ing 10 per cent for moisture in the coke, 10 per cent for radiation, or 40 per cent in all. The amount of coke per ton of metal should not exceed 112 pounds, although the actual consumption is usually much higher. On this point we may quote the following result of a blow made on the 8th of March last at Messrs. Rushforth and Co.'s, St. James Foundry, Bradford, with a cupola 4 feet in diameter and 19 feet length of shell:

	Time.		Charge of coke in lb.	Charge of iron in lb.
Time of lighting fire	10:0	A.M.	Bed 336	1792
Put in coke for bed of cupola	10:30	"	" 112	2,016
Making up of door	11:0	"	" 112	2,016
Commenced charging	11:5	"	" 112	2,016
Filled up cupola	12:30	P.M.	" 112	2,016
Commenced blasting	1:5	"	" 112	2,016
Metal running down	1:15	"	" 112	2,016
Took away first metal in 35 min. after blasting	1:40	"	" 112	2,016
2d metal taken	2:15	"		
3d do. do.	2:30	"	1,232	17,920
4th do. do.	2:35	"		
Finished Charging	2:15	"		
Finished blasting	2:35	"		

Fuel used for bed coke	336 lb.
Fuel used for fusion coke	896 lb.
Total consumption of fuel	1,232 lb.
Amount of iron melted in cupola	17,920 lb.

The speed of the blower was from 425 to 430 revolutions per minute, and the pressure varied between 29 inches, 32 inches, and 37 inches of water. The above figures show that 8 tons of iron were melted with 1,232 pounds of coke in one hour and a half, time from starting to finishing blowing. The time taken to melt the iron after having taken away the first ladleful of metal from the receiver to taking away last metal was 55 minutes. This gives 14·54 pounds of iron to 1 pound of coke, or, taking the coke used, exclusive of the bed coke, namely, 896 pounds, and weight of iron melted, 17,920 pounds, we have 1 cwt. of coke per ton of iron, and the makers say that the cupola will never "make up" if care is taken in charging 1 cwt. of coke per 18 cwt. of iron.

It is unnecessary to say anything further as to the economy of the cupola in working, but it may be mentioned that it is claimed that less blast is used, as it has not to traverse so heavy a mass as in the ordinary cupola, that the wear and tear is less, and that the melted metal is obtained freer from impurities, while it is made hotter.

In their description the makers observe that the bottom of the cupola is raised up to the tuyeres, so that the metal as fast as melted runs straight into the receiver. "The hot blast also enters receiver at the same pressure as the inside of cupola furnace. This blast agitates and mixes the metal in receiver, and then the hot air from receiver is carried back through a vertical pipe into the cupola, above the belt, and is by this means utilized in heating up the iron in upper part of cupola. The receiver, which is applicable to new or existing cupolas, enables such a quantity of molten metal to be stored up and kept to a proper temperature that with an ordinary sized cupola large steam hammer blocks may be cast with the same ease and certainty as smaller castings, and at the same time the metal may be held in reserve for any required length of time while the moulds are being prepared. It will be noticed that as the blast is diverted in its course, and does not entirely pass through the charge, the coke or fuel is not consumed before it is required for melting the metal, and hence a much smaller quantity of fuel is required to melt a given quantity of metal." Some of the cupolas are being fixed in France for the Thomas-Gilchrist steel process, and they have also been introduced for smelting copper ores. The metal, in the latter case, is run into large portable receivers, and is then taken to other refining furnaces, or run into the ingot direct.

The following, on introducing fine slack coal in the blast as mentioned by the makers, is of interest: In the United States pulverized coal and fine slack have been used in cupolas. The practicability of this utilization of a comparatively waste product was discovered in the following manner: There had been some trouble through scaffolding in the cupolas, and, to melt down the "salamander," the manager withdrew the tuyere pipes, rammed in a lot of small coal through the tuyere holes, and again put on the blast. The scaffolding was removed in a very short time, and the work proceeded as usual. The blast pipe was then perforated, and a small quantity of fine coal was supplied to the cupola through the tuyeres, which it was found not only prevented scaffolding, but caused the cupola to work much more rapidly. The great waste in melting iron in a cupola usually occurs at the zone of the tuyeres, on account of the large quantity of air blown in, and the absence of carbonic oxide at that point. What little carbon the air comes in contact with at this point forms carbonic acid, which is almost as destructive to the iron as free oxygen. The principal waste of the metal occurs after its fusion, and in its passage through this carbonic acid and atmosphere. By the injection of the fine coal with the blast its combustion is secured at the zone of the tuyeres, producing carbonic oxide, and thus preventing the oxidation of the descending metal. Beyond saving the waste of iron by this improvement, a much larger percentage of the carbon which the pig contains is transmitted to the converter, an advantage which would also be of great value in all cupolas for melting iron for castings; as the chief difficulty in that line is that the carbon is burnt out of the metal, and metal thus prepared is said to run more fluid and to produce finer and tougher castings than that melted in the ordinary manner. The following from the directions for lining is also worth quoting: "The durability of fire bricks depends largely upon the amount and quality of the fire clay used in laying them, and the way they are fitted together. If wide spaces are allowed, and too much fire clay used, there is shrinkage in the first heat, the bricks are attacked on all sides, and the key or wedge of the brick is lost. Only use the best fire clay; thin it with water to the consistency that will allow the brick to be dipped; fit the bricks so closely that, being dipped, they will take up sufficient slip to make the joint when rubbed together; fill all spaces with the thin slip, and dry with a slow fire."

SELF-ACTING SPRING LEG BRACE.

The engraving represents a self-acting spring leg brace which the inventor guarantees will cure any knee-sprung or ankle cocked horse in a few weeks.

Laced at the knee joint is a strap, to the opposite sides of which are attached the ends of a metal band which is so curved that it touches the band only at the ends. Secured to this band are the ends of two springs which pass down

COTE'S SELF-ACTING SPRING LEG BRACE.

and under the foot, being kept from spreading by a metal clasp, and being held securely in place by being passed through holes in the rear corks, nuts being screwed on the ends. The construction of the device and the way it is applied are very clearly shown in the cut. The tendency of the springs is to force the knee back to its normal position, and straighten the leg.

Further information may be had by addressing the patentee, Mr. Alphonse Cote, 850 Seventh Avenue, New York city.

The Ohio Earthquake of September 19.

The earthquake in England, April 22, and that along our eastern seaboard, August 10, have now been followed by one whose effects were felt in every quarter of the State of Ohio, about half of Indiana, and the southern part of Michigan. It covered an area of about 100,000 square miles, although in many places within this area it was not noticed at all, and in many others so slightly that people did not suppose there had been any shock until informed of its occurrence in other localities.

The time of the earthquake is variously given at from 2:40 to 3:30 on the afternoon of September 19, the differences in time being probably somewhat owing to the differences in timepieces. In Cleveland three distinct shocks were reported, the vibrations seeming to pass from west to east, and lasting from fifteen to thirty seconds. At Defiance, Ohio, it is said the swaying of buildings was so violent as to cause much consternation, and that a Methodist conference in session in one of the churches immediately adjourned, the members rushing to the street. In Cincinnati there was only a slight shock.

In Indiana the shock was felt at Indianapolis, Fort Wayne, Seymour, Lawrenceburg, and many other places, the effect being very plain in Lawrenceburg.

At Detroit, Mich., the shock was plainly felt, the Chamber of Commerce building being violently rocked, while in several buildings men rushed out on the streets in their shirt-sleeves, looking anxiously around as if they expected to see the structures toppling to the ground. At Dresden and London, Canada, the most northerly points where the earthquake was felt, the tremor was but slight.

The observations made are locally reported in a very indefinite and unsatisfactory form. Even though no material damage seems to have been done at any point, this earthquake may well serve to direct more earnest attention to the study of these disturbances. Instruments for registering earthquakes have now been so perfected as to automatically register the slightest vertical or horizontal movement, giving their direction, with the duration and exact time of occurrence, and such instruments are now in use in many places in Europe. With their aid there would be no difficulty in determining the extent and force of an earthquake wave, and we trust our leading educational institutions will not hereafter think them entirely unworthy of a place among their scientific apparatus.

The International Electrical Exposition, Philadelphia.

(FOURTH PAPER.)

European visitors to the Exposition have expressed, from time to time, no little surprise at the discovery of improvements made by American electricians and mechanicians in apparatus which were invented in their own countries only a short time ago, and introduced there, though in a somewhat crude form. At various points of the building is to be seen that which only through the interposition of Yankee ingenuity has been enabled to completely accomplish what was evidently in the mind of its original designer. That idea, incomplete, was his. It represents, perhaps, years of mental labor. But the mechanism by which it is adjusted with nicety to its work, and made to fulfill its mission, was perfected by a man who, it may be, never had an original thought, or, having one, knew not how to express it in wood or iron or steel. It is readily conceded that, in making practical what before was little more than an idea, he performs a valuable work, as does every man who produces that which tends to increase the happiness or lighten the labors of his fellows. But, when it is remembered that the same mind which conceived the improvement or laboriously plodded it out by experiment might, if properly trained and directed, have originated something of equal value, it is to be deplored that it should be restrained within the narrow limits of practicability.

On the other hand, the foreign exhibits, when compared with our own of similar character, are for the most part cumbersome and intricate. The American electrician, like the American mechanic, is always seeking after simpler methods and reduction of parts. He is so well known for his success in this pursuit that American mechanical models are, in some fields, used abroad as *criteria*.

In engine building, for instance, this is especially true. American engineers, though perhaps less scientific than those of England or the Continent, have improved and modified engine building all over the world.

Even at this late day new objects of interest appear in the various sections of the Exposition, so that he who returns to a favorite locality after a week's absence may discover still other apparatus to claim his attention and awaken his interest. Up to Tuesday night, the 23d inst., 117,000, people had visited the Exposition. Now the attendance is still greater, averaging about 7,000 daily.

Among the exhibits which have but recently appeared is an electric railway in full operation. It is laid between the main building and the annex; and though the line of rail is too short to permit of estimates of efficiency or economy being made, it deserves, by reason of the novelty of its design and the smooth working of the parts, some little attention. Readers of the SCIENTIFIC AMERICAN will remember that three types of electric railways were exhibited at the expositions at Munich, Paris, and Vienna. These were the charged-rail system, the overhead contact-motor, and the secondary battery system. All these systems are now in operation in different parts of the world, but it is very doubtful if any of them can be economically operated, save where the road is short and connects two thickly populated cities, or where the power required to run the motors is gathered from running water along the route or at the mines, where coal is cheap. On the charged-rail and overhead contact-motor systems, there is a large and sometimes ruinous loss of current while *in transitu*, and the secondary battery has not yet reached that point of perfection at which a fair amount of the power originally required to charge it may be recovered in the form of electrical energy. It should not be inferred from this that the type of railway now in operation in the International Exposition is either more economical or more efficient than the better known types just described. It has not as yet been tried on a sufficiently large scale to determine either of these two important points.

It consists of a new method of conducting the electricity along the line for the use of the motors and also for lighting. By the method employed in transmitting the current, it has been found, it is said, that it can be economically distributed along the line of the road for purposes of illumination and even for power. In other electric lines, where electricity is transmitted to the motors from a central station, large losses of current take place, owing to the exposure of the conductors to atmospheric influences. When cold rains, sleet, and snow prevail, such lines are utterly unreliable. In the system at the Exposition there are tubes running along each track—one for the outgoing, the other for the returning current. This arrangement, it is said, protects the current from all exterior and foreign influences, while a slot cut along the bottom permits the entrance of a contact-rod from the motor, and allows of a nearly perfect contact, which, even under the most favorable conditions of weather, may not be had in the systems now in use.

The uncertainty of charged-rail currents, either on the surface or overhead, may, not inaptly, be likened unto the uncertainty of the arc light currents when first introduced into the streets of the city of New York. On wet and stormy nights these currents proved unreliable, because they were transmitted over unprotected conductors. Now, however, since the conductors have been properly protected, this is not the case. But to thoroughly isolate and insulate the rails of an electric railway is both costly and difficult. In the tubular system, however, since there is no pressure whatever upon the tubes, the process is both inexpensive and simple. As a result the losses from leakage and induction are, if no mistake has been made in the figures, but slight, being only 10 per cent, as against from 25 to 75 per cent in the charged-rail and overhead contact-motor systems. This saving of current would be immediately apparent in the smaller number of dynamos and decreased horse-power required to operate the line.

As said before, an arm reaches down from the motor to the tubular conductor; the crook thereon, armed with wheels or brushes, reaching underneath and making the contact. The current after leaving the motor passes to the wheels of the negative conductor, thence to the tubular conductor on the same side of the track, and returns to the dynamo. During this operation it may be intercepted by attaching wires to the negative tube, and led off to different points on either side of the road, where it should be needed to light up towns and houses, and operate small stationary motors.

The contact between the tubular conductor and the running motor is said to be so perfect that only a comparatively small amount of current is required. When the motor is at a standstill, the current passes through the switch to the negative conductor and thence to the various lighting plants along the line.

For elevated roads, or those running through the country, the conductors are attached to wooden guards placed on the ties between the rails. These can be planked over at street crossings; a slot being left for the arm to pass through.

The projectors of this system claim that, when in good running order, it will prove much cheaper than the ordinary steam railway, and that a twenty-ton electric motor on their line will do as effective work as a sixty-ton steam locomotive. For ordinary traffic, electric-motors of from six to ten tons will, they say, readily haul from three to six cars at a high rate of speed. For street cars, they think a motor of five hundred pounds, giving five horse-power, would be all that is required. On street railways, the tubes are placed in a conduit having a slot through which the contact arm receives the current.

There is an exhibit near the center of the great hall which, though remaining almost unnoticed, is, from a historical rather than from a scientific standpoint, one of the most curious and interesting groups of apparatus to be seen along any of the corridors. It is marked "Wallace Exhibit," and consists of several roughly put together electric machines that wear a weather beaten appearance, as though they had been left out in the storm. One of these machines is composed of an electro-magnet having the poles arranged vertically.

An armature, shaped like a Pacinotti ring, and made up of a series of wire coils placed at different points about a cast iron circle, revolves between the enlarged poles. The bushes on the commutator are adjusted through the agency of a worm gearing. Next to this machine comes that used at the Centennial for lighting purposes—a crude device in which an armature revolves in a field of force of antique pattern. Then there is an electroplating machine of somewhat similar construction, and, lastly, a magneto-electro "telemachon." Joined together in a field of force so as to make one magnet with multiple winding, there are twelve magnets, between the poles of which revolves an armature. Many thin plates of iron, each insulated from its neighbor, compose this armature.

For Mr. Edison, this so-called "telemachon" must have a peculiar interest. It is the first dynamo machine he ever saw, and the magnificent possibilities of such a contrivance, or rather of a further development of the principle on which it is constructed, changed the current of his thoughts, there is reason to believe, indeed he has avowed as much, into channels of scientific research where before he had been a stranger.

A brief narrative of Edison's first introduction to the dynamo machine may possibly not prove devoid of interest in connection with this historical exhibit at the Exposition. It was about six years ago that Edison and some friends, upon the invitation of Prof. Barker, of the University of Pennsylvania, visited Ansonia, Conn., to examine a power transmitting machine, as the "telemachon" was called. Being Sunday, the Wallace factory on the bank of the river was deserted, and one of the work-rooms was used for the exhibition. Electricity was generated by the rubbing together of two wire brushes, and six or eight large arc-lights were kept aglow. The amount of power recovered at the end of the second machine of that applied to the first was variously estimated, but it was sufficient to demonstrate to Edison the feasibility of the project of collecting the power of running streams and transmitting it to a distance in the form of electric energy. The operation of the machine filled Edison with delight, the genuine, unalloyed delight of the child when first in possession of a new and ingenious toy. It is alleged that Edison was never known to be enthusiastic, but the writer, who was one of the party that day, can bear witness that this allegation is unfounded. There is reason to believe, however, that the thoughts of the wizard were straying far beyond the walls of the Ansonia factory. In all likelihood, it was more than the mere working of this crude machine that filled his mind. It was its future possibilities—the development of the principles and laws upon which it was constructed.

Some weeks later this "telemachon" or a similar one was sent out to Menlo Park, and thereafter his attention was directed almost wholly toward improving the dynamo, and in discovering a means whereby its current could be economically subdivided.

The Edison dynamo and the mechanism of the incandescence light are the results of his experiments and investigations in this direction.

An electric cigar lighter is shown at the Exposition, which has the merit of not costing anything for current when not in use. It is not designed for use with a primary battery, and very properly, because this would render it at once expensive and troublesome.

It is made to hang between two incandescence lamps of the sixteen candle power type, and diverts a sufficient quantity of the current to feed itself, while at the same time not taking enough to appreciably lessen the intensity of either. As may be inferred, this cigar lighter is designed for use only where there is already an electric installation.

It consists of a circuit breaking device somewhat similar to that used in the telephone, the weight when it is hung up breaking the connection. The weight of this cigar lighter is sufficient to keep the connection broken at all times when not in use, and hence, as said before, there is no loss of current. The act of raising the handle to light a cigar switches in the current. This acts upon several fine strips of platinum set in a plug of cement.

These platinum strips are placed in series with the incandescence lamps overhead. The handle in which they are set hangs by a flexible cord, and, so far as appearance goes, does not differ from that usually employed with gas.

If only a tithe of the instruments for indicating distant temperatures, relative humidity, specific gravity, height of water, etc., shown at the Exposition ever come into general use, the average citizen may, not unreasonably, be expected to become something of a scientist. He may keep himself so exactly informed of the conditions of air and water afar and anear, and the strength and direction of prevailing winds, as to look upon weather reports as upon old almanacs and the bureau whence they come as a purveyor of obsolete intelligence. Some of these instruments on exhibition are good but not new, while many have the commendable quality of novelty without the necessary adjunct of efficiency. With a multiplicity of indices over his head, indicating the temperatures of his dwelling, his office, and his country-seat, the height and temperature of his ponds and wells and the boilers in his factory, the average man is likely to fall into grave errors. The sudden fall in the temperature of his cellar, as indicated in the index over his head, might throw him into a towering rage, under the impression that the cook had let the furnace fire go out, whereas it is only a burglar climbing in through the cellar window; and the delight experienced in seeing by his office index that the spirit barrel in his wine closet has suffered no diminution would be turned to bitterness in discovering, upon a personal examination, that this height had been maintained by his man, by pouring in water to make up for the liquor that he had abstracted.

The telethermometer shown at the Exposition may be relied upon, as its name implies, to indicate temperature at distant points. In breweries, malt houses, distilleries, oil, sugar, and other refineries, refrigerators and the like, it will prove of great service; but that it may be relied upon to indicate the presence of icebergs at sea, as its projectors declare, there is very excellent reason to doubt. It is likely, at sea, to prove about as valuable as the ordinary thermometer, and not more so. The fact is, as masters of ships have frequently testified, but little confidence can be placed upon any type of thermometer so far as indicating the approach of ice is concerned. Sailing gradually from the cold wall of the Gulf Stream into its warmer waters, the thermometer will invariably rise, though large masses of ice are ahead, because the warm influences of the Stream are stronger than the cold influences of the ice. Given a dead calm or a head wind, that is to say, a wind blowing against the course taken by the ship, and the thermometer will indicate the presence of icebergs ahead, because the wind having come from their direction has felt their influence.

But it has often been demonstrated that, where a fair wind prevails—a wind blowing in the same direction the ship is going—the fall of the mercurial column, if it takes place at all, will be so insignificant as to prove no warning whatever. Hence it is that masters of ships place little reliance upon thermometers for indicating the approach of ice; and as the telethermometer can only indicate distant temperatures when the distant point is connected by wire, it would prove, as said before, no more reliable aboard ship than any other good thermometer. The telebarometer indicates and records electrically barometric pressures at a distance, and like the telethermometer is valuable in all continuous meteorological observations. The telemanometer indicates and records automatically and continuously the pressure in a boiler. The telehydrobarometer indicates and records the heights of water in reservoirs, storage ponds, rivers, lakes, dams, and tanks.

A valuable use for this instrument is that of recording at one point the heights of water in various sections of canals, and recording at one point simultaneous tidal observations taken at different parts of a river or bay. In other words, it might readily be made to take the place of the self-registering tide-gauge, which has been used for years to keep a record of the tides of various localities. It is worked automatically by clock work; a pencil being made to draw a curve upon parchment, the high points indicating high water, the horizontal lines slack water, and the low points low water. The telehydrobarometer, despite its name, is of simple construction, and does its work in much the same manner as the self-registering tide-gauge, save that, as said before, it can send its readings, electrically, to a central station.

The official tests of the various exhibits, from which so much is expected, have little more than begun, and it is not easy to understand at the present rate of progression how even a small portion of that which should not be permitted to depart without critical examination can be tested before the Exposition closes its doors. Of course there is much that does not require very elaborate tests, and still more the projectors of which are by no means enthusiastic to have compared with similar apparatus. But it was understood, indeed proclaimed, at the start that everything would be critically examined, and an official report made thereon by the Committee; a certified copy of which would be given to the proprietors of the apparatus.

Many persons are looking forward with not a little curiosity for the official reports to be made of the several apparatus, because, since the committee having the matter in charge are in no wise interested, save scientifically, in what they are to pass upon, and are abundantly able to get at the real measurements, cold facts are likely to appear in a somewhat phenomenal profusion, and that is likely to be learned regarding the efficiency of certain apparatus of which the projectors have not, up to the present, given even a hint.

Rapid Progress in Electric Science.

The Philadelphia *Ledger* makes the following note of progress in the application of electricity: "Only twelve years ago Professor Tyndall gave his course of memorable lectures in Horticultural Hall. He had with him as a part of his apparatus an arc light. The lamp was regulated by clockwork, and cost probably ten times as much as the lamps made to-day. It was imperfect in every way, the light being very unsteady, and several times got out of order at critical moments. The current was supplied from a voltaic battery, at a cost that precluded its use for any but lecturing purposes. The battery, besides being costly and troublesome, required the constant work of an attendant for a day or two to 'set up,' and it also was very apt to get out of order. Dynamo machines were not unknown at that time, but they too were costly, and for lecturing purposes the battery was considered best. Looking at the display of lamps in the exhibition, and the great variety and number of dynamo machines, it seems almost incredible that it is only twelve years since such a man as Professor Tyndall was well pleased, rather than otherwise, to be able to exhibit his poorly regulated clockwork lamp, run by some hundreds of cells in a voltaic battery!"

The First Telegraphic Instrument.

At the Electrical Exhibition a large display of models from the Patent Office, under the charge of Mr. J. M. Churchill, are exhibited. Among the two hundred and fifty pieces is the original Morse telegraphic apparatus, patented April 11, 1846. The transmitter is mounted on a pine block, and is very crude. The armatures are wound with very coarse and poorly insulated wire, and the sounder consists of an ordinary piece of stick, which strikes against a piece of iron. The clockwork which operates the cylinder, about which the perforated paper was wrapped, is of a more improved pattern. On the card attached to the exhibit is the following, said to be an effusion of a clerk at the Washington office:

"The steed called Lightning," says the Fates,
Was tamed in the United States.
'Twas Franklin's hand that caught the horse
That was harnessed by Professor Morse."

A New Carbon Battery.

A new voltaic battery has been brought out by M. Tommasi and M. Radiguet, in which peroxide of lead surrounds the carbon plate as it lies on the bottom of the cell. The other plate is also of carbon, covered with fragments of retort carbon platinized. The two plates are placed one above the other, but separated by a sheet of parchment paper which divides the containing vessel into two compartments. A saturated solution of chloride of sodium, or common salt, is filled into both compartments until the upper carbon fragments are partly immersed in it. The electromotive force is 0·6 volt. The negative pole is that carbon plate which is not in contact with the peroxide of lead. If other saline solutions, such as sulphate of ammonia, sulphate of soda, chlorhydrate of ammonia, or even dilute sulphuric acid, be used instead of the solution of salt, the electromotive force does not sensibly vary.

Isaac Newton.

Isaac Newton, chief engineer of the Croton Aqueduct Department, New York, committed suicide Sept. 25, in a fit of temporary insanity, said to have been caused by overwork. He was in his forty-seventh year, and a brother of the late Dr. Henry Newton, the geologist. He studied mechanical engineering in the Delamater Iron Works, made a survey of the shoals of the upper Hudson, was engaged in the construction of the orignal Monitor, and was an engineer on board during her combat with the Merrimac. He was a member of the American Society of Civil Engineers and the Society of Mechanical Engineers.