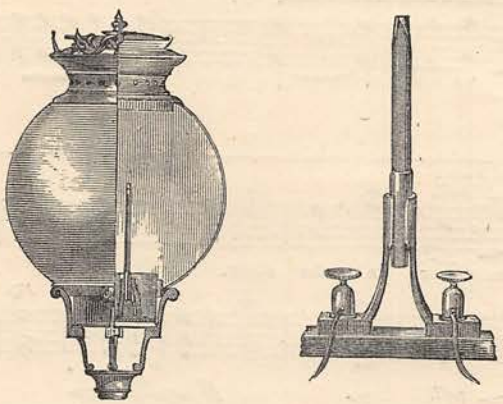
THE ELECTRIC LIGHT AT THE PARIS EXHIBITION.

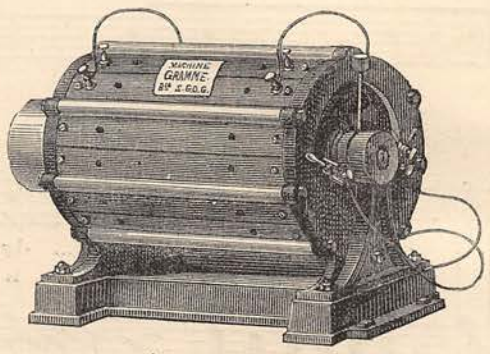
BY J. MUNRO, C.E.

ELECTRICITY is rapidly becoming the most important of all the physical sciences. The steam-engine and the development of railways have given a great value to the science of heat during the last fifty years, but the future plainly lies with electricity. With the steam-engine and the electric telegraph, as triumphs of the Victorian era, we usually class gas-lighting; but electricity already bids fair to compete with coal-gas for lighting purposes, and, as some contend, may even at some remote period drive it from the field. Similarly in the more remote future electricity may out-rival steam, and relegate the marine engine and the modern locomotive to the limbo of past inventions; for the fuel of electricity is of light weight compared with coal, a matter of great moment where fuel has to be transported by the motor itself. As coal becomes more expensive, electricity becomes cheaper; and it is not making any prophecy to say that, by-and-by, our heating, as well as our lighting and motive power, may be produced by electricity. Man takes and uses first the source of energy nearest to his hand, but when that begins to fail, he develops some deeper and more occult source. Thus wood, wind, and water have yielded their place to coal and steam, which may in turn yield their place to electricity. The fine display of electrical apparatus at the Universal Exhibition at Paris, this year, exhibits in a striking manner the growing empire of electricity. The electrical apparatus at the Paris Exhibition may be broadly classed into two groups—namely, those relating to telegraphy and those relating to the electric light. We shall glance at the most prominent and interesting exhibits of these groups in turn.

The subject of telegraphy in the French department of the Exhibition has a special annex (numbered 65 in the catalogue) all to itself. The foreign telegraphic exhibits are, on the contrary, scattered about anywhere in the respective national sections to which they belong. The French display is very fine, but the foreign show is miserably deficient for some reason or other. England, which is justly regarded by all peoples as the birthplace and head-quarters of the electric telegraph, is represented in a meagre manner by some well-known apparatus, but no novelties—a fact significant to some people of the fatal blow struck at telegraphic invention in this country by the union of the old rival telegraph systems under a Government monopoly. Telegraphic invention languishes in England at present, while America, with her competing telegraph companies, is astonishing the world by her telegraphic novelties. A commission of eminent electricians, appointed to examine and encourage new inventions by grants of money, would do much to counteract the repressive influence of the Postal Telegraph monopoly. Such a commission exists in France, where the telegraphs are also a Government monopoly, but not in England. The result of this wise arrangement is seen in the number of novelties which are on view in the French Telegraphic Annex at the Exhibition.



JABLOCHKOFF'S ELECTRIC CANDLE.



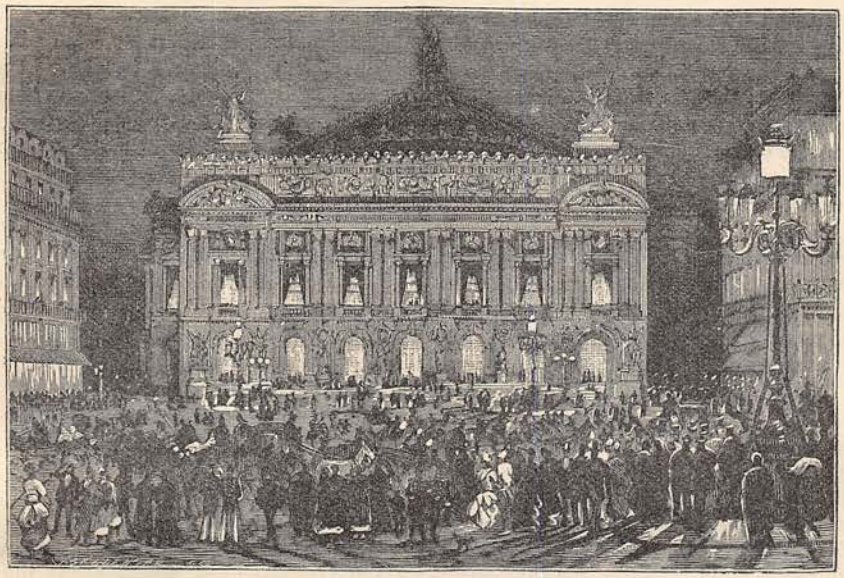
GRAMME'S ELECTRO-MAGNETIC MACHINE.

The annex is a spacious hall, lined all round the walls with the handsome stalls of the exhibitors. The central area is occupied by tables covered with the apparatus employed on the French postal telegraph lines. In the centre of the hall rises an ornamental column of "hard rubber" or ebonite, a kind of electrical trophy, surmounted by a golden globe and semaphore, and wound with a scroll on which are inscribed the names of a few of the most famous electricians, conspicuous among which is that of Bain, the Edinburgh clock-maker. Construction tools, specimens of wire, cables, insulators, poles, lightning rods, batteries, telegraph instruments of all kinds, electric bells, telephones, models and maps of telegraph and pneumatic despatch lines, electric motors, alarms, and the thousand and one things to which electricity can be usefully applied are represented here. The telegraph system in France is a very large one, the revenue arising from it being nearly twenty million

francs a year. It is conducted on much the same footing as our own, but with this difference, that a private person may do his own telegraphing if he obtains the necessary permission from Government.

The telegraph instrument most used in France is the Hughes Type Printer, which prints off the message as it is received in Roman characters, so that a Frenchman receives his telegram printed in blue capitals on slips of paper by the electricity itself. We in England have long ago abandoned this method as too slow; but the continental peoples have retained it, and, of course, improved upon the original instrument, so as to bring up its speed of working. By the recent inventions of M. Meyer, M. Baudot, of the French telegraph service, and M. Olsen, of Christiania, the original Hughes instrument, forsaken by us, has attained a power of transmission which enables it to compare not unfavourably with our "Wheatstone Automatic Morse" and duplex instruments, which mark the message in "dot-and-dash" signals.

M. Meyer's invention consists in sending five or eight messages along the same wire concurrently. We use the word concurrently to distinguish it from the duplex, quadruplex, or, in a word, the multiplex systems of sending messages. In the multiplex systems, the signals of the five or eight messages would actually be flowing along the wire simultaneously; that is to say, eight dots or eight dashes would pass over the wire together at the same instant. But in Meyer's system, although the result is the same, the manner is different. The eight messages are really being passed over the wire in a group, but the separate signals do not traverse the wire at the same instant as in the multiplex method. The eight separate signals, one for each message, really follow one another in Meyer's mode, but in this way, that one signal of a message is sent at a time; and, before another signal of the same message is sent, a signal of each of the other messages in order has to be sent. For example, Meyer's instrument first sends a signal of the first message, then it sends a signal of the second, then a signal of the third, and so on, till a signal of all the eight has been sent. When this has been done it sends the second signal of the first message, followed by the second signal of the second, and so on as before. In this way the eight messages are being sent concurrently and yet in fragments, one by one. This is effected by an apparatus called a "distributor," which causes the end of the line or wire to sweep over the eight keys which send the message one by one and thus pick up the signal ready for it on each key. The keys are set round in a circle, and the end of the line continuously revolves, so as to come in contact with them one by one, and take up the signal currents which they present to it. These signal currents travel to the receiving station, and by a similar arrangement they are distributed to eight receiving instruments, each corresponding to its proper key. Thus the signals sent out by any particular key are recorded by the particular receiving instrument corresponding to it. In order to effect this it is necessary that the two ends of the line should revolve in time with each other; but this is managed by means of clock-work. The swiftness of the distributor enables a considerable speed to be attained on this instrument. By means of an improvement on Meyer's system, M. Baudot is enabled to send ten letters per second, or 100 words per minute—that is, 300 messages, of twenty words each, per hour, a speed rivalling the "Wheatstone Automatic Morse" when worked on the quadruplex system—*i.e.*, two messages going one way along the wire, and two going the opposite way, at the same time. The apparatus of M. Olsen is an automatic printing instrument on the model of Hughes', but with some important differences, which give it a



THE PLACE DE L'OPÉRA ILLUMINATED (*p.* 754).

gain in speed of 33 per cent. over the ordinary Hughes instrument; and since the distributing system of M. Meyer can be applied to Olsen's apparatus so as to enable the latter to send five or eight messages together, it is likely to become a favourite instrument in the future.

The chief feature of the electrical show in the section for instruments of precision was, however, the apparatus for electric lighting. This comprised the dynamo-electric machines for generating the electric current required, the lamps for regulating the light, and the carbon "points" or "wicks" which are heated to a white-heat by the passage of the current, and yield the glowing "electric arc" or source of the light. The principal machines are those of Jablochkoff, Lontin of Paris, Siemens of London, and the Brush machine of America. The electric lighting of the present, in all parts of the world, is mostly done by these machines in the respective countries to which they belong. The splendid beams of the Lizard Lighthouse are born in the dark womb of a powerful Siemens machine. The rich clusters of moon-like lamps, now illuminating the handsome squares and buildings of Paris with enchanting effect, are fed by the unwieldy machines of Jablochkoff.

The best regulating burners are those of Foucault, Serrin, and Dubosq. The best carbon wicks are those of M. Carré and M. Gaugain. They are formed of fine willow and poplar charcoal, or baked carbonaceous compositions, such as willow-sawdust or sifted gas-carbon dust kneaded with molasses or sugar, then baked.

Dynamo-electric machines, regulators, and wicks are now so perfect that it is only the difficulty still experienced in "dividing" the electric light so as to make it feed a number of separate lamps, as gas can be made to feed numerous burners, which stands in the way of its more rapid adoption for the general lighting of streets. For the special illumination of large areas and great thoroughfares it is quite efficient at present, and is indeed being rapidly introduced; for its singular merits as an illuminator, its power and beauty, its freedom from destructive and hot emanations, as well as its cleanliness and economy, are becoming universally recognised. But, in addition to this, there are already several ingenious arrangements devised for dividing the light, and we may confidently expect that electric lighting will soon enter into a serious competition with gas for the lighting of the streets of cities. Every visitor to Paris this year can see for himself the attempt to solve the problem of street-lighting by electricity on a large if not a convincing scale. The fine Place de l'Opéra in front of the magnificent Opera House, and the noble Avenue de l'Opéra leading up to it, are nightly illuminated by large globes of opal glass glowing interiorly with the rich, soft effulgence of Jablochkoff's electric candles. As compared with the yellow and feebler gas-flames near them, they look like clear full-moons beside a host of minor stars. Yet the contrast of the golden and silvery light of the two illuminators is pretty in itself when seen in the pure air of a Parisian summer evening, and lends a richness to the architecture of the beautiful city. The whole area of the Place and Avenue is bathed in a uniform flood of brightest light resembling noon-day; the most delicate tints of the Parisian ladies' costumes (and even, alas! the spurious roses on their cheeks) can be distinguished as well as in daylight. There is no meretricious dazzle or startling black shadows, as some have prophesied; but on the contrary, the light is soft, diffused, and grateful to the eye, and the shadows shrink into nothingness under the feet. At many others of the most frequented resorts in Paris, the Place de la Concorde, the Arc de Triomphe, the Place du Châtelet, the façade of the Madeleine, the Magasins du Louvre, the Théâtre Français, the Belle Jardinière, the Théâtre de l'Orangerie in the gardens of the Tuileries—where the famous tragic actress, Mademoiselle Sarah Bernhardt, plays—the Trocadéro Palace, and many other places are illuminated with Jablochkoff's candles. Amid the green foliage of the boulevards and summer gardens of Paris these moon-like globes of delicious light, seemingly hung in the air of the cool and leafy groves, create a scene which reminds the spectator of the happy earthly paradises told of in the "Arabian Nights."

The display of Jablochkoff in the city itself, and in the special annex which the company working his light have fitted up at the Exhibition, cannot fail to impress thousands of visitors from all parts of the world. Jablochkoff's machines are heavy, and his system is consequently expensive; but, as the pioneer system, it is a complete success. The candle consists, as is now well known, of two sticks of carbon placed side by side, with a stick of pure porcelain clay or kaolin intervening. The current is made to flow up one carbon stick and down the other; and, in order to do this, it has to pass across the top of the middle stick of kaolin, in doing which it heats the kaolin into a soft lambent glow, which yields the light. Both kaolin and carbon waste away and burn down; and as the carbon up which the current flows tends to waste away much faster than that down which it flows, Jablochkoff's machine is so constructed as to yield rapid alternations of positive and negative currents, which comes to the same thing as saying that the current alternately reverses its direction, flowing first *up* one stick and *down* the other, then *up* the other stick, *down* the first. In this way the candle burns down equably. Four candles are required to burn eight hours—that is, during each night. When one candle burns down, the next automatically lights itself in such a way that there is no momentary eclipse of the light; but only a slight reddish tinge is visible whilst the change is effected. No attendance on these candles is required. It is only necessary to daily insert the four candles provided for night; and when the hour of lighting-up comes, to start the machine, when the candles at once begin to glow brightly. Each machine feeds as many as sixteen candles.

The progress of the electric light is more rapid in France, the Continent, and America than in our own country, but it is now making its way even here. The Gaiety, and other theatres in London, private

factories, public seats, river-buoys, docks, men-of-war, and lighthouses are now being lit by it. Polo matches and garden *fêtes* have taken place by night under its happy auspices. Street and square illumination by its means is a subject seriously engaging the consideration of town magistrates; and we hear that in Dundee it is proposed to light the streets by electricity derived from a machine driven by the water-power of the "Reekie Linn," a neighbouring cascade. The field for the electric light, entirely outside the purposes of gas, is of the widest kind, since it is a kind of artificial day, and far exceeds ordinary lamps and gas in its extent of applicability. It will enable all kinds of employment to go on by night as well as by day, if such a course be advantageous; and it will even relieve the long darkness of semi-arctic winters by an artificial sunshine.

It is not to be assumed, however, that electric lighting will speedily sweep away gas-lighting; and we are not of those who, panic-stricken themselves or counting upon the fears of others, are writing as if all gas property was in danger of permanent deterioration. Electricity has first to become a wholesome and vigorous competitor. The electric light is quite ready at present to be adopted with splendid effect in wide areas and public squares, as Brussels, Madrid, St. Petersburg can testify; but as yet it has serious drawbacks for general street illumination. The chief of these is the practical difficulty which exists in distributing the light to a number of lamps, and conveying the electricity to a distance; for, unlike gas in pipes, electricity rapidly loses power in traversing the wires which lead it, because of the electric resistance of the conductor to its passage. To obviate this difficulty, it is necessary to have a considerable number of machines or electric sources, and this causes a considerable first outlay. According to the recent report of Mr. Stayton to the Chelsea Vestry, in order to light the Chelsea Embankment, which is 1,530 yards long, and has 109 gas-lamps, by Jablochkoff's system, three electric stations would be required, each having a 16 horse-power engine, and a "Gramme" dynamo-electric machine. The installation of these would cost £4,800, and to provide coal, oil, waste, and wages for the 48 lights produced, during 3,250 hours per annum, the hourly cost would be £1 4s. As against this, the present cost of the 109 gas-lamps employed is only 2s. 1½d. per hour, for 3,850 hours per annum. It should be taken into account, however, that the 109 gas-lamps only give a light equal to 1,500 wax candles, whereas the 48 electric lights would yield a light equal to 24,000 candles. So much for Jablochkoff's system, which is the most expensive of any. Mr. Hollingshead, to whom we are indebted for the fine Lontin lights burning nightly in front of the Gaiety Theatre, Strand, states that M. Lontin is prepared to light an area 1,540 yards long and 44 yards wide (a slightly larger area than the Chelsea Embankment) by 36 electric lamps, having an illuminating power equivalent to 2,000 gas-lamps, at an hourly cost of 10s. 6d. Thus, in place of 109 gas-lamps, the public would get a lighting power twenty times greater at a cost only five times greater.

These figures represent the question of cost for street-lighting; but for open areas, such as Trafalgar Square, the experience of Paris, even with Jablochkoff's system, is that the hourly cost of the electric light is less than gas, even although several times the amount of light is given.

The original cost, the difficulty of dividing the light, and inconvenience of installing machines, are therefore against the ready introduction of the electric light. These are, however, all difficulties which can be overcome, and the intrinsic superiority of the light over gas is unquestionable. The fact that it does not heat or consume air gives it an important hygienic virtue; the fact that it does not disguise colours gives it an industrial value; while its pure splendour requires only to be seen to be appreciated. Sir William Thomson, our highest electrical authority, has said that "he believed it would be possible to carry the electric energy to a distance of several hundred miles." Thus, towns by-and-by would be lighted by means of coal-dross, burned at the pit-mouth, and highland villages by power derived from the nearest waterfall.

This, however, is a view into the future. At present it can only be said that for street-lighting it is too costly to rapidly supersede gas, but for public squares and large works it is fully capable of supplanting the latter already. It is at least fairly equipped as a vigorous and promising competitor against gas, and if gas is to hold its own for any length of time, it will have to exert itself. We owe much to the old system of gas-lighting, and its cognate industries, such as the manufacture of ammonia and the bright aniline dyes, and it is very probable that the rivalry of the electric light will cause improvements in the manufacture of gas to be effected, which will enable it to maintain much of its old importance. Thus, whether the electric light be adopted, or gas-light improved in quality and reduced in price, the public at large cannot fail to be a gainer.

Before leaving this interesting subject we must not omit to notice an application of the electric light on a very diminutive scale, which is to be seen at the Exhibition—namely, Trouvé's "Polyscope," a medical appliance. It consists essentially of a small "secondary battery," or electric reservoir, stored with electricity from a voltaic battery, and a fine platinum wire with a little disc flattened on it. Wires connect up this platinum wire to the electric store, so that the electricity can be caused to flow through the wire at will. The current, as is well known, has the effect of heating the platinum wire and making the disc to glow with an intense brightness, emitting a small but powerful electric beam. By means of a minute silver reflector, and a suitable handle, this miniature electric light can be inserted into the mouth, so as to enable the dentist to examine a broken tooth, or into other cavities of the body. It is also very useful in lighting up the interior of cannon, rifles, and shells, so as to expose the slightest defects in their interiors.