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THE ELECTRIC SUBWAYS OF THE CITY OF NEW YORK.

On July 5, 1887, at the office of the Mayor of the city of New York, the Board of Electrical Control was organized, which is the successor to the Board of Commissioners of Electrical Subways. The name indicates its function; it is charged with the regulation of the distribution systems of the electrical supply, telephone, and telegraph companies of this city.

Both these organizations are the outcome of legislation looking to the placing underground of all the electric wires in this city. The Board of Electrical Control has supervision over both aerial and underground lines, and hardly anticipates success in having all wires placed underground, because in some parts of the city the demand for electrical service is so scant that it would not pay to place expensive conduits in such districts. In the present issue we illustrate the subways at present in use in this city, representing types which, it is fair to say, will probably be followed in general for many years to come. It consists of two elements, the manholes and the conduits.

The general system is the following: At regular distances throughout the streets where the conduit is to be placed, manholes are established. These are generally square or rectangular excavations lined with brick or iron. They are about 5 or 6 feet in diameter, and vary in depth according to the needs of the locality. There about 700 in the city, and hardly any two are identical in all respects. Some are rounded, six-sided, or diamond shape, although the rectangular outline prevails. A typical brick manhole is shown in Fig. 9.

They are capped with a heavy iron curb, and pro-

(*Continued on page* 246.)

Fig. 2.—FEEDING ELECTRIC LIGHT CABLES INTO THE DUCTS OF THE SUBWAY.

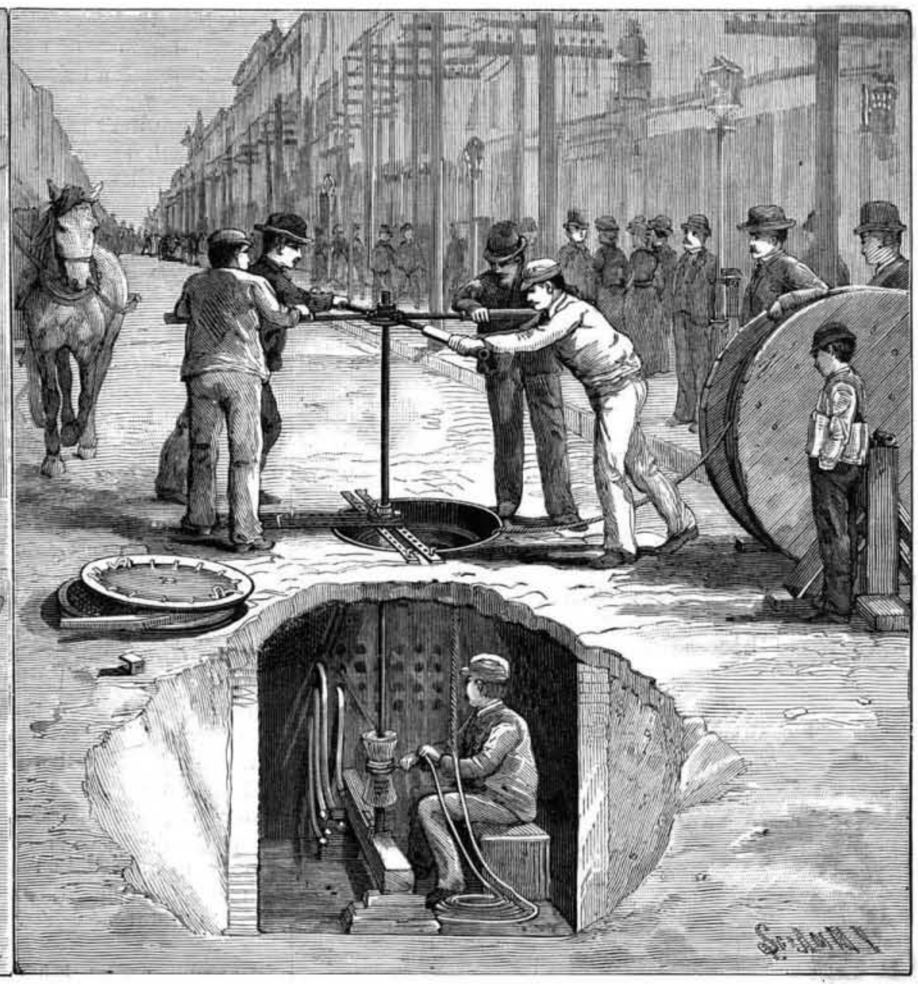


Fig. 3.—WORKING THE CAPSTAN FOR DRAWING CABLE INTO THE DUCTS.

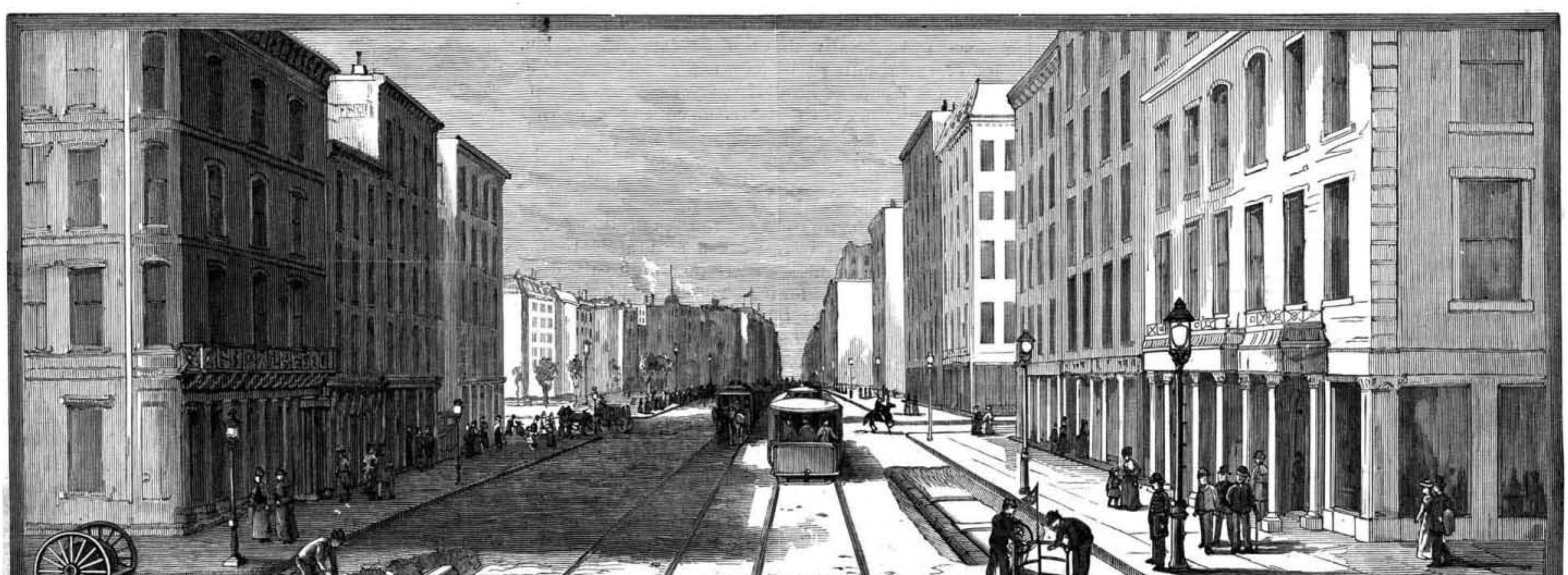
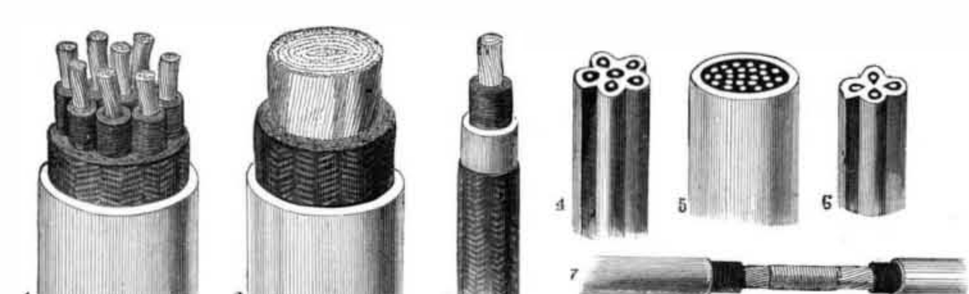


Fig. 1.—ELECTRIC SUBWAYS OF NEW YORK CITY, FOR TELEPHONE, ELECTRIC LIGHT AND POWER, AND TELEGRAPH SERVICE.

THE ELECTRIC SUBWAYS OF THE CITY OF NEW YORK.

(*Continued from first page.*)

vided with a double lid. The lower lid is held down in place by a gun-metal cross-bar and screw, and is provided with a tubular India rubber gasket, which is held in a groove and never leaves the lid. (See Figs. 2 and 3.) This gasket bears against a lip on the curb, so that when the lid is in place and the fastenings screwed, the hole is almost or quite hermetically closed. Above this inner lid comes the second lid, which is loose, and which lies flush with the pavement of the street. These manholes are placed about 250 feet distant from each other. They average one for each street block.



1. Eight-lead arc light cable. 2. Incandescent light cable. 3. Single-lead arc light cable. 4 and 6. Fire department cables. 5. Telegraph cable. 7. Splice in arc light cable.

Fig. 4.—DIFFERENT FORMS OF SUBWAY CABLES.

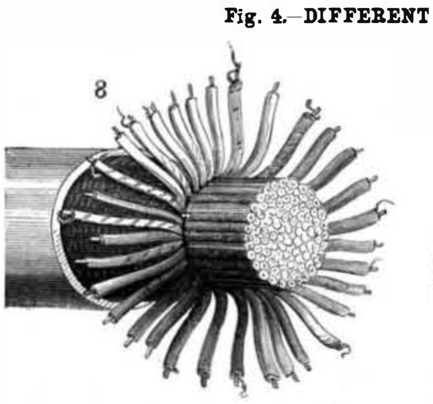
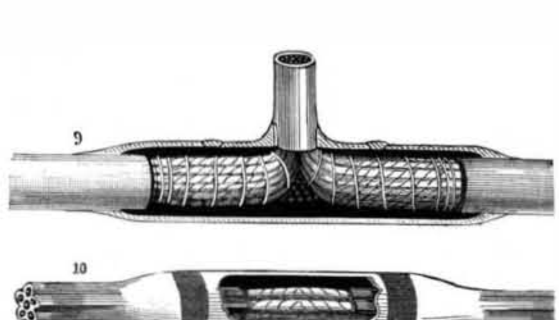


Fig. 5.—TELEPHONE CABLE OPENED FOR SPLICING.



9. Branch connection with cable. 10. Splice in cable.

Fig. 6.

From manhole to manhole a number of pipes are carried, 2½ to 3 inches in diameter. These pipes are generally of wrought iron of the type of gas or steam pipe. They are asphalted inside and out, or coated with some equivalent protective material. On each end they are threaded, forming slightly tapering screws. They are connected by means of sockets as usual in steam or gas fitting, and are screwed up powerfully, so as to bring metal against metal, forming the most perfect joint that can be made in this class of pipe. When in place they are embedded in concrete. Thus, taking the system as a whole, we find at every block a manhole, the iron or brick lined excavation already described, and connecting the manholes are a number of wrought iron pipes embedded in concrete. As a matter of nomenclature, the pipes are called ducts ; the system of pipes and the concrete in which they are embedded is termed a conduit ; and the whole system of ducts, conduits, and manholes together is termed an electric subway.

The method of laying the concrete conduits may now be given. Its direction is first determined, and the pavement is removed over the line ; a trench is then excavated in the street to a depth which may vary from 3 ft. to 5 ft. The bottom of the trench is first leveled to the determined grade. This, of course, is subject to wide variation, because the streets are at present so occupied with gas mains and water pipes that very wide departures from what would be the normal level have to be made to meet these exigences. The bottom of the trench is then well rammed, and planks are laid against the side, in order to prevent it from caving in. A layer of concrete is put in place and rammed home. On this is placed a horizontal series or row of the iron pipes, which in turn are covered with a second bed of concrete. A second row of pipes is placed upon the new concrete base, and they are covered with a third bed of concrete. Any number of pipes may thus be embedded. A typical subway would give a breadth of five lines of pipe and a height of four layers, but the system lends itself to any number.

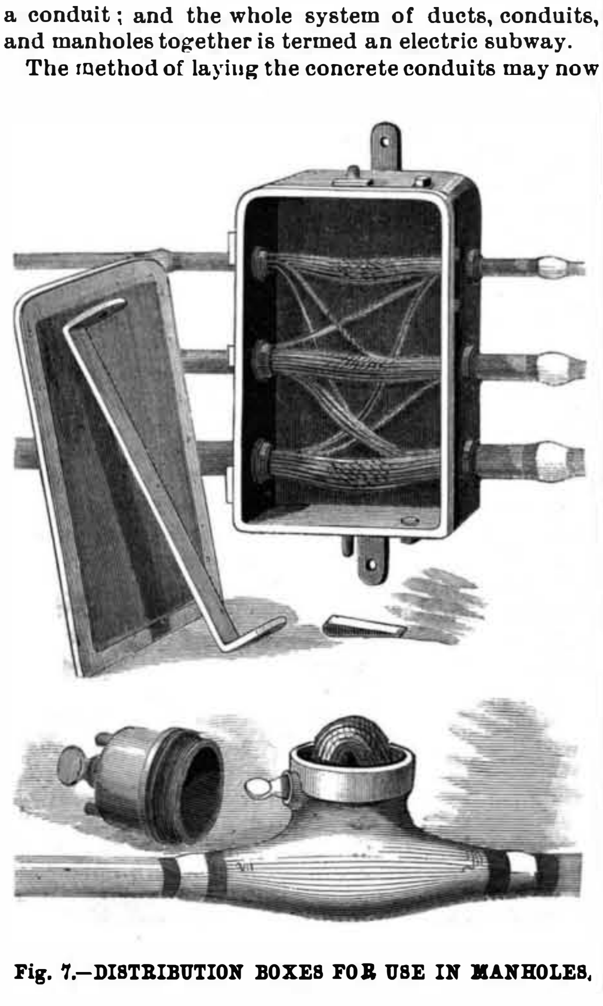


Fig. 7.—DISTRIBUTION BOXES FOR USE IN MANHOLES.

When the cement, which is the best American cement that can be procured, has set, so that the concrete is hard, the whole forms a homogeneous monolithic mass. The concrete on the bottom, sides, and top of the subway is far thicker than between the pipes, so as to form a better protection. Above the concrete, 2 inch yellow pine planks are laid, which have been creosoted with from 12 to 16 pounds per cubic foot. This is designed to protect the structure from injury by pickaxes or crowbars in the hands of workmen excavating for any purpose. When it is considered that the pipes used are lap-weledd, and can withstand an internal pressure of 500 pounds to the square inch, and, naturally, a very much higher external pressure, the great strength of the conduit will be apparent at a glance.

The conduits being laid and manholes built, completing the subway, the next problem is to introduce the cables into the ducts. These cables vary greatly in size and arrangement of wires, and we illustrate a number of sections in the cuts, Figs. 4 and 5.

In Fig. 4 the general type will be seen to comprise the conductors surrounded with insulating and wrapping material incased in a pipe of lead or of lead and tin alloy. The arc light cable contains sometimes eight leads. The incandescent cable is of very large capacity, consisting of a multiple wire conductor insulated and protected with the lead coating. The Fire Department cables are fluted in outline, and one rib is pointed or angular on one shoulder. This gives a means of identifying the leads ; calling the one under the angular rib No. 1, the others in regular order are designated as No. 2, 3, etc. The method of splicing arc light cables is also shown in the cut No. 7 and in Fig. 9. The ends are brought together and lapped and wound with wire, and solder is applied to secure the most perfect electrical contact. A telephone cable is shown in Fig. 5. It contains wires that are individually insulated only. Different colored wires are used to facilitate identification. These admit of easy separation for splicing purposes or for making side connections. The Metropolitan Telephone Co. generally uses a cable containing the wires arranged in pairs and each pair twisted. The ultimate use of these is for metallic circuits, the twisting tending to diminish induction.

The cables have now to be drawn into the conduits. This operation is illustrated in Figs. 1, 2, and 3. The workmen are supplied with a number of rods of wood, each about 3 feet long, and tipped with brass male and female screws at the ends. Entering a manhole, the workman pushes one of these into a duct into which a cable is to be introduced. He screws another rod to it, and pushes it about 3 feet farther, or its own length, screws another rod to that, pushes it in, and soon until a line of rods screwed together reaches through the conduit to the next manhole, perhaps 250 feet distant. These rods are shown in Figs. 1 and 3. A small line is attached then to the last rod introduced, and a workman at the further manhole withdraws the rods, unscrewing them as they come out, until he gets the end of the small line. To this a strong rope is attached, which is drawn through. The end of the cable is fitted with an iron loop screwed fast to it. Brass bushings are placed within the end of the duct, provided with shoulders to prevent their being drawn into it. These prevent the sharp edge of the iron pipe from marring the metal coating of the cable. The rope is now fastened to the loop, attached to the cable, the end of the cable is passed down into the manhole, and made to enter the duct through the bushing, and the rope is drawn through from the other end, the cable following it. Of course, great power is required to do this, on account of the stiffness of the cable, and we illustrate in Fig. 3 the form of capstan used in drawing the cable into the duct. It will be seen that the power of four or more men may be required in turning the drum. Where care has not been exercised in laying the pipe, burrs may exist at the couplings. These materially increase the friction where they exist. The ends of the pipes should be smooth internally, and any projecting metal should be removed by filing or reaming. As a general rule, the cable is cut in pieces, so that a single length is enough to reach from manhole to manhole, with an allowance for splicing. In many cases the cable is of double length, when it is fed into the manhole, both to right and left, its loop or bight gradually disappearing into the manhole, and being gradually straightened out in the operation. It is often necessary to use a blower, to expel gas and bad air while work is going on. This plan is adopted when a manhole contains so much gas as to render work in it difficult. It is seen in Fig. 1.

The ends of the lengths of cable thus introduced have now to be joined. To do this, they are opened, the wires for a few inches are stripped of their insulation, and connected. The joints thus made are wrapped, in the case of telephone or telegraph cables for each individual wire, with insulating tape, and a lead sleeve previously passed over the cable is slid over the joint. Wiped joints are now used to secure the whole, so that the joint is as strong and water-tight as any other part of the cable. The operation is shown in Fig. 9.

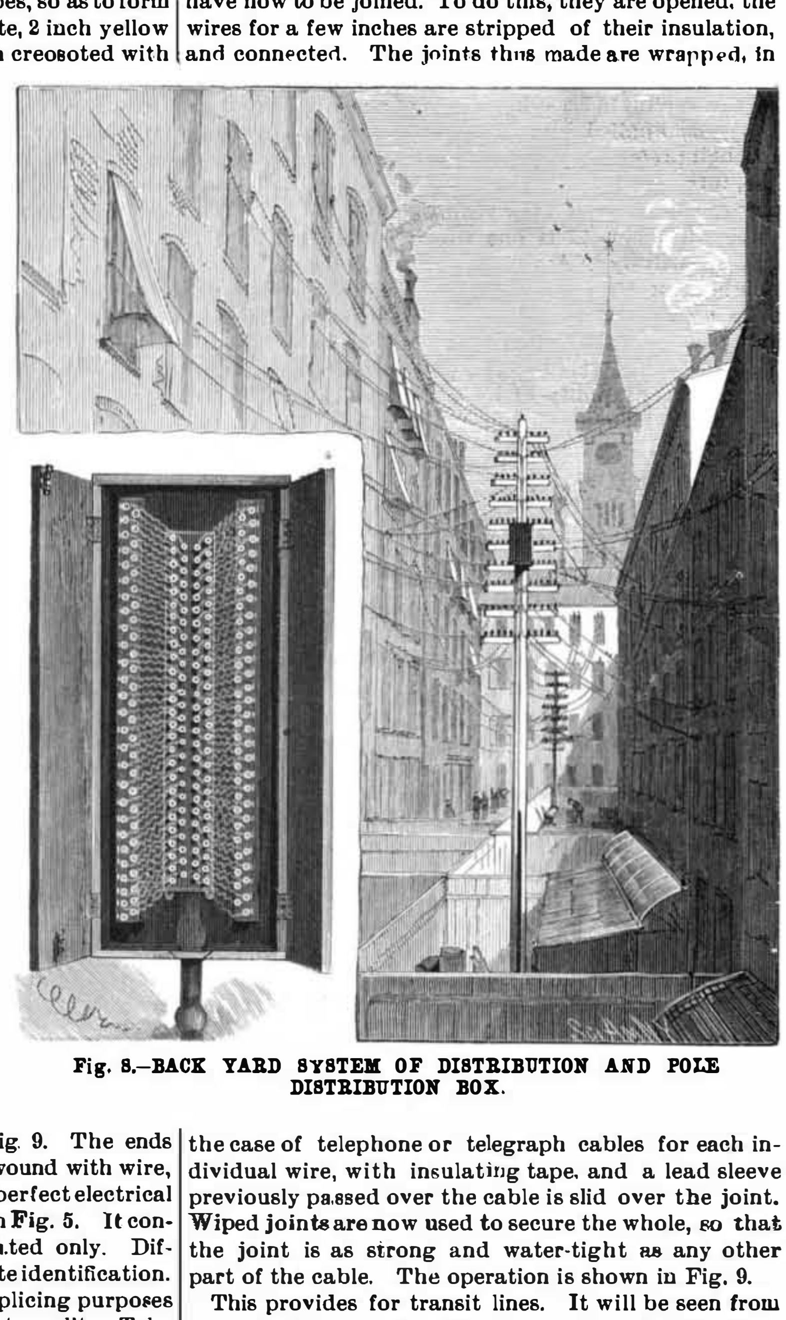


Fig. 8.—BACK YARD SYSTEM OF DISTRIBUTION AND POLE DISTRIBUTION BOX.

This provides for transit lines. It will be seen from the cuts, Figs. 6 and 7, how the cables lend themselves to lateral leads. The cable can be opened and any desired wire picked out for side connections. For use in the manholes, distributing boxes, shown in Fig. 7, are provided, which allow perfect freedom for the with-drawing and distributing of specific wires from the manhole as a center. Hand-holes, shown at bottom of Fig. 7, are used for distribution from a single cable only. The transit ducts included in the conduits, as described, are supplemented by external lines of pipe, laid above the creosoted plank work, directly in the earth, which are termed distributing ducts. These are to provide for local service, and at intervals they have hand-holes, which are hollow castings similar to the lower box in Fig. 7, giving access to the wires, to which castings pipes are connected leading into the separate buildings or to the different lamp posts. These last named pipes are termed service pipes.

For private house distribution, the house top or back yard system is adopted. For the first named as many leads of cable or wire as requisite are taken out of the manhole and carried up the front wall of a building to its roof and thence distributed where needed. The back yard system, shown in the cut, Fig. 8, involves the erection within the block of a single distributing pole. The cable is brought to it from the manhole, preferably by an underground and cellar route, and carried up to a distribution box shown in the same cut. Entering this box the cable is opened and its wires distributed and carried to the cross arms of the pole and thence to the houses requiring the service.

The kinds of current to be provided for resolve themselves into two—high and low tension. The low tension represents telephone and telegraph service; the high tension, the electric power and light leads. When it is necessary to have both kinds of current in the same street, two main conduits are laid, one for each type of service, and they are placed on opposite sides of the street. Furthermore, the rules of the Board of Electrical Control do not permit the use of wires in the same cable which differ in potential from each other more than 500 volts.

Other forms of subway are in use. The Dorset conduit,* made entirely of asphalt concrete without iron ducts, was one of the earliest forms laid. This presents the peculiarity of insulating the cable covering. The regular conduit grounds it, through all that lies within the ducts. The Johnstone subway, seen in Figs. 1 and 2, made of sectional iron castings for conduits and manholes, has also been used, and is approved of by the commissioners. It grounds the cable coverings. Wooden pipes have also been used in the concrete ducts instead of iron ones. On account of the recent gas explosions the manholes will probably be ventilated, so as to permit any accumulation of gas to escape into the air through a pipe reaching well above the street attached to an electric light pole.

These conduits have been laid by a construction company, as the Board of Electrical Control and their predecessors have had no authority to spend money for such purposes. The construction company, for its return on the investment and general expenses, relies on the revenue received for the use of these ducts. The rental has been based on the use of a single duct per annum and per mile. It will be clear that as each duct can carry six electric light wires, when each wire is in a separate lead-covered cable, and that when the wires are in a single cable eight wires can be contained in a 2½ inch duct, a fairly remunerative rental will not be extravagant. As regards telephone service connection, the cable introduced containing some fifty double wires arranged to provide for through metallic circuits, it follows that on a ground system 100 telephone wires can be provided for by a single duct. The entrance of the telephone cables from the subway ducts into the central station building in Cortlandt Street is shown in the SCIENTIFIC AMERICAN of March 30, 1889.

To give an idea of the extent of work, the figures from the report of the Board for the past year may be quoted: 240,155 feet of trench have been excavated, giving 2,287,880 feet of single duct transit and distributing and central station connections. Allowing 80 wires to the duct, this gives a capacity for telephone and telegraph service of nearly 35,000 miles of wire, long enough to go nearly one and a half times round the earth. For lighting and power service, 316,796 feet of single duct, with a capacity of 600 miles of wire, had been laid by the end of 1888. The Edison incandescent conduit is separate, and represented 338,376 feet, with over a million feet of conductors.

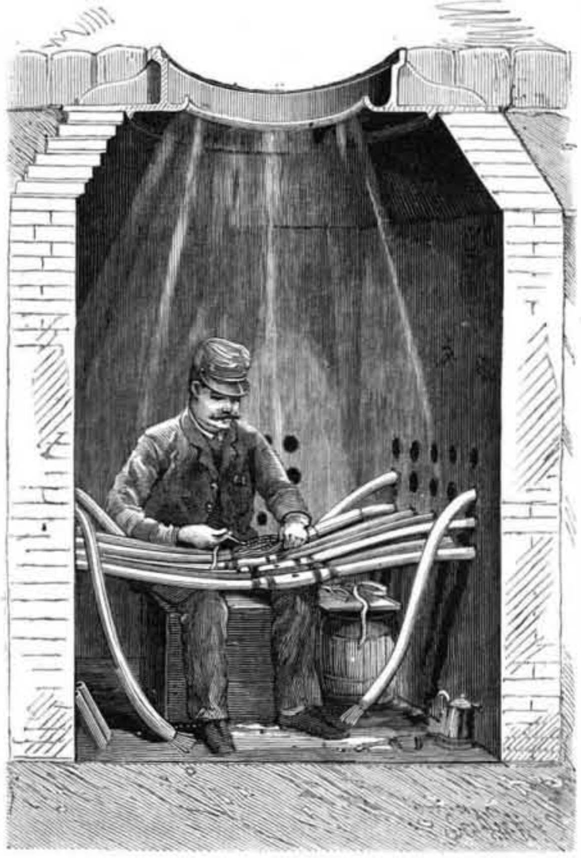


Fig. 9.—SPLICING WIRES AND CONNECTING CABLES.

* See SCIENTIFIC AMERICAN, October 9, 1886.

MICHEL EUGENE CHEVREUL.

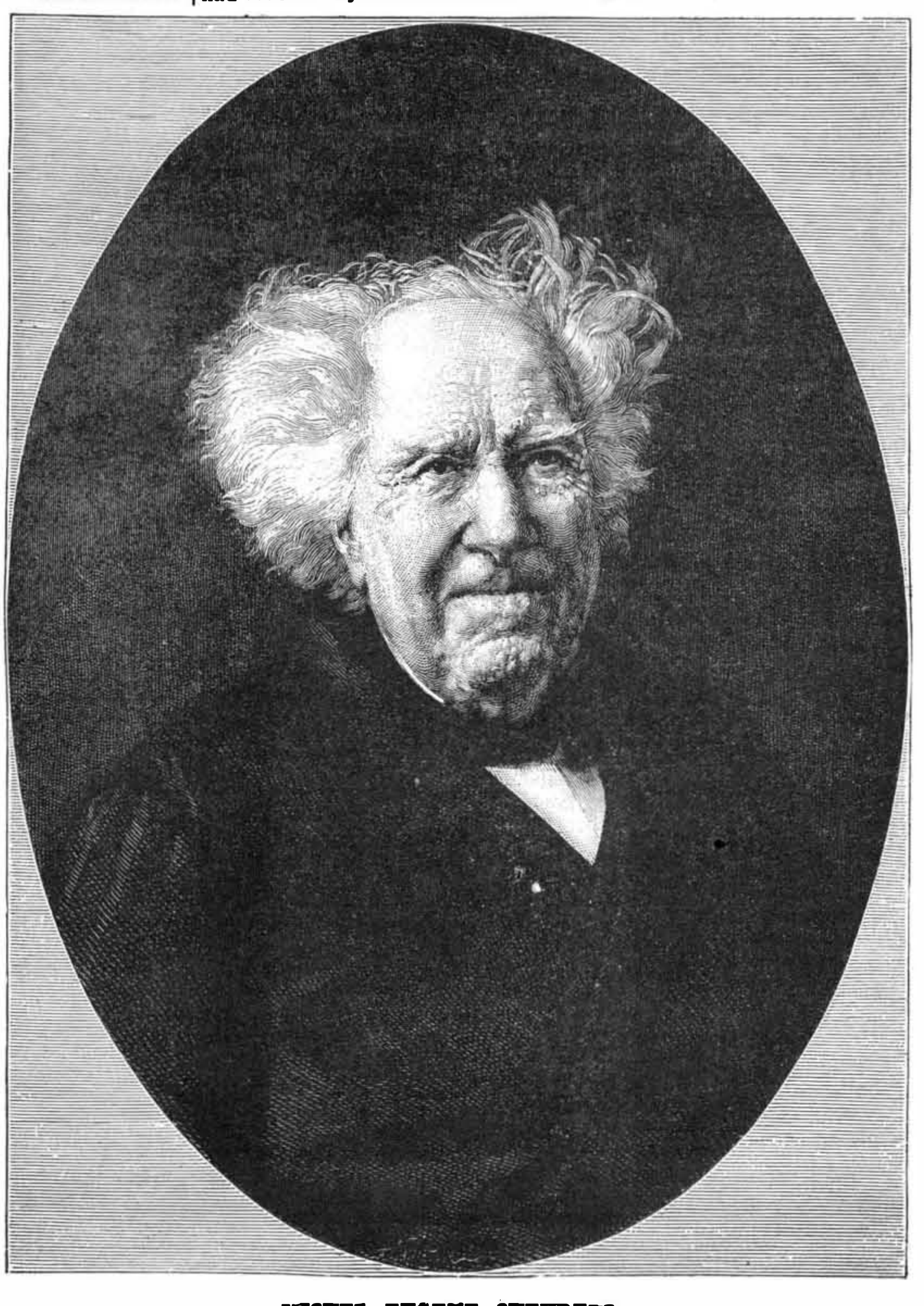
This distinguished French chemist died in Paris on Tuesday, April 9, at the great age of 102 years 7 months and 9 days. His strength had been failing for some months, but his friends had not been without hope that he would live till the 31st of August next, to celebrate the completion of his 103d year. His son, Henri Chevreul, died a few weeks ago, 70 years of age.

The date and place of M. Chevreul's birth are well authenticated. He was born at No. 11 Deux Haies Street, Angers, an old city of France, at 8 o'clock in the evening of August 31, 1786, the record bearing the attestation of many witnesses. The parents were both persons of some distinction, the father being a physician and a professor, and living to the age of 91 years. The mother died at 93 years of age. M. Chevreul's memory of his early life was also remarkable, and he used to relate having been the witness of the guillotining of two persons in 1793, when he was but seven years old.

M. Chevreul studied at a central school in Angers from the age of 12 to 17 years, thence going to Paris, where, in 1797, he was admitted to Vaquelin's laboratory, taking his place among several students who were afterward to win a high place as chemists. At the same time Chevreul was giving instruction in another college, and four years afterward became preparator at the Museum. At the age of 30 he was appointed director of the dyeworks and special professor of chemistry at the Gobelins. In 1814 he demonstrated that oils and fats were formed of a mixture of several peculiar principles, including margarine, oleine, and stearine, the latter furnishing stearic acid, and giving rise to the industry of making stearine candles. M. Chevreul's further labors upon fatty bodies and saponification aided also in creating other new industries, besides much enlarging the field of organic chemistry.

In 1842 M. Chevreul assumed charge of the dyeing operations at the Gobelins and Beauvais establishments belonging to the government, and his researches and valuable discoveries touching colors have been almost continuous from that time to this. He has shown that the harmonies of colors are submitted to immutable laws, which may be demonstrated by calculation. His laboratory was a vast room surrounded by show cases, in which were kept specimens of his work, and numerous parcels sent him by various industries, with closets containing various specimens of coloring matters, test tubes, graduates, glass rods, balances, etc. It is not too much to say that there was but little work of much importance, during the past half century, touching the dyeing industries, which his researches did not cover in the extraction, fixation, and observation of colors.

He was examiner for many years at the Polytechnic School, and had always been president of the National Agricultural Society. Up to 1855 he had been a member of the jury of every French exhibition. A member of the Legion of Honor, commander in 1844, grand officer in 1865, grand cross in 1875, he has had all the grades that any scientist could be covetous of. The foreign decorations that he received would cover his entire breast. But honors never elated the indefatigable worker, who was ever studying, and remained more than ever, at the age of over one hundred, the dean of the students of France and of the entire world. The life of the centenarian was passed between the Museum of Natural History, the Gobelins, and the Institute of France. He never failed to be present at the Monday sessions of the Academy. The number of memoirs that he presented to his colleagues is almost incredible. He was never desirous of being a politician, but during the Franco-Prussian war (1870–71), at the age of eighty-six, he willingly endured the pri-



MICHEL EUGENE CHEVREUL.