aerial on masts which will be erected on the tops of two buildings about 180 ft. apart. He asks:

Q. 1. Will there be any danger from lightning with the aerial?

A. 1. There is very little danger from lightning if the aerial is properly grounded when not in use.

Q. 2. The masts are to be guyed with galvanized iron wire. Should these guy wires be insulated?

A. 2. The guy wires should be insulated by inserting strain insulators every about 20 ft.

Q. 3. Will the above mentioned aerial be satisfactory for transmission?

A. 1. The aerial which you mention will entirely too long for transmission. You should reduce its entire length to about 60 ft. for this work.

EXTENSION PHONES ON A RADIO SET

(183) Mr. Edmund Burke, Kansas City, Mo., wants to know:

Q. 1. How can I connect a pair of phones to my receiver so that one pair of phones is near one edge of the house and the other pair of phones is away from the house, or in some distance away can listen in on the concerts?

A. 1. My set consists of a detector and two stage amplifier.

Q. 2. By running two wires from your house to your neighbor's, and connecting one end of the two pairs of phones to your set, the other end of the two pairs of phones to your neighbor's set will you have a pair of phones in each set? If you also wish to listen in at your house at the same time you may connect your receiver to a pair of phones which are parallel with the two wires, as is found best by trial.

RADIO SET IN A PHONOGRAPH CABINET

(184) Wm. D. Fox, Philadelphia, Penn., refers to the radio set illustrated and described in the June, 1922, issue of SCIENCE AND INVENTION, on page 156, and asks:

Q. 1. Could this set be used in connection with a loud speaker and what type would be best?

A. 1. The set you mention could very well be used with any form of loud talker; this would do away with the need of head phones.

Q. 2. Could this set be incorporated in a phonograph cabinet?

A. 2. Of course, this set could be incorporated in a phonograph cabinet, but since it has quite complicated controls, it would take some space.

Q. 3. Since I have had no experience in radio, I would like to have some information as to how to begin.

A. 1. A receiving set of this type is not advisable for the beginner in radio. You should start with a simple crystal or single tube receiver, and gradually enlarge this set as you become more familiar with the workings of the same.

SHIELDING

(185) Carl H. Fastig, Des Moines, Iowa, says that he has had considerable trouble with his radio receiving set in that whenever he brings his hand near the controls he hears a loud whistle and when he has a station tuned in and removes his hand the signal disappears. He asks:

Q. 1. How can this be eliminated?

A. 1. It is desirable to shield all the instruments of a regenerative receiving set, in order to reduce body capacity, and prevent the circuits from "howling." This may be done by fastening aluminum plates to the back of the panel, directly in front of the tuning instrument, and connecting the same to a ground such as a water pipe, or to the ground post on the set. Be very careful in installing the instruments that you do not short circuit them on the aluminum plates. Everywhere that a hole is drilled in the panel and through the aluminum plates, the hole in the plate should be made larger than the hole in the panel. In this way any bolts or machine screws passing through the panel will not touch the plates and become short circuited. The customary use of variable condensers should be ground, not the stationary ones.

AUTOMOBILE CURTAIN
(No. 1,451,555 issued to Frederick J. Thuroczy.)

A new way of securing automobiles, cigar boxes, etc., to a touring car and likewise of concealing them when not in use is described in this extract.

The automobile curtain itself is folded up and when in this folded condition falls down in the vacant space immediately back of the front seat. The fasteners for the curtain are few, although several rods run vertically through it in various places. Of particular interest is the L-shaped rods fastened to each door which clamp up and hold them. It now becomes possible to open the doors of the car without unlatching or otherwise disturbing the curtain. The ends are curved to meet a portion of this swing open with the door.

MINIATURE AIRPLANE ATTACHMENT
(No. 1,458,276 issued to Henry H. Dodge.)

As will be readily seen in the illustrated form, this attachment proposes to attach to the radiator cap of an automobile a small airplane. This is held in position by two arms capable of being rotated freely, but so arranged that the plane is always maintained in last position possible.

A balance weight is secured to one of these arms to properly counterbalance the weight of the airplane itself, When the vehicle speeds along, the reaction of the plane will be directly proportional to the speed of this plane also the speed of the wind. The plane will thus be caused to tilt, and, upon the amusement of the occupants of the automobile who may be watching it. This position of the plane is due in part to the tilt termed line in our illustration. There is no doubt but that a novelty of this nature will find a very ready market if placed upon the public at a reasonable price.

CHECK PROTECTOR
(No. 1,452,674 issued to Albert E. Loebel.)

In the drawing, one will see in the top view the device, differing only from the ordinary case in that the same is provided with a cutaway portion, a ventilating and inclining mechanism. This mechanism, a small wheel, is provided on its surface with sharp projections, which when brought to bear upon the face of a check and moved in contact with it, but under pressure, perforate the check and ink the perforations. The ink is supplied by means of a felt or ink absorbing roller rotating in a small inkwell. It consequently absorbs the ink from the well and transmits it to the roller. The cap is so arranged that too great a pressure cannot be applied to the rotating mechanism, assuring the user of perfect results and of a non-smudged check.

LIGHT-CLEANING APPARATUS
(No. 1,453,273 issued to James A. H. Bell.)

In factories where a great amount of dust is found, the electric light bulb and reflectors are often to be cleaned with grime after a short while, and if left to employ someone to clean them very frequently, otherwise much of the lighting value of the lamplight and reflectors is lost. In this particular device, the inventor employs a motor securely fastened to each of the reflectors. The motor is operated at intervals, and, when it operated it causes a wiper to pass through the reflector, cleaning it, and likewise removing any dusty accumulations on the lamp bulb. An automatic type draws both over the wiper of the reflector and bulb away from their respective surfaces when the motor starts.

SAFETY PAPER
(No. 1,458,827 issued to Burgess W. Smith.)

This paper is to prevent erasures or alterations on checks, drafts and other valuable documents. On the paper are the words "void" printed thereon with indelible ink. Upon these words comes "void," printed to form a continuous line, which when the paper is torn in any way, the words will be obliterated, and likewise removing any dust particles which are brought in contact with the paper. This Safeguard should be used on all important documents, and when it is employed in the making of checks or drafts, it will be impossible for a person who may later come to the document, to alter or deface the instrument in any manner.

SCENIC EFFECT FOR SHADOWGRAPHS
(No. 1,451,946 issued to James Maxwell.)

It will be known that if lights of different colors are thrown upon a screen to cover the same surface the lights will combine to form such a color as results from a combination of the colors projected individually on the screen. The colors may be red, blue and green, for example, and the illumination will be green. If on the other hand, a red light and a blue light are both projected upon the screen, perfect red will be reflected, and the illumination will give purple. If yellow and blue lights are projected, the illumination will be white. This is the principle which is incorporated in the present invention. By controlling colored lights, changing them, very beautiful effects may be obtained.

PISTOL TARGET FINDER
(No. 1,458,651 issued to Charles H. Smith.)

As our sketch clearly indicates, this target finder is merely a combination of a tubular flashlight and a holder, whereby it may be attached to a regulation revolver or other firearm. It will be noted that clamping members or brackets are secured to the flashlight at either end. Between these two members a long red rod is fixed. On this rod a shorter member capable of sliding is located. This member however, kept in a more or less fixed position by means of a coil of spring at one end and is of course removable at the shorter member. The shorter member likewise is rigidly attached to the revolver by means of two thumb nuts. It is a simple and low cost affair, and, therefore, that the recoil of the revolver will not materially affect the flashlight, and thus the filament of the bulb there found which would ordinarily be broken after a series of repeated shocks, is quite safe from injury.

MOTOR-DRIVEN MIXER
(No. 1,454,223 issued to Roy W. W. Smith.)

If this little household utility is placed on a turntable and the operator feels that it will meet with a favorable sale, the possibility of a small water motor being placed in the bottom of a cup, which in turn is placed in a Mason jar, and the apparatus so arranged that a water turbine here formed will rotate a wire egg-beater when it is put into action, due to the water current acting upon the blades of the turbine. A large opening permits the water to flow out again into the waste. As will be noted in our illustrations, it is stopped hastily through the top of the cover to prevent the water. For this purpose the movables and other materials may be passed, and when thoroughly beaten, may be removed without disturbing the motor element.

LATEST ADVERTISMENTS
(No. 1,451,946 issued to James Maxwell.)

To advertise: to publish, exhibit, illustrate, or otherwise display for sale, for the purpose of selling or otherwise disposing of, a thing or a thing or things, including an advertisement for the sale or other disposal of such thing or thing or things, is to be protected by the laws of the United States.
TELEPHONE TRANSMITTER QUERIES

(1531) E. B. Mitchell, Wiggins, Colo., asks the facts as to granulated carbon used in a telephone transmitter.

Q. 1. Why is granulated carbon used in a telephone transmitter?
A. 1. Granulated carbon is used in a telephone transmitter, because when the diaphragm is vibrated by the sound waves, the carbon is ab- 

ELECTRIC PUMP CONTROL

(1534) Roland Holloway, Marysville, Mo., requests

Q. 1. Can you tell me how I can construct an apparatus which will turn an electric current from one magnetic field to the other on an electric pump, by means of electro-magnets?
A. 1. We gather from your question that you wish to use some sort of a relay arrangement to close two different circuits. We sub- 

BLUING GUN BARRELS

(1532) E. W. Ludwig, Havana, Cuba, says that he has been considering troubles with his bluing gun barrels. Bluing gun barrels are continuously lifted off from the jars and they become extremely hot, but it is impossible to say how long they remain hot and states that he is having trouble in getting pure chemicals and asks if we can help him solve this problem.

ELECTROLYTIC RECTIFIER QUERIES

(1533) J. W. Larvin, Pasadena, Texas, says that a tank of warm water placed in a vacuum the water will freeze. B. says that the water will not freeze. A. says the tank is a vessel of warm water placed in a vacuum the water will freeze. B. says that the water will not freeze. A. asks: Q. 1. Who is right?

WARM WATER IN A VACUUM

(1534) J. W. Larvin, Pasadena, Texas, states that he has been considering troubles with his bluing gun barrels. Bluing gun barrels are continuously lifted off from the jars and they become extremely hot, but it is impossible to say how long they remain hot and states that he is having trouble in getting pure chemicals and asks if we can help him solve this problem.

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Einstein's Restricted Theory

By VLADIMIR KARAPETOFF

(Continued from page 442)

between the point A and his respective origin
(O or O'), and (b) the instant at which the flash took place. Einstein claims that the two observers will not only record different results, but that this difference cannot be explained on our common sense of point of view. Einstein claims that the usual way their relative positions at the instant of the flash, and knowing the relative velocity of the flash, his formulae can be graphically interpreted as shown in Fig. 3, and the model in Fig. 1 is based on this interpretation.

The Two Sets of Axes for the Same Event

In Fig. 3, OB is a general reference axis (universal bisection), OX is the line along which the S observer plots his distances and OT is the axis along which he plots his time intervals. The angle AOT is greater than 90° by an angle α which depends upon the relative velocity v of the two observers, in a manner explained below. On the model the circular scale on top is directly calibrated in values of α, in per cent of the velocity of light. The S' observer plots his distances along OX' and his time intervals along OT'. As α is less than 90° by the same amount α.

Let A in Fig. 3 represent the instantaneous points of two parallel wires, and let S observe that at his respective origin the wires will be seen by him at different intervals of time, which the wire CO was at his respective origin. Then the S observer will find the distance from his origin to be equal to O'C' and the time equal to T. The fundamental assumption of the model is that on event represented correctly for one observer is also represented correctly for the other, and it is assumed that it is measured in the proper direction of time and distance axes. The proof of the correctness of the model in the fact that the relationships derived from it and represented by algebraic equations check with Einstein's equations. We shall now show the use of the model on a few examples.

Shortening of Lengths

Let the S' observer mark a length x' in his system, parallel to the direction of the relative motion and let S be asked to measure this length while the two observers are in relative motion. To S', the length x' is represented by two parallel lines, OT and AD (Fig. 4), the distance OB being equal to x'. By the fundamental assumption, the same two parallel lines represent this event correctly for S, who, however, measures his distances along OX, and thus finds a length x smaller than x'. This apparent shortening of a moving length is known in physics as the Fitzgerald contraction, and its magnitude depends upon the relative velocity v of the two observers. In Fig. 4 this contraction depends upon the angle α which in turn depends upon v. The value of the ratio of x to x' comes out from the model exactly as predicted by the theory.

The Clock of a Moving Observer

Let the S' observer have a clock at his origin O' (Fig. 2) and let him be instructed to send a signal after his clock ran, say for an interval of time w. The two observers will see the clock S' in the direction which is represented by δO'F' at instant O'. For S' the event is represented by the point δF' (Fig. 4), where OE = t' is the agreed interval of time. In order to find out what time w S will read at the instant of the signal, we draw EF parallel to OX. Then OF = t is the interval of time represented by S, and EF is the distance between O and O'. Fig. 2, at that instant. We see that t is greater than t'; hence S will claim that the S' clock was slow. Again the ratio of t' to t comes out from the model exactly as the value predicted by Einstein.

Velocity Measurement

Let a small body A, say a bullet or an electron, be fired out with a velocity along XX' (Fig. 2) and let each observer be asked to measure this velocity relatively to his own stationary system. Fig. 5 by the straight line O'H. For such a line both observers will find that the distance covered is proportional to the time elapsed. Then they will agree that the material point A is moving at a uniform speed. By definition of velocity, it is equal to the distance covered divided by the time elapsed. If we lay off OF equal to unit time, and draw FD parallel to OX, the point of intersection, C, will determine the length FC = x, which is the velocity as measured by S. In accordance with our agreement regarding units, x is expressed as a fraction of the velocity of light.

To find the value of the velocity v of the point A, as measured by the S' observer, we repeat the experiment with his axes rotated 90°. That is, we lay off O'E' = 1, and draw F'D' parallel to OX'. FC' is then equal to v'.

Let OF have been measured by a small angle clockwise. This means a point for which both observers will measure higher velocities. Finally, when OH coincides with OB, the velocity measured by S will be FD = 1 and that measured by S' will be F'D'. It will thus be seen that the universal bisection O'B represents a point moving at the velocity of light with respect to both observers. In other words, Einstein's formula for the addition of velocities and, consequently, his predictions, do not need to be a separate assumption.

The Angle Between the Axes

We can now readily see what value the angle α between the axes must have. To S' the observer, the S' axes rotate at the velocity of light, while to S this axis represents a point moving at the velocity v. By laying off FG = q from point F', we find the position of PT if OT' is given. From the geometry of the figure, these two relations can exist simultaneously only if one set of axes, say TOX, comprises the angle 90° + α, while the axes TOX' are drawn at an angle α apart. The two axes, then, will be orthogonal, so that the angle of v can be readily obtained for a desired q, or vice versa. The angle between the two sets of axes will be seen at once that Sin α = q, where q must be expressed as a fraction of the velocity of light. The circular scale shown in Fig. 1 is marked directly in per cent of velocity of light using the above relationship between q and α.

Details of the Model

The model (Fig. 1) is made of sticks of wood, 2.5 cm. by 0.5 cm., and the four axes are about 100 cm. long measured from O. The bars OT and OT' are weighted at right angles to each other, and are the bars OT and OB. The bars OT and OX extend to the left, and with two other short bars form a rhombus. The bisection OB is made of steel bar 1.5 cm. by 0.5 cm. and is 100 cm. long, measured from O. It also extends to the left of O and serves as a guide for the rhombus. The rhombus is provided with a slider and a set screw at the acute left, and in this way the two sets of axes can be fastened at any desired angle of to each other. The straight scales (DF and DF') in Fig. 1, are also shown in Fig. 1. They are provided which saddle sliders at D and D' and are pivoted at P and P'. The holder and some other sticks shown on the bisection to the right serve for various experiments that can be performed with the model.

Speed

By HAROLD F. RICHARDS, Ph.D.

(Continued from page 451)

New York, and found to function with great precision. Five hydrophones for receiving under water are located at known distances from a central recording station on the shore, and a I-pound bomb of TNT is detonated electrically at a known distance offshore. The shock wave of electric pressure which serves to detonate the bomb also causes a radio transmitter to send out a radio wave along a direction parallel to the shore. It is enough to go seven times around the world in a second, the times required for the radio signal to travel this distance of perhaps 10 miles, may be neglected. In contrast with the time required for the sound to reach the various hydrophones under water. The arrival of the radio signal is recorded photographically on a moving film, which is calibrated to the thousandth part of a second, and, consequently, when the various hydrophones receive the sound impulse, they also produce, on the film, a corresponding record on the moving film. Thus a single photographic record indicates the times required for the sound to travel to each hydrophone from the point of explosion. The arrival of the sound pressure wave at a hydrophone produces an electric pressure in the cable and in the radio receiver. From this data, together with the known distances of the hydrophones from the point of explosion, the speed of sound in water (about 1400 ft. per sec.) is easily calculated.

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The Planet Mars
By PROF. WILLIAM H. PICKERING

MARS' TEMPERATURE LOWER THAN OURS

Where the snow is melting the temperature is necessarily 32° Fahrenheit. In general, the mean temperature of the planet is probably about 20° lower than that of our Earth, but the polar regions are warmer than ours during their long summer season. The extreme of +30° occurs about 10° greater than with us, and frost occasionally forms, even in the daytime, on the equator. Clouds are a frequent sight, especially at sunrise and sunset. They often conceal large areas of the surface near the melting polar caps. During the latter part of the Martian August, and through September, snow storms are of frequent occurrence near the north pole, and the deposited snow is readily seen through the telescope.

WHAT ARE THE "CANALS" OF MARS?

In 1882, the canals in the dark regions were discovered, and it was shown that the snow-covered supposed canals crossed the supposed seas, it became at once evident that the canals were not real water canals, or else that the seas were not real seas.

It was then decided that a suggestion made in 1888, that the whole process of vegetation, was more probable, and this may be described as until recently the practically universal opinion among planetary observers. On the other hand, the idea of vegetation is supported by invisible central irrigating pipes or ditches, and the later suggestion that the flow of vegetation is determined by a gigantic artificial pumping installation, while still popular with a certain section of the general public, is now largely replaced by the overwhelming majority of the practical observers of the planet as a whole conspired to the scrap heap.

Investigators now believe that since these regions evidently change color with the seasons, that they may perhaps be arid, but certainly cannot be described as permanent deserts. A suggestion has recently been made that the broad and fairly permanent canals mark the points of nooculous rainfall showers. Unlike the canals, they never appear green. It is shown that on Mars any such heavy precipitation would almost certainly occur, whereas, the planet's atmosphere would experience a very striking fall of temperature, much more marked than ever observed on Earth. These canals are moreover curved in the right direction as determined by theory, and indicate by their rate of curvature wind velocities differing but little from those that are often observed in our own upper atmosphere. It is as yet too early to say how well this explanation will withstand the assaults of time, but we may say that at least it seems promising.

The shorter narrow canals, which always appear rather late in the season, may perhaps also be explained in the same way. We have not yet found out just what is their cause. Of course, they may be artificial. There is no reason why the assumed Martians should build their canals out of bricks, which they choose. They may have a special fancy for a linear distribution, but the chances are there is some definite natural reason for it, probably associated with artificial looking upon the hills and valleys. We have found canal-like markings quite artificial looking upon the seas, but a traveling variety of vegetation on either planet seems still more unlikely.

MARS' MOON HAS CANAL MARKINGS ALSO

Mars, in fact in numerous respects, presents a much greater analogy to our Moon than it does to the Earth. Both Mars and the Moon possess canals, which differ from one another mainly in size, rather than in their appearance, the lunar canals being very much smaller. Oddly enough, both are found to shift across the surfaces of their respective planets, and in general towards the Sun. Sections of the Martian canals shift as much as 120 miles, the lunar ones being smaller shift much less, only two or three miles. It is probable that at first a study of the lunar canals would help us to understand the Martian ones, but it only appears to deepen our uncertainty. It seems improbable that a lunar canal could be both natural and artificial, but a traveling variety of vegetation on either planet seems still more unlikely.

Doubtful That Mars Is Inhabited

If our own Earth possesses the sea, it is the same distance that we view Mars, never less than 35,000,000 miles, it is certain that we cannot find any trace of life, or the slightest evidence of civilization upon it. Nothing but the constant changes induced by the rotation of the gigantic forces of nature — the melting of the snows, the light of the seasons, the canals and the various vegetation with the progress of the seasons. Mars' puny efforts could nowhere be seen. There is no evidence that the Martians, if they exist, are more advanced than ourselves. They may be much less so—perhaps they are advanced as insects or insects, or as advanced as men ever advanced for assuming their superiority, the new discarded pumping theory. With the assistance, I mean that the canals were laid out in straight lines, and with the belief that their planet is perhaps older than ours, the last really might be a good reason, if Mars were like the Earth, I would know that it is not. It may be that it is better adapted to the development of an unadventured civilization, or it may be that it is less so. We should not expect to find any advanced civilization upon the Moon even if we waited a hundred thousand years for it. It is pleasant to dream of the Martians as being far more advanced in knowledge than ourselves, and there is no harm in our doing so, so long as we are ready to admit that the idea has the slightest foundation, either for or against it, in fact as far as we can know.

Experimental Electro-Chemistry
(Continued from page 458)

Experimental Electro-Chemistry.

The success can be had with some grades of denatured alcohol. The iodine electrode should be selected, though sheet nickel can be used. This forms the cathode. A porous pot or cylinder containing a cold saturated solution of iodine with an electrode of lead serves as the anode. The porous pot is inserted into the jar or beaker. This capillary membrane to separate the two electrolytes. Keep the whole cell well cooled and pass a current of about 6 amperes through the cell for 3 hours and then cut the current strength down to about 2 amperes for another hour. Replace alcohol which is lost by evaporation. The large red crystals of azobenzene should then be collected and preserved. They are rather impure. An ingenious device now having a wide sale is illustrated in Figure 4. It consists of two electrodes fitted in a large jar. The electrodes are an alloy of aluminum, containing about 97 per cent aluminum, the other constituents being magnesium or silver or both. When the electrodes are connected to the 110-volt mains and thrust into a liquid, aluminum hydroxide forms about the electrodes and is thrown off.
Motor Car Leaps, Loops and Skids
By HAROLD F. RICHARDS, Ph.D.
(Continued from page 454)

However, not to simply explained. There is great doubt as to whether the blow-out furnishes a legitimate excuse for accidents, many drivers reporting that a blow-out had not apparently increased the difficulty of steering; and I remember one driver who, after losing an entire rear wheel, held the road easily for thirty yards, with the end of the axle dragging on the ground. We may, however, note the following effects of a sudden blow-out.

1. The axle is inclined towards the side blown-out, producing a cone-effect which causes the car to turn in the direction of the blow-out. This, of course, is due to the sudden deflation of the tire.

2. There is a slightly greater pressure on the blown-out tire than on its mate, due to the inclination of the axle, which tends to produce a slightly greater traction on the side where the blow-out occurs, resulting in a twist of the car. This effect is small.

3. Due to the collapse of the tire, the wheel affected gives the road a sudden push of its own account, entirely independent of the motor. This effect is produced by the sudden concentration of the mass of the tire closer to the rim, which decreases the moment of inertia of the wheel. The angular momentum of the wheel tends to be conserved, and since the moment of inertia of the wheel has become less, the wheel tends to speed up, acting like a flywheel and thus pushing the car asymmetrically. The principle is exactly the same that involved when a weight fastened to a string is swung around in such a manner that the string winds up on the finger. As the weight approaches the finger, due to the shortening of the string, it goes faster and faster. How important this effect is, in relation to other results of a blow-out, can hardly be determined without performing exact experiments, and it appears that such experiments have not yet been carried out.

It may be said, in conclusion, that the cone-effect, due to the sudden inclination of the axle, which, of course, is not corrected for by the differential is probably the greatest factor in causing loss of control when a tire blows out, and that the flywheel action of the affected wheel comes second in importance. The explosive action, in spite of the sound of it, is not a factor; the air simply leaves and the wheel drops. The experience of many motorists suggests that a blow-out, with its accompanying surprise and wrench of the steering wheel is seldom a sufficient cause to account for complete loss of control.

Spectroscopes—How to Build Them
By C. E. BARNES
(Continued from page 444)

Potassium, etc.—a small particle of the substance experimented upon is held in the flame by a short length of platinum wire with long handles. The bright lines of these various substances will instantly be visible.

A PORTABLE HAND-SPECTROSCOPE
A most beautiful and serviceable hand-
spectroscope, suitable alike for laboratory experiment and for the observatory in conjunction with a telescope (as well as forecasting the weather with amazing accuracy.) is what is known as the Amici prism, containing three, or, better still, five prisms in combination: three crown and two flint. The evolving rays are dispersed into a brilliant flame, and the grinding of the prisms to form can be undertaken by the novice possessed of the necessary lens-grinding tools.

A grinding tool with a plane surface screwed to the end of the vertical shaft moved by the worm-screw is the main implement for getting the form and also for polishing. A vernier caliper and a goniometer for measuring angles with great accuracy are quite essential during this grining process so that all prisms of the series will fit together. These are afterwards cemented together with Canada balsam and blackened with vegetable ink and lacquer. When the fine-emy work is complete, the surfaces are polished on a disc of hard cartridge paper affixed to the revolving tool with glass paste and ironed down smooth, dry jeweller's rouge oxide of iron or potty powder being used as the polishing agent, as used in lens-polishing, will not do, as it tends to turn the edges.

ADVANTAGES OF THE AMICI PRISM

The advantage of the Amici series is that the spectral image widens with each prism traversed; and being set in alternate units, the emergent beam is on a line with the incident ray, and there is no turning of telescopes and collimators; in other words, there is no need to take the instrument to pieces in order to pick up the spectrum. In other words, the entire system, from eyehole to slit, is in a straight line, so that it may be slipped on to the inner tubes of the eyepiece; this is a refractor for stellar observation. In this case, the objective serves as a collimating lens; and as a star is only a point of light anyway, the slit-cap is also removed from the spectroscope, the elongated image of the star is then a line of the slit. True, carrying the star-image through a slit increases its definition and makes clearer the spectral lines—or, rather, dots—distributed along the thin brilliant line of many colors, often twice or three times the entire breadth of field. The spectrum is very difficult to pick up through a slit; and without a driving-clock, harder still.

The difference between the spectrum of the sky on a bright clear day and one in which the heavens are slightly overcast is very marked. The thin lines of vapor, even in currents at very great heights, are soon discerned by those skilled in the use of this little instrument. The darkening, paralleling and shifting, etc., to be a haze of the otherwise hard dark "D" line of sodium in the solar spectrum is itself an almost infallible criterion.

Popular Astronomy
By ISABEL M. LEWIS, M.A.
(Continued from page 431)

Sweeps past the Aleutian Islands it is early in the morning, local time; it is about 1 o'clock, Pacific Time, when it reaches San Diego and Ensenada 2:15 m., Mountain Time, when it comes to Hermosillo, and 2:35 p.m. when it passes Cuencame. At 3:45 p.m., Central Time, it is on the Gulf of Mexico, and as the sun is setting it passes off of the earth in the vicinity of the Lesser Antilles.

As the Alaskan peninsula, the western and southern parts of the United States and the West Indies lie comparatively near to the path of total eclipse, the eclipse will be the most favorable; it will be largest in these sections as well as in all parts of Mexico and Central America. In the New England States the maximum obscuration will be about 40 per cent and in eastern Canada it will be even less.

CAUSE OF TOTAL SOLAR ECLIPSE

It is probably known to everyone that a total eclipse of the sun is due to the passing of the moon directly between the sun and the earth. It is not so generally known that eclipses can only occur when the moon is at, or very close to, the nodes of its orbit which are the two points 180° apart where the plane of the moon's orbit crosses the plane of the earth's orbit around the sun. The moon passes through each node of its orbit once every month, but eclipses will not occur unless the moon is near or on one of its nodes. The moon is at or near one of its nodes. This is bound to occur twice a year at intervals of six months, when the nodes of the moon's orbit and the times when eclipses of both sun or moon are likely to occur are spoken of as the eclipse seasons. These eclipses do not occur in the same months each year is due to the fact that the positions of the nodes of the moon's orbit are slowly shifting at a rate which causes them to complete one revolution around the (Continued on page 489)
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52 Pages—Two-Color Cover

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A non-technical book for the beginner. Gives complete constructive data on the building of a complete Crystal Detector Set, Tuning Coil, Loose Coupler and a Single Audion Tube Set with Amplifying Units. It furnishes all dimensions and working drawings of every part that must be constructed by the amateur. Written in plain, simple language that anyone can understand. The opening chapter gives a complete description of the theory of radio and tells what it's all about, teaching the principles of wireless so that the constructor knows what he is doing.

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This book describes and gives complete data for building two distinct types of loud talkers. One chapter deals with improvised loud talkers, and gives complete instructions on how to build suitable horns for use in loud receivers of the Baldwin and other types. In preparing these designs, the point has been constantly kept in mind to use the simplest parts possible, so that anyone can build a successful loud talker, equivalent to the commercial types, costing $40.00 or more.

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ecliptic once in about nineteen years. As a result eclipses occur at a different time each year, but always at intervals of six months.

Two weeks following or preceding the time of a solar eclipse there may be also an eclipse of the moon, when earth, sun and moon are again in line with the earth between the sun and moon, which happens at the time of full moon. There are usually two lunar eclipses a year and there may be three under certain circumstances. In some years no lunar eclipses occur, but there must be at least two solar eclipses each year and there may be as many as five. The greatest number of eclipses that can occur in a single year is seven, five of the sun and two of the moon. All solar eclipses are not total. In some cases the axis of the shadow-cast cone by the moon passes just clear of the earth above one of its poles without striking the surface of the earth at any point and in this case the partial phase of the eclipse is observable upon the earth's surface.

The Path of Coming Solar Eclipse.

The principal work that will occupy the attention of the eclipse expeditions will be the procuring of negatives to test the Einstein effect.

A "DX" Receiver with Novel Tuner
Ey P. A. PRICE
(Continued from page 473)

The antenna rotor, or primary, is made up of a helical, hard rubber or wooden ball-type rotor fitting snugly but free to turn in the static tube. It is wound with 35 to 40 turns of No. 22 silk-covered wire. The tickler rotor is similar to the primary, but is wound with 35 to 60 turns of No. 26 silk-covered wire. 30 feet of No. 22 wire is used on the antenna rotor and 45 feet of No. 26 is required for the tickler.

The condenser bank to be used in the aerial circuit is constructed of five fixed condensers of the following capacities: two .0005, two .00025, one .0001. When they should be set upon a two-inch brass bolt in this order: .001, .0005, .00025, .0005, .00025. The setting of 56 to 60 turns on No. 26 silk-covered wire. They may be connected together at the top and this condenser and each one of the other condensers connected each to a separate tap in the condenser bank switch set. It will be noted that when the switch-arm is placed on the tap connected to the .001 condenser, a capacity equal to that of a pair of variable condenser is obtained. When the switch-arm is placed on the tap which is connected to the .0005 and .00025.
condensers hooked together, a capacity is obtained approximately that of a .17-pla-
ted condenser. When the switch-arm is turned to the tap connected with the ,005 condenser a capacity approximating that of a 23-pla-
ted condenser is obtained, and when the ,0025 condenser tap is used, a capacity approxi-
mating that of an 11-plaite condenser is available.

Five condensers are indicated in the fore-
ground description of the condenser bank but this number may be reduced to three: 001, ,0005, and ,0025 M.F. The grid condenser should be ,0025 M.F., preferably mica, and the grid leak should be five or six meg-
ols.

Variable Stars
By RUFUS O. SUTER, Jr.
(Continued from page 437)
denly blaze forth from invisibility, attain great brilliancy, then gradually fade away
until no longer discernible. (See Illustra-
tion 1, Fig. C.)

2. Stars which periodically pass from
a maximum brightness to a minimum faint-
ess. The time elapsing between two suc-
cessive maxima or minima, the period is
more than 100 days.

3. Stars that are irregular in period and
range.

4. Stars whose periods are less than 100
days, and fairly regular.

5. Stars that are regular in period and
range.

Sir Norman Lockyer's meteoric hy-
pothesis explains both the peculiar fluctu-
ations and the apparent motion. Groups of
meteors entered a nebulous area, where their
repeated collisions caused frequent confi-
cations of varying magnitude. The greatest
configuration was the nova. The lesser con-
figurations, illuminating different parts of
the nebula, gave the effect of motion. It
is interesting to consider that if Kayser's theory
is right, the new star actually burst forth at
about the time Galileo discovered the moons
of Jupiter. The light bearing the image of
the catastrophe has just reached us.

The novae are no more baffling than the
long period variables of Class 2, whose
spectra undergo changes almost coincident
with the light cycle. At minimum either
titane or carbide predominates, or carbon, or elements
which have not been recognized in earth.
During the rise to maximum, hydrogen lines
appear which become most distinct at actual
maximum, and are accompanied by iron,
magnesium, and calcium vapor. With the
decline in brilliancy, these latter elements
frequently outshine the hydrogen. At mini-
mum the stars display the same spectra
as originally. Long period variables are usually
characterized by a comparatively rapid
ascent to maximum, where they remain
a few days, then more gradually descend to
minimum, in which condition they remain
the greater part of the time. (See Illustra-
tion 1, Fig. A.)

The most plausible theory is an adoption of
Sir Norman Lockyer's meteoric hypothesis.
If a mass of meteors were conceived as
traveling in an orbit around a larger and
more diffuse mass, situated toward one side
of the orbit, frequent collisions between the
two groups of meteors would cause periodic
outbursts of brilliancy. The maxima, in
accordance with observation, would differ
slightly from time to time. (See illustra-
tion 2.)

Entirely distinct from the novae and long
period variables, are the stars of Classes 3
and 4. The fluctuations in the former case
are without regularity; those in the latter are
so complicated that a long series of ob-
(Continued on page 498)
underneath the boat, he would be able to support the residual weight of the boat in the palm of his hand.

Numerous other tanks are contained in the vessel, such as the trimming tanks, which, as the term implies, affect the position of the vessel; they are used to correct the form and fit of the vessel which may vary by the shifting of weights such as men, stores, torpedoes, fuel, lubricating oil or fresh water. The larger submarines are not so sensitive, but in the smaller types in use a few years ago, it was customary for the crew to remain at their stations without moving, unless the commanding officer ordered a man to move forward or aft some feet. In fact, we used to say we had to keep our hands on the middle, the boats were so sensitive.

Our balsa; tanks are full, fore and aft trim is established also the buoyancy. We are now ready to go about our business, which is either a practice run, an attack on a real enemy, or last but not least in the eyes of theهل الإطارات المشغول، للإحراج إلى موارد محايدة، التي تصل ما قد يثيره من أشعة من التدابير إلى الماء والطين، مثلا للسيارات، والتطويرات، والبيانات، والمساحات التي تصل إلى الماء والطين، مثلا في سبيل السيارة، والجهاز المختص، والمساحة اللازمة، للسماح للسيارين فحص الأنابيب، والتحفيز، والصيانة، كما يمكن استخدام أداة للسماح للسيارات بفحص أنابيب الماء والطين، والتحفيز، والصيانة، كما يمكن استخدام أداة للسماح للسيارات بفحص أنابيب الماء والطين، والتحفيز، والصيانة، كما يمكن استخدام أداة للسماح للسيارات بفحص أنابيب الماء والطين، والتحفيز، والصيانة، كما يمكن استخدام أداة للسماح للسيارات بفحص أنابيب الماء والطين، والتحفيز، والصيانة، كما يمكن استخدام أداة للسماح للسيارات بفحص أنابيب الماء والطين، والتحفيز، والصيانة، كما يمكن استخدام أداة للسماح للسيارات بفحص أنابيب الماء والطين، والتحفيز، والصيانة، كما يمكن استخدام أداة للسماح للسيارات بفحص أنابيب الماء والطين، والتحفيز، والصيانة، كما يمكن استخدام أداة للسماح للسيارات بفحص أنابيب الماء والطين، والتحفيز، والصيانة، كما يمكن استخدام أداة للسماح للسيارات بفحص أنابيب الماء والطين، والتحفيز، والصيانة، كما يمكن استخدام أداة للسماح للسيارات بفحص أنابيب الماء والطين، والتحفيز، والصيانة، كما يمكن استخدام أداة للسماح للسيارات بفحص أنابيب الماء و
Some people have an idea that submarines always run submerged when traveling from place to place. If you stop to think, it will be readily seen that this would be impossible, as the submarines would become quickly exhausted especially at high speed. It is possible, however, to remain submerged for long periods of time by running at very low speeds or by resting on the bottom of the sea. It is merely a question of battery energy.

I hear you say. It is perfectly simple. The air is purified from time to time and then we have the compressed air, too, to fall back on. In addition, the submarine can be submerged for 48 hours or longer. It is no joke, but it can be and has been done.

As the engineer in command we find the motor room, containing the main electric motors, high pressure and low pressure pumps, a small lube and drill press, and the usual shiny wheels and air compressors. There is no noise here either, except the low hum of the motors as they turn over, tended by the men on watch.

Again we go afloat. We find ourselves in the tiller room, a small, cramped place, containing the tiller and steering gear. Aft of this is the engine room.

Having finished our superficial inspection of the interior of the boat, let us go back to the C. O. C., and see what has happened. The four slain planes on the periscope, a depth (about twenty feet below the surface) taking it easy, keeping at the set speed, looking for the depth as the helmsman steering by gyro-capsule, but it seems to be getting rough on the surface, so to escape the wave motion we descend to, say 100 feet.

OBJECTS SEEN WHILE RUNNING SUBMERGED

By looking through the coming tower port holes, we can see the bow and the stern of the boat and the bottom of the boat if the water is clear, the propellers showing in vague blurs as they spin.

Especially if the boat is warm and stuffy one feels as if it would be nice to open the hatch and go on deck for a stroll in the cool green water, because it seems as if the boat were suspended and without motion until we look down we will, if in shallow water, see the bottom of the ocean sliding by.

The question is often asked: "Do you see any fish?" No, not unless the boat is lying on the bottom perfectly still as the hum screeches through the ship. But if you put on a diving suit, arm yourself with a spear and walk around you will see many kinds of fish, rocks of many fantastic shapes, coral and many other various kinds.

We are ready to come up, so the commanding officer orders the main ballast tanks blown, which is done by compressed air, forcing the water out of the tanks; or by pumping—and once again we are on the surface and in the sunlight.

200 FEET A SAFE DEPTH

In the Holland type of submarine boats we note first the hull which is almost circular in cross-section except aft where it is flattened, so as to allow for the attaching of the propellers and horizontal and vertical rudders.

The hull is designed to withstand a pressure of 888 pounds to the square inch, or in other words, the hull can descend a depth of 200 feet with safety. This test must be made before the Government will accept the vessel and move in. Let's understand that undistortion of the hull or damage to any part of it is the same. Greater depths have been attained though not always by design, but occasionally. In fact boats have descended to three hundred feet and returned without being seriously damaged.

Upon the hull rests a various-structure of light construction, which provides a working platform and housing for various things, such as pipe lines, rudder rods, bow rudders, anchor gear, exhaust lines, mooring lines, and material and stores not damageable by salt water.

The hull of the boat is the conning tower surrounded by what is known as fair water, then we see the periscopes. Above water are the conning tower and the clearing wires, which are strong cables stretched fore and aft. The clearing wires are so designed and placed that in case the submarine should foul a net, the boat would slide underneath instead of being held fast. In addition to these clearing wires, the German submarines have a con- trivance securely fastened to the bow which looked like a tremendous saw. The idea was that the moment of the bow hit the water it would cause the wires to be cut when making contact with the saw.

Looking again we see something projecting like the ears of a jackass. They are the bow-planes, rigged out from inside the boat for steering or for diving. These planes are operated by a screw, in conjunction with the after planes, keeping the boat submerged on an even keel or pitch, or slight variations of it. The rudder plane is an extension of the horizontal plane. The ship is steered in the ordinary manner and is provided with twin screw propellers, which is by means of Diesels engines on the surface and electric motors while submerged.

THE ENGINES

The engines are either 2 or 4 cycle heavy oil, reversible or non-reversible, depending on the type in use, internal combustion engines using gas oil for fuel, ignited by the heat of compression instead of ignition by a spark. A big feature is the non-reversibility of the Holland type. The boats are also provided with anchors of two types, patent and mushroom, operated from inside the boat, so it is possible to anchor while submerged, a very handy method of lying in wait for the enemy, paying out the anchor cables thus rising to the look out, then heaving round and drawing the boat down to safe depths again with the least expenditure of energy, almost no noise.

THE 5-INCH DECK GUN

On deck we find a 5-inch deck firing gun, called a "hot gun" because it is always left exposed to the water when submerged and having house. It is possible to get the guns into action as soon as the deck is out of water and the crew can get up out of the boat and should be blazing away in less than a minute after emerging from the depths, as ammunition is stored near at hand ready for use.

SPEAKING OF TORPEDOES

While on the subject of armament I will say a few words about the torpedoes and tubes. A modern modern real submarine is driven by steam and air at a high speed for extremely long ranges. For the benefit of those unacquainted with the wonderful weapon, we will picture a shiny cigar-shaped cylinder provided with its own complicated machinery, its own steering and diving gear, in fact a moving iron gauge which after it is once started by air from the tube, is let absolutely to itself, speeding on its deadly mission like an automatically steering, keeping its depth, oiling its own machinery, generating its own power, all in all a self-sustained self-charging which is carried, for its explosion, which will happen regardless of whether the boat is above or below, just as the sword sweeps the vessel. Then goodbye enemy and torpedo, too.
Many people think that to disable a submarine all you have to do is shoot off a periscope. If that was all that could be done to a submarine, life would be a sweet dream thereon. There is usually another periscope in reserve and sometimes a third. This is also an altiscope, used for searching the sky for aircraft.

**How to “Bag” a Submarine**

The things to do to bag a submarine is to shoot it full of holes before it can submarine itself. This is practically impossible to do, and as you pass over the spot where she went down drop an assortment of those innocent looking cans (depth bombs) we used to see on the quarter deck of destroyers, which are filled with T.N.T. and can be set to explode at any depth, so to make life interesting for the submarine crew. It was customary for the destroyers to tear around like mad at high speed, sending bombs as fast as possible, which was the only shallow and deep explosions, hoping that at least one would connect properly and destroy the submarine.

What is the submarine doing meanwhile? Trying, of course, to avoid the bombs or to change its course and using different speeds and depths, with all hands wondering how close the next one will be. Maybe the boat is damaged so that it cannot come up but goes down and down until finally it is crushed like an eggshell or made stop at the bottom in shallow water, helpless, the water pouring in, the crew working to repair the damage, finally giving up, and trying to escape from the wrecked boat by air pressure through the conning tower and coming to the surface to be picked up or to die as the circumstances may be.

Any number of wartime incidents could be related about damaged submarines both in our navy and in foreign navies. So you see life in a submarine is not all beer and skittles, and it is most assuredly no place for weak sisters. But for the men who can take a few hard knocks and come up smiling, it is a mighty interesting life, with plenty of both shallow and deep explosions, hoping that at least one would connect properly and destroy the submarine.

A number of wartime incidents could be related about destroyed submarines both in our navy and in foreign navies. So you see life in a submarine is not all beer and skittles, and it is most assuredly no place for weak sisters. But for the men who can take a few hard knocks and come up smiling, it is a mighty interesting life, with plenty of both shallow and deep explosions, hoping that at least one would connect properly and destroy the submarine.

**Liquid and Solid Hydrogen in Quantity Production**

**By S. R. WINTERS**

(Continued from page 449)

duplicate of the machinery employed in manufacturing liquid air. Moreover, the method of changing the atmosphere into a fluid is closed and analogous to that of manufacturing liquid hydrogen. The difference in the two processes is this: In liquefying hydrogen, instead of coating the liquid with an olive or room temperature, as in the case of liquefying air, the compressed gas is first cooled to 280 degrees Fahrenheit below the commonly accepted zero point. This temperature is attained by forced evaporation of liquid air under reduced pressure. With
Auction Off Your Money

THINK of your money as something for sale to the highest bidder. That's what it actually is.

And bidders are legion. Look through the advertisements and you will find them—every one. They shout, beckon or nod to you through the medium of type and picture. Each seeks to outdo the others in the attractiveness of his offer. Each vies with the others for the privilege of your attention.

Competition is keen, if you only realized it. Each advertisement in this paper is an offer made directly to you. Each is worthy of your interest in some degree.

Read the advertisements. Know what is offered in return for your cash. Hear all the bids. Compare values. Check up on the offerings. Then you can be sure you are getting the most for your money.

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Work the magic in cryptography at once, whether your door or mailboxes are flimsy—proof. Save and test thousands of different locks. Recommended by users in ten different nations. Most wonderful and only key that will fit nearly every lock. Send $1 today. Novel key article FREE with this

MASTER KEY CO., 8 Manhattan Block, Milwaukee, Wis.

the exception of this one departure, the conversion of hydrogen into a fluid is in principle identical with the liquefaction of air.

HOW GAS IS LIQUEFIED

The method of producing liquid air at the Bureau of Standards is, briefly, as follows: The atmosphere is first reduced to a high degree of vacuum, by the application of 3,000 pounds to the square inch. The resultant heat is removed and the air is partly purified. It is preferable, but not absolutely necessary, that the atmosphere be pre-cooled to a point of a few degrees below room temperature, after which it is passed through a heat interchanger and permitted to expand to atmospheric pressure through a valve. The air in its expanded form, is then given passage back over the heat-exchanger as a means of cooling the incoming compressed air. Thus little cold is wasted. The apparatus then gets colder and colder until a portion of the air is liquefied.

Fortunately, however, the Fixation Nitrogen Laboratory of the United States Department of Agriculture has developed a method for determining the presence of nitrogen in hydrogen, which element is most troublesome in the production of liquid hydrogen. This method makes it feasible to analyze the gas at all stages of its manufacture and use, as well as to locate the sources of contamination. This means of analysis is being applied at the Bureau of Standards, where hydrogen for its own needs is being made electrolytically. It is assembled in a gas holder, containing oil instead of water, and is compressed into cylinders for storage. The hydrogen, as it comes from the generator, contains about one-hundredth of one per cent nitrogen. After the gas is compressed into cylinders, about two-one-hundredths of nitrogen is present. The oxygen that gains entrance into the generator is removed by a device which neutralizes the gas sufficiently to cause the oxygen and hydrogen to combine. If any water is present, which does not offer a serious difficulty, it may be absorbed by ordinary drying agents.

Liquid hydrogen is produced at a temperature of 423 degrees Fahrenheit below the zero point of the Fahrenheit scale. This fluid, liquid air, may be preserved in vacuum containers, the vacuum serving as barriers against the entrance of heat from the outside. Liquid hydrogen may be thus retained for a period of one or two days.

SOLID HYDROGEN

Solid hydrogen is being produced in the Low Temperatures Laboratory of the Bureau of Standards at the lowest temperature ever attained in Washington, D. C., and probably the lowest point yet reached on the thermometer scale south in the United States—at 434 degrees Fahrenheit below the zero point and only 25 degrees Fahrenheit above absolute zero.

Once gaseous hydrogen has been reduced to a fluid, however, it is comparatively easy to convert it into a solid. This is accomplished by further reducing the temperature—about eleven degrees Fahrenheit lower—of the liquid by rapid evaporation in a partial vacuum. Hydrogen in this state is a solid known, being one-third lighter than carbon. Solid hydrogen takes the form of flakes bearing a similarity to snow or ice, and it is well-nigh impossible to separate the solidified element for even a period of a few hours. For instance, an attempt to carry the flaky substance for a distance of four or five miles proved futile, it having completely melted.

www.americanradiohistory.com
when malarial fever might be indicated. If the temperature rises on the first day to 106°, we know definitely that the patient has not developed typhoid fever, because typhoid case produces a temperature of over 104° in the evening of the first day, although temperatures of 102° in the evening and 104° in the morning which show a rather severe attack of this disease, may result disastrously during the third week of the attack. On the other hand, should the temperature be below 102°, it would indicate the commencement of convalescence or a relatively mild attack of this disease, and the temperature increase above 99 but without attaining 102, and should the patient exhibit signs of pneumonia, we know that there is no slight infiltration of the lungs. A temperature of 104 in pneumonia cases indicates a severe attack. The same temperature in acute rheumatism is something to cause the individual to be anxious. Generally when the temperature rises steadily to about 106.3 to 108° the prognosis is very unfavorable, and if the temperature of 110° is almost certain to prove fatal in diseased conditions. Nevertheless, there have been some remarkable reports which would tend to disprove the above statement. In cases of sunstroke, 110° is quite frequently found. In scarletin a case has been reported in which the patient developed a temperature of 112°, and in tetanus at the time of death a patient has exhibited a temperature of about 114.

A RARE CASE

It is doubtful whether anyone shall ever have another patient as remarkable as the one treated by E. E. Holt, M.D., of Portland, Maine, who is the founder of the Maine Eye and Ear Infirmary, and who was executive and senior attending surgeon of the Infirmary for more than thirty years. This patient, twenty-one years old, was treated for an ear condition from which she recovered; after an operation for the ablation of the left mastoid, she was discharged. A year later in 1901, following another operation, the temperature rose at first to 105.6° F. without any chilly sensations, giddiness or any other outward signs indicating fever conditions. There was another operation, and in twenty days the temperature rose to 108°. The skull was then trephined, and for fourteen days the temperature was normal, after which it rose again on one occasion to 108°. The temperature repeatedly rose from a point below normal, 97° to ever 114°, almost daily, with the pulse running as high as 116 on rare occasions. The strangest fact was that temperatures in two different portions of the body were entirely different. Where one would register 114° and break the clinical thermometers, the other extreme point where internal temperature was taken, registered below 94, and consequently could not be recorded on the thermometer. A large number of thermometers were used and the temperatures taken by many surgeons. Two thermometers that registered only 114° were broken. Inasmuch as the patient was in the hospital, there was absolutely no chance of fraud. In this patient, however, although at times the temperature varied, it generally remained around ninety beats per minute, and the respirations were never far from normal. It was evident that there was a divergence of the heat centers in the body, but why or how has never been determined. The patient subsequently was discharged as cured, left the state and on writing to the doctor more than a year later claimed she had no further trouble whatsoever.

What Temperature Can the Body Stand?

By JOSEPH H. KRAUS.

(Continued from page 429)

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Luminous Water Signs

(Continued from page 452)

part has been bent into a sinuous form, as shown in the illustration. Above the bent tube another tube puts it in communication with the atmosphere, so that air enters being aspirated by the liquid drops, on exactly the principle used in water air pumps. The liquid arriving at the base of the bent tube gathers itself together in a capillarity, and is attracted to the walls of the tube, and forms thus a little cylinder with a concave meniscus at each end. Between the capillarity, a siphoning atmosphere is produced, and what we may term a string of beads, is already formed within the circle of the glass tube, and in that string, following it, fall by their own weight, drawing with them the bubbles of air separated by the cylinders of water and keeping the whole progressively in motion. The fall by the current of water and air is continuous; no matter how long and curved the tubes may be, the liquid and air in this headline formation persists. As the drops reach the outlet of the tube, they are permitted to escape into the atmosphere, as are ordinary water. If on the contrary, they are composed of any colored liquid, it would be waste to let them escape, so they are collected in a beaker. If the beaker is very small, or in a tank if the apparatus is large, and various arrangements can be made for raising the liquid to the original level for distribution. A small pump actuated by hand is sufficient for quite large installations. An automatic pump operated electrically, is of course, superior.

These liquid drops circulating in the tubes properly bent, and of proper design to carry out the natural, if it must be so termed, are illuminated obliquely by concealed lights, either on one side or on both. The meniscus of the water being in their form, act as concave mirrors and concentrate the light which strikes them from the right and the left, the impinging light producing luminous points, much more brilliantly illuminated than the liquid of the heads or the air of the bubbles separating them, and whose luminous effects change constantly on account of their continual movement, all of which, combined with their alternation of direction of motion in the different juxta-positioned tubes, produces the light and illumination comparable to the refraction seen in the case of precious stones. There is another effect of the moving order, the letters and design seem to take on varied movements and effects of deformation, of trembling, of rotating, etc.

This effect is sufficiently artistic for the process to be valuable for decoration as well as advertisement.

The general design of the advertisement, both luminous and other portions of it, must not be kept in use too long, as it is easy to come monotonous and cease to attract the public.

In the process which we have explained, the effect is due to the design. It is enough to replace the screen to obtain a completely new effect, which only takes a few minutes.

In some animated pictures it is possible to make jets of water, fountains in action, and waterfalls in the middle of picturesque country scenes. These designs can be infinitely varied.

Finally, as a matter of some importance, the expense incidental to obtaining this effect of water in motion, is practically negligible.

The luminous sign of whatever description, whether animated or intermittent, since its invention has been used up to date, is exclusively adapted to the exterior of a store. It has been found that this kind of sign will not attract the eyes of the passers-by, except around the store, while it is much more impossible to attract the objects which it contains, or to attract the attention of the persons detained by curiosity before the window.
Selenium Star
Photometer
By LEWIS J. BOSS
(Continued from page 46)

In using the selenium photometer to determine the periods of unknown variable stars, a comparison star is selected, which is as near to the color of the star under investigation as possible and which is also known to be of a permanent brilliancy.

Betelgeuse, the conspicuous reddish star in the upper part of the constellation of Orion, is one of the most interesting subjects upon which the selenium photometer has been put to work. This star, whose period has never been accurately determined, has been under observation since 1919, and records have been kept of all readings obtained. These have now been reduced to a common scale and the result plotted as shown in Fig. 5. Just above is shown a curve of the late Professor Barnard's naked eye comparison of Betelgeuse with the star Aldebaran. In this curve note that the zero line is representative of the visual brilliancy of Aldebaran, or, as it is known to astronomers, α Tauri. All deviations above or below this line indicates that Betelgeuse (α Orionis was at the time shown many tenths of a magnitude above or below α Tauri). The star is then the comparison star, or, as it is more properly called, a secondary standard for comparison. Fortunately this star was used as a comparison star in the curve shown, since the same one was used as a standard for the selenium photometer. In the lower curve the abscissa are the millimeters of galvanometer deflection produced by the varying light of α Orionis being impressed upon the sensitive selenium cell. The ordinates are in this case, as in the curve above, representative of elapsed time. The full line extending completely across the graph at abscissa 15.25 is the deflection produced by the standard star, α Tauri. Deviations above or below this line indicate, just as in the curve above, brilliances greater or less than that of the comparison star. From a careful study of the two curves it appears as though the selenium photometer was about to realize the goal of the astrophysicist, that is, the possession of a device would depend wholly upon physical methods for the determination of stellar magnitudes.

Not only is the new photometer useful in observing stars known to be variable, but it will also undoubtedly prove to be of inestimable value in settling questions of degenerate variability (e. e.) whether the light of certain stars really does vary a small amount or whether they shine with a steady effulgence, as well as being useful in determining the periods of maximum and minimum brilliancy of that large class of variable stars, the irregular variables.

In the development of this method of investigation, the idea has been, primarily, to adapt a piece of apparatus to the measurement of variable stars, which apparatus would eliminate as far as possible some of the difficulties attendant upon other methods. In doing this care has been taken to consider the errors likely to occur and to eliminate them in so far as it is possible to do so. They have, at least in the present form, been reduced to a minimum. The precision attainable with the selenium photometer has not yet been prosecuted to its fullest extent, nor have enough numerical results been tabulated to indicate what additional observations are to be expected from the use of this instrument in variable star photometry. A line of work most promising for the future is that which is possible with the selenium photometer is that of the study of the irregular variables of long period, many of which have never yet had a reliable period assigned to them. Such research, which can be prosecuted accurately by means of the selenium photometer, will result in the addition of considerable information to the scanty knowledge now available concerning them.
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By BASIL NEWCOMB

This book is a practical guide for the home manufacturer who wishes to build his own wireless apparatus. It covers all the practical details of building wireless sets, including the assembly and testing of the various parts. The book is illustrated with diagrams and photographs, and is written in a clear and concise style. It is suitable for anyone who has a basic knowledge of electricity.

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Star Clusters
By BASIL NEWCOMB

(Continued from page 438)

Such are Orion, the Scorpion, the Big Bear. Somewhat more condensed, and also actual clusters, are the Hyades and the Pleiades; and from them we can trace the lines of light to the globular clusters. The Hyades, as the name implies, are a group of stars which are relatively close to the earth and are visible to the naked eye. The Pleiades are a more condensed group of stars which can be seen as a faint asterism in the constellation Taurus. Both of these clusters are relatively close to the earth and are visible to the naked eye.

The globular clusters, on the other hand, are much more remote. They are a group of stars which are much more condensed and packed together than the open clusters. They are visible only with a telescope, and are located at great distances from the earth. The most famous globular cluster is M22 in Ophiuchus, which is located at a distance of about 6,000 light years from the earth.

The globular clusters are a fascinating subject for astronomers, and are a valuable tool for studying the evolution of stars. They provide a glimpse into the past of the universe, and help us to understand how stars and galaxies formed.

HUSSAINI

DEALERS—ASK FOR WHOLESALE DISCOUNT

DEALERS—ASK FOR WHOLESALE DISCOUNT

EXPERIMENTER PUBLISHING CO., INC.,
53 PARK PLACE, NEW YORK
Tantalum—All About It
By O. IVAN LEE, B.Sc.
(Continued from page 447)

be dissolved from a tantalum cathode leaving it malleable. Caustic alkali solutions and in general all water solutions of chemicals (with the single exception noted above) are without action upon it, so that it is acknowledged to be the most resistant of all metals to wet corrosion.

One of the earliest uses to which commercial tantalum was applied was in the production of electric lamps, and apropos of this, one should note the great ductility of the material. A bar of tantalum as thick as the finger may be drawn into fine wire for filaments without heat treatment during the process. The strength of wire thus made is much greater than that of copper, nickel or platinum, but less than that of molybdenum and tungsten.

Since tantalum expands at nearly the same rate as platinum, it is, too, it may be sealed into glass. This property, of course, is very useful when it is necessary to lead an electric current into a glass vessel.

THE UNIQUE ELECTRICAL ATTRIBUTES OF TANTALUM

To begin with, the electrical resistance of tantalum is only about eight times that of copper and about three times that of tungsten. This, however, though interesting, is not likely to cause it to displace cheaper materials already in use. The unique characteristics of a new material that set inventors to work to apply them to useful purposes.

Since tantalum when heated, eagerly combines with the common gases oxygen, hydrogen and even inert nitrogen, this very obstacle besetting the preparation of the metal becomes a most valuable property when, for example, tantalum is heated in a vacuum tube such as is used in the telephone. Thus it may be brought into a balance of residual gas suitable to the best conditions for transmitting or receiving. It is, however, the peculiar valve properties of tantalum that are of the greatest promise of possibilities in applied electricity.

Suppose two polished sheets of tantalum are immersed in a solution of the strength used in storage batteries and connected with a battery circuit of 75 volts. For an instant the current flows as with any ordinary metal, and then it suddenly trails off to a minute fraction of the original value—perhaps the tenthousandth of an ampere. Simultaneously, a rainbow film covers the piece by which the current enters the acid.

If now a plate of lead is substituted for one of tantalum, and the cell connected to an alternating-current transformer of usual frequency, the current flow in one direction will very nearly be suppressed, resulting in a pulsating direct current. The electrical energy is expended in electrolytic decomposition of the water into hydrogen and oxygen, the former appearing at the tantalum electrode while the latter is evolved at the lead. The current thus derived may be used to charge a storage battery, for electrolytically evaporating water in hot weather.

It is even possible by using two tantalum electrodes, to rectify an alternating current that both halves of the waves are made to pass in the same direction, and then manipulated finally to become a smooth unidirectional current.

The leakage of electric tantalum valves varies under the conditions of the apparatus utilized, voltage, nature of electrolyte, current density, etc., but because of the great

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inertness of tantalum towards chemical solution of all kinds, the electrodes of this marvelous metal are practically indestructible.

This is not the only property of tantalum, however, with valve apparatus constructed of aluminum or magnesium which, although capable of rectifying, soon disintegrate from chemical action. Tantalum is the efficient conduct of heat. By charging an ordinary storage battery is in the neighborhood of 35%, comparing favorably with other types of storage batteries.

The tantalum rectifier is noiseless, devoid of moving parts and needs no attention except occasional replenishment of water.

The Future of Tantalum

It has been stated by Mr. Wells that the “scientific prophecy will not be fortune-telling, whatever else it may be,” so that it is with a feeling of considerable reluctance that one ventures to make any predictions concerning the probabilities of a metal so new to us as tantalum. It is, however, a strange and significant but consoling fact, that the useful metals seem to occur in nature in abundance nicely adjusted to the demands made upon them. A world in which mercury was worth as much as indium, if we have scarcely enough to tip our fountain pens, would be unthinkable, but at 90c per pound is no complaint. Russia’s single experiment in plug in cottage home demonstrated again the folly of any metal save gold as a monetary standard. Soon after vanadium created an insistent demand for itself, a providential forest created by some freak of geology was uncovered at a height of three miles in the Peruvian Andes. About the time that the advantages of zirconium oxide were appreciated, thirty tons boulders of it were discovered lying ready to move on the highlands of Brazil.

SUMMARY SUGGESTIVE OF THE DIVERSE POSSIBLE APPLICATIONS OF TANTALUM

Mechanical

Pen (nibs): elastic, hard, non-rusting.

Watch and Clock Springs: By alloying with carbon, silicon, boric, aluminum, tin, titanium.

Tools: Such as pistols where lubricated surfaces are subject to mechanical wear. Case hardening may be obtained by addition of oxide, aluminum, titanium, tin, silicon.

Cutting Tools: Knives, etc.

Dental Purposes: Pins for teeth, instruments, non-rusting, can be sterilized, sharpest and most durable hardness equal to steel.

Surgical Instruments: Non-rusting, can be sterilized, sharpest hardness equal to steel.

Jewelry: With or without an alloy having appearance of gold but harder and more elastic.

Steel Industry: Alloy with iron, tungsten, molybdenum, chromium.

Alloys: With molybdenum as substitute for platinum; with tantalum, nickel from 60-100%, an alloy of great hardness.

Chemical

Colors: Olive green and orange pigments were described and recommended in 1881 by Hatchett. It is the earliest suggestion for the utilization of tantalum—foealuminiunum.

Refractory: Tantalum oxide is well adapted for withstanding high temperatures.

Standard Weights: Permanent, hard, economical.

Platinum Substitute: Cheaper, in some respects superior and releases platinum for indispensable purposes.

Chemical Apparatus: Crucibles, dishes, etc. Ideal if subjected to too hot a temperature.

Chemical Manufacture: Of sulfurous acid, replacing platinum for expensive in the acid chambers; possess great durability.

Alloy: 31.8% oz., 6.5% columbium, 57.5%, tantalum 37.5%, not attacked by any acid, resistant to whitening without oxidation.

Electrical

Filament: For incandescent electric lamp.

Wire: For electric hatters and resistance furnaces; current leads, etc., beautiful strong, strong.

Sheet and Gauge: For radio tubes, X-ray tubes, electronic detectors, light bulbs.

Plates: For electrolytic condensers, valves and rectifying purposes.

Springs: For replacing molybdenum and tantalum; possesses great elasticity, lower density and cost, and the of all metals plated being removed by treatment in acids.

Magnetic Alloy

Non-magnetic Alloy: With nickel.
In this Department we publish such matter as is of interest to inventors and particularly to those who are in doubt as to certain Patent Phases. Regular inquiries addressed to "Patent Advice" cannot be answered by letter. Such inquiries will be referred to counsel. If the idea is thought to be of importance, we make it a rule not to divulge all details, in order to protect the inventor as much as possible; and we therefore advise you to consult a patent attorney before filing application for patent protection. In no case will we publish any material presented by us as to an invention without the consent of the inventor or his attorney. Should advice be desired by mail a nominal charge of $1.00 is made for each question. Sketches and descriptions should be clear and explicit. No advice will be written or returned to us without your name and address being given.

NOTE.—Before mailing your letter to this department, see to it that your name and address are upon the letter and envelope as well. Many letters are returned to us because either the name of the inquirer or his address is incorrectly given.

CARBIDE GAS ENGINE

(727) Robert Smith, Plentyswood, Mont., asks for patent advice on a gasoline engine using carbide gas for the driving agent. A. There is no reason why carbide gas could not be used in automobile engines to run them, neither is there any reason to suppose that any other inflammable gas will not explode when mixed with air or oxygen. As much as you have not changed the construction of the internal combustion engine in order to make it operate with carbide in any detail, you doubt if you could put into the use of a particular kind of gas in connection with the engine. We disagree with you on the efficiency and economy of this system. Carbide gas is more expensive in its practical use than any gasoline, and except for lighting motors on cold days, its use would be undesirable. We would suggest that you work along this line, namely, that you design a carbide gas engine without any explosive gasses are mounted at the ends of the wing structure, as illustrated there.

BATTLE PLANE

(728) Constant A. Slubosi, Detroit, Mich., desires advice on a plane which machine guns are mounted at the ends of the wing structure, as illustrated there. A. You do not think that the world has had enough war for at least twenty or thirty years? If so, then certainly you may not be interested in applying for a patent for your device. There probably will be no more war for at least twenty years—considering our present military and political conditions, any war in this period, as your questions, are worthless, and at the end of the seventh or eighth year the motive will cease to operate to the inventor. Even then, equipping your airplane with machine guns is going to be of advantage, as they are mounted so that the operators of the machine-guns cannot operate the plane. Consequently, when a plane of this nature is sent crashing to earth, there is a loss of five lives instead of one, or at the most, two. Firing the guns is more directive and effective, and maneuvering an airplane with heavy bodies at the ends of the wing structure is more difficult while the speed of the airplane has increased and wind resistance. We would not suggest attempting to patent this idea, nor any other war idea, unless of extreme importance.

FIREFIGHTER DEPARTMENT

(729) Geo. J. Frankovich, Anaconda, Montana, asks whether he should patent a fire alarm system, in which a fuse is laid throughout the building connected with an explosively operated switch, the fuse being of the type used for lighting purposes. A. We most strenuously advise against attempting to patent such a device. In the first place, the setting off of the fuse requires that a flame come into contact with the fuses with said flame means that the fire will necessarily have obtained considerable headway, if not be already spread by the burning fuse. The device is also impractical because of the fact that an alarm is鞋起 in dispatching the mechanism of the same. Explosives cannot be sent out in the air, as they are too light and easily blown around. We also find that you had better be alert to the fire alarm system. The system we are quite expensive, when one considers the amount of fuse which has to be kept and altered after each configuration. We are positive that insurance and fire underwriters would not sanction this method, which, rather than being a detector of fires, would positively lead to complete combustion. Many other drawbacks will present themselves if you think along such lines.

SPARK GAP

(720) Eugene Froehling, Fort Smith, Ark., asks whether he should patent a spark gap for radio purposes, a diagram of which he sent. A. Without a doubt your device can be patented, but what will be the use? Today an open spark gap is employed, is employed for radio principally for automobiles and naturally experimental purposes. A patent upon your system with reference to its experimental use, would hardly be worth the expense. Within another year or two radio spark gaps together with much other trash with which radio was and is today invested will be relegated to the junk pile. All of these make historical material for readers interested in radio's romance. But to attempt to patent devices to be placed in the hands of such historical works would be the height of folly. We therefore advise you strongly against attempting to secure a patent upon this scheme.

A LEGAL QUESTION

(731) Alfred First, Dongan Hills, New York, asks what could happen if he infringes upon a patent. A. We do not profess to be legal experts, therefore this can only be definitely decided from a suit has been settled. However, this may occur: If you infringe upon a patented article, and a suit is brought against you, the action is won, anything which you have or which may be coming to you as a result of this infringement, may be attached and all your personal belongings and properties worth about $25,000 worth of property, real and personal, may be claimed by the concern who won the suit. Any money or monies which you may have put into the manufacture, ask an exploitation of your device could be attached, and subsequent returns would come into the hands of the winner. The court then may enjoin you from manufacturing this device, and should you fail to heed the warning, a jail sentence is apt to follow.

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to whether space is a vacuum, or is filled with ether or with highly rared air or other gas, no balloon could ascend very high in it, as the density diminishes as we ascend. Hydrogen, the lightest gas known, would not carry us very far. Even if we were able to make a vacuum balloon, with concentric envelopes strong enough to resist crushing from the atmosphere, and if we dropped off one shell after another as we ascended, this balloon would have to be so large, to rise even a few hundred miles, that it would be impracticable to build it.

"Why so? A balloon, with no gas inside, ought to be very light."

"True, but at a height of one thousand miles above the earth, our atmosphere must be so rarefied that it would probably take thousands of cubic miles of it to weigh a pound. Consequently the problem would be to build a balloon of thousands of miles long and weighing less than one pound. This would be a manifest absurdity. So we may dismiss the idea of a balloon as a means of traveling to the moon or to the planets."

"What is your opinion about the possibility of screening a body from the effects of gravitation?"

"This method is used for sending his first men to the moon. He places them in a car that is surrounded by shutters, which, when closed, are impervious to the attraction. By opening the shutter in the direction in which he wishes to go, the passenger lets in the attraction of the earth or the moon and the car starts off in the desired direction. When his speed becomes too great, he lets in a little counterattraction from the opposite side, and so can regulate his speed and direction at will. What do you say to that idea?"

"The idea is certainly ingenious," observed Doctor Hackensaw with a smile, "but it is open to the objection that we have as yet found no means of shutting off gravitation, nor have we ways to lead us to believe that gravitation can be shut off. Of course, as yet, we do not know what gravitation is. Several unsatisfactory metaphysical theories have been advanced, but none of them satisfies me. As for myself, I cannot even make up my mind as to whether attraction is, as commonly believed, a pull between two bodies, or, what appears to me more probable, a push exerted on the two bodies from outer space, forcing them closer together. Analogy, however, would lead me to believe that gravitation is, like heat, light, sound, electricity, &c., is merely 'a mode of motion,' as the physicists call it--in other words a vibration. The whole subject is as yet in complete darkness, but, as I observed at the beginning, I have discovered no new force and no new method of controlling the forces already known to man. I am relying entirely on old and well-known forces to carry me to the moon."

Silas Rockett was puzzled. He had apparently exhausted his entire arsenal. He tried one more shot, however.

"Is it possible that you are thinking of using atomic energy?"

Doctor Hackensaw shook his head. "No," he said. "I shall not use atomic forces."

"Nor radio-active force? You will not propel your car by means of wireless waves?"

"No indeed, our electrical knowledge at the present day is insufficient for any such schemes."

"Then I give it up," said Silas. "I have read something that says the earth were twenty-four times its present diameter, bodies at the equator would be traveling (Continued on page 504)"

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Science and Invention for September, 1923

Answers to Scientific Problems and Puzzles

(The Human Sampson)

If the stone weighs a few times as much as the hammer the feat here described would be impossible, but if it exceeds the weight of the hammer many times, the

inertia of the stone will prevent it from

responding quickly to the blow and most of the energy of the stroke will be dissipated

on the rock without affecting the man's head at all. The most difficult part of the

performance is to support the stone—not to withstand the blow.

THE ENCHANTED RING

The results can be obtained in hiding a powerful electro-magnet within the figure

of the man, connection being made to a source of alternating current. As the vis-

itor approaches the figure to crown it with the ring, the magician steps on a contact

maker concealed by the carpet and thus energizes the magnet. The alternating field

of the magnet produces exceedingly eddy currents in the ring, and, as the very nature

of eddy currents is to oppose the action by which they are produced, repulsion results

between the ring and the magnet. The eddy currents are also responsible for the heating

of the ring.

CALIBRATING A HYDROMETER

Since the hydrometer weighs 20 grams, it will displace 20 grams of any liquid in which

it floats. At the level at which it floats in water it will displace 20 cubic centimeters

because each cubic centimeter of water weighs a gram. For some other liquid, say for

a liquid of density D, it will displace 20/D cc. Between the points marked "I" for

water and "D" for some other liquid the stem must displace (20 - 20/D) cc. But this

volume is also 0.25 x where x is the distance in centimeters between the points "I" and "D.

Hence 0.25 x = (20 - 20/D), or x = 80 (1 - 1/D).

Another Pulley System

Let X represent the force with which the man has to pull to maintain himself in

equilibrium. Then the force on rope A will likewise be x pounds and the tension

on each of the ropes will be 2 pounds. But since the two ropes B and C together

support the entire weight of 240 pounds we have that x = 240, or x = 60 pounds.

Waxing or Waning?
The phases of the moon are, of course, due to the relative position of earth, moon

and sun, which constantly changes as the moon revolves eastward in its orbit around

the earth. If the moon is on that side of its orbit in which it approaches the sun it is
evident that we will see progressively less and less of the illuminated surface of
the moon until when the moon is almost between us and the sun we cannot see it at all. When

the moon is in this part of its orbit, we have, then, a waning moon. We also have a moon

with its illuminated surface toward the east. But when the moon is moving away from

the sun on the other side of its orbit we see progressively more and more of the

illuminated surface and we have a waxing moon with the illuminated surface now to

ward.

R.A.Y. Treatment for Lungs

Rafael Sampson, the 23-year-old medical student in the University of Paris, declares

he has discovered an infallible cure for tuberculosis.

After three years of experimenting at the leading hospitals, he has constructed a

set of lenses for introducing ultra-violet rays into the human lungs. He declares that his

experiments proved that these rays will kill all tuberculosis bacilli in less than half an

hour.
seven miles per second and hence would be hurled off into space. Have you found means of swelling the earth to twenty-four times its present size?"

Doctor Hackensaw went to a hearty laugh. "No," said he, "I shan’t attempt to give the poor old earth a fit of the dropsy. Nor shall I attempt to build a mountain on the equator, of the required height. Let me see. The radius of the earth is four thousand miles, so my mountain would have to be 60,000 miles high! I’m afraid I couldn’t find a contractor willing to undertake the work, nor would there be materials enough to complete it. But you are learning, Silas; you are getting nearer and nearer to the correct solution. It is centrifugal force that I shall use, but not the centrifugal force of the earth itself."

“What then?"

DR. HACKENSAW EXPLAINS HIS SCHEME

"Well, Silas, the problem is this. I must find means of giving my car a speed of about seven miles per second, and yet I must start the car gradually in order not to harm the passengers. Evidently the solution is to get the required speed and keep it going more and more rapidly until it has acquired the necessary velocity, and then launch it. In this way my passengers will suffer scarcely any inconvenience. There will be no shock at starting."

"I begin to see."

"Yes, the solution is obvious. What I need is a large revolving wheel like a Ferris-Wheel, with that fastened to the end of one of the spokes. The wheel can be started very slowly and its speed gradually increased until the required velocity is attained, and then, at the proper moment, the car can be released and shot off into space. In this way there will not be the slightest shock for the passengers. But why am I jabbering away here? I have kept the audience so far, but I am soon to make it public. Come along with me and you can see the machine for yourself. It is all completed, save for a few final tests to make sure everything is in good working order."

Luna City was the name which Doctor Hackensaw gave to the secluded spot which he had chosen as the launching-place of his car for the moon. For miles before arriving at the place, Silas Rockitt was eagerly scanning the horizon for the gigantic wheel which he firmly expected to see. His disappointment may be imagined therefore when, on arriving at the spot, he found that the apparatus was no larger than an ordinary Ferris-Wheel.

CENTRIFUGAL FORCE FROM SPINNING WHEEL LUNScribes CAR MOONWARD

"What!" he cried in a tone of disgust. "Is it that little toy-wheel that is going to shoot your car to the moon?"

"Yes, Silas, just as if my calculations are correct. Please notice that the frame, which supports the wheel, has its foundations in the solid granite beneath. In fact holes have been drilled deep into the rock, and the whole frame-work has been solidly tied down by means of powerful chains. This is not only to prevent wobbling, but to ensure that the wheel itself will not be carried away as well as the car."

"But that wheel seems only twenty feet in diameter!" said Silas. "Each revolution would be only about one hundred feet. To get a speed of seven miles per second (Continued on page 514)
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“We’re on our direct course to Jupiter now,” Sir Isaac answered. He had shaved and washed. His hair was slicked back and he was smoking a cigar; but his face was haggard and he looked tired.

Sir Isaac’s Sketch Giving a Rough Idea of the Positions of the Planets.

“You can take charge now,” he added. “I must get some sleep; if only for a few hours.”

Tubby sat alone on a cushion at the floor window of the instrument room. From the view from which they were just receding, as Sir Isaac had told him, at a velocity of 15,650 million miles an hour, was blazing high over the roof of the vehicle, and thus was invisible from the starlit room downstairs.

Tubby whisked to keep himself awake. After an interval he looked at the chronometer. It was 8:20 A.M. Why didn’t Ameena wake up? Tubby was lonesome and depressed. A little later he went into the kitchen and made himself a cup of coffee. Again he wished fervently Ameena would come down and join him. Should he wake her up? Was it quite early for breakfast? Wouldn’t she ever come down?

For another hour he wandered disconsolately about the lower rooms, glancing at intervals through the floor windows to make sure no derelicts were in sight. Remembering Sir Isaac’s jaunty appearance, he shaded and washed. Fortunately having had the forethought, the night before, to rescue his razor from the bedroom upstairs.

He had about decided in desperation to awaken the girl, when, on an impulse he climbed into the little dome on the roof where Sir Isaac had mounted a small telescope. A moment later Sir Isaac was uttering directions through the vehicle, hollering loudly for Sir Isaac and Ameena.

THE SKY TRAVELERS ARE FOLLOWED

“Hey, professor! Ameena! Oh, Ameena! Get up, quick! There’s somethin’ followin’ us!”

Sir Isaac came bounding upstairs from the store room, meeting Tubby in the upper hallway. From one of the bedrooms came Ameena’s sleepy voice:

“What is it? Must I get up?”

Together the two men rushed up into the little observatory. Another vehicle, twice as large as their own and somewhat different in shape, had appeared directly above them, showing as a dark spot in the firmament and edged with silver from the Sun’s rays behind it.

“That Mercurian girl!” Sir Isaac gasped, with sudden memory. “She flew to the Twilight Country! She said she was going to have revenge!”

They were indeed, being followed! This pursuing enemy was at that moment more than twice away, and was overtaking them rapidly.

CHAPTER VI

IN WHICH THE VOYAGERS PASS MARS, DODGE THE MINOR PLANETS AND INTERVIEW HIS SUPREME HIGHERNESS

Sir Isaac dashed back to the instrument room three steps at a time, with Tubby at his heels. Ameena came from her room and followed them.

“What is it!” the girl demanded. “Is something wrong?”

Tubby broke back over his shoulder:

“Them Mercurians is after us. Right overhead—come in fast. Come on down, we got to do somethin’!”

Sir Isaac rushed to the keyboard.

“Switch our course,” Tubby suggested. “Let’s see if they can turn when we do. . . . Or how about going faster? Can we go faster?”

“Wait!” commanded Sir Isaac. He depressed two keys—a black one on one bank and a white one on another—and raised the ones which had been down. Then he dashed away upstairs again.

Tubby had no more time to compliment Ameena on her appearance—she was dressed quite as on the day before, but her face was flushed with excitement and her eyes sparkled, so that she was more beauti-

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in her orbit. This Tubby and Ameena readily understood by another glance at Sir Isaac's drawing, which they consulted soon after breakfast.

About 8:15 A.M., while Tubby had been on watch alone, they had crossed the orbit of the Earth—though nearly twice as far from the Earth as they had been from Venus.

"Mars revolves around the Sun at a mean distance of 141,700,000 miles," said Sir Isaac, some little time after breakfast. "We should have intersected his orbit about 10:40 A.M.—that was when we were closest to him."

"An! you didn't really!" cried Tubby reprovingly. "I want to get a look at that—that murderin' villain!"

It was then about ten minutes of eleven. Mars, to which it was nearest compared, was resound-ingly, close still showed as a half-lighted, circular, reddest disc. Its tracings of fine intersecting lines—the "canals"—were quite distinguishable.

Even at the enormous velocity the vehicle had now attained, all the heavenly bodies appearing apparently in the firmament—except Mars, which because of its nearness, seemed slowly moving upwards as the vehicle dropped past. Tubby, standing by the side window, shook his fist at the disturber of the Solar System.

"Well for you yet—you—"

meena laughingly pulled him away.

"Is Mars as large as my Venus?"

she asked Sir Isaac. "Or your Earth?"

"The diameter of Mars is 4,316 miles," said Sir Isaac. "The Earth is 7,917 and Venus 7,629."

"Only a little guy!" Tubby was contemptuous.

"This is certainly the most charming view I've ever seen."

They talked with them little fellers—Mercury too—always lookin' for a scrap.

Sir Isaac went on:

"Mars revolves around the Sun once in a little less than 687 days. That is the length of his year. His orbital speed is 15 miles per second. He is about half the Earth now in his orbit, but the Earth travels forward at the rate of 18½ miles per second. Thus you see, the Earth is overtaking Mars, and when they are both in line with the Sun, that will be opposition. That's closest point to each other until the Earth comes around again—that's when the Martians will attack."

Poor Sir Isaac, from one threatened catastrophe of another, had had so far very little sleep since leaving the Planet Earth less than a month.

About half past eleven that morning Tubby and Ameena sent him to bed again.

"Don't let me out for two hours at the most," he said anxiously. "There are thousands of Minor Planets in here between Mars and Jupiter."

"Shucks," disclaimed Tubby, "That don't make no difference. Ain't I on guard?" It was a magnificent chance for sarcasm. Yes, but the sternest character of Sir Isaac forbade such weakness. All he said was:

"Our velocity of 28,000,000 miles an hour would be sufficient to bring us from Earth to Venus in about two hours, or to Venus to Mercury in a little over sixty minutes! I don't want you to forget how fast we are falling now."

With which admonition he retired.

It was a long, tiresome, comparatively uneventful day—at least it would have been, if Tubby hadn't been in the company of a companionship. She sang to him again; and with her somewhat raucous tenor voice they contrived "inter-planetary duets" as Sir Isaac joyfully called them. They had tired of music they climbed into the dome to make sure their pursuers had not again come into sight. The dome had slid, out of which they were falling, showed nothing unusual—Mars—well above them now—had dwindled to a small, reddest disc, and Venus and Mercury were indistinguishable among the mass of other glittering worlds.
"Look at the Sun," said Tubby. He pulled Ameena toward him. He had indeed, progressed to where his arm was almost constantly near her, which, since you may love the same the Universe over, Ameena accepted as quite reasonable and natural.

"Ain't the Sun gettin' little?" Tubby added.

The orb of day had dwindled to half its apparent size as viewed from Earth. The vehicle, too, was growing hourly colder. Ameena shivered a little.

"Come on down," said Tubby solicitously. "We'll have to get the professor to heat the place up—oh, get your sweater dressed warmer." His appreciative Ameena's dainty figure. "I'll see what I can dig you up—right after lunch. Come on down where it's warmer—let's play cards."

Explaning to the girl the intricacies of the fifty-two different cards of the deck took nearly another hour, after which Tubby's stomach peremptorily informed him that it was time for lunch. He swept up the cards, and with a hidden thought glanced around quickly through the lower window to see if they were about to collide with anything. Jupiter had grown to a marvellously luminous afar; beyond that, everything was a before.

"You go fix somethin' to eat," he said to the girl, "I'll call the professor—he's around (oh, any time)."

Sir Isaac came down shortly, dressed in a warm-looking tweed suit with golf trousers. Glancing at the chronometer, he immediately plunged into an intricate mathematical calculation.

"Our velocity since 9.30 this morning has averaged just 28,502,122 miles an hour," he announced a little later. "My guess was right."

"Good," said Tubby. "Come on into the dinin' room. Lunch is ready."

After lunch Tubby himself dressed more warmly—in a Norfolk jacket, golf suit and heavy grey flannel shirt, an outfit that was extremely becoming. He then sent Ameena upstairs, apologizing for offering her anything and everything in the way of apparel she could find. She returned a few moments later and stood shyly awaiting his approval. She had donned a heavy pair of golf stockings and rubber-soled shoes which made her almost as tall as her. And over her knee-length white dress, she was wearing a natty-looking man's overcoat which almost swept the ground. Her hair was now curled and that head, with a huge, red-silk headkerchief bound around it.

Even Sir Isaac glanced up from his figures long enough to admire her appearance. She looked indeed, like a radiantly beautiful little English girl, on her way to the beach for a swim. "Fine," declared Tubby, "Keep that coat buttoned up as you'll be nice and warm.

The temperature was now about 98°F., more than half-way in distance from Mercury to Jupiter, Sir Isaac announced.

"Tell us somethin' about Jupiter," said Ameena, sitting down beside Tubby and giving him her little hand to hold. "You said you'd get somethin' for science.

"It's mean diameter is 89,380 miles," Sir Isaac answered. "Its volume is 1,390 times greater than the Earth!"

"How big is Jupiter," Tubby commented.

Sir Isaac added: "And it makes one revolution around the Sun 4332 2/3 times. Thus its year is equal to 11 years, 3149 4/3 days on Earth."

"My goodness" said Tubby.

"It seems to me it takes only about 9 hours and 56 seconds long. That is because it rotates on its axis so very swiftly." Tubby interjected,

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**Science and Invention for September, 1923**

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“Here Jupie’s a re-mark-able Planet, ain’t it?”

“Go on,” said Ameena. “Tell us more.”

Sir Isaac seemed embarrassed. “Well, tell you the truth,” he said hesitantly, “I don’t really know very much about Jupiter. You see I’ve never really had occasion, up to now, to—”

“Right,” interrupted Tubby. He had no wish to be hard on his friend, especially before a girl. “What’s the difference? They soon be there an’ see it for ourselves. . . .

“When do we land, perceptor?”

Sir Isaac looked worried again.

“At our present velocity I calculate we should enter the Jovian atmosphere about 10.15 p.m. tonight, but—”

“Very good, re-feed, perceptor.”

“But I dare not maintain this velocity,”

Sir Isaac finished.

“Why not? Ain’t we in a hurry?”

“We are in a hurry certainly.” Sir Isaac conceded. “But, as you know, the more you haste the less speed sometimes. We are now in the region of Minor Planets. More than eight hundred of these little worlds have been discovered and listed, even by those inefficient astronomers of Earth. We have never given the subject much attention—except in the case of ‘Hector Servadac’—and in that story—

“We’ve seen no Minor Planets yet.”

Tubby hastily interrupted.

Sir Isaac drew him and the girl to the side window.

“There are a dozen or so,” he said simply.

Tubby made them watch a moment—very tiny half-moons gleaming among the stars. They were apparently moving upward as the vehicle fell past them, while all the stars appeared quite motionless.

“Some of these little worlds are from a few hundred thousand to a million miles away from us,” Sir Isaac added. “We could reach them with this velocity in a minute or two! They’re all around us now—so you can understand what chances we’re taking.”

Tubby understood indeed; and when, a little later, he saw through the lower window a gleaming disc come into sight, grow to the size of the Moon, and sweep past them to one side and out of sight above them—all in the space of a minute—he was glad enough to have Sir Isaac reduce his speed.

It gave the pursuing Mercurian vehicle a better chance to overtake them, of course, but even that was the lesser of the two dangers.

The evening was a long one. Tubby and Sir Isaac played cards after dinner, with Ameena an interested spectator. They discussed their Mercurian pursuers a little—the other vehicle had not again appeared. Ameena retired about ten o’clock and Sir Isaac, shortly afterward, lay down at Tubby’s feet on the floor of the instrument room.

Tubby faithfully kept watch until two in the morning. Jupiter was now considerably larger than the Moon appears from Earth—a silver disc with broad dark bands on it, and a huge red spot. Like a doll red lantern gleaming from its lower hemisphere. The red spot winked and went out shortly after Tubby discovered it.

When Sir Isaac woke up, of his own accord, Tubby, too tired to ask any questions, fell asleep on the floor, wrapped up in a blanket from the floor, in a sitting position. Sir Isaac dreamt he was a railroad train and that Jupiter was flagging him with a red lantern. He wanted to stop, but couldn’t. There was a terrible collision.

Tubby opened his eyes to find Sir Isaac shaking him violently.

“All right,” he protested, sitting up dizzyly. “Lemme alone. What time is it? Ain’t we there yet? Where’s Ameena? What’s that red light comin’ from?”
THE TRAVELERS APPROACH JUPITER
It was just six o'clock. A lurid red glare was shining up through the lower window. The room was faintly lit. Sir Isaac, as Tubby, as soon as he was fully awake, started down through the heavy glass pane. The dark surface of Jupiter, over which they were poised, stretched out before him, as he could see in every direction. Directly underneath the window, like the huge mouth of a red-hot furnace, yawned a gash in the Jovian atmosphere from which lurid tongues of flame were linking upward into Space—vomous, scarlet-red tongues thousands of miles in length.

Tubby was awed as well as alarmed. They were dropping directly into the mouth of Hell!

"Don't be frightened," laughed Sir Isaac from behind Tubby's shoulder. "We're two million miles up yet and falling only at the rate of half a million miles an hour. That is the great red spot of Jupiter. I've always wondered just what it was. Those are tongues of flame, hydrogen. It proves conclusively that Jupiter is more like the Sun than any other Planet. Its surface is not solid on this side, and, as you see, it is internally heated to a very considerable degree."

While Tubby gazed, fascinated, Sir Isaac went on enthusiastically.

"Jupiter is partially self-luminous, which I have always believed. And, because of its internal heat, the surface temperature is easily warm enough to keep a certain life, even out here so remote from the Sun."

"That looks absolutely too hot to live in," Tubby declared, gasping down into the crater of this mammoth volcano.

Sir Isaac laughed again; evidently he was in high spirits at this complete verification of his theories.

"Of course it's too hot on this side. I knew that, but I came around here to see the red spot. We had to follow it around, as you see, because of the Planet's very rapid axial rotation. The surface, as I said, isn't solid. Nevertheless, now that we know that Jupiter is inhabited, however much it would appear not to be, there must be at least a small portion of solid surface. We'll go around to the other side again and locate it."

"Like lookin' for land when flyin' over the ocean? Tubby illustrated.

"Exactly." Tubby rose to his feet.

"Very, good, professor. Very, good. Indeed, you navigate such a world, and I'll go wake up Ameena. She mustn't sleep all the time. We got to eat."

PASSING ONE OF JUPITER'S SATELLITES
They passed fairly close to Satellite IV which revolves around its mother globe at a mean distance of 1,162,000 miles. They were then having breakfast, and during the remainder of the meal Sir Isaac entertained them with a most interesting dissertation on the nine satellites of Jupiter.

They were all up dressed as on the evening before, though Ameena had discarded the overcoat. She resumed it after breakfast, however, and when they had passed around over the other hemisphere of Jupiter, beyond the flames of the "red spot," exposed again to the cold of Inter-planetary Space and were now only a very small, pale little Sun, the interior of the vehicle rapidly cooled off.

After breakfast an observation of Jupiter through the lower window showed only dense, black cloud masses.

"Let's go down, perfectly," Tubby suggested.

"Can't do, I'm afraid, up here through them clouds," He added gloatingly:

"I guess we beat them Mercurians in, all right!"

They entered the Jovian atmosphere about eight o'clock—at an altitude of 1,400 miles—

(Continued on page 513)
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**Around the Universe** (Continued from page 511)

depth of air strata that surprised even Sir Isaac. Inky blackness surrounded them for a time. At 110 miles they emerged into daylight. Later all the clouds swept away. The pale Sun shown through the side window, rising over the horizon—for it was no longer early morning on this portion of the mighty Planet—shortly after dawn of a clear, frosty-looking Jovian day.

"Looks awful chilly out," Toby replied dubiously.

"Yes," agreed Sir Isaac. "We would be freezing in here. Cities were not for our occupation in passing through the atmosphere. I have shut off our heating apparatus... it will be much warmer down below, however. The internal heat of Jupiter warms its lower strata of air."

At an altitude of 25,000 feet they could distinguish quite plainly the Jovian landscape over which they were passing horizontally—a barren land that looked as though it might be thick black water and mud. It seemed to be little bays and islands in spots. Here and there it appeared firmer—and there were curious vegetative growths as near as two hundred and moisturous as anything else Toby could think of.

**JOVIAN CITIES APPEAR**

The landscape was changing constantly. Now they came over a barren, almost rocky land, with enormous cypress-like pines and cedars. Half an hour later the forests began occasionally to be dotted with cities—mammoth buildings rising in terraces two thousand feet into the air. Everywhere seemed built on the same gigantic scale. They selected, quite at random, one of the largest of the cities, and descended in an open space nearby. It was 9,500 A.M. when they came to rest upon the surface of Jupiter—a flight from Mercury, smallest major planet in our solar system, to Jupiter, the largest of exactly 34 hours and 5 minutes.

**THE SKY PARTY MEET THE GREAT MODUL**

The audience with the Great Modul of Jupiter—who came riding out of the city with his Wise Men on an enormous animal—like a queer-looking elephant with broad, very flat-topped—took place about 12 o'clock noon Earth Eastern time, though it was then late afternoon of the Jupiterian day.

It may seem remarkable that so great a dignitary would go to visit his visitors rather than bidding them come to him. The answer however, is obvious to any thinking student. Toby and Sir Isaac had flatly refused to allow themselves to be carried away; and since gravity on the surface of Jupiter is more than 2½ times that of the Earth, they could hardly stand on their feet, much less walk. The Great Modul, on the other hand, trailing him some fifteen feet tall, with his Counsellors in proportion. A robe of richly-colored cloth fell in folds to his feet. There were ropes of enormous gobs about his neck—that is to say they might have been considered gems, though they looked more like little gargoyles molded out of red and green pottery and his braided white beard hung down his chest to his waist. (To be continued.)

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(Continued from page 304)
second your wheel must revolve 350 times per second! You surely cannot obtain such a speed as that!

"Certainly, I can. It is just a matter of gearing. Many small wheels in machinery travel more than 350 revolutions per second. But I have a plan that will enable me to run this wheel at a much lower speed. Do you notice the wheel itself revolves over a very deep excavation?"

"Yes, I was wondering what that deep hole was for."

"That is to enable me to increase the diameter of the wheel without increasing its weight."

"What?" cried Silas puzzled.

"To be plain, there are serious objections to having the wheel too large, as it would tend to fly apart at the high speed of revolution. On the other hand it must not be too small or the dizzy whirling motion might kill the passengers. So I have devised the following method. I have a very long and very strong chain wound on a windlass anchored to the rock itself. The free end of this chain passes through the axle of my Ferris wheel, up through a hollow spoke and is there attached to the bottom of the car. The centrifugal force, encased in a swivelled tubing to avoid twisting, can be gradually let out as the wheel increases in speed. The centrifugal force makes the car move away from the wheel, but it is held by the chain. Gradually as I let the chain out the car describes larger and larger circles. In this manner with a small wheel revolution at a moderate speed, I can obtain the same effect as with a large wheel, and without the attendant disadvantages. I use electricity for my motive power and use small ball bearings, but wherever possible, in order to reduce friction I use a stream of compressed air for the bearings—a little invention of my own."

"I suppose you have to aim your car aloud of the moon, Fred Silas."

"Seven factors to couple with"

"The problem is by no means so simple as that," retorted the doctor. "As a matter of fact, I don't aim anywhere near the moon. Seven factors have to be taken into consideration in aiming the car. First there is the rotation of the earth. The earth revolves on its axis. A body at the equator if shot off from the earth would have this centrifugal speed of 1,000 miles per hour in a straight line tangent to the earth. But I see you don't understand."

Here is a diagram that will help you. When a body, which is revolving in a circle, is suddenly allowed to fly off, it flies off at a tangent. Thus in the diagram, a body released at either A, B, C or D will fly off in the direction of the arrow. For the same reason, the direction my car will take will depend largely on the time of the day at which it is released. If released at noon this speed of one thousand miles per hour will be in exactly the opposite direction to what it would be if the car were released at midnight.

"The second factor is similar and depends upon the speed of the earth in its revolution around the sun. The faster the earth will fly off at a tangent to the orbit, at a speed of nine miles per second, the direction depending on the day of the year and the time of the day. The third factor of course depends on my revolving wheel. From this, too, the car will fly off at a tangent, its direction depending on its position on the wheel when released."

"But doctor," asked Silas puzzled, "can a body fly off in three different directions at once?"
"These three tangents are all straight lines. When a body is acted upon by three such forces it takes a diagonal course—the average of the three. This is what is known as the law of the composition of forces."

"The next three factors are the attraction exerted on the car by the earth, by the moon, and by the sun. These attractions change as the car moves, hence these forces would each move the car along a curved line. When all six forces are combined the path of the car will also be a curve. The seventh and last important factor to consider is the resistance of the air. The car's flight will be greatly retarded when passing through our atmosphere. Hence this, too, must be allowed for in aiming the car."

"How long will it take your car to reach the moon?"

"The distance is about 240,000 miles. At seven miles per second the speed would be about 25,000 miles per hour. In other words we should reach the moon in less than 10 hours if this speed were maintained. As however the speed continually decreases, owing to the earth's pull backwards, until the car has reached the neutral position between the earth and the moon and there slowly increases again owing to the increasing attraction of the moon, the calculation of the time required for the trip is rather complicated. I allow for four days, which ought to be more than sufficient. I am running no chances, however, but am taking enough provisions and liquid air to last me for a month."

**THE MOON CAR**

"Doctor," said Silas, "I notice that your car has accommodation for two passengers. May I ask whom you are sending?"

"I don't know. The probabilities are that I shall never get back. But I have a wireless apparatus on board capable of sending radio messages from the moon. I have over a month's supply of air, water, and provisions. Even if I pay for the trip with my life, I hope to be able to send home descriptions of inventions I see there, and that will far out-balance any scientific research work I could accomplish on the earth."

"When do you start?"

"I start on Thursday of next week." "Doctor," cried Silas excitedly. "I am going with you!"

"I thought as much," replied Doctor Hackensaw, shaking the reporter warmly by the hand.

And thus these two men, as much for the interests of science as for the love of adventure, cooled resolved to risk their lives in one of the most novel and exciting enterprises ever undertaken by man."
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