grammar, metre, etymology, and historical allusions that we have no leisure to enjoy and appreciate.

I have little fear that the scientific age which is now upon us will be permanently hurtful to literature. The higher criticism, which is the study of life as well as of letters, will survive too. One literary art, the art of rhetoric, may be weakened and lost when the scientific spirit becomes predominant—that sort of rhetoric, I mean, which may be fitly described as insincere eloquence. Rhetoric seeks above all to persuade, and in a completely scientific age men will only allow themselves to be persuaded by force of reason. Even in our imperfectly scientific age those men gain most by speech who have something important to say, who say no more than they know, and who use all possible plainness. It will be enough for my present purpose if we can agree that literature has an aim and purpose of its own, and must not be treated simply as a branch of useful knowledge. Literature and science, for instance, are incommensurable.

The Necessity of Choosing.—Every headmaster and headmistress is occupied with the eternal question how to make room for all the things that are demanded of the school. Theorisers, who have no responsibility for the time-table, insist from time to time upon new additions, and are happy if they can only express their own opinions with an emphasis which satisfies their sense of justice. It is my opinion that far too much has already been conceded to demands which, reasonable when taken separately, are unreasonable when taken together. Thus, by ancient usage, Latin is made a necessary subject in certain schools. Then a claim is put in for Greek as more interesting and equally important. French and German demand admission, and put forward claims which can hardly be overstated. The result is that some boys in secondary schools attempt four languages, and many attempt three. Then we usually find that no foreign language, ancient or modern, is mastered to the point at which it can be used in reading, writing, or conversation. Our wish to be fair and consistent has landed us in an absurdity. The root of the whole difficulty lies in the fact that while there are perhaps 15 or 20 branches of knowledge eminently fit to be taught in school, no pupil can profitably undertake more than five or six at a time. The sciences taught in school may spoil one another's chances in the same way. Not a few schools are convinced that they must have chemistry and physics because of their industrial importance, hygiene because of its relation to the health of the community, physiology to make the hygiene intelligible. The schoolboy is made to buy more sciences than he can pay for, and his time is gone before he reaps any of the advantages which are so much desired.

One inevitable result is that the school hours, including the preparation of lessons, are nearly always too long. Another result is that the schoolboy who is willing, but not very clever, is often overworked. I have known many such cases myself, and have also known cases in which excellent results have been attained in a good deal less than the customary time. If we could consent that our pupils should remain ignorant of many useful things, if we could materially shorten the lessons of very young pupils, and if we could bring the home-lessons into much smaller compass, I believe that the education which we offer would really be more valuable.

Mastery of Something.—The accumulation of miscellaneous knowledge of useful things, copious, inexact, inapplicable, may, like rag-picking, leave us ignorant of the world in which we live. Let us try to reach the inner life of something, great or small. The truly useful knowledge is mastery. Mastery does not come by listening while somebody explains; it is the reward of effort. Effort, again, is inspired by interest and sense of duty. Interest alone may tire too quickly; sense of duty alone may grow formal and unintelligent. Mastery comes by attending long to a particular thing—by inquiring, by looking hard at things, by handling and doing, by contriving and trying, by forming good habits of work, and especially the habit of distinguishing between the things that signify and those that do not. It is too much to expect that mastery will often be attained in school. School is but a preparation, not I think for promiscuous learning, but for the business of life. The school will have done its part if in favourable cases it has set a pattern which will afterwards develop itself naturally and harmoniously.

Electrification of Pacific Railroads.—According to the *Electrical World*, Mr. E. H. Harriman has recently stated that as soon as the money market conditions improve, three sections of lines of the Harriman system will be electrified. It is his purpose to electrify the mountain division of the Union Pacific road, which runs over the Rockies; the mountain division of the Southern Pacific, which runs over the Sierras, and the new mountain division of the Shasta route, which will run, like the present route, over the Siskiyou Mountains. The estimated cost is said to be about £8,000,000.

THE ELECTRIC LIGHTING OF DRURY LANE THEATRE ROYAL.

On March 25, 1908, the stage of the historic theatre of Drury Lane was completely destroyed by fire, and the daily Press promptly attributed the disaster to some electrical cause. As to how far this was the case may be gathered from the fact that on the previous day the current was switched off at 6 p.m. and the fire alarm sounded at 3:20 a.m. next morning. Whatever the cause, a great deal of damage was done, and needless to say most of the electrical equipment was more or less useless. Consequently, after the inevitable delays caused by the assessment for the insurance companies involved, the work of reconstruction was begun, and has been carried through in an extremely short time. The electrical part of the work has been practically completed in six weeks from the start. To some people this may not seem to be so very short a time after all, but it is difficult to realise without actual inspection the great quantity of work involved; thus it is no exaggeration to say that many miles of cable have been used in connection with the new installation, the whole of the wiring being carried out in screwed tubing, whilst a new design of batten has also been evolved, so that great credit is due to the contractors, Messrs. Pinching & Walton, for the rapid way in which the work has been carried through. This will be better understood when it is stated that owing to the size of the installation, ordinary accessories and fittings could not be used.

In our issue of February 12, 1904, we gave a full account of the electrical equipment of the theatre at that time. A great deal of the present equipment is practically the same as there described. For example, the hoisting gear of the bridges is the same as it was at that time, although it has been necessary to rewind the motors after their experience of being several feet under water. There were also certain parts of the installation which were not affected, as for example, the main services from the supply company. These are in duplicate in order to comply with the regulations of the London County Council, but they are both taken from the mains of the Charing Cross, West End & City Electricity Supply Co. One service is from the regular theatre system of the company, and the other from the lighting system, so that they really form two distinct sources of supply.

A recently introduced feature is the system of ventilation of the stage. It was found that a great deal of discomfort was experienced by that part of the audience sitting in the stalls anywhere near the stage, by what may be described as a waterfall of cold air from the stage into the stalls. In order to check this, warm air is now forced by a fan on to the stage at any point where cold air would come in if this system of ventilation were not adopted, that is at doors, &c. In this way a stream of warm air finds its way on to the stage and rises straight up without passing into the auditorium. Matters can be so adjusted that there is either no passage of air from one to the other, or that the air actually tends to pass from the auditorium on to the stage. The warm air so supplied is forced in by a 3 ft. fans of the well-known "Sirocco" type, the air being drawn through sheets of moistened canvas; the latter is fixed on a large horizontal drum, kept rotating so that it is continually moistened with water, the air being then forced through a grid of pipes which are steam heated, somewhat similar to an air cooled condenser, and finally supplied to the required points by ducts in the usual way. In all probability the air so forced in will rise to the top of the building, and will pass through the ventilators, there provided, without further assistance, thus giving a very efficient ventilation. If this does not prove entirely satisfactory, there is provision for fixing a fan for the purpose of extracting the air, similar to one which is already in use above the auditorium.

Beneath the stage is fixed the electric and hydraulic plant for operating the bridges. There is also the dimmer room, the latter being unaltered though rewired. The lights used for illumination-effects consist of white, red and blue, the white lights being naturally more numerous. The dimmer room contains three rows of dimmers corresponding with these three colours. Each large dimmer at present controls 125 35-watt lamps, and each of the smaller dimmers controls 62 35-watt coloured lamps; but each is capable of controlling the 64-watt lamps which were used before the change to metallic filament lamps was made. Recently "Z" metallic filament lamps have been substituted for the carbon lamps, notwithstanding the fact that most makers of such lamps held the view that they were unsuitable for theatre work, on account of the difficulties occasioned by "dimming." Experience has shown that such lamps are eminently satisfactory, and apparently this erroneous view was only due to the fact that the lamps were tried without modifying the conditions. Naturally the resistances to be inserted in order to dim metallic filament lamps have not the same value as for carbon lamps, and, equally, both kinds of lamps cannot be expected to run in parallel off the same dimmer. Fig. 1 is an illustration of the dimmer board, which is placed on the stage immediately above the dimmer room. Each wheel controls a dimmer, and they can be worked separately or altogether as desired, the three rows corresponding, of course, to the white, red and blue lamps.

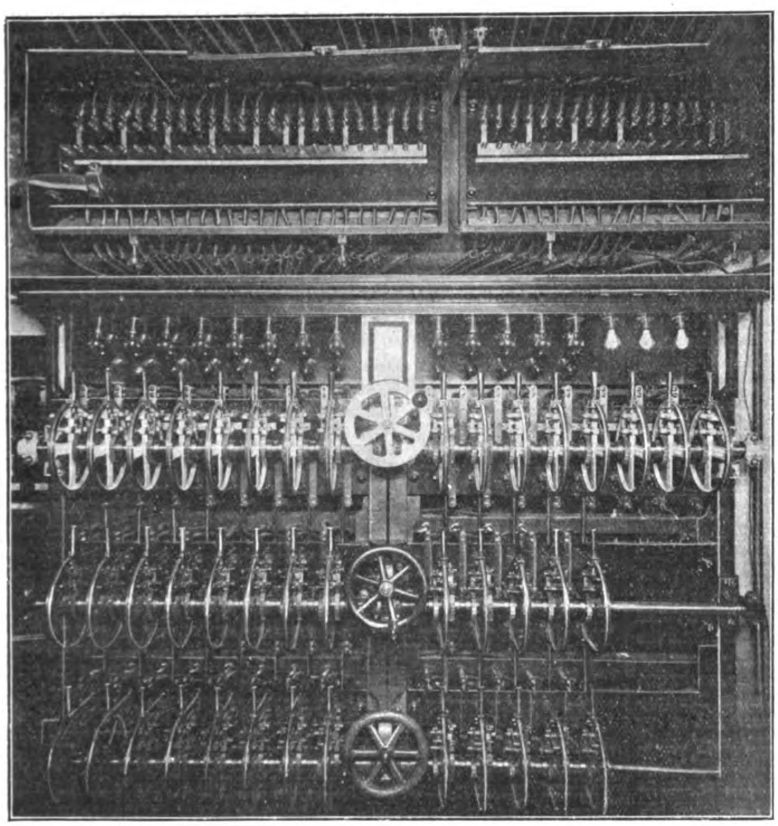

FIG. 1.—DIMMER BOARD.

It might be thought that arc projectors would be used largely in a theatre of this kind for varying the illumination as desired, at any particular point. This, however, is not the case, partly because the light so obtained is apt to be coloured, and partly because the stage is very large, and such lamps, as a large number of them would be required, would be prohibitive. In the flies on either side are about 20 oxy-hydrogen projectors. In order to supply these there is an oxygen main and a hydrogen main along each of the galleries, and as these mains are quite small it will be realised that a very simple arrangement is obtained, the necessary supply being taken from india-rubber tubing as desired. Signals are given to the operators by means of red and blue lamps. The supply of oxygen and hydrogen is kept in four very large drums, about 10 ft. high, at a pressure of 3 lb. per sq. in. Water is automatically run into these drums to keep up the pressure and they are recharged from the familiar gas cylinders as required.

The new battens, of which there are 12, for lighting the stage are of some interest, as they are of new design. Each is 42 ft. long, only 10½ in. wide, weighs 7 cwt., and contains 250 lamps, so that altogether 3,000 metallic filament lamps are fixed in these battens. Originally such battens were not earthed; in fact earthing was not permitted, but the result of this was that it was impossible to know, generally speaking, if there was any defect in the insulation. Under certain circumstances this may be dangerous. For example, in one case a wire, which had doubtless been used for the flight of a stage fairy, was being drawn up with a weight attached when it came against the metal work of a defective batten. The wire made a good earth, with the result that the weight dropped on to the stage. All the battens are now earthed by earthing the runners, which form the guides for the counterweights on either side of the stage. Fig. 2 shows the arrangement of the wiring for the battens, and it will be seen that it does not cause any obstruction on the stage. When it is remembered that each batten contains 250 lamps and is only 10½ in. wide, the difficulty involved in the design will be apparent. It may be mentioned that the width is a matter of some importance where a great deal of scenery and many other battens have to be handled. Another point of interest is that no tilting of these battens is required, as is often the case with other designs, the distribution of light being varied by merely altering their height.

For connecting up each batten a fuse board is provided, having 11 circuits and lined with uralite. This board is fed by two pairs of 19/16 cables and one pair of 19/14 cables, so as to give the three sections desired, and from each box 22 7/18 cables are taken to feed the batten. The circuits are divided up so that 5 supply white lights, 3 red and 3 blue. The 22 outgoing cables are covered by a canvas hose and pass over a counter-weighted bridle. (See Fig 2.) The latter rises and falls with the batten, and thus unnecessary slack is avoided. In addition to the battens there are 52 hanging lengths for use in various positions as found necessary.

Over the main switchboard is fixed a junction box, 8 ft. 6 in. long by 3 ft. wide, into which pass all the cables. From this box they pass through screwed tubing to two other junction boxes a short distance above the one just mentioned. These two boxes are 5 ft. by 4 ft. and 4 ft. by 3 ft. respectively. The cables are then taken to twelve iron cased fuse boards, fixed on the fly rail, for the battens referred to above. These boards have cast-iron bases, 18 in. by 18 in., and each is fitted with three 1½ in. tubes screwed in to the box so as to make a solid connection. A special nozzle is fixed at the back of each box, on to which the hose pipe leading to the battens is fixed by means of a special clip.

On the lighting gallery are twelve 25 ampere plugs, these being controlled from a "special effect" board on the stage, which also controls twenty-four 25 ampere plugs on the stage floor. This "special effect" board is fed by a pair of 37/12 cables which are run from an independent "intake" room on the other side of the building and fed by a separate service from the mains. The plugs just referred to are of a special, cast-iron cased, type with two pins, and in each instance the tubing is screwed into the plug, so that the installation may be considered watertight throughout. There are also twenty-four

25 amp. plugs which are controlled from the main switchboard, and which can be used in connection with the dimmers.

One of the smaller details consists of an electrically operated centrifugal pump, which can be coupled up to a fountain on any part of the stage, the water flowing back to the tank from which it is taken, thus avoiding objectionable damp from water used without any particular means of escape, as is often the case.

The lighting in the auditorium remains as it was, except that metallic filament lamps are being used to a large extent. Adequate control of the lighting is essential in a theatre, so as to avoid danger of panic, but on the other hand, it is necessary that the lighting of the auditorium, as distinct from that of the corridors, should be controlled from the stage. In order to enable the attendants in the auditorium to switch

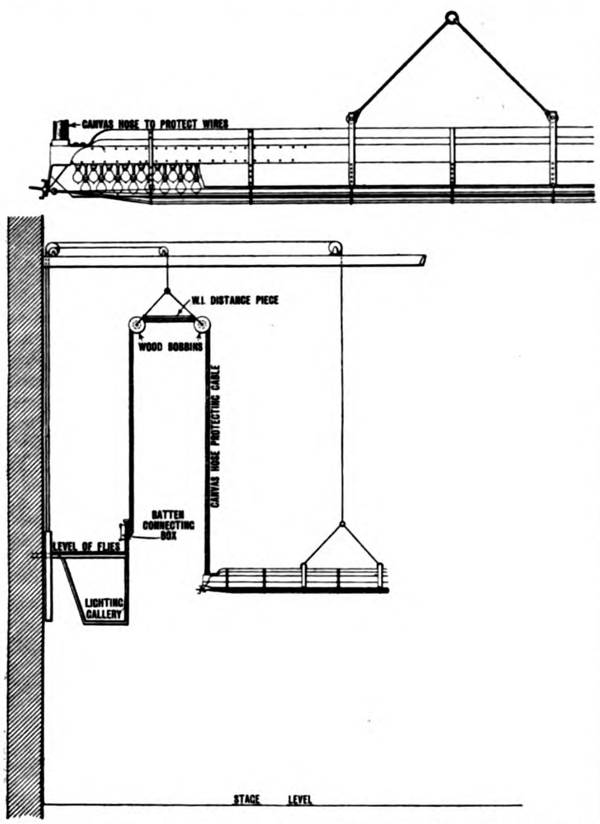

FIG. 2.—ELEVATION OF PART OF A LIGHTING BATTEN (ABOVE); ALSO METHOD OF SUSPENDING SAME AND THE CABLE TO BOX IN THE FLIES.

on the lights if necessary, although turned off at the stage, a set of double pole switches has been provided coupled together and worked by a single handle. This handle is generally tied down, but on an emergency the whole of the lights can be thrown over to the other circuit by forcing the handle over.

We are indebted to Mr. Adrian Collins, A.M.Inst.C.E., consulting electrical engineer to the Drury Lane Theatre, for his courtesy in showing us the details of the installation, and to Messrs. Pinching & Walton, the contractors, for supplying us with information in regard to some of the details.

INFLUENCE OF TEMPERATURE ON THE E.M.F. OF CADMIUM CELLS.*

BY R. JOUAST.

In 1901 Jäger and Lindeck showed that the E.M.F. of standard cadmium cells with saturated electrolytes could be represented as a function of the temperature by the equation—

$$E_t = E_{20} - 0{\cdot}000038(t-20) - 0{\cdot}00000065(t-20)^2,$$

the formula being applicable down to 0°C. for cells whose negative electrode was an amalgam containing 12 or 13 per cent. of cadmium. Certain cells, containing a 14 per cent. amalgam, showed irregularities in the neighbourhood of zero—*i.e.*, their E.M.F. exceeded by some ten-thousandths of a volt the value given by the above formula.

As a result of experiments made recently in the Laboratorie Central d'Electricité, we have determined that for all cells containing a 12·5 per cent. amalgam, the way in which they are made not effecting the result, the formula stated above represents very accurately their E.M.F. at zero as a function of that at 20 deg., the increase observed being on an average about $\frac{1}{10000}$ less than that given by the formula.

The same does not apply to cells containing a 10 per cent. amalgam. In the neighbourhood of zero the E.M.F. of these cells, which agree fairly well at 10 deg., differ between themselves by several ten-thousandths of a volt. They are all higher than the values given by the formula by amounts which may reach $\frac{1}{1000}$ of a volt. Further, when the cells are quickly cooled, their E.M.F. increases suddenly by about $\frac{2}{1000}$, then sinks slowly, and does not attain a constant value for several days. In cells containing a 12·5 per cent. amalgam, on the contrary, the E.M.F. increases slowly and reaches a constant value in a few hours.

These anomalies are not explained by the hypothesis put forward to account for irregularities in the 14 per cent. cells. It has been admitted that cadmium amalgam is made up of two parts, the one solid and the other liquid, which cease to co-exist at zero, in a 14 per cent. amalgam, but do so in a 12·5 per cent. and *a fortiori* in a 10 per cent. amalgam. New researches are necessary to clear up this point, but at least it seems prudent in accurate measurements to avoid the use of cells with 10 per cent. amalgams, or at least to prevent their temperature from falling below 10°C.

* Translated from the *Comptes Rendus*.

WIRELESS TELEPHONY.*

BY REGINALD A. FESSENDEN.

(*Continued from page 830.*)

Summary.—The author first gives a brief history of the development of wireless signalling, proceeding to describe the method and apparatus used in wireless telephony. He also discusses its possibilities and how its development has been retarded.

4. *Receivers.*—The receiver which the author has found most satisfactory for general purpose is the liquid barretter. Fig. 12 shows this receiver. It consists of a fine platinum wire, about a ten-thousandth of an inch in diameter immersed in nitric acid. Tests

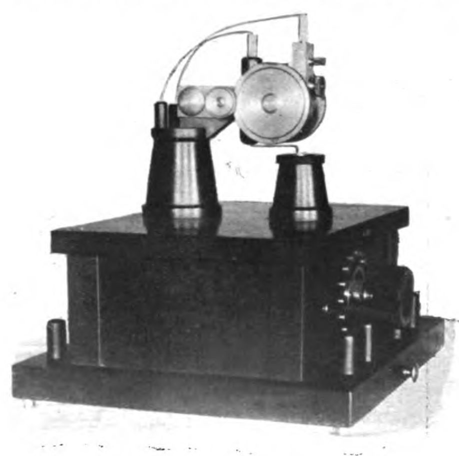

FIG. 12.—LIQUID BARRETTER.

made with this receiver show that it responds without apparent loss of efficiency to notes as high as 5,000 per second. Some very careful measurements recently made by my assistants, Messrs. Glaubitz and Stein, give the following results :—

Voltage of high-frequency circuit necessary to produce readable signals	15×10^{-5} volts.
Ohmic resistance of receiver	2,500 ohms.
Value of high-frequency current necessary to produce readable signals	6×10^{-5} amperes.
Electromagnetic wave energy required to produce audible note for period of one second	1×10^{-4} ergs.

The telephone used for detecting the signals had a resistance of approximately 1,000 ohms. Some measurements were made to determine the change of current in the telephone circuit by using a sensitive galvanometer in series with the telephone, but the results

* Abstract of a Paper presented at the 25th annual Convention of the American Institute of Electrical Engineers, June-July, 1908.