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(Editors: Prof. Rutherford has furnished Science Service at our request an advance copy of his epoch-making address which is reported below. He is the discoverer of the means for the artificial disintegration of the elements.)

SIR ERNEST RUTHERFORD  
TELLS HOW HE BREAKS  
UP THE ATOMS

(By Science Service)

London, Feb. 9 (By Mail)- How one element can be changed over into another was explained this evening to the Chemical Society of London by Prof. Sir Ernest Rutherford of Cavendish Laboratory, Cambridge, who has gone farther than any other man toward realizing the old dream of the alchemists.

We are as far off as ever from the making of gold out of lead, but experiments by Prof. Rutherford have previously shown that it is possible to get hydrogen out of nitrogen.

Prof. Rutherford tonight declared that it is also possible to obtain hydrogen from at least five other elements, boron, fluorine, sodium, aluminum and phosphorous.

These experiments have given us an entirely new idea of the structure of the atom. As Prof. Rutherford says: "Since the development of the atomic theory on an experimental basis by Dalton, the progress of chemistry has been based on the central idea of the permanency and indivisibility of the atoms of the elements. The whole experience of chemistry for nearly a century had shown clearly that it was impossible to break up the atoms of the elements by the application of ordinary chemical and physical processes. This idea has had to be modified to some extent by the rapid growth of our knowledge during the last twenty years of the inner constitution of the atoms. It is now generally accepted that the atoms of the different elements have all the same general type of structure. At the centre of case, we may suppose the nuclei of all atoms to be composed ultimately of hydrogen



the atom is a positively charged nucleus of minute dimensions which is responsible for most of the mass of the atom. This is surrounded by a distribution of electron held in equilibrium by the forces from the nucleus.

"By the action of light and electrical discharges, we can readily remove one or more of the external planetary electrons from the atom, while by the action of X-rays we may even eject one of the more strongly bound electrons of the system. In this way, we can effect in a sense a transformation of the atom but it is merely a temporary one and a new electron is soon captured from the outside and the atom is as before. The general evidence indicates that even if a number of the planetary electrons were removed by suitable agencies the stability of the nucleus would not be disturbed and the atom would in a short time regain its original structure. In order to effect a permanent change in the atom it appears to be necessary to disrupt the nucleus itself. When once a charged unit of the nuclear structure is removed, the nuclear charge is altered permanently and there is no evidence that this process is reversible under ordinary experimental conditions.

"The discovery of the instability of the radioactive elements was the first severe shock to the idea of the permanency of all atoms. This radiating property is, however, confined mainly to the two heaviest elements, uranium and thorium, and their long series of descendents, and is only shown by two other elements, potassium and rubidium, and then only to a minor extent. Apart from these exceptions, the great majority of the atoms appear to be highly stable structures and to remain unaltered under ordinary conditions in this earth for periods of probably thousands of millions of years.

"The property of radioactivity belongs to the nucleus and is shown generally by the emission of a swift particle or helium nucleus and occasionally a swift electron from the nucleus. The number and velocity of emission of these particles appear to be quite uninfluenced by the most powerful physical or chemical agencies and to be an inherent property resulting from the instability of these very complex nuclei.

"These results show clearly that the nuclei of heavy atoms contain both positively charged helium nuclei and negative electrons, and lead to the general view that the complex nuclei of all atoms are built up of hydrogen and helium nuclei and electrons. It is also generally supposed that a helium nucleus itself is a secondary unit composed of four hydrogen nuclei and two electrons. If this be the case, we may suppose the nuclei of all atoms to be composed ultimately of hydrogen



nuclei, or protons as they have been termed, with the addition of negative electrons.

"It is probable that the forces which bind together the components of the nucleus are exceedingly powerful and that consequently a large amount of energy will be required to disrupt its structure. The swift alpha particle from radium and thorium, which is by far the most concentrated source of energy known to us, seems the most likely agent to succeed in an attack on the strongly bound nucleus. The alpha particle is expelled from radium with a velocity of about 10,000 miles per second and thus has a speed 20,000 times greater than that of a swift rifle bullet. Mass for mass, its energy of motion is 400 million times greater than that of the bullet".

In investigating the disintegration of atoms, Prof. Rutherford makes use of the same phenomena that are displayed in the luminous watch dials made of a radioactive element bombarding zinc sulphide. He allows the particles projected from radium to bombard the element and then counts the number of electrons or hydrogen atoms that are knocked out by the flashes they produce when they hit a screen of zinc sulphide.

"If we had charged atoms available of ten times the energy of the alpha particles of radium, we could probably penetrate the nuclear structure of all atoms and occasionally effect their disintegration", says Prof. Rutherford. "The general evidence indicates that the atoms as a whole are such stable structures and the nuclei are held together by such powerful forces that only the most concentrated source of energy like the alpha particle is likely to be effective in an attack on such well protected structures."

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#### MARINE FOE THREATENS ATLANTIC COAST HARBORS

(By Science Service)

New York, Feb. 20.- An insidious marine foe threatens destruction of New York's wharfing and docks. What may be the first portion of a destructive submarine attack upon harbor works along the whole of the Atlantic coast by a species of ship worm apparently new to this locality was discovered last summer in Barnegat Bay, about fifty miles south of New York on the Jersey Coast.

This ship worm, *teredo navalis*, is the one that in 1919 and 1920 caused damage amounting to \$15,000,000 to the wooden piling in the upper portion of San Francisco Bay, and for centuries it has been the pest of the harbors of northwestern Europe.

Scientists and engineers are afraid that the history of the San Francisco



attack will be repeated in New York and other Atlantic Coast ports. Other ship worms, found on both coasts, are well-known and steps are taken to guard against them. Most of them, however, live in waters of the ports which are about the same salinity as the sea and whose waters are not badly contaminated by sewage. But the new worm can live in brackish water and stand large doses of sewage.

It matures much more rapidly, reproduces much more prolifically, works more rapidly, and is altogether much more destructive than many other species. As many as 50,000 to 100,000 females of this species may often be found in a single pile. Each female can produce from 500,000 to 1,000,000 young. These when in a very minute stage may float about for three or four weeks and attach themselves promptly to any unprotected wood. Piles, 20" to 24" in diameter have been utterly riddled in San Francisco Bay within six months.

The greater portion of harbor works of New York have been built on piling that is untreated and vulnerable to attack by the new borers, as reliance has been placed in the contamination by sewage and trade wastes to keep out the borers.

The seriousness of the situation in this and other ports has caused the National Research Council to appoint a committee on marine piling investigations to consider protective measures. The committee consists of: R. T. Betts, Chief Engineer, Robbins-Ripley Company, Chairman; George J. Ray, Chief Engineer, Delaware, Lackawanna and Western Railroad, Vice-Chairman; Albert L. Barrows, Assistant Secretary, National Research Council, Secretary; George M. Hunt, United States Forest Service; C. A. Kofoid, University of California; Hermann von Schrenk, Consulting Engineer, New York Central Railroad. They plan a complete study of the habits and life of the teredo and researches into the protective measures for wood piling, and the suitability of other materials, concrete and metal, for marine construction.

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SPECIAL TELESCOPE  
FOR EINSTEIN'S USE

(By Science Service)

Berlin, Feb. 20.—A tower, containing a large vertical telescope and spectrographs, has been erected in the grounds of the Potsdam Astrophysical Observatory. These instruments will be devoted to investigations to determine the presence or absence of the shift of the spectrum, predicted by the Einstein theory of relativity. Prof. Einstein will be in general control of the work, with Dr. E. Freundlich in charge. Dr. Freundlich, with a party, hopes to observe the total solar eclipse from Christmas Island this September. A further test of the Einstein theory will be possible at this time.

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BROADCASTSRadio News of the WeekPERFECT NEW RECTIFIER  
FOR RADIO USE

(By Science Service)

Washington, Feb. 00.- A new rectifier for radio work, differing in principle from those formerly used, was explained here by Howard Tyzzer at a meeting of radio amateurs.

It has been called the "S" tube because it was invented by C. G. Smith, and it consists of two carbon electrodes in a glass tube containing helium gas of a certain density.

In sending wireless messages with vacuum tubes apparatus it is necessary to have high voltage direct current of low amperage. Most people have only alternating current available from their house lighting circuits and as it is not practicable to obtain voltages of 500 to 2000 combined with small quantities of current from batteries, there must be some way of converting the pulsating, forward and backward current to a steady current flowing in one direction.

An alternating current motor driving a direct current generator is one form of rectifier but this becomes very expensive for high voltages. For low currents, there are electrolyte rectifiers, but these are more or less untrustworthy. The "Kenetron" tube is a vacuum tube with two elements, a tungsten filament and a molybdenum plate, which when heated by the passing current allow the current to flow in only one direction. The heating of the filament consumes energy and also causes the gradual burning out of the tube.

The "S" tube because of the cold electrodes does not consume current in the way that the other tube does. It is claimed that the efficiency of the new tube is high, with only one per cent. of the current flowing in the wrong direction. The current is prevented from flowing backward through the tube by the shape of the electrodes.

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RADIO THREAD WILL GUIDE  
FUTURE SHIPS OF THE AIR

(By Science Service)

New York, Feb. 00.- An electrical thread is about to be used to guide aircraft of all kinds at night and in foggy weather. Experiments recently were made in France applying to aviation the idea of the radio cable, now used to guide ships through narrow waterways.



Vice-Admiral Fournier of the French Navy recently presented before the French Academy of Sciences, the scheme of W. A. Loth for guiding airships by means of a charged cable. Mr. Loth is also the inventor of the radio cable employed in marine work.

Experiments made at the Villacoublay aerodrome, used a discarded power line employed as the radio cable. An alternating current of 600 cycles frequency was sent through the transmission line so as to set up the desired magnetic field. If a number of different routes are to be identified by aircraft, then the various cables along these different routes are supplied with different frequencies which give rise to different notes in the telephone receivers of the aircraft pilots, or various characteristic codes are employed.

On board the aircraft, three simple loops of wire are employed, two of these being placed vertically and one horizontally. In the case of the usual airplane, the loops are placed at the end of the machine and form part of the tail construction.

The two vertical loops, one of which is placed longitudinally and the other right angled to the direction of flight, tell the direction of the cable. When the aircraft is moving directly over the charged cable, the humming of the alternating current is heard loudest in the telephone receivers worn by the pilot. However, the more the aircraft deviates from the path of the cable, the weaker becomes the hum. It practically vanishes when the longitudinal loop is at right angles to the cable. The other vertical loop operates in just the opposite manner; the hum is loudest when the aircraft is at right angles to the cable. By switching from one loop to the other, the aviator can pick up the cable and follow it along by means of sound.

With the horizontal loop, which is used at high altitude to explore for the guiding charged wire, the cable can be detected at 10,000 feet. At about 8,000 feet, the vertical loops become operative, but the distance has to be less than 6,500 feet before the cable can be followed. The safest distance is about 5,000 feet, however, at which range the cable can be followed without difficulty.

Experts declare that this invention is of great importance in the commercializing of aviation. One of the greatest handicaps to regular aviation service has been the difficulty of maintaining schedules and routes in foggy weather and at night. The radio cable will mark the aerial highway for the airplanes and dirigible of tomorrow.

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SCIENCE OF GROWING THINGSAgricultural News of the Week.GRAFT LIVING LIMBS  
TO BRACE TREES

Wooster, Ohio, Feb. 00.- A method of making apple trees grow their own bracing for protection against storms has been developed by the Ohio Agricultural Experiment Station here. Living branches of trees ten years of age or less are intertwined to form a living splice. After a few years the branches actually coalesce and unite and finally a single smooth cylindrical limb having two places of origin is formed.

This method of bracing by intertwining living branches is used for remedying weakness of the tree that has been caused by imperfect pruning when younger, Paul Thayer of the Experiment Station staff explained. Storms often destroy many unbraced apple trees from fifteen to eighteen years old by splitting them down the center of the trunk, beginning at the point where the main limbs branch off.

In the case of old trees whose branches can not be grafted, a system of bracing made up of eye-bolts through the limbs with wire connecting them is recommended.

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TO MAKE MOVIES OF  
INSIDE OF COW'S STOMACH

(By Science Service)

Fargo, N.D., Feb. 00.- Taking movies of a cow's stomach in action may sound like a movie studio fake, but the actual performance is to be attempted soon by experimenters in the veterinary science department of the State Agricultural College here who are making careful scientific investigations of the digestive process in the stomach - of gastronomic mobility if you please.

Injured, diseased cattle, that would ordinarily be disposed of have been used for actual observations of stomach movements, and the action of the stomach on different feeding materials. In this manner important physiological observations which have rarely been studied in a live animal are being made with no apparent discomfort to the animal.

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Sharp Sickle Saves Labor- Tests made at the Wisconsin Experiment Station show that where the cutter bar and knife of a mowing machine are in first class condition the draft is 297 pounds, but that when either the bar or knife are in bad order the draft is increased by one-third.



# LIGHT EMITTED BY MOST COMPLEX SECRET METAL REVEALS COMPOSITION

(By Science Service)

Release, Tuesday, Feb. 21.

New York, Feb. 20. - The discovery of the secret compositions of alloys and hardened metals is not a great problem when the metallurgist uses the spectroscope and the microscope, W. H. Bassett and C. H. Davis of the American Brass Co., Waterbury, Conn., told the American Institute of Mining and Metallurgical Engineers at their meeting here this afternoon.

A mere few hundredths of a gram of a metal will usually be enough for spectrographic analysis, they explained. The light given off from the metal, slightly volatilized by a spark jumping between two electrodes, is broken up by the prism of the spectrograph and spread out into a band of colored light. A photograph of this spectrum consists of a series of vertical lines and the location of these lines tells the metallurgist just what elemental metals are contained in the alloy being investigated.

Even the most minute impurities are instantly detected by this method that is beginning to be used in many industrial laboratories. Traces of boron, magnesium, manganese, silicon, and vanadium, impurities that would complicate metallurgical processes, are easily detected while days of chemical analysis often fail to reveal their presence. Bismuth has been detected spectrographically in zinc and in alloys where the presence of a few thousandths of a per cent. would be harmful. In addition to telling what elements are present, this method of analysis also gives an idea of the relative amounts of each element.

A very accurate spectroscopic method of routine analysis for the gold that is used in making the coins of this country was recently perfected by the Bureau of Standards at Washington for use in the United States Mints. It is not only more accurate than the assay, but an analysis can be made in much less time. The spectroscopic analysis of gold will detect impurities even though <sup>only</sup> one part in a million is present.

WORN MACHINERY MADE  
NEW BY IRON COAT

(By Science Service)

Release, Wednesday afternoon, Feb. 23.

New York, Feb. 23.- When some iron or steel part of machinery becomes badly worn, it will now be possible to restore its usefulness by giving it a coat of iron, applied to it by electricity, David G. Kellogg, research engineer of the



Westinghouse Electric and Manufacturing Company of Pittsburg, described the successful development of commercial electrolytic deposition of iron at the meeting of the American Institute of Mining and Metallurgical Engineers here this morning.

A worn motor shaft repaired with a coat of iron applied by his new method gave as satisfactory service as a new one, Dr. Kellogg said. Cast iron as well as steel can be electroplated, and this is expected to prove useful in repair work of special machine parts. Dr. Kellogg's work is an improvement on the War methods of the British army repair shops which used the electrolytic method in repairing about 6000 steel and iron machine parts. Electrodeposition of iron has been practiced for years but earlier work was undertaken in order to produce pure metallic iron.

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#### ENGLAND HAS SMALLEST AMOUNT OF RAIN IN HUNDRED YEARS.

(By Science Service)

London, Feb. 20.- The past year was the driest that England has experienced for over a hundred years. The shortage of rainfall was felt in other parts of Europe as well as the British Isles.

At Greenwich Observatory, where records are available for more than a hundred years, there is no previous year since 1815 with so small an amount of rain. The total for 1921 was only 12.50 inches, only 51 per cent. of the average for 1816 to 1915, 24.41 inches. Droughty conditions continued in the south and south-east of England at the end of the year.

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#### PAY MORE TO CARPENTERS THAN BRICKLAYERS IN BUILDING BRICK HOUSE

(By Science Service)

Washington, Feb. 20.- Planning to build a cozy six-room brick house? Then count on paying the carpenters who help build it more money than the bricklayers. Nearly one-third of the labor cost in building an average brick house of that size will go to the carpenters, while the bricklayers will receive only 21.5 per cent. of the money spent on labor. These are official figures announced by the Bureau of Housing and Building of the National Bureau of Standards, Department of Commerce, after a nation-wide survey of house-building labor costs. Wages of carpenters consume 49.6 per cent. of the labor cost of a six-room frame house, with second honors to the painters who require one-tenth of the labor cost. Regardless of whether you build of frame or brick you will spend about the same proportion of the total on plasterers, plumbers and electricians, about 19 per cent. for the three combined.

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NEWS OF THE STARSSuper-Giants of the Universe

By Isabel M. Lewis,  
of U. S. Naval Observatory,  
(Science Service)

One of the greatest astronomical achievements of the day has been the measurement of the diameters of the stars, an undertaking that the astronomers themselves would probably have pronounced impossible a few decades ago. Only a little more than a year ago the diameter of the red giant star Betelgeuse in the constellation of Orion was successfully measured by means of the interferometer, devised by Professor Michelson and developed by him at the Mount Wilson Observatory of the Carnegie Institution of Washington, in cooperation with its staff. The largest telescope in the world, the 100-inch Hooker telescope, which was installed on Mount Wilson only a few years ago was used for the experiment.

So successful has been the interferometer method of measuring minute angles, such as the distance between the two members of a very close double star and the diameters of the stars, that greater results are to be expected from it in the future than in the past. Like the spectroscope it opens up new realms for the astronomer to explore.

Work on the measurements of the diameters of the stars has progressed steadily at Mount Wilson. The stars chosen for measurement have been the bright red stars such as Betelgeuse in Orion, Aldebaran, Arcturus, Antares and Beta Pegasi. It is known that these bright red stars are the giants of the universe. Among the deep red stars we find both the pygmies and the giants, but the pygmies are extremely faint while the giants are of noticeable brightness and when comparatively near to the earth are always to be found among the stars of first magnitude.

Though astronomers have known for some time that the bright red stars stand out as giants among the other stars they were startled at their own results when it was found from the measurements on Betelgeuse with the interferometer that the diameter of this star is 218,000,000 miles. Our own sun has a diameter of 864,000 miles, 108 times the diameter of the Earth. This seems a respectable size for a sun but this sun of ours if placed next to Betelgeuse would look like a marble along side of a ten-foot globe.

Yet before we have had time to fully assimilate some facts regarding the red giant in the constellation of Orion we are informed that the fiery red star in the heart of the Scorpion, known astronomically as Alpha Scorpii and popularly as Antares



that many of us have admired in summer, as it twinkled and flashed low in the southern skies, is a true super-giant of the universe and worthy of our admiration. It far surpasses Betelgeuse in size. Its diameter is not less than 280,000,000 miles at a most conservative estimate and may be as great as 430,000,000 miles. The uncertainty of the result is not due to any uncertainty in the angular measure of the diameter which is given to us very exactly by the interferometer but to the uncertainty as to the distance of this star from the earth which has to be known before we can convert the angular diameter into a diameter expressed in miles. When stars are as distant from the earth as Betelgeuse and Antares it is very difficult to obtain accurate measures of their distances.

Antares, which appears to be the greatest in size of all the red giants, was called "Rival of Mars" by the ancients because when Mars is in that portion of its orbit farthest from the earth it closely resembles in color and brightness this super-giant of the universe. How astounded the ancient astronomers would be to know that this bright star that they believed rival of a solar planet is in reality so large that it would more than fill the entire orbit of Mars if placed at the center of our solar system. Our own earth would be lost far beneath its surface.

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#### LIQUID AIR ACTS AS NUT CRACKER

(By Science Service)

Washington, Feb. 20.- Liquid air for cracking nuts is the latest application of science. Experts at the National Bureau of Standards here were appealed to for a method of breaking the shells of the chicha nuts, without damaging the kernels. They found that it took a weight of nearly a ton to crack the nuts, and that after that effort the meat of the nut was broken in many small pieces.

Then they applied liquid air to the problem. They did not freeze solid a piece of rubber and use it as a hammer, as is done in the classic stunt<sup>of</sup> physics classes, but they simply immersed the nuts in liquid air for thirty seconds and cracked them easily, without damage to the kernels. Now the physicists are trying to find out whether this method can be applied commercially on a large scale.

Chica nuts are grown in South America. Their dense strong shells were used during the war to make charcoal for gas masks and the oil from the kernels is a valuable food, similar to copra.

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## TWO PAGES OF TELLERS OR A DAILY FEATURE

## DO YOU KNOW THAT -

Of the 30 different kinds of flash light batteries now made, 22 could be eliminated, without loss to anyone.

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Although hardly known a decade ago, fox farming is a growing industry in this country, with 10,000 to 15,000 silver foxes being raised in captivity.

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The last Cornish tin mine has closed down and an industry which was the oldest in Great Britain, having been carried on by the Phoenicians long before the invasion of the Romans, is now extinct.

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In addition to their use as Christmas decorations mistletoe berries are capable of being used as a source of mucilage. The mucilage which causes them to stick to twigs can be and already has been extracted in a small way by water, and used as an adhesive.

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## DO YOU KNOW THAT -

The largest water-power development in the world is at Niagara Falls, where the plants in operation have a capacity of 870,000 horsepower, of which 385,500 horsepower is on the United States side.

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Paper made from sugar cane refuse and wood pulp is used in sugar and pineapple plantations in some parts of Hawaii to keep the weeds down. In the case of pineapples the paper is laid down and holes cut where the plants are to be set.

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A tortilla-making apparatus has been invented by Sr. Borge of Nicaragua. The machine takes the corn, grinds it to the proper fineness, mixes the dough, shapes the tortilla, and passes it to an oven, where it is rapidly baked.

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The 1922 Gordon-Bennett Balloon race will start from Geneva on August 6.

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## DO YOU KNOW THAT -

A cyclone recently caused great damage to the Portuguese fleet.

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The cost of oil drilling in remote and isolated fields, such as are located in various Latin-American countries may easily amount to ten times the cost of drilling in favorably located fields in this country.

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The gray squirrel is becoming scarce in many parts of Southern California.

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The first known strike is recorded in an ancient Egyptian inscription. The workers on one of the pyramids refused to stay on the job unless their ration of onions was increased. They won their strike.

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## DO YOU KNOW THAT -

Mountain lions can still be found in certain parts of California. Recently eleven were killed by one man in less than two months.

Successful efforts to teach home economics and cookery to men and boys are being made in Syracuse, New York, and at the Kansas State Agricultural College.

The number of suicides in France during the war was not abnormal, thus proving that suicide originates from a mental and mostly hereditary defect rather than from a state of despair.

Airplanes flying low were recently utilized in Texas to search for drowned bodies.

## DO YOU KNOW THAT -

A new airplane engine, weighing 729 pounds, developing 450 h.p., with only three-fourths the number of parts of any other engine of that power has been tested successfully in England.

Rosen rye or its grades now constitutes about 85% of the rye grown in Michigan. It originated from a sample sent from Russia to the Michigan Experiment Station by J. A. Rosen in 1909.

A recent typhoid outbreak in New Jersey was traced to a Harvest Home supper where chicken salad infected by a typhoid carrier was served. Often a human being, apparently in health, may be carrying typhoid germs unknowingly.

Recent very accurately made measurements show that tree trunks are a little larger in the early morning than in the evening.

## DO YOU KNOW THAT -

An instrument called the "foot-candle meter" is used to measure the illumination of desks, machines and other places where the human eye must work.

Thrips on roses may be controlled by spraying with tobacco extracts.

At least thirty-one different chemical elements have been found in the ash of plants.

Splendid forests of hardwoods, ginkos and conifers, and great swamps in ancient times covered what are now the treeless plains of North Dakota.