## THE RESPIRATION OF ROOTS.

There are two functions peculiar to vegetables, which are often confounded: Respiration and assimilation. With air-breathing animals such a confusion is impossible, as their alimentation takes place only by the introduction into the digestive organs of solid and liquid matters, while respiration requires the penetration of oxygen into the lungs. With vegetables, on the contrary, the function of nutrition involves not only the introduction, through the roots, of substances soluble in water, such as nitrates, ammoniacal salts, and phosphates, but also the introduction of carbonic acid gas through the leaves. The latter also take oxygen from the atmosphere; and if the plant ceases to grow when it no longer finds carbonic acid gas in the air about it, and if this privation produces death through inanition, so also the plant perishes when deprived of oxygen, dying in such case through suffocation.

The leaves thus play the double part of organs of assimilation and organs of respiration; but the two gases which penetrate into the tissues act very differently. Under the influence of solar rays, the leaves decompose carbonic acid and emit oxygen. The carbon remains in the plant, when it is found united with water, forming those compounds—such as cellulose, starch, sugar, etc.—as are commonly called hydrocarbons. The penetration of carbonic acid into the leaves and the decomposition by light which it there undergoes are necessary to the growth of the plant, and thus constitute a phenomenon of assimilation.

Oxygen also enters the leaves, but its action is not well understood. Why a plant perishes when deprived of the gas is not definitely known; but it is certain that oxygen is not only necessary to the air-breathing organs of vegetables—the leaves, flowers, and branches—but equally so to the roots.

In order to determine the effect exercised by plant roots on the atmosphere of the soil in which they are buried, M. Vesque has recently undertaken a series of experiments, the description of which, with the annexed illustrations, we find in *La Nature*. To examine whether roots consume oxygen as do other vegetable organs, plants of various kinds were set out in vases filled with pulverized pumicestone. A soil absolutely free from vegetable matters was necessary in order to render it certain that such changes as might occur in the atmosphere about the roots were due to those organs, and not to the oxidation of carbonaceous matters which exist in arable earth. The arrangement of apparatus is shown in Fig. 1. The vessel, A, has three mouths, in one of which the plant is sustained by a stopper of rubber; the second, *c*, has a stopper and cock, and the third, *a*, has a thermometer and a mercury manometer, *b*. Water for watering the plant is admitted at *d*, the water coming from the funnel, C. In order to prevent bubbling and the consequent modificat ons of the atmosphere in

Fig. 1.

the vase, A, the water from the funnel is led into the reversed flask, B, where the air contained in the water is caught. The water then passes off to the plant vase through the tube, *n*, and rises in said vase until it escapes at the cock, *c*. The cock, *d*, is then closed, and that at *e* opened, when the water runs off to a vessel under the table, the pumicestone in the vase being left sufficiently moistened to answer all needs of the plant.

When it is desired to remove a certain quantity of air from the vase, A, for analysis, the apparatus represented in Fig. 2 is used. The vessel, D, is attached to a musket barrel and filled with mercury, in which is plunged a pipette, E, having a glass cock. A vacuum is thus produced in the pipette, and it is connected with the cock, *c*, of the vase, A, Fig. 1. In Fig. 2, the connection is established with a bell glass covering the leaves. The cocks, *c*, Fig. 1, and *i*, Fig. 2, are then opened, and the air from A rushes into the pipette. This air is then drawn off into a suitable vessel and analyzed. It is always poor in oxygen, but it contains a small quantity of carbonic acid. The quantity of the latter being a small fraction of that of the oxygen consumed, there is a diminution of the volume of air contained in the vessel enclosing the roots—a fact also shown by the manometer. Thus, like the leaves, branches, and flowers, the roots respire, and the oxygen consumed is not integrally replaced by carbonic acid.

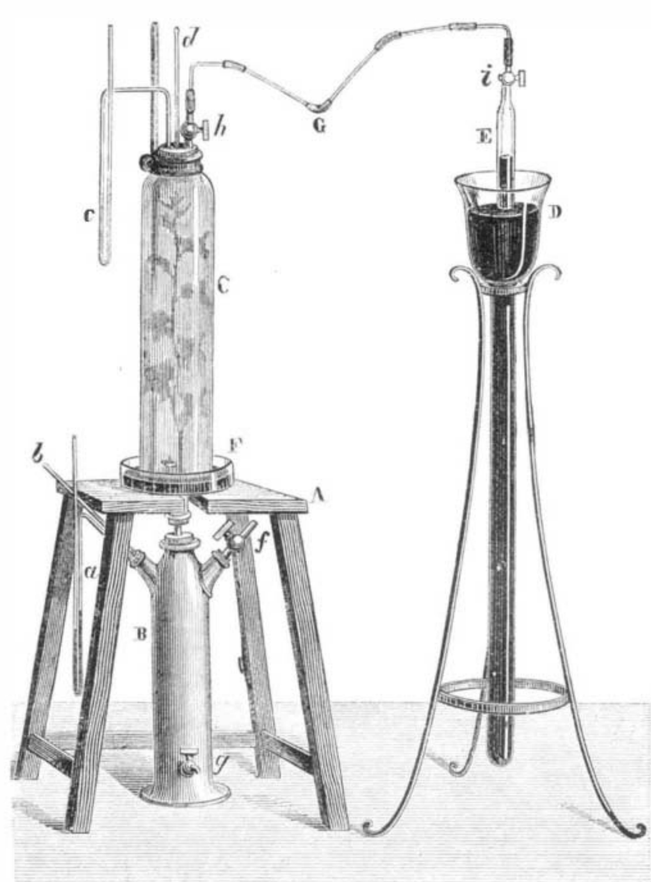


Fig. 2.—MM. DEHERAIN AND VESQUE'S APPARATUS FOR STUDYING PLANT RESPIRATION.

It is easy, by means of the apparatus shown in Fig. 1, to replace ordinary air with pure oxygen. The absorption of that gas by the roots is considerable, and the manometer indicates that a partial vacuum is formed in the containing vessel, and that carbonic acid is emitted. The plant lives very well when its roots are thus plunged in oxygen; but when nitrogen or carbonic acid is substituted for the latter, it dies.

It will be seen, therefore, that the respiratory function of the plant is not localized in any one organ, and that all its parts must be in contact with oxygen. This shows the great advantage of draining land. Water in marshy soil hinders access of the air, and the roots therefore keep near the surface where they can best obtain oxygen. When, however, the soil is thoroughly penetrated by drains, the roots go down to the subsoil, where they still find the necessary gas. Hence this allows the plant to gain sustenance from a larger amount of soil, and the development of these organs is promoted.

While the roots are organs of absorption of soluble matters, they also absorb carbonic acid. By means of the apparatus shown in Fig. 2, the leaves and roots may be enclosed in different atmospheres. The carbonic acid supplied to the roots passes to the leaves, is decomposed, and thus charges the vessel, C, with oxygen.

M. Vesque proposes to carry these investigations much further, and doubtless will reach many other important and interesting results.

### How Do You Keep Your Books?

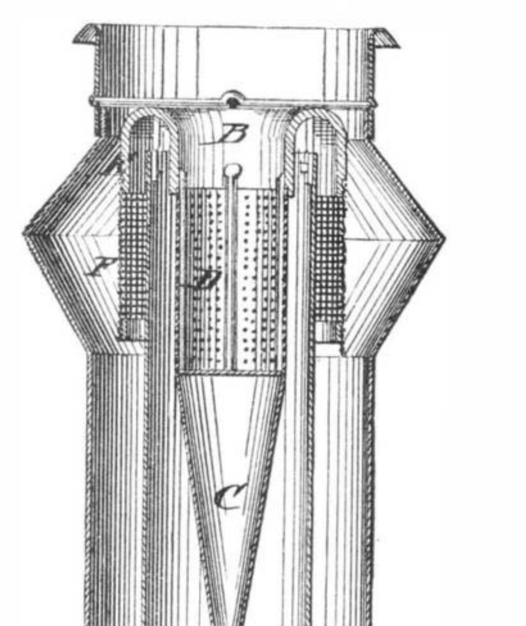
We believe, says the *American Cabinet Maker*, that there is a considerable proportion of men engaged in business—men who know how to buy goods, and can make a good sale of the same—who do not understand the details of keeping accounts. These men go on, year after year, without this knowledge, content if they find enough money in their drawer or at their bank to meet their bills. But, when you talk to them about a balance sheet, they immediately show a lamentable ignorance of the rules by which it should be made. Such ignorance may be very well when trade is flush and the skies are bright; but when the screw of hard times is applied, they are like the captain of a rudderless ship, who does not know when or how the rudder was lost. Partners go on drawing out money for personal expenses exceeding in amount the profits of the business, but they fail to see that this excess diminishes the capital of the concern. A and B form a partnership, and put in $15,000 each. If each draws out $2,500 for living expenses during the year, there must be a profit of $5,000 made by the business in order to keep the capital at its original figures. If the profits fall below the amounts drawn out, the capital is diminished by whatever that difference may be. This is simplicity itself, and it requires no special education to understand it. Therefore, if a business man understands how such a sheet should be made, he has no excuse for not knowing just how he stands.

### Buy Small Trees.

Nurserymen usually describe trees on their catalogues as "second class," "medium," "first class," and "extra." The difference in these classes is principally, if not wholly, in the size and height of the trees; and as most farmers desire the best, they suppose that the large "extra" trees merit that description, and hence order them. The fact is, however, that a small tree will grow faster and (if a fruit tree) come into bearing condition sooner than a large one; and, as the *New England Homestead* states, in half a dozen years the tree that was small when planted will be larger and finer than the other. The larger the tree, the larger the roots which it has, and the larger the roots the less fibers there will be upon them. A tree that has plenty of fibrous roots will grow readily if proper care is used in transportation; but no amount of skill can coax a tree to live and flourish which is destitute of these little fibers. The roots of large trees are always more or less mutilated in the process of taking up, while small trees sustain little injury from this source. Dealers in trees assert that experienced men buy small, thrifty trees, while those who are just starting are anxious for the largest to be had. Those who are to set trees the coming season will do well to learn from the experience of those who, at considerable loss to themselves, have demonstrated that small trees are the ones to buy.

## IMPROVED LOCOMOTIVE SPARK ARRESTER.

An improved spark arrester for locomotives has been patented through the Scientific American Patent Agency, Nombever 14, 1876, by Mr. Simon Smith, of Mauch Chunk, Pa. As shown in the illustration, there is an inside and outside stack, and an annular space between the same. To the top part of the inner stack is attached a cone, B, which is extended partly downward into the interior, and partly around the outside of said stack. The cone terminates at the lower end with a tapering deflector, C, against which the exhaust steam and sparks strike in their upward motion. Above is arranged a cylindrical wire netting, D, through which the steam escapes to the outside, while the sparks are passed up to the annular top part, E, of the cone, which forms a conducting channel for them. Below the top part is again arranged a cylindrical wire netting, F, through which any steam carried around to the outside may escape, while the sparks drop down in the space between the inside and outside stacks to pipes communicating with the dirt box, from which they can be let out at the will of the engineer. The tapering deflector, C, that extends down through the inner stack, divides the steam and sparks gradually while passing up through the stacks, and avoids thereby the difficulty arising from the reaction



of steam and sparks by the direct impact of the steam on the horizontal bottom of the steam escape. A free escape of the exhaust steam and a free draught for the fire is thus secured.

### Metropolitan (Underground) Railway, London.

The *Pall Mall Gazette* states that the Metropolitan Railway, with a traffic almost exclusively in passengers, is the most economically worked railway in England. During the last year it earned £100 for every £39 which is expended, being 32 per cent better in this respect than the average of English lines. At the same time its revenue per mile was between nine and ten times that of the average, exceeding $200,000 per mile.