SCIENCE NEWS

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THE COOLIDGE CATHODE RAY TUBE

CRYSTALS glowing with "cold light," layers of wax permanently electrified, and acetylene gas made solid—these were some of the wonders exhibited on the evening of October 20 at the Franklin Institute, in Philadelphia, when Dr. W. D. Coolidge, assistant director of the General Electric Company's Research Laboratory at Schenectady, N. Y., gave the first public demonstration of his new cathode ray tube. At the same time the institute presented Dr. Coolidge with its Howard N. Potts gold medal, given for "distinguished work in science or the arts," for his invention of a type of X-ray tube that has now come into nearly universal use.

In his new cathode ray tube, Dr. Coolidge follows out a line of research commenced nearly fifty years ago by an English scientist, the late Sir William Crookes, who first investigated the cathode rays. These rays are obtained when a high voltage electric current is passed through a glass tube from which the air has been exhausted and into which has been sealed two metallic electrodes, usually of aluminum. They consist of a stream of minute charges of electricity, or electrons, moving with a speed of thousands of miles per second.

Though about thirty years ago a German physicist, P. E. A. Lenard, succeeded in getting the rays outside the tube in small quantities through a thin aluminum window, the new tube, designed by Dr. Coolidge, is the first with which they have been obtained with great intensity outside the generating tube. It uses a window of nickel, five ten-thousandths of an inch thick and three inches in diameter, supported in back by a grid of molybdenum, a very strong metal, to enable it to withstand the air pressure. This window is completely airtight, and is attached to the glass by an all metal joint, so the tube is now for the first time capable of being sealed off from the air pump.

The new tube is about 30 inches long, and in the center is a round glass bulb about eight inches in diameter. From this bulb projects the cylindrical tube at the end of which is the nickel window.

In the center of the bulb is a small electric light filament, which, when lighted with a low voltage, gives off electrons like the filament of a radio vacuum tube.

Then, when a high voltage (Dr. Coolidge uses about 350,000 volts) is applied, these electrons are converted into cathode rays and driven to the end of the tube and through the nickel window with a speed of as much as 150,000 miles a second. Because the electrons are so much smaller than the atoms of which the window is made they can dodge between them and out into the open air, but the atoms of air are too large to squeeze through and into the tube.

When the tube is operated, the air in front of it becomes luminous with a beautiful purple glow, extending for as much as two feet in front of the window, and partly in back of it, because of the scattering of the rays by the air. Various crystals glow when placed in the path of the rays, and Dr. Coolidge showed the effect on a crystal of calcite, a very pure form of marble, which shone with an orange light. Even after the current was turned off, the crystal continued to glow, as if red-hot, but that it was cold was demonstrated by passing it around.

Dr. Coolidge also demonstrated changes produced by the rays in various chemicals; potassium chloride, for instance, which is ordinarily white, turned purple, while the water clear crystals of cane sugar turned white. Castor oil becomes a solid under their influence, and he exhibited a yellowish powder obtained by exposing acetylene gas to the rays. This powder is unique, he stated, because no chemical has been found that will dissolve it. Just as a fountain pen becomes electrically charged when rubbed on a cloth, a disc of wax becomes charged when exposed to the rays, but unlike the fountain pen, the charge on the wax is permanent.

On living organisms the rays have an effect similar to that of radium, for the so-called beta rays, one of the principal radiations of radium, are, like the cathode rays, rapidly moving electrons. Dr. Coolidge estimates that the tube gives off as many electrons as a ton of radium, which, at present prices, and if it could be obtained, it would be worth a hundred billion dollars.

The audience was shown photographs of the effect of the rays on rabbits. When a rabbit's ear was rayed over an area about the size of a dime for a tenth of a second, with a relatively small current, the skin became pigmented, as if sunburned, a few days later, and the hair dropped out, and not until seven weeks later did new hair appear. But when the ear was rayed with a more powerful current for a second, a scab formed, which dropped out, taking the hair with it. Two weeks later a profuse growth of snow white hair started and soon became longer than the original gray colored hair. When a third area was rayed for nearly a minute, a scab also formed, but when it dropped out, it left a hole, the edges of which became covered with the white hairs.

The rays kill insects and germs almost instantly, but the range of the tube is fortunately limited. With the highest voltages that he has used so far, the rays do not extend more than two or three feet from the window, and with the highest attainable this could not be increased to more than a few yards, which prevents the tube being used as a weapon of warfare.

THE NAVAL RADIO STATION AT SAN DIEGO

A VACUUM tube transmitter eighty times as powerful as the ordinary transmitter in a broadcasting station has just been installed in the Chollas Heights naval

radio station at San Diego. This sending vacuum tube radiates 80,000 watts of electricity and is said by naval officials to be the most powerful tube transmitter in the world. It is four times as powerful as any other United States naval sending station.

This broadcasting device was not designed for telephone use, but will be employed for radio-telegraph communication, using dots, dashes and spaces, at a rate of 100 words a minute.

Chollas Heights is a remote control station, used by the navy for sending purposes only. The messages leave antennae strung on three masts which, 600 feet in height, form a triangle 1,100 feet on each side. The "cross arms," or platforms at the top of the masts, are 60 feet long and contain a bridge on which electricians may work. The actual sending is done from the Pt. Loma naval radio station, 11 miles distant across San Diego and the bay by air line. The Pt. Loma key works the Chollas Heights sender, while receiving is handled at Pt. Loma.

Six transmitters are employed in the station. The 80,000-watt tubes replace 200,000-watt arc transmitters. Under the new arrangement the station will be able to communicate with American ships in any part of the world during the night, when the station has a sending range of 12,500 miles; during the day it can span the continent to eastern points to a total of about 3,000 miles.

The set is operated from an alternating current commercial power supply, by means of six 50kw rectifier tubes which can deliver up to 150kw at 15,000 volts. Included is a 20,000-volt master oscillator which excites eight 20,000-volt amplifiers. The approximate antenna current is 300 amperes.

The significance of this station is found in the declaration of radio officials connected with its construction and operation that, if it proves completely successful, as they predict it will, tube transmitters will replace all large arc transmitters such as are employed by the navy at Washington, D. C., Honolulu and Cavite.

The Chollas Heights set is one of three built recently by an American company. A second was constructed for the Japanese government, like this in essential details though differing in some minor points. A third was built for use in South America, but it is reported lack of funds has caused it to be stored at New York, where it had been sent for shipment.

The 20,000-watt tube used at Chollas Heights is the largest vacuum tube yet constructed for commercial use. It is so large and becomes so hot under ordinary conditions that the copper plate used is water cooled. Twenty-two volts of electricity are required to light the filaments in these tubes. The plates take from 7,500 to 15,000 volts.

The new transmitter cost $80,000. Chollas Heights station was originally constructed in 1914 on contract at a cost of about $350,000. At that time there was considerable discussion concerning the location of the station, some maintaining that it should be at Riverside, 75 miles further north from the Mexican border. It is now on a hill ten miles from the center of San Diego, with a view of both mountains and Pacific Ocean. The heavy towers are capable of withstanding a horizontal safe pull of 20,000 pounds.

Amateur broadcasting fans suffer no interference from the station, according to navy officers, even when in the immediate vicinity of the station. Among other interesting facts, 50 gallons of water are required every minute to keep the tubes cool. The plate transformer weighs four and one half tons, and the total weight of the set when packed is 58,500 pounds.

THE CRYSTALLINE STRUCTURE OF RUBBER

THE question whether raw rubber, apparently the most formless of substances, really has a crystalline structure appears to have been recently settled by actually seeing the crystal pattern produced on a luminous screen, according to Professor George L. Clark, of the Massachusetts Institute of Technology. Dr. Clark, in a report to the American Chemical Society, gives the credit for this achievement to Dr. Ernst Hauser, of the Metallbank of Frankfurt, Germany.

"Dr. Hauser and an assistant imprisoned themselves in total darkness for five hours," said Dr. Clark, "in order to make their eyes sensitive enough to see the faint pattern of spots produced on a glowing screen of calcium tungstate by X-rays which had passed through a sample of the rubber."

The effect, which is not the same as the familiar use of X-rays to reveal the bones of the body, flaws in metal, etc., was described by Dr. Clark as follows: "When a beam of X-rays passes through any material composed of crystals, such as salt or ice, a definite pattern is produced, and the design of the pattern depends on the arrangement of the atoms in the crystal. Noncrystalline substances, like glass, give no such patterns. Many materials and even rubber have been studied in this way, and their patterns are more or less well known, but practically only from photographs. In the case of rubber it was especially important to see the pattern directly with the eye, in order to be sure that the crystal structure was not changed, or even, possibly, produced in the rubber by the action of the X-rays.

"Dr. Hauser and his helper not only subjected their own eyes to a long and tedious sensitizing process, but they used an X-ray tube of extraordinary power, which consumed 130 milliamperes of current at a potential of seventy thousand volts."

"When they turned on the X-rays after their long imprisonment," said Dr. Clark, "the hitherto unseen pattern flashed out instantly, faint but clear, against the pale greenish glow of the screen."

THE STRENGTH OF CONCRETE

WATERPROOFING concrete with water is the possibility pointed out by Cloyd M. Chapman, chairman of committee on concrete of American Society for Testing Materials. "By regulating the amount of water a more watertight concrete may be made than if too much

or too little water is used,'' Mr. Chapman explained. ''The same is true of durability and wearing qualities. Any owner, engineer, architect, or contractor who neglects this factor is not getting the most for his money in concrete.''

It is the common notion that the strength of concrete is entirely dependent upon the amount of cement in it, that to make stronger concrete more cement must be added. This is not true. The cheapest ingredient in concrete is the one that really controls its strength. A sloppy concrete mixture will make about half as strong a concrete after it sets and hardens as will exactly the same concrete mixture with one fourth less water. An extra gallon of water added to a one-bag-batch of concrete is about equivalent to taking out of the mixture fifteen pounds of cement and throwing it away, so far as the strength of the concrete is concerned.

A one-two-four mix is commonly considered ''good concrete.'' So it may be if the materials are all of good quality and about six gallons of water are used for each bag of cement. The resulting concrete, if properly handled, will have a crushing strength of about 3,000 lbs. at the age of a month, and probably 4,000 lbs. or more in a year. But for every pint of water used in excess of the six gallons the strength at the end of a month will be reduced about 100 lbs. If eight gallons of water are used, instead of the six, the strength would be only about 1,500 lbs. per square inch. To repair the damage done by those two extra gallons of water it would be necessary to add about one third more cement. With cement selling at more than $2.00 a barrel, it becomes rather expensive to neglect to take those facts into account.

SUN SPOTS

AN unusual number of sun spot groups, four of which can be seen by the naked eye when properly protected, are now being observed by Dr. Frederick Slocum, director of the Van Vleck Observatory of Wesleyan University. In fact, Prof. Slocum says that it is the finest display in many months.

''Early in October a period of marked activity began on the sun,'' said Professor Slocum in a recent statement to ''Science Service.'' By October 13 there were eight distinct groups of sun spots, the finest display since last December. Four of the spots can be seen with the unaided eye, with the aid of a piece of smoked glass or a piece of exposed photographic film.

''The largest single spot is forty-five thousand miles in diameter, and the largest group of spots is one hundred and fifty thousand miles long. Five of the groups are in the northern hemisphere of the sun, forming a chain which extends completely across the solar disc. Three of these groups are nearly the same distance from the sun's equator, or from sixteen to seventeen degrees north in solar latitude.

''Two other groups have recently swung into view around the eastern edge of the sun, and are in latitude twenty-four and twenty-five degrees north. There are also two groups of spots in the sun's southern hemisphere, at latitude eight and nine degrees, but these are small and inconspicuous.

''A very marked feature of the sun is the contrast in number of spots between the northern and southern hemispheres, but this is not uncommon. According to early records, not a single spot was observed on the sun's northern hemisphere from the year 1672 until 1704.

''Since the sun rotates on its axis once in about twenty-seven days, all the spots now visible will have passed out of sight around the western edge of the sun by October 26, perhaps to reappear again at the eastern edge in November.''

ITEMS

THE birth rate among British teachers averages only 95 children for each 1,000, according to public health statistics for 1925 just published. The medical profession is only a little better off, producing 103 babies for every 1,000 physicians, while the rate for ministers of 105 per 1,000 contrasts unfavorably with that of 231 births for every 1,000 laborers. The birth rate per marriage among upper working classes has dropped from four to two and a half children within a generation while that of casual laborers and feeble-minded is seven. Grave concern is expressed on the part of medical authorities over present economic conditions that cause the educated classes to limit their families or to forego raising children altogether, though the birth rate among the least desirable sections of the population continues at normal rates.

The wearing qualities of silk are greatly lessened by exposure to sunlight, it has been learned from tests recently completed at the U. S. Bureau of Standards. The strength of unweighted dyed silk decreased 25 per cent. when exposed to sunlight for 100 hours. Silk of cheaper grade that had been weighted with metal to give it a rich shimmering appearance lost as much as from 50 to 75 per cent. in general tensil strength. The silk garment that hangs in the closet or reclines in a bureau drawer is safe, apparently, for the tests showed that silk kept in storage for two and a half months gave no signs of deterioration. No harmful results were found, either, from the action of dry cleaning solvents on different silk fabrics.

BOYS are more immune to scarlet fever than girls and country children are more susceptible than city children is the indication shown in a recent series of tests by the United States Public Health Service. The Dick tests to ascertain scarlet fever susceptibility applied by Public Health Service officials showed that in general children from the same family have the same degree of susceptibility or immunity. As a rule the younger children gave more positive tests than older ones, though this was not always true. The different reactions from the toxins produced by germs of scarlatinal origin suggest, according to Dr. R. E. Dyer, assistant surgeon-general of the Public Health Service, that the different strains of scarlet fever streptococci may produce quite different toxins.