the working classes, it is a clear instance of public good, and they should be empowered to purchase the land required at a fair valuation. Instead of this, they are obliged to pay any fancy price that the land may have risen to, in consequence of the enormously enhanced value of it, in and about London. This circumstance is quite sufficient to serve as a death blow to the commercial success of nearly all such well-intentioned projects.

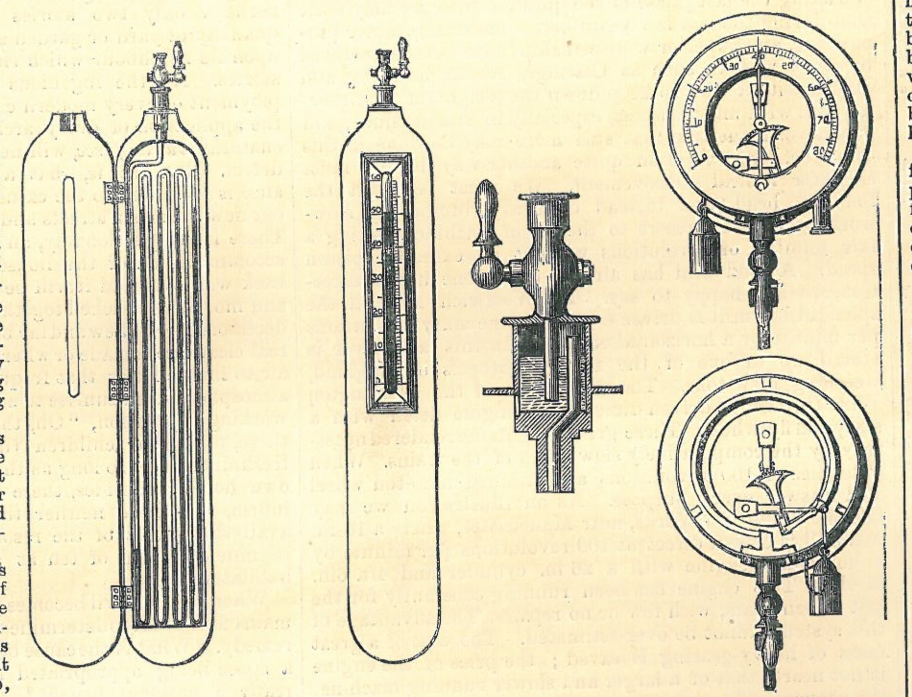
A bill was introduced a short time ago, embodying clauses which tended to remedy the evil complained of. Judging, however, from the effect produced, it appears to have been quite inoperative. It is idle to imagine that the mere erection of masses of bricks and mortar packed closely together, will benefit the sanitary condition of the poorer inhabitants of a vast metropolis similar to London.

ENGINEERING EDUCATION IN INDIA.

THERE appears to be really no sufficient reason why the natives of India—or at least some of the more intelligent amongst them —should not be educated in engineering science as practised in the western hemisphere, and so be made quite competent, in time, to design and superintend important public works. The whole country abounds with evidences of works requiring the aid of no inconsiderable skill, having been at one time in existence, and native record attributes them to certain ages and rulers. Who that has studied this matter can be ignorant of the names of Feroze Shah and Shah Jehan, or of that of Ali Murdan Khan, in connection with the progress of India, or rather of certain parts of it, in bygone days. But now we look in vain for similar evidences of native talent, although the Government is doing its best to encourage it. In reach of the three presidencies, and at Roorkee, in the north-west provinces, civil engineering colleges have been established, and successful candidates at the examinations are annually drafted into the public works department.

At a recent convocation of the University of Bombay, the Chancellor (His Excellency Sir Seymour Fitzgerald) in his speech, referring to this subject spoke as follows:—"There is another fact to which I would draw attention, in which I myself take particular interest, and that is that this year we have admitted to a degree in engineering, for engineering acquirement, a member of the Poona Engineering College. Last year I ventured to impress on the young members of this university—and I desire to impress it upon them again—that there is no career which will more certainly enable them to be of use to their country—no career in which it is more certain that they will attain honour and distinction than that of civil engineering. At present, unfortunately, among those who conduct the engineering works in this country, there are not many who are natives; but I would remind you that you live in a country which is studded with the remains of the most magnificent architecture—that you live in a country where there are remains of vast works of irrigation and works of public utility—that these were carried on by your forefathers long before they had the advantage of that education which is now vouchsafed to you; and I ask you, will you not advance in the same course, will you not avail yourselves of the opportunities that are offered to you, and thus qualify yourself for entering into the service of the State, which is bent upon promoting, as far as its means will allow, all those works that shall increase the wealth, the happiness, and the prosperity of the country?"

MESSRS. KING AND CO'S PRESSURE AND VACUUM GAUGES.



We illustrate in the annexed engraving two improved gauges now being introduced to the public by Messrs. King and Co., engineers, Montrose-street, Glasgow, which present some peculiarities. The mercurial gauge is made of a tube containing alternate columns of mercury and glycerine. The tube for the 60 lb. gauges is made of a single length of glass, which besides avoiding joints, and not being acted on by the mercury, possesses the very special advantage of enabling the mercury to be seen, whereby the accuracy of the gauge can be determined at any time by simply measuring the columns, adding them together, and multiplying the sum by ·44.

One of the principal features about the gauge is the tap on the top, which is so constructed that no dirt or water from the boiler can enter the first tube and comein contact with the mercury.

The sectional illustration shows this arrangement; it consists of a cylinder below the tap, to the bottom of which a small tube, connected with the boiler, dips. As the fluid in the cylinder rises, it compresses the air at the top, which transmits its pressure to the glycerine in the glass tube above the mercury. A further precaution is taken by partially filling the cylinder with oil. This in the case of leakage of any kind, owing to its small specific gravity, finds its way into the glass tube first, and prevents the water from coming in contact with the mercury, which has always been a great objection in mercurial gauges. The glycerine fluid between the columns of mercury in the series also prevents corrosion, and is not affected by frost.

The dead-weight check pressure gauge illustrated is constructed on Bourdon's principle, but its special advantage consists in its capability of being checked at any time by simply hanging on the weight to a hook which projects from one side of the gauge when the cap is removed; if working correctly, the pointer will fall to a corresponding figure on the check scale.

There are three ways in which a gauge may work incorrectly. In the first place the tube may take a permanent set, in which case the pointer will not fall to zero; in the second and most general case, the tube becomes weaker from corrosive action, and in the third place the working parts may become rusted and move stiffly, or the teeth of the pinion and sector become clogged up or deranged. These last two errors a dead weight at once detects, and the first is found by turning off the pressure from the boiler, which throws the tube open to the atmosphere. To apply the weight, an arm is cast on the sector, and from this the hook is hung on which the weight is placed. If the gauge is right the weight and the figure pointed to should correspond.

RECENT LECTURES AT THE ROYAL INSTITUTION.

FEBRUARY 26TH.—THE INFLUENCE OF CIVILISATION UPON THE PUBLIC HEALTH.

MR. JOHN H. BRIDGES, M.A., in a Friday evening lecture upon "The Influence of Civilisation upon the Public Health," said that as social changes are governed by natural definite laws and not by arbitrary or supernatural influences, the laws actually at work may be known, and they can be artificially modified to some extent by man. In all ages, some great ruling principle has influenced the daily life of all civilised nations; for instance, there was a time when men sought the reward and approbation of society by a self-denying religious life. When the acquisition of wealth becomes the ruling passion in any age, it will weaken all moral and religious ties, but will cause a great demand for labour, and will increase the wages and improve the clothing of the labourers. The aggregation of people in large manufacturing towns tends to weaken health by an insufficient supply of pure air, water, and sunlight, also to weaken the harmony of the moral nature. These weakening effects may, to some extent, be balanced by fresh influxes of healthy blood from rural districts; but experience and recent Government reports demonstrate that the enclosing of common lands and territorial aggregations have taken away all hope in life from the field labourer, and this great pressure upon his brain and mind must have correspondingly reduced his vitality. The decadence of the military spirit, the weakening of moral and religious ties, and the great rush to accumulate wealth, tend to cause an enormous growth of large towns with a feeble, unhealthy population, and at the same time to depopulate rural districts. Society, in such a state, cares little for the health of the labourers who live in houses worse than tents, for the latter are not so liable to poison both the air and the water used by the inmates; the unhealthy fathers and mothers produce weak children, who are put to work at an unnaturally early age, in consequence of the demand for their cheap labour. In overcrowded towns the means of enjoyment necessarily resulting from this state of society are such as to break down all natural, moral, and physical laws. Some few attempts have been made by the Legislature to improve this state of things in England, and tens of thousands of lives have been saved by sanitary laws; yet the terrible question remains—"Are these lives vigorous?" The enormous growth of the great towns in England is shown by the following table:—

Population above.	Number of towns (1811).	Per cent. of total population.	Number of towns (1861).	Per cent. of total population.
10,000	51	24	165	44
20,000	16	19	72	38
100,050	1	10	12	25

The adult mortality per 100,000 in these overcrowded towns is shown by the following figures—

	Men, age 25—55.	Women, age 15—45.
England	1,236	920
Liverpool	2,253	1,212
Manchester	1,966	1,157
Birmingham	1,569	918
Sheffield	1,464	988
Cotton towns	1,358	1,347
Iron towns	1,280	895
Rural districts	1,056	942

The following is the infant mortality per 100,000:—

Town or district.	Age: 0—1.	Age: 0—5.
Liverpool	27,703	13,201
Manchester	26,125	11,724
Stockport	25,353	9,376
Nottingham	25,293	10,226
Bradford	25,034	9,788
Wolverhampton	24,950	10,480
Ashton	24,713	9,839
Preston	24,440	9,753
Leeds	23,932	10,271
Sheffield	22,600	10,025
England	17,731	6,760
South-west	14,507	5,253
Sedbergh	9,636	3,261

In agricultural districts, where gang system prevails, infant mortality increases greatly, because of early neglect on the part of the mothers. The following figures show the results:—

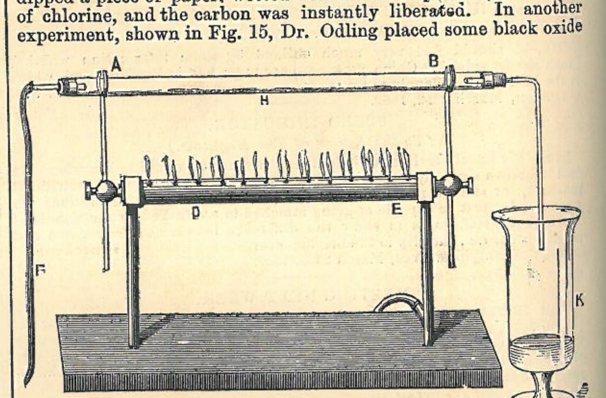
Witchford	22,601	6,958
Whittlesey	23,772	7,272
Wisbeach	26,001	7,605
Spalding	21,845	6,268
Holbeach	23,495	6,894

London is much healthier than the other large towns, because its vitality is chiefly recruited by fresh blood from rural villages, and not from the manufacturing districts. The figures relating to infant mortality, especially those showing the effects of the gang system, raise the serious question, which ought to be faced boldly —"Is it not best that these children should die, considering all the evils that surround them?" Deliberate infanticide was common in olden times, and among the Greeks and Romans only the healthiest infants were allowed to live, but in these days religious ideas and moral influences prohibit any such actions, and preserve unhealthy lives. He thought the true answer to the problem is that it is best either to stop sanitary regulations altogether, or to carry them out completely, a middle course being decidedly the worst of the three. The agricultural districts cannot much longer help to renew the vitality of the towns, for the parliamentary report, published a few months ago, shows that since 1775 the condition of the agricultural labourer has been growing worse and worse, in consequence of the enclosure of common lands, the withdrawal of his ancient privileges, and other legislation. After giving evidence as to the great superiority of the health of savages in their natural unmixed unconquered state over the health of civilised men, the lecturer asked what was to be done to remedy the growing evils. He thought that the united efforts of scientific men and capitalists could alone renovate society. If many men of science would quit their present ignoble course, and bring their trained intellects to bear upon the provision of remedies for the evils that afflict the whole nation, there would be more hope for the future, and it is high time that scientific men and capitalists should discover that they cannot morally do what they like with their own, for their intellects and their wealth are each acquired as the results of the labours of many men. Scientific men ought to bring their powers to bear to raise the rest of society, both morally and intellectually.

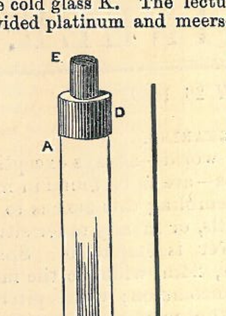
FEBRUARY 27TH.—HYDROGEN AND ITS ANALOGUES.

Dr. Wm. Odling, F.R.S., began his seventh lecture upon the above subject, by saying that gases must be compared under similar conditions of pressure and temperature, to obtain their relative volumes and weights. He said that the standard unit volume recognised by philosophers is the particular volume occupied by one gramme of hydrogen (or eight grammes of marsh gas, sixteen grammes of oxygen, and so on in the order of their specific gravities) under varying conditions of pressure and temperature. He then proceeded to show that the gases have fixed combined proportions. He took some sodium amalgam and passed it up into a tube inverted over mercury, and filled with hydrochloric acid gas; the sodium absorbed the chlorine, and the hydrogen left in the tube occupied exactly half the space formerly taken up by the compound gas. He admitted a measured volume of oxygen into a tube inverted over water, and then added oxygen and hydrogen mixed in their combining proportions, as they were evolved from the platinum electrodes of a Grove's battery. The gases in the tube were then fired by a spark from an induction coil, the result being that after the explosion the surplus oxygen at first introduced remained behind uncombined in the tube. The gas thus left was proved to be oxygen by its rekindling action upon a piece of smouldering wood. He then repeated the experiment, but substituted a surplus of hydrogen instead of oxygen. The hydrogen remained uncombined in the tube after the explosion, and was proved to be hydrogen because it caught fire on the application of a lighted taper.

Among some experiments showing the liberation of hydrogen from its compounds, he added some strong nitric acid to oil of turpentine, and the hydrogen united with the oxygen with much flame, liberating carbon in the form of dense smoke. He also dipped a piece of paper, wetted with oil of turpentine, into a jar of chlorine, and the carbon was instantly liberated. In another experiment, shown in Fig. 15, Dr. Odling placed some black oxide



of copper along the bottom of the glass tube, A, B, and warmed the tube by means of the gas jets along the pipe D, E. A current of hydrogen gas from the flexible tube F, was then passed over the oxide of copper. The flame of a Bunsen's burner was then applied at H, to the glass tube already well-warmed by the row of gas jets, and where this extra heat was applied the hydrogen took up the oxygen from the black oxide of copper, leaving the metal in its metallic state at the bottom of the tube. The oxygen united with the hydrogen to form steam, which was condensed into water by the cold glass K. The lecturer then took a ball made of finely divided platinum and meerschaum and inserted it in a tube of mixed oxygen and hydrogen gases inverted over mercury. The two gases were condensed within the pores of the platinum, and united with more violence than was intended, in consequence of the ball being so highly platinised as to become red-hot in the mixed gases, and at length to fire them. Dr. Odling next exhibited the same surface action of platinum, by the method shown in Fig. 16. In this cut A, B, is an Argand glass and gas burner, supplied with common gas by means of a flexible tube. The brass ferule D, carries an interior horizontal diaphragm of wire gauze, upon which the spiral of platinum foil E, was placed, after the said foil had been made red hot. In the stream of gas and air rising from the tube below, the foil kept at a red heat, causing the gas to unite with the oxygen at a lower temperature than that of flame. At last the foil became white hot, and then it set fire to the gas. Lastly, he took a bottle of liquid "white indigo," which turned blue during the simple act of pouring it out of the bottle, because of the avidity with which the liquid absorbed oxygen.



(Continued on page 226.)

THE TOWER SUBWAY.

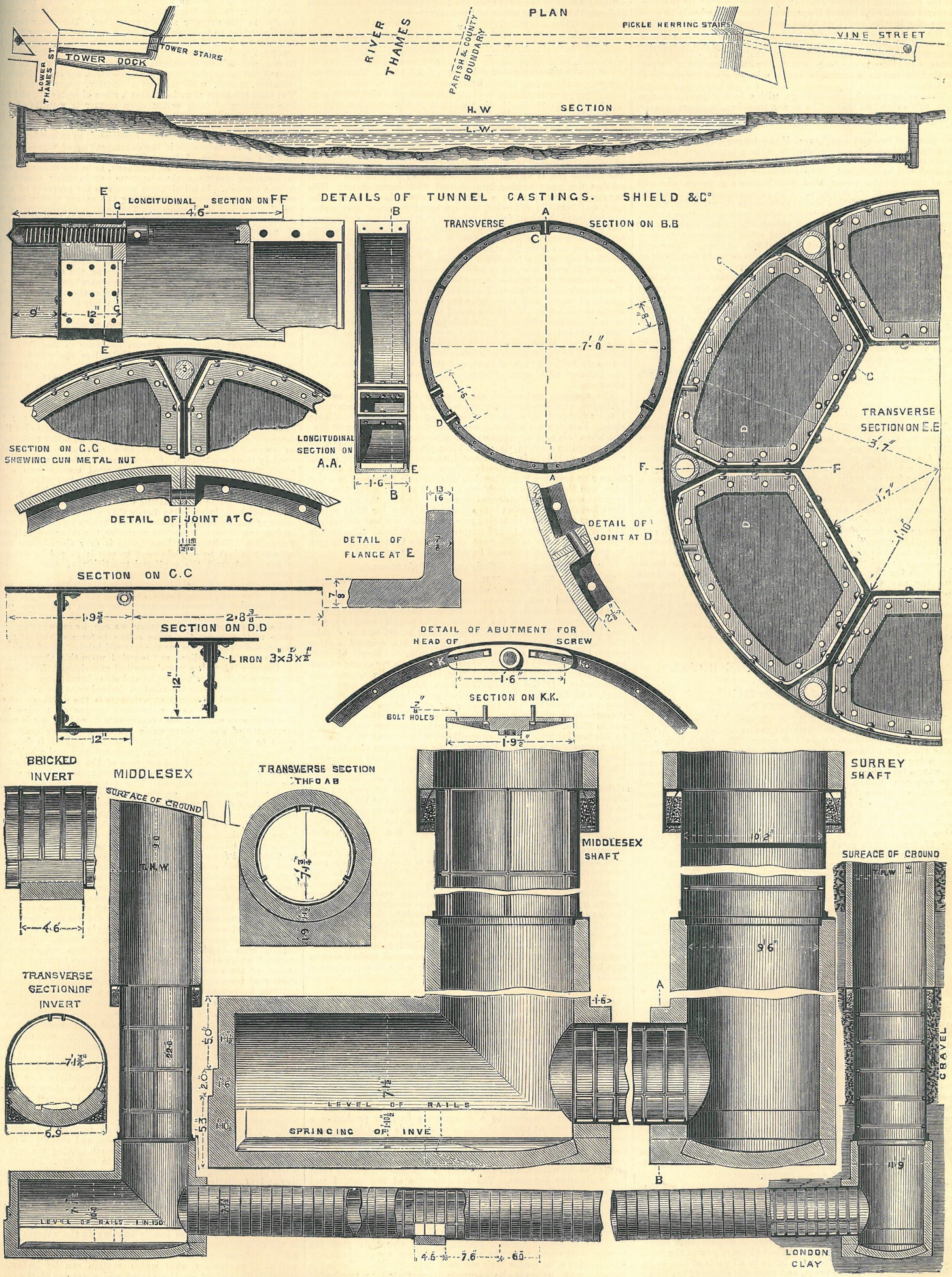
ON the next page will be found the drawings of the proposed subway from Tower-hill, underneath the bed of the river Thames, to Tooley-street on the Surrey side. The engineer of this work is Mr. Peter W. Barlow, jun., and now that the works have begun under that gentlemen's immediate superintendence, it is possible within the year 1869 we may see the subway opened to the public for traffic.

In the year 1863 a bridge was proposed to be erected over the river below the Tower, which scheme was abandoned in consequence of the great height required for the passage of ships, by the Conservators of the Thames. It was at that time the idea of a subway was mooted by Mr. Peter W. Barlow, sen., the father of the engineer of the present works, and accordingly an Act of Parliament for a subway was applied for in 1864, but from the opposition of the wharf owners in the vicinity of the proposed works that was also abandoned.

Steam ferries were suggested similar to those which run from New York to Brooklyn; but the navigation of the river would have been seriously impeded thereby; so that nothing was left but a subway. Accordingly the same company again applied, and early last year an Act of Parliament was obtained by the proprietors

THE PROPOSED TOWER SUBWAY.

MR. P. W. BARLOW, JUN., C.E., ENGINEER.



for the construction of the subway. As usual in England, a delay of a year took place in consequence of difficulties in purchasing the land, and not until the 16th of February, 1869, was the work commenced. The shaft on Tower-hill is now being sunk, and when finished, as the drawings show, will be composed of brick-work and partly of cast iron cylinders, the internal diameter being 10ft. At a depth of 48ft. below high-water mark, the tunnel will run nearly horizontal for a distance of 100ft., when it will incline to the middle of the river at the rate of 1 in 40, being at this point 22ft. below the river bed. The tunnel will rise in the same way at the opposite side of the river. The tunnel will be 7ft. in diameter, formed of cast iron segments firmly bolted together. A wrought iron shield, as shown, will be used in the construction of the work. This shield, which has an outer plate, will overlap the completed work, and a smaller heading will be carried forward in front of the work, and the shield propelled by screws, and as it progresses the tunnel segments will be bolted on behind. In the event of bad ground being met with during the work, the central opening of the shield may be partially or entirely closed; but we are informed by Mr. Barlow that the borings give great promise of good ground.

This subway is only intended for passengers, who will be conveyed through it in carriages formed of wrought-iron plates, running on very accurately laid steel rails. This carriage will be worked by stationary engines, fixed in brick chambers at the bottom of the shafts. The stations at the tops of the shafts will be only sufficiently large to admit the lifts, and hence will not occupy more street space than the stand of an omnibus. The work, thus well begun, is expected to be complete by January, 1870. The question of the mode of conveyance for passengers through the subway is a very important point, and therefore very naturally has elicited much attention; therefore Mr. Barlow has decided, after mature consideration, that the carriage, or rather subway omnibus, shall be the mode, and lifts instead of stairs are to be used for descent and ascent. There is no difficulty in lighting the subway, and allowing the passengers to descend and ascend by stairs, and walk through as in the Thames Tunnel, but the effect of burning gas in a subway or tunnel is to cause the air to become very impure, and render the walking through very disagreeable. "The question of the power to overcome inertia of railway trains," says Mr. W. P. Barlow, sen., "has engaged my attention for many years, and on it I have made many experiments, which have led me to the conclusion that the amount of power exerted by the locomotives on railways having frequent stations is principally to overcome the inertia, and that the power required for the traction of the train is a very inconsiderable portion of the whole power exerted." That gentleman has estimated the actual power required to propel an omnibus carriage from one shaft of the subway to the other, a fall being given from each shaft to the centre of the river, so that the inertia is overcome, and a velocity given by gravity as follows:—

The steel or wrought iron carriage, with a load of twelve passengers, will weigh two tons. The power, therefore, required to make a journey of 1320ft. will be $12 \times 1320 = 15840$; $\frac{15840}{33,000} = 48$, or nearly the power of two and a-half men, if the journey was made in one minute. But as it is not proposed to make a journey oftener than every two or two and a-half minutes, one man power constantly applied will be sufficient. The stationary engines will, however, be of much greater power than Mr. Barlow's estimate, and will effectually propel the carriages. The resistances to be considered in the case are the friction and resistance to the air. The numerous experiments on railway trains which were made to ascertain their resistances, were conducted principally in the early days of railway trains, before fish-jointing and other improvements were known—gave an average result of about 9 lb. per ton. This result is not to be taken, as a rule, as the resistance depends very much on the condition of the rails; and when the latter are in good condition, and no points or crossings in the way, the resistance is much less. Again, in a situation where the rails are free from dust and moisture as in a dry tunnel or subway, the friction will be much diminished, and therefore Mr. Barlow asserts that the friction in the Tower subway will not exceed 4 lb. per ton. The resistance of the atmosphere in a small tunnel is a matter to be well considered; and 2 lb. per ton-foot is allowed in the foregoing estimate; and as the maximum velocity will not exceed twenty miles per hour, the result is 6 lb. as against 9 lb., the average on railways.

Lieutenant J. C. Ardagh, R.E., has made elaborate calculations, which justify Mr. Barlow's conclusions.

WILSON'S DONKEY PUMP.

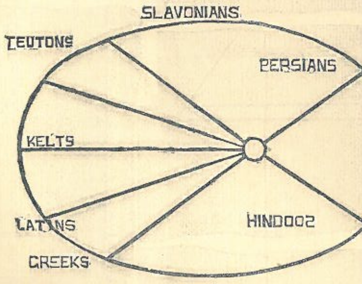
WE illustrate on p. 216 a steam pump of large size, manufactured by Messrs. Wilson and Co., which, while differing considerably from their well-known pattern, contains several points of novelty, and, for a fly-wheel pump, gets the machinery into the smallest possible compass without any over-crowding or complication. A prominent feature is the adaptation of the framework to form a capacious air-vessel, and the steam cylinder is placed between two pump barrels, which, however, work into the same suction and delivery valves, each set of which is conveniently accessible by means of doors on either side of the pump. The prolongations of the pump rods form very efficient guides to the steam piston rod, all three being made of Bessemer steel. At first sight, objection might be taken to the close proximity of the water barrels having a tendency to cool the steam cylinder; but in practice it is found that when the engine has been running for half an hour without pumping any water, the temperature of the barrels does not sensibly increase. The general details of the design will be readily understood from the drawings. Messrs. Wilson have special machinery for turning out every portion of these and other donkey pumps, of which they are now making about twelve per week. As a result the price of these pumps is extremely moderate.

RECENT LECTURES AT THE ROYAL INSTITUTION.

(Continued from page 224.)

MARCH 2ND—COMPARATIVE PHILOLOGY.

The Rev. F. W. Farrar, F.R.S., in his second lecture upon the above subject, said that Sanskrit is not the mother of the Aryan languages, but is probably the eldest sister. The Aryan languages alone are strictly inflectional, thus giving the speaker the power of expressing many ideas in few words. In all the Aryan languages the names for the metals, the words father, mother, tree, and such like common things, are substantially the same. The word "daughter" means "the milkmaid of the family," and points to the primitive life of our Asiatic forefathers, 3000 or more years ago. These shepherd fathers of the race, lived somewhere near the banks of the Oxus, and the Kelts were probably the earliest to leave their early home. The Western Aryans, as shown in Fig. 17, formed five great races—the Slavonians, Teutons, Kelts,



Latins, and Greeks. The Persians and the Hindoos are the chief of the Eastern Aryans. The names of some well-known things are not alike among all the Aryan languages. For instance, those who left their original home and travelled westwards, would first meet with oysters in the Caspian Sea, hence the root of the word "oyster" is the same in all the languages of the Western Aryans. The Eastern Aryans would have to travel far before they met with oysters, and then would give them a very different name. The words for "tree" and "branch" are substantially the same in all the Aryan languages, but not the names of different trees, because those who migrated would constantly encounter new kinds of vegetation. The birch tree alone has practically the same name among all the present members of the Aryan family. The names of domestic animals are much the same in all the Aryan languages.

MARCH 4TH.—RESPIRATION.

Dr. John Harley, in lecturing for the second time upon "Respiration and its Influence upon the Heart," said that popular ideas about the heart and its functions are, to a great extent, erroneous. The heart is not the seat of the emotions, and in reality the human body contains two hearts side by side, one to the right and the other to the left. The right heart receives impure blue blood, which it pumps into the lungs, and the left heart pumps the renovated and reddened blood from the lungs to all parts of the body. The heart lies between the lungs, and upon the centre of the upper part of the large air-tight diaphragm which separates the lungs from the lower part of the body. As the lungs contract and expand in the act of breathing, the great diaphragm below rises and falls, at the same time raising and lowering the heart by the act. The heart is a great hollow muscle, and it works quite independently of the influence of the brain or of the spinal cord. Any the pumping motion of the heart. He also exhibited a large model in india-rubber of one of the peculiarly constructed valves of the heart, and showed that grains of rice, representing blood-globules, would pass freely through the model in one direction, though not in the other. Many diseases tend to unnaturally distend the heart. Dr. Harley gave the following figures as to the influence of the position of the body upon the beats of the pulse, which beats indicate the pumping action of the heart:—

MAN

Position.	Beats per minute.			
Standing	61	81	101	120
Sitting	55	68	82	93
Lying	52	67	74	81
Difference between standing and lying	9	14	27	39

WOMAN.

Position.	Beats per minute.		
Standing	71	92	108
Sitting	67	85	97
Lying	63	83	90
Difference between standing and lying	8	9	18

MARCH 6TH.—HYDROGEN AND ITS ANALOGUES.

Dr. Wm. Odling, F.R.S., began this lecture by exhibiting the brilliant combustion of phosphuretted hydrogen gas in pure oxygen. The former gas, it will be remembered, is so combustible that it catches fire upon coming into contact with common air. The oxygen was contained in a strong tall glass gas jar, about 18in. long, and 2½in. in diameter, the jar being inverted over water, and not more than half full of oxygen. Just before the experiment was performed a few bubbles of chlorine were added to the oxygen, because without this addition two or three bubbles might enter the oxygen one after the other without catching fire, and then all go off at once with a dangerous explosion. The chlorine should be added within ten minutes or so of the time of the performance of the experiment, otherwise it may be absorbed again by the water. The phosphuretted hydrogen was held in test tubes inverted over a basin of water, and in transferring each tube from one vessel of water to the other, Dr. Odling closed the orifice with his thumb to prevent contact with air. The tall jar of oxygen was then held firmly in his left hand, and with the other he allowed one bubble at a time of phosphuretted hydrogen to rise into the jar. Each bubble, directly it came into contact with the oxygen, gave an intensely brilliant flash of light, and shook the jar and the arm of the lecturer with some violence. It is not an experiment for amateurs.

The speaker next called attention to the fact that nascent hydrogen, at the moment the gas is liberated from its compounds, is more energetic in chemical action than the gas in its ordinary state. Ferridcyanic acid will not, as a rule, unite with hydrogen; but when this acid comes in contact with the gas at the moment it is liberated by electrolysis, union takes place, and the ferridcyanic acid is changed into ferrocyanic acid, as was proved by experiment. Nascent hydrogen will also transform nitrobenzole into aniline. Some zinc turnings were placed in nitrobenzole contained in a test tube, and then some hydrochloric acid was added; when the consequent ebullition of hydrogen began to slacken, the contents of the test-tube was emptied into a large tall glass jar filled with a colourless solution of bleaching powder, which is a test for aniline. The jar of liquid were tinged purple by the addition. The lecture was closed by a few experiments, showing the absorption of oxygen by protosulphate of iron and liquid sulphurous acid.

MARCH 9TH.—COMPARATIVE PHILOLOGY.

The Rev. F. W. Farrar, F.R.S., in this lecture, spoke principally of the Semitic languages, of which Hebrew is a fine specimen. He said that nobody who has examined the subject thinks for a minute that the Greek, Latin, and other leading European languages are in any way derived from the Hebrew. The Semitic mother speech may have been Egyptian or Coptic, but it is difficult to decide. Philology does not go completely against one original mother speech for the whole human race, if an unlimited length of years be granted to effect the transformations; but as far as the science has progressed up to the present time, its evidence is against such a conclusion. Of the Semitic languages Arabic is the most developed, and the Hebrew is the other great branch; the Semitic languages represent the central zone of Western Asia, and at present are spoken only in Arabia, in a small portion of Africa, and in Malta. The Phœnician and Carthaginian languages belong to this family, which is a very small one as compared with that of the Aryans. It is doubtful whether the Babylonian and Assyrian languages were Semitic; in fact, these appear to have been mixed languages, which might have been produced supposing the countries to have had Semitic inhabitants subject to Aryan conquerors. In Hebrew the meaning of words is not altered by prefixes and affixes; but the consonants are always the same, and the meaning of the word is changed by altering the vowels between the consonants. The language was thus hard, rigid, inflexible, completely unfitted for a scientific or advanced people; the Hebrews, also, could never be an investigating people, because they put down everything to the miraculous intervention of God. The only great book they have handed down to posterity is the valuable one containing some records of the Hebrew branch of the Semitic family, a family from which sprang the three religions of Judaism, Christianity, and Islam. The Semitic family conferred a great benefit upon the world by giving Europe an alphabet, for the Greeks acknowledge that they took the idea from the Phœnicians, though perhaps the alphabet was first invented by the Egyptians. The few Semitic races left are all on the decline, and have ever given way before the Aryans, as again exemplified very recently by the Abyssinian war. The Semitic languages are all spoken over an area not more than 1800 miles long by 600 miles broad, situated chiefly upon the Asiatic continent.

LETTERS TO THE EDITOR.

(Continued from page 222.)

THE CHRYSALIS SLOWLY DEVELOPING.

SIR,—As this and other countries spend a part of their wealth in employing coals and water for producing motive power (and we anticipate a time when our coal-fields will yield no more, although the want for such may even be increasing), I think it worthy to inquire how far this want can be supplemented by combinations of matter annually formed on the earth's surface.

In directing attention to a composition fuel for producing a safe and convenient source of motive power, it is essential to point out the obstacles which have been found to bar its utility. All fuels are combinations of matter of gaseous origin; and when produced in the dense state of liquids or minerals, either by the hand of man or by nature, that state only is the most practical form for locomotive purposes. The investigation of the nature and character of such suggests the aptitude of professors of chemistry to furnish information respecting them. If we seek this we learn that compositions of this kind cannot be restrained from "blowing over," which would soon choke the passage of the engine and prevent its working in consequence. This obstacle alone would be sufficient to render the fuel useless, but we also learn that the gaseous matter acts upon the metals in common use so injuriously by oxidation as to render their adoption impracticable. The latter obstacle may, however, be successfully combated by employing the precious metals; but if this is encouraging, there still remains the first! How shall we overcome that? Happily, we have now the privilege of referring the whole matter to the engine itself, and from it we may learn that such obstacles no longer exist, so that we enjoy the liberty to believe whom we choose.

The investigation of matter leads us to inquire what is the repetition of previous actions. Pre-eminently conspicuous amongst these properties is force. Force is of two kinds, absolutely antagonistic, but possessing attributes in common, and upon their activity and the preponderance of one force over the other depend all conditions of matter. One force constantly strives to fetch, to draw, and to hold or keep matter together in a mass around a centre, and is therefore absolutely attractive, being powerful in contraction, in condensation, in density. This force preponderates in the exterior surface of matter. The other force constantly strives to push away, to drive out, and to extend or separate matter from a mass or from a centre, being absolutely as repellent and powerful in repulsion, in expansion, in rarefaction, and this force occupies the interior or centre of all matter. Among the properties they have in common are concentration and radiation, which, with temperate activity, generate and sustain life; their cessation of action leaves a state of rest, cold, and death. The intensity of their action upon matter is manifested by the resultant effect in its temperature, which is variously termed heat, electricity, magnetism, gravity, &c. If their action be slow and moderate, a temperate warmth is produced, as in our bodies, in an egg during incubation, or in the decomposition of vegetable matter and the generation of insect life. If their action be intensely energetic, the effect becomes luminous, as in the flare of a candle, in lightning during a thunderstorm, or in their concentration around the sun. In all of these processes the property of concentration is conspicuous in rendering the action visibly luminous, for if dispersed it disappears. The local concentration of their action by radiation also originates motion in all bodies and masses of matter, and when excessive often terminates in some unaccountably terrific explosion, sometimes proving fatal, as in coal-mines, or with steam boilers, as that of the Great Eastern steamship.

It thus seems that we must not rely on the atomic theory nor on modern true chemistry alone for success when composing a fuel which shall not "blow over" nor oxidise the metals in common use, but our reliance should be placed solely on the law regulating the ability of these forces to displace each other. For example, ice in which the attractive force predominates cannot vapourise ice, because it cannot displace itself; neither can vapour in which the repellative force predominates condense vapour into ice for the same reason, but the one must displace the other. This is their law and office. The attractive force combines and holds together; the repellative force decomposes and separates as under. In Grove's "Correlation" is stated: "Heat appears to act differently upon the elements of hydrogen and oxygen, according to its intensity: in one case producing composition, in the other decomposition." In Tomlinson's "Cyclopædia" is stated: "Dr. Faraday found that the quantity of electricity requisite for the decomposition of a substance is exactly the quantity necessary for its composition." The theory here advocated may, perhaps, simplify these quotations. Gunpowder is a familiar example in which the attractive force has contracted matter into a small space, having displaced the repellative force, but when action is excited the repellative force rarefies the matter and expands it into a large volume by displacing the attractive force.

It is not here intended to imply that either force possesses the power of totally displacing the other; but by gaining the preponderance one force may become excessive, the other proportionately diminutive. Neither of these forces is ever absent from matter, but what is lost by displacement by one is gained by occupation by the other, and the continual repetition of these actions is eternity.

Whatever may be said in opposition to this theoretical reasoning, it is to such alone that I attribute the practical solution of the difficulty in preventing my composition fuel from passing over other than purely gaseous matter and from injuriously oxidising the metals; and, further, we can, by introducing appropriate matter, cause the same action to form a lubricating substance, and thus provide for the internal lubrication of the engine. As this result is realised and founded upon this theory, may we not improve it by a few years' practical experience? This has been the case with electric telegraphs and other inventions.

The most interesting information derived from the action of this composition fuel in recent experiments is the development of its practical adaptation as a convenient source of motive power. The engine in which these experiments have been made contains a capacity of about sixty cubic inches for gaseous matter, from water to pistons. 1 oz. of gaseous matter yielded from one bar of composition, besides leakage, produced two and a-half strokes in each cylinder. The temperature of the generator (containing 25 oz. of water) was raised to blood heat; that of the cylinders was not perceptibly increased. The gases were evolved clear, and produced no oxidation on the metals—brass, iron, and steel—during the five following days. The time occupied in the decomposition and work done was about four minutes. In another experiment, when the engine was coupled to the wing-journals of "the chrysalis," 1½ oz. produced one stroke in each cylinder. Having had no other experience in the construction of machinery than obtained from the engine here referred to, the imperfections from untrained and unskilful workmanship are such as to frustrate the practicability of acquiring from it any reliable comparison of the relative values of this composition and coals; and as it seldom falls to the lot of inventors, after spending some twenty years in the practical development of their schemes, to be in a position to spend £500 or £1000 in the construction of accurate and well-made machinery, it is highly probable that no such desirable comparative value will ever be made, although the facility with which the constituents of this composition fuel (some of which exists as waste) can at all times be obtained on the surface of the earth and be manufactured, renders it a subject worthy of investigation, from which might spring a commodity not less important than coals nor less valuable than steam, yet for want of means it may, perhaps, remain worthless as dust.

In connection with this is the prospect of a new field opening for locomotion. Rapid and international communication has been greatly developed within the last half century, and during the last quarter of a century electrical communication has proved to a marvellous extent the value of the radiative property of the forces of creation for the despatch of messages throughout the world, and this field of industry is not more exhaustible now than in times past, when our ancestors were content to allow these forces to remain dormant, but necessity having imparted motion to matters of this kind; the impetus thus acquired is stored up in the momentum of life.

What, then, constitutes the law of motion? Density and velocity. Velocity comprises time, space, and motion—a familiar example of which is afforded by the earth moving through space a distance equal to its rolling surface in one day. Density comprises surface, weight, and force. In virtue of density the attractive and repellative forces impart to the earth its diurnal revolutions, and by their common property of concentration store up momentum in its mass, whereby its uniform motion is preserved; for the earth would possess no independent motion if it possessed no weight—no dense matter—but, like a balloon in the air, would participate in any motion locally existing in the ethereal matter of the solar system. Adequate density is, therefore, most essential to independent motion in individual bodies or masses of matter. The facility with which motion can be imparted to matter is dependent on the extent and character of the preponderating force. When the attractive preponderates, as in iron or platinum, we can with adequate power project it through the air with considerable velocity, but if the repellative predominates, as in hydrogen, we cannot with an equal power project an equal weight with any velocity at all, because with less density we get more surface, and with more density less surface. 1 lb. of platinum