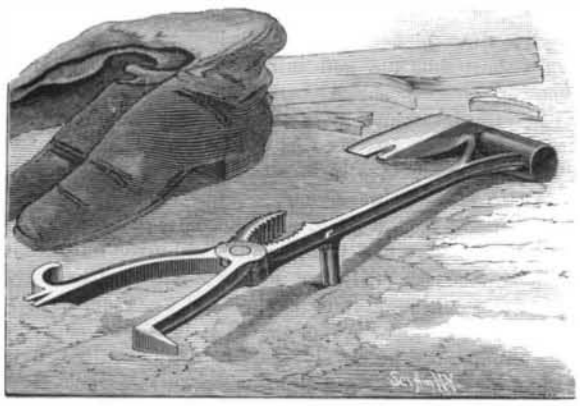
### COMBINATION TOOL.

A combination or universal tool for household use recently patented by Mr. George B. Gable, of 1518 Jones St., Omaha, Nebraska, is shown in the accompanying engraving. The hatchet has a malleable iron handle, and is made with a notch for drawing nails. The outer end of the handle is curved to one side, and an arm of corresponding shape is pivoted to the handle, so as to form a boot jack and box holder. The extreme end of the handle is of flat form for use as a stove lifter, notched to serve also as a tack puller, and at one side is a hook for lifting pots. On the outer end of the other arm is a straight hook for use in regulating



GABLE'S COMBINATION TOOL.

stove doors and for use as a screw driver; this arm has a roughened tail piece for use, in connection with the handle, as a nut cracker or wrench. The tool thus constructed is inexpensive, and can be used for twelve distinct purposes, most of which are generally performed by separate tools.

### Porosity of Wood.

An unpainted wooden pail showed some of its staves saturated and others nearly dry. Experiments with wood of the same character—the cucumber wood—showed that pieces sawed from the same board differed in their absorptive qualities as one end or the other was set in water, the trials appearing to suggest that when the wood was placed in water as it grew, butt downward, the water was absorbed more rapidly than when the position was reversed. As a further test two pieces were taken from the same board, and both painted on the outside—both faces—but one had the top end also painted, and the other the bottom, or butt end, painted. The one with the unpainted butt filled and sank, while the other floated. Perhaps differing results would have been obtained with differing woods. The fact of position affecting saturation seems to be recognized in the frequent custom of reversing fence posts from their natural position and in the driving of piles.

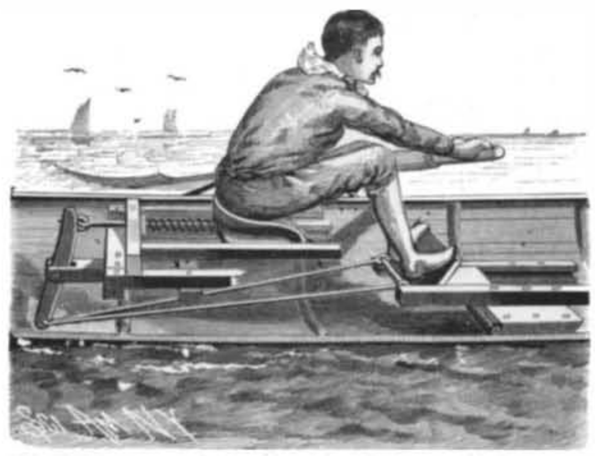
IF a man empties his purse into his head, no man can take it away from him. An investment in knowledge always pays the best interest.—*Franklin.*

### SEAT AND FOOT BOARD FOR ROW BOATS.

The sliding seat, of the usual construction, slides between two tracks held on a suitable frame. From the back of the seat projects a rod whose rear end is pivoted to the upper end of an upright lever pivoted to a bar projecting from the rear of the frame. A spiral spring, surrounding the bar, is held between the rear of the seat and a cross piece. The foot board is secured to a cross piece sliding in longitudinal grooves formed in plates in the boat. The lower end of the lever is connected by rods with the foot board. The pressure of the spring can be varied by a collar on the rod back of the seat.

When the oarsman makes a stroke, the seat is moved back and the spring is compressed, and the rod is moved in the same direction, when by means of the lever the foot board is moved in the opposite direction. As the oarsman recovers, the spring expands and pushes the seat back while the foot board is drawn forward, thereby relieving the oarsman of the necessity of pulling back the seat, and enabling him to expend all his force and power on the stroke. The recovery being very rapid, fast rowing is admissible.

This invention has been patented by Mr. James J. Turpel, of North Starr Street, Halifax, Nova Scotia, Canada.



TURPEL'S SEAT AND FOOT BOARD FOR ROWBOATS.

### IMPROVED "RAPID" CUPOLA.

The cupola illustrated by the accompanying engravings is made by Messrs. Thwaites Brothers, of Bradford, Eng., under Stewart's patent. It will be seen that it is of the receiver class—the receiver is separate from the cupola.

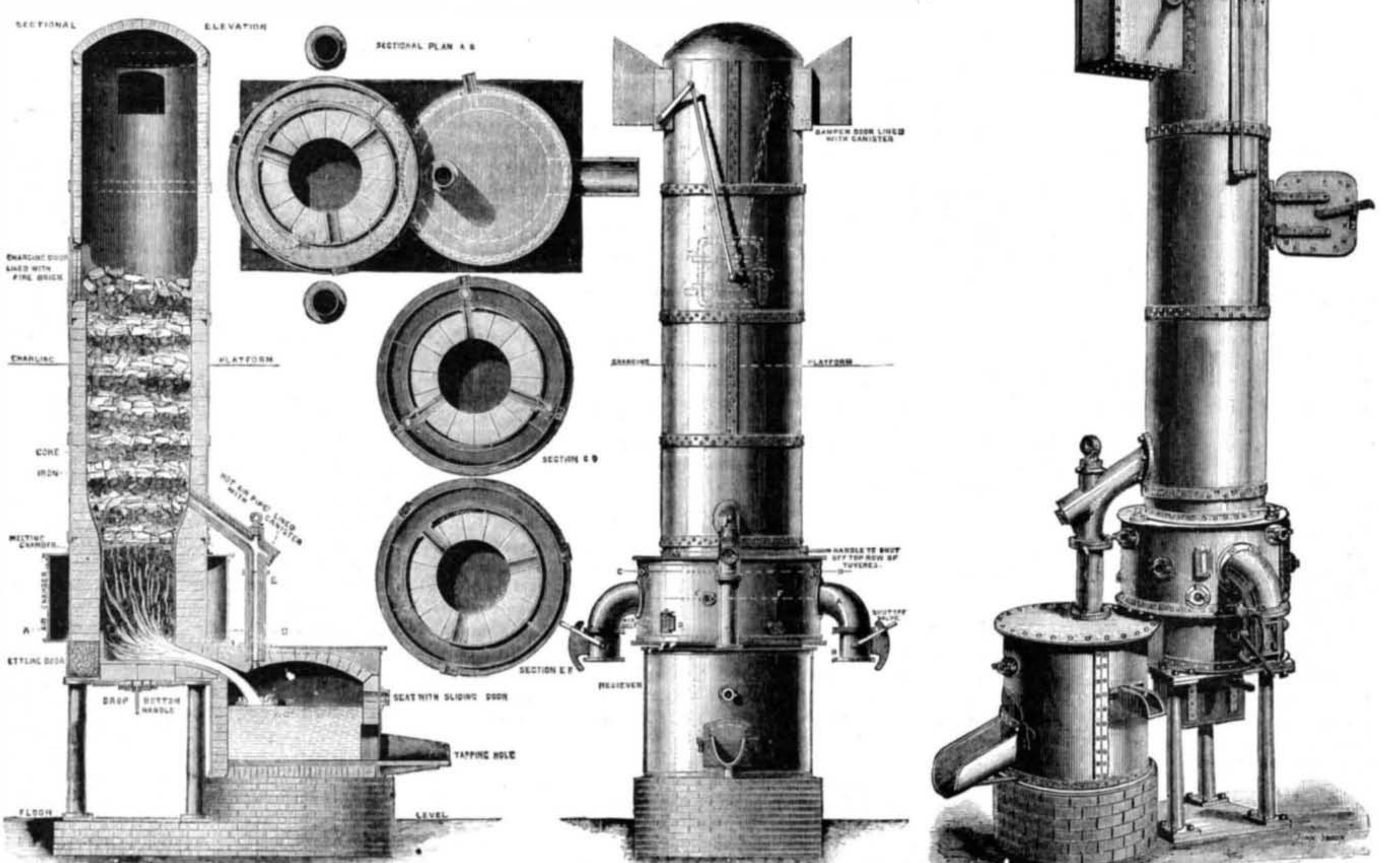
The shell of the cupola is of plate iron with butt joints, covered with strips and rings, and riveted together with cup head rivets outside, the heads inside being flattened to allow the brick lining to fit close to the shell, which is of one diameter and parallel inside. There are several rings of angle iron inside shell in the length of the cupola to support the lining. To the shell is attached an annular air belt. Referring to the engravings, which are from *The Engineer*, it will be seen that on each side of the air belt is secured a cast iron quarter bend blast pipe, and to each bend is connected a turned shut-off valve. Inside the shell, and communicating with the air belt, are three rows of cast iron tuyeres. The two bottom rows each consist of three tuyeres, and the top row of six tuyeres. All the tuyeres are fastened to the shell with bolts and an asbestos ring. Opposite each of the top tuyeres in the air belt is fixed a cast iron shut-off turned plug valve. The plugs of these valves come through cover plates fixed upon the top of belt. All the plugs are fitted with small sprocket wheels, and are connected to each other with Ewart's malleable chain, so that all can be controlled from one handle at any convenient position. Opposite each tuyere is fixed a seat with sliding door, fitted with blue tinted glass peep holes. In front of each glass is a mica disk. Upon the air belt is a blast pressure gauge to indicate the pressure of air in cupola. The upper part of cupola above the belt is provided with charging door—fire brick lined—and with damper door and shield at the top on one side. The cupon stands upon a cast iron base plate. This base plate is fitted with a wrought iron hinged drop bottom door, in halves, opening from the center. Each half of the bottom is connected to a shaft, on which is fixed a wrought iron hand lever. A strong wrought iron bolt is shot across the door when closed, securely retaining it in position. A fettling door is provided at the back of the cupola. The base plate of the cupola is supported by four cast iron pillars upon a strong cast iron bed plate. The receiver shell is also made of plate iron, with angle iron ring, top and bottom, and cover plate on top; and provided, as shown, with tapping hole, spout, and fettling door, slag hole and spout, and hot air pipe and plug to convey hot air from the top of the receiver into cupola.

Several advantages as attending the use of this cupola are claimed by the makers, not the least important of which is its speed. According to the experiments of Dulong, 1 pound of carbon, combining with the necessary quantity of oxygen to form carbonic acid, develops 12,906 units of heat. The specific heat of cast iron being about 0 13, the melting point 2,190 degrees, and the coke containing 82 per cent of carbon, then to heat a ton of cast iron of a temperature of say 40 degrees to a temperature of 2,190 degrees would require

Heat Iron Sp. heat

$$2190-40 = \frac{2150 \times 2240 \times 0{\cdot}13}{12906 \times 0\ 82} = 59{\cdot}1 \text{ lb. coke.}$$

This is supposing that the whole of the carbon is converted into carbonic acid; but if by any means carbonic oxide is formed, a very different result is obtained. Then 1 pound of carbon burning to carbonic oxide only evolves 4,453 units of heat. If, however, by admitting air above the zone where the oxide is formed, we recover 4,478 units, this + 4,453 gives 8,931. This is a little over two-thirds of the available heat to be got out of 1 pound of carbon, allow-



IMPROVED RAPID CUPOLA.

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