The Twin Polygraph and Strobograph

ULTRA-RAPID CINEMA-PHOTOMICROGRAPHY

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THE process consists primarily of filming rapidly moving micro-organisms by means of intermittent light. The source of light is an open arc-light and the intermittent character is obtained by rotating, at high speed, a suitable disc, pierced by one or several slots, between the arc and the microscope. The number of exposures per second obtained in this way is almost unlimited while the time of each exposure can be made very small. Thus if the disc is rotating at 100 rev. a second, and there are 12 slots in it, the number of exposures will be 1,200 a second. If each slot subtends an angle of 1°, the exposure will be $1/100 \times 1/360 = 1/36{,}000$ sec.

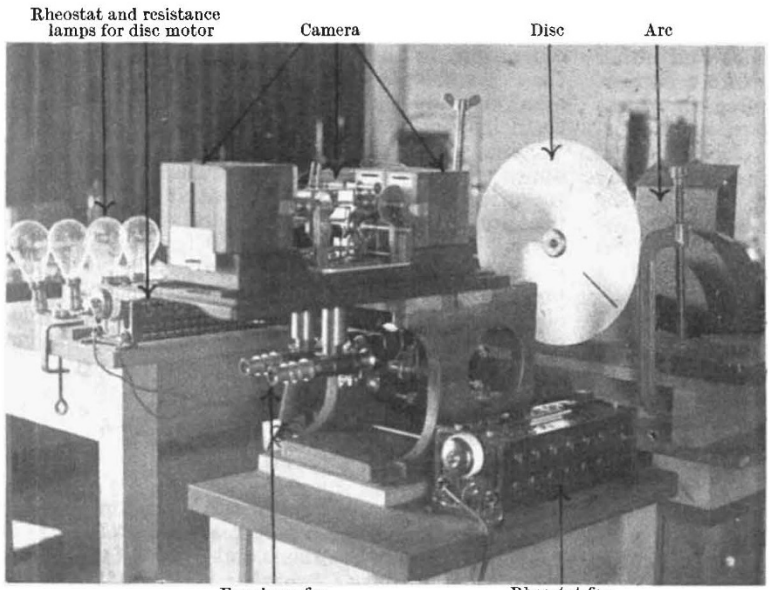

FIG. 1. Twin polygraph and strobograph.

Attached to the eyepiece of the microscope is a suitable cinema camera, and matters are so arranged that it is possible to see the object all the time it is being filmed. Nearly all cinema cameras work on the principle of the intermittent frame, or so that during exposure the film is still and then moves forward one frame; the shutter of the camera cutting off light during the change of frame. In filming micro-organisms this introduces a difficulty, for if an organism gives a spasmodic leap, the critical point is as likely to occur during cut-off as during exposure. In order to overcome this, a microscope is used possessing a single objective but two eyepieces, while the camera is constructed so that a film works in conjunction with each eyepiece, cut-off in one occurring during exposure in the other. Thus so long as the camera is working, continuous exposure is assured.

The next important point is that the speed of the camera is not that of the high-speed disc; the two are worked quite independently by separate motors. The speed of the camera is much lower than that of the disc, so that each frame of film will receive several images (hence polygraph). If the object is still, the images will be superimposed and will coincide, while if the object moves they will be spread over the frame of film.

With certain objects (for example, a cilium or the long antennule of a copepod) it is advantageous to get several images on one frame, and the interpretation and measurement of the movement presents little difficulty, but in other cases it is unwise to get more than three images on one frame.

The process was originally invented for the investigation of limb-movement of minute Crustacea, or ciliary movement, etc., and was not intended for projecting purposes, but in certain cases these *polygraph* films were highly successful when projected. Two such films showing the movement of the ostracod sperms under the highest powers of the microscope were shown in Section D (Zoology) at the Aberdeen meeting of the British Association. For projecting purposes better films are obtained by the *strobographic* process, but such films are only obtainable if the object shows metachronal or rhythmic movements. In this case the high-speed disc carries one slot only and the speed is tuned-in to the object, giving the ordinary stroboscopic effect. The camera is then tuned-in to the disc so that a single frame receives a single image.

The advantages of the method are: (1) the great saving in cost of film; (2) the comparatively low cost of the apparatus (camera, microscope, motors, arc-light and resistances, etc., £350); (3) the large number of exposures per second: (4) the ultra-rapid exposures.

The alternative method of obtaining rapid exposures is by running the film through a camera at a very high rate. This is the principle of the slow-motion camera, and has the disadvantage that when in use film is costing about 3*s*. 9*d*. a second, while the camera itself (without microscope or lighting) may cost anything up to £2,000 or even more. The number of exposures is about 250 a second while the time of exposure is about 1/3,000 sec. Slow-motion films are, however, eminently suitable for projecting purposes. Another disadvantage is that the camera only attains full speed after an interval of 1–2 sec., and about 24 ft. of film is wasted every time the camera is stopped.

In the polygraphic and strobographic processes, speed and exposure depend on the disc only, and this can run continuously without using film. So far, a speed of 24 frames a second has proved ample, and with a twin film the cost is 6*d*. a second, or 3*d*. with a single film. The speed of the disc can be varied and the slots are adjustable, so that the time of exposure, the interval between exposures, and the number of exposures a second can all be adjusted to suit the

object. The camera can be driven at speeds varying from 20 to 120 frames a second, while a single or twin film can be used. At these low rates the camera can be started or stopped practically instantaneously without loss of film, and one can expose either 1 ft. or 100 ft.

The apparatus is somewhat cumbersome, since the arc and high-speed disc must be on separate stands or tables from the camera and microscope, while in high-power work the camera itself with its motor must be insulated from the microscope, otherwise vibration will cause difficulties.

International Congress for Scientific Management

THE International Congress for Scientific Management to be held in London on July 15 and subsequent dates is the sixth of a series which have been held in various European capitals since 1924. The hosts of the Conference are a Council—nominated by a number of societies interested in one phase or other of the management movement, and the technical societies—which has appointed an executive committee composed of outstanding industrial leaders and others with Sir George Beharrell as chairman. The patron is H.R.H. The Prince of Wales. The organisation is in the hands of committees having as chairmen, Dr. E. F. Armstrong, Sir Henry Fowler, Mr. G. R. Freeman, Sir George Courthope, Prof. Winifred Cullis. The genesis of the invitation is the desire both to entertain the delegates in England, to show that Britain has a factory and business organisation fully up to the most modern practice, and to arouse public interest in general in the subject of scientific management.

The work of the Congress is divided into six sections each of which will hold four technical sessions. The sections will deal with development, distribution, educational and training, manufacturing, agricultural and domestic management respectively. At each session, papers falling under a specific heading will be discussed. The papers, of which there are two hundred, in six distinct volumes, are already in type and have been circulated to members: each paper has a summary in three languages. The papers for each session have been summarised by an expert *rapporteur*, which summary alone will be read, leaving the session available for discussions which are to be the main feature of the meeting. Presidents of eminence—in all twenty-four—have been obtained for each session.

The Conference will be opened at noon on July 15 by H.R.H. The Prince of Wales, who is taking a keen interest in it and is expected to speak at some length on particular phases of the subject.

The subject chosen for the first plenary session is the topical one of management problems arising from Government intervention, which is expected to give rise to an illuminating discussion.

The second plenary session will be devoted to consideration of the simplification of data, the place of statistics and the standardisation of terms.

A large number of visits has been arranged to factories and to places of interest for members of the agricultural and domestic science sections.

At the end of the Congress, tours have been arranged in special trains with sleeping cars to enable the overseas visitors to combine the inspection of some of our most famed scenery with visits to some highly organised factories, chosen so as each to illustrate a different phase of the management problem. The social side of the Congress has not been neglected and every opportunity will be given for members to fraternise.

Many of the papers are of outstanding interest and make important contributions to the development of management regarded as an exact science; the authors of the British papers were invited to contribute them by the organising committee as representing the best experience in the particular phases. The information accumulated in the volumes is such that no industrial library can afford to be without them.

It is anticipated that the Congress will have a large, if not a record, membership, but its arrangements have been made as far as possible sufficiently elastic to allow for expansion. There are few in business or wishing to attain managerial rank who are unlikely to profit by attending its deliberations; moreover, every support is deserved by the organisers, who are working on a purely voluntary basis with the sole object of giving testimony to the up-to-date state of British business organisation in every phase of activity.

Intending members should apply immediately to Mr. Harry Ward at 21 Tothill Street, Westminster, S.W.1, so that they may receive the Congress papers in ample time to give them the necessary study.

Fuel Research in Great Britain

THE Fuel Research Station at East Greenwich was open for inspection on June 4, and about 250 guests were received by Sir Harold Hartley, chairman of the Fuel Research Board, and Dr. F. S. Sinnatt, Director of Fuel Research. The whole of the plant was on view, and the work in progress was explained and demonstrated.

Particular interest was taken in the new semi-commercial scale plant for the hydrogenation-cracking of tar to motor spirit. This plant commenced working on March 1, and was on view for the first time. It is designed to deal with 300 gallons of tar or creosote a day. One passage through the plant converts about half the tar to motor spirit, and by recirculating the residue the whole of the tar can be converted, yielding an equal volume of spirit. Demonstrations were given of a new plant for the dry cleaning of coal, while a washery table was preparing 'ultra clean' coal containing less than $1\frac{1}{2}$ per cent of ash, from a commercial coal containing about 5 per cent. The coal survey that is being carried on throughout the coal fields of Great Britain has shown that large quantities of 'ultra clean' coal of various types can readily be prepared if required for special purposes.

The pulverised fuel burners designed at the Fuel Research Station, and now in commercial use, were