refinery, where it is treated, and yields from 2 to 5 per cent of burning oil.

PERU.

It is proposed to build a pipe line from the refinery on the estates of Henry Meiggs to the shipping port, a distance of about 7 miles. It is stated that oil can be produced at this point for less than 1 cent a gallon, and as the fields have produced from time immemorial, there is no prospect of their early exhaustion.

ONTARIO.

The oil refinery at St. Thomas, Ont., is running day and night; 494 barrels of crude petroleum were brought from Petrolia for it in one week recently.—*Stowell's Petroleum Reporter*.

Railway Notes.

THE new track laid in this country during the year ending September 10, 1878, was 1,160 miles. During the six preceding years the number of miles of track laid was: In 1872, 4,498; 1873, 2,455; 1874, 1,066; 1875, 702; 1876, 1,467; 1877, 1,176.

THE statement made in the recent Narrow Gauge Convention, that standard gauge freight cars weigh ten tons and carry ten tons, is indignantly disputed by users of the latter. One gentleman, having much to do with freight cars, says that the modern freight cars weigh from 17,000 to 18,000 lbs., commonly carry (and that on long hauls) 28,000 lbs., are guaranteed to carry 30,000 lbs., while he has seen them show on the scales 30,000 and 32,000 lbs. of load, and in one case 35,000 lbs. The general tendency for some years has been to increase loads without increasing, but in many cases decreasing, weights of cars; and it seems quite likely that 30,000 lbs. will soon be the standard load. The tank cars used for carrying petroleum have an average capacity—and they are almost always run full—of 30,000 lbs. The Standard Oil Company, which has some 3,000 of such cars, carried on four-wheeled trucks with the Master Car Builders' standard axle, has run them with such loads for years, and only recently had its first case of a broken axle, manifestly due to a defect in the iron.

INTERESTING observations have been made recently on the Cologne-Minden Road, Prussia, on the rusting of iron rails. A pile of rails of odd lengths were laid on sleepers over a bed of gravel early in 1870, and remained undisturbed until the fall of 1877, there being no use for them. It was then found that they were covered with a layer of rust 0·12 inch thick, which had to be removed by striking the rail with a hammer. The cleaned rail weighed only 398·2 lbs., while its original weight was 419·1 lbs., showing that 5 per cent of the rail had been destroyed by rust, which covered the rail quite uniformly. This confirms the observation often made, that rails stacked away are much more liable to rust than those laid down in a track.

ACCORDING to *Le Fer*, at a meeting of directors of the German railroads held at Constance, the following information was furnished in regard to the relative value of the different methods of injecting ties:

1. Railroad from Hanover and Cologne to Minden. Pine ties injected with chloride of zinc; after 21 years the proportion of ties renewed was 21 per cent. Beech ties injected with creasote; after 22 years, 46 per cent. Oak ties injected with chloride of zinc; after 17 years, 20·7 per cent. Oak ties not injected; after 17 years, 49 per cent. The conditions were very favorable for experiment; the road bed was good, and permitted of easy desiccation. The unrenewed ties showed, on cutting, that they were in a condition of perfect health.

2. Railroad "Kaiser-Ferdinands-Nord." Oak ties not injected; after 12 years the proportion renewed was 74·48 per cent. Oak ties injected with chloride of zinc; after 7 years, 3·29 per cent. Oak ties injected with creasote; after 6 years, 0·09 per cent. Pine ties injected with chloride of zinc; after 17 years, 4·46 per cent.

THE annual official reports of the railroads of India place the length of railways there at 7,551½ miles, of which 492½ miles were completed during the year 1877, and 223 miles since the close of the year. There are 806½ miles of double track; 5,912¾ miles are constructed on the 5 foot 6 inch gauge, and 1,638¾ on narrower gauges. The capital outlay on the State lines amounted to £3,122,051, and on the guaranteed lines to £1,374,882, bringing the total capital expenditure, up to the end of October, as regards the State, and to the end of March last, as regards the guaranteed lines, to £113,144,541. The expenditure up to the end of the year may be taken in round numbers at £13,344,500. The revenue from all the open lines was £6,232,888, of which £6,091,532 were earned by the guaranteed lines, with a capital of £95,482,941, and £141,356 were earned by the State lines, on a capital expenditure of £17,661,600. The net receipts from the guaranteed lines exceeded the amount advanced for guaranteed interest by £1,454,591; the year previous there was a deficit of £216,517.

A FRENCH engineer named Duponchel has made a report on the project of a railroad across the Desert of Sahara. The projected railway would run from Algiers to Timbuctoo, a distance of 2,500 kilometers. M. Duponchel stated that the principal portion of the line would rest during nearly its whole extent on layers of sand, and toward the end on primitive volcanic rocks, granite, gneiss, etc. No mountainous obstructions would have to be encountered. The average heat does not appear to exceed 23° or 24° C. (73·2-5° or 75·1-5° Fah.), but account must be taken of the great variations which occur in the 24 hours. For instance, occasionally, a very cold night succeeds a temperature of 40° C. (104° Fah.) in the day time. The great difficulty to be overcome would be the want of water, which is not to be procured in that region. M. Duponchel calculates that for three trains daily the amount of water required would be 4,000 cubic meters, and that the engineering science of the day is quite sufficient to supply even a much greater quantity at the requisite points.

THE government of Costa Rica has advertised for tenders for building bridges on the second Atlantic Division of its railroad. There will be needed 194 bridges. The bridges will vary in length from 3 feet to 1,044 feet, and will be built for a track of 3 foot 3½ inch gauge. They will be of sufficient strength to stand a strain of 2,240 lbs. to the lineal foot, in addition to the weight of the usual freight carried.

THE WERDERMANN ELECTRIC LIGHT.

It has been looked upon as essential that a certain distance should separate the ends of the carbon electrodes used in

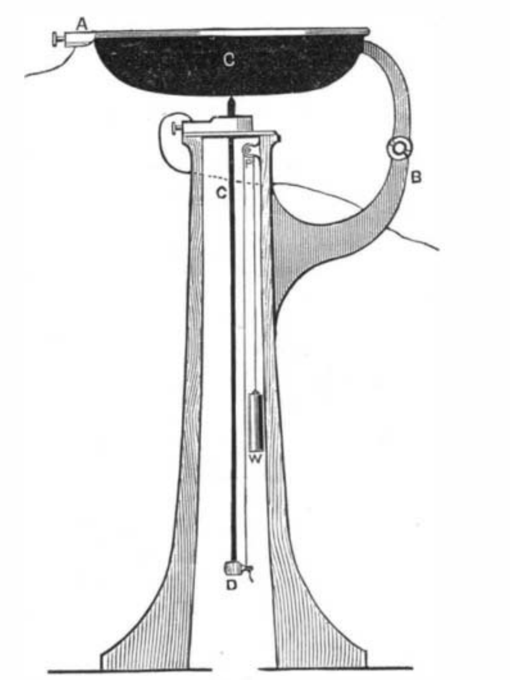

FIG. I

THE WERDERMANN LAMP.

electric lamps. Every one has accepted this as an axiom. Mr. Werdermann's skepticism has, however, caused him to doubt the axiom, and the result is that he has discarded the electric arc space, and by placing his electrodes in actual contact, has produced a lamp which provides the means of dividing the electric current, and promises to give almost any number of lights from a single machine. Mr. Werdermann's inventions, says the *Engineering*, are secured by patents considerably in advance of those of Mr. Edison, and may in their chief points be explained as follows:

In place of two electrodes of similar form and dimensions, one electrode consists of a large bun-shaped disk of carbon placed with the rounded face downward. The other carbon is a fine rod of carbon of about ⅛ or 5-32 inch in diameter. The upper end of this is pointed and maintained in contact

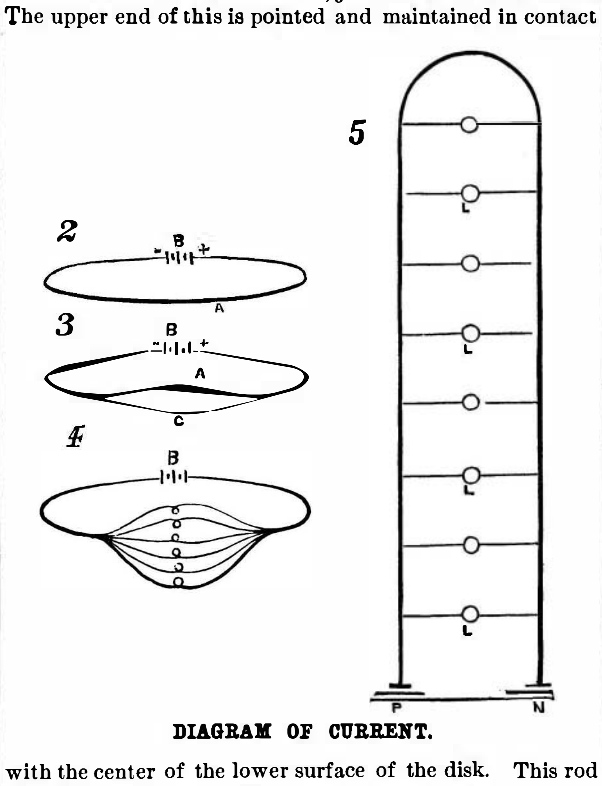

DIAGRAM OF CURRENT.

with the center of the lower surface of the disk. This rod is supported by means of a spring collar, which also forms the circuit connection. This is within about ¾ in. of the top of the carbon, so that the ¾ in. becomes incandescent, and the contact between the two carbons being only a point, a small electric arc is produced between the two carbons, while the electricity is at the same time passed on through the carbon disk, and the connections there attached to the next lamp.

Referring to our diagrams, in Fig. 1 the upper carbon is shown at C, and the rod carbon at *c*. The former is supported by means of an adjustable jointed bracket, B, attached to the wood stand. The rod carbon is guided by the spring collar on the top of the stand, and to which the connection is made, and is supported by the fine cord running over the pulley, P. This cord is attached to the clasp, D, at the bottom of the rod, and to the balance weight, W, by which the rod is maintained in constant, practical, though not absolute contact with the disk. Round the upper part of the disk is a metal band, A, to which the circuit wire is attached, and the current thus passed on to the next lamps.

At a recent trial of this lamp, the current was derived from a small Gramme electro-plating machine, requiring only 2 horse power to put it in full work. It may therefore be assumed that this was about the limit of the power at work to produce the light. At the commencement of the proceedings two lights were maintained, each stated to be equal to 320 sperm candles. At this rate the two lights would be equal to 640 candles, or 40 full power gas lights, each consuming 5 cubic feet of 16 candle gas per hour. Such gas lights, it may be observed, are not often seen, except in the argand form. The two lights burned with extreme steadiness, there being no undulation or flickering whatever, although there was no glass globe to tone down any variations of luster. The lights were perfectly bare and unprotected, and the place where the trial was made was a workshop of moderate size.

Later in the evening one light was exhibited outside the building, in an open thoroughfare, and the same perfect steadiness was observable. After the two lights had been burning for a time they were extinguished, and the current was sent through a row of ten lamps. The light per lamp was of course reduced, but there was the remarkable fact that ten lights were maintained by a comparatively weak machine, driven by an engine exerting the power of only two horses.

The light of each of these ten lamps was stated to be that of 40 candles, making, therefore, a total of 400. A reduction of light, consequent on the further division of the current, is thus apparent; but for this loss there may be ample compensation in the superior economy of a distributed light as compared with one that is concentrated. In the case of the ten lamps, the light is equal to that of 25 full power gas lights, consuming altogether 125 cubic feet of gas per hour. The extremely small arc due to the peculiar arrangement of the carbons in the Werdermann light has the advantage of offering the least possible resistance to the passage of the current.

This resistance increases much more rapidly than is represented by increase of distance between the carbon points. Hence the electric power with Werdermann's lamp is economized to the utmost in this respect, and it becomes possible—as in the recent experiment—to make use of an electric current large in quantity but of low intensity. The tension being small, there is the less difficulty with regard to insulation. If one lamp or more should be accidentally extinguished, the rest will continue to burn. The whole of the lamps can also be extinguished and relit by merely stopping the current and then sending it on again. No nice and troublesome adjustment with reference to the length of the electric arc is requisite, and simple contact between the point of the rod and the surface of the disk is sufficient for the manifestation of the light.

In respect to duration, a carbon rod 5-32 in. in diameter, and a yard long, obtained from Paris, costs a franc. This, placed in a large lamp, having an estimated lighting power of 320 candles, will last from 12 to 15 hours. The smaller lamps take a carbon of ⅛ in. diameter.

Mr. Werdermann endeavors to make the resistance of the external portion of the circuit equal to the internal resistance, in order to obtain the greatest effect. It is well known that the best results are obtained when the internal and external resistances are equal. The method adopted is that known to electricians as the divided arc, and will easily be understood from Fig. 2. Let B represent the source of the electric current, and A a copper wire connected to the positive and negative poles of the source as in the diagram. The wire, A, has a certain resistance. Suppose, now, we arrange for the current to pass as in the diagram, Fig. 3. By the insertion of the new wire, C, we have lessened the total external resistance and increased the current, as will be seen by reference to Ohm's law. $C = \frac{E}{R + r}$ where C = current; E = electromotive force; R = resistance external; r = resistance internal. The fraction $\frac{E}{R + r}$ increases as its denominator is lessened.

The current passes along the two branches in equal quantities if the resistances of the wires are equal, but inversely as the resistances if they are unequal. Thus, if the branch, A, has a resistance, 9, and C has a resistance, 1, 9-10 of the current will pass through C, and 1-10 through A. Similarly, for any number of branches the current will divide itself according to the resistances. If, then, we have a number of branches, as indicated in Fig. 4, the current will divide itself equally among the branches when the resistances of the branches are equal. This is the arrangement adopted by Mr. Werdermann, as will be seen from the annexed diagram, Fig. 5, in which N and P represent the negative and positive poles of the machine, and L L the electric lamps.

When any one lamp is put out the inventor arranges that an equivalent resistance shall be put into the circuit, so that as a whole the circuit is unaltered, and the other lamps unaffected.

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