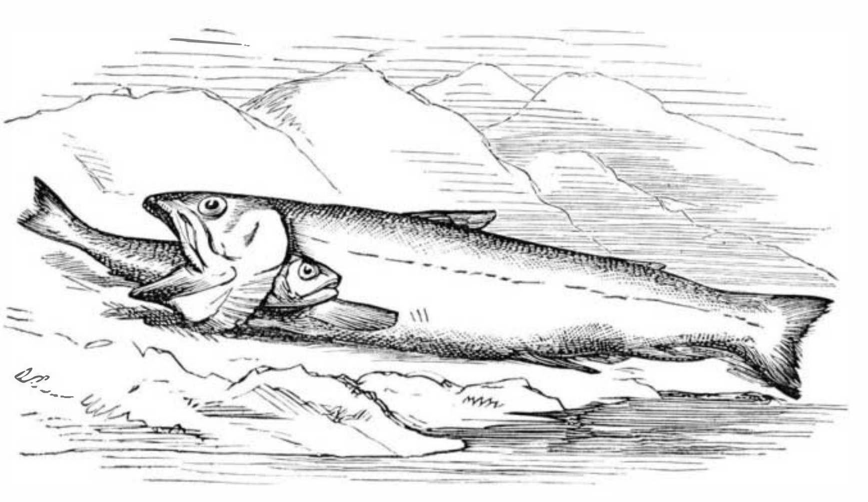
SINGULAR ACCIDENT TO A TROUT.

The trout shown in the accompanying engraving was recently captured in England, having come to an untimely death. Mr. Frank Buckland, the indefatigable naturalist who edits *Land and Water*, states that the trout was found lying dead, on its back, with a dace fixed tight in its gills, and further says:

"The only interpretation that I can give of this accident is that the trout had rushed at the dace to eat him, and, seizing him by the head, had attempted to swallow him; the dace, objecting to this process, and possibly knowing by instinct that if be got into the trout's stomach he would never return therefrom alive, fought hard for his life; and seeing a possible way of escape through the aperture of the gills,he used his best efforts to pass through: fate, however, was against him, and the unfortunate dace became wedged among the gills of the trout, and both fish thus perished.

"When we consider the delicate structure of the swallowing apparatus in all animals, ourselves included, it is really wonderful that more accidents by choking do not take place. In our own persons the apparatus for preventing accidents of this kind are, indeed, most marvellous. The trachea or windpipe is situated immediately in front of the œsophagus, and every morsel of food and fluid we swallow has to pass over the opening of the trachea, which is in fact not unlike the slit of a money box, before it can get into the œsophagus or gullet. The pain and irritation caused by even a crumb or a drop of water getting by accident into the trachea is very great. We cannot, therefore, sufficiently admire the wonderful valve which the Creator has placed upon the top of the trachea. The valve is self-acting, and luckily for us does not depend upon any volition of our own. If it were not so, a person's whole time might be taken up in watching every morsel of food he put into his mouth. By a beneficent arrangement, the act of swallowing is quite as independent of the volition of ourselves as is the action of the heart, the power of thought, and the machinery of the human system in general. The same state of things that is found in the structure of the inhabitants of the land prevails also in the structure of the creatures which live in the water, and among them, as among land animals, an accident is very rare; the above drawing is therefore the more interesting, inasmuch as it shows that even fish are sometimes choked by the living prey on which they subsist."



A TROUT CHOKED BY A DACE.

Correspondence.

The Tripartition of an Angle.

To the Editor of the Scientific American:

Dividing an angle in two parts is one of the easiest operations in geometry; but the division of an angle into three equal parts is considered a difficult and an impossible one.

Let it be supposed that the angle, A B C, is divided into three equal parts by the lines, B D and B E; then draw the arc, A C, and its chord; next draw the lines, A D, A E, D E, D C, E C, resulting in two isosceles triangles, A E D and D C E. Studying the properties of these triangles, we find that their altitudes are the division lines. These lines, therefore, must divide the base lines in two halves, and stand rectangular upon them. Therefore, if A D is really equal to D E, then A F must=F E, and D F be perpendicular to A E; and if D E=E C, then D G=G C, and G E is perpendicular to D C.

The following is the construction and solution of the problem: The angle, A B C, is to be divided into three equal parts: 1. Draw the arc, A C, with any radius. 2. Draw the chord, A C. 3. Divide the angle, A B C, in two parts by he line, B H. 4, 5. Draw the lines A H and H C. 6, 7. Draw semicircles, A F B and B G C, over each side of the given angle. These semicircles have the property of dividing all lines (chords) drawn from A or C to the periphery, A H C, into two equal parts, because each of their radii is half that of A B C. 8. Draw B I perpendicular to H C in its middle, and B M perpendicular to A H. 9. Make L I=B K. 10. Draw, with radius H I, the arc, H G C. 11. Draw B E through the point, G, where the arc, H G C, intersects the semicircle, B G C, and the same on the other side of B H, where B D is drawn through the intersecting point, F.

If the arc, A H C, is divided into a convenient number of equal parts, 8, 16, or so, of which M and K are two, draw M C, and K N perpendicular to M C; then N is the nadir of the altitude of the triangle, M C K. In the same way more points are found, all lying in the circle, H G C, with the radius, H I=B K+L K.

Both conditions are really complied with; C G=G D and E G is perpendicular to D C; the triangle, D C E,is isosceles, and D E=E C; and further, A D=D E. Therefore we have A D=D E=E C, and angle A B D=D B E=E B C.

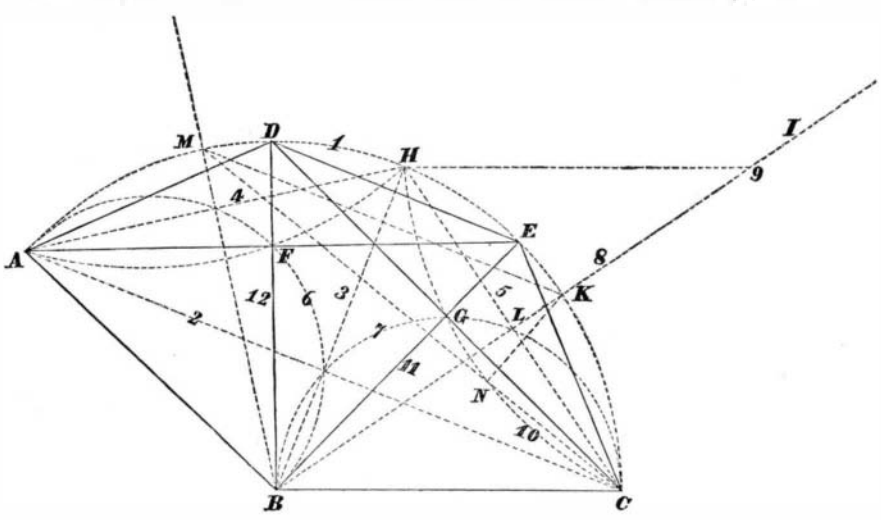
It remains to show that triangle D C E is the only isosceles triangle that answers both of these conditions.

M K C cannot be an isosceles triangle, because we made C K=H K=H M=A D, and therefore C K is not equal to K M. In every triangle in consideration, one side must be parallel with the chord of the given angle, as M K, A C, D E. Only one isosceles triangle fulfils this and the other conditions, and this is the one sought for.

In a similar way I tried to find the law for dividing an angle into n equal parts, when n is a prime number; but I am obliged to confess that I did not succeed. Nevertheless there is some law in these divisions. I found that the semicircle, A F B, is intersected in $\frac{n-1}{2}$ points by as many circles, the positions of which I cannot find, and there are as many parallel lines connecting the points of division. So 3 parts has 1, 5 parts 2, 7 parts 3, 11 parts 5, 31 parts 15. If n is an even number, for instance 6, then the problem is to be reduced to tripartitions, which must be made in each half. The semicircle is intersected in 2½ points, that means that one of the dividing radii goes through the points where the two semicircles cut each other, thus dividing the angle in two parts.

W. THIESE.

Rochester, N. Y.



A New Photographic Test Plate.

Mr. William A. Brice, of London, England, the inventor of the improved portable photographic apparatus illustrated in these columns not long ago, has patented through the Scientific American Patent Agency, September 12, 1876, a novel testing plate, which will enable photographers to determine with considerable certainty the quality of the chemicals employed, the quick or slow working of the lens,and to define whether the presence of "fog" or want of clearness in the picture is attributable to impurities of the chemicals, alkalinity of the bath, diffused light, over-exposure to light, or to other causes.

The invention consists of a frame with a sliding glass plate, to which are applied fixed pieces of transparent material superposed in layers of one, two, three, and more, in regular succession, to produce a greater or less obstacle to the passage of the light. This is set up between the lens and the sensitized plate, and the picture is then taken in the usual manner. The result is a picture which produces the the light shade or shadow of the object to be photographed with the chemicals and lens, and with light of more or less the same actinic quality, intended to be used for the picture to be taken. When the picture is developed on this plate, it is, while visible, wholly divided into sections of unequal intensity, being more or less distinct according as the light has passed through one or more layers. The absence of fog where the light has been transmitted through several sheets of transparent material indicates that the chemicals are pure, that there is no diffused light, and that the nitrate bath is of proper acidity. If at that section details of the picture are clearly developed, it may be concluded that the exposure has been sufficient with the lens, light, and chemicals used. The second section of the testing plate, where the light passes through a less number of layers, gives more or less the same information, but indicates more clearly whether the exposure has been adapted to existing conditions or not. The next section indicates, if properly developed,what time, chemicals, etc., are to be used for the picture to be taken; while the middle or uncovered section indicates by the evident over-exposure that the lens is good and rapid in action,that the chemicals are in good condition, and that the light is sufficient in actinic power to produce good pictures with rapid exposure. The device is one which photographers will doubtless find labor-saving and of much general assistance.

The Preparation of Salicylic Acid.

Cahours obtained salicylic acid in 1844, from methyl-salicylate, or oil of wintergreen (*gaultheria procumbens*). Professors Kolbe and Lautermann in 1860 brought out their method of obtaining the acid from carbolic acid; but it was not until within the last year that Kolbe discovered its peculiar preserving and disinfecting properties. The manner of obtaining the acid from carbolic acid is as follows: The saturating capacity of a carbolic and also that of a soda lye is determined, and both are then mixed according to equivalents, so as to form sodic carbolate. The solution thus obtained is carefully evaporated to dryness, taking care that the dry mass sticking to the bottom of the vessel is constantly removed by scrapers, and that the mass itself is also constantly crushed, with a pestle or other tool, to facilitate its drying out, until at length the carbolate remains as a perfectly dry powder of a rose-red tint. Excess of carbolic acid gives always an inferior dark-looking residue, which, when it undergoes the final process of treatment with carbonic acid gas, gives far less salicylic acid than is in accordance with the amount of carbolate calculated in the mass. The dry carbolate is then either put into the retorts at once, or it may be kept for further treatment by putting it, while hot, into vessels which may be hermetically sealed. The fact that sodic carbolate is very hygroscopic explains the necessity of this manipulation.

After the carbolate is put into the retorts,the contents are slowly heated to 212° Fah.,and when this temperature is reached, a slow current of perfectly dry carbonic acid gas is allowed to enter the retort. The temperature is then slowly increased to 356° Fah., and may, towards the end of the operation, reach to 428° or 482° Fah. About an hour after the beginning of the operation, carbolic acid will begin to distil, and the process may be considered finished, if, at the latter mentioned temperature, no more carbolic acid distils. It will be found that the distilled carbolic acid amounts to just one half of the original quantity employed. The residue in the retort is basic salicylate of soda, which is dissolved, and which, on acidifying with an acid, yields a brownish-colored crystalline precipitate of salicylic acid.

With regard to the purifying of the crude acid as obtained by the process given above, Rautert's method is usually employed; it is as follows: The crude acid is placed in a retort and strongly heated to 338° Fah., when a current of steam at a like temperature is injected into the retort. In the presence of the superheated steam, the acid distils at once; and after a short time, nothing remains in the retort but a trace of a black resinous mass. The apparatus must be arranged in such a manner that the neck of the retort may be kept free from crystals, as, for instance, by an inserted movable wire.

The Literature of Manganese.

Dr. H. C. Bolton of this city has been ransacking the literature of the past and present to learn what has been said and written about manganese, its ores and its compounds. In a communication to the Lyceum of Natural History, in November last, he detailed all the sources of information on this subject. The results of his patient labors have recently been published in the *Annals* of that society, and also reprinted in pamphlet form under the title of "Index to the Literature of Manganese." In this little pamphlet of 44 pages are contained 400 distinct references to manganese minerals, extending from 1596 down to 1873, and 1,700 references to chemical papers beginning with Pott's "*Examen chymicum magnesiæ vitriariorum, Germanis Braunstein*," published in Berlin, in 1740. The value of an index of this kind, to a person wishing to examine the literature of or study any of the compounds of manganese, can scarcely be over-estimated. The references are arranged in chronological order,and give the name of the investigator, subject of the paper, and list of all the journals into which it has been copied with number of volume and page.

Nor is this the first work of the sort done by this chemical antiquarian. In 1870, Dr. Bolton published a similar index to the literature of uranium, from its discovery by Klaproth in 1789 to 1869.

We hope that other chemists, who have prepared extensive lists of reference on subjects that they were investigating, will be induced to put them in print for the benefit of others that may come after, in a style uniform with those above described.

Electrical Dust Figures in Space.

A brass rod pointed at one end, and with a ball at the other, is laid horizontally on an ebonite plate supported on wood; receives sparks from an electric machine; is discharged by touching, and removed; and the plate is then sprinkled with a fine powder. The author gives drawings of the negative and positive figures obtained. Conceive these turned about their axes, and we have the electrical dust figures in space, of which the ordinary Lichtenberg figures are merely sections.

M. Lommel fixed the brass rod in a certain position, and moved the ebonite plate up and down under it, taking figures at each position. He also used an ebonite plate with an aperture, allowing the brass rod to pass through it. He shows how the various figures are related to the original two. The cause of the Lichtenberg figures is to be found (he thinks) in a peculiar state of motion of the air about the conducting body, and this is simply imaged on the ebonite plate.

TURBINE WATER WHEELS.

BY S. W. ROBINSON.

A look at the numerous turbines on exhibition in Machinery Hall, and their elaborate catalogues, giving lists of the thousands which have been introduced in this country, gives evidence of a thriving and extensive business; and one can hardly realize that thirty years ago the turbine was scarcely recognized as a motor.

The first wheel of this kind was made in France by a Frenchman named Burdin, in 1827 or 1828, but the real merits of the wheel were not generally accepted till some five years after. Soon after this it began to receive the attention of American engineers; and the first of these wheels of importance was constructed by Uriah A. Boyden, in 1844, and introduced into the Appleton Company's cotton mills at Lowell, Mass. Tests of these wheels gave remarkable results, the maximum being 92, and the mean maximum 88, per cent of useful effect from the power of the water.

This extraordinary figure is supposed to be due to the engineer's extreme precaution in polishing the surfaces of the apparatus, using Russian iron guides and floats, and in giving such form to the flume as to impart to the water, as it approached the guides, such a spiral-like rotation as to cause it to enter the guides without resistance. The trials which gave the above percentages decided the great superiority of the turbine over the old breast wheel, and engineers at once saw that, for perfecting water motors, their attention must be turned into a new channel.

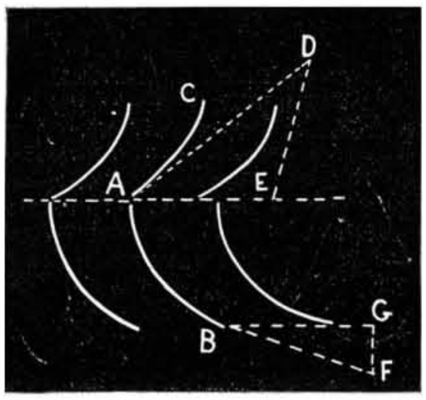
The breast wheel was at once summarily dismissed, and the turbine adopted for reasons unmistakably in its favor, some of which are the following: 1. Increase of percentage from five to fifteen. 2. Greater compactness. 3. Perfect freedom from back-water annoyance. 4. Perfect adaptation of given wheel to all heads. 5. More convenient speed of running. 6. Much less subject to fluctuations of speed. 7. Convenience of installment, and for shipment ready made. Advantages of breast wheel, none.

Some of these point are self-evident, but others, such as Nos. 1, 3, 4, and 6, may not be. To help this, and also for the reason that the correct theory of the turbine wheel is but poorly comprehended, as evinced by the forms given the parts in existing ones, the following descriptive exposition of the main theory is given with the hope that practical builders may thereby receive a benefit.

First of all, water wheels must receive power from the water by reducing its velocity, and water engines by action of its pressure. These points are believed to be sufficiently evident from observation. It is therefore obvious that, for a maximum of effect, the water should have the greatest possible velocity due to head in approaching the wheel; and in leaving, the motion should be entirely destroyed. To illustrate, suppose a flat disk be placed square against an isolated jet of water. If stationary, the water will be thrown in all directions without much change in velocity, and no power is developed because standing still. If it moves with the water the stream is not disturbed, and also no power developed. At half the water velocity, the vane receives its greatest power, but the water is projected laterally, and for this reason the motion of water is not destroyed, and the maximum of effect is known by hydraulic engineers to be only half the power stored in the moving jet. But this is what may be styled a fair example of percussion, and hence builders of wheels who operate on this principle must expect low returns.

Next, suppose the vane be in the form of a hollow half cylinder, and placed so that the jet strikes it tangentially at one side. While stationary, the water is sent around the smooth surface, and escapes, with velocity unchanged, in a direction differing by 180°: and of course we have no power. Giving the vane the velocity of the jet, we get no power again, but with half the velocity of the stream it receives the water with a relative velocity, one half its absolute, and passes it to issue at 180° unchanged, at which the absolute velocity of the water is zero. Now multiplying the motion of vane by the pressure against it, the result is found to be equal to the whole power of the water. In this example we see that the water is delivered upon the float without shock or percussion, and leaves it without velocity, which principle has long been known in theory as the necessary condition for high percentages. As this has regard to the power of the jet only, the latter should, of course, be made the maximum, by giving the water the highest possible velocity of projection. Of the forms of orifice of projection, the one known, from experiment, to give the greatest velocity is that formed in a thin wall, whose coefficient, or realizable percentage of the theoretic velocity, is about 97. Rapidly converging adjutages give very nearly this, say upwards of 92, while prismatic adjutages give only 82 per cent. Hence a turbine, whose chutes have parallel sides, can only return a percentage of 82, provided the wheel otherwise be absolutely perfect. It is therefore evident that the form of chute is of no whit less importance than the wheel.

Again, in turbines there should be a certain adaptation of chutes and floats to each other, and certain forms of wheel passages and exits. The forms most consistent with theory are best explained by aid of the accompanying diagram, which may be regarded as a side view of a Jonval turbine. Let A B represent a float of the wheel, and A C a guide. Let D A represent the direction and velocity of the affluent water, and B F the same for the issuing water. Take A E or B G for the velocity of wheel, which must be equal, from the nature of the case. The point, D, should be found by making D E equal to A E, and the direction of D E the same as the first elements of the floats. Then we have D E = A E = B G.



Now if a particle of water moves from D to A, while a point on the wheel moves from E to A, the direction and velocity of the water, relatively to the wheel, will be D E, and hence will enter tangentially upon the float with entire freedom from shock. Compared with the cylindrical vane above, the water will move along the curved float, A B, without change of velocity, and issue with a velocity, B F, equal to D E. But as D E = B G, then B G = B F, and the absolute velocity of the water will only be G F. If the water could be made to issue tangentially, G F would be zero, as required for a percentage of 100. Though in practice G F must have a magnitude, it should be reduced to the minimum. The water has also been regarded as having uniform velocity from A to B. That this be possible, the transverse sections through the inter-float passages should be the same at all points. Hence, that the exits be thin, requires them to be long from crown to crown. And again, in order to deliver the water on wheel in direction, D A, the last elements of the guides should have the direction, D A; otherwise the form should be favorable for high velocity of projection.

Now this diagram may be greatly varied, and still these principles hold equally well. It is only necessary that D E = A E = B G = B F; last element of guide have direction D A; first element of float have direction D E; and inter-float passages be uniformly large from beginning to exit. The velocity of wheel will be to that of the water as A E is to A D. When the first elements of float, for instance, are perpendicular to A E, the guide direction, A D, should be 45°. For float direction, A D, 60° to the right, guide direction will be 60° to the left, and A D E will be an equilateral triangle. Indeed A D E is always an isoceles triangle.

In designing a wheel it is very important that there be no interference to free passage of water in the curbing or penstock, or in the vent from wheel; and hence these should be large and unobstructed.—*Polytechnic Review.*

THE BLACK KNOT.

There are many things in Nature seemingly so insignificant that we consider them unworthy of our notice; yet they have the power of doing us great benefit or harm according to their habit. The mold, upon bread, cheese, and on most other neglected vegetable matter, is well known to be a plant growth of a low order. It is a fungus, and of the same nature as our common mushrooms. The potato disease, which is causing so much anxiety in England and on the continent of Europe, is also the result of a fungous growth. These plants are now receiving considerable study from botanists on account of both their practical and their scientific interest.

In this country, and peculiar to it, the black knot, as it is called, on plum and cherry trees has recently been proven to be another fungus. Dr. W. S. Farlow, of Harvard University, has presented, in the *Bulletin of the Bussey Institution*, a most important paper as the result of his researches on this subject. The black, warty excrescences on plum trees and on all kinds of wild and cultivated cherries have been noticed by every one from early time, and have long been the bane of fruit growers. For the most part, these have been attributed to the work of insects; and this has not been without considerable shadow of reason. Insects are not unfrequently found there, and in old knots insects or their remains are generally found. The curculio often pierces the knot in its young state, and deposits within it its eggs, which soon hatch out. The young live in the knot, and may be found there in the various stages of their development. Insects also of different species have been found within these knots.

But it is now conclusively demonstrated that the unsightly knots are not of insect origin. Though, till very recently, the subject has been almost entirely neglected by botanists, it now seems certain that they have determined its true character. The knots are not like galls, made by a known insect; and when young, they are most frequently entirely devoid of insects. Again, the fact that the insects are not all of one species, and the very same are also found on trees which are never afflicted with knot, would be quite conclusive against this assumption. On the other hand, the knot has never been found without the presence of the specific fungus (*sphæria morbosa*), which is now accepted as its origin; and this fungus is not known to exist except in connection with the knot. The mycelial threads, however, of the fungus are found in the slightly swollen stem long before any real semblance to a knot has appeared; but the growth of these may be traced till the knot has attained its full size, and the fungus has shown all its phases of life.

Dr. Farlow has considered the life history of the fungus, whether the disease is the same on plum and cherry trees, and the means of preventing its ravages.

The knots vary in size from a few lines to several inches in length, and average about two inches in circumference. They seldom entirely surround the branch, and often cause it to bend or twist into unsightly shapes. The vegetative portion first appears in the form of very minute threads (mycelium), twisted together and extending from the cambium—or inner—layer of the bark towards the outer portion of the stem. "The fungus first reaches the cambium either by the germination of spores on the surface of the branch, or by the mycelium proceeding from a neighboring knot." Hence the Professor concludes that the growing layer of tissue is where the fungus commences its work of destruction. During the growing stages of the knot—which continue to the flowering time of its victim—it is of a greenish color and solid or pulpy throughout. When it has attained its maturity, it turns black; and in the winter it often becomes cracked, broken, worm-eaten, and hollow. The outer shell contains the perithecia, which are small pits or sacs containing the sexual spores. These, always eight in number, are borne in *asci* or cells. These cells grow slowly during the winter, and the spores in them ripen from the middle of January to the end of February. Those ripening in February germinate in from three to five days, if sufficiently moist.

Microscopic investigation proves that the knots on plums of all sorts, and on cultivated, wild, and choke cherries, are identical: though, to the naked eye, they differ slightly in general appearance, owing probably to the more favorable circumstances for their growth in some species of the genus *prunus* than in others.

The remedy against this contagious disease is a very obvious one: simply to cut off and burn the knots and swollen branches when and wherever found. This should be done in autumn as soon as they become plainly seen by the falling of the leaves. It is not sufficient to cut them off, for some of the spores which do not ripen till late in the winter have been carefully observed to ripen after the branches were cut from the tree and not afterwards burnt. Professor Farlow recommends the complete destruction of choke cherry, bird cherry, and wild plum trees, since they furnish means for the rapid propagation of the knot, and are themselves of little value in comparison with the cultivated cherries and plums. "Concert of action is what is needed in this matter, and not only by attending to one's cultivated trees, but to the wild plums and cherries that frequent our fence rows and woodlands as well: as in very many instances the latter prove to be pest houses where the contagion is propagated and sent forth to carry desolation over many a thriving tree, dear to the eye of its owner." The wild plums are the most abundant in the Western States, and the wild and choke cherries in the Eastern. These, in their habitats therefore, require special attention.

This is a matter of vast importance to fruit growers; and to institute vigorous measures, against this destructive fungus, will be a great source of profit to fruit producers and merchants, as well as an equally great source of comfort and enjoyment to the consumer. S. H. T.

The American Reports on the Vienna Exposition.

We have received the four volumes of reports of the United States Commissioners to the Vienna Exhibition of 1873, which have just been published, under authority of Congress, at the Government Printing Office, at Washington, D. C. The work possesses a double interest: first, in that it is a tangible result of the expenditure of $200,000 of the people's money, and of the labors of certain paid scientific commissioners and eight practical artizans: second, in that it is a valuable record of the Vienna show, edited with much ability and discriminating judgment.

Professor Thurston devotes volume first to an introductory description of previous world's fairs, following which is a complete account of the organization of the Vienna Exposition. Copious extracts from the reports of the commissioners from other nations uponthe United States exhibit are given; and a report on forests and foresting, by J. A. Warder, M. D., and one on sheep and wool, by J. R. Dodge, close the volume. In volume second are collected all the reports on scientific and educational subjects. Volume third is mainly occupied by the editor's own report on machinery and manufactures, to which are added Mr. William Watson's paper on "Engineering and Architecture," that of Mr. Fairfield on "Sewing Machines," and that of Mr. Charles Davis on "Hydraulic Engineering." Volume fourth contains reports on buildings, wood and stone industries, metallurgy, and a copious general index, which greatly adds to the value of the work as a book of reference. There is a lavish profusion of maps and engravings, and the general appearance of the book is superior to the usual official productions of the government printer. We shall, as opportunity offers, lay before our readers such abstracts from the work as appear interesting. Meanwhile, and in advance of the public verdict, we can warmly commend Professor Thurston's labors. He has accomplished a task of great magnitude, with a thoroughness which will secure wide and favorable recognition, and he has given us probably the best set of reports ever based upon a world's fair.