the whole country will be compelled to adopt it, so great is the saving in time and cost. In commencing a bleachery, the cost of plant by this system is, I understand, less than by the old processes.—*Textile Colorist*.

INSTRUMENTS FOR DRAWING CURVES.

By Prof. C. W. MACCORD, Sc.D.

I. THE HYPERBOLA.

We are free to express the opinion at the outset, that for various reasons the draughtsman is likely to gain very little advantage by the use of mechanical devices for describing mathematical curves by continuous motion. Such instruments are as a rule not only complicated and expensive, but cumbersome and difficult of adjustment. It may be suggested, *per contra*, that these objections do not apply to the fami-

liar combination of two pins and a string, for tracing the "gardener's ellipse." But we question the propriety of classing a string among strictly mechanical devices; it has its uses, to be sure, but in respect to perfect flexibility and inextensibility it cannot be relied on when rigid accuracy is required in drawing any of the conic sections.

Nevertheless, the construction of such apparatus affords a study which to some is fascinating, and even in the abstract is not devoid of utility. In each case a definite object is presented, and usually a choice of methods of attaining it; success requires a thorough knowledge of the properties of the curve in hand, while ingenuity is stimulated, and familiarity with expedients is cultivated, by the effort to select the most available of those properties, and to arrange parts whose motions shall be in accordance with them. Such exercise of the inventive faculties, then, is good training for the mechanic. And it must not be forgotten that a mechanical movement thus devised for one purpose very frequently is either itself applicable to a different one, or proves to be the germ from which are developed new movements which can be made so; the solution of one problem sometimes furnishing a hint or clew of great value in dealing with another.

FIG. 1.

The apparatus as thus represented does not at first sight appear unduly complicated. But in order to render it adjustable, so that hyperbolas of varying eccentricities and on different scales may be drawn with it, several parts not here shown must be added. A frame must be provided, in which to arrange supports for the pivots at F and F', and these supports connected by a right and left handed screw, or equivalent means of altering the distance between the foci; the crank CI and the socket F'G must be of variable length, and these in each case would require to be carefully adjusted. So that, as we stated in the beginning, it is questionable whether a draughtsman of ordinary skill could draw the curve any more readily by the aid of such a piece of mechanism than he could without it; but it may claim a passing notice as a novel device, and the first one, we believe, for describing the hyperbola by a combination of rigid parts.

EXPERIMENTS WITH FIBERS.

By Dr. THOMAS TAYLOR.

As Microscopist of the United States Department of Agriculture, I am frequently called upon to make investigations as to the character of textile fibers and fabrics, not only for the public generally, but also for several departments of the Government.

Textile fibers are presented both in the raw and as articles of manufacture. In the latter case they may have been dyed, stained, or painted. It is obvious that under these conditions the fibers should be subjected to chemical reaction to bring them as nearly as possible to their normal condition.

Considering how well the structures of the common textile fibers of commerce—cotton, flax, ramie, hemp, jute, Manila hemp, silk, and wool—have been investigated and minutely described by able and exact microscopists, I will in this paper confine myself chiefly to such experiments as I have personally made with textile fibers, treating them with chemical agents while under the objective.

While I am aware that this method is not wholly new, I am satisfied that comparatively little work has been done in this direction, and that a wide field is still open for future research.

As microscopists, we have to fortify ourselves in every way that will sustain, by truthful work, the value of the microscope as a means of research, sometimes conducting our experiments under the most trying circumstances. Fibers may be so treated by experts as to make it difficult to determine how their changed appearance has been effected, and it may happen this age of experiment and of fraud that important decisions in commercial transactions and in criminal cases may depend on our observations.

DETECTION OF A FRAUD.

A case in point will illustrate this. While Dr. Dyrenforth was chief of the chemical division of the U. S. Patent Office, a person applied for a patent on what he called "cottonized silk," inclosing specimens. He claimed that he had discovered a mode of covering cotton fiber with a solution of silk which could be woven into goods of various kinds; in order to satisfy the public of the reality of his invention, he placed on exhibition, in various localities, specimens of silk-like goods in the form of ribbons in the web and skeins of thread, representing them to be "cottonized silk."

Dr. Dyrenforth was not satisfied that the so-called discovery was an accomplished fact, and he forwarded

a few fibers of the material to the division of which I have charge for investigation. I subjected them to my usual tests, and found them to consist of pure silk, and I so reported to Dr. Dyrenforth, who rejected the application for a patent. The microscope was thus usefully employed to protect capitalists from imposition.

METHODS EMPLOYED.

It may be well to state briefly the methods I employed in detecting the real character of the material. The fibers were first viewed under plain transmitted light, secondly, polarized light and selenite plate. Since silk and cotton are polarizing bodies, "cottonized silk," if such could be made as described, would give, in this case, the prismatic colors of both fibers, and the complementary colors would differ greatly because of the great disparity of their respective polarizing and refractive powers.

The fact will be observed that a cotton fiber presents the appearance of a twisted ribbon when viewed by the microscope, while silk, owing to its cylindrical form, cannot twist on itself. It should also be considered that the diameter of "cottonized silk," so called, would be greater than that of a fiber of silk, because the silk solution would have to be applied to an actual thread of cotton, and not to a single cotton fiber, by reason of the shortness of the original hairs of the latter. Were a single fiber of such a combination put under a suitable objective, and a drop of nitric acid brought in contact with the fiber, it would be seen that the acid would destroy the silk and leave the fibers of cotton untouched, the latter being insoluble in cold nitric acid. The action of muriatic acid is similar in this respect. Were a fiber of cotton present and a drop of pure sulphuric acid placed on it, followed quickly by a drop of a transparent solution of the tincture of iodine, a peculiar change in the fiber would take place, provided the right proportion of acid be used. Cotton fiber, and especially flax fiber, under such conditions, forms into disks or beads of a beautiful blue color.

Fig. 1 represents a cotton fiber, and 2, 3, 4, 5 those of flax, as they appear under the acid treatment. Every textile amylaceous fiber is convertible into these forms, more or less, by strong sulphuric acid. The fibers of cotton, flax, and ramie are examples of amylaceous cellulose, that is to say, these fibers are converted to starchy matter by treatment with the last-named acid. Therefore combinations of these fibers in any composition of non-amylaceous fiber (lignous or woody fiber) will be dissolved, leaving the latter unharmed; the woody fibers remaining will prove suitable objects for examination under the microscope.

COTTON MIXED WITH LINEN.

Again, it might be important to know whether a certain pulp or composition contained flax in combination with cotton. The composition might be of such a well-digested character as to destroy all appearance of normal form, that is to say, the "twisted ribbon" character of cotton, as well as that of the cylindrical and jointed characteristic of flax, might be lost to ordinary view. In this case make a watery solution of the pulp, spread it out thinly on a glass slide 3 inches by one, draw off any superfluous water, then add one or two drops of a strong solution of chromic acid to the preparation, and place over it a glass cover; when viewed by the microscope, any portion of the flax joints present will appear of a dark brown color; a solution of iodine has a similar effect. The brown portions of the joints are nitrogenous in character; cotton fibers are devoid of nitrogen.

EXPERIMENTS WITH FLAX.

A chemist of the Department of Agriculture had once occasion to make experiments with flax fibers, his

1 2 3 4 5

FIG. 2.

We proceed, then, to describe a few instruments of this kind, which we believe to be new, in the hope that in the manner just pointed out they may render a greater service than that for which they are directly intended.

The first of these, shown in Fig. 1, is for the purpose of describing the hyperbola. The properties of the curve, upon which the action of the instrument depends, are illustrated in Fig. 2, where MM, NN, are the two branches of an hyperbola; C the center; AB the major axis; F and F' the foci. If now a tangent TT be drawn at any point as P of either branch, and a perpendicular let fall upon it from the nearer focus F be produced to cut at G a line drawn from P to the farther focus F', then this perpendicular will cut the tangent at a point I upon the circumference of a circle described about C upon AB as a diameter, and also the distance F'G will be equal to AB.

In Fig. 1, then, we have a crank CI, whose radius is equal to CB, half the major axis, turning about a fixed center C. Upon the crank-pin I is hung, so as to turn

object being to make them chemically pure; and to this end he treated them with excess of bleaching agents, thus rendering them of a beautiful white, silky appearance, to the naked eye; but when I examined them under the microscope, I found the brown nitrogenous matter of the joints still present, and on using the chromic acid test, they became deeply stained. A chemical solution of flax therefore would prove for some purposes undesirable, owing to the presence of this lignous matter. A chemical solution of cotton which is destitute of lignous matter will give a chemically pure solution. Cotton is therefore better adapted than flax for collodion compounds.

WOOL TESTED WITH ACID.

It is known that when wool is treated with the sulphuric acid of commerce or in strong dilute sulphuric acid, the surface scales of the fiber are liberated at one end, and appear, under a low power, as hairs

proceeding from the body of the fibers. Wool may remain thus saturated in the acid for several hours, without appearing to undergo any further change, as far as is revealed by the microscope. When treated in mass in a bath of sulphuric acid, strength 60° B., for several minutes, and afterward quickly washed in a weak solution of soda, and finally in pure water and dried, it feels rough to the fingers, owing to the separation of the scales. I have preserved a small quantity of wool thus treated for the last twelve years, my object being to ascertain whether the chemical action to which it was exposed would impair its strength. As far as I can observe, without the aid of the proper tests, it seems to have retained its original tenacity. Wool thus treated seems to possess the property of resisting the ravages of the larvæ of the moth. This specimen, although openly exposed for the period named, suffered no injury from them. Under the microscope, the lubrications appear to have resumed their natural position, and appear finer.

From these experiments it would seem not improbable that a new article of commerce might be produced from wool thus treated, considering that it seems to be moth-proof.

I find in practice that when sable brushes are washed in a weak solution of pure phenic alcohol and afterward in warm water, the moth worm will not eat them. In this way I preserve sable brushes. I mention this chemical fact because it shows that a change of this material is brought about by the phenol as to its edibility, and this may explain why wool treated with sulphuric acid is rendered moth-proof.

I find that when brain matter has been subjected to a solution of weak phenic alcohol, weak alkaline solutions afterward applied fail to separate its nerve-cells on the process of maceration. (This is probably owing to its albuminoids being coagulated by the action of the phenol.) When brain matter is subjected to a weak solution of soda alone, the nerve-cells are easily separated by maceration, and well adapted for microscopic use.

TESTS OF DYED BLACK SILK.

The fibers of dyed black silk may be viewed with interest under the microscope. If a few threads of its warp are placed on a glass slide, and one or two drops of concentrated nitric acid placed in contact with them, the black color changes first to green, then to blue; a life-like motion is observed in all the fibers; they appear marked crosswise like the rings of an earthworm; the surface of each fiber appears loaded with particles of dye-stuff; finally the fibers wholly dissolve in the acid. If we now treat a few threads of the weft in the same manner, a similar change of color takes place. When the fibers assume the blue color, a dark line is observed in the center of each, running longitudinally the whole length; this dark line is doubtless the dividing line of the two original normal threads formed directly by the two spinnerets; the dark air line or shadow finally breaks up, and in the course of a few minutes the silk is wholly dissolved. Were ramie, cotton, flax, or hemp present, they would be observed, as all their fibers remain unchanged under this treatment. If wool be present, rapid decomposition will follow, giving off copious fumes of nitrous acid, allowing, however, sufficient time to observe the separation of the scales of the fibers and to demonstrate by observation under the microscope that the fibers are those of wool.

In making these experiments it is not necessary to use a glass disk over the treated fibers. If a disk or cover is pressed on them while undergoing this treatment, the life-like motion of the silk will not be so apparent.

IMPROVED PYROMETER.

MR. JOHN FREW, Langloan Iron Works, Coatbridge, has been successful in perfecting a most ingenious pyrometer, an instrument which is capable of continuously indicating every variation of temperature with a remarkable degree of correctness. This instrument, which we here illustrate, has already become known to a number of proprietors and managers of blast furnaces; and on the occasion of the members of the Iron and Steel Institute visiting Coatbridge, in connection with the meeting of that body which was held in Glasgow last autumn, many persons became interested in its construction and in the practical determination of blast temperatures by its readings. Furthermore, Sir William Thomson has expressed himself as being highly delighted with it on account of the manner in which its use illustrates various beautiful scientific principles.

The leading principle on which the construction of this pyrometer has been based is the well-known law of the expansion of gases. Referring to our engraving, it will be seen that at A is a pipe through which air from the cold blast main is admitted into another and larger pipe, B, which reaches nearly to the bottom of a water cistern, C. By means of the inlet and outlet pipes, D and E, the height of the water in the cistern is maintained at a uniform level. In this way there is provided a head of water which retains within the pipe, B, a constant pressure of air, equivalent to the head of water between the open end of that pipe and the overflow at E. Any excess of pressure is prevented by means of the open-ended pipe, which permits the air to escape by the central tube. This latter prevents the agitation caused by the upward rushing air from disturbing the level of the water in the cistern; and in order further to assist this, the central tube is filled loosely in its upper part with lead bullets or other suitable materials supported on a perforated plate. The water level in the cistern is indicated by means of a glass gauge, which is represented at G. To the upper end of the pipe, B, another pipe, H, is attached. This is required for conveying the cold air to the pyrometer proper, for the piece of apparatus above described is simply an arrangement for securing a flow or current of air at constant pressure.

At any point where it is desired to fix a pyrometer, a connection is made with the pipe last spoken of, by means of a small pipe such as is indicated at J, into which is fixed a platinum or other metallic nozzle of small bore, as shown at K. To this same pipe there is attached a solid-drawn copper spiral heater or worm, L, which is fixed into the place or the material the temperature of which it is desired to indicate. Into the outlet of this worm another similar but larger

nozzle, M, is fixed. At N is shown a small pipe which is connected with the pipe, J, at any convenient point between the inlet nozzle, K, and the spiral heater, L. The other end of this pipe passes through the India rubber stopper of a small cistern or bottle, O, which, when in use, is about two-thirds filled with a colored liquid. It will be seen that the tube, N, only passes through the stopper, so that it may convey pressure to the surface of the liquid. At P is a glass tube which also passes through the stopper and then to the bottom of the colored liquid; and as its upper end is open, any variation of pressure in the spiral heater is directly transmitted to the indicating column of colored liquid.

The operation of the instrument is as follows: As the cold blast used in the apparatus would be useless for the working of the pyrometer if taken direct from the cold blast main, owing to its irregularity of pressure, the regulator that has been described is employed, and by its means an absolutely steady flow of cold blast air at an unvarying pressure is secured. The diameters of the inlet and outlet nozzles are so nicely adjusted that, so long as both are at the same temperature, the outlet nozzle, which is open to the atmosphere, will pass all the air that the inlet nozzle can deliver without disturbing the pressure in the cistern, O; but if heat be applied to the circulating air through the walls of the spiral heater, the air expands in volume, and is unable to pass through the outlet nozzle in its heated condition as rapidly as it is delivered cold by the inlet nozzle. The consequence is that an increase of pressure takes place in the apparatus between the two nozzles, and it is this pressure that indicates the amount of heat that the air has taken up from the hot blast pipe, in which the spiral heater is fixed. Then, again, as this pressure is directly transmitted to the indicating liquid in the cistern and the vertical tube immersed in it, a rise takes place in the column which is in exact propor-

FREW'S PYROMETER.

tion to the expansion of the current of blast passing through the spiral heater.

The method of graduating the indicator scales of the Frew pyrometer is worthy of special notice. When the apparatus is fitted up, and before it is permanently fixed in position, the spiral heater is placed in cold water of known temperature, and the point noted at which the colored liquid stands in the indicator tube. The water is then boiled, and the rise in the liquid in the tube is again noted. Suppose, in the first instance, the cold water temperature to be 62 deg. Fahr., and that, from this point up to 212 deg. Fahr., the liquid to have risen $2\frac{1}{2}$ in. in the tube; this is equal to $1\frac{1}{2}$ in. per 100 deg. Fahr., and from these data a scale is constructed, the correctness of which is easily verified by transferring the spiral heater into an air bath or oil of high boiling point, and then comparing the readings of the pyrometer scale with those of a mercurial thermometer placed alongside of the spiral heater. By this means it can be clearly demonstrated that, up to the highest point to which it is safe to use a mercurial thermometer, the readings of the pyrometer scale and that of the thermometer are identical.

While this pyrometer is particularly valuable for indicating the temperature of hot blast stoves of every description, there are doubtless many uses that will suggest themselves to persons engaged in various industrial arts and manufactures. The apparatus is neat and substantial in its parts, while it occupies very little space, is not at all liable to derangement, and is entirely automatic in its action. A number of the instruments have been in continuous use at the Langloan Iron Works, with the most satisfactory results, for about eight months. The temperatures they are graduated for vary according to the furnaces with which they are connected and the kind of work to which these are applied.—*Engineering*.

An exchange gives the following very simple way of avoiding the disagreeable smoke and gas which always pours into the room when a fire is lit in a stove, heater, or fireplace on a damp day: Put in the wood and coal as usual; but before lighting them, ignite a handful of paper or shavings placed on top of the coal. This produces a current of hot air in the chimney, which draws up the smoke and gas at once,

[FROM PHOTOGRAPHISCHE CORRESPONDENZ.]

ORTHOCHROMATIC PLATES.

By CH. SCOLIK.

SINCE the emulsion process has taken root, no improvement has awakened such a lively, steadily increasing interest as photography of colored objects in their correct tone proportions; a process which makes it possible to reproduce the warmer color-tones, particularly yellow, orange-red, and yellow-green, in their correct light value as they appear to the eye.

In professional circles, as also among the public, the value of this invention cannot possibly be underestimated; an invention with which a new epoch in photography may begin, and by which the handsomest results, particularly in reproductions of oil paintings, can be attained. But in portraiture, as well as in landscape photography, recourse must also be had to orthochromatic plates to obtain effective pictures, particularly as plates can now be produced in which the relative sensitiveness closely resembles that of the ordinary emulsion plate. Although a good deal has been written about this subject, none of these sometimes excellent treatises contains a complete and generally comprehensive formula for the production of color-sensitive plates, and this circumstance causes me to publish my own experiences.

The following coloring matters are particularly recommended in the several publications as preferable:

Eosine yellow and eosine blue shade, iodine cyanin, erythrosine, methyl violet, aniline violet, iodine green, azalein, Hoffmann's violet, acid green, methyl green, rose bengal, pyrosine, chlorophyll, saffrosine, coralline, saffranine, etc.

Particularly important is the correct concentration. The most excellent color matters make the plates oftentimes quite useless by an incorrect proportion of con-

centration. If this should be too strong, the total sensitiveness will sink (decrease); but when too weak, the color sensitiveness is much reduced.

This fault, particularly, cannot be corrected during washing, but I have mentioned, at the end, how such overcolored emulsion can be made of use before wetting (flowing).

By the addition of some coloring matter to the emulsion, the light sensitiveness of the film toward some individual colored rays is increased, but the sensitiveness for the stronger refractive rays is, as a rule, generally reduced. The result is a loss of the total sensitiveness for white light. Color-sensitive plates are therefore less sensitive to light than ordinary plates of the same origin.

The action of the coloring matter depends also very essentially upon the emulsion. If the emulsion contains iodide of silver, it has a greater sensitiveness for light blue and blue-green light. At all events, the iodide combination must not amount to more than one or two per cent., a small quantity of iodine acting much better upon the total sensitiveness of the plates than can be obtained by pure bromide of silver emulsion.

Methyl violet, rose bengal, and azalein act perceptibly in 100000 per cent. upon yellow sensitiveness. Eosine and its varieties, eosine yellow shade, or eosine J, pyrosine J, erythrosine yellowish, may all be noted as very good sensitizers for green, yellow-green, and eventually for yellow. The bluish shades of eosine colors, on the contrary, have an absorption band further in the yellow. This is also the case with the blue shade eosine (eosine B) and the most bluish of all eosines, the bengal rosa. Of both eosines, yellow shade and blue shade, the latter gives a little more intensity.

Although the eosine permits a large limit in the quantity, it will reduce the sensitiveness greatly in larger quantity.

If eosine solution is mixed with bromide of silver emulsion, which is entirely free from nitrate of silver, no eosine silver can form; it acts, therefore, only as an optical sensitizer.

Of the several kinds of cyanin, chlorosulphate, nitrate, and iodide, the latter acts best, as stated by Eder.

Schumann has already said that one drop of cyanin solution, 1 to 2,500 to 6½ c. c. emulsion, already acted as sensitizing in orange; five to ten drops cyanin, 1 to 1,500 to 15 c. c. emulsion, even gave red action.

There are two ways to color the gelatine film with a suitable coloring matter: by mixing the latter directly before filtering into the ready made emulsion, to produce at once colored plates; or to bathe the dry emulsion plates for one to five minutes in a solution containing the sensitizing coloring matter. The plates have previously to be soaked for a few minutes, whereupon they are bathed in an aqueous alcoholic solution (with eosine yellow shade and eosine blue shade, in a solution of 1 to 3,000; but with cyanin in a diluted solution of 1 to 5,000). A mixture of $\frac{1}{10}$ cyanin and $\frac{1}{10}$ eosine yellow shade (of above concentration) acts as a very favorable sensitizer. Lohse recommended bathing of the gelatine plates in a solution of 0.03 eosine and 10 c. c. ammonia in 100 parts of water. He found that very diluted eosine solutions, 1 to 20,000, acted as a yellow sensitizer.

After washing, the plates have to be rinsed and dried—colored plates, as long as they remain moist, being less sensitive than dry ones, and very seldom the reverse.

This bathing of the ready made plates may give good results, but pure and faultless plates are very seldom obtained, wherefore the first mentioned manner (direct addition of color to the emulsion) is to be preferred.

After the experiments made by me, eosine mixtures acted equally in the yellow and blue shade; likewise mixtures of cyanin $\frac{1}{10}$ and eosine yellow shade $\frac{1}{10}$ were the most favorable. The process with eosine under-