A number of very ingenious contrivances, worked for the most part by compressed air, fill up a great part of Hero's pneumatics. Many of these are of no practical use, but remind one more of conjurors' tricks than of mechanical appliances. Take the following as examples:—

“A steam boiler, from which either a hot blast may be driven into the fire, a black-bird made to sing, or a Triton to blow a horn.”

“An automaton, the head of which continues attached to the body after a knife has entered the neck at one side, passed completely through it, and out at the other. The animal will drink immediately after the operation.”

(To be Continued.)

Monster Steam Hammer.

From the Journal of the Society of Arts, No. 593.

Messrs. R. and W. Morrison, of Newcastle-on-Tyne, have just forged what is believed to be the largest and most powerful steam hammer in the world, for the Russian Government. The piston-rod, to which the hammer is attached, weighed no less than 42 tons in its rough forged state, and now, when dressed down to the required dimensions, it has only been reduced to 35 tons. The length of the piston-rod is 38 ft., the diameter 2 ft. 4 ins., having a stroke of 14 ft. 6 ins., the piston being 6 ft. 8 ins. The forging of this mass of metal occupied 44 days. The cylinder for this hammer was cast at the Elswick Engine Works. Its diameter inside is 6 ft. 8 ins., its weight upwards of 40 tons. The two standards weigh nearly 40 tons each.

On Artificial Illumination. By EDWARD FRANKLAND, Esq., F. R. S.

Ten years ago the speaker gave in this Institution a sketch of the condition of Artificial Illumination. Since that period but little progress had been made towards perfecting those processes of producing artificial light at that time in general use. Nevertheless, the improvements effected in the production and application of the electric light, the increase of our knowledge both of solar and terrestrial light, and especially the discovery of an entirely new illuminating agent, threatening to produce a revolution in lighting almost equal to that which was the result of the invention of gas—rendered it desirable again to review this subject after the lapse of a decade.

In glancing at the improvements effected in the different departments of artificial illumination, those which relate to the electric light were first noticed. The electric light is produced by the interruption of an electric current flowing through good conductors; by this interruption the current is made to leap across a space provided in its circuit. The boundaries of this space, in the ordinary electric light, are formed by two portions of gas carbon, and during the passage of the electric current across it, the two pieces of carbon are heated to a most intense

degree, and far beyond that produced by any other means at our disposal. The great source of illuminating power was shown to be the ignited ends of these two pieces of gas carbon, and not the space between them.

Such being the nature of the electric light, the principal improvement which has been effected in it, during the past ten years, consists in the production of the electric current through the intervention of heat and mechanical force, by what is termed magneto-electricity. More than thirty years ago, Mr. Faraday produced a spark from the ordinary permanent magnet. Here, said the speaker (producing a magnet) is the very cradle of this magneto-electric light, and this is the very magnet with which Mr. Faraday operated. This improvement constitutes one of the greatest steps in advance which have been made in the application and production of the electric light. By the combustion of coal a certain amount of mechanical power is obtained, which is applied to the rotation of masses of iron in the neighborhood of very powerful permanent magnets. In this way, currents of electricity are produced, and these are thrown together, and made to circulate through a system of conductors: in fact there is no difference, as regards the effect at the carbon-prisms, between the action of this magneto-electric current, and the ordinary electric current produced by the chemical action which takes place in the voltaic battery. But this improved mode of producing the electric force demands less manual labor; the mechanical work being performed by a steam engine, which causes the rotation of the armatures.

This magneto-electric apparatus, as perfected by Mr. Holmes, has now been in use for upwards of two years in the South Foreland and Dungeness lighthouses, where, as well as in other similar beacons, the production of a light of the greatest intensity is of the greatest importance to the mariner. During this time it has performed its office remarkably well, and without a single instance of failure; thus proving itself well adapted for the purposes of lighthouse illumination.

For domestic light it has not yet been brought into use; its expense, doubtless, at the present moment, being far too great to admit of its being employed in this way: but where a light of great intensity, regardless almost of the question of expense, is required, as in the case of lighthouses, this magneto-electric light can scarcely be too much prized.

The speaker also described the mercurial electric light, but considered it inferior both in brilliancy and steadiness to that procured by the passage of the electric current between carbon terminals.

The discoveries and improvements connected with gas as an illuminating agent were then considered. It is of great importance that gas, as a light-giving material, should be improved to the utmost possible extent, so as to make it a perfect source of light. Its conveniences are so patent to every one, its use is attended with so few discomforts, and the light is obtained with such facility, and of any desired intensity within certain limits, that there is, perhaps, no source of artificial light capable of such general application. Nevertheless, this is one

of the modes of illumination which, having been long previously in use, have not made great progress during the past ten years. The sulphur compounds, which at the commencement of that time were complained of as being present in purified gas, are still there in considerable, if not in undiminished quantity, although there has recently been a process devised by means of which these impurities can be, to a great extent, got rid of. It remains to be seen whether this process be applicable, on a large scale, in the gas manufactory; but, so far as can be judged from experiments made upon a small scale, it is a process which is likely to be very effective. It is the invention of the Rev. Mr. Bowditch, of Wakefield. These sulphur compounds are irremovable in the ordinary process of purification. The gas may be passed in the usual manner over hydrate of lime, or the peroxide of iron; but this operation does not, in the slightest degree, affect the sulphur compounds in question. During the combustion of the gas, however, their sulphur is converted into sulphurous acid, which diffuses itself into the apartment in which the gas is burned, and a great deal of the discomfort of which many complain in the use of gas is due to this cause. Mr. Bowditch discovered that though cold hydrate of lime will not remove these impurities, they are to a great extent got rid of by heating the hydrate of lime to a temperature varying from the boiling point of water up to 400° or 500° Fahr., a temperature of 400° being the most convenient for the development of the effects of his process. The heated hydrate of lime converts the sulphur compounds into sulphuretted hydrogen and carbonic acid, which can then be removed by the ordinary purifying material—cold hydrate of lime. This process has been found by repeated experiments to remove all but about 2 or 3 grains of sulphur per 100 cubic feet of gas, the quantity of sulphur originally contained in the gas varying from 5 or 6 grains up to 20 grains in 100 cubic feet. Heated hydrate of lime was shown to develop sulphuretted hydrogen from the gas supplied to the Institution.

Another recently ascertained fact in connexion with gas is the discovery of a new illuminating constituent recently made by M. Berthelot. This is a gaseous body, called acetylene, which is produced under very peculiar circumstances. Unlike all other hydrocarbons with which we were formerly acquainted, an intense heat is favorable to the production of this body. For instance, it is produced when coke is very intensely ignited in hydrogen gas; and Dr. Odling has recently demonstrated that two of the constituents of coal-gas, light carburetted hydrogen and carbonic oxide, which are useless for lighting purposes, may, by means of strong ignition, be made to form acetylene, and thus become luminiferous agents. It has generally been considered important to preserve a moderate degree of heat in gas-making in order to prevent the destruction of the luminiferous hydrocarbons; but the discovery of the formation of acetylene, under the circumstances named, will render it necessary to investigate how far the production of this substance can be carried on upon a large scale, and rendered valuable for increasing the illuminating power of gas. The subject is yet in embryo; but it has an important bearing upon the future progress of gas-

lighting. Acetylene and olefiant gas contain, in equal volumes, the same amount of carbon, but the former contains only half as much hydrogen as the latter; consequently, the illuminating power of acetylene is probably at least double that of olefiant gas.

The compound of acetylene with copper, is a substance not altogether devoid of interest to the gas manufacturer. When it attains a certain heat, it explodes with considerable violence, and the same effect may be produced by friction. It has been demonstrated recently, that acetylide of copper can be produced by the passage of ordinary coal-gas, containing, as it does, a trace of ammonia, through copper or brass tubes; and explosions which have taken place through cleaning out such tubes, resulting in serious injury to workmen, have been doubtless due to the presence of this substance. It is, of course, obvious that an explosion of this kind, even if slight in itself, may be communicated to explosive mixtures of gas and air (in a gas-holder or gas-meter, for instance), and may thus lead to very disastrous results. An explosion of this kind occurred a few years ago in Lancashire. A large meter had been detached, and brought into the open air; a workman was unscrewing one of the brass connexions, when the meter exploded with a loud report. The explosion could not be accounted for, as all the eye-witnesses were positive that no ignited body of any kind was near the meter.

The improvements effected in the production and application of oils for illuminating purposes were next referred to.

The animal and vegetable oils, which for ages have been employed for this purpose, have received no development of importance during the last ten years. On the other hand, new sources of this class of illuminants have been discovered, which threaten to produce a great revolution in the modes of obtaining artificial light.

One of the most important of the materials manufactured from these sources is paraffin oil, the production of which from bog coal has been carried out on an immense scale with great ingenuity and success by Mr. Young, of Bathgate, near Edinburgh. [The speaker here exhibited several lamps fed with this oil.] This new source of light is however already threatened by a formidable rival—native coal oil—which has been distilled by nature herself, and consequently does not require those preliminary processes which oil produced from bituminous coal has to undergo. These discoveries have been made principally in the United States of America, and more especially in Canada. In the latter country alone no less than twenty millions of gallons of this oil have been obtained from wells, several of which are spouting-wells. From these the oil rises, probably from the pressure of gas, to a considerable height above the surface of the ground, so as not to require pumping. The twenty millions of gallons, which represent the annual production of the Canadian wells, may, upon a moderate calculation, be said to furnish, in refined oil alone, illuminating material equal to one hundred and eighty millions of pounds of sperm candles.

The importance of such a vast amount of illuminating material so

cheaply obtained can scarcely be overrated in connexion with the question of the production of artificial light. Up to the present time, the refined oil from this crude petroleum (specimens of which were exhibited) has been prevented from coming into effective competition with the original paraffin oil, owing to the carelessness with which the former has been manufactured. There is a considerable portion of light naphtha left in this oil, which renders it capable of forming explosive mixtures in the lamps wherein it is burned. Both these American oils require to be still further freed from volatile naphtha. They would then form valuable illuminating materials.

The speaker then directed attention to the following tables. The first contains the results of his experiments on the illuminating effect of these oils in connexion with that of some other materials used for giving artificial light:—

Illuminating Equivalents, or the Quantities of different Illuminating Materials necessary to Produce the same amount of Light.

Young's Paraffin oil,	.	.	.	1	gallon.
American rock oil, No. 1,	.	.	.	1.26	"
do, No. 2,	.	.	.	1.30	"
Paraffin candles,	.	.	.	18.6	lbs.
Sperm do.	.	.	.	22.9	"
Wax do.	.	.	.	26.4	"
Stearic do.	.	.	.	27.6	"
Composite do.	.	.	.	29.5	"
Tallow,	.	.	.	36	"

From this table was made the following calculation of the comparative cost, from different sources, of the light of twenty spermaceti candles, each burning for ten hours, at the rate of 120 grains per hour:—

	s.	d.
Wax,	7	2½
Spermaceti,	6	8
Tallow,	2	8
Sperm oil,	1	10
Coal gas,	0	4½
Cannel gas,	0	3

Paraffin,	.	.	.	.	3	10
Paraffin oil,	.	.	.	.	0	5
Rock oil,	.	.	.	.	0	6½

Thus, from an economical point of view, the rock oil and the paraffin oil approach gas much more closely than any other illuminating agent hitherto invented; while the enormous quantities in which these oils are now being produced cannot fail to make them still lower in price. They may consequently be regarded as very formidable rivals of gas-light.

The following table contains the amount of carbonic acid and heat

generated per hour by various illuminating agents, each giving the light of twenty sperm candles:—

	Carbonic acid.		Heat.
Tallow,	10·1 cubic feet	.	100
Spermaceti, }	8·3 "	.	82
Wax, }		.	
Paraffin,	6·7 "	.	66
Coal gas,	5·0 "	.	47
Cannel gas,	4·0 "	.	32
Paraffin oil, }	3·0 "	.	29
Rock oil, }		.	

This table shows to what extent the atmosphere of rooms is deteriorated by these illuminating agents. It shows also that, from this point of view, paraffin and rock oils stand out as the best sources of light.

The chemical and physical laws upon which all modes of artificial illumination depend were then referred to. Every method of artificial illumination depends upon the heating of certain bodies to such a temperature that they become incandescent. With gases this temperature is much higher than with liquids or solids. There is only one instance in which the incandescence of vapor is used, and that is the mercurial electric light, already alluded to. In all other cases the incandescence of solid bodies is employed. In the ordinary method of obtaining the electric light, the incandescence of solid prisms of carbon is the source of luminosity. In gas and oil flames, it is the incandescence of little particles of carbon, and in all these cases the light is produced from solid matter. The luminosity of any flame depends, first, upon the number of solid particles which exist in it at any given moment; and, secondly, upon the temperature of the flame. The number of solid particles is dependent upon the nature of the flame itself, whether it be a flame produced by the burning of bodies rich in hydrocarbons, or by the burning of bodies which are poorer in this respect. Such a flame is always affected by the pressure of the atmosphere. The higher the pressure of the air, the greater the number of luminous particles of carbon present at one time in the flame. If, after the barometer has been standing at 30 inches, it falls to 29 inches, the light of all flames is reduced to the extent of about 5 per cent. The temperature, upon which the luminosity of a flame also depends, may be increased by heating both the gas and the air supplied to it for combustion, before they are brought together to be burned.

The speaker exhibited a gas lamp which he had constructed to effect this object. It consisted of an ordinary Argand burner, with glass chimney, but furnished with an outer glass cylinder resting upon a solid plate of glass, through the centre of which the tube supplying the gas rose. Thus all the air supplied to the flame was compelled to pass down between the chimney and outer cylinder, becoming thereby strongly heated before it reached the flame, whilst considerable heat was also imparted to the gas before the latter issued from the burner. In this manner a great increase of light, with the same consumption of gas, was obtained.

The following table was exhibited, showing the effect of this hot air gas-burner in reducing the consumption of gas for a given amount of light, and thereby also the impurities and heat which are thrown into the atmosphere in which such a lamp is burned:—

	Rate of consumption per hour.	Illuminating power.
Argand burner supplied with cold air,	3.3 cubic feet,	13 Sperm candles.
	3.7 “	15.5 “
	4.2 “	17 “
Same burner supplied with hot air,	2.2 “	13 “
	2.6 “	15.5 “
	2.7 “	16.7 “
	3.0 “	19.7 “
	3.3 “	21.7 “

For an equal amount of light, the saving of gas = 33 per cent. For an equal consumption of gas, the gain in light = 62 per cent.

The temperature necessary to render substances incandescent may be imparted to them in various ways. It may be given directly by mechanical power, as in the “steel mill,” formerly used in coal mines. Usually, however, chemical action is employed, as in gas, candle, and oil flames; or electricity is used, as in the various forms of electric light.

The conditions necessary for a good and satisfactory artificial light were now examined. In the first place, the light should contain all colors; that is, it should be capable of showing every variety of tint which will be exposed to it. This is the case with the carbon electric light, and that candle, oil, and gas flames, since the light from these sources contains all the colors of the spectrum. But there are many colors which the mercurial electric light is incapable of showing, since they are absent from its spectrum. It was also shown that all pure colors, except yellow, were perfectly black, when seen by the light of incandescent sodium vapor.

Solar light, although in so many respects superior to artificial light, is defective as regards the showing of colors. There are certain colors which cannot be seen by solar light—for instance, all the color which can be seen by the sodium flame is quite invisible in daylight. If a pigment could be made of such a yellow color as to be of exactly the shade of that produced by the sodium flame it would be absolutely black in solar light. But our pigments are all mixed colors, and no such pigment which thus entirely disappears in the light of the sun is known. But in addition to this tint of the sodium flame, there are hundreds of other tints which are also not present in the solar spectrum, and which are consequently invisible in daylight.

Although solar light is inferior to artificial light in the completeness of its colors, yet, in another respect—in the comparatively small amount of heat which accompanies its rays in proportion to the light itself—it is greatly superior to every sort of artificial light. The great amount of heat in our artificial lights is absolutely useless. It is nearly all intercepted by the humors of the eye before it reaches the retina, and, no doubt, produces that irksomeness which is felt after working

in artificial light for any considerable time, and which is not experienced from daylight.

The speaker concluded as follows:—The history of artificial illumination cannot fail to impress upon us the difficulties in the way of the application of scientific discovery to the utilities of life. How long was it after the discovery of the production of gas from coal, before a manufacturer could be found to bring it into actual operation? Thirty years ago working in his laboratory at Blansko, Reichenbach showed us the process by which we could obtain paraffin and paraffin oil from bituminous coal; but the discovery remained unheeded for twenty years. More than thirty years ago, Mr. Faraday pointed out a source of the electric light in the permanent magnet; but we are only now beginning to use it for illuminating purposes. The brilliant little spark was long looked upon as a mere scientific curiosity, and is only now beginning to flash across the sea, guiding the mariner safely into harbor, or warning him from approaching a dangerous coast. How long will thermo-electricity have to wait before it receives a similar application? In thermo-electricity we have a direct transformation of the force of heat which we obtain with such great economy from coal, into an electric current, and this, by further education and development, might be rendered available in the production of the electric light. Hitherto, its application in this direction has been altogether unheeded, and yet of all sources of the power necessary for the electric light, thermo-electricity evokes this power most directly from coal. In the magneto-electric light we have the great disadvantage, that the heat of burning coal must be first transformed into mechanical power, which is made to rotate the armatures of magnets, and thus produce the necessary electric current. In this transformation of heat into mechanical power there is no less than $\frac{9}{10}$ ths of the original force in the coal absolutely lost. Hence the advantage which would result from the direct application of heat to the production of the electric current.

The man of science rejoices in the discovery of truth for its own sake. He gives his results freely to the world. It is no part of his duty, it is not his function, to apply those truths to the utilities of life. Success in this direction demands quite different powers of mind. Those who possess these powers, ought also to acquire the necessary knowledge which would enable them, with more facility, to seize upon the discoveries of science, and apply them to the wants of every day life. This scientific knowledge is the link which, up to the present time, has so sadly failed in the application of science to the manufacturing arts.

Proc. Royal Inst., Feb. 13, 1863.

New Maximum Thermometer.

From the Journal of the Society of Arts, No. 503.

The novelty in this thermometer consists in the addition, near the bulb, of a small tube at right angles to the tube of the thermometer, and in connexion with the bore; and when the thermometer is placed horizontally, this tube stands perpendicularly above it. On an increase