ONE SHILLING

THE MAGIC LANTERN

HOW TO BUY
AND
HOW TO USE IT
ALSO
HOW TO RAISE A GHOST
BY
"A MERE PHANTOM"

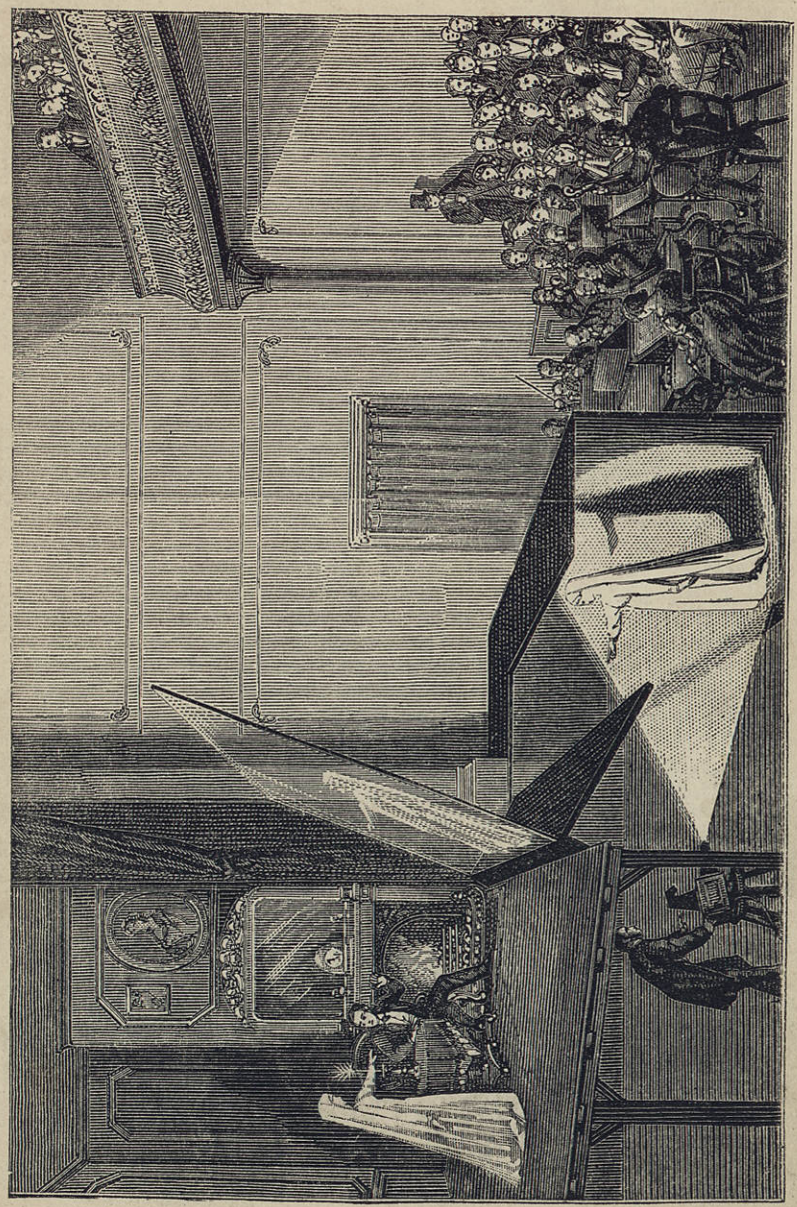


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THE MAGIC LANTERN, IN ITS APPLICATION TO THE MODERN METHOD OF RAISING A GHOST

See page 78.

T. & H. DOUBLET, OPTICIANS, 6, MOORGATE ST.

THE

MAGIC LANTERN

HOW TO BUY,

AND HOW TO USE IT.

ALSO

HOW TO RAISE A GHOST

By "A MERE PHANTOM."

"If this be Magic, let it be an art
Lawful as eating."

Shakespeare.

Tenth Thousand.

LONDON
HOULSTON AND WRIGHT
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W.D.
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ADVERTISEMENT.

THE following pages have been written as a "Handy Guide" for those desirous of amusing the younger members of a family, or imparting instruction to a class at school; all technical terms which could be dispensed with have, therefore, been carefully excluded.

The increased use of the Magic Lantern as a means of beguiling the long evenings of winter, and the absence of any book on the subject, render a brief and simple guide for the unscientific purchaser not only desirable, but necessary.

The high position now accorded to this instrument may be inferred when it is remembered that the Secretary of State for War has issued a circular, providing for a supply of Magic Lantern slides to illustrate lectures to the soldiers in our Army; nor is our Navy left without similar resources of recreation and instruction. Scarcely anything could be devised so likely to awaken the minds and fix the attention of those for whom the lectures are prepared, as these *viva voce* addresses, and appeals to the eye, through the agency of the Magic Lantern.

It is also a very suggestive circumstance that Dr. Livingstone took with him a Magic Lantern to instruct and amuse the natives of the countries he visited; so that while naturalized in London, the centre of the world's civilization, the Magic Lantern is no stranger to the dusky denizens of the heart of Africa.

The leading organs of the literary and scientific Press having given most favourable opinions on the merits of the earlier editions, and the principal Opticians of our country having adopted the Manual, as a Guide to the Use of the Magic Lantern; the author is encouraged to hope that this enlarged and improved edition may be found even more *solidly* useful, though still only the production of

"A MERE PHANTOM."

THE MAGIC LANTERN.

HOW TO BUY IT.

THE Magic Lantern, which three centuries since served no better purpose in the hands of pretended wizards and necromancers, than to induce a belief in their possession of supernatural powers, now occupies a deservedly high position as a Scientific Instrument, capable of affording rational amusement to the young, instruction to "children of a larger growth," and in the hands of the philosopher, a means of demonstrating some of the most beautiful phenomena in science.

By its means the monotony of "evenings at home" has been charmed away; new ideas have been introduced, fresh mirth inspired, and useful instruction gained.

How delightful is one of those gatherings! where youth, infancy, and maturity are, for different reasons, equally interested in the mimic scenes so vividly presented; infancy charmed with the rapid change of form and colour and grotesque fun, and its infectious laughter echoed by young and old.

Notwithstanding the general diffusion of scientific knowledge, few are accurately informed as to the method by which such charming effects are produced;

and it is the object of the present treatise to offer such information in a compendious form.

In writing of this instrument, Sir David Brewster says, "The Magic Lantern, which for a long time was used only as an instrument for amusing children and astonishing the ignorant, has recently been fitted up for the better purpose of conveying scientific instruction, and it is now universally used by popular lecturers on Astronomy for representing the phases and the motions of the heavenly bodies, all of which are minutely painted on the sliders.

"The Magic Lantern may be employed in almost every branch of scientific instruction where it is desirable to give a distinct and enlarged representation of phenomena to a public class. The lecturer is thus saved the trouble of carrying about with him unwieldy diagrams, which are soon destroyed by use, and rendered unfit for their intended purpose."

In general terms, a Magic Lantern may be described as an optical apparatus, furnished with lenses, for the purpose of projecting on a wall or screen enlarged images of transparent objects placed before it.

Its invention is ascribed to Roger Bacon, about A.D. 1260, but more correctly to Athanasius Kircher, who died in 1580.

Figures 1 and 2 are illustrations of the simplest form of Magic Lanterns, fig. 1 giving a general view of the instrument, and fig. 2 showing the same apparatus in section.

Those numbered in most Opticians' catalogues from 1 to 6 are of the simplest construction, as shown in the figures, the lenses being single, and not double.

The following is a list of the Magic Lanterns found at Opticians' shops, of a kind best adapted for the

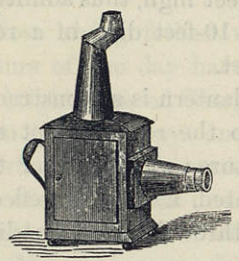


Fig. 1.

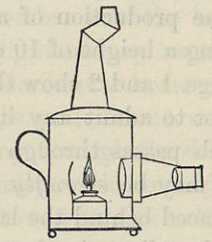


Fig. 2.

amusement of children at a juvenile party. They are usually sold at prices varying from five to fifty shillings, and the description contained in this list will enable any purchaser to indicate to a salesman the kind of lantern he requires.

No.	Diameter of condenser.	Distance to be placed from screen.	To yield a disc having a diameter of
1	1½ inch.	4 feet.	3 feet.
2	1¾ ,,	5 ,,	4 ,,
*3	2 ,,	6½ ,,	5 ,,
4	2½ ,,	8 ,,	6 ,,
5	3 ,,	10½ ,,	8 ,,
6	3 ,,	10½ ,,	8 ,,
7	3½ ,,	14 ,,	10 ,,

For Parlour or Drawing-room Phantasmagoria, the lantern may be conveniently placed on the box supplied with it, and the whole elevated on a small four-

* No. 3 is the first size of the smaller Lanterns which (being furnished, like the larger ones, with a spring to hold the slides) admits of the use of small Chromatropes (page 54), Changing Comic Slides (page 50), small Lever Slides (page 51), and 2-inch Views and Photographs on separate discs of glass.

legged deal dressing-table, such as usually supplied for a servant's bedroom. This will raise the centre of the lantern between four and five feet high, thus admitting of the production of an 8 or 10-feet disc, in a room having a height of 10 or 11 feet.

Figs. 1 and 2 show that the lantern is so constructed as not to admit any light into the room except that which passes through the picture; and in order that this may be *strongly* illuminated, a concave reflector is placed behind the lamp, to throw back all the light which radiates in that direction.

The lanterns usually supplied in the shops may be divided into three classes, viz., those intended to be illuminated by oil, those for the oxycalcium, and those for the oxyhydrogen light.

The first class, on account of the moderate prices of the smaller sizes, are bought in large numbers for the amusement and instruction of the "little ones;" the consideration of which brings us to our—

Chapter for Children.

Most loving fathers will remember how the heavy labours of the day have been lightened by recalling the bright faces of George and Florence at home; and when the birthdays and Christmastides come round, paterfamilias may be seen smiling through the dreariness of London fogs or country mists, as he anticipates Lilian's laugh and Gertrude's crow when he exhibits that Magic Lantern which he has determined to buy; and though chained to "desk's dead wood," thought is free, and suddenly his spirit is far away. He sees his little drawing-room brilliantly lighted, and his family brilliant too, with smiles and gaiety; the wondrous sheet is suspended, the lantern fixed, the children sitting round,—he fancies even his own deep bass, commencing with "View of the Temple of the Sun at Baalbec"—when a mild tenor interposes with, "Cheque upon Barclay, sir;" and lo! the dream is dispelled, his spirit returns, and the fog is visible again. But there is a light behind it,—the light of love,—and papa says, inwardly, "They *shall* have a lantern;" and business being over, he goes to the nearest Optician's, and with a cheerful spirit, launches out his sovereign, more or less, receiving in exchange a neat brown paper parcel; calls a cab, and triumphantly drives away with his treasure. The parcel is laid on the table, and excites the curiosity of the young folks. "What ever can it be?" says Florence. "What a funny shape!" says Lilian; and the impetuous George, impatient of the string, is snubbed for rushing to his mamma's workbox for

scissors. At length the paper is removed, and the lantern stands revealed in all the jetty brilliancy of black japan. "Well," says papa, "what shall we do first?" "Stick up the sheet," says one. "Light the lamp," says another. "Ah! but what about the oil?" says mamma. "The very thing I have forgotten," says papa. The first thing done, therefore, by paterfamilias will be to send for some of the BEST SPERM OIL.* Having obtained this, he should gently warm a portion on the hob in the lamp near the fire, and then pour into the lamp a sufficient quantity to nearly fill it. With the Magic Lantern he will doubtless have obtained from the Optician a piece of COTTON WICK, of a size properly suited for it. This should be made *quite dry* by holding it for a while before the fire. It may then be passed through the wick-holder, which has, of course, previously been unscrewed. A scissors will now make the wick of a length suitable for the size of the lamp, after which the whole is placed in the ring at the top of the lamp. (See fig. 2.) This being done, the scissors will again come into use, and this time they should be very sharp, so as to cut the wick very neatly, and without a jagged edge, and not so close but that *a portion* protrudes through the wick-holder.

The great element of success is the obtaining of a CLEAR AND BRILLIANT LIGHT FREE FROM SMOKE; and this depends mainly—on having good oil slightly

* SOLID PARAFFIN yields a light of equal brilliancy to the camphorated oil. It is melted by a gentle heat, by placing the lamp containing it on the hob of a grate; when, however, the first charge is exhausted, it involves the slight inconvenience of melting some more paraffin in a separate vessel before it can be poured into the lamp.

warmed, the neatness with which the wick is trimmed, and the amount which is allowed to project beyond the wick-holder; observing also to allow sufficient time (say five minutes) for the complete saturation of the wick by the oil.

Those conditions upon which the obtaining *a clear and brilliant light mainly* depend have been mentioned: there are other points, of hardly less importance, to which attention should now be directed.

The reflector attached to the lamp should be quite bright. To this end it should be polished with any material *free from grit.* That found handiest in most households is a little whitening and water, or oil, which, rubbed over by the finger or a piece of linen rag, and polished dry with a chamois leather, will generally accomplish the end in view. Rouge, rottenstone, or Tripoli may also be used.

The object-glass and the condenser, or, in other and simpler words, the front and back lenses, now claim attention. In the smaller sizes of lanterns, to which these remarks are intended specially to apply, they simply require to be removed from their places very carefully, polished with a chamois leather, and replaced. It is only necessary now to light the lamp and place it, when kindled, inside the lantern, and close the door, and the lantern is ready for use.

Before inserting any of the slides, it is necessary to have a suitable surface on which to project the pictures to be exhibited. This may be contrived by stretching a linen or calico sheet, as free from folds as possible, on the wall, or pinning it to the window-curtains.

Such operations involve a slight disturbance of do-

mestic arrangements, *e. g.*, unhanging pictures, &c., and elicit decided objections from materfamilias, in which case a very convenient screen for the smaller lanterns may be made by stretching a piece of linen over an ordinary child's hoop of three or four feet in diameter.

On turning the lantern containing the lighted lamp towards the screen, there will be observed, not only an indistinctness of outline at the margin, but dark spots in or about the centre of the disc of light.

The remedy, in the first case, is to turn the sliding tube in the front of the lantern, in or out, until the desired sharpness is obtained; in the second case the dark spots will disappear on moving the lamp nearer to or farther from, and from right to left of the *centre* of the condenser. In some of the smaller sizes of lanterns (from No. 4 upwards) this adjustment is made in the course of manufacture, and a suitable recess provided, in which it is only necessary the lamp should be placed as soon as trimmed and lighted.

A clear disc of light having been obtained, the slides should be carefully dusted before being placed in the lantern, and each picture accurately centred and focused until a clear outline is obtained upon the screen. A piece of wood, cut as shown at No. 21, fig. 35, page 76, will be found very useful to elevate the slide, and thus bring the picture in a line with the *centre* of the condenser. The optical centering of the components of a Magic Lantern is illustrated by fig. 30, page 59, where the dotted line cuts the source of light, the condensers, the object, and the object-glasses. If a good result be desired, this point requires attention.

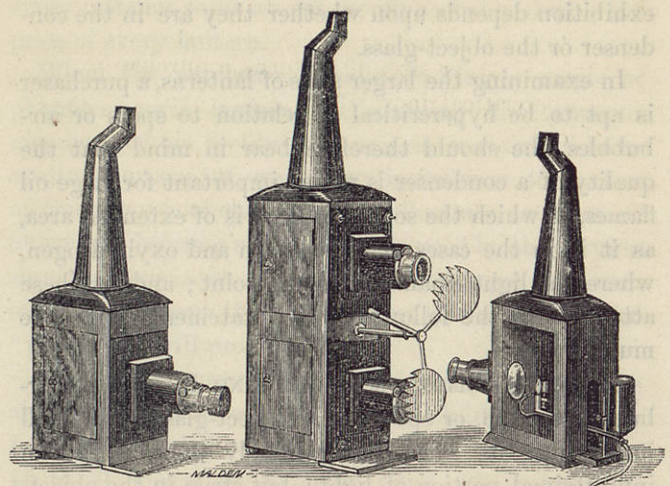


Fig. 3. Fig. 4. Fig. 5.

THE PHANTASMAGORIA LANTERN.

HOW TO BUY IT.

The Lanterns classified under this head are usually of large size, and made of japanned tin, as are the smaller ones, but sometimes of mahogany, lined with sheet iron; and so long as they bear outside evidence of being substantially made, the purchaser may rely for their durability upon the reputation of the house at which he makes the purchase.

The condensers and object-glasses, however, being the parts upon which the success of an exhibition mainly depends, may undergo at the hands of the purchaser a more rigid scrutiny than the mere body.

These essential portions of the apparatus are liable to three defects, viz., scratches, air-bubbles, and striæ, the influence of either of which on the success of the

exhibition depends upon whether they are in the condenser or the object-glass.

In examining the larger sizes of lanterns, a purchaser is apt to be hypercritical in relation to spots or air-bubbles; he should therefore bear in mind that the quality of a condenser is not so important for large oil flames, in which the source of light is of extended area, as it is in the cases of oxycalcium and oxyhydrogen, where the light emanates from a point; and for these attention to the following brief statements will save much time:—

1. Object-Glass, or Magnifying Lens.—An air-bubble, scratch, or spot on the object-glass is of small importance, its effect being merely to intercept an infinitesimal portion of light; but striæ in the object-glass may not be so lightly passed over, since the effect of these is to confuse the image.

2. Condenser, or Bull's-Eye.—It is far more important that an air-bubble, scratch, or spot should be absent from a condenser than an object-glass, since, if present, an enlarged image thereof will be reproduced upon the screen (if in the biconvex lens), while striæ, which are so deleterious in an object-glass, are here of comparatively small importance.

3. It will be obvious that the defects above referred to would be better absent, both from condenser and object-glass; but as the perfection of construction which obtains in a portrait or microscope lens is neither aimed at nor necessary in lantern lenses, it would be simply puerile to reject or abstain from purchasing on account of a small defect which—according to its nature and locality—produces no ill effect, and if required in

every instance to be absent would probably double the price of every lantern.

When the purchaser, besides desiring a magic or phantasmagoria lantern for amusing the younger members of his family, wishes it to answer the more exalted purpose of conveying instruction to a class of Sunday school children, or to illustrate an amateur lecture, he becomes sometimes perplexed by the varying sizes and prices in an Optician's catalogue. In such cases it is hoped that the advice of an experienced "phantom" will prove useful.

The lanterns usually met with in the shops may be arranged under three heads:—1st, Children's, or Toy Lanterns, having *simple* condensers, varying from 1½ to 3½ inches in diameter. 2nd, Phantasmagoria Lanterns, having *double* lens condensers, from 3 to 4½ inches in diameter, for use either with the oil, oxy-calcium, or oxyhydrogen light. 3rd, Phantasmagoria Lanterns, with double lens condensers, from 3 to 4½ inches in diameter, but with iron-lined mahogany bodies, and double achromatic object-glass, with rack and pinion adjustment.

Of the first class it may be said that they answer their purpose admirably well, and, when price is considered, the wonder is they can be offered so low. The lanterns in the second class possess all the *essentials* of a good lantern, viz., double condensers and object-glasses; and where the purchaser desires to keep within the limit of £5 or £10 for lantern and slides, he may be well assured that these will prove satisfactory purchases. The third class includes what may be regarded as finished and perfect lanterns, being fur-

nished with every appliance and adjustment, besides the additional comfort of working with, or rather handling, a wood body rather than one of japanned tin. (See fig. 3.) These can be recommended, from actual experience, as a kind of lantern which will give permanent satisfaction, and prove suitable either for amusement or instruction, admitting of the use of, and serving for, the oil, oxycalcium, or oxyhydrogen lights; yielding with the first a well-illuminated disc of 10 or 12 feet in diameter, and with the latter means of illumination, discs of 20 to 30 feet.

Lanterns of the kind last described are sometimes furnished with blue discs of glass let into the doors, to enable the operator to make the necessary adjustments when using the oxycalcium or oxyhydrogen lights without injury to the sight. If these be absent he will do well to furnish himself with a pair of deep blue spectacles.

The Phantasmagoria Lantern.

HOW TO USE IT.

"What mighty magic!"—*Shakespere.*

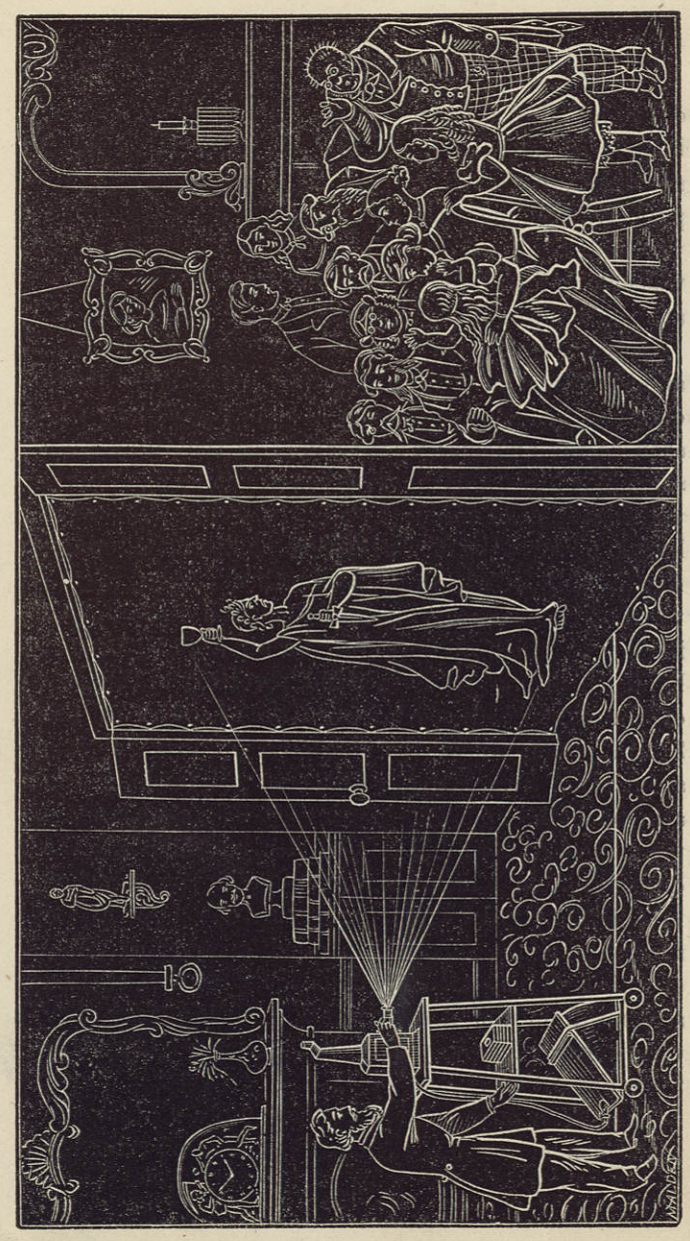
This high-sounding name, derived from the Greek words φαντασμα (*phantasma*), *a spectre*, αγαραομαι (*agaraomai*), I meet, and having reference only to the *manner* in which the lantern is used, is applied to the Lanterns described above under the second and third divisions, which give greater flatness of field, and a more truthful delineation of the picture over the whole extent of the illuminated disc.

The manner of using the Magic Lantern so as to pro-

duce the effect known as the *Phantasmagoria* was introduced into London in the year 1802 by a French gentleman named Philipstal, who, when showing it publicly at a time when those who formed his audience were entirely ignorant of the means by which the effect was accomplished, did not fail to increase the mystery attending the exhibition by every means at his disposal.

An oil lamp suspended from the centre of the room, and yielding a most dismal light, served only "to make darkness visible;" and even this was withdrawn as soon as the audience were seated; so that they were surrounded by "a darkness which might be felt," amid which strains of music, having "a dying fall," were heard, followed by the rumbling of distant thunder, the flashing of lightning, and other tokens of the warring elements. While this elemental strife was at its height, there appeared in the air a small disc of light, which gradually expanded, revealing to the gaze of the astonished spectators "The Phantom of the Storm," upon whom the skies seemed to "spit fire, spout rain," &c. The phantom "waved its long lean arm on high," rolled its glaring eyeballs with an expression of unutterable woe, suddenly retired into the darkness from whence it came, and finally vanished in a little cloud. Other spectres, with appropriate accompaniments, followed in quick succession; some of which, rushing suddenly upon the spectators, elicited screams from the more nervous, showing that they were regarded as anything but "honest ghosts," or "fine apparitions."

The effects introduced more than half a century ago with such mysterious surroundings may now readily



THE METHOD OF USING THE "PHANTASMAGORIA" LANTERN.—Fig. 6. *See page* 21.

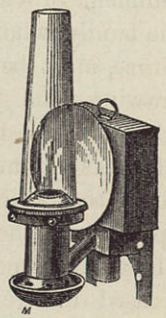
be produced in an ordinary parlour or drawing-room by adopting the arrangement shown in the accompanying engraving, fig. 6.

To the scene so skilfully and amusingly portrayed by the artist, these words from "Lily," in *London Society*, seem singularly appropriate: —

> "A baby boy of seven years,
> I lavished sighs and wasted tears
> On Mary ten years older.
> Does she remember Prior Park?
> The Magic Lantern? In the dark
> I kissed her *on the shoulder*."

The whole picture is suggestive of "a happy home," and keen social enjoyment; and the family circle, to increase which, "a few friends" have evidently been invited, seems to enter fully into the spirit of the entertainment provided for them by the scientific man of the family, who, from the superior character of the furniture, must be assumed to be in the front parlour or drawing-room. Between this apartment and the one where the guests are assembled, it will be seen, by the tin tacks hammered into the framework of the folding-doors, that a linen or muslin screen has been stretched, upon which the phantom is projected by the lantern. The transparency of the screen has been previously increased by wetting, and the Magic Lantern being placed on a stand, or "what-not," as represented in the diagram, and a piece of white tape tacked down to the floor, in a direct line from the centre of the screen, to guide the operator in advancing or receding, the picture is placed in the lantern. The stand bearing the

lantern should then be wheeled* up close to the screen, when a bright disc of light, varying in diameter from four to eight inches, will be produced. Before focusing the image in so small a disc, a piece of crape should be dropped over the front of the lantern, so as slightly to diminish the brightness, as it will unavoidably become less bright as the lantern is run backwards in the direction of the white tape. Simultaneously with the act of receding, the crape may be removed, thus compensating for the dilution of the light over a larger surface, and the consequent diminution of brightness. It will be understood that the object of the Phantasmagoria is to produce the idea of *approaching* and *retiring* by means of images, which really only *contract* and *expand;* and the disadvantage attending the operation is, that when the image is at its brightest it occupies the smallest area, and *vice versâ*. The contrary would, of course, be the most appropriate conditions; and hence the necessity for the employment of crape, or partially obscuring the light by the fingers, since the illusion is as much dependent on equal brightness as equal distinctness.



Fountain Argand Oil Lamp.
Fig. 7.

When Sperm Oil is used, the lamps supplied with these larger and more carefully constructed lanterns are generally of the best Argand fountain form, and the concave silvered reflectors attached thereto of large diameter and substantial material. Such a lamp is shown in the margin.

* The wheels should move *noiselessly*, and should therefore be well oiled, and, if practicable, covered with india-rubber.

A brief recapitulation will here prove useful.

In the first place, it is essentially necessary that the room in which the exhibition takes place should be PERFECTLY DARK, as any stray light is apt to mar the distinctness of the picture. A *new dry wick* having been attached to the brass collar furnished for that purpose, the lamp should be filled with warm *Camphorated* Sperm Oil—made by dissolving two ounces of Camphor, in small pieces, in one pint of Sperm Oil, by aid of a gentle heat,—and while sufficient time elapses for the complete saturation of the wick with oil, the lamp glass or chimney should be wiped with scrupulous care, so as to be perfectly bright and clear. The wick should then be kindled, allowed to burn for a short time, and then blown out. This makes it easier to trim the wick down to that clean level edge which is essential to the production of a bright light. After careful trimming, the wick may be rekindled, and the lamp glass placed in the gallery around the lamp (fig. 7). The concave reflecting mirror, having been previously well polished with rouge and chamois leather, should also be placed in position behind the lamp. While, however, the whole of the above has been going on, the condensing lenses should have been removed from the lantern and placed inside the fender in front of the fire to warm gently, so as to prevent their cracking with the heat of the lamp; and assuming this to have been done, they should now be taken up and carefully wiped, nay, even polished, with a clean linen cloth or dry chamois leather. The same operation of wiping and polishing having been observed with the front lenses or object-glasses in the

sliding tube, and the lamp having been placed inside, the lantern is now ready for use.

Each picture, having been previously *freed from dust*, should now be pushed UPSIDE DOWN into the groove provided for that purpose between the condenser and object-glass.

The wick of the lamp should now be turned up as high as possible short of smoking, and finally the focus adjusted by turning the pinion screw or sliding tube in or out until a well-defined image is obtained on the screen.

RECAPITULATION.

From a new lamp remove all dust.
From a lamp which has been used remove old oil.
Dry the wick thoroughly.
Warm the *Camphorated* Sperm Oil.
Fill the oil cistern about two-thirds full.
Allow wick to become *saturated* with oil.
Light lamp, and put out after burning a minute.
Now trim the wick neatly with sharp scissors.
Re-light, turn wick up without smoke.
Flame to be in centre of bull's-eye and reflector.
Polish reflector with rouge and chamois leather.
Warm the condensers or bull's-eyes at the fire.
Wipe carefully with silk duster, and replace them.
Also wipe object lens in front sliding tube.
Wipe and dust pictures, and arrange them in order.
Darken room.
Place pictures in slide-holder *upside down*.
Determine *size* of picture by *distance* from screen.
Secure sharpness by focusing with front sliding tube.
Have chamois leather and a duster always at hand.

THE OXYCALCIUM LIGHT.

"Giving more light than heat."—*Shakespere.*

Hitherto it has been assumed that the means of illumination is Camphorated Sperm Oil, and when it is desired to exhibit in a drawing-room on a disc of eight feet, oil will, when properly managed, give a sufficiently brilliant light.

THE OXYCALCIUM LAMP.

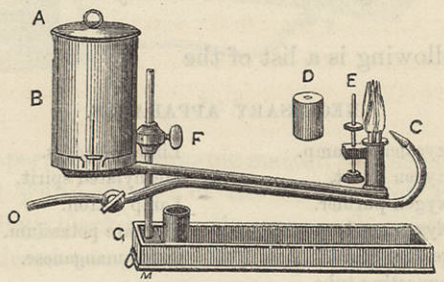


Fig. 8.

A and B are parts of the cistern for containing the Methylated Spirit, which flows through a long tube to the wick at C. Immediately under this is shown the tube which, terminating in a jet curved at a suitable angle, enables the Oxygen to be directed through the centre of the flame upon the Lime cylinder D, which has been previously placed on the holder E provided for that purpose. The screw F is to facilitate the adjustment of the lamp in relation to the centre of the lenses when in the lantern. G is the stopcock to regulate the passage of the Oxygen gas. This lamp is shown in position on the right hand of the group of Lanterns on page 15.

But when with the same lanterns it is desired to exhibit in a lecture-room where a disc of twenty or perhaps thirty feet is necessary, some means of pro-

ducing a more brilliant light must be adopted: such means are offered in the oxycalcium and oxyhydrogen lime-lights.

It may be observed in this place, that theoretically there is no limit to the amount of enlargement which may be effected by means of a pair of 3½-inch condensers and their accompanying object-glasses; but practically the limit is determined by the degree of intensity of the artificial light employed; Oil bearing the least dilution, and Oxyhydrogen the most, while the same arrangement of lenses may be used in either case.

The following is a list of the

NECESSARY APPARATUS.

Oxycalcium lamp.	Lime cylinders.
Oxygen retort.	Methylated spirit.
Oxygen purifier.	Lamp cotton.
Oxygen gas bag.	Chlorate potassium.
Pressure board.	Oxide manganese.
Connecting tube.	

The possession of a supply of the above materials will enable the exhibitor to commence the preparation of Oxygen gas.

The arrangement of the apparatus is shown in fig. 9; the actual distances of each piece from the other may be varied, according to circumstances, by lengths of Caoutchouc tubing.

A mixture of four parts of Chlorate of Potash in crystals, as usually supplied at the shops, with one part of powdered black Oxide of Manganese, is now made. In the preparation of this mixture, which is best done on a large sheet of brown paper, with a bone

spatula or knife, care should be taken to avoid the accidental introduction of small fragments of straw,

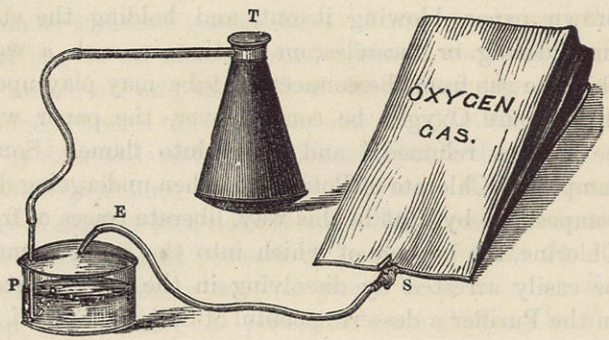


Fig. 9.

twine, paper, or other organic matter. As soon as every beautiful white crystal of the Chlorate of Potash is made a dirty black by the Manganese the mixture may be considered complete. The top T of the retort R (fig. 9) is now unscrewed, and about two pounds of the mixture introduced therein through the wide neck; and in order that when replaced the top may fit so accurately as to prevent the escape of Oxygen, the neck should be carefully wiped from fragments of the oxygen mixture before screwing on the top. This being done, and the connections being made *in the manner shown in the engraving*, the retort R is placed on a moderate fire. In a short time bubbles will be heard passing through the water which has been previously placed in the purifier P; but as the first portions which come over will not be pure Oxygen, but will contain a large admixture of air, the connection with the gas bag

should not be made until pure Oxygen is being evolved.*

This may be ascertained by lighting a piece of brown paper, blowing it out, and holding the still smouldering or incandescent portion in such a way that the gas from the connecting tube may play upon it; if pure Oxygen be coming over, the paper will be "again relumed," and burst into flame. Some samples of Chlorate of Potassium, when undergoing decomposition by heat in this way, liberate traces of free Chlorine, the passage of which into the gas bag may be easily arrested by dissolving in the water placed in the Purifier a dessert-spoonful of Salt of Tartar, *i. e.*, Carbonate of Potassium. Oxygen thus freed from Chlorine becomes less corrosive in its action on the India-rubber Gas Bags.

Previous to making the final connection with the oxygen tube, the bag should have been rendered soft and flexible by warming, and rolled to expel all atmospheric air. When the retort is placed on an ordinary fire, it not unfrequently happens that, owing to the too intense heat, the Oxygen comes over too rapidly, and not only is some of the powder of Manganese carried from the retort into the purifier, but the mechanical action of the bubbles of gas in the purifier causes the projection of minute particles of water through the connecting tube into the gas bag; this

* Theoretically, one pound of Chlorate of Potash should yield five cubic feet of Oxygen; in practice, however, more than four feet are seldom obtained; hence, a quarter of a pound may be regarded as yielding one cubic foot. A little more might be obtained by powdering the Chlorate of Potash, but it is not so safe as heating the unpowdered crystals.

may be avoided by occasionally lifting the retort from the fire to the hob; also by keeping the gas bag higher than the purifier while collecting the gas. As soon as sufficient gas has been collected to distend the gas bag to an almost drum-tightness, the stopcock S is turned off, and that end of the India-rubber tubing connected with the central or exit tube E of the purifier P is detached, and then connected with the end O of the Oxycalcium Lamp (fig. 8), near the stopcock. Previously to this, however, the filled gas bag should have been placed between the pressure boards, fig. 10, and the necessary weights placed in position on the top, whence they are prevented from slipping by the cross-rail C. The form of the gas bag and pressure board will naturally suggest that the stopcock of the former is to be drawn through the opening O of the latter, between the hinges.

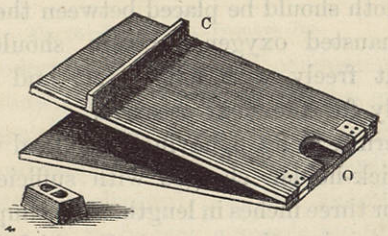


Fig. 10.

Fig. 11 represents a form of Pressure Board and arrangement of gas bags which is found exceedingly useful in working the oxyhydrogen light. The advantages are, greater equality of pressure, the dispensing with half the weights, the smaller space occupied, and the slope given to the bags carrying any

water accidentally introduced away from the stopcock to the larger end of the bag.

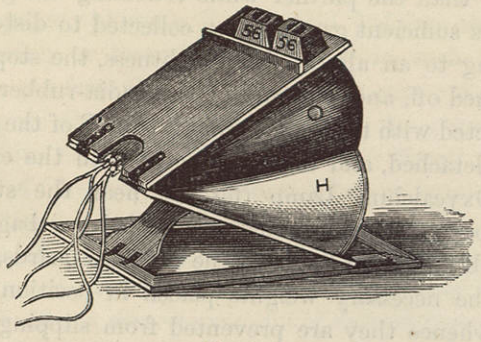


Fig. 11.

The elasticity of the contained gas gives the bags a tendency, when thus placed one over another, to spring out from the pressure boards: to prevent this a piece of sail or oilcloth should be placed between them.

The exhausted oxygen mixture should now be washed out freely with hot water, and the retort dried, ready for the next occasion.

The cistern A B, fig. 8, having been filled with spirit, and the wick-holder charged with sufficient wick—about two or three inches in length—the lamp is lighted; but before turning the stopcock G, which admits the Oxygen, the wick should be so trimmed and disposed right and left of its centre that none of the threads shall project towards the oxygen jet or the lime cylinder. The stopcock may now be turned on, and as soon as the lime cylinder "warms to its work," which will be in a minute or two, a most brilliant light will be produced. The only precaution necessary to be

observed in this place is that the Oxygen should work *silently*, and not be allowed to rush through the tube with such force as to make a singing noise. In order that this may be so, it is advisable not to begin with a greater pressure than a quarter of a hundredweight, which may be gradually increased to double that amount.

No anxiety need be entertained about the bursting of the bags by increasing the pressure within reasonable limits, as good *new* gas bags of Caoutchouc will stand a pressure of five hundredweight.

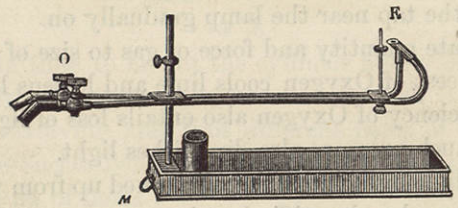


Fig. 12.—Safety Oxyhydrogen Jet.

A more modern, and exceedingly convenient form of jet, is that shown in fig. 12, in which the cistern for spirit is entirely dispensed with, and replaced by an extra tube and stopcock for conducting ordinary coal gas (carburetted hydrogen) into the vicinity of the lime cylinder. It is, in fact, a simple modification of the oxyhydrogen jet, and may be regarded as absolutely safe. The method of using consists in simply igniting the gas at the point of exit E; and when it has burnt a sufficient time to warm the lime cylinder, and thus prevent its cracking, the stopcock O is turned to admit the Oxygen, as in the case of the oxycalcium spirit lamp. There are numerous advantages attached

to this form of light, not the least of which is its economy, gas being cheaper than spirit, and no extra gas bag being required. The pressure "from the main" being usually sufficient, it is only necessary to attach a piece of tubing to the chandelier, and regulate by the stopcock.

Recapitulation.

Cistern to be charged with half a pint of spirit.
Wick, when trimmed, to project ¼ in. above tube.
From 28 lbs. to 56 lbs. to be placed on the oxygen bag.
Turn the tap connected with the bag "full on."
Turn the tap near the lamp gradually on.
Regulate quantity and force of gas to size of flame.
An excess of Oxygen cools lime and lessens light.
A deficiency of Oxygen also entails loss of light.
Too much pressure also diminishes light.
Keep lime cylinders carefully corked up from the air.
If the gas bag be stiff, place in warm room to soften.
Expel air at stopcock by rolling bag before filling.
Empty gas bag at close of entertainment.

The Oxyhydrogen Light.

"More light and light it grows."—*Shakespere.*

This light emanates from a cylinder of lime, rendered white-hot by a mixture of Oxygen and Hydrogen gases, projected thereon in a state of combustion.

The lime cylinder is mounted in this instance, as in the case of the oxycalcium, so as to occupy the place of the lamp flame in an oil lamp, in relation to the condensing lenses of the lantern. It will be naturally inferred that, although the lime cylinder *seems* to be

burning, it does not undergo actual combustion; but as the mechanical action of the current of mixed gases in flame has the effect of wearing it away, it is advisable, where an exhibition is continued for any

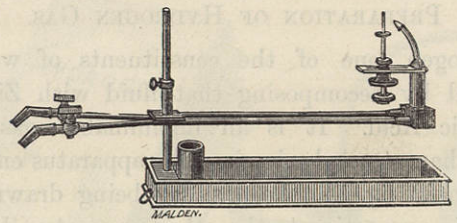


Fig. 13.

length of time, to mount the cylinder holder in connection with Clockwork, by means of which it is kept slowly revolving, and thus different parts of the surface are successively presented to the action of the heating jet of flame.

The apparatus and materials necessary for the exhibition of pictures by this intensely brilliant light are —in addition to those required for the oxycalcium— a special lamp, fig. 13, an extra bag for Hydrogen Gas, a Hydrogen Generator, some Zinc, Sulphuric Acid, and a pair of blue spectacles. The following list will be found useful for reference :—

Apparatus and Materials for Oxyhydrogen Light.

Oxyhydrogen jet.
Oxygen retort.
Ditto purifier.
Ditto gas bag.
Hydrogen generator.
Ditto purifier.
Two pressure boards.
Connecting tubes.
Lime cylinders.
Oxide manganese.
Chlorate potassium.
Granulated zinc.
Sulphuric acid.
India-rubber tubing.
Hydrogen gas bag.
Blue spectacles.

In working the apparatus the production of a full supply of gas first claims attention. The preparation of Oxygen has already been treated of; it remains therefore to describe the

Preparation of Hydrogen Gas.

Hydrogen, one of the constituents of water, is produced by decomposing that fluid with Zinc and Sulphuric Acid. It is an inflammable gas, much lighter than atmospheric air. The apparatus employed is shown in fig. 14, the gas bag being drawn much smaller in proportion to the other apparatus than it is in reality.

A few hours before generating the gas, a mixture of one part of strong Sulphuric Acid (oil of vitriol) and seven parts of water is made. Considerable heat is produced in making the mixture, and for this reason it should be made beforehand in an earthenware, not a glass vessel, so as to allow sufficient time for it to become cool before being added to the granulated Zinc contained in the generator A.

About half a pound of Zinc is introduced into the generator (usually made of lead, but sometimes of glass), the top of which, bearing the tube funnel and bent exit tube, is then replaced, and the joint being made airtight (in the case of a leaden generator, by means of a screw, and in the case of a glass bottle and cork, by means of linseed meal luting), the diluted acid is poured down the long tube funnel B, the end of which descends far enough into the liquid to prevent the return of gas in that direction. A brisk action ensues, the gas effervescing like so much soda water.

The first portions must, however, be allowed to escape for some minutes, to expel the air.*

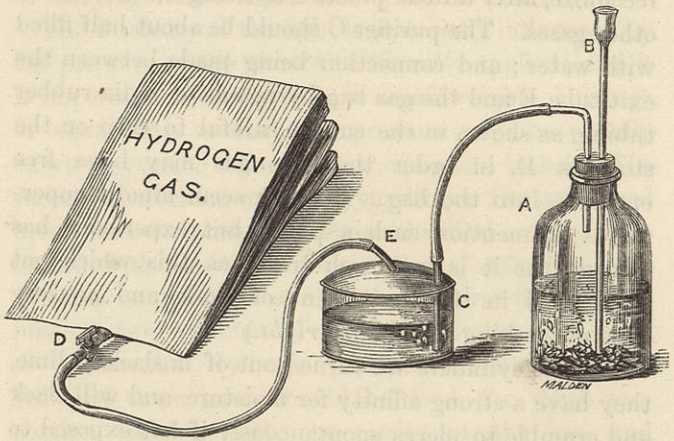


Fig. 14.—Apparatus for Generating Hydrogen Gas.

Where the precaution of diluting the sulphuric acid and allowing the mixture to cool has been neglected, and sufficient time cannot be allowed for the purpose, the Zinc and Water may be placed in the generator, and the concentrated acid slowly poured down the tube funnel as it is required.

It is equally important that, before collecting the gas, the bag in which it is to be received should be pressed quite flat, or rolled with the stopcock open, so as to exclude all trace of atmospheric air. The time when pure hydrogen is coming off may be known by

* In applying a light to ascertain if pure Hydrogen be coming over, a piece of wire gauze, having about the same number of meshes as common net, held over the aperture, will afford absolute safety from explosion.

the rapid rise of the bubbles to the top of the water, and by the accompanying sound, which the ear will recognize, after a little practice, as being unlike that of other gases. The purifier C should be about half filled with water; and connection being made between the exit tube E and the gas bag by means of india-rubber tubing, as shown in the cut, be careful to turn on the stopcock D, in order that the gas may have free entrance into the bag. (It may seem almost superfluous to mention such a point, but experience has shown that it is just such trifles as this which get overlooked in the excitement of work, and anxiety that everything should *go right*.)

As lime cylinders are turned out of unslacked lime, they have a strong affinity for moisture, and will slack and crumble to pieces spontaneously if left exposed to the air; the cork, therefore, should not be left out of the bottle, or the cover off the tin canister.

Where it is possible to procure ordinary coal gas, it will be found a convenient substitute for, and save the trouble of making, hydrogen. It should not, however, be used from "the main," as in the case of oxycalcium, the amount of force with which it impinges on the lime cylinder being insufficient; but should be collected in a gas bag, and pressure applied in the usual way. It may be observed, in connection with the subject of pressure, that iron weights, although obviously preferable, are by no means indispensable; the pressure boards usually supplied are furnished with a ledge or shelf upon which a fender and fire-irons or other heavy "chattels" may be placed, taking care not to diminish pressure by the removal of any weights

until the stopcocks are turned off. Bags filled with sand form convenient weights, and save the trouble of carrying iron weights from place to place.

The intensity of the light is materially influenced by the pressure, which should be liberally applied; and it is important not only to have equal weights, but bags of equal size, so that the pressure may be equally exerted over the same number of square inches. The successful working of the Oxyhydrogen Light is based upon well-established facts in chemical science connected with the "combining volume" of gases; and whereas one volume of Oxygen requires for its combustion two volumes of Hydrogen, when Coal Gas or Carburetted Hydrogen (C_2H) is substituted, equal bulks of these gases should be used, the exact proportion varying with the purity of the gas, and ascertainable at the time of burning by the quality of the light. An extra bag of Oxygen should therefore be prepared when Coal Gas is intended to be employed.

It should be understood that the gases used in the production of these powerful lights, especially Oxygen and Carburetted Hydrogen, have a deleterious influence on the india-rubber gas bags and tubing, and that any overplus at the conclusion of an entertainment should therefore be expelled, and the bags not filled too long before beginning to work.

The preceding woodcuts and their description will have shown the reader that a few yards of flexible india-rubber tubing, over and above that supplied with the apparatus at the time of purchase, will form a very desirable appendage to the outfit. The kind

best suited for the purpose is that which is stoutest in the tube itself. That lined with a spiral coil of iron or brass wire is not so advantageous, since, if trodden on with sufficient force, the enclosed wire in bending often breaks the tube, and thus renders a great length useless; and also, if the Oxygen gas contains traces of Chlorine, the wire becomes corroded, and forms a deliquescent mess in the inside of the tube.

Circumstances sometimes arise in which it becomes necessary to place the lantern at some distance from the source of gas supply, in which case lengths of tubing have to be joined one to another. To accomplish this efficiently, pieces of brass tubing, about two or three inches in length, called connectors, should be employed,* and of such a diameter that some degree of force is necessary to strain the india-rubber tubing over the metal. Leakage will, however, sometimes occur, in spite of all precautions, in which case it is best to tie the tubing firmly with packthread.

The success of the Oxyhydrogen Light is influenced by the use of much more pressure on the gas bags than in the case of the Oxycalcium arrangement; it is therefore very important that all joints should be perfectly airtight, a fact which is ascertained by holding a piece of incandescent charcoal or brown paper near the points of junction; if Oxygen be escaping, its property of supporting combustion will become at once apparent in the increased brilliancy of the charcoal, or the bursting of the paper into flame. If Hydrogen be escaping, a lighted match or paper will kindle it into flame.

* See No. 12, fig. 35, page 76.

When all joints have been secured, the Hydrogen should first be lighted, and the lime cylinder turned round in the flame in order to warm it, dissipate moisture, and prevent its cracking. The Oxygen should then be turned on *slowly* until the required brilliancy of light is obtained—the degree of brilliancy being, in fact, the guide as to the extent which each stopcock should be turned on. An excess of Hydrogen imparts a reddish tint.

In the absence of Clockwork (a desirable purchase where lengthy exhibitions are intended), and for the larger lanterns, the lime cylinder should be kept frequently turned, in order to avoid the diffusion of minute particles of lime mechanically thrown off, which fall on the condensers, and also the reflection of the great heat by the concavity in the lime cylinder, which not unfrequently cracks the lens. In addition to this, small pieces of red-hot lime sometimes fall from the cylinder through the lantern, and burn the box on which it is supported, whence it becomes desirable to place a sheet of tin under the lantern to catch these pieces, and prevent the burning of the box.

The metallic pin upon which the lime cylinder is supported may be brought near enough to the jet to allow only room for the cylinder to revolve freely. The two adjustments with which it is furnished are for the purpose of determining its distance from the jet, and allowing the cylinder to revolve on its axis; an arrangement the necessity for which becomes apparent very shortly after beginning to work, owing to the mechanical action of the jet of gas, aided by the intense heat, wearing away small cavities in the lime cylinder.

The object of these delicate adjustments is to produce the greatest amount of light; and by way of further precaution, it may be observed that, an excess of Oxygen having a cooling effect, loss of light ensues: a slight excess of Hydrogen, however, burning with a faint lambent flame round the white-hot portion of the cylinder, produces the best effect.

When Coal Gas is used, a deposition of Carbon on the Lime Cylinder often occurs. This may be prevented by adding to the Coal Gas one-sixth of its bulk of pure Hydrogen, and occasionally turning the cylinder. The brilliancy of the light is also said to be increased by this addition of Hydrogen to the Carburetted Hydrogen.

Recapitulation.

Carefully dust and wipe every portion of lanterns.
Warm condensers, wipe and replace them.
Fill gas bags, according to directions.
Place *equal* weights on *each* bag, if of equal size.
Carefully dust and *arrange* slides before exhibiting.
Water sometimes enters gas bag while filling.
To prevent this, keep bag higher than purifier.
All air should be expelled from gas bags.
To prevent leakage, see that all joints are tight.
To insure passage of gas, blow through tubes and jets.
Use pure Chlor. Potash and Manganese for Oxygen.
Use good Zinc and Sulph. Acid for Hydrogen.
Wash out and dry the Oxygen retort after use.
If lime cylinder breaks, turn off the Oxygen.
In commencing exhibition light Hydrogen first.
Keep lime cylinders carefully corked from air.
If gas bags are stiff, soften in warm room.

Gas Bags.

Jeanet and twill, rendered impervious to air and gases by treatment with india-rubber, are the two materials employed in the manufacture of gas bags. The former will answer very well for the Oxycalcium, while the latter, as being stronger, is more suitable for the Oxyhydrogen Light. On account of the wedge-shape imparted to them to facilitate the extrusion of the gas through the stopcock with which they are all provided (see figs. 9, 11, and 14), it is somewhat difficult to calculate their cubic contents with accuracy. The following figures should be regarded, therefore, only as approximate :—

Size of Gas bags.	Approximate cubic contents.
24 × 18 × 18	3 feet.
29 × 20 × 18	5 ,,
34 × 26 × 20	7 ,,
36 × 32 × 24	10 ,,

The Opaque Lantern.

The Catadioptrical Phantasmagoria, introduced by Sir David Brewster, forms the basis of an ingenious modification introduced and registered in 1864 by an enterprising provincial optician.

It is represented at fig. 15, and in many respects resembles the Physioscope and the Opaque Microscope. The main difference between this and the ordinary lantern consists in its representing by reflection, instead of transparency, an almost unlimited variety of opaque objects, such as card photographs, either plain or coloured, engravings, lithographs, coins, medals, plaster of Paris casts, bas-reliefs, &c., the latter producing a singularly *raised* effect.

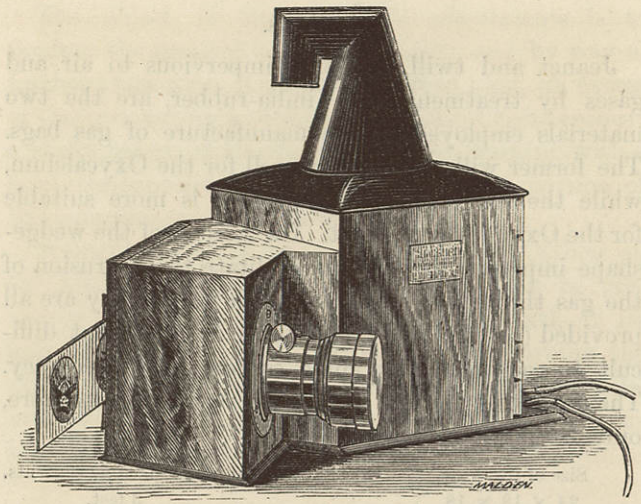


Fig. 15.

Its successful use requires a light of intense brilliancy; nothing less than the oxyhydrogen light will do. The rays from such a source are collected by a concave silvered reflector, of large diameter (12 in.), and thrown upon the surface of a plano-convex condenser of about nine inches in diameter, which concentrates the rays upon the opaque object, which, thus brilliantly illuminated, transmits the rays through a double achromatic object-glass of large diameter and long focus to project the image upon the screen. When the works or face of a watch, with the "second" hand in motion, is thus exhibited, the effect is very striking, and never fails to elicit the warmest expressions of interest.

The angular portion of the lantern is placed at 45° to the axis of the condenser, because of the necessity

for the object-glass being out of the angle of reflection; and although especially designed for opaque objects, it can be replaced by the ordinary lantern front, and thus rendered suitable for the exhibition of transparent slides.

It may be also made for dissolving effects, in the form of a double lantern, one over the other, or with the angular compartment at each end of the square box.

The Slides or Pictures.

"Why, all these should be in the lantern."—*Shakespere.*

A Magic Lantern without a collection of slides may not inappropriately be compared to a Theatre without scenery or actors, and the purchaser will consequently need some information relative to these important adjuncts.

They may be considered under two different heads, viz., Paintings and Photographs.

The Paintings are made on glass with transparent varnish, and are for the larger lanterns, from No. 4 to No. 7 (see table, page 9), painted on circles varying from 2 inches to 3¼ inches in diameter. For the smaller lanterns, Nos. 1, 2, and 3, the paintings are exclusively executed on slips of glass, about 6 or 8 inches long by 2 inches wide,* while the lanterns from No. 4 upwards, although adapted for use with single pictures, may also be furnished with slides up to the length of 14 inches. It will be understood that the dimensions here given are merely approximate, and although applicable to the stock obtainable in most Opticians' shops, may now and then be found not to agree with the sizes kept in some houses.

* See figs. 16, 17, 18, page 44.

The long, narrow slides consist of detached figures of clown, pantaloon, and other grotesque subjects, and sometimes of connected stories—*e.g.*, "Death and Burial of Cock Robin," which seems to be always full of interest for the ever-rising generation. Such a slide is called

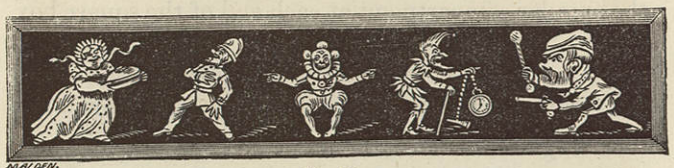


Fig. 16.

"A Comic Slide."



Fig. 17.

The "Natural History Slide"

abounds in good representatives of the division Vertebrata, viz., Mammals, Birds, Reptiles, and Fishes.

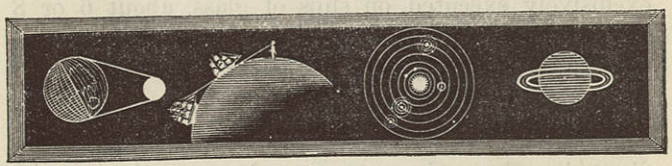


Fig. 18.

The "Astronomical Slide"

bears some really good diagrams of the Solar System, Earth's Motion round the Sun, Spring and Neap Tides, Moon's Phases, Rotundity of the Earth, &c., &c. These



Fig. 19.

Elephant Hunt, Described by Du Chaillu.

are very instructive and entertaining sets; and it is to be regretted that equally favourable remarks cannot be made in reference to the remaining class, called "Scripture History." The last-mentioned are slides in which subjects of the most sacred character are treated in a manner more calculated to excite ridicule than reverence, and comparable only to the vulgar and inartistic outlines which were once so common on Dutch tiles. It will be readily understood that the style of drawing and colouring which might not be inappropriate for such subjects as clown and pantaloon would be altogether unsuitable for illustrating the events narrated in sacred



ANTELOPE, fig. 20.

Division, VERTEBRATA; *Class*, MAMMALIA;
Nat. Ord., RUMINANTIA; *Genus*, ANTELOPE; *Species*, CERVICAPRA.

history. Such a treatment of sacred subjects cannot be recommended; and the purchaser of slides of this class is referred to the very excellent photographic reproductions of the old masters now to be found in every Optician's warehouse.

The preceding remarks refer especially to those narrow slides varying in length from 6 to 14 inches, and employed generally with the simple Magic Lantern. It remains now to offer some remarks on the better class of pictures, painted on separate circles of 2 inches, 2½ inches, 3 inches, 3½ inches, and 4½ inches diameter,



EAGLE, fig. 21.

Division, VERTEBRATA; *Class*, AVES;
Nat. Ord., RAPTORES; *Genus*, AQUILA; *Species*, CHRYSACTA.

together with the photographic reproductions of the old masters.

The separate coloured slides include nursery tales, such as "Blue Beard," "Cinderella," "House that Jack Built," "Robinson Crusoe," "Pussy's Road to Ruin," &c., &c., in sets of 6 or 9 slides, varying in price from £1 to £3 or £4, according to the quality of painting and the number of pictures. Panoramas are also included in this series, and views of remarkable buildings and places, *e. g.*, Switzerland, Holy Land, &c.; illustrations of the travels of Gordon Cumming, Livingstone, Du



ADDER, fig. 22.

Division, VERTEBRATA; *Class*, REPTILIA;
Nat. Ord., OPHIDIA; *Genus*, VIPERIDA; *Species*, COMMUNIS.

Chaillu, &c. A scene from the experience of the last is appended, fig. 19. Sets of views, with effects for dissolving, afford scope for the display of great ingenuity, and are a source of unfailing amusement and instruction.

The Society for the Diffusion of Christian Knowledge publishes a work on Natural Phenomena, by Charles Tomlinson, Esq., containing numerous illustrations, which, reproduced as paintings on glass for the



VERTEBRATA, fig. 23.

STURGEON.—*Cl.* PISCES; *N. Ord.* CHONDROPTERYGII; *G.* ACIPENSER; *Sp.* STURIO.
SHAD. „ „ „ MALACOPTERYGII; „ ALOSA; „ FINTA.
BASSE. „ „ „ ACANTHOPTERYGII; „ LABRAX; „ LUPUS.

Magic Lantern, form, with the book, the materials for an admirable lecture to a Sunday school. There is little difficulty in obtaining them from any respectable Optician, and this series (about thirty in number) can be recommended as proving entertaining and instructive. Phantasmagoria pictures are essentially distinguished from ordinary Magic Lantern slides by having the outline of the figure so filled in with black paint that light comes only through the figure (see fig. 6), while the ordinary slide (fig. 20) yields a complete circle of light.

The four 3-inch Natural History slides at the head of pages 46, 47, 48, 49, are illustrations, not only of the style, but of the enormous amount of detail sometimes introduced into the better class of slides; and the words referring to the position of the subjects in the Animal Kingdom are attached merely as suggesting an accurate and scientific method of labelling slides of this character when required for educational purposes.

SLIPPING SLIDE.

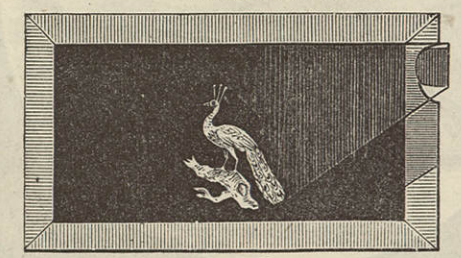


Fig. 24.

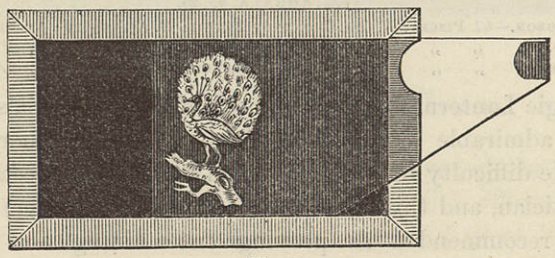


Fig. 25.

Of all the slides, however, prepared for the Lantern, those with mechanical effects prove the most interesting to persons of all ages, from seven to seventy years; they consist of slides provided with slipping plates, pulleys, levers, rackwork, and other arrangements, by means of which life and motion are apparently imparted to the objects exhibited, and the phenomena of moving waters, storms, lightning, volcanic action, &c., illustrated, in the manner described by the showman as being "as natural as though in reality."

The drawings on page 50 will give an idea of a simple slipping slide, wherein the picture is painted on two pieces of glass, one of which is firmly fixed in the frame, and the other moveable.

LEVER SLIDE.

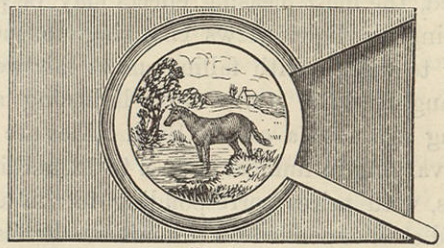


Fig. 26.

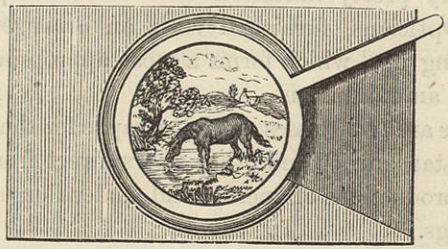


Fig. 27.

These glasses are so adjusted that when the sliding glass is pulled out, an effect is produced which differs entirely from that shown when the same glass is pushed in.

An illustration is appended of another popular but rather more expensive kind of mechanical effect, pro-

duced by what is called a LEVER SLIDE, in one of which a horse, having approached the water, fig. 26, may be "*made to drink*" (the old adage to the contrary notwithstanding) by raising the brass lever on the right hand, as shown in fig. 27.

More startling effects and greater excitement may be produced by combining the lever and slipping motions, thus producing a most vividly life-like effect.

When a pair of lanterns are used, as in the case of dissolving views, and *sets* of slides suitably painted are employed, the most pleasing effects may be produced, illustrating daylight views changing to moonlight; summer to winter, with falling snow; fair weather at sea, changing to a storm with lightning and rain, returning again to a calm. Such slides are supplied in sets, varying in number from 2 to 12, and in various qualities, with prices corresponding to the amount of time and skill expended on the minute details. There is a very pretty imitation of a curtain supplied by some Opticians, furnished with an arrangement for "drawing up," which forms a most appropriate beginning to an exhibition.

There are two classes of Photographs for the Lantern, viz., instantaneous and other views direct from nature, and reproductions of ancient and modern engravings or paintings.

It would be difficult to overrate the advantages which have accrued from the application of Photography to Magic Lantern illustrations, or describe the difference between the delicate and accurate little gems produced by its means, and the daubs which once were supplied for the cheaper lanterns.

Some idea of the value of Photography, associated with the Magic Lantern as an educational instrument, may be gathered from the fact, that as the camera has now penetrated to almost every habitable part of the globe, the physical peculiarities of every country, together with life-like portraits of their inhabitants, and the form and arrangement of their dwellings, may be obtained in miniature, and reproduced as large as life.

Photographs of the sun and moon in various phases, and partially and totally eclipsed, also the fixed stars and nebulæ, have been obtained, and employed for lecture illustration. Enlarged photographs of microscopic objects have also been obtained, and these again still further enlarged to 8 or 10 feet in diameter, so that, in fact, a diatom no larger than a grain of sand may be shown of such a size in the lecture theatre that a large audience may together examine its details with perfect comfort. The productions of the most celebrated painters and sculptors may be shown with equal facility, as well as maps, hymns, music, &c., so that an entire school may learn or sing together.

THE CHROMATROPE.

"Into all the colours of the rainbow."—*Shakespere.*

Fig. 28 represents the pulley form of the Chromatrope (literally *colour-turner*), but can give no idea of the dazzling brilliancy of the effects it produces on the screen. There is nothing it resembles so much as the kaleidoscope, with the addition of constant motion and rapid change. It was first shown at the Polytechnic Institution about twenty years ago, and consists

of two discs of glass painted with an almost endless variety of geometrical and other designs in brilliant colours. By turning the handle shown in the figure, the multiplying band causes the rapid revolution of one disc over the other, producing two apparent motions; and with good designs the result "beggars all description." There are two forms, one of which is illustrated by fig. 28, the *construction* of the other being shown in fig. 29, the motion being accomplished by means of a double rack and pinion instead of a band. As there are two discs, revolving one over the other, each is necessarily furnished with a toothed rack, as shown in fig. 29, and the one pinion works both racks.

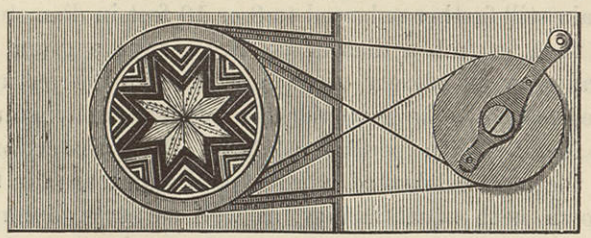


Fig. 28.

It has been said that Chromatrope designs do not admit of description, but for the guidance of purchasers it may be stated that many are furnished with central paintings representing fountains, windmills, watermills, &c., *in action*, and the words "Welcome," "Adieu," "Good night," &c., to be used at the beginning and end of an entertainment. The sentiment of loyalty is also provided for, such phrases as "God Save the Queen," "Rule Britannia," &c., forming the centre in some chromatropes, from which are thrown off the most dazzling rays of glory.

Chinese Fireworks.

These are similar in principle to Gorham's Colour-Top and Goodchild's Trocheidoscope, being founded on the phenomena of the "persistence of vision." They consist of a Chromatrope painted with bands of the seven prismatic colours, and a set of shifting screens representing temples, fountains, cascades, fireworks, &c., the outlines of which being traced on black painted glass, and inserted with the Chromatrope into the Lantern, become *fringed* with prismatic colours.

Revolving Figures.

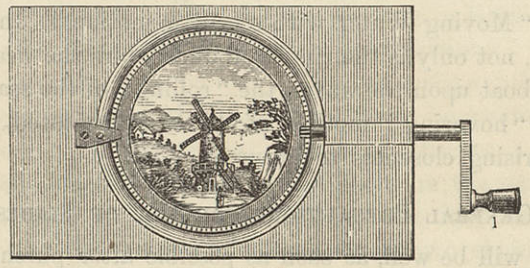


Fig. 29.

In this class of slides the rack and pinion, so useful in the Chromatrope, is applied for the production of motion in the sails of a windmill, the wheel of a watermill, or the paddle-wheel of a steamer; the mill itself, and the landscape surrounding it, being painted on a fixed disc of glass, while the sails are painted on a disc having a toothed rack attached to its circumference, to which motion is imparted by the pinion handle P, fig. 29. Such slides form an interesting and valuable addition to the outfit attached to the larger sizes of lanterns.

Moving Waters.

Under this title two forms of slides are sold; by means of which, in a single or double lantern, very pleasing effects may be produced. In the simplest form, a moonlight scene is painted on a fixed disc, and the "rippling waters" on a piece of glass attached by one corner only to the framework of the slide, which, being moved up and down, causes the appearance of a ripple on the water.

Another somewhat more expensive, but infinitely more truthful, effect is produced by a slide having two moveable and one fixed disc of glass, and known as the "Moving Water with eccentric motion." In this slide, not only is the ripple produced, but the heaving of a boat upon the waves, the "rolling" of the sea, and the "hovering" motion of birds is imitated with surprising closeness to nature.

General Precautions for Use of Slides.

It will be well, as soon as possible after purchasing a set of slides, to have a private performance, for the purpose of ascertaining *exactly* how far in to push each slide, how high up or low down in the slide holder each should be placed, &c. In the case of chromatropes, and other slides bearing printed words, as "welcome," "adieu," in a wreath of flowers, it is important not only to insert the slide *upside down*, but with the right side towards the front, for unless this precaution be observed the most ludicrous results are produced.

This preliminary examination of the slides is especially necessary in the case of dissolving views, where

it is required that the "moonlight" in one slide should "register" with the space in the sky of the other in which it is intended the moonlight effect should be brought on. This "*correct registration*" can only be obtained by a preliminary experimental trial of each set of slides, and by making notches or attaching such other distinguishing marks as can be readily understood in an obscure light, or *felt* in the *dark*, and enable the operator so to place the slide in the lantern front that the correct effect shall occur with ease and precision on the screen.

The words RIGHT, LEFT, TOP, FRONT, will suggest themselves as being suitable for printing, in large type, on slides of the kind now under consideration.

It should always be remembered that the exhibition of pictures by the Magic Lantern has to be conducted, if not in total darkness, at least in so obscure a light that the operator has to depend more on the sense of feeling than sight; it is therefore of the first importance that the number of slides to be shown should be determined beforehand, that these should be carefully freed from dust and finger marks, and arranged in the order in which they will have to be exhibited; also, that they should be so labelled as to be readily distinguishable one from another in the subdued light referred to, for which purpose white paper labels, $1\frac{1}{2} \times 1\frac{3}{4}$, bearing figures one inch long, should be attached to the "right" side of the picture, the frame of which should bear a notch on that side turned towards the source of light and *heat*, which should be the side upon which the picture is painted, and not the bare glass, when showing on an *opaque* screen, but

when showing *through* a *transparent* screen the painting should be turned away from the light. The clearness with which the slides are shown is greatly dependent on the maintenance of perfect darkness, on which account it is desirable to slide the hand *gradually* over the front of the lantern during the interval of exchanging one slide for another, so that the dazzling disc of light may not unfit the eye for the appreciation of the next picture. There are slide-frames so constructed that *square* glass slides may be pushed *through* in succession, and the interval of bright light thus avoided, while some lanterns are furnished with brass caps wherewith to cover the fronts while changing slides.

It should also be recollected that the intense light necessary for the effective exhibition of Magic Lantern Slides is accompanied by great heat; and as the water and oil colours and varnish of which the pictures are composed are unfavourably affected by heat, it is desirable that they should not be too long submitted to its action; five minutes generally suffice, but the time should never exceed ten minutes.

The Lantern Microscope.

This instrument is intended to show natural objects, suitably prepared and mounted with Canada Balsam, between two discs of glass. They consist of details in the anatomy of a bee, wasp, flea, spider, larvæ of insects found in stagnant water, as gnats, dragon-flies; parasitic and other insects, parts of insects, sections of woods, teeth, bones, fossil bones, shells, lace, silk, muslin, &c., &c.; and as such objects are smaller than

paintings for the Lantern, and contain more delicate details, a proportionately higher magnifying power is required, which may be adapted to the front of the larger sizes of lanterns at a moderate cost.

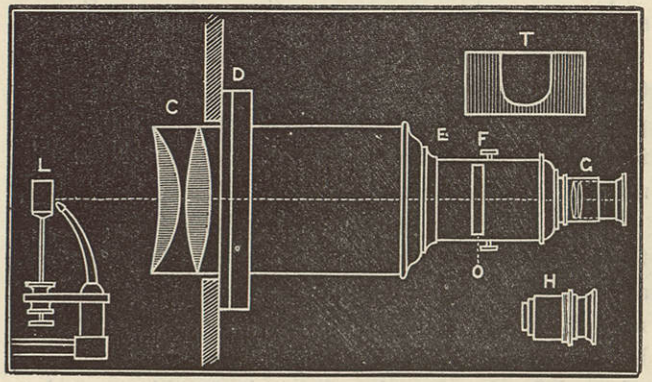


Fig. 30.

The above diagram shows this valuable addition to the lantern in section. L is the source of light, which should be preferably either oxy-hydrogen or oxycalcium; but excellent results have been obtained by the writer with an ordinary Argand oil-lamp, on a disc one foot in diameter, which is quite large enough for most objects. At C are shown the combination of condensing lenses, and at D the opening through which the ordinary slides are introduced. At E the usual object-glass has been unscrewed, and replaced by the Microscope, which has an opening at O, into which the objects are thrust, and retained in position by a strong spiral spring, which may be held back while placing an object, by the milled-heads F. Two powers are usually supplied with the instrument, the lowest of which is shown in position at G, the higher power H being detached. T is a glass trough, the use of which is explained below; it is made of a size suitable for entering the aperture at O.

By filling a glass trough (T) with diluted sulphuric acid, and dropping into it a few pieces of granu-

lated zinc, the decomposition of water may be shown to an entire audience.

The crystallization of salts may also be shown by placing a drop of a strong solution of Epsom salts, or sulphate of copper (blue vitriol), on a piece of glass of suitable size.

Another effective result is obtained by placing in the glass trough a small horse-shoe magnet, and dropping around it some iron filings, which will be found to arrange themselves, or rather be attracted by the magnet, in a most extraordinary manner.

Of the two "powers," G and H, the lower one serves to exhibit objects of an inch or more in diameter, such as fronds of maiden-hair fern, sea-weed, whole insects, mosses, wings of moths, butterflies, &c., while the higher power (the smallest in appearance) is best adapted for showing the more minute objects, such as animalculæ, hairs of animals, spicules of sponge, and scales from the wings of butterflies, moths, &c. Large collections of such objects may be selected from the stock of the Optician supplying the Microscope.

A third object-glass of great power, and having a rack and pinion adjustment, is sometimes furnished for the most minute objects.

It is desirable to have two or three sets of lenses, of different powers, with the microscope, which are varied to suit the object to be exhibited; and it is important to observe that when minute objects are being exhibited, and a high power consequently in use, the source of light should be drawn farther from the condensing lenses. A very interesting addition to the microscope consists of a diagonal mirror, whereby the image of the

objects, instead of being projected directly on an opaque screen, may be thrown down at right angles on a sheet of paper placed on a table, and a drawing very conveniently made.

The Magic Lantern Kaleidoscope.

"Beggars all description."—*Shakespere.*

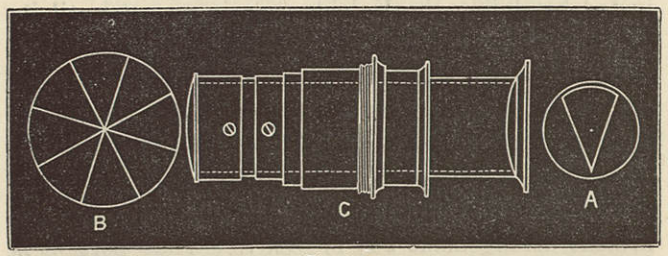


Fig. 31.

The Kaleidoscope* was invented by Sir David Brewster in 1814, and all who have witnessed the beautiful effects produced by the instrument will welcome its adaptation to the Magic Lantern, which, notwithstanding the attendant optical difficulties, has, through the ingenuity of a London Optician, at length been accomplished, and the results exhibited to the delight of large audiences at the Royal Polytechnic Institution.

The instrument is figured above; A being a sectional view, showing the disposition of the mirrors; B an outline of the eight-celled image; C a side view of the brass mount, containing the reflectors and lenses, with sliding adjustment for focusing, and projecting the image upon the screen.

* Καλος, beautiful; ειδος, form; σκοπεω, to see.

It is attached to the lantern by unscrewing the front, and screwing the Kaleidoscope into its place, turning it round in its sliding tube until the reflectors are upright like the letter V. A rack slide, containing some fragments of coloured glass, bugles, beads, and other transparent objects, is then introduced into the usual slide-holder of the lantern, and the focus adjusted by sliding the Kaleidoscope in or out until its back lens is at a proper distance from the slide.

In a former paragraph, the great importance of having the various parts of the lantern and the objects to be shown *properly centred* has been dwelt upon at some length. Now, however, attention has to be directed to the importance of having a portion of the present arrangement *out of centre*. That portion is the *light*, which should always be *above the centre of the condensers;* in the case of oil lamps, the elevation should be about half an inch, but with the oxycalcium, one inch. The maximum of illuminating power is obtained in the usual way, by pushing the light backwards and forwards, and the correct focus is obtained by means of the *front* sliding tube. Any dark portions of the image may be removed by turning the Kaleidoscope round a very little to the right or left.

The "*un-centering*" of the light may be accomplished, in the case of oxycalcium or oxyhydrogen lamps, by means of the rod at the back of the lantern; while in the case of oil lamps, two pieces of wood, half an inch thick, placed in the pan, will effect the purpose.

The instrument, before using, should be warmed, to prevent what is popularly known as the "steaming of the glass."

Rackwork frames, containing pieces of coloured glass, are supplied by the Opticians; but exceedingly beautiful effects are obtainable with the Chromatrope, a piece of perforated zinc, the bow and the wards of a key, grasses, feathers, a bunch of oats, &c., &c.

The Oxyhydrogen Polariscope.

"Full of forms, figures, shapes, objects."—*Shakespere.*

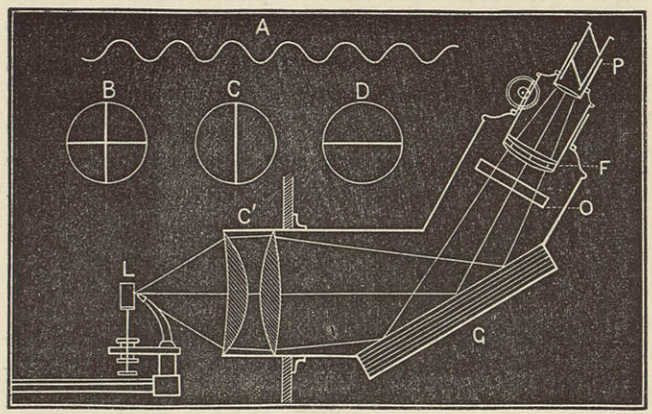


Fig. 32.

Fig. 32 shows the OxyhydrogenPolariscope, which consists of two tubes inclined to each other at an angle of 56° 45′, and truncated at their points of junction, the oval space thus formed being closed by some ten or twelve pieces of thin crown glass, the lowest of which is blackened to absorb the polarized ray. This apparatus replaces the object-glass of the lantern, which should have condensers not less than 3½ inches diameter. When attached, it will be seen that the light emanating from the point L, after passing through the condensers C′, becomes incident on the crown glass G, inclined at the polarizing angle (56° 45′); the reflected, and in this case polarized, light then passes through the selenite, or other object in the aperture at O; after which, it is brought to a focus by the object-glasses at F, and finally again polarized, or *analysed*, by the Nicol's prism, P, and thence thrown on the screen, the disc on which should not exceed three feet in diameter.

The phenomena connected with the polarization of light are attended by a most gorgeous display of colours, and are, in consequence, among the most attractive in the whole range of physical optics; an apparatus, therefore, which facilitates their exhibition to an audience becomes a most valuable adjunct to the Magic Lantern.

The objects best suited for the Polariscope are designed with films of selenite of various thicknesses and forms; sections of quartz, cut in different relation to the axis of the crystal, producing most splendid tints; unannealed glass, quill, Iceland spar, and, indeed, almost any matter the particles of which are in a state of tension. Specimens may be seen, and lists of the various designs are obtainable from Opticians supplying the apparatus.

The Screen.

"There's magic in the web of it."—*Shakespere.*

The qualities necessary in a good screen are,—1. Freedom from seams, folds, or creases. 2. Pure whiteness. 3. Freedom from texture. 4. Adequate size. 5. Opacity, *or* transparency.

The materials employed, with the view of attaining these conditions, are linen, calico, muslin, and a material called "union;" but of these four, linen is decidedly to be preferred, as including more of the above qualities than either of the others.

Linen can be obtained of the width of 10 feet without seam; it is stronger than calico; and although this latter material is cheaper in the first outlay, it will not bear washing like linen, which is, moreover, quite as transparent, if not more so than calico, when moistened for showing pictures *through* the screen.

If a larger screen than 10 feet square be desired—say, for instance, 20 feet square,—it should not be made by joining two 10-feet widths of linen, for that would give a seam in the centre, but one 10-feet width should have a 5-feet width sewn on to each side, so that the centre of the picture may be free.

If extreme transparency be desired for exhibiting microscopic objects on a comparatively contracted field of three or four feet in diameter, a material known to drapers as Nain Zook Muslin may be advantageously employed, moistened or varnished, and stretched over a child's hoop of the required size. This form of screen, though very elegant and efficient, is seldom used, on account of its expensive character and want of portability.

The framework necessary for stretching the screen may be extemporized on the occasion by using two clothes-props, or other material of sufficient length and weight to stretch the fabric; but the bulky character of the frames and rollers supplied at the shops renders them undesirable purchases.

Where a screen with a seam must necessarily be employed, it should be so arranged that the seam is in the lower part, so as to come among the dark objects which usually occupy the foreground of a picture, and thus leave the brighter middle distance and sky free from the dark line which would be unavoidable were this precaution neglected.

The material of which the screen is made should be kept clean and free from folds, for which purpose it should be rolled on a pole about three inches in diameter, and of suitable length. When so far soiled

as to require washing, it should be carefully ironed before using, or if this be regarded as too troublesome an operation, stout white paper may be smoothly pasted over the whole surface, and then whitewashed; should this require renewing, a fresh coat of whitewash may be very readily applied, and a pure white reflecting surface thus obtained.

Where it is convenient to assign a permanent place to a Magic Lantern Screen, as at the end of a schoolroom, it may be mounted in a manner exactly similar to the ordinary linen blinds in a bedroom window, and coated with pure dead white "distemper," which yields the purest white known for this purpose. To neutralize the *yellow* light of an oil lamp, a *faint tinge of blue*, called "French white," may be laid on.

Beautiful effects may also be produced with statuary, and similar subjects, by using as a screen a piece of finely ground focusing glass, about two feet square, which, being suitably framed, may be placed on the table to receive the image.

Dissolving Views.

"Look here upon this picture, and on this."—*Shakespere.*

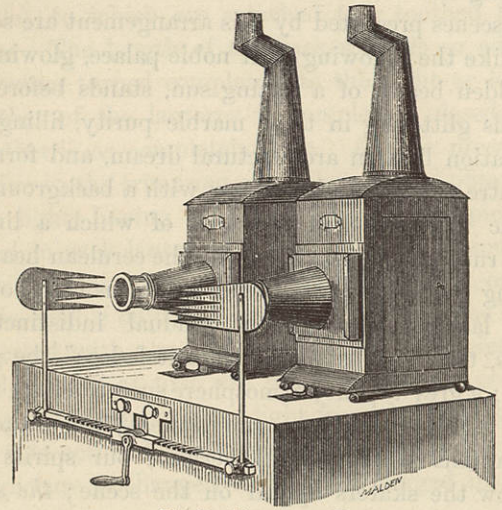


Fig. 33.—Dissolving Views.

The simplicity of the means by which the numerous illusions and peculiarities already described are produced will have shown the reader that the results are attributable, not so much to any changes effected by modern science in the chief instrument, as to various accessories recently discovered and applied by the aid of racks, slides, rollers, &c.

The apparently supernatural scenes with which science has familiarized us need not again be referred to; we will pass on to the chamber where the charming and ever-changing Dissolving Views are being exhibited. Most persons would be disposed, if these exhibitions were not so familiar, to make a great effort

to see them; but familiarity has, perhaps, in this case, bred a sort of half contempt, which the beauty of the dissolving charm seldom merits.

The scenes presented by this arrangement are something like the following:—A noble palace, glowing in the golden beams of a setting sun, stands before us; its walls glittering in their marble purity, filling the imagination like an architectural dream, and forming the centre of a lovely landscape, with a background of majestic mountains, at the foot of which a limpid stream runs at its own sweet will, the cerulean heavens shedding a charm over all that makes us think of "a better land;" when lo! a gradual indistinctness appears, the "insubstantial pageant fades;" the glow is gone; a grey vapoury atmosphere succeeds; the river is ice; the trees are bare and leafless; the meadows and gardens white and flowerless; our spirits fall. But now the skaters appear on the scene; *the snow falls, too,* at first slightly, then heavily, and the scene is half obscured, when once more appears the enchanted palace, the everlasting hills, the beauteous landscape, and the blue sky; and when this scene disappears, we go away filled with delight, and wondering HOW the charm was wrought.

This interesting and valuable method of exhibiting Magic Lantern Slides, and producing with them what are called "effects," involves the employment of two or more lanterns, placed either side by side, or one over the other, and so arranged that their axes may be made to converge and produce coincident discs of light on the screen.

The two lanterns are fastened to a base-board, or

the top of the box in which they are contained when not in use, as in fig. 33, and to the front of this box is attached a rack and pinion (worked by a winch-handle), to which are attached two toothed fans or combs. The length of the rack-work is so adjusted, that when turned completely to the right or left, one or other of the lanterns is completely closed, while the other is as completely open. All the precautions relative to the trimming of the lamps, and obtaining a good light, having been duly observed, a picture is placed in each lantern. It will thus be obvious, that when the pinion is turned as above described, only *one* will be visible on the screen. On turning the handle connected with the pinions, however, the picture so clearly shown at first will gradually become confused, owing to the admission of light from the other lantern, and this action being continued, the character of the first picture is changed, and finally merged in that of the second.

The picture first shown should now be withdrawn and replaced by a third, into which the second may be "dissolved" by reversing the action of the dissolving rack and pinion.

The apparatus described under this head is identical with that known in America as the Stereoptikon.

Discretion and good taste should of course be observed in selecting subjects of appropriate character for "dissolving" into one another, so as to avoid such anomalies as "The Deluge" dissolving into "Vauxhall Gardens by Night," &c. A continuous or connected series of slides should be chosen; and if the object be amusement, such stories as "Puss in Boots," "Tale of

a Tub," "Cinderella," "Blue Beard," &c., are very suitable; and if it be further desired to produce "effects"—as of lightning, moonlight, snow, &c.,—such sets of slides as "The Mill," "The Ship," "The Soldier's Dream," &c., may be chosen. These three sets may be regarded as representatives, and the method of working, if described, will enable an amateur to manage almost any other series he may meet with.

It frequently happens that two succeeding slides in a set differ very slightly from each other, showing, possibly, the same house, but with a different group of figures in front. In this case it is very important that they should "register" one with the other; that is, occupy the same place on the disc; and though the arrangements necessary for their doing so (see page 57) will cause some trouble, it will not be regretted, as the result obtained is so much more satisfactory.

That series of slides, with "effects," known as "The Mill," is an exceedingly interesting one, and finds numerous purchasers. It consists of five different slides:—No. 1 representing a water-mill, the wheel of which is made to revolve by means of a rack and pinion. This is called a "rack slide." It may be placed in either of the lanterns, and while it is being shown on the screen, No 2, a "lever slide," representing a swan, should be introduced into the second lantern. Great care is necessary in marking and adjusting this slide; and in order that the swan may swim on at the right portion of the water in the foreground, and not continue *swimming on the land*, the slide should be pushed in as far as it will go, or up to *a notch* previously cut in the slide. The necessity for showing this swan slide at the same

time as the picture of the mill, involves the lowering of the fan in front of the second lantern, due provision for which is made in the dissolving apparatus. By working the lever in this slide the action of drinking by the swan may be very cleverly imitated.

When the swan has been shown a sufficient time, the fan of the lantern may be again replaced, so as to cover the light, and as the object of No. 3 slide (also a "lever slide") is to produce a night "effect," with moonlight on the water, the idea or effect of *approaching* night may be produced in the first lantern by *slowly* turning down the light, which may be done before removing the swan slide.

No. 3 slide being now placed in the second lantern, and the fan of the dissolver lowered, it will be seen whether or not the two slides "register," *i. e.*, whether the windows in No. 3 overlap or exactly cover the windows in No. 1. Should this not be so, one or other of the slides must be moved until this result is accomplished, when by lowering the lever of No. 3, the moon will be seen to break from behind the clouds and illumine the water in the foreground of the picture. The effect having been shown a sufficient time, the lever should be slowly elevated so as to shut off the moon, the fan replaced, No. 3 replaced by No. 4 slide, the lamp turned on gradually so as to produce the idea of returning day; the winch handle should then be turned so as to shut off the first view and allow the fourth gradually to appear; the result will be the change from summer to winter. The first slide, bearing the summer view, is now withdrawn, and No. 5 inserted; this is merely a piece of black linen

pierced by numerous pinholes, through which the light passes when the fan is lowered, and on turning the handle in the *proper* direction, the appearance of falling snow is produced. Care must be taken that the handle be not so turned as to cause the snow to fall *upwards;* also that the perforated curtain be focused *while* bringing it down, otherwise the snow will fall invisibly.

In the series called "The Ship," an operation has to be performed which at first sight is suggestive of difficulty,—viz., *the flashing of lightning,*—the means of accomplishing which is, however, extremely simple. It consists in *quickly* lowering the toothed fan or comb, and as *suddenly* replacing it in front of the lantern containing the lightning slide, while an assistant works the lever of the slide in the other lantern representing the tempest-tossed ship. A screw is attached to each fan to meet the requirements of this and similar cases (see fig. 33).

"The Soldier's Dream" represents a Scottish soldier "of the period," asleep upon the battle-field; and while "oblivion visits his war-weary head," visions of home, wife, children, &c., &c., are supposed to pass before him; and the mechanical point requiring attention in these is, that the fan in front of the lantern from which the visions are thrown on should be *slowly* lowered and raised as opposed to the *rapid* motion necessary when "throwing on" lightning. The *gradual* appearance and disappearance of the visions, accompanied by appropriate music, *softly* played, makes this series very entertaining.

The same slowness of motion should be observed

when exhibiting the "Fields of Bethlehem, with Angels and Star," and the music most appropriate to this series is the Pastoral Symphony from the "Messiah."

The variety of effects producible in exhibiting Dissolving Views varies with the number of lanterns employed, the construction of the lanterns, and the mechanical appliances attached to the slides.

At the Royal Polytechnic Instution, in London, where these effects are exhibited in, perhaps, greater perfection than at any institution in the world, no less than four large lanterns, having 10-inch condensers, are permanently kept ready for use; and on some occasions as many as six are employed at one time.

At page 15, in the centre of a group of lanterns, is represented what is called a double-bodied lantern, which differs chiefly from the ordinary arrangement in this respect; that while in the latter two separate lanterns, with the necessary arrangements for coincidence of luminous discs and for dissolving, are arranged *side by side,* in the former, the same result is obtained by attaching the optical and illuminating portion of two lanterns to *one body, one above the other.*

It is an indispensable condition in working a Dissolving View apparatus, that the discs of light produced by the two or more lanterns should occupy exactly the same place upon the screen. When separate lanterns are placed side by side, this is effected by causing the fronts of the lanterns to converge laterally. The same result is secured in the double-bodied lantern (fig. 4) by a vertical convergence of the fronts, which are provided with hinges and milled-edged screws for that purpose, the turning of which in suitable directions will cause one front to turn a little upward, and the

other slightly downwards. The "Dissolving" effect in this form of lantern is produced by the slow revolution of the toothed fans attached to the projecting axis between the two object-glasses; and when it is necessary to "flash" lightning, the handle of the dissolver should be unscrewed, and one of the brass fans used as a handle, by means of which the other may be *rapidly* removed from, and replaced in front of, the second aperture.

There is a short series of slides supplied by some opticians, representing a group of Snow Huts, and some Esquimaux, with Dogs and Sledges, illuminated by the Aurora Borealis. In showing this series, the first is assumed to be a day view; and when the Aurora appears at night the effect is considerably heightened by turning down the light in the day view, and thus giving greater prominence to the Natural Phenomenon, the flashing of which, by aid of what is called a "rack Aurora," is very effective.

There is another illusion (which may be classed among the "things not generally known"), which consists in throwing on the screen from one lantern a *plain photograph*, and then "dissolving" into the *same picture, coloured*. To the uninitiated, the effect seems truly magical, and differs entirely from the ordinary change from one picture to another. In a pair of pictures like this, the reader will readily understand the importance of correct registration referred to at page 57.

In showing statuary with two lanterns, a piece of sapphire or ruby glass should be placed in one lantern, and the dissolver being worked causes the pure white statue to appear as though it were coming out of and retiring into a cloud.

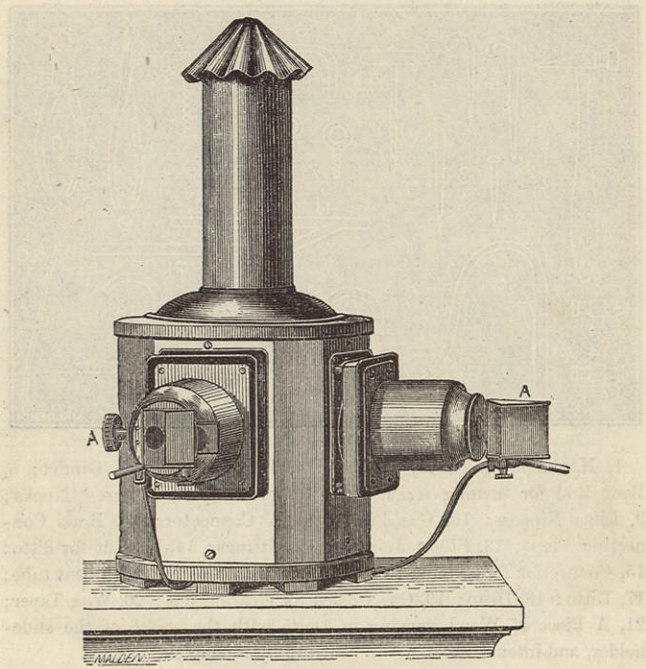


Fig. 34.

THE PRISMATIC DIOPTRIC DISSOLVING APPARATUS.

An ingenious and efficient form of Dissolving View Apparatus is represented in the above drawing. The body, which is of Mahogany, lined with iron-plate, is a square, having its four corners truncated, thus yielding an octagonal body, having four principal and four minor sides. Upon two of the principal sides are attached ordinary Lantern fronts, such as in fig. 4, page 15, in front of each of the object-glasses of which is placed a 3-inch plate-glass prism, so mounted as to be adjustable at any angle. The oxycalcium or oxyhydrogen light

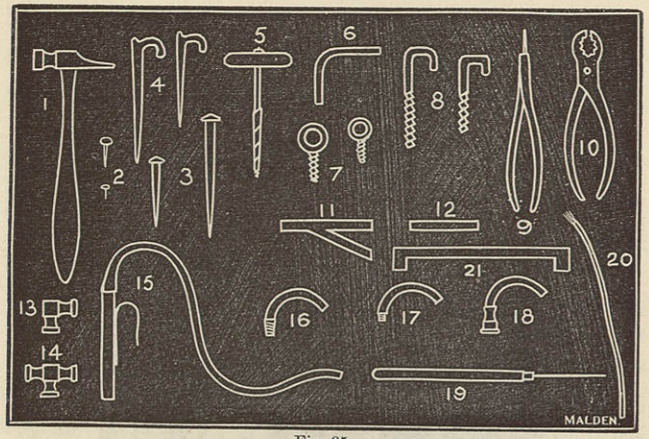


Fig. 35.

1, Hammer; 2, Tacks; 3, Nails; 4, Driver Hooks; 5, Gimlet; 6, Bent Rod for turning screw eyes; 7, Screw Eyes; 8, Screw Hooks; 9, Lime Nippers; 10, Gas Pliers; 11, Y Connector; 12, Brass Connecting Piece; 13, Elbow Joint for gas fittings; 14, T Joint for ditto; 15, Connection for hooking to gas burners; 16, Gas Nib with bent tube; 17, Ditto; 18, Ditto; 19, Gas Broach for clearing jets; 20, Wax Taper; 21, A Piece of Wood, varying in *length* with the *width* of the slide-holder, and intended to assist in centring by raising the picture.

is employed in the usual way in the interior of the lantern; and passing through the optical arrangement, with a lustre proportionate to the large diameter ($3\frac{3}{4}$ inch) and long focus ($5\frac{1}{2}$ inches) of the condensers, is so refracted by the prisms in front that the two discs of light are made to perfectly coincide. The optical portion of this apparatus is equal to the production of a well-defined disc of 20 feet in diameter, and it offers facilities for the production of a variety of effects, as the discs may not only be thrown together to form one circle, but united at various distances in length upon the screen.

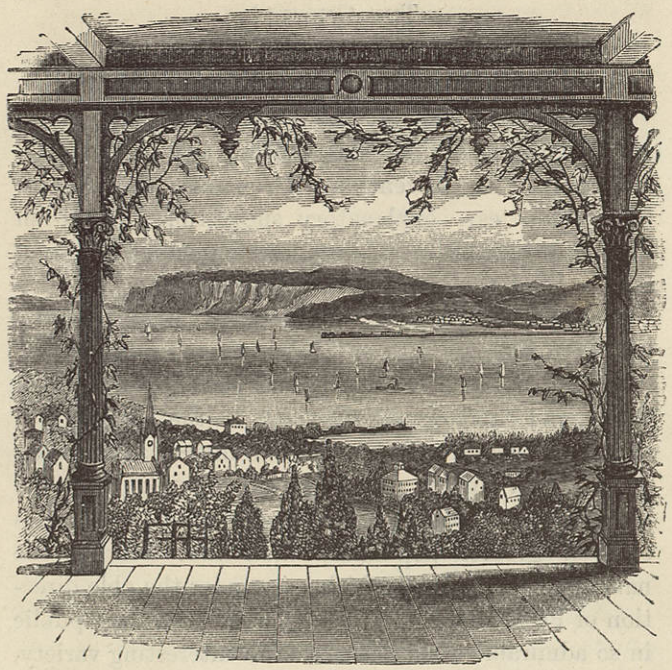


Fig. 36.

The purpose of this illustration (fig. 36) is to show the pleasing effect producible in showing a series of views with two lanterns, by placing the picture in one lantern, and a verandah or window of appropriate design in the other. If in adopting this suggestion the verandah be focused for the edges of the field, and the view focused for the centre, the want of sharpness sometimes resulting from imperfection in the optical portion of the instruments is thereby overcome, and a beautifully flat field obtained over the entire disc. A knowledge of the peculiarities or remarkable features of different countries will suggest appropriate borderings for different series of views.

The above drawings (fig. 35) and list (page 76) are intended to remind lecturers leaving home of what they should take with them.

The Ghost!!

"Fine apparition!"
"'Tis an honest Ghost that, let me tell you."—*Shakespere.*

The days of witchcraft and sorcery are happily past; and when in this nineteenth century any phenomenon savouring of the inventions of romantic fiction gains the public ear, explanatory suggestions, based on known principles of science, are immediately forthcoming, and the mystery is soon solved.

"The Ghost," "Sphinx," "Proteus," "Magic Casket," "Modern Delphic Oracle," "Cherubs Floating in the Air," associated with the names of Dircks, Pepper, Tobin, and Stodare, will be fresh in the memories of thousands who read this little volume; and among these clever optical illusions, all dependent on the phenomena of reflection, there is none which has enjoyed greater popularity than that bearing the name of "the Ghost," which has, under the able direction of Professor Pepper, been placed before the public in so admirable a manner and such interesting variety, at the Royal Polytechnic Institution.

This illusion has special claims to notice in the present work, on account of the Magic Lantern, as a source of brilliant light, being indispensable to its succesful production.

The frontispiece so clearly shows the conditions necessary to be observed in this, the modern method of raising a ghost, that a verbal description is almost unnecessary. It will be seen that the spectators are placed in a distant and for the most part elevated portion of an assembly room, which is darkened. In front of these is a stage, upon which actors are engaged.

The spectators regard both as living actors, while in reality one is but "the shadow of a dream," and "coming like a shadow, so departs." The *real* "woman in white" stands *under* the stage, concealed from the spectators by the usual board near the orchestra; the Magic Lantern, illuminated by the oxy-hydrogen light, directs its beams full upon her figure, the reflection of which appears as far behind the inclined plate of glass as the real figure is in front. The living actor on the stage, notwithstanding his expressive attitude of surprise, really *sees nothing*, and is simply staring at a portion of space where he has been previously instructed "the apparition comes," the spectators alone being so situated that they "take false shadows for true substances."

It will thus be seen that the peculiar feature of the exhibition consists in associating living actors with those which are merely visionary, and in so sustaining the illusion that no distinguishable difference shall appear to the spectators until the requirements of the scene necessitate the vanishing of the spectre. The disappearance or "vanishing" of the Ghost is produced by simply turning off the light either suddenly or gradually, according to circumstances.

The minute details requiring attention are such as result from reflection: *e.g.*, if the phantom has to raise her *right* arm, the left arm of the solid figure *under* the stage should be raised; similar points should be attended to in *dressing* the person whose reflection will be seen by the spectators; if armed, the sword should hang on the *right* side; if writing, it should be done with the left hand, &c., &c.

On Colouring Magic Lantern Slides.

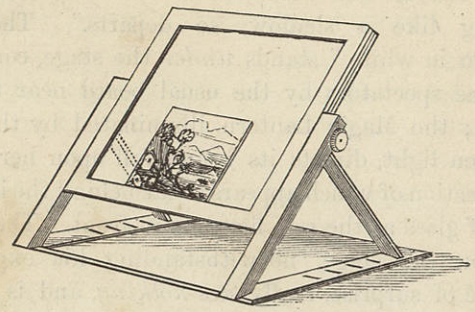


Fig. 37.—Easel.

There are so many useful treatises on this branch of art, that it would be superfluous to do more than give a list of apparatus and colours.

Apparatus.—The easel, an assortment of brushes and dabbers, an ivory and a steel palette knife, a small muller and slab, a palette, a penknife, an etching point, lithographic pen for outlines, pieces of linen or cotton rag.

Media.—Oil of spike-lavender, turpentine, varnish, ox-gall, Canada balsam.

Colours.—Italian pink for yellow, Prussian blue, Antwerp blue, crimson-lake, carmine.

These are the three primary colours, which are capable of yielding nearly all the rest by judicious mixture. The colours purchased should be those prepared for oil painting, in collapsible tubes, and the purpose for which they are intended should be explained to the colour maker.

Glass.—Patent Plate and Flatted Crown are the two kinds obtainable. The latter will answer most purposes.

J. & W. Rider, Printers, 14, Bartholomew Close, London, E.C.

THE

MAGIC LANTERN:

HOW TO BUY AND HOW TO USE IT.

BY "A MERE PHANTOM."

OPINIONS OF THE PRESS.

"THE MAGIC LANTERN: HOW TO BUY AND HOW TO USE IT. By 'A MERE PHANTOM.'—To persons who possess Magic Lanterns which they are vainly endeavouring to 'manage properly,' this brief treatise on the properties and uses of a popular scientific toy will be of service. Under 'A Mere Phantom's' tuition, the stupidest and clumsiest paterfamilias alive, or any other man, may soon learn to 'work a lantern' to the satisfaction of a highly critical assembly of boys and girls."—*Athenæum.*

"THE MAGIC LANTERN: HOW TO BUY AND HOW TO USE IT.—Such is the title of a little work which has been some time awaiting notice in our columns. The designation is suggestive and comprehensive: it suggests amusement blended with instruction, upon a very interesting subject; and it comprehends at least as much as amateurs would care to know with respect to the apparatus to which it refers. But titles are sometimes delusive; hence we have looked through a considerable portion of the work to ascertain if the promise it bears upon its front is fulfilled. We have experienced no disappointment. It is neither a worthless catchpenny nor the offspring of a smatterer in science. All the title leads us to expect is faithfully set forth in the book; and, what is of equal importance, the subjects treated are not rendered unintelligible to ordinary readers by a needless parade of scientific terms. The work is said to be the product of 'A Mere Phantom;' but he is evidently a spectre who does not confine his attention to the 'glimpses of the moon,' or the mystic region of spiritualism. We have in his book the results of philosophic reflection and considerable research in physical science. Upon these grounds we unhesitatingly advise such as contemplate providing amusement for the long evenings of winter by means of the magic lantern, to consult its pages. The advice necessary to enable a purchaser to secure a good instrument, and to manage it successfully when he has it, is here prepared to his hand; and upon these points the 'Phantom' who speaks in this book approaches the reader in no 'questionable shape.' We need only add that the work is published by Messrs. Houlston and Wright, of London, and may be had for a shilling of any bookseller."—*Monmouthshire Merlin.*

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"THE MAGIC LANTERN: HOW TO BUY AND HOW TO USE IT. By 'A MERE PHANTOM.' (London: Houlston and Wright).—The little manual before us will be especially welcome to a large number of our readers, as containing in a compact form just the information important to possess, and difficult to acquire without the costly and tardy operations involved in gaining experience. The different sizes, qualities, and prices of various lamps; the various modes of lighting, with the results; the modes of preparing gas where it is required; the various kinds of slides, and the means of getting moving effects and dissolving views; the mode of colouring slides; and the mode of working all the apparatus required, are detailed in some sixty pages of readable matter."—*Photographic News.*

"THE MAGIC LANTERN, by 'A MERE PHANTOM' (Houlston and Wright), will be found a most useful companion, by those who employ the instrument either for amusement or instruction."—*Popular Science Review.*

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