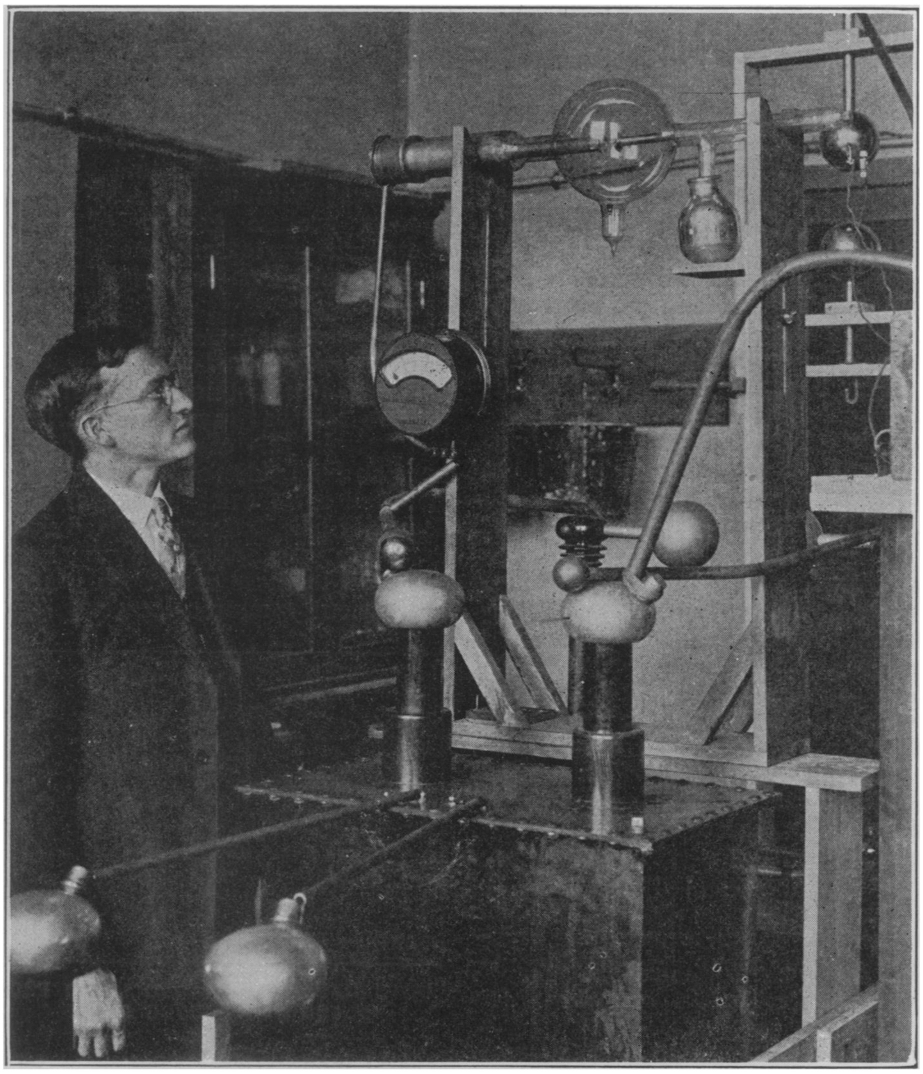
PHYSICS

Crystals Glow with "Cold Light" under Cathode Rays



H. F. TAIRIS
Dr. Coolidge's assistant, with the new cathode ray tube and the apparatus for producing the current to run it.

By JAMES STOKLEY

The days of "witchcraft" are over, and men are no longer imprisoned or executed for intercourse with the Devil—a fortunate fact for many modern scientists, for commonplace experiments in the chemical laboratory or the physics lecture room today would have cost their performers their heads not more than a few centuries ago. And some of the things now being performed in the modern research laboratory would have amazed even Roger Bacon and the pioneer scientists themselves.

The scene that has been enacted a number of times in a small room in the Laboratory of the General Electric Company at Schenectady, N. Y., in recent months is one of these. Last Wednesday evening it was repeated before a distinguished group of scientists at the Franklin Institute, in Philadelphia.

The room is darkened and the dim figure of the scientist is seen at a switchboard. Suddenly a light shines from a tube in the center of the room, but this is not the most conspicuous light, for in front of the tube is a crystal of calcite, a very pure form of marble, which shines with a red glow. Around the crystal is a solid ball of purple light, and the pungent odor of ozone permeates the room.

Again the scientist is seen to move a switch. The light in the tube ceases, as does the purple glow, but the crystal remains apparently red hot. Evidently the scientist does not mind being burned, however, for he calmly picks up the glowing crystal and passes it around. To the amazement of the spectators, it is cold, and looking at it closely, bluish white sparks are seen to come from spots on its surface, and then they cease, leaving a dark spot where the scintillations occurred. But the crystal continues to glow with this cold light for several hours.

The tube that does this is the latest invention of Dr. W. D. Coolidge, assistant director of the General Electric Company's Research Laboratory, but it is not his first great discovery. Mazda lamps, with their filaments of tungsten, have almost completely replaced the old carbon lamps that were used in the first days of electric lighting, and Dr. Coolidge is largely responsible for this. When tungsten was first used in electric lamps, the filaments were extremely brittle, and the slightest jar immediately put them out of commission, but Dr. Coolidge discovered a way to make strong, ductile filaments of tungsten. And so the tungsten lamp, which gives us many times as much light for our money as did the carbon lamps, came into its own.

Again, thousands of soldiers in the war who had their pain alleviated by the skilful use of X-rays, and thousands more in peace time who are indebted to the X-ray photograph for locating an abscessed tooth or a broken bone owe Dr. Coolidge a debt of gratitude. Roentgen discovered the X-rays in 1895, but for many years the best X-ray tubes were erratic in their behavior, until the invention of the Coolidge X-ray tube. This invention won for Dr. Coolidge the Howard N. Potts medal of the Franklin Institute, of Philadelphia, and it was upon the occasion of the award of this medal last Wednesday evening that he gave the first public demonstration of his new tube.

When a high voltage electrical discharge is passed through a glass tube into which a metallic terminal has been sealed at each end, and from which the air has been almost completely exhausted, a rapidly moving stream of minute electrical particles or electrons results. These streams of electrons are called cathode rays, and when they hit a piece of some dense metal, such as platinum, another kind of ray is given off. This secondary radiation forms the X-rays.

The electrons are parts of the atoms of which all matter is made, and in the ordinary cathode ray tube they are knocked out of the atoms comprising the aluminum cathode by

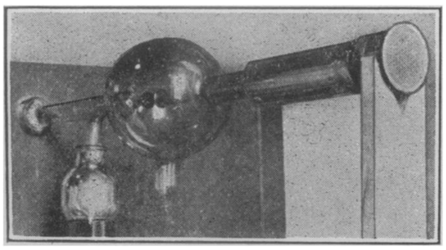
(*Just turn the page*)

Cathode Rays

(Continued)

positive ions coming from the small amount of air that remains within, for the vacuum, while high, is not perfect. But there is another way of getting electrons. The glowing filament in an electric lamp gives them off in abundance and Dr. Coolidge utilized this fact in his X-ray tube.

Instead of using an ordinary piece of metal for the cathode, one of the terminals inside the tube, the Coolidge X-ray tube makes use of a tiny electric light filament. So complete is the vacuum in the tube that with the highest voltages no current would pass through it when this little filament is cold. But when it is heated by a low voltage current, no more than that used in an automobile headlight, electrons are given off, and when a high voltage is applied, these electrons are driven against the heavy metal target, and



CATHODE RAY TUBE FROM THE FRONT

we have a steady and reliable source of X-rays.

This same hot cathode, the tiny electric light filament, is used in the new cathode ray tube. Many years ago the English scientist, Sir William Crookes, found that strange effects were observed when different substances were sealed within a cathode ray tube. Then a German physicist by the name of Lenard succeeded in getting the rays outside the tube by gluing a tiny piece of thin aluminum over a hole in one end. However, he used the old type cathode, and his aluminum window had to be small or else the pressure of the air would break it. If he made the aluminum thick enough to withstand the pressure over a larger window, it was too thick to let the rays through. The resulting radiation was very feeble.

Where Lenard was confined to a window an eighth of an inch in diameter, the new tube uses one three inches in diameter. It also uses more powerful electric discharges, for while Lenard put something like 30,000 volts into his tube, Dr. Coolidge puts 350,000. The tube of Lenard required for its operation that it should be connected to a high vacuum pump system, while the new tube can be sealed off from the pump and used in any position. Instead of aluminum, Dr. Coolidge makes use of a nickel window, five ten-thousandths of an inch thick and supported in back by a grid of molybdenum, to help it withstand the air pressure. Through this window come quantities of cathode rays far in excess of any that Crookes obtained inside his vacuum tube. 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.

It is these rays that produce such wonderful effects as that described in the first paragraphs. But the effect on calcite is not the only remarkable one. Curious chemical effects are produced. For example, when the gas acetylene is exposed to the rays, it turns into a yellowish brown powder, which is unique because no chemical has been found to dissolve it. Castor oil is no longer a liquid when the cathode rays are played upon it, but it too turns to a solid; water-clear crystals of cane sugar turn white, while white crystals of potassium chloride become purple.

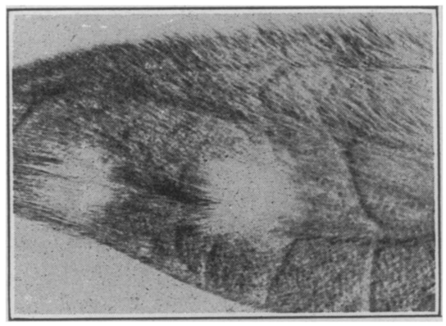
However, it is the effect of the rays on living tissue that arouses the most interest, and here may lie the future importance of the tube, for the cathode rays which it gives off are of precisely the nature, but of lower average velocity, than one of the most important rays of radium, the so-called beta rays, and Dr. Coolidge estimates that the new tube furnishes as many of these rays as a ton of radium. At the present price of radium, such an enormous amount would cost a hundred billion dollars ($100,000,000,000) but there is less than a pound of radium in existence in the world.

Small insects are killed with an exposure to the rays of a fraction of a second, while bacteria are killed almost instantly.

When the leaf of a rubber plant was exposed to the rays for a few seconds the rayed portion became covered with a white milky substance, as though the cell walls had been broken, but even more remarkable were the effects on the skin of a rabbit. First, his ear was rayed for a tenth of a second over an area about a half inch in diameter, and after a few days the skin became darker and the hair came out, and not until seven weeks later did the hair return.

Then a similar area was exposed to the rays for a second. This made a scab, and when it came off, the hair went with it, but two weeks later a profuse growth of snow white hair started and soon became much longer than the original gray hair.

But the cathode ray tube is hardly to be recommended as a cure for baldness for a third area of the rabbit's ear was rayed for nearly a minute. In this case a scab developed on both sides of the ear, which later fell out, leaving a hole, at first devoid of hair, but now fringed with the white hair. Apparently the rabbits used in these experiments were not seriously injured, however, for



WHITE HAIR ON A RABBIT'S EAR PRODUCED BY CATHODE RAYS

several months later they were still frisky, and there were more of them than when they had first arrived!

But though the rays from the new tube have such a powerful effect, with the highest voltage that has been used so far, the range of the rays is only two or three feet from the front of the tube, and with the highest possible voltages obtainable, this could probably not be increased to more than a few yards, a fortunate limitation, for it makes the apparatus unavailable as a weapon of offense in warfare.

But in the warfare of health against disease, and of scientific knowledge against ignorance, a powerful weapon has been provided, and one so new that even its inventor hesitates to predict its possibilities.

Science News-Letter, October 23, 1926

Temperatures 800 degrees higher than the heat of bubbling volcanoes are registered in cement kilns.

Science News-Letter, October 23, 1926