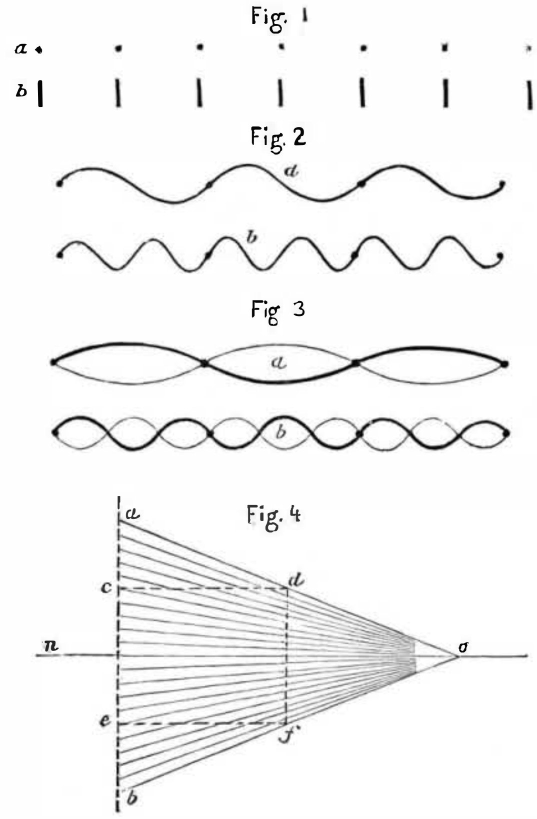
THE CYCLOSCOPE.

The very remarkable apparatus which we are about to describe was invented by Professors McLeod and Clarke, of the Royal Indian Engineering College. It is designed for measuring the velocity of revolution of any kind of machine whatever, and allows the *absolute* speed of the mechanism in motion to be determined at the very moment of observation, and that too with an accuracy that has been hitherto unknown. In order to make the description of the apparatus easier understood, we will state, in a few words, some of the phenomena upon which it is based. Every one knows, or has observed, that if any series of objects whatever are revolving or moving with a certain velocity the eye loses the faculty of distinguishing their outlines; and this is owing to the persistence of impressions upon the retina. Upon this physiological phenomenon are based the "phenakisticope" and other similar toys. Now, then, let us suppose that a certain number of points (Fig. 1, *a*) are examined in a mirror fastened to one of the prongs of a tuning fork. When the latter is set in vibration, these points, by reason of the phenomenon above mentioned, will appear to us like so many lines (Fig. 1, *b*). Now let us place these points (which we will suppose to be equidistant) on the diameter of a cylinder, and let us cause the latter to revolve with a uniform motion. If we arrange our tuning fork so that the vibrations will occur in a direction parallel to the cylinder's axis of revolution, the points will then appear to us in the form of a sinuous line (Fig. 2, *a*) or wave, and the height of this wave will naturally depend upon the amplitude of the vibrations, while its length will vary with the velocity with which the cylinder revolves. It will be readily understood that if a certain relation exists between the period of the tuning fork and the speed of the cylinder, the wave will appear stationary. Nothing is easier than to determine the conditions which are necessary for the formation of a stationary wave. In fact, if, for example, the velocity of the points is such that the time taken by each of them in traversing a space equal to the distance which separates them, is equivalent to the duration of *one* complete vibration of the tuning fork, a stationary line will appear (Fig. 2, *a*). If, on the other hand, the time employed by each point to pass over a space equal to *two* intervals is again equivalent to the duration of one complete vibration, the wave traced by the image of each point will meet the adjacent point; and, as each point will trace a wave of its own in space, these waves will be superposed and form a double one (Fig. 3, *a*). Each of these waves may, through a change of length, vary as to its form In fact, if we apply to the tuning fork the same reasoning that we have applied to the points, that is to say, if we suppose the duration of the vibrations is changed in some manner, waves like those represented in Fig. 2, *b*, and Fig. 3, *b*, might appear. Theoretically we might obtain for each wave an infinite number of waves of like order.

Now let us see how this phenomenon can benefit us in estimating, for example, the speed of a revolving cylinder. For this, let us suppose that our points are 100 in number, and that they are placed at equal intervals. Let us take a tuning fork making 60 complete vibrations per second; then let us examine our points, and let us, moreover, suppose that a *stationary* wave (similar to that represented at Fig. 2) appears to us; then it is very evident that 60 *points per second* (or 3,600 per minute) will pass before the mirror. But for *one* turn of the cylinder 100 points will have to pass before the mirror, so the velocity of the cylinder is then equal to $\frac{3600}{100}=36$ revolutions per minute. The least change in the speed of the cylinder will give an apparent translatory motion to the wave; and, if the velocity is too great, the wave will move in the same direction as the points, but if too little it will move in the opposite direction. This very simple experiment is the fundamental base of the "Cycloscope," which it now remains for us to describe.

If upon the cylinder we had but one series of points, a single rate of speed might produce the wave that we should have chosen to determine its velocity; but if we place a series of dotted rings side by side, the number of points varying in each, it is very evident that in order to obtain the same wave on examining the points of one of these rings, it would be necessary to give the cylinder different rates of speed. Nevertheless, it would be practically next to impossible to place such a series of dotted rings upon a cylinder. Fig. 4 shows the ingenious means employed by the inventors to overcome this difficulty. Upon a sheet of paper are traced a series of lines all converging to a point, *o*, and passing through equidistant points marked off on the line, *a b* (these lines are usually white on a blue ground); this done, a parallelogram, *c d e f*, is cut out equal to the superficial area of the cylinder and glued upon the latter. The distance from the point, *o*, to the line, *a b*, as well as the number of points between *c* and *e*, are determined by a very simple calculation. If we now examine these lines, not as before in a mirror, but through a slit cut in a thin sheet of metal or cardboard, all the abovementioned phenomena will exhibit themselves exactly in the same manner; and, moreover, from a single inspection of Fig. 4 it will be readily seen that these lines act the part of an infinite series of equidistant points, and that consequently we shall be able to determine all the velocities that are possible between the extreme ones determined by *e c* and *d f*. These lines possess another important property: if we trace lines parallel to *e c* they will cut the oblique ones at a great number of points proportional to their distance from the line, *e c*. If, for example, the side, *e c*, is equivalent to 60 revolutions of the cylinder, and the



THE CYCLOSCOPE.

side, *d f*, to 20, the line which divides *e f* and *c d* into two equal parts will mark the position that must be occupied by the slit through which it will be necessary to examine the lines in order to obtain the stationary wave when the cylinder is revolving at a velocity of 40 revolutions per second. The wave generally adopted is the one of the second order (Fig. 3, *a*), as being the easiest to recognize.

Fig. 5 represents the cycloscope as it is now constructed. At B we see the cylinder with its paper covering. The wheel, R, serves to put it in communication with the machine whose rotary speed is to be measured. The movable box contains a reed or vibrating lance, which performs the functions of a tuning fork, and to which is fastened a small plate of zinc, in which there is a slit about equal in width to the breadth of the lines traced upon the cylinder. The lance vibrates 60 times per second. The small toothed wheel, E, and the wheel, D, being situated upon the same axis with the box, A, the latter can, by simply turning the wheel, D, to the right or left, be moved to any position in front of the cylinder. At S is an opening through which the lines are examined; it contains a lens for the purpose of magnifying the images. When the apparatus is to be operated the plate is caused to vibrate by means of a small bellows, the tube of which is seen at C C′. The box, A, carries an index by means of which the speed is read upon a graduated scale. Supposing that the cylinder is revolving and that we wish to learn its speed, we place the eye at S, and with the right hand turn the wheel, D, until we meet with the stationary wave which has served to determine the divisions; the index, O, will then point to the figure that indicates the speed. The graduated scale has also been arranged by Professor McLeod so that the speed can be read off without removing the eye from S.

By means of the cycloscope we can ascertain the minutest variations in velocity, and learn thereby that the most perfect machines, no matter how well regulated they may be, are constantly subject to variations. The services that such an apparatus may render are numberless, and, as Sir William Thomson has well said, Professor McLeod has here given us a more sensitive and more perfect measurer of time than that which we possess in the best made chronometer.—*La Nature.*

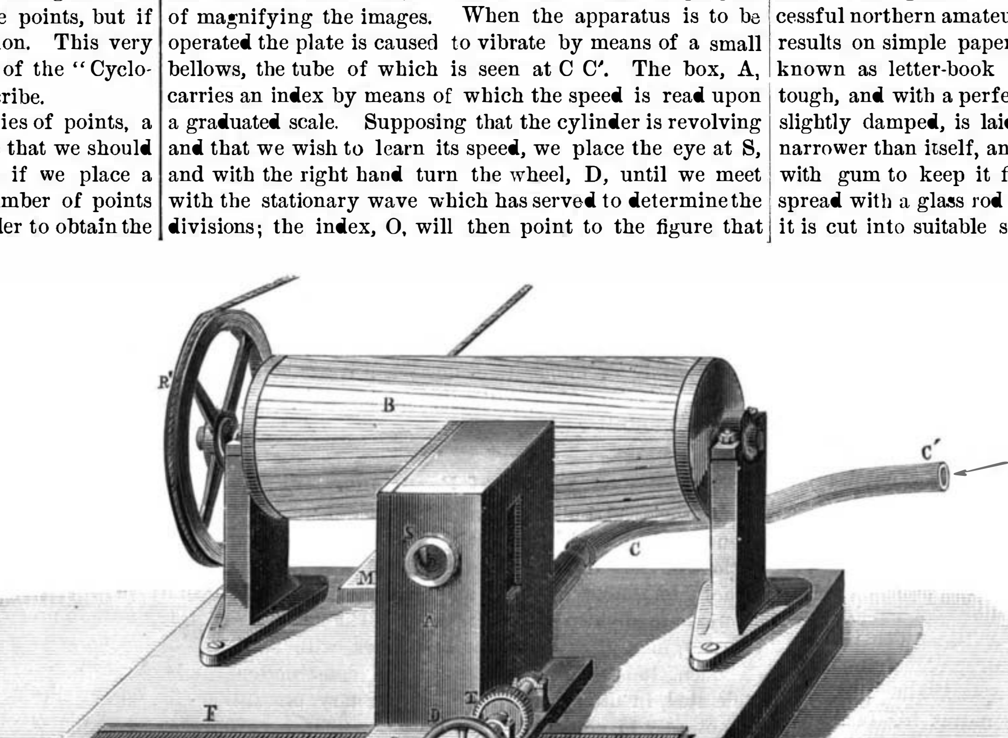


Fig. 5.—THE CYCLOSCOPE.

ARSENIC IN WATER COLORS.

According to the *Chemiker-Zeitung*, M. Fleck, in searching into the causes of the death of a young engineer, found in the corpse remarkable quantities of arsenic, the origin of which he attributed to the water colors which the deceased had been in the habit of using; for, on an analysis, he found that a specimen of sepia contained 2·08 per cent of arsenious acid; one of terra di Sienna, 3·14 per cent, and one of red brown, 3·15 per cent. The deceased engineer having been in the habit of drawing his brush, charged with the color, through his lips, it is not impossible that the arsenical colors were absorbed by degrees in the saliva. M. Fleck was then led to make a profounder study of the subject, and with the following result:

The dark colors of French make usually have an iron base; when they are dissolved in water they give a colorless liquid most generally containing no arsenic, while the residue left on the filter contains the organic matter combined with iron and mixed with arsenious acid. Some of the darker colors, marked "chenal," and "Paris et Richard," gave the following quantities of arsenic: Colored sepia, 1·10 per cent; natural sepia, 0·98 per cent; burnt sienna, 1·76 and 2·23 per cent; Van Dyke brown, 0·81 per cent; brown ocher, 0·52 per cent; sap green, 0·82 per cent; bister, 0·67 per cent; Indian red, terre de Cassel, burnt umber, raw umber, each 0·5 per cent.

Among the water colors known under the name of "Hornemann's technical colors," which were submitted to analysis, brown ocher and sepia contained only traces of arsenic, while terra di Sienna showed 1·19 per cent. It might be perhaps inferred that because oxide of iron has been successfully employed as an antidote to arsenic, and because arsenite of iron is not poisonous of itself, the arsenic contained in water colors in the form of arsenite of iron could exert no injurious influence on the health. But this would not be so unless the arsenite of iron were accompanied by ferric hydrate and magnesia in a free state (as happens when iron is exhibited as an antidote), since these substances neutralize the acid juice of the substance and thus prevent the decomposition of the arsenite of iron formed. When the latter comes in contact with the gastric juice without being protected by a base, the hydrochloric acid of the juice destroys the arsenite of iron introduced with the color and sets the arsenious acid free.

Negatives on Paper.

The success which has followed the practice of the gelatino-bromide process and the easy character of its manipulation have revived the desire for a substitute for glass as a support for the sensitive film. The Rev. H. J. Palmer has already shown good work on a gelatine film, and several operators have been more or less successful with various substances; but we want something simpler and less troublesome before glass can be dispensed with. One of our successful northern amateurs is at present getting pretty good results on simple paper. The kind he at present prefers is known as letter-book paper—a variety extremely thin but tough, and with a perfectly smooth surface. A roll of this, slightly damped, is laid on a perfectly level board a little narrower than itself, and the edges folded over and fastened with gum to keep it flat. The emulsion is poured on and spread with a glass rod in the ordinary manner. When dry it is cut into suitable sizes and exposed between plates of glass, as was the case with waxed paper. So far the results are promising, and I have little doubt that some such arrangement will ultimately be found in every way satisfactory for all outdoor work. It is probable that a previous coating of rubber in benzole, as suggested by me a number of years ago, might be an advantage by keeping the emulsion on the surface. Should simple paper be found to answer, as I have little doubt it will, some of our enterprising manufacturers will soon be sending it into the market in rolls similar to carbon tissue, as it may be made by the same apparatus and in exactly the same way by simply substituting the sensitive emulsion for the pigmented gelatine. In addition to the advantages of lightness and non-liability to break, there will be the further and, to many, greater advantage of reduction

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