E. Chromium.

4. Silicates.

F. Iron.

H. Cobalt, Nickel.

1. Sulphides.

I. Zinc, Cadmium.

2. Oxides.

K. Lead.

3. Salts not silicates.

L. Copper.

4. Silicates.

M. Mercury.

G. Manganese.

N. Silver.

1. Sulphides.

O. Platinum and associated metals.

2. Oxides.

3. Salts not silicates.

VII. Resins, or organic compounds.

Of course, in this arrangement, the word metal is used in its popular sense.

(To be continued.)

From the London Engineering, No. 70.

PUMPING BY WATER POWER.

THE April number of *Les Annales du Génie Civil* contains a paper by M. Achard, descriptive of the water-works carried out under his direction for the supply of two suburbs of Geneva, known as Petit Saconnex and Grand Saconnex, the latter elevated 104 metres, or 341 feet, above the level of the Rhone, a little below where it leaves the Lake of Geneva. The river, here—and it is here that Bonnevard (the Prisoner of Chillon) was supposed, by a fiction of poetry, to have seen it when he spoke of the “Blue Rhone in fullest glow”—has a current sufficiently swift to work a large paddle or undershot wheel for driving pumps, and water-power pumping works have accordingly been erected by MM. Menn, Lullen & Co., engineers, of Coulouvrenière, near Geneva. These consist of a wheel, 33 feet 6 inches in diameter and 20 feet face, driving a pair of double-acting pumps, of a collective capacity of $6\frac{2}{3}$ gallons, or $13\frac{1}{3}$ gallons for the double stroke, at four times the speed of the wheel itself, the ratio of the gearing being as 4 to 1. At $2\frac{1}{4}$ revolutions of the wheel per minute, 120 gallons per minute are thus pumped. Including friction and all resistances, the pumps work against the great resistance of 472 feet of water. The usual speed of the water-wheel is, however, $1\frac{3}{4}$ turns per minute, and the corresponding head, including friction, is 380 feet.

ERECTING THE INVERTED IMAGE

IN THE MAGIC LANTERN.

By HENRY MORTON, Ph.D.

A LENS, as every one knows, inverts the image which it makes of any object; hence, in the magic lantern, we place the picture upside

down, and right for left, in order that its image on the screen may occupy a true position. This is the shortest road out of the difficulty, of course, where it can be followed ; but there are many cases in which such a treatment of the subject is inadmissible. Thus, if we wish to exhibit to a large audience the manner in which tacks or iron filings are vivified by a magnet ; how water assumes the spheroidal state on a heated surface ; how the same fluid is caused to circulate by local changes of temperature, or is decomposed by a galvanic current, or any of the many similar experiments which may be conducted with striking effect in a lantern, we must resort to some means other than "inversion of the object" to secure an erect or right-side-up position of the image on the screen.

The desirability of some means for reaching such a result is very manifest, and the most natural first thought is to use a square prism, as described by Brewster in his *Optics*, page 270, where a drawing is given, curious at once for its theoretical accuracy and practical impossibility ; an equilateral triangle being taken to represent a square prism, and the refracting action indicated as about eight or ten times as great as it could possibly be. Yet, viewed as a symbol or hyro-glyph, this drawing, as will be shown presently, may be regarded as embodying actual results, which, if known to the author, were certainly not hinted at, and to the best of our belief, will find their first publication at this time.

A more accurate drawing of the same thing is to be found in Frick's *Physical Technics*, (an admirable work, which should be in the hands of every experimenter and manufacturer of apparatus,) page 209.

With such authority, we should have proceeded to experiment, but for the information, from one who had given much attention to lantern manipulations, that the plan had been tried and abandoned by him, in consequence of the loss of light and reduction of field which it entailed. Professor R. E. Rogers, who had gone further than we, and had made some experiments, was, we believe, deterred from further attempts by the same cause.

A trial, however, was at last made which satisfied us that, under proper conditions, a good result might be realized with a square prism, placed in front of the objective of an ordinary lantern.

The accompanying cut, which is drawn with some attention to accuracy of direction and angle, will show, on inspection, how the upper and under rays, D and M, change places, and thus how the inversion is corrected. In using this prism, no inclination is given to the lan-

tern. It remains directed to the screen, exactly as with the inverted image.

The loss of light experienced is not serious, so that we are able,

Fig. 1

with an ordinary lantern, to cover a screen of twenty feet in diameter with a brilliant circle of light; while the contraction of field, though notable, is not of any practical inconvenience.

The only drawback was the difficulty and cost of obtaining prisms large enough, and this difficulty has been overcome by the ingenuity of Mr. Zentmayer, who has devised the excellent improvement we shall now proceed to describe.

Observing that with the square prism, only the lower portion is available, any ray above D, Fig. 1, such as H, for example, failing to strike the base and be reflected, but suffering reflection downwards at K, and so being lost, he proposed to make the prism of such a shape as is indicated in Fig. 2.

Here the angle B is calculated to equal the angle of refraction of

Fig. 2.

an horizontal ray, such as D at the surface A B, plus 90° . Under this condition, such a ray, after refraction, would be parallel to the further side, B C, and would therefore reach the base, A E, and be reflected from it, however near to the summit, B, it might strike.

The lower ray, H, would be in an equally favorable condition, as is clear from inspection of the figure.

The angle, B, is $125^\circ 30'$, A and C, of course, $27^\circ 15'$ each. It

might be thought that the great obliquity of the surface, A B, would cause a serious loss of light by reflection, but this drawback does not appear in practice.

The economy in thickness of glass required to produce a prism of given effect is decidedly very great. In fact, the ordinary optical glass, which is easily procured, answers perfectly; while for the square prism of sufficient size, it would be necessary to order blocks especially from the foreign manufacturers.

With regard to the curious *symbolism* of Brewster's drawing, we can now explain, that the rays, after refraction, were represented as proceeding in lines parallel with the faces of the prism, as in Fig. 2, though with a triangular, or even with a square prism, this was entirely impossible.

We do not wish to claim any originality in the use of a square prism, as above described, but only to call the attention of those interested, to the practicability and success of the arrangement. The form devised by Mr. Zentmayer is, however, we believe, entirely new, and certainly most efficient, and he is entitled to all the credit of its invention.

EDUCATIONAL

(Continued from page 356.)

THE MAGIC LANTERN

AS A MEANS OF DEMONSTRATION.

HAVING now pretty fully discussed the methods of preparing, and storing the oxygen and hydrogen gases, we will next proceed to describe the best form of jets for burning them, first, however, giving some account of a simple gauge, to indicate the pressure employed on the gases, which we have found of the greatest possible value and convenience.

A mere inspection of Fig. 8 will make this arrangement plain, almost without a description. The two bottles of two necks, such as may be obtained from chemical dealers, are blown from glass tubes, and hold about two ounces. The tubes are fitted to their necks by means of rubber corks, or short pieces of rubber hose used as corks,