kilogrammers. Besides, the pulley shaft actuates a revolution counter, and a clock measures the time employed in the experiment. In order to obtain a simultaneous starting and stopping point for all these apparatus, they are connected electrically, and, through the maneuver of a commutator, are all controlled at once. The electric current is furnished by two series of bichromate batteries.

The tests of traction machines are effected by means of a three-wheeled vehicle carrying a dynamometer. The front wheel is capable of turning freely in the horizontal plane, and the dynamometer is mounted upon a frame provided with a screw that permits of regulating its position according to the slope of the ground. The method of suspension of the dynamometer allows it to take automatically the inclination of the line of traction without any torsion of the plates. There are two models of this vehicle, one designed to be drawn by a man, and the other by a horse.

The station is provided, in addition, with registering pressure gauges, a large double dynamometric indicator, a counter of electricity, balances of precision, etc.

An apparatus designed for measuring the rendering of presses is now in course of construction.

Although the station has been in operation only from the 1st of January, twenty-five machines have already been presented to be tested.—*Extract from Le Genie Civil.*

WATER SOFTENING AND PURIFYING APPARATUS.

WE have recently had brought under our notice a system of water and sewage purification which appears

WATER SOFTENING AND PURIFYING APPARATUS.

to possess several substantial advantages. Chief among these are simplicity in construction and operation, economy in first cost and working and efficiency in action. This system is the invention of Messrs. Slack & Brownlow, of Canning Works, Upper Medlock Street, Manchester, and the apparatus adopted in carrying it out is here illustrated. It consists of an iron cylindrical tank having inside a series of plates arranged in a spiral direction around a fixed center, and sloping downward at a considerable angle outward. The water to be purified and softened flows through the large inlet tube to the bottom, mixing on its way with the necessary chemicals, and entering the apparatus at the bottom, rises to the top, passing spirally round the whole circumference, and depositing on the plates all solids and impurities.

All that is needed in the way of attention, even when dealing with sewage, or the most polluted waters, is stated to be the mixing in the small tanks the necessary chemical reagents, at the commencement of the working day; and at the close of the day the opening of the mud cocks shown in our engraving, to remove the collected deposit upon the plates. For the past six months this system has been in operation at a dye

works in Manchester, successfully purifying and softening the foul waters of the river Medlock. It is stated that 84,000 gallons per day can be easily purified by an apparatus 7 feet in diameter. The chemicals used are chiefly lime, soda, and alumina, and the cost of treatment is stated to vary from a farthing to twopence per 1,000 gallons, according to the degree of impurity of the water or sewage treated.

The results of working at Manchester show that all the visible filth is removed from the Medlock's inky waters, besides which the hardness of the water is reduced to about 6° from a normal condition of about 30°. The effluent is fit for all the varied uses of a dye works, and is stated to be perfectly capable of sustaining fish life. With results such as these the system should have a promising future before it in respect of sewage treatment, as well as the purification and softening of water generally for industrial and manufacturing purposes.—*Iron.*

THE TRISECTION OF ANY ANGLE.

By FREDERIC R. HONEY, Ph.B., Yale University.

THE following analysis shows that with the aid of an hyperbola any arc, and therefore any angle, may be trisected.

If the reader should not care to follow the analytical work, the construction is described in the last paragraph—referring to Fig. II.

Let $abcd$ (Fig. I.) be the arc subtending a given angle. Draw the chord ad and bisect it at o . Through o draw ef perpendicular to ad .

We wish to find the locus of a point c whose distance

In this equation the x' terms should disappear.

$$\therefore -6Ex' - 2Dx' = 0$$

$$\therefore E = -\frac{D}{3}$$

That is, the distance from the origin o to the new origin or the center of the hyperbola o' is equal to one-third of the distance from o to d ; and the minus sign indicates that the measurement should be laid off to the left of the origin o . Substituting this value of E in equation II., and omitting accents—

We have

$$y^2 - 3x^2 + 2Dx - \frac{D^2}{3} + D^2 - 2Dx + \frac{2D^2}{3} = 0$$

$$\therefore y^2 - 3x^2 = -\frac{4D^2}{3}$$

This is the equation of an hyperbola referred to its center o' as the origin of co-ordinates. To write it in

the ordinary form, that is in terms of the transverse and conjugate axes, multiply each term by C , i. e.,

Let $\sqrt{C}$ = semi-transverse axis

$$\text{Thus } Cy^2 - 3Cx^2 = -\frac{4CD^2}{3} \quad \text{[III.]}$$

When in this form the product of the coefficients of the x^2 and y^2 terms should be equal to the remaining term.

That is

$$3C^2 = -\frac{4CD^2}{3}$$

$$\therefore C = \frac{4D^2}{9}$$

And equation III. becomes :

$$\frac{4D^2}{9} y^2 - \frac{4D^2}{3} x^2 = -\frac{16D^4}{27}$$

$$\text{The semi-transverse axis} = \sqrt{\frac{4D^2}{9}} = \frac{2D}{3}$$

$$\text{The semi-conjugate axis} = \sqrt{\frac{4D^2}{3}} = \frac{2D}{\sqrt{3}}$$

Since the distance from the center of the curve to either focus is equal to the square root of the sum of the squares of the semi-axes, the distance from o' to either focus

$$= \sqrt{\frac{4D^2}{9} + \frac{4D^2}{3}} = \frac{4D}{3}$$

We can therefore make the following construction (Fig. II.) Draw ad the chord of the arc $abcd$. Trisect ad at o' and k . Produce da to l , making $al = ao' = o'k = kd$. With ak as a transverse axis, and l and d as foci, construct the branch of the hyperbola $kc c' c''$, which will intersect all arcs having the common chord ad at c, c', c'' , etc., making the arcs $cd, c'd, c''d$, etc., respectively, equal to one-third of the arcs $abcd, ac'd, ac''d$, etc.

TEST CARD HINTS.

By Dr. F. OGDEN STOUT.

I KNOW it is the custom with a great many if not the majority of opticians to fit a customer without knowing whether he has presbyopia, hypermetropia, or any of the other errors of refraction. Their method is first to try a convex, and if this does not improve, a concave, etc., until the proper one is found. This, of course, amounts to the same thing if the right glass is found. But in practice it will be found both time saving and more satisfactory to first decide with what error you have to deal. It is very simple, and, where you have no other means of diagnosing (such as the ophthalmoscope), it does away with the necessity of trying so many lenses before the proper one is found. You should have a distance test card placed at a distance of twenty feet from the person you are examining, and in a good light.

A distance test card consists of letters of various sizes which it has been found can be seen at certain

from a given straight line ef is one-half the distance from a given point d .

In order to write the equation of this curve, refer it to the co-ordinate axes ad (axis of X) and ef (axis of Y), intersecting at the origin o .

$$\text{Let } oc = x$$

$$\text{Therefore, from the definition } cd = 2x$$

$$\text{Let } od = D$$

$$\therefore hd = D - x$$

$$\text{Let } ch = y$$

$$\therefore (2x)^2 = y^2 + (D - x)^2$$

$$\text{or } 4x^2 = y^2 + D^2 - 2Dx + x^2$$

$$\therefore y^2 - 3x^2 + D^2 - 2Dx = 0 \quad \text{[I.]}$$

This is the equation of an hyperbola whose center is on the axis of abscissas. In order to determine the position of the center, eliminate the x term, and find the distance from the origin o to a new origin o' .

$$\text{Let } E = \text{distance from } o \text{ to } o'$$

$$\therefore x = x' + E$$

Substituting this value of x in equation I.

$$y^2 - 3(x' + E)^2 + D^2 - 2D(x' + E) = 0$$

$$\text{or } y^2 - 3x'^2 - 6Ex' - 3E^2 + D^2 - 2Dx' - 2DE = 0 \quad \text{[II.]}$$