

## EARTHQUAKES AND FIRE-DAMP

*On the Observation of Earth-shakes or Tremors in Order to Foretell the Issue of Sudden Outbursts of Firedamp.*

By M. Walton Brown. Excerpt Minutes of Proceedings of the North of England Institute of Mining and Mechanical Engineers, vol. xxiii. 1884.

*A Theory of Mine Ventilation.* By M. Walton Brown. (Printed by Lambert and Co., Limited, 50, Grey Street, Newcastle-on-Tyne, 1884.)

THE first of Mr. Brown's two papers contains a proposal to institute the systematic observation of earth-tremors for purposes which he describes as follows:—

"Whatever may be the cause of the issue of sudden outbursts of firedamp the quantity of gas produced is extremely variable and irregular. Many theories have been from time to time advanced with the object of defining the laws which govern these sudden outbursts of gas from coal and adjacent strata.

"It would appear that there is some connection between sudden outbursts of gas and the motions to which the crust of the earth is subject: in other words, that slight motions of the earth's crust may be followed by more or less violent outbursts of gas. Thus, if there were a large body of gas pent up in a subterranean reservoir, and some movement of the earth's crust took place forming fissures of varying depth and width, affording channels for the escape of this gas, upon such a fissure being reached in the workings of the mine, a blower would be the result, the volume and duration of which would depend upon the volume of the reservoir, pressure of the gas, and width of the fissure. If this theory is the true solution of the problem, it follows that the systematic and regular observation of earth movements would eventually prove a reliable means to some extent of foretelling when outbursts of gas should be anticipated."

If gas existed in subterranean reservoirs such as those imagined by Mr. Brown, then, undoubtedly, when the workings of a mine reached a fissure communicating with such a reservoir all that Mr. Brown anticipates would happen. Supposing it possible, however, that a fissure could be formed by an earth-tremor at the depths at which firedamp exists in a sufficient state of tension to give rise to an outburst when tapped, it does not by any means follow that the observation of earth movements could assist us in foretelling when such outbursts would be likely to happen. For the position of any given fissure, relatively to that of the workings, must obviously be an unknown quantity, so that, for anything we could know to the contrary, the fissure might either be broached on the day of its formation or not for many years afterwards.

This paper is illustrated by two plates: one, a seismographic map of Western Europe, showing the distribution of earthquakes, copied from the map prepared by the Messrs. Mallet; the other a diagram showing, by curves, the relative frequency of earthquakes and fatal explosions of firedamp, and the mean height of the barometer monthly from January of one year to April of the following year. The explanation of the second plate appears to be incomplete. As regards the barometrical curve, we consider this a good opportunity of remarking that all attempts to correlate mean barometrical observa-

tions extending over longer periods than a few hours with explosions in mines appears to us to be labour lost, and similarly we are satisfied that the bald statement so often met with, that the barometer was rising or falling at the moment any particular explosion happened, is devoid of value, and leads simply to confusion. This subject was most carefully investigated by Mr. R. H. Scott, F.R.S., and the writer some years ago, and the results were published in various papers at the time (*Proc. Roy. Soc.*, 1872; *Quart. Journ. Met. Soc.*, 1873 and 1874). The diagrams which accompany these papers show very distinctly that the barometrical curve ought to be known accurately for several days before the occurrence of an explosion if it is desired to form a true opinion as to the probable influence of atmospheric agencies in the case.

In his second paper Mr. Brown does good service by calling the attention of the English reader to the manner in which the problem of ventilating mines has been simplified by the recent researches of M. Murgue, the able director of the Bessèges Collieries in France. M. Murgue's articles were contributed to the *Bulletin de la Société de l'Industrie Minière*, second series, vols. ii., iv., and ix.; and his views are also very clearly set forth in the second volume of M. Haton de la Goupillière's excellent and concise "*Cours d'Exploitation des Mines*," just published.

It is evident from the nature of the case that the details of no two mines can be exactly alike as regards the resistances which they oppose to the circulation of ventilating currents through them. The diameter and depths of the shafts, the lengths, areas, bends, ascents, and descents, and comparative roughness of the sides, of the air-ways, the temperature, tension of water vapour, and the velocity of the air-currents, must all vary with every varying circumstance. Accordingly, any attempt to compare the total resistance of one mine with that of another by finding the value of each element in the calculation and summing up the results could produce nothing but complication and disappointment.

M. Murgue has solved the problem by referring the sum total of all the resistances to one single and very simple resistance, namely, that of an orifice in a thin plate, which he calls the *equivalent orifice*. He describes it as *the area in square metres of the orifice through which the same manometrical depression will cause the same volume of air to pass in the same time as in the mine*. This area is found as follows:—Let  $a$  be the area required,  $q$  the quantity of air,  $v$  its velocity in passing through the orifice, and 0.65 as the value of *vena contracta*. Then—

$$q = 0.65 a v.$$

Taking  $w$  the specific gravity of the air (estimated by M. Murgue at 1.2 kilo. per cubic metre), and  $h$  the manometrical depression (expressed in kilograms per square metre, or, what is the same thing, in millimetres of water), we have:

$$h = w \frac{v^2}{2g}, \text{ or } v = \sqrt{2g \frac{h}{w}},$$

whence

$$q = 0.65 a \sqrt{2g \frac{h}{w}}.$$

Then by introducing the numerical values of  $w$  as given above, and of  $g$  as 9.8088 metres, we get—

$$q = 2.63 a \sqrt{h},$$

whence

$$a = 0.38 \sqrt[3]{h}.$$

But we can always ascertain by observation the values of  $q$  and  $h$  in any given case, so that the value of the equivalent orifice can be easily found.

M. Murgue has determined this value for a large number of mines and has given the results in tables in his second article, already referred to. The values vary somewhat above and below a square metre, but a large number of them are very little different from that unique area. The author calls those mines whose equivalent orifice is greater than a square metre, *wide*, or *roomy*, and those in which it is less than a square metre, *narrow*, or *confined*.

M. Murgue has applied the same mode of comparison to the resistances which the air has to overcome in passing through the various kinds of ventilating machines, and in this case he distinguishes the corresponding orifice by the name of *orifice of passage*. The manner in which its value is found is similar to that of the equivalent orifice.

In Mr. Brown's paper will be found a table containing a summary of experiments made, with six different kinds of ventilators, by a Committee of the Société de l'Industrie Minérale, in which the translator has reduced the French measures to their English equivalents. He also gives two diagrams: one showing the volumes of air produced by the same ventilators kept running at a uniform velocity, while the equivalent orifice is gradually increased; the other showing the curves of useful effect for four of them. On the whole, we consider that the contents of this paper deserve the careful consideration of those who have not an opportunity of consulting the original articles.

W. GALLOWAY

#### MAGNETO- AND DYNAMO-ELECTRIC MACHINES

*Magneto- and Dynamo-Electric Machines.* From the German of Glaser de Cew, by F. Krohn. Specially Edited, with many Additions, by Paget Higgs, LL.D., D.Sc. (London: Symons and Co., 1884.)

THIS book is issued as Volume I. of "The Specialists' Series," to be edited by "Dr." Paget Higgs and "Professor" Charles Forbes. From what University Mr. Higgs holds his degree of Doctor of Science does not appear. Presumably, he is the same person as the "Rev. William Higgs, M.A., D.D.," who formerly edited an electrical periodical in London, and afterwards left his country. Readers of the admirable volume on the "Transits of Venus" in the *Nature Series* know the name of Prof. George Forbes, and appreciate his scientific standing. They are not likely to confound him with the Mr. Charles Forbes who appears as joint editor.

The present volume, translated and "specially edited," gives to the public little that it did not previously possess. Of books on electric lighting there are enough and to spare. Dr. Schellen's work on "Magneto- and Dynamo-Electric Machines"—an excellent translation of which is now appearing in New York—was the first good work of the kind, and it has run to a second edition. In title and in matter it is greatly resembled by the present work;

but Schellen's work is far more elaborate and complete; whilst the one merit of the Glaser-de-Cew-Krohn-Higgs-Forbes volume is that it includes a brief chapter on accumulators—too brief, considering that the various types are well and concisely explained. For the rest, the additions are chiefly scissors and paste work. Chapter VII., on Constructional Laws, is largely taken from Prof. S. Thompson's "Cantor Lectures"; Chapter VIII. gives the old set of tests executed for Trinity House in 1877 on obsolete types of machine; the only addition, relating to the later and far more perfect tests made at Paris in 1881, Munich and Crystal Palace (London) in 1882, and Vienna in 1883, being an editorial footnote five lines in length. Chapter X. is extracted from Du Moncel's book on "Electromagnets"; Chapter XI. (on Instruments for Measurement) is apparently amplified from the price list of a certain firm of electrical engineers, whose instruments, exclusively, are described. Chapter XIII. is an abridgment of Clausius' theory of the dynamo-machine, reprinted *verbatim* from the abstracts from foreign journals in the *Proceedings* of the Institution of Civil Engineers. The index is most elaborate: it occupies nearly a twelfth of the whole book. There are several glaring errors in the work. Of these is the statement, on p. 100, that in a compound-wound dynamo—in which it is desired to provide a current varying exactly proportionally to the number of lamps that are connected to the mains—there must be maintained "a constant magnetic intensity." On p. 143 it is elaborately set forth that the ratio of the part of the effective electrical energy which is converted into real work to the total electric energy of the current can "never be greater than  $\frac{1}{4}$ "; and on p. 147, equally elaborately, that "the maximum efficiency of an electro-generator is obtained when its internal resistance is equal to the resistance in the external circuit." If the latter statement were true the maximum efficiency could never exceed  $\frac{1}{2}$ . The fact is that both statements are untrue and misleading, as are several of the statements relating to efficiency on p. 144. Apparently, either the translator or the editor does not understand either the English meaning of the German word *Nutzeffekt*, or the technical meaning of the English word *efficiency*. On p. 173 the shifting of the neutral point in the rotating armature is referred to the alleged fact (?) that "the magnetism of the iron core and the current in these turns of wire (which have passed the poles) remain at the same intensity for a few moments." The statement is misleading, and the supposed explanation of the shifting of the neutral point is well known to be a fallacy. Still more extraordinary is the statement made, apparently with scientific seriousness, on p. 174, that the heating of the iron core of the armature is another "consequence of the fact that the maximum magnetism does not immediately disappear." There are several mistakes in the definitions of the electrical units as given in the last page of the preface. The *watt* is given as the unit of *work*, instead of the unit of activity; and the extraordinary statement is made that the unit of potential difference "exists between two points when the unit quantity of electricity, in moving from the one point to the other, *requires a unit force* to overcome the electrical repulsion," thus making the definition of potential depend on *force* instead of *work*. Moreover, the static units are called the "C.G.S." units