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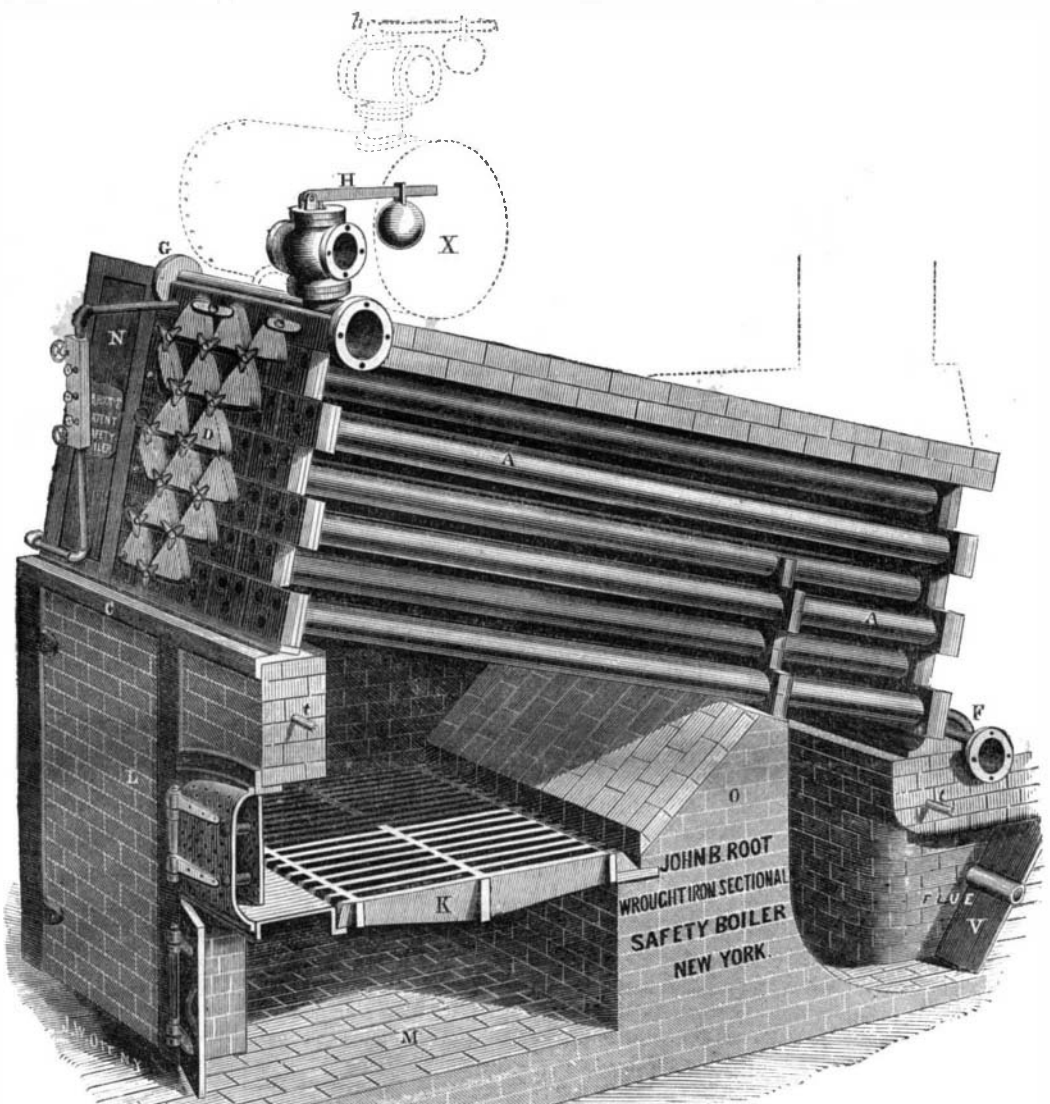
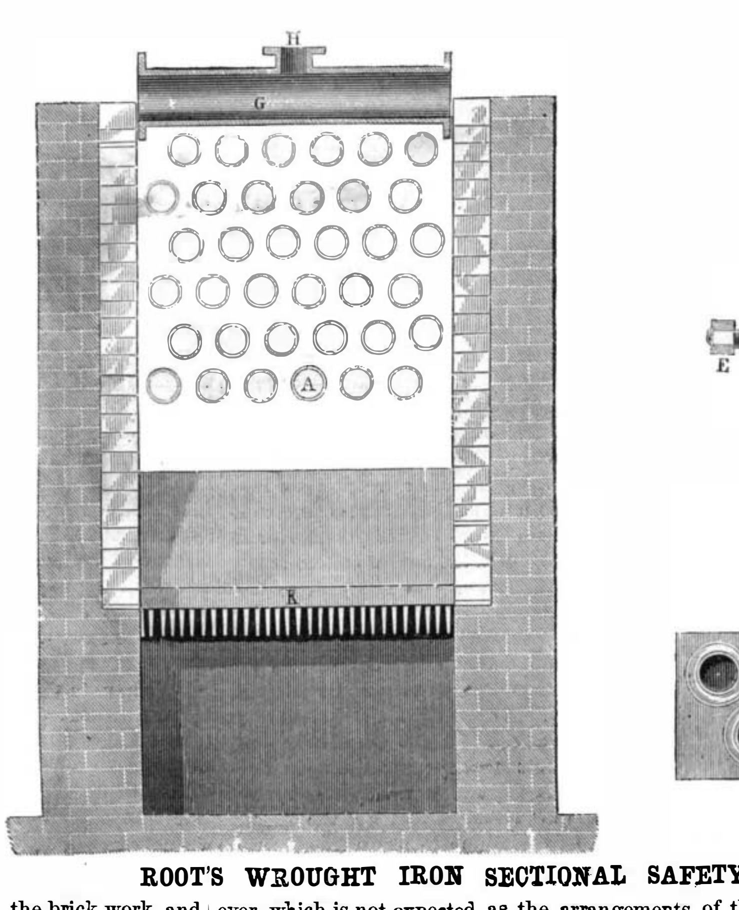
Improved Sectional Tubular Boiler.

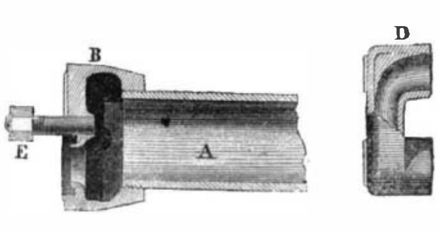
The marriage of fire and water has given birth, in these latter days, to a power immensely stronger than either, and yet more easily controlled. But, if through ignorance of its nature or carelessness of its requirements, this power is permitted to assume the leadership, its anger recognizes no curb and its strength no opposition. As a master, steam is merciless; as a servant, docile. To restrain and guide this power, under all circumstances, is the object of the nightly dreams and daily efforts of engineers, the world over, and steam boiler explosions are to be prevented, or their results shorn of their harmfulness to life and property before this power can be said to be fully under control. Therefore, the proper construction of steam boilers is a subject of personal interest to every one whose life or property may be affected by the consequences of an explosion, and in one or the other of these classes may be reckoned almost every member of a civilized community.

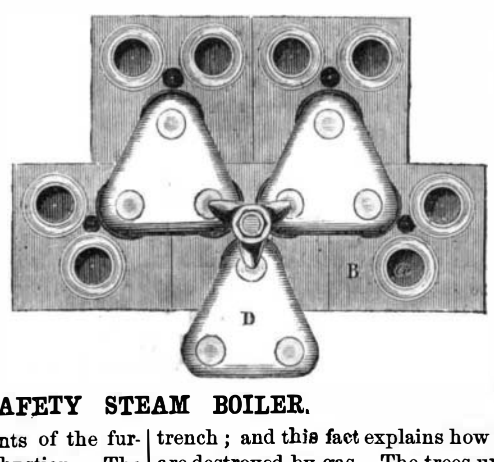


The chief points to be considered in a perfect boiler are safety, economy, durability, and ease of management and facility of control. Sectional boilers have for a number of years been growing gradually into favor because of their more nearly fulfilling these conditions than those of other types. They are portable, easily handled, readily removed, set up, repaired, and enlarged, are rapid generators of steam, free from danger of disastrous explosion, easily kept in order, simple in principle, and direct in operation.

Mr. John B. Root, of New York city, well known as a successful inventor and as a builder of engines and boilers, is now constructing boilers of the pattern shown in the accompanying engravings, more than one hundred of the boilers being now in use. As seen from the large (perspective) engraving, the boiler is a collection of parallel tubes of wrought iron, set on an incline of about two inches to the foot, from the front, back. The same letters refer to the same parts in each engraving. A represents the tubes, B, the heads of cast iron, square in their superficies, and into which the tubes are seated by means of screw threads on the ends of the pipes and in the heads. C is the front plate on which the lower section of heads rests, and which also supports the superincumbent weight of that end of the tubes. D is the connecting elbows forming passages between the pipes, being held in place by the nuts, E, over saddles that have a bearing on the corners of three elbows. In the Heads, B, are recesses in which are placed glands of rubber forming elastic joints to allow for expansion and contraction. F is the injection pipe for the feed water, situated at the rear of the boiler, and leading to the lower end of the lower tier of tubes. G is the steam connection of the upper tier of tubes on which is seated the safety valve, H, and from which the steam is led to the engine. K is the grate, L the front of brick work, M the floor of the ash pit, N the steam-gage pipe, O the inclined bridge wall at the back of the furnace, Q (dotted lines) is the stack for escape of the smoke, *t*, bolts connecting the side framing for the brick work, and X a steam dome, if required, on which, if used, the safety valve, *h*, and steam eduction pipe are placed. A damper, V, is placed in the flue at the rear when desired. The larger engraving represents only a portion of the boiler, some of the sections being removed.







ROOT'S WROUGHT IRON SECTIONAL SAFETY STEAM BOILER.

The tubes are placed zigzag, not directly over one another, which arrangement brings their surfaces nearer together, while, at the same time, it allows space between them for cleaning when the outsides become foul, a contingency, however, which is not expected, as the arrangements of the furnace are intended to insure almost perfect combustion. The inclination of the tubes and their connection with each other by the plates or caps, D, are designed to insure continual circulation of the water—a very important point—and the heated gases of combustion, being compelled, by the arrangement of the tubes, to impinge upon or envelope all portions of their outer surfaces, are fully utilized before being discharged into the stack. The circulation of the water in the tubes keeps them free from scale, but if deemed necessary to examine them it is only required to remove the elbows, D, for the purpose. A boiler may be enlarged by adding tubes at the top and side of the boiler, as all the connecting parts are in sections.

The inventor sets forth the advantages of his boiler by the following claims: First, safety; owing to the small diameter of the tubes, not over five inches, and tested to 500 lbs. to the square inch. In case of burning or cracking, no explosion can occur, but only a rupture, confined in its effects solely to the tube affected. No case of rupture has yet occurred during the two years these boilers have been in use.

Second, economy; the inside surfaces constantly washed by rapid circulation, and the products of combustion—flame, heated gases, smoke—thrown against every portion of the heating surfaces by eddies which change the otherwise diretc course of the draft.

Third, durability; preventing bad results of unequal expansion and contraction by the use of elastic joints, impossible in shell boilers, which, owing to greater necessary thickness and variation of the amount of that thickness, as where joints occur, encourage unequal expansion, and suffer most from varying temperatures.

Finally, cheap and quick removal of an injured part (no weakening by patching), and facility for examination and cleaning of either inside or outside surfaces, and, also, facility of enlargement without disturbing the boiler as first erected.

Mr. Root is now putting in a 200-H. P. boiler of this pattern for one of the oldest and largest iron manufacturing concerns in Philadelphia. All communications should be addressed to John B. Root, 95 and 97 Liberty street, New York city.

Destruction of Trees by Street Gas.

Many a city and town, says the *Boston Journal of Chemistry*, has had to deplore the loss of fine shade trees, by carbureted hydrogen gas coming in contact with their roots, and poisoning them by being absorbed. There is a strange instinct in the roots of plants or trees. As if they had eyes to see, they bend and stretch in the direction from which they can derive nutriment; and wherever they can have free and easy access to the soil and find food, there the number and thickness of the filaments are augmented. If we plant a tree in hard, unyielding soil, it will struggle most wonderfully to sustain itself, by pushing its roots through the packed earth. If, under these circumstances, a trench is dug ten, or even twenty feet from the tree, filling back the loosened earth again into it, the roots appear to be cognizant of the fact, and commence a struggle with the impacted soil, to reach the trench; and this fact explains how it is that the roots of trees are destroyed by gas. The trees upon the sides of streets are placed in hard soil; and when the trench is dug for the gas pipes, and the earth returned, the roots instinctively push for the trench as a point of relief, or where food can be more easily secured. We have seen gas pipes, after having lain for several years, perfectly covered with a network of roots proceeding from the neighboring trees. Now, if there is the slightest leak in the line of pipe, the gas moves in the direction of least resistance, and that is along the trench in which is placed the pipe; hence, the tender spongioles are presented with strange and poisonous food, the gas is absorbed, and the tree dies.

We can hardly suggest a remedy for this great evil. It may be well to compel gas companies to cover their pipes, in the vicinity of trees, with a thick coating of cement, or plank the walls of the trench, so as to prevent the tree roots from passing through. The loss of fine shade trees in cities and towns is almost irreparable, and every practical method should be adopted to prevent it.

EXPLOSIVE COMPOUNDS FOR ENGINEERING PURPOSES.

NO. V.

We resume the statements of facts in relation to the above subject contained in Mr. Nursey's paper. He speaks of the Nobel arrangement of the same substances, differently combined, under the title of "dynamite." We have heretofore published articles on dynamite, but Mr. Nursey appears to have given particular attention to the subject, and his report of experiments is very interesting. He says:

"To this new substance Mr. Nobel has given the very expressive name of 'dynamite.' It consists of fine gravel saturated with nitro-glycerin, in which condition it presents the appearance of coarse brown sugar. In July last, some interesting experiments were carried out with this substance at the Merstham Graystone Lime Works, near Red Hill, Surrey, at which the author was present. So important were these experiments as bearing on the subject of the paper, that the author will here give their details from notes taken by him at the time. The object of the experiments was to illustrate the perfectly safe and harmless character of dynamite under any other conditions except those of actual work, and to show its resistless energy when confined and fired according to the special mode proposed by Mr. Nobel.

A number of cartridges of various sizes were made up of dynamite wrapped in thin paper. To each of them was attached a fuse which burned at the rate of 18 inches per minute. On the end of the fuse, which was inserted in the cartridge, was fixed a copper cap primed with a powerful detonating compound, and to which is due the development of the explosive energy of the dynamite. A charge of half an ounce of dynamite was first exploded on an oak plank about 6 feet long, 9 inches wide, and 2 inches thick, and supported at each end. An exceedingly loud and sharp report ensued, and an examination of the plank showed that the charge had taken effect completely through the board, the under side being rent and splintered. A similar charge was then fired on a balk of fir timber placed flat on the ground. A deep indent was made in the timber, and one side was splintered off. To prove the harmlessness of the dynamite when fired by an ordinary light, Mr. Nobel cut a cartridge in two, and lighted one-half in his hand with an ordinary fuse. It burned quietly and quickly, but not rapidly out. The remaining half of the cartridge was then fired with a capped fuse, when a violent detonation resulted. The absence of all danger in case of collision or fire during transport or storage was then demonstrated in a most marked manner. A small deal box, containing about eight pounds of dynamite, was thrown down from the top of a cliff about 70 feet high, upon a hard bed of rock below. The concussion started the joints of the box, but the contents remained uninjured and unchanged. The test of fire was then applied to a box similar to the last, containing the same quantity of dynamite. A fire was kindled, upon which the box was placed, and after a few minutes the box quietly turned over on one side, a gentle puff of smoke and flame issued from it for a few seconds, and 8 pounds of one of the most violent of modern explosives were almost noiselessly dissolved into air. The charred and blackened box was removed from the embers, and on examination the joints were found to be sound and whole. The author examined this box of dynamite before it was nailed down and placed on the fire, as also the one which was thrown down the precipice after the occurence, and therefore writes from his own knowledge of the matter. Such tests ought to satisfy the most skeptical of the safety of the new blasting powder either in a railway collision, or accidental upset of a package, or a fire.

The next point was to test the power of the dynamite when under conditions of partial and also of perfect confinement. To this end, about 4 ounces of dynamite were placed upon a block of granite, measuring 3 feet by 2 feet 9 inches by 2 feet, the dynamite being only covered in with a lump of clay and a shovelful of gravel. A very loud report followed, and on examining the stone it was found to be traversed by rents and fissures, large masses being easily detached by a crowbar. The effect was certainly surprising, considering the comparatively loose and unconfined condition of the charge. In the next experiment, a cylindrical block of wrought iron, about 12½ inches high and 10½ inches in diameter, and having a one-inch hole bored through the center, was used. The bore hole was filled, but not rammed tightly—with dynamite, and fired. A report soon followed, remarkable for its penetrative loudness, and on examination one-half of the cylinder was found about 80 feet from the place where it originally stood, being then only stopped by a grass embankment. The other half was found some 50 feet in an opposite direction, lodged against a pile of broken rock, which stopped its further progress. The iron showed a clean split, which revealed an excellent quality of metal. The bore showed an extraordinary enlargement near the center, measuring nearly 1⅝ inches across, while the measurements at the top and bottom of the bore were in each case 1 inch, as before firing. It would appear that power developed increased as it approached the center of its length, becoming reduced again as it neared the further end of the hole, although of course the explosion was practically instantaneous. Both ends of the bore were open to the atmosphere, there being no plugging or tamping. The strain on the metal must have been enormous to have thus compressed it around the center of the bore, and to have rent such a mass and sent its halves yards away in opposite directions.

Dynamite is of course unfitted for use, either in heavy guns or small arms, its very power being against it in this respect, as forcibly illustrated in the experiment with the cylinder. But it can be utilized in shells with great advantage. A time fuse fitted with the detonating cap would effect its explosion at the proper moment, while if the shell broke up in the gun, no harm would result, as demonstrated by previous experiments. The danger attending the use of a shell was too great to allow of its adoption by Mr. Nobel, but he fairly met the point by filling a tin case with 4½ pounds of dynamite, and firing it behind a piece of curved ⅝-inch wrought iron plate, 2 feet high and 3 feet long, measured round the curve. The plate was broken into four unequal parts, which were blown considerable distances away. The face of the plate upon which the powder had acted was completely pitted with small holes, due doubtless to the atoms of silica in the dynamite. This experiment satisfactorily demonstrated the great velocity which would be imparted to fragments of shells charged with this explosive.

The next experiment was directly illustrative of the present subject—that of blasting rock. Here a charge of 12 pounds of dynamite was inserted in a vertical bore hole 15 feet deep and 2 inches in diameter, tamped with sand. The explosion was indicated by a low subterranean thud, and a perceptible tremor of the surrounding land, even at a considerable distance from the blast. The rock showed a series of fissures which indicated that an enormous mass had been loosened, and was ready to be detached by the pick. Had the rock been of a harder and less friable nature, it would have offered a greater amount of resistance, and the whole mass would doubtless have been blown out. This was the case with some granite quarries at Stockholm, where an immense mass was detached by a charge of dynamite, and thrown down in huge blocks. On the present occasion, a further charge of 4½ pounds of dynamite was fired at the same depth as the last, with proportionate results. The method of charging in dry ground was next illustrated by filling a glass tube with a series of cartridges which were tamped with loose sand and fired. This experiment was repeated with water tamping to illustrate the mode of operation in wet ground. A striking effect was produced by firing a cartridge in a bucket of water. The detonation appeared to be stronger than under any other conditions; the bucket was shattered, and fragments were picked up several hundred feet from the spot where the charge was fired.

It will thus be seen that the most severe tests for safety failed to show that any danger was present in this material, while, on the other hand, there was no condition under which its violence was not developed when fired with a detonating fuse. So far, dynamite appears to be well calculated to supersede gunpowder for blasting purposes. The only point of doubt which has arisen in the author's mind, is whether any mechanical or chemical change might not occur in the course of time, which would render dynamite as dangerous as nitro-glycerin. The author recently made this objection to Mr. Nobel, who, however, stated that there was no fear of such an occurrence, inasmuch as he had kept dynamite in store for very lengthened periods, subject to high temperatures, and that it retained its original condition under some very trying tests. The stability of dynamite has been practically confirmed by extensive and daily use in various mines, and by the large quantities which are stored at the factories. Beyond this the most careful investigation has shown that there is not the slightest ground for apprehension on that score. Under continued exposure to the direct rays of the sun during the whole of last summer, not the slightest chemical changes could be detected, and the same was the case with some dynamite exposed for forty days to a heat varying between 150° and 200° Fah. All nitrated, or rather hyponitrated organic compounds, are liable to spontaneous decomposition—or what is understood by this hackneyed and ridiculous term—unless they are completely rid of free adhering nitric acid. The reason is that the free acid will produce a local decomposition, which sets hyponitric acid free, the latter producing a new local decomposition, and so on until sufficient heat is evolved to set fire to the compound. There is no difficulty whatever in ridding dynamite of free acid, but in the case of cotton, or any other fibrous substance, the utmost care is required, as free acid will sometimes adhere in spite of repeated washing.

Sweden consumes at present nearly as much dynamite per month as Great Britain does in a year, which only proves the want of organization which has hitherto stopped its progress in this country. In Norway, the consumption of dynamite is not very large (from about 33,000 to 40,000 pounds per year, the author is informed) but it is steadily increasing. In California, dynamite is in great favor, and is transported by rail without any restriction. In the Eastern States of the American Union, the miners still continue to use nitro-glycerin, chiefly because dynamite has not been manufactured and sold there. In England, comparatively little dynamite has been used until recently. This is owing to the difficulties of transport, and to the fact that Mr. Nobel has hitherto directed his attention to its manufacture and sale upon the Continent. There is but one depot for the whole of Great Britain, and that is situated at Carnarvon. As, however, dynamite is not carried by rail, a great many orders are not executed.

The author has referred to several catastrophes which have been caused by nitro-glycerin, but he can only find that a very few have resulted from dynamite. Since the latter material has been introduced, no accident has occurred either from its manufacture, conveyance, or storage. When the nitro-glycerin factory exploded at Stockholm last year, the dynamite stored close by was found scattered about, but not exploded. Two accidents have happened from the use of dynamite in mines. The first was caused by the tamping having been incautiously removed after a miss fire—an operation which ought not to be allowed in any case. The second was due to the folly of lighting the fuse of a charged cartridge and holding it by the hand until it exploded. These are the only accidents the author can discover. Accidents like these, through carelessness, must and will occur in mines, however safe the explosive may be to handle.

The Amoeba---A Most Remarkable Creature.

The amœba is one of those singular forms of animal life which seemingly occupy the extreme boundary between animal and vegetable life. In an article attempting to set forth the distinguishing points between animal and vegetable life, the *London Quarterly Review* gives the following description of this most remarkable of living creatures:

"But perhaps the clearest instance of the uselessness of attempting to make the possession of a stomach a distinctive feature of animal nature is shown by the history of a group of creatures, of which the well-known and common amœba may be taken as a type. In these there can be no question of definition, for in no sense whatever can they be said to possess a permanent stomach.

"The amœba has a just claim to the title of animal, for its affinities with the foraminifera are clear; and no one would deny that these creatures, with their exquisitely beautiful shells, are animals. Nor is this position shaken by the fact that the life history of the amœba can at present hardly be said to be fully made out. Yet the amœba has no stomach, possesses indeed no organs at all, unless we consider its so-called nucleus as one; and there are closely allied forms in which even this is absent. Conceive of a minute drop of transparent jelly, so small as to be invisible without the help of a microscope, a drop of jelly sprinkled and studded with a dust of opaque granules, sometimes hiding in its midst a more solid rounded body or kernel called the nucleus, and perhaps with the outer rind a little different from the internal mass. Conceive further of this amœba as of no constant shape, but like the Empusa shifting, as we look upon it, from one form into another At one moment it is like a star with straggling unequal limbs, at another club-shaped; now it is a rounded square, soon it will be the image of an hour-glass. None of these changes can be referred to currents in the water in which it lives, or to any other forces acting directly upon it from without. It seems to have within it some inner spring, an inborn power of flowing, whereby this part of it or that moves in this or that direction. And not only do its parts thus shift and change in form, but through their changes the whole body moves from place to place. As we begin to watch it, for instance, at the moment when it is in what may be called its rounded phase, a little protuberance may be seen starting out on one side. Speedily the little knob swells, lengthens, flows into a long process. The process thickens, faint streams of granules indicating in which way the currents of the unseen molecules are setting. The substance of the body surges into the process; and as the latter widens and grows thick the former shrinks and grows small. At last the whole body has flowed into the process; where the body was there is now nothing, and, where the process reached to, the whole body now is. The creature has moved, has flowed from one spot into another. Here, then, we have movement without muscles, locomotion without any special organs of locomotion. We have also feeling without nerves or organs of sense, for if a process such as we have described, while flowing out, meet with any obnoxious body, it will shrink back and stop in its work. And the whole body, terrified by some potent shock, will often gather itself up into a ball. As it moves without muscles, so also does it eat without a stomach. Meeting in its sluggish travels with some delicious morsel (and diatoms are its frequent food), it pours itself over its meal, and coalescing at all points around it, thus swallows its food by fluxion. To use a homely illustration it is much as if a piece of living mobile dough were to creep around an apple and to knead itself together into a continuous envelope in order to form an apple dumpling. Watching the food thus enveloped by the gelatinous substance of the amœba we see it grow fainter and fainter as its nutritious constituents become dissolved by the corrosive action of the same transparent but chemically active jelly; and when all the goodness has been got out of the meal the body of the eater flows away from the indigestible remains just in the same way that it flowed around the original morsel.

"We have in this creature, then, eating without a stomach, moving without muscles and without limbs, feeling without nerves, and, we may add, breathing without lungs, and nutrition without blood. The amœba is a being of no constant outline, of no fixed shape, which changes its form according to its moods and its needs, and turns its outside into its inside whenever it pleases, which is without organs, without tissues, without unlike parts, a mere speck of living matter all alike all over. And yet in the midst of this simplicity it enjoys all the fundamental powers and fulfills all the essential duties of an animal body, and is, moreover, bound by chains of close