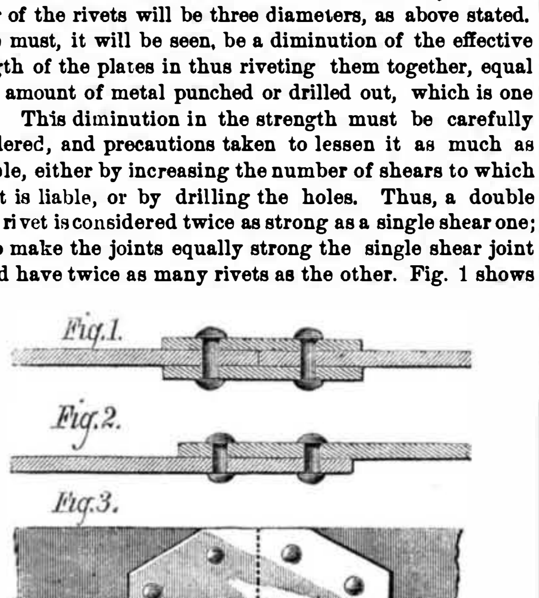
cal tests were instituted by government authorities by the application of hydraulic or steam pressure of double the usual working pressure.* It is very evident that the strength of a boiler depends, first upon the resistance to tearing of the plates, and secondly upon the resistance to shearing of the rivets. New plates may tear along the line of rivet holes, or by the detrusion of the pieces of plate between the holes and the edge of plate. In this case, the resistance is measured by the shearing strength of the plate per square inch, multiplied by the number of pieces detruded or pushed out. We have already shown that the tenacity of boiler plate is about 20 tuns per square inch. As regards rivets, the shearing strength may be taken as the same; 22 tuns is considered the average, however, for best Yorkshire iron. We have next to consider how the riveting can be made to equal in in strength the plates, so as to obtain the greatest amount of strength from both. This is usually done by making the rivet equal to twice the thickness of the plate. Then the pitch or distance from center to center of rivets must be considered, as it is very clear, if this distance is not sufficient to make the plate between two rivet holes as strong as the rivet itself, no advantage is gained, as the least resisting will give. Thus, in a single riveted joint, the breadth should be at least equal to three diameters of the rivet, and the pitch should also be three diameters. The plates at the lap joint are double, hence are equal in strength to the rivet; and the distance from the rivet hole to the edge of the plate must be one diameter, hence the whole width of the joint from center of the rivets will be three diameters, as above stated. There must, it will be seen, be a diminution of the effective strength of the plates in thus riveting them together, equal to the amount of metal punched or drilled out, which is one third. This diminution in the strength must be carefully considered, and precautions taken to lessen it as much as possible, either by increasing the number of shears to which a joint is liable, or by drilling the holes. Thus, a double shear rivet is considered twice as strong as a single shear one; and to make the joints equally strong the single shear joint should have twice as many rivets as the other. Fig. 1 shows



a double shear rivet, and Fig. 2 a single one. When plates are in tension, the aggregate shearing area of the rivets on each side of the line of joint, multiplied by the safe strain to shearing per inch, should equal the total working strain on the plates. In some joints, as in girder plates, the collective shearing area of the rivets should be nearly equal to the effective plate area. In practice, the rivet area is made about $\frac{1}{10}$ greater, to compensate for any inequality in the strain. "In steel plating," observes Mr. Bindon Stoney, "the rivet area of the rivets in steel should be one third greater than the nett area of the plates, but the heads of steel rivets are very apt to fly." Mr. Hodgkinson deduced from experiments that the "strength of plates, however riveted together with one row of rivets, was reduced to about one half the tensile strength of the plates themselves; and if the rivets were somewhat increased in number and disposed alternately in two rows, the strength was increased from one half to two thirds or three fourths at the utmost. For the relative strengths the following may be taken:

Strength of an unpunched plate, 100; strength of a double riveted joint, 66; strength of single-riveted joint, 50. Punching, it would appear, reduces the tensile strength of iron to a greater degree than the entire area of metal punched out. It has been stated that drilled plates are 15 per cent stronger than punched ones. The preceding remarks apply to girder and boiler riveting. We give here the rules adopted by boiler makers. For plates less than $\frac{1}{2}$ inch thick, the diameter of rivet equals twice the thickness of the plate. For plates more than $\frac{1}{2}$ inch thick, the diameter of rivet equals once and a half the thickness. The pitch of single joints equals $2\frac{3}{4}$ to 3 diameters, and that for double joints equals $3\frac{1}{2}$ to 4 diameters. The lap for single joints equals 3 diameters, and that for double joints 5 diameters, of the rivet. While in boilers the distance between the holes and edge of plate is 1 diameter, in girders it is seldom less than $1\frac{1}{2}$ times diameter of rivet, and the pitch varies from $2\frac{1}{2}$ to 5 or 7 inches. Some joints, as in girder work have covers or plates riveted on one or both sides; these covers should equal in strength the plates. See Fig. 3, which shows an economical arrangement of tension joint. Another resistance must be noticed, which tends to increase that of the riveting, namely, that due to the contraction of the rivets when cooling. This frictional resistance does not, however, when added to the rivet's resistance, quite equal that of the plates, though much stress is placed upon it by engineers.

Various ingenious devices have been proposed to obtain a uniform strength both in the plates and joints. Oval rivets have been suggested, in which a greater area is left between the holes by putting the narrowest part of the rivet in line with the joint, the longest diameter being placed in the other direction. Thus a $\frac{3}{4}$ inch round rivet may, as far as its strength goes, be transformed into an oval one of the same area of section and strength; but the hole being reduced in the direction of the joint or weak line of the plate, greater advantage would result, because the plate could be made so much stronger. Oval holes may as easily be drilled as round ones, and it is not improbable this mode of riveting will supersede the ordinary kind for boilers before long.

Sir W. Fairbairn proposed rolling the plates with thicker edges along the rivet holes so as to approximate the strength of both; this, too, is a feasible suggestion. Another equally good plan is to arrange the plates and joints diagonally, the joints being at an angle of 45° with the axis of boiler. By this plan the strength of the boiler is increased considerably, according to Mr. W. R. Browne, in the ratio of four to five.

In good boilers the joints that have to resist the greatest strain, the circumferential, are double-riveted, while those subject to longitudinal strain are single-riveted. Even this precaution, however, does not make the joints so strong as The plates by a ratio of one fifth.

* Testing by steam would be, however, rather hazardous

Correspondence.

The White Streak in Silk.

To the Editor of the Scientific American;

I am aware that manufacturers have been more or less troubled with the appearance of a white streak on machine twist, and that dyeing by the ordinary process for silk would not color it. It is alleged that it may arise from not thoroughly washing the material from soap; or it may arise from dead wood, or from adulteration, or from a parasite or fungus. That it is not soap, every dyer knows. That it is not a parasite or fungus is evident, because an ordinary thread of twist contains about 15 threads as reeled, and each thread about 5 as spun by the worm, so that the aggregate is 75 threads. Were it a parasite or fungus, it would be a spot only on 1 thread of the 75, and the other 74 threads would wrap round it, and it would be lost to view. No silk made on mills where the spindles are run with leather belts and the silk is taken up on shaft bobbins, and is not stretched on the stretchers now in use, ever developed the so-called white streak.

That it is a vegetable substance is shown by the fact that the process for dyeing cotton, flax, or woody fibers colors it; but the process for silk, wool, feathers, or other animal substances will not color it.

The friction rolls on spinning mills are continually wearing, by friction with the silk. The bands are whipped and worn, at the knots, into fine threads flying around the spin dle; the wood rolls of the stretcher are constantly wet and softened, and are subject to friction, giving off fine particles. All these latter are taken up more or less by the thread; and it is from this source the trouble must be looked for.

I would like to confirm the statement that it is found on raw silk by boiling and dyeing; then if the streak remains, I will admit that there is something in the theories of adulteration, parasite, or fungus. LEWIS LEIGH

Mansfield Center, Conn.

A Remedy for Potato Blight.

To the Editor of the Scientific American:

Having read a communication from Mr. Lyman Reed, of Boston, some months since, concerning the cause of the potato rot, and referring the process to the action of microscopic parasites attacking the tubers, I devoted some spare hours to the verification of his view, which, with some modifications, I am compelled to indorse. My investigations have been conducted with an instrument magnifying 800 diameters (640,000 times), assisted by a dissecting microscope giving 50 diameters, for the preparation of sections and the isolation of specimens. My method has been to procure specimens of the different varieties, and, having carefully cleansed them, to subject them to gentle heat for 96 hours or more, then to submit them to a careful examination. The ova of the insects seem to occupy the interior layer of the cuticle of the tubers, and pass rapidly into larval state under the proper thermal condition. I have no doubt that they commence that histolytic process that ends in the destruction of the tuber; but I doubt whether there is any genetic connection between the fungi developed on the stalks in the course of the degeneration, and the larvæ, in which the degeneration primarily starts. The fungi are very likely independent structures resulting from the deposition of spores from the atmosphere, on vegetable tissue already in the course of dissolution from other causes. Indeed, I may say that from actual examination I am assured that such is the case, and that, as a general rule, vegetable tissues develop microscopic fungi in the process of breaking down, where similar spores deposited on healthy tissue would remain undeveloped.

I have made drawings of the larvæ mentioned by Mr. Reed, in their various stages, and, what is more important, have tested them with various re-agents. Tested with weak solution of sulphuric acid, they become very active for a few minutes, then fall into a torpid state, but finally recover. Substantially the same effect is produced by alcohol. Ordinary whale oil attacks them virulently in the larval state, but not so virulently in the less developed stages. Kerosene oil is still more fatal to them in the larval state; but unless a considerable quantity is absorbed they gradually recover, and the younger the larvæ the less readily they yield to the action of kerosene. In some experiments prosecuted last summer on what are generally known as apple tree worms, he same rule held good. Sperm oil and kerosene were both destructive to the fully developed larvæ, but very inefficient when applied to the undeveloped ova. After thoroughly testing the potato larvæ in their various stages, with solutions of nitric, muriatic, sulphuric, and oxalic acids, then with alcohol, sperm oil, and kerosene, and with various alkalies, and finally with iodine tincture, I was forced to the conclusion that the remedy was not to be sought in this direction, and tried a combination of one part of carbolic acid to thirty parts of common whale oil, with unerringly destructive results, both as respects the larvæ and the ova.

If you will permit me, on a subject of such importance, through your universally read journal, I will take the liberty of announcing that a bland solution of carbolic acid in common whale oil or kerosene is the scientific remedy for the rot. The best way to use it would, I think, be to dip the potato, just before planting, in the solution, which is very inexpensive and very easily obtained. I may add that my experiments convince me that carbolic acid in this bland solution in no way impairs the germinal activity of the tuber; but, by way of certainty, let me recommend your farmer readers to first try the experiment on a few hills this spring, and, if successful, to adopt it as a remedy for the blight.

I will, should you signify that it would be agreeable to you, be glad to give you full details of my investigations, accompanied with drawings of the insects in different stages, and descriptions of structure and manner of development from the egg, of which I have copious notes: according always to Mr. Reed the full honor of first discovery.

New York city. FRANCIS GERRY FAIRFIELD.

The Flow of Water in the Suction Pipes of Pumps.

To the Editor of the Scientific American:

In reply to your many correspondents who ask about (and are pleased to commend) my recent article (in "Practical Mechanism") on the subject of pump suction pipes, I would say that the result of my experience has been that, by allowing the flow of water through suction pipes to be 300 instead of 500 feet per minute, the following increase in the ratio of efficiency of the pump is attainable, and carefully conducted tests show it to be correct: Under a 27 feet lift, 15 per cent; under a 15 feet lift, 7 per cent; under a 5 feet lift, 2 per cent.

I account for this increase of efficiency as follows: Since the area of a circle increases as the square of the diameter, the friction of the water is, proportionally to its volume, less in the larger pipe. The check given to the upward movement of the water (in the suction pipe) by the pump piston (when it reverses its motion at the end of the stroke, and before the suction valve has had time to close) is experienced to a less degree upon the larger than upon the smaller body of water contained in the suction pipe. The larger suction pipe holds a proportionally larger supply of water close to the pump barrel, and serves in the same way as does a steam chest to a steam engine, to increase the volume of the supply. The increased efficiency, due to the application of an air chamber to the suction side of a pump, is in part, if not wholly, due to the same principle. The presence of air in communication with the suction pipe is neither desirable nor obtainable in a continuously working pump, because the water in time absorbs all the air, and fills the chamber which contains it. That vessel may therefore be more correctly termed a supply reservoir. In the experiments referred to above, there was one bend or elbow in the suction pipe immediately outside the pump barrel, and the water was received into a reservoir in the pump and directly beneath the suction valves, which were of rubber and of the kind known as griddle valves. They were as large in area as the barrel of the pump; the reservoir referred to was about two thirds as large in cubical contents as the pump barrel, and (as a consequence) but very little difference in the ratio of the efficiency of the pump was observable, whether the suction pipe was supplied with an air chamber or not, excepting at the 27 feet lift test, at which the application of the air chamber increased the efficiency about 3 per cent. The number and radius of the bends in a suction pipe affect the efficiency of the supply of water to a serious degree, as the greater their number, and the less the radius of each bend, the larger should be the area of the suction pipe. These conditions are, however, so variable that but little would be added to our present knowledge upon the subject by making tests, unless under a multiplicity of those conditions.

I stated, in the article on pumps, that "all pumps throw less water than their capacity, the deficiency ranging from 20 to 40 per cent, according to the quality of the pump This loss arises from the lift and fall of the valves, from inaccuracy of fit or leakage, and in many cases from there being too much space between the valves and piston or plunger." To this latter remark, I would now add that, in cases where the defect referred to exists, I have increased the efficiency of the pump as much as 25 per cent by simply filling in the vacant space with lead, first boring a few holes in the metal for the molten lead to run in, so as to prevent the lead from moving when cold. It is of vital necessity to keep the space between the pump plunger or piston and the valves as small as possible, filling in all corners and allowing only room sufficient to allow the latter to open to the necessary distance. JOSHUA ROSE.

279 West 12th street, New York city.

SAWDUST, mixed with any resinous substance, cut in small cakes and dried, makes good fire lighters, and saves kindling wood.