at the bottom, and is fastened to a swiveled wire support so that it can be whirled rapidly. The motion causes the coating to be evenly distributed by centrifugal action and at the same time plate is dried. The half-tone printing frame does not differ materially from the ordinary photographic printing frame, except that it is much more strongly built and is heavier. In the front of the printing frame there is a sheet of plate glass about an inch thick. The negative is placed in the printing frame next to the front glass with the face of the negative in contact with the sensitized copper plate. The back of the printing frame is then secured and by means of a number of hand screws great pressure is applied so as to hold the copper plate in the closest possible contact with the negative. Either daylight or electric light can be used for printing. One of our engravings shows the latter method, the required exposure with electric light taking more time than with daylight. When the plate is taken out it is placed under a jet of running water, by which means the image is developed. Following development the copper plate is gripp d with a pair of pliers and held over a gas stove, as indicated by one of our illustrations, for the purpose of "burning in" the image, after which process the plate is placed in an etching bath of chloride of iron, wherein it receives the first etch. What are termed flat proofs of the plate are then made on a "Washington" hand proving press, and if the flat proof indicates the presence of those qualities in the plate that have been sought, the plate then passes to the "router."

In the case of a vignetted subject, where the tint is allowed to die away around the edges, the plate is clamped in what is called a "routing" machine which is designed to give a speed of three or four thousand revolutions per minute to a small cutter whose section is varied according to the part of the work it is intended to perform. The routing machine, like all the other machinery of this establishment, is run by an independent electric motor. The router follows around the edges of the tint, cutting away all superfluous metal. Except in the case of silhouettes, there is little routing in subjects which are not vignetted, but in some cases the sky or background of a picture which is defective is removed by the router. In the case of what are known as "square" plates, a bevel groove is run all around the plate at a short distance from the printing edge to allow for securing it to the wooden block on which it is to be mounted, and also to permit of the excess metal being readily cut off.

If an examination be made of most half-tone plates, it will be found that there is a black line bounding them with a white line just inside the black one. Both lines, together with the grooving, are made on the plate by a beveling machine, which is something like a planer and a milling machine combined. The plate is securely clamped to a movable bed, which is moved by hand, planer fashion, so as to bring the plate under a steel graver, which cuts the black line and the white line in the plate. The current is then turned on to the motor, causing a circular beveling cutter to rotate at a high rate of speed. The bed carrying the copper plate is then run under the cutter, which "mills" a groove. This is done with all four sides of the half-tone.

The plate is now ready for the "finishers," upon whose artistic judgment much of the success of the plate depends. The finishers "stop out" or paint out with asphaltum varnish those parts of the engraving which are not to be re-etched. In the accompanying illustration of the finishing operation, the workman on the right is engaged in painting out the locomotive, to the smallest detail, so that the background may be lightened by re-etching. The finishers take out all imperfections in the plate, improving it as compared with the original copy by means of roulettes, burnishers, and wood engravers' tools. The extreme high lights are often put in with the engravers' tools, a sample of which work will be seen in the cut of the grooving and scoring (technically styled "beveling") machine, in which the high lights are emphasized by white lines. The high lights of the picture having been re-etched, and the shadows burnished where necessary, in order to secure brilliancy without a sacrifice of the delicate middle tones, a proof of the plate thus "finished" is inspected and passed upon, the full quota of proofs are "pulled," and then the plate is ready for mounting or "blocking." Holes are drilled for the nails that are to secure the plate to the wooden block, which is cut to the proper size, the excess metal being cut away before blocking. Nothing but the best seasoned maple, specially prepared, is used for blocking. Such, in brief, are the many and complicated steps necessary to make a satisfactory half-tone plate. It needs not only a considerable plant, but also expert and conscientious work at every step of the process. We are indebted to The American Machinist Press, whose photo-engraving plant we illustrate, for courtesies in the preparation of this article.

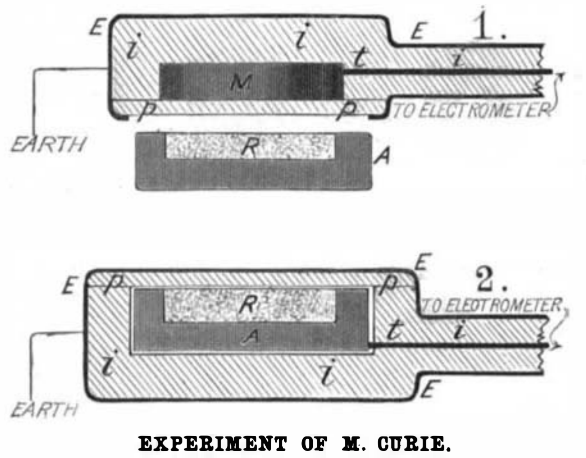
SILCHESTER, Hants, England, still continues to yield valuable specimens from the old Roman city, and an exhibition of some of them was recently held at Burlington House, London.

EXPERIMENTS ON THE CATHODE RAYS.

M. Curie, in continuing his researches upon the waves given off by radium, has brought to light a remarkable phenomenon in connection with this form of radiation, namely, that these waves are possessed of an electric charge. They thus show a close relation to the cathode rays. It will be remembered that M. Becquerel has shown that the rays given off by radium may be deflected by the magnetic field, like the cathode rays, and that M. Curie, in a former series of experiments, showed that two kinds of rays were given off by that body, only one of which is thus deflected, the other remaining unchanged. It is the former series of waves that are to be considered in the present experiments.

The cathode rays, as M. Perrin has shown, are charged negatively, and this charge may be carried through a metallic envelop which is connected to earth, as well as through an insulating screen. It is found that in those cases where the cathode rays are absorbed, there is a continuous disengagement of negative electricity. M. Curie has now shown that the same phenomenon takes place in the case of the rays given off by radium; like the cathode rays, they are charged negatively. As this charge is much weaker than that of the cathode rays, special precautions must be taken in making the experiments, in order to reveal the presence of the charge by the electrometer. The action of the air was found in some preliminary experiments to have an objectionable influence, and it was found, in fact, that it was impossible to observe the phenomenon unless the air is excluded, to a certain extent, from the path of the rays. The radio-active matter must be placed, therefore, in a vacuum tube, or surrounded completely by insulating material. The latter method is the most convenient to carry out, and the experiments were made in the following manner:

A metal disk, *M*, Fig. 1, is connected by a rod, *t*, to a sensitive electrometer, the disk and rod being completely surrounded by insulating material, *i*, *i*, *i*, and the whole covered with a metallic envelop, *E*, *E*, *E*, connected to earth. Opposite one of the faces of the



EXPERIMENT OF M. CURIE.

disk the thickness of the insulation is made very small, as well as that of the metallic envelop, and it is this face which is exposed to the action of the radio-active matter, *R*, contained in the lead vessel, *A*. The rays given off by the radium pass through the metallic envelop and the thickness of insulation, *p*, *p*, and are absorbed by the disk, *M*. The disk then becomes the seat of a continuous disengagement of negative electricity, as is seen by the action of the electrometer and a delicate current-measuring instrument. The current thus produced is very small; with the radio-active matter having a surface of 2·5 square centimeters and a thickness of 0·2 centimeters, a current was observed having for its order of magnitude 10^{-11} amperes, the rays having passed through 0·01 millimeter thickness of aluminium and 0·3 of ebonite before being absorbed by the disk. For the disk different metals were used, such as lead, copper, zinc, etc., and for the insulating material, ebonite and paraffine; the results were about the same in all these different cases. The current is naturally diminished when the source of the rays is further removed, or when less active matter is used.

A second experiment was made in which the lead vessel was placed in the center of an insulating mass and in connection with the electrometer, as shown in Fig. 2, the whole being enveloped by the metal covering, connected to earth as before. In this case, it is observed that the radium takes a positive charge, equal in value to the negative charge of the first experiment. This is due to the fact that the rays pass through the insulation and the metal covering, carrying off a negative charge and leaving the interior conductor with a positive charge. It will be observed that the second form of radiation given off by the source does not enter into action in these experiments, these rays having been already absorbed by the metallic covering, as they have but little penetrating power.

The experiments thus show that the rays given off by radium carry an electric charge, in the same manner as the cathode rays, though in less degree. Up to the present the existence of an electric charge which is not connected with ponderable matter has not been admitted, and, therefore, it must follow that the radio-active matter is the seat of a continuous emission of particles which are negatively electrified, and which will pass through a conducting or dielectric screen without discharging.

The World's Great Fires.

U. C. Crosby, late President of the National Fire Protection Association, has compiled a very interesting list of the world's great fires. In describing some of the most important disasters he says:

"London was nearly destroyed by fire in 798; again in 982, 1212, and 1666. The latter fire is known in history as the Great Fire; it burned over a territory of 436 acres, including 400 streets; 13,200 buildings and property-values upward of $53,000,000 were destroyed. Edinburgh was nearly destroyed by fire in 1700. Lisbon was burned in 1707. Venice was destroyed by fire in 1106 and again in 1577. Berlin was destroyed in 1405. Berne in 1634 and again in 1680. Hamburg was nearly destroyed by fire in 1842; 4,219 buildings were burned, and 100 people lost their lives; property value destroyed, $35,000,000. Copenhagen was burned in 1728; 1,650 houses destroyed; again in 1795, and 1,563 houses burned. Stockholm in 1751, with 1,000 houses destroyed. Moscow in 1752, visited by a large fire; 18,000 houses destroyed. Again in 1812; this time the fire set by Russians in order to prevent the French occupation of the city; 38,000 houses were destroyed, and over $150,000,000 of value.

"Constantinople has been the scene of numerous and costly fires; in 1729 a great fire destroyed 12,000 buildings and nearly 6,000 people. In 1745 another great fire lasted five days; again in January, 1750, 10,000 buildings destroyed. In April, the same year, another fire, with $15,000,000 of property destroyed. Again, later in the year, a fire destroyed 10,000 houses; in 1756, 15,000 houses were destroyed and 100 lives lost. In 1782, 10,000 houses were burned; in 1791, between March and July, serious fires destroyed 32,000 houses, and nearly the same number were destroyed again in 1798. In 1816, 12,000 houses and 3,000 shops were destroyed. In 1870 Pera, a suburb of Constantinople, was nearly destroyed, 7,000 buildings and over $25,000,000 property value being consumed.

"Smyrna had great fires in 1763, 1792, and 1841, destroying from 2,000 to 12,000 buildings at each fire. Great fires have occurred in India, China, and Japan; in many cases large cities were entirely destroyed. In Quebec, in 1845, 1,650 buildings were destroyed, and the same number in May and June following; and in 1866, 2,500 buildings and 17 churches were destroyed.

"St. John, N. B., 1837; nearly all the business portion was destroyed. In 1877 the 'great fire'; over 200 acres burned, and 10 miles of street; about $13,000,000 of property-value. St. John's, Newfoundland, in 1846 was nearly destroyed and $50,000,000 of property-value burned; again a big fire in 1896. Montreal in 1850 had a great fire; 250 buildings destroyed; in 1852 about 1,200 buildings were destroyed. Various cities in South America and West Indies have been destroyed by fire; in some cases property-values of $30,000,000 and upward were destroyed; a large loss of life resulted also.

"The United States has a record of destruction of property by fire not equalled by any other country. Charlestown, Mass., in 1796, $300,000; in 1838, 1,158 buildings. Savannah, Ga., in 1820, 463 buildings and $3,000,000 value. New York, in 1835, 530 buildings, 52 acres burned over, and 15,000,000 of property destroyed; in 1845, 300 acres burned over, $7,500,000 value, 35 lives lost. Pittsburg, Pa., in 1845, 100 buildings; $1,000,000 property value. St. Louis, Mo., in 1849, 15 buildings; $3,000,000 value; in 1851, 2,500 buildings destroyed. Philadelphia, Pa., in 1850, 400 buildings. San Francisco, in 1851, 2,500 buildings, and a number of lives lost; property value, $10,000,000. Portland, Me., in 1866, over one-half the city; 200 acres burned over, and 1,743 buildings destroyed. Chicago in 1871, known as the 'Great Fire'; 2,124 acres nearly covered by buildings entirely burned over, including 17,430 buildings; many lives were lost, and property value of upward of $106,000,000 was destroyed. Boston, Mass., in 1872; 65 acres of the mercantile section burned, including 776 buildings; nearly all of brick-and-stone construction; property value, $75,000,000."

THE French Naval Department has been conducting further experiments with its submarine vessels. At Toulon the "Gustav Zédé" left the harbor submerged, and continued her journey under water, until the middle of the roadstead was reached. This was considered by the officials conducting the experiments to be a phenomenal performance. The "Morse" and and the "Narval" went through their trials at Cherbourg. According to the opinions of the officers surveying the experiments, the "Morse" is considered the more satisfactory, since it plunges with more ease, and travels with more freedom than the other vessel, which occupies at least twenty minutes in sinking. This is considered too great a length of time. Two other types of submarine vessels are approaching completion at Cherbourg. They are La Française and L'Algérien. They will undergo their official trials at an early date.