CONQUESTS OF SCIENCE

MOVING PICTURES

HOW THEY ARE MADE AND WORKED

BY

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REVISED EDITION

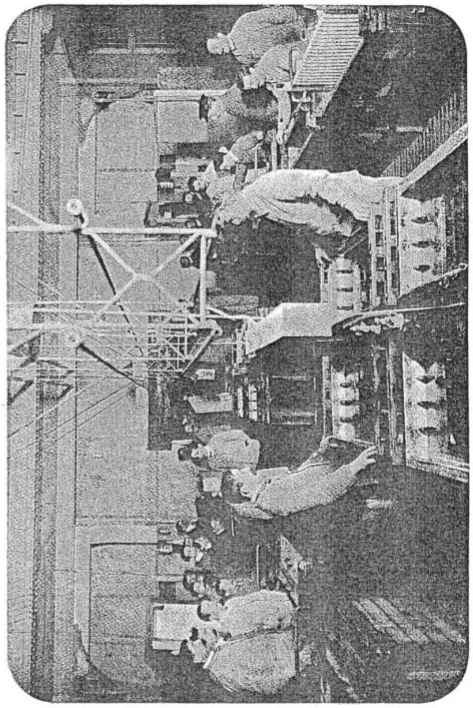
ILLUSTRATED

LONDON
WILLIAM HEINEMANN
1912

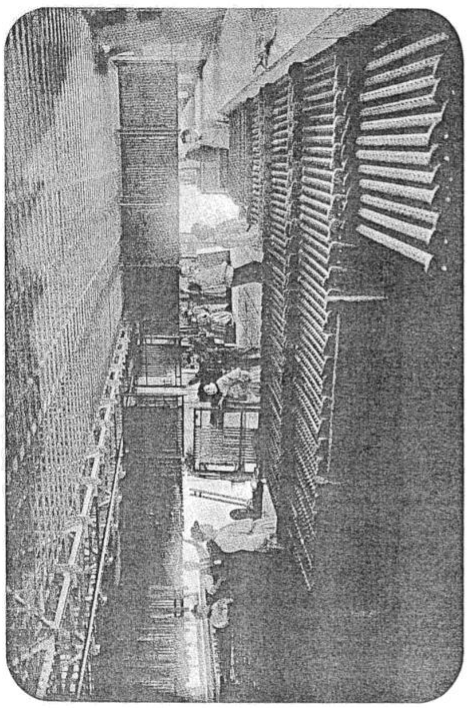
the other, as if being wound upon a wheel, as it was uncoiled from the spool, the inner end of the film being likewise secured to the frame. This rack was dipped first into a vertical tank to soak the film, and then was placed in a flat tank or trough to be developed in the same way as an ordinary glass plate. By this means every part of the exposed surface was developed equally. Development carried to the requisite degree, the frame was withdrawn, washed, and finally immersed in the fixing tank, which was of the same horizontal design. When the image was fixed it was placed in another tank and received a thorough washing, to remove all traces of the fixing solution, as in the ordinary developing process. This task completed, the film was uncoiled from the flat rack to be re-coiled upon a wooden drum, which was suspended from the ceiling in the drying chamber, until the film was dry and hard.

As may be supposed, different factories practise different methods of carrying out this operation. Nowadays a film may be as much as 300 or 400 feet in length, and consequently special methods have to be employed. I have been in some establishments where development is carried out upon an extensive scale, in which the films, as withdrawn from the camera film box, are wound at once upon a large wooden reel, seven feet or so in length, suspended upon brackets above the developing bath. When the drum has received its full length of film it is lowered into a deep tank containing the desired solution, and there kept revolving slowly and steadily until the treatment has been completed. Then the reel is withdrawn by two men and lowered into the next bath; and so on until at last the reel finds its way into the drying room, where the film is uncoiled from the developing drum and re-wound upon the drying reel. The disadvantage of this process is that two men are required to handle the reel, whereas, when a frame is used, one pair of hands is sufficient.

The developing and printing rooms in a large film-picture factory are highly interesting hives of activity. Large troughs and tanks containing the various solutions



THE DEVELOPING ROOM AT THE PATHÉ WORKS.
The films are wound upon wooden frames and immersed in large tanks containing the various solutions.



THE DRYING ROOM AT THE PATHÉ WORKS.
This illustration shows the wooden frames upon which the lengths of film are wound and the overhead racks from which they are suspended.

are on every hand, together with adequate supplies of running water. Everything, of course, is carried out in semi-darkness, the only light available being that emitted from ruby lamps. The fixing solution after it has served its purpose is not thrown away, but is subjected to a chemical treatment to recover the bromide of silver which the hyposulphite of soda has dissolved from the sensitised emulsion on the film. The silver in suspension is precipitated by chemical action in a thick sediment. In large works this recovery process is profitable, several pounds of this metallic silver being secured every week.

The solution employed for development is either a combination of hydroquinone and metol, or a bath of rodinal, developing agents which are familiar to the amateur photographer, while the fixing bath is a solution of hyposulphite of soda. The developing formula is modified by various firms as a result of individual investigation. The drying operation is one that has to be carried out very carefully; the temperature of the chamber must be evenly maintained, and the air which is circulated through the room must be filtered before admission, in order to arrest all particles of dust which otherwise might settle upon the gelatine surface and wreak appreciable damage.

In the early days the fickle character of the film was a serious difficulty. If it were dried too rapidly it evinced a tendency to curl, and severe shrinkage often ensued. To guard against this trouble the film was glycerined before being dried, by being passed through a bath containing a solution of glycerine and alcohol. The improvements effected in the manufacture of the film, however, have enabled this subsidiary treatment to be dispensed with. In cases where a topical film must be rushed out quickly to catch the public in the height of its interest, however, drying is accelerated by subjecting the film to a bath of alcohol in some form or other.

Although a spool of film, measuring perhaps 300 feet in length, is handed over for development, possibly that 300 feet carries two, four, or more exposures, *i.e.*, different sections were exposed at different times, on different days,

or under different conditions of light, &c. The camera operator has indicated the end of each exposure by means of the camera punch. When the developing operator receives the spool, he first searches for such marks as he uncoils the film, and the latter is severed at those points, and each exposure is developed separately. When the developing process is completed, therefore, the film relating to one subject is in a fragmentary condition. These odds and ends have to be sorted out, all useless parts cut away, and then arranged in sequence and joined together to form a continuous band containing, in the ordinary case, the whole subject. If the series of pictures runs into two or three thousand feet, the aggregate will be divided into 1,000 feet sections, which is the approximate capacity of the spool mounted on the projector. The sections are united by means of a transparent cement, known as amyl-acetate.

When the negative is dry and the gelatine surface has hardened enough to permit the sections to be handled and joined together, the next stage is taken in hand. This is printing the positive. Obviously a printing frame, such as the amateur uses for printing from a single glass plate, is quite out of the question with a negative several hundred feet in length. Invention born of necessity has met this question in a novel manner, and the printing process is one of the most interesting phases in the preparation of a picture. Considerable mechanical ingenuity has been displayed, and various types of printing machines produced; but for the purposes of explaining the subject most lucidly and comprehensively two typical machines will suffice. Before printing, however, the raw film or stock intended for the purposes of the positive or transparency must be perforated, an operation which is similar to that followed in perforating the negative film.

Printing is carried out by contact; that is to say, the sensitised surface of the positive film is pressed tightly against the emulsion side of the negative film at the instant the exposure is made. One image is printed at one time. The two films are given an intermittent action, the consecutive images on the negative film and the corresponding sections of sensitised surfaces on the positive film being brought before the illuminant during the brief period that the light is cut off from the printing box by the passage of the shutter.

In the Newman-Sinclair apparatus, Fig. 8, the negative-film is wound upon spool 1, while the positive film is carried on spool 2, both being supported upon the projecting bracket 3. The negative passes over the guide roller

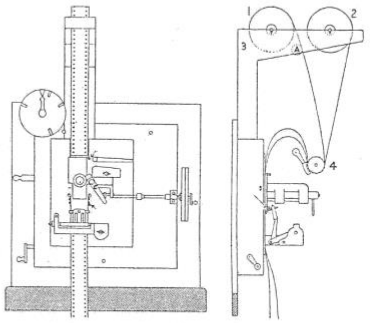


FIG. 8—FRONT AND SIDE VIEWS OF NEWMAN-SINCLAIR PRINTING APPARATUS.

A, and descends with the positive film to the toothed sprocket 4. At this point the two films are brought together with the gelatine surfaces inside, while the teeth of the sprocket mesh with the perforations in each. The two films pass from this sprocket, form a loop, and together enter the gate, which clamps them tightly and flatly together, with their respective perforations exactly coinciding.

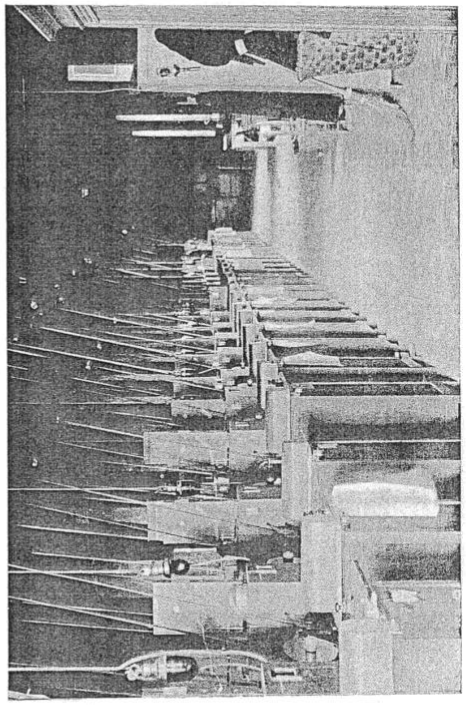
At the point where the two films come opposite the aperture through which passes the light from the lamp, there is a mask, by which the position of the picture relative

to the exposure hole is corrected. The mask also determines the shape of the positive picture. It may be rectangular, oval, circular, or have rounded corners as desired. Immediately behind the film, in line with the exposing aperture, is a red screen, over which a shutter slides. When this shutter is opened, the operator can see the negative image through the positive film, and thus can ascertain that the position of the picture is correct in relation to the exposure aperture, and also that the perforations on the two films are in synchrony. The light by which the exposure is made is contained in a light-tight box, or may be placed on the outside of the wall of the printing room, an aperture being cut in the partition to admit the light to the printing apparatus, which is screwed to the wall. Between the light and the film there is a revolving shutter, as in the camera, which cuts off the light intermittently, enabling the succeeding negative image and area of positive film to be brought into position before the exposure orifice.

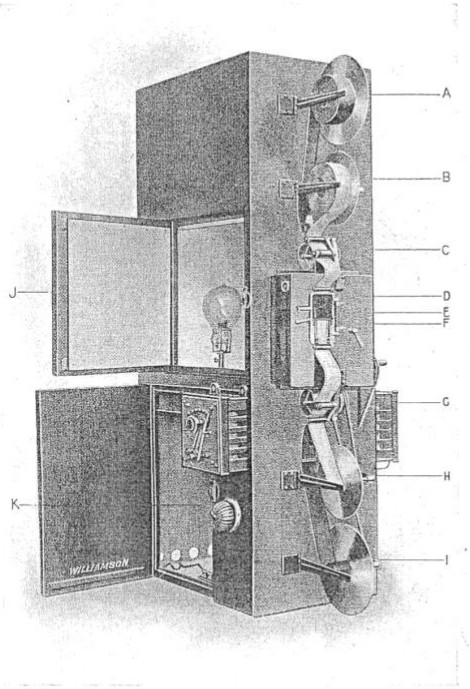
The film is drawn through the machine by a pair of fingers or claws which engage with the perforations of the two films and pull them downwards together. As the pictures are printed, the negative and positive films pass into boxes or other suitable receptacles to be re-wound on their respective spools. The machine can be operated either by hand or power according to the requirements of the establishment. As the sensitised surface of the positive film is slower than that of the negative, printing is carried out at a reduced speed, the average recommended with this apparatus being about five pictures per second.

Another printing machine has been recently produced which is regarded as the simplest, most mechanically perfect, most compact, and self-contained apparatus yet devised for this work, and which compels attention as much from its efficiency as from the point of view of mechanical excellence. This is the Williamson printer. It is a complete unit, and can be moved from place to place with facility.

It comprises a large rectangular box or cabinet, standing on one end. The front face carries the printing mechanism,



A ROW OF PRINTING MACHINES IN THE ROME WORKS OF THE CINES COMPANY.
This establishment is able to print 100,000 feet of film per day.



THE WILLIAMSON PRINTING MACHINE.

For making the positive films.—*For explanation see page 82.*

while the interior, divided into two compartments, contains the driving mechanism and the illuminating agency for printing. The apparatus is so designed that after printing the films are wound upon separate spools at once, thus saving time, and dispensing with the necessity of a box or basket to gather the loose films, which is both a dangerous and an unsatisfactory process, inasmuch as the films are liable to become damaged by curling and cracking, and through the surfaces rubbing against one another.

The negative film is placed upon the spool *A* immediately below which is the positive film spool *B*. The sensitised surfaces of the two films face one another, and the two are brought together as they pass under the grip rollers and over the toothed sprocket *C*, where the teeth mesh with the perforations in the respective films. Issuing from this sprocket a loop is formed, and then the films enter the gate *D* over the printing aperture. This gate is side-hinged, and when closed it presses evenly upon the whole surface of the films under exposure, ensuring a perfect even contact. There is a small red screen *E*, which, when released by means of a small lever, drops down, thus enabling the negative to be examined without danger of the positive film being fogged in the operation. By this means the printer can satisfy himself that the picture is central to the exposure hole.

As the picture is printed, a simple claw device *F*, resembling two hooked fingers, engages with the perforations in the two films and draws them downwards. This claw device is of very simple construction, working on a cam, so that when the film has moved downwards the proper distance—sufficient to bring the succeeding picture and its area of unexposed positive film before the printing aperture—the fingers disengage themselves from the films, rise, and move upwards to drop into other perforations and repeat the operation.

As the film descends, it forms a loop, and passes under a double smooth-faced roller and a toothed sprocket *G*, at which point the two films part company, the positive to be wound upon the bobbin *H*, while the negative film is

wound upon the lower bobbin *I*. These lower spools are driven by belt and pulleys from a bevel gear wheel, which carries a spindle actuating the claw giving the intermittent movement to the films, and which by means of another spindle rotates the upper and lower sprockets *C* and *G* so that the loops above and below the gate remain constant. By this arrangement no pull or strain is imposed upon the films by the sprockets, which act merely as guides and not tractive devices.

The compartment *J* is lined with asbestos, and contains the illuminant by means of which the printing is done. An electric lamp of 50 candle-power, having a filament in the form of a grid, is placed directly opposite the window through which the exposures are made. This lamp is mounted upon a slide controlled by a lever on a quadrant on the face of the machine, by means of which it may be moved as required from 2 inches to 10 inches from the printing window. The power of the light may be varied according to the density of the negative by means of a controller, which increases or decreases its intensity in much the same way as a gas jet can be turned up or down, it being possible to secure six variations in light intensity ranging between 16 and 50 candle-power. When the door of the chamber is closed the compartment is perfectly light-tight, though ample ventilation is secured.

The lower compartment *K* carries the electric motor by means of which the apparatus is driven, and the speed of printing is altered at will by means of a controller. The motor is of 1/12 horse-power, and six direct speeds can be obtained. The drive is communicated to the mechanism through a system of cone pulleys, which enable three speeds to be obtained; and as each of these three speeds can be given one of the six speeds of the motor by means of the regulating switch or controller, the apparatus can be driven at eighteen different speeds, according to requirements. Wide range of action, combined with simplicity of control, characterise this apparatus. The printing speed varies according to the density of negative and the intensity of the light, but the average speed in printing from a normal negative is about 500 exposures of pictures per minute.

The positive film, after being exposed, is developed by a method similar to that used for the negative. Both these developing processes demand considerable skill and experience in order to ensure the best possible results. An accomplished developer, like his colleague working with glass plates, can rectify many deficiencies arising during exposure. The camera operator often has to work under the most adverse conditions concerning light, and it is the task of the man in the dark room to obtain the utmost from a poor negative. By care and attention, combined with experience and knowledge, he will be able to improve, make up for under-exposure, and mitigate the evils due to over-exposure. It will be realised that development is the most critical stage in the whole operation, for upon the manner in which it is carried out much of the excellence and merit of the projected picture depends.

The fact that the cinematograph camera is being regarded more and more as an indispensable unit in the impedimenta for travelling and exploring expeditions has resulted in attention being devoted to the perfection of a small portable developing outfit to enable films to be developed at once, instead of sending them home for treatment, as hitherto has been the case. The "N.S." developing apparatus is an excellent appliance of this character. It has been taken by Captain Scott, R.N., upon his Antarctic expedition, and forms part of the photographic outfit carried by Mr. Cherry Kearton upon his travels. The developing apparatus consists of a rotating cylinder and two or more semi-circular troughs. The film is wound spirally upon the drum, being held in position by means of wire staples, and the apparatus is so designed that the drum with its film can be moved from one trough to the other by the simple movement of a lever. The design of the apparatus ensures economy in the quantity of developer required. Three pints of solution are sufficient to treat 75 feet of film, and the bath can be thrown away when work is finished or bottled for further use.

After washing, the film is wound upon a collapsible drum, which folds into a small space when not in use. The outfit is made of pine, with waterproofed joints, the whole of the woodwork being treated with paraffin wax to render it impervious to the action of chemicals and moisture. When packed, the apparatus, capable of dealing with 50 feet of film, measures 3½ feet in length, by 26 inches wide, and 18 inches deep. The outer packing constitutes the support for the apparatus when in operation.

Waste is absolutely unavoidable in the cinematograph industry, and no matter how carefully operations may be conducted, it is bound to assume impressive proportions. In a travelling expedition the operator records pictures of what he deems to be sufficiently interesting from various points of view—scenic, ethnographic, historical, or merely anecdotal and humorous. When the films are developed and a trial positive is struck for projection before the powers that be, to receive official approbation and sanction to enter the market, the critics in the private projecting room sometimes fail to see eye to eye with the cinematographer, and deem this and that to be lacking in the essentials which render a film attractive to the public. Accordingly, these sections are eliminated. From 300 to 3,000 feet may be destroyed in this manner.

The waste is still greater in the filming of picture plays. Sometimes a scene, occupying 100 or 150 feet of film, will have to be photographed three or four times. I once saw a scene, taking 200 feet of film, recorded six times before it gave satisfaction. It was a picture involving the movements of a large crowd, and in five instances something went wrong at one point or another, despite the fact that rehearsals had been prosecuted with such energy and persistence that at last everything appeared to move with the precision of the wheels of a watch. A thousand feet of film were spoiled in this particular case, which, at an average of 1½*d*. (three cents) a foot, represented a waste of £6 or $30 in film alone. Yet this is by no means an isolated instance; the proportion often approximates 20 per cent.; that is to say, 200 feet out of 1,000 feet are useless.

The bigger the production being recorded, the heavier the waste in this direction.

When the positives have been dried and hardened sufficiently to enable them to be handled, they are sent to a room where the different sections are identified and allotted to their positions in the subjects to which they belong. The sections are joined together, the lengths of film bearing the explanatory sub-titles are inserted in the proper places, and the whole subject, after a final examination, is wound upon a spool ready for the market. The examination of the films is carried out rigorously, those suffering from the slightest blemish or coming below the firm's standard being discarded.

It has been seen from the foregoing that the preparations for developing and printing are somewhat elaborate, and demand expensive apparatus in order to insure the most satisfactory results. These considerations react against the amateur cinematographer. But should one fall a victim to the fascinating glamour of cinematography, one need not apprehend difficulties in connection with developing and printing. There is no necessity to acquire perforators, to establish a complete developing room, or to invest in a printing machine. The majority of cinematograph manufacturing establishments undertake to develop negatives, and to supply positive prints ready for projection at a nominal figure. It is far better to entrust the work to a skilled staff, who can be trusted to handle the film successfully, than to attempt to wrestle with unknown difficulties with a serpent-like film 200 feet long, in the murky gloom of the dark room.