APPARATUS FOR SCIENTIFIC DEMONSTRATION

Some of the best made and most unusual lanterns are those with a scientific application. This extract from Lewis Wright's book is the first of a series on the use of the lantern in science.

83. **Demonstrating Lanterns.**—Any good ordinary lantern can, by a little modification, be made effective in almost any class of demonstration. It may have a good microscope fitted to it, as described in the next chapter, interchangeable with the ordinary front. With a slide-stage open at the top, it will project chemical and other tank experiments. With accessory apparatus such as is presently mentioned, it will perform optical experiments. And by withdrawing the front, and arranging small apparatus in the rays from the condenser, it will project that apparatus. But for certain preponderating kinds of work, certain forms of lantern are best adapted; and for constant work, especially in educational institutions, the form of lantern should therefore be determined with reference to the kind of work to be chiefly done.

The modification and use of the lantern in a cheap and simple way to project pieces of apparatus as well as slides, was first systematised in the schools of Germany. Fig. 81 represents such a German school lantern.

The essential points are that the flange-nozzle is entirely removed, only an open spring-holder stage being left in the front of the condensers; that the objective is mounted in a separate support, which can slide along the double-rail stand or base; and that a small table, adjustable for height, can also be fixed anywhere on the same base. On this table any piece of sufficiently small apparatus can be adjusted, and projected as if it were a slide. The objective is surrounded by a shade to keep stray light from the screen. Ordinary slides or diagrams are placed in the spring holder, and projected as usual.

This arrangement has been a great deal popularised in England by Mr. W. Lant Carpenter in connection with the Gilchrist Lecturing Trust; and where actual physical apparatus, and diagrams, are the principal subjects of projection, it can hardly be improved upon for handiness, cheapness, and simplicity; but it is not so well adapted for optical and acoustical experiments, on account of the stray light. Fig. 82 is an American modification of it, arranged with a special view to portability. The rails and legs are here dispensed with; the lantern body is a mere frame hinged together, with a metal top, and covered round when in use with thick black cloth; and the whole is placed on a table. The jet is also modified for compactness, the usual long metal tubes being dispensed with. Otherwise the lantern is essentially the same as the German model.

Lanterns of this type, either mounted on rails, or for simply placing on a table, with little unimportant variations in detail, are now supplied by all the leading opticians.

For optical experiments chiefly, and incidentally for other physical demonstrations, the most popular pattern in public institutions till lately has been the well-known Duboscq lantern (fig. 83), fitted usually with the electric light. The square body is of sheet brass, and is mounted upon four brass pillars. There is a flange-nozzle fixed to the body; and the special feature of the arrangements is, that the condensers are fitted in the back end of a large tube which slides freely backwards and forwards in this nozzle, the character of the beam being modified by *sliding the condensers to and from the light*, instead of moving the light to and from the condensers. An adjustable slit, and a circular revolving diaphragm of apertures, fit into the front of this sliding tube. An ordinary front for showing diagrams can be interchanged with the optical flange when required.

This arrangement of movable condensers is convenient for *purely* optical experiments, and for focussing with the well-known Foucault and Duboscq regulators, which would be difficult to adjust in relation to a stationary optical system, and which as a rule are only employed intermittently. But for anything like a continuous arc light, the lantern itself is much too small, and has occasioned many very unpleasant burns: and optically the arrangement is unsuitable to any other projections than those with beams or pencils of light, because to get a good disc, in which to exhibit either diagrams or apparatus, is exceedingly difficult with it.

In some cases this increase of power may be best obtained by using two or more single lanterns, one of which might have a front on the Duboscq plan, and another carry an ordinary lantern stage and front for diagrams, or other fittings. For powerful arc lights the bodies should, however, be much larger.

Two detached lanterns have some obvious advantages, where detached or side experiments are of frequent occurrence. But in perhaps the majority of cases the demonstrator, equally with the exhibitor, may find it most advantageous to employ a bi-unial or even tri-unial arrangement, modified, however, according to his special purposes. This is especially the plan where the lime-light is the radiant employed. The simplest case is perhaps that of a medical school, which may desire to supplement the demonstrations of such a lantern microscope as is described in the following chapter, by photo-micrographs

Fig. 81.—German Lantern

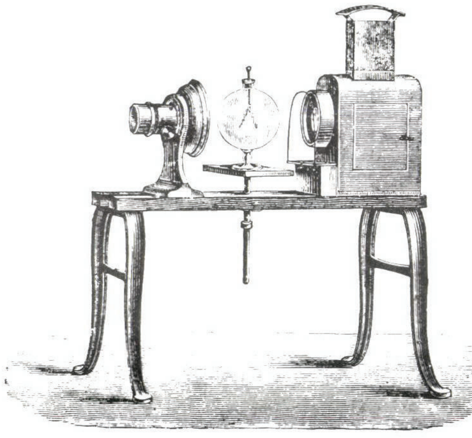


Fig. 82.—American Lantern

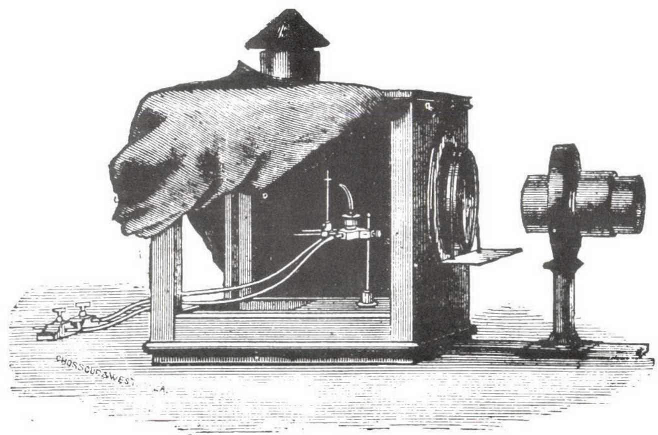
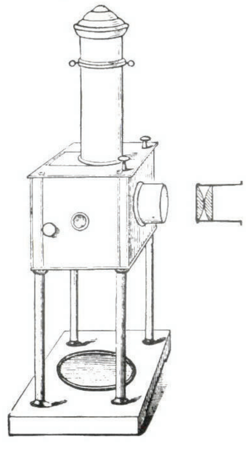


Fig. 83. Duboscq Lantern



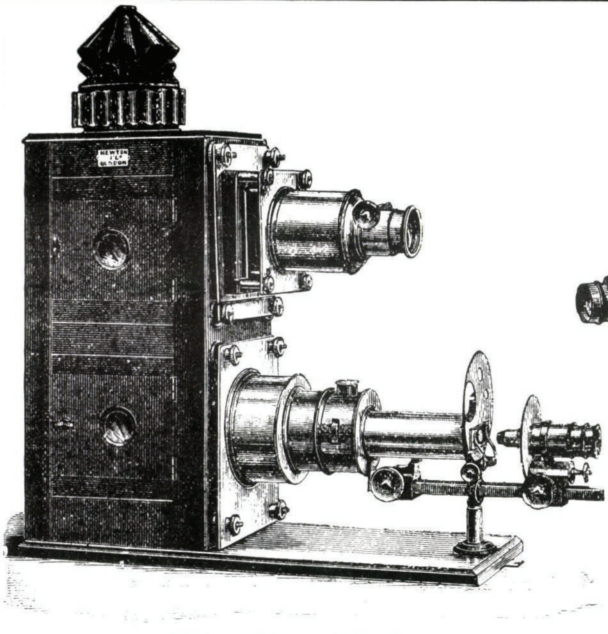


FIG. 84.—A Microscopic Bi-unial

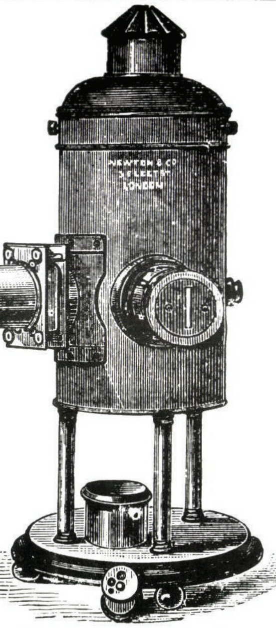


FIG. 85.—Double Electric Lantern

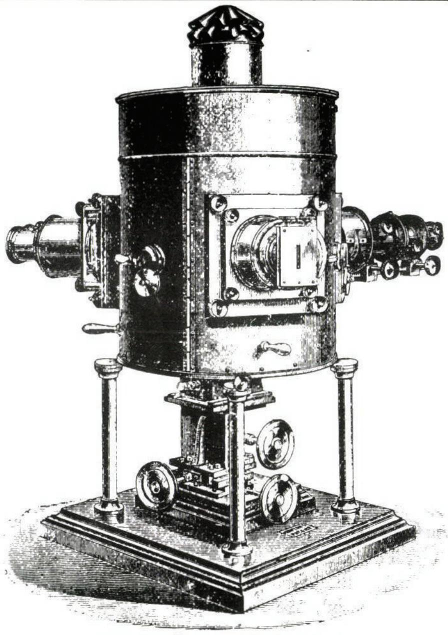
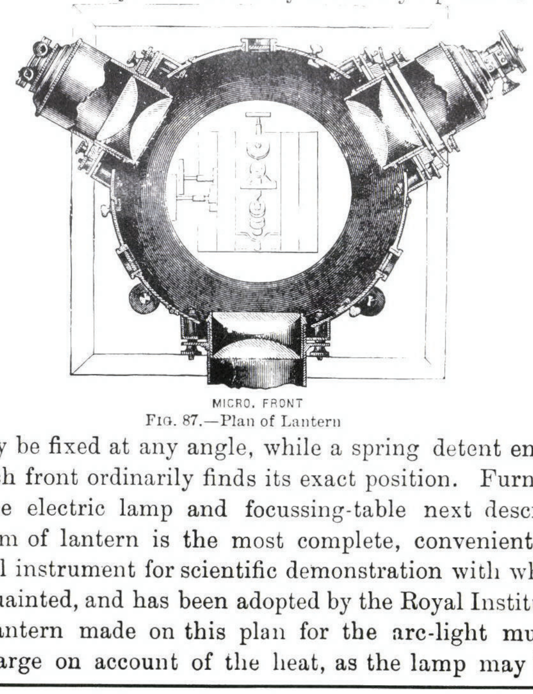


FIG. 86.—Tri-unial Electric Lantern

and other diagrams. A suitable bi-unial, the simplest modification of the ordinary form, is that in fig. 84, and will perfectly suffice for such purposes, where physical experiments are not required,

My own bi-unial lantern, being required for experiment, as well as exhibiting slides and microscopic projections, was designed differently. The bottom is supported on four brass pillars, each 4 inches high, which allow gas-pipes for coloured flames, or any other apparatus, to be readily introduced from below, while a black curtain round these pillars, and another round the back of the lantern, stop all stray light when required, the dark blue sight-holes being also covered by brass shades. The top lantern is rarely used for anything but slides and diagrams, and another similar front for the bottom one converts the whole into an ordinary dissolving lantern when required. This lower front is interchangeable with the microscope front; or both can be removed, leaving the bottom lantern free for parallel-beam work or physical projections. The base-board is also made to slide out, or close up shorter as required; and although the whole lantern is too small to make regular work advisable with the arc-light, the jets are so removable that the lamp presently described could be used if required. The wooden body is of teak, *darkly stained* and dull-polished. I believe the instinct which leads a scientific demonstrator to desire something which *looks different* from the ordinary 'magic-lantern' of the itinerant lecturer, to be a sound one; at all events I plead guilty to the weakness, while the dark wood and brass pillars have actual advantages in practice.

Such a lantern is not, however, suitable for constant work with the arc-light. A very well-known pattern of double arc lantern is Ladd's, better known as the Browning model, shown in fig. 85, where two nozzles, one reserved for diagrams, and the other generally fitted on Duboscq's sliding-condenser plan, centre on the same arc-light at the centre of the circle. This is a good arrangement for one *fixed* position in a theatre, if the optician understands his business and arranges matters so that the arc-light is at a focus which gives an even disc at the given distance; but if this is not attended to, a good disc of clear diagram will rarely be obtained. It is also best suited for old-fashioned lamps, with the carbons in perpendicular line, and was in fact first designed for spectrum-work, the nozzles being so arranged that, without moving the lantern, the rays deflected by the prisms should fall on the same screen as diagrams projected direct. To accomplish this, however, the same dispersive power must always be used: otherwise the lantern must be made to revolve upon the circular rim supported by the pillars. When thus modified, however, it is better to have a tri-unial lantern, the most complete instrument of all, when properly constructed. The first attempts in this direction were not successful, the three nozzles being arranged on three adjacent sides of a hexagon, copying an old exhibition arrangement by Canon Beechey. The objection to it is, that, whichever nozzle is directed towards the screen, another, or two others, also project in front, and interfere with manipulation. This fault is a grave one, and such lanterns have never come into use. The first one I am aware of, constructed on sound principles, was planned and carried out by Messrs. Newton & Co. for the Santa Clara College of California, on the plan represented in fig. 86, and shown in ground plan, with its lamp, in fig. 87. Here the three nozzles (which in this case carried a projection-microscope capable of 5,000 diameters, a diagram front, and an optical front with all the usual accessories) are arranged at equal intervals round the whole circle, so that whichever points forwards, the others are backwards, and out of the way. There are three doors with shuttered sight-holes of darkened glass, between these nozzles, so that the arc can always be examined either from the back in the optic axis, or from either side. The foundation circle is supported on four strong pillars, standing rather outside the body, for steadiness; and the whole body revolves easily and truly upon this circle,



MICRO. FRONT

FIG. 87.—Plan of Lantern

and may be fixed at any angle, while a spring detent ensures that each front ordinarily finds its exact position. Furnished with the electric lamp and focussing-table next described, this form of lantern is the most complete, convenient, and powerful instrument for scientific demonstration with which I am acquainted, and has been adopted by the Royal Institution.

A lantern made on this plan for the arc-light must be pretty large on account of the heat, as the lamp may be in action all the time, or nearly so, with one nozzle or the other; for any front can be brought into operation as simply and easily as by turning a dissolving-tap. But it has also been constructed on a smaller scale for the oxy-hydrogen light, which in this case is best fitted with three rectangular adjusting motions. As such a lantern may be occasionally used with a moderate arc lamp without detriment, and the arc is really only required for occasional purposes, unless a long high-power microscopical demonstration be on hand, such a smaller pattern would be sufficient for the majority of institutions. The larger pattern is preferable where a current is available and used constantly.

85. **Vertical Projections.**—It is very often necessary to throw the projection of fluid surfaces, &c., vertically upwards, afterwards reflecting it to the screen; and the same arrangement is very convenient for working out a diagram before a class. This is generally effected by some form of the *vertical* attachment devised by Professor Morton, and shown in fig. 89, a similar arrangement by Stöhrer of Leipzig being shown in fig. 116, on page 227. The lantern condensers are arranged so as to throw a parallel beam, which by a large reflectonatian angle of 45° is deflected vertically, where it passes through a third plano-convex lens, which converges the light, and over whose face is the field of the instrument. A pillar at the side supports the focussing power, a ring allowing various powers to be used: and the same ring-fitting carries a second silvered reflector, turning on an axis so as to throw the image at any desired height on the screen. If a sheet of fine ground or smoked glass be simply laid over the face of the large lens, a diagram can readily be worked out, and is often better understood when so worked out, than if projected complete. It will be still more transparent if the glass is first rubbed with a very little paraffin oil.

Some opticians substitute a right-angled reflecting prism, but the second reflection from a silvered mirror is practically imperceptible except in white line diagrams drawn upon really blackened glass. For such a prism is advisable, and is always employed in Duboscq's form of the apparatus.

An effective apparatus can be made very cheaply as in fig. 90. The reflector is here simply set in a wooden cubical box, with the side which is turned towards the lantern condensers left open. A rod at the side carries a plain lens in one of the sliding fittings presently figured, and another sliding socket carries the reflector.

The illumination is not even and good with such attachments, unless pains are taken to accurately adjust the first reflector as regards the parallel rays from the lantern condensers. To ensure this the lantern itself is often fitted up by Hawkridge, and other American opticians, as in fig. 91. Here the two first lenses of a triple condenser are mounted in the body of the lantern, which is supported on pillars; while the third or converging lens is fitted in a plate hinged to the top of the lantern front. This plate has at one side a pillar or standard, which carries the focussing power and second reflector. For vertical work, the lantern is arranged as in the diagram, the front plate and lens being supported in a horizontal position by a movable triangular box, to whose hypotenuse side is fixed the reflector; but when ordinary work is required, this box is removed, when the plate drops down to a vertical position, with the focussing power out in front as usual. The second small reflector is then removed, when the lantern projects direct. Several of these lanterns have reached England; but there seems a sort of national 'fashion' in apparatus, and so far as I am aware, they are thought rather awkward in use by their possessors.

Messrs. Newton & Co. have constructed a bi-unial lantern which produces vertical projections in another way, shown in fig. 92. There are two separate lanterns, the top one so *hinged* to the bottom one that the top lantern can be turned back in a moment, so as to rest against stops and point vertically upwards. An adjustable mirror can then be attached by a very simple fitting, and will reflect the image upon the screen. The objectives of both lanterns are mounted on the detached system already described for physical work. One lantern is therefore always ready for ordinary work of any kind, while the top one can either be used in the same way (the whole as an ordinary bi-unial exhibition lantern if necessary) or can be converted at a moment's notice to vertical purposes. A screw is provided to keep the tray and jet from dropping out of the proper position.

I was at first apprehensive that the heat of the jet, when thus brought under the condenser, might prove a fatal objection to this arrangement; but it has not proved so, provided the jet be kept *in work* while the lantern remains vertical. If the jet is turned off so that the flame of coal-gas, released from the pressure driving it down, rises *upwards* towards the condenser, a crack will probably result; but it is easily avoided with this caution, and more brilliant projections are thus obtained than in the other way.

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FIG. 89

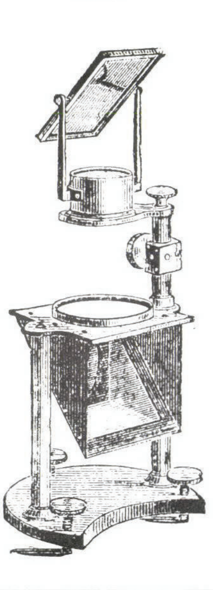

FIG. 90

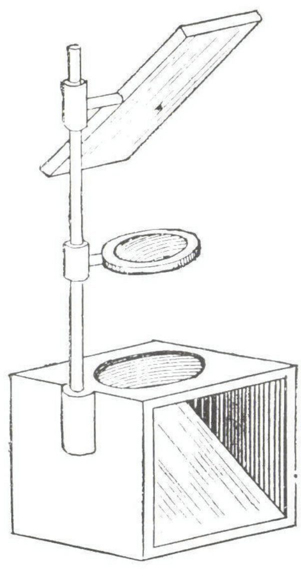

FIG. 91

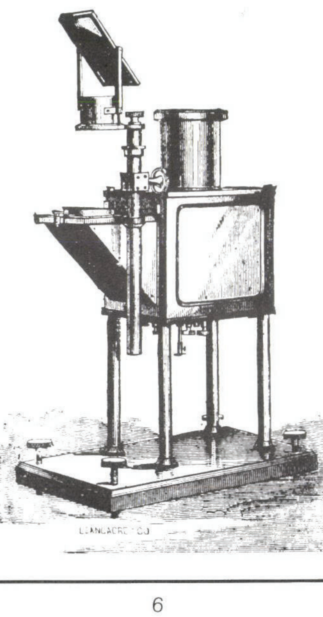

FIG. 92.—Newton's Vertical Bi-unial