course, contain a good deal of lead, sulphur, etc., and if selenium is present are generally red. They should be digested with the cyanide solution at a temperature below boiling, until the residue has lost its red color. If no red substance separates on adding an excess of hydrochloric acid, it may be assumed that selenium is absent, or present in too small quantities to pay for working it. If a deposit forms it may be tested as below described.

Another method of making selenium consists in dissolving the slime or sediment in caustic potash, and then exposing the solution to the air at a temperature of 44° Fahr. Hyposulphite of potash is formed, and selenium separates. Mansfeld soot is levigated, washed with water acidified with hydrochloric acid, then with pure water, dried, and fused with crude carbonate of soda, or potash. The selenates are extracted with water, and exposed to the air as before. The fusion, even on a very small scale, *must not be performed in a platinum vessel*, as it always contains more or less lead, which would destroy the crucible.

PURIFICATION.

Selenium prepared by any of the above methods forms red scales. If washed on a filter and then boiled in water, it agglomerates together to a hard, reddish black mass, with a metallic luster and ring. To purify selenium, Bunsen dissolves it in hot nitric acid, which oxidizes it and converts it into selenious acid. By evaporating this *slowly* on a water bath to dryness, he obtains anhydrous selenious acid as a white powder. By too rapid evaporation some of the seleniumi s carried off with the nitrous vapors. The selenious acid is next purified by subliming it in a current of air at, or below a red heat. A piece of combustion tubing is drawn out narrower in the middle, and loosely stopped with a tuft of asbestos; the dry acid is placed in one end, which is heated quite strongly, and other end cooled, while a current of air is drawn through it. Selenious acid sublimed in this way forms beautiful long white crystals. It is next dissolved in water, and a current of sulphurous acid (SO_2) passed through it, whereby the selenium is precipitated as a red powder, which may be melted and cast in moulds if desired.

TESTS FOR SELENIUM.

The characteric odor of burning selenium, resembling, as some say, decayed horseradish, is generally a sufficient test. Its soluble salts give a red precipitate when sulphurous acid is passed through their solutions; if there is but little selenium present, the solution has a *green* appearance by transmitted light. (SCIENTIFIC AMERICAN, Oct. 26, 1872.) Selenium colors the flame a bright blue, which does not serve to distinguish it from sulphur. If a small bit of any selenious compound be brought on an asbestos thread into a small reducing flame, and a glazed porcelain dish of *cold* water be held one-half inch above it, a brick-red film will be deposited on the cold porcelain; heated with strong sulphuric acid, it gives an olive green solution, which yields a red precipitate when poured into water (Bunsen). Selenium does not dissolve in sulphuric acid unless this is very strong, but if boiled in the acid for a very long time, it becomes oxidized to selenious acid, sulphurous fumes are evolved, and no precipitate of red selenium can then be obtained on dilution (Hilger).

MELTING POINT.

We have already seen that selenium can assume various forms or states, some of them soluble and others not; some conduct electricity while others do not. In regard to the melting point of selenium statements are at variance, for it sometimes becomes soft long before it is really fluid. When melted and allowed to cool very slowly, selenium becomes granular, or crystalline, with a leaden gray to reddish violet color. In this form it melts at 217° C (423° Fahr.) without previously softening. According to Bettendorff and Wüllner, the amorphous selenium begins to soften between 40° and 50° C. (104° to 122° Fahr.) Berzelius says it softens when warmed, at 100° C. (212° Fahr.) it is semi-fluid, and perfectly liquid at a slightly higher temperature, but on cooling remains soft, like sealing wax, so that it may be drawn out in long, elastic, transparent threads. Sacc says that selenium has no definite melting point, for it softens and hardens gradually; that it probably melts at 200° C. (392° Fahr.), for at that temperature it ceases to adhere to the bulb of the thermometer. It is completely melted at 250° C. (482° Fahr.), and when cooled to 150° C. (302° Fahr.) it is entirely solid.

ACTION OF LIGHT ON SELENIUM.

This seems to have been first observed by Willoughby Smith and his assistant, Mr. May, in 1874. At first the effect was attributed to heat, but the experiments of Lord Rosse, Werner Siemens, and others, soon demonstrated the fact that it was light, and not heat, that effected this change. Selenium, like most non-metals, is a very poor conductor of electricity; in the amorphous form it does not conduct the current at all, in the crystalline form it conducts the current feebly, but the resistance is less when the selenium is exposed to light than when kept in the dark. Even the cold light of the moon has the same effect as found by Adams. So sensitive can it be made by suitably "annealing," or rather crystallizing it, that Siemens constructed an artificial eye that would wink, while Tainer and Bell have produced sound by the agency of light in their photophone. The latter claims to have made sensitive selenium cells, having a resistance of only 155 ohms in the light, and 300 ohms in the dark. The cells used are made by taking a plate of brass and heating it, then rubbing it over with a stick of selenium. It is annealed by heating it over a gas burner until the reflecting surface becomes dimmed. The cloudiness resembles somewhat the film of moisture produced by breathing on a mirror. Bell says that his best results have been obtained by heating the selenium until it crystallizes, then continuing the heating until it shows signs of melting, when the gas is immediately put out. The portions that had melted instantly crystallize, and the selenium is found, on cooling, to be a conductor, and to be sensitive to light. The appearance of the crystals, seen under the microscope, differs according as the heat is removed, as soon as cloudiness begins, or not until fusion begins, or when complete fusion is followed by slow cooling.

CHEMICAL AND OTHER PROPERTIES.

We have seen that selenium does not dissolve readily except in chloride of selenium. Sulphuric acid, free from water (H_2SO_4), dissolves it, nitric acid oxidizes it, and the alkalies combine with and dissolve it. It unites directly with bromine and chlorine, and on heating, will unite with iodine, sulphur, phosphorus, and the metals. It unites with iron to form a selenide, and when this is decomposed by acid, a hydrogen compound, H_2Se, is formed, which resembles sulphureted hydrogen in its power of precipitating the heavy metals from solution, but is distinguished for its unpleasant odor. Selenium forms nearly all the compounds that sulphur does. Owing to the ease with which it may be liberated from its compounds by reducing agents, it is generally estimated in the free state, by precipitating with sulphurous acid as a red powder, boiling to cause it to adhere together, and collecting it on a tared filter, drying and weighing as such.

ELECTROLYTIC DEPOSITS.

Selenium is easily reduced from its solutions, whether acid or alkaline, by the galvanic current. According to Schucht the deposit is at first light-red, but as it grows thicker becomes darker. The precipitation is so complete that it could be employed for quantitative estimations. Only a feeble current of two elements can be employed, or the selenium would become pulverulent. When deposited on a platinum electrode, it rubs off easily; probably on brass or copper it would adhere better. From its combination with potassium, selenium precipitates nicely with a feeble current; in acid solutions some seleniureted hydrogen is given out at the negative pole. If the solution contains a metal, like copper, the selenium and copper are precipitated together, and the color of the deposit is darker than that of pure copper.

For covering metals with selenium, the method of melting on seems preferable to electrolytic deposition.

NOVELTIES AT THE NEW ENGLAND INSTITUTE FAIR.

The engravings on our front page illustrate the special features of several devices which attracted our artist's attention at the Boston fair, as combining novelty with a promise of considerable economic and industrial value.

Fig. 1 represents the general plan and pulley connections of the Harris Revolving Ring Spinning Frame. The purpose of the improvements which it embodies is to avoid the uneven draught of the yarn in spinning and winding incident to the use of a fixed ring. With the non-revolving ring the strain upon the yarn varies greatly owing to the difference in diameter of the full and empty bobbin. At the base of the cone, especially in spinning weft, or filling, the diameter of the cop is five or six times that of the quill at the tip. As the yarn is wound upon the cone the line of draught upon the traveler varies continually, the pull being almost direct where the bobbin is full, and nearly at right angles where it is empty. With the increasing angle the drag upon the traveler increases, not only causing frequent breakages of the yarn, but also an unequal stretching of the yarn, so that the yarn perceptibly varies in fineness. The unequal strain further causes the yarn to be more tightly wound upon the outside than upon the inside of the bobbin, giving rise to snarls and wastage.

These difficulties have hitherto prevented the application of ring spinning to the finer grades of yarn. They are overcome in the new spinning frame by an ingenious device by which a revolving motion is given to the ring in the same direction as the motion of the traveler, thereby reducing its friction upon the ring, the speed of the ring being variable and so controlled as to secure a uniform tension upon the yarn at all stages of the winding.

The construction of the revolving ring is shown in Fig. 2. C is the revolving ring; D, the hollow axis support; H, a section of the ring frame; E, the traveler.

To give the required variable speed to the revolving ring there is placed directly over the drum, Fig. 1, A, for driving the spindle a smaller drum, B, from which bands drive each ring separately. The shaft, which is attached by cross girts to the ring rail, and moves up and down with it, is driven by a pair of conical drums from the main cylinder shaft; and is so arranged with a loose pulley on the large end of the receiving cone as to remain stationary while the wind is on or near the base of the bobbin. When the cone of the bobbin diminishes so as to materially increase the pull on the traveler the conical drums are started by a belt shipper attached to the lift motion. By the movement of the belt on these drums a continually accelerated motion is given to the rings, their maximum speed being about one-twentieth the number of revolutions per minute as the spindle has at the same moment. This action is reversed when the lift falls. The tension of the wind upon the bobbin is thus kept uniform, the desired hardness of the wind being secured by the use of a heavier or lighter traveler according to the compactness of cop required.

The model frame shown at the fair did its work admirably well, spinning yarns as high as No. 400, a fineness hitherto unattainable on ring frames. It is claimed that this invention can do whatever can be done with the mule, and without the skilled labor which mule spinning demands.

This invention is exhibited by E. & A. W. Harris, Providence, R. I.

Figs. 3, 4, and 5 illustrate some of the applications of the electric stop motion in connection with cotton machinery. The merit of this invention lies in simplifying the means by which machinery may be stopped automatically the instant its work, from accident or otherwise, begins to be improperly done. The use of electricity for this purpose is made possible by the fact that comparatively dry cotton is a non-conductor of electricity. In the process of carding, drawing, or spinning, the cotton is made to pass between rollers or other pieces forming parts of an electric circuit. So long as the machine is properly fed and in proper working condition the stopping apparatus rests; the moment the continuity of the cotton is broken or any irregularity occurs, electric contact results, completing the circuit and causing an electro-magnet to act upon a lever or other device, and the machine is stopped. The current is supplied by a small magneto-electric machine driven by a band from the main driving shaft, and is always available while the engine is running.

Fig. 3 shows the general arrangement of the apparatus as applied to a drawing frame. In the process of drawing down the roll of cotton—the sliver—four things may happen making it necessary to stop the machine. A sliver may break on the way from the can to the drawing rollers, or the supply of cotton may become exhausted; the cotton may lap or accumulate on the drawing rollers; the sliver may break between the drawing rollers and the calender rollers; or the front can may overflow. In each and all of these cases the electric circuit is instantly completed; the parts between which the cotton flows either come together, as when breakage occurs, or, if there is lapping, they are separated so as to make contact above. In any case the current causes the electro-magnet, S, against the side of the machine to move its armature and set the stop motion in play.

Figs. 4 and 5 represent in detail the manner in which electric connection is made in two cases requiring the intervention of the stop motion. In Fig. 4 the upper part of a receiving can is shown. When the can is full the cotton lifts the tube wheel, J, until it makes an electrical connection, and the stop motion is brought into instant action. In Fig. 5, the traction upon the yarn holds the hook borne by the spring, F, away from G, and the electric circuit is interrupted. A breakage of the yarn allows this spring to act; contact is made, and the stop motion operates as before.

This simple and efficient device is exhibited by Howard & Bullough & Riley, of Boston.

Fig. 6 shows the essential features of a positive motion loom, intended for weaving narrow fabrics, exhibited by Knowles, of Worcester, Mass. The engraving shows so clearly how, by a right and left movement of the rack, the shuttle is thrown by the action of the intermediate cog-wheels, that further description is unnecessary.

THE NATIONAL ACADEMY OF SCIENCES.

The annual meeting of the National Academy of Sciences began in this city November 14, Professor O. C. Marsh, of Yale, vice-president of the Academy, in the chair.

In the first paper Professor Loomis, of New Haven, discussed the mean annual rainfall of the several geographical divisions, and pointed out that on our Atlantic coast an annual rainfall of at least fifty inches extends from latitude 35° north to latitude 33° south. In the principal part of South America a rainfall of fifty inches extends nearly to the Andes, and there are extensive districts which have a rainfall of seventy-five inches. In Africa there is a rain belt of fifty inches, whose average breadth is 1,000 miles, and which is apparently continuous from ocean to ocean. There are also extensive districts where the annual rainfall exceeds seventy-five inches. In nearly all the islands of the East Indian Archipelago the mean rainfall exceeds seventy-five inches. We have thus an equatorial rain-belt amounting to at least fifty inches annually, having an average breadth of nearly 1,500 miles, and which appears to be continuous across all the islands and continents. With regard to the ocean our knowledge is very limited. As we recede from the great equatorial rain-belt, the amount of the rainfall diminishes rapidly, with the exception of certain districts of limited extent, where local causes give rise to a large rainfall.

Very large portions of the globe have an annual rainfall of less than ten inches. In North America such a region is found in Southern California and Arizona, and there is a large district about Slave Lake where the annual precipitation is only about ten inches of water, and is apparently less than that amount. In South America such a region is found on the west side of the Andes. In Europe there is no district having so small a rainfall as ten inches, except in Spain. In Asia there is such a region, 3,000 miles long and 1,000 broad. In the northeastern part of Asia there is also an extensive region where the precipitation scarcely exceeds ten inches. There are also large stretches of country nearly rainless in Africa and Australia. Thus we find that about one-fifth part of the entire land surface of the globe has a rainfall less than ten inches, and a still larger portion has a rainfall so small as to render it valueless for agricultural purposes, except in those limited districts which allow irrigation.

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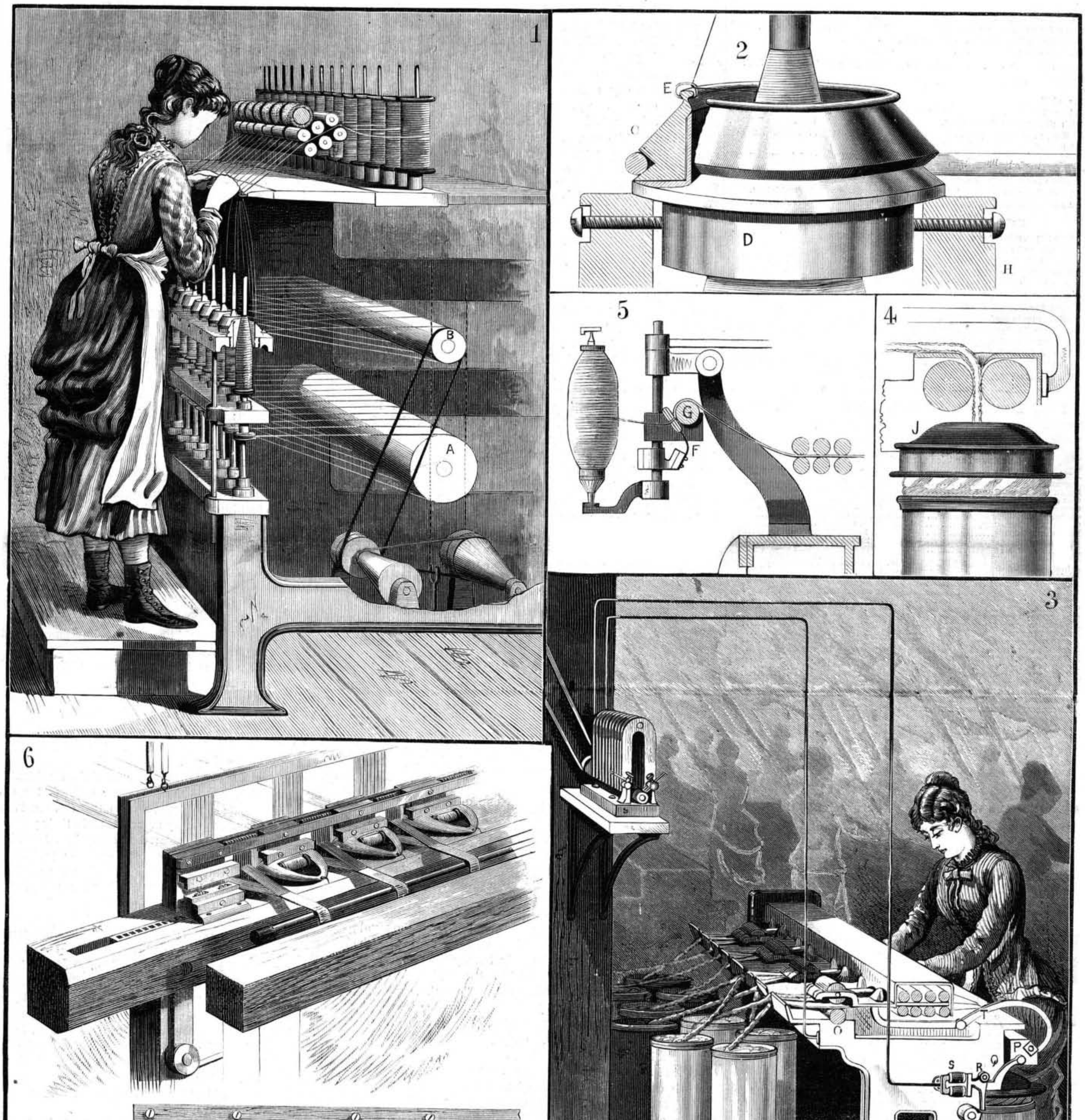

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