"anchor," with the long ropes, are here dispensed with; and if the adjustment of the plows, as used by Fowler, is found most convenient, there is nothing to prevent its adoption, and the drawing of his plows with this locomotive engine.

Smith's (of Wolston) Cultivator.

In the progress of all arts and sciences it is observed how principles, at one time deemed most vital, come afterward to be regarded as of secondary importance, and still later, again assert their original claim to attention. Pulverization of the soil was, more than a century ago, advocated by Jether Tull as the one essential to good husbandry, and he even regarded manure as valuable only as assisting to pulverize the soil by fermentation. In later years, chemistry assumed a conspicuous position in agriculture, and many have been inclined to regard more the constituent elements of plants and of artificial manure than the mechanical condition of the soil, like quack doctors, whose attentions are so much occupied by their specifics, that they entirely overlook the condition of their patients.

But now, after the practical failure of the theories of some distinguished chemists, agriculturists are again disposed to regard the physical condition of the soil as of primary importance, and the operations of drawing, subsoiling, and otherwise opening a greater depth of soil to the action of the atmosphere, and to the roots of the plant, engage the attention of the farmer. As land becomes more valuable, it is found more convenient to add another seed-bed to the field by preparing it *under* the shallow furrow turned by our fathers, rather than by annexing our neighbor's farm, in the covetous desire to possess all the land that adjoins our own. And so we are looking for more power to work our land deeper, and to pulverize it more thoroughly. In England, four or five plowings are considered an essential preparation for a good crop of turnips. In America, where labor is more costly and products usually cheaper, we the more need some more aids to our husbandry. Twig says that Romulus, in his distribution of the land, allotted two acres to each citizen, and that after the expulsion of the kings it was increased to seven. Columella tells us that the patrimonial estate on which Cincinnatus employed himself consisted of four acres! Yet we, whose single farms are larger than the city of Rome, with her seven hills, are plodding along, bound to the old notion that the plow used by the Romans, or at least its principles of operation, must be forever preserved. Every one knows how much better is the preparation of the garden by forking up and raking, than by turning with plows and harrowing; and the implement desired now in place of the plow is a forking or digging machine, that shall, at one operation, stir the ground to sufficient depth, leaving it as nearly as possible in the condition of a garden bed prepared with a fork. Such a machine has been attempted by Smith, of Wolston. At Salisbury, in 1857, when the Royal Agricultural Society repeated their offer of £500 for a steam-plow, Smith was excluded from the competition by the condition which made it essential that the *implement should turn the soil over*, while, as already observed, it is an essential feature of the Wolston system that the soil should be "stirred and smashed up," and *not* turned over.

At the Chester exhibition, however, in 1858, Smith and Fowler being competitors, the prize of £500 was awarded to Fowler, and the gold medal to Smith. From Dickens's "All the Year Round" we give the best description that can be found of Smith's machine:

"Mr. Smith uses an ordinary agricultural portable steam engine, of from eight to ten horse power, which he fixes at one corner of the field, of from ten to twelve acres. In front of the engine is a windlass, or capstan, with two drums of a peculiar shape, with a coil of wire rope around it, and this rope is led over four anchored pulleys, one at each corner, and along each side of the field. The windlass attached to the fly-wheel of the steam engine by a driving band can be instantaneously driven in either direction. Four different plows, or cultivators, are used as occasion requires. To the bow of the one in use two ends of the rope are attached. An engine-driver, a man at the windlass, a plowman, an assistant to shift the pulleys, and a boy, are the staff required. The plow cultivator begins by traveling along the more distant side of the field, between the two anchored pulleys; at the end of the first journey the pulley in front is shifted, the engine is reversed, and in thirty seconds the plow is traveling back. And thus, by alternately shifting, bringing up each of the two most distant anchors, strip by strip, the whole field is 'smashed up,' in parallel lines, to the spot where the engine stands.

"His plow No. 4 consists of a very strong frame, in which are fixed three subsoil plows, with a pair of wheels in front to guide it, and above the center another pair, to regulate the depth. The shares for breaking up clay soil, in autumn, are set to work six or eight inches deep, (a depth impossible with horse-power.) The points of the shares become imbedded in the subsoil, and the whole mass, nearly a yard wide and six or eight inches deep, is torn from its position and more or less mingled together, leaving, for the most part, the weeds or grass, which it is desirable to destroy, near the surface. An implement of greater breadth and more shares, on light and moderately tenacious soils, has been made to move more than ten or twelve acres a day. But, for a description of the four Wolston cultivators, those further interested must refer to the inventor's own pamphlets and pictures. The obvious drawback of the system consists in the loss of power by the friction of the rope along four sides, and consequent induct friction. Common farm laborers have been repeatedly and easily taught the duties of Smith's system of steam cultivation. According to universal testimony, nothing can exceed the quality of the work and the satisfactory result in crops of all kinds."

It seems to be admitted that Smith's system requires two operations—the first to stir up and break the soil, and the second to pulverize it; the two operations being completed at *the rate of three and a half acres a day*.

It is said that Smith, before 1859, had sold some thirty sets of his machinery to purchasers who were successfully working them.

The idea which has thus been advocated by Mr. Smith seems at about the same time to have possessed some ingenious agriculturist on the

other side of the Channel. In a walk near Paris, in July, 1857, I accidentally came upon a steam cultivator, or digging machine, in full operation. It was a locomotive engine, with, I think, twelve spades, or forks, working in pairs, on bent axles, from which the spades, if they may be so called, projected at right angles. My impression is, that each pair of spades struck the ground and entered it separately, each of the six pairs successively doing its work, as the locomotive traversed the ground, and thus forking up the soil to the depth of six or twelve inches, at the will of the operator, and four and a half feet wide. The machine was under examination by some commission at the time, and I was informed that no report had yet been made upon it, no patent secured, and that no description or drawing of it could be obtained. I took a great deal of pains, afterward, to obtain information, and, from my inability to do so, inferred that there were reasons why the inventor desired, at present, that his machine should not be made public. I was told upon the ground that the engine was only of three horse-power; but its performance indicated far more. It moved upon broad wheels, however, over the soft ground, which had been before stirred by it, and turned without difficulty, at the end of the furrow. The spades, I think, were upon three or four independent axles, and worked between the wheels of the engine. Doubtless, the invention will soon be made public, and a full description of it given to the world. With my inability to converse on a technical subject in the French language, I could not understand its details, and find it impossible to convey more than a general impression of the working of the machine.

AMERICAN STEAM CULTIVATORS.

In a glance at what has been done and attempted by Americans, in the way of cultivation by steam, we shall be struck with the predominant idea of "going ahead." While the greatest performance claimed for any English implement is one acre per hour, or eight or ten acres a day, we find American machines actually plowing an acre in ten minutes, and promising to plow sixty acres per day. With the motto, however, which is no favorite with us, of "*festina lente*," it would seem that more real progress might probably be made. For, we shall see that in nearly every attempt at operating these implements the experiments closed by the breaking of some part of the machinery. The United States Agricultural Society, in their premium list for the exhibition at Chicago, in 1859, offered their grand gold medal of honor "for that machine which shall supersede the plow, as now used, and accomplish the most thorough disintegration of the soil, with the greatest economy of labor, power, time, and money."

The medal was awarded to FAWKE'S STEAM PLOW, together with $3,000, offered by the Illinois State Agricultural Society, in connection with the Illinois Central Railroad Company; and thus this implement is placed, at once, at the head of the list of American steam cultivators, and claims our particular attention.

Fawkes's Steam Plow.

This is the invention of Joseph W. Fawkes, of Christiana, Pennsylvania. The striking peculiarities of this machine seem to be, that it is a locomotive, running on a large roller, or drum, six feet in diameter and six feet long, instead of wheels, the design being to obviate the ordinary objection to locomotives, that their wheels cut into the soil, and obstruct the motion. The engine draws behind it a gang of eight plows, as shown at Chicago, though it is manifest that the number is unlimited, and that cultivators, harrows, and other pulverisers, may readily be substituted; the great desideratum is, a locomotive practicable on a reasonable proportion of land, and, at the same time, cheap and durable. This machine, and Waters's steam plow, which was its only competitor, were both caused by the committee to run twice round the half-mile track at Chicago, and to turn a single furrow, within the inclosure. They were then taken to the smooth, open prairie, for final trial. The result, as reported by the Quarterly Journal of Agriculture, was, that Fawkes's implement plowed at the rate of one acre in seventeen minutes, or three and a half acres per hour, including turns, and the work was excellent. There was some detention by clogging of the plows, which may be easily obviated. It would seem that, after plowing about two acres, the steam got too low for the continuance of the experiment; and the committee suggest some improvement as expedient for increasing the power of the engine. The committee conclude by remarking, that while they "are by no means prepared to certify that Mr. Fawkes's plowing machine has reached the degree of perfection only to be had after much practical working on a farm, they do not regard its several weak points as invalidating its claim to public favor, for enough good work was done, in the two miles of furrow it run on Friday, to prove it to have great merit."

For the benefit of those who desire an understanding of the details of this implement, we add a description of it, by the committee of mechanists who conducted the recent trials of steam plows at the fair of the Illinois State Agricultural Society:

"To form a complete conception of this steam plow, let the committee recall the appearance of a small-sized tender of a locomotive engine. Let about half the forward portion of the sides and tank be removed. We now have something which resembles the body of Fawkes's machine. In the middle of the forward portion of the platform stands the upright boiler, which is about 6½ feet high and 4 feet in diameter, the fire-box and ash-pit being of course below the level of the platform, and the fire-door opening forward. The boiler contains 220 1½-inch tubes, which, computed together with the fire-box, gives 375 feet of fire surface. Steam may be got up in 15 minutes, although twice that time is usually necessary. The fuel may either be bituminous coal or wood. The cylinders are horizontal, 9 inches in diameter and 15 inches stroke, and are placed one on each side of the boiler. The pistons communicate motion not to the side-wheels, but to a drum or roller, 6 feet in diameter and 6 feet long, which, as the sides of the platform overhang its end, is comparatively out of sight. The drum is placed about mid-

way between the front and back of the machine; before it depends the fire-box, and over and behind it is the tank; so that when the boiler and tank are full they nearly counterbalance each other on the axles of the driving drum.

"This drum is composed of two iron heads or 'spiders,' and an intermediate one; to these, thick, narrow planks, cut like staves, fitting closely, are bolted and form the periphery. The adhesion is, therefore, produced by a surface of wood six feet long, which never becomes polished, and the bearing of which is always across the grain. There is no slipping; the machine is started and stopped instantly; and, except when propelling itself a considerable distance on turnpike or paved roads, the wear and tear is slight. This substitution of the driving-roller for the ordinary side-wheels wonderfully increases traction, and prevents sloughing in wet or yielding soil; while moderate irregularities of surface scarcely affect the onward march of the plow. Another great advantage is gained by the gearing of the drum. Instead of being attached directly to a crank on the axle of the drum, each connecting rod communicates motion to a pinion which turns easily, but without shake on the axle just mentioned; the pinion interlocks with a cog-wheel which, by a pinion on its axis, imparts motion to the cog-wheel bolted to the drum; the whole being so proportioned that six strokes of the piston cause one revolution of the drum.

"Increase of power and of control over the movements of the engines are secured.

"In front of the fire-box is a short tapering bow of sheet-iron, which serves as a seat for the fireman and a receptacle for fuel. The bow is supported by a body-bolt on a truck composed of two iron guide-wheels three and one-half feet in diameter and fifteen inches broad. The truck moves freely like the front wheels of a chaise, and is controlled by a steering wheel in charge of the engineer, so that the whole machine is turned as readily and as short as a farm-wagon. The engine is thirty horse power. The entire length of the machine is about 18 feet; its weight with water and fuel, 10 tons; and cost, including 'donkey' engine and pump, about $4,000. By this pump, water may be drawn from a well or creek, and the tank filled, or water forced from the tank to the boiler.

"The tank holds twelve barrels, sufficient for three hours' running. The plows, eight in number, are attached to one frame, which is suspended by chains, passing over grooved pullies, in two beams, projecting from the seat of the engine. These chains communicate to a windlass, in charge of the fireman in front, by which a gang of plows may be raised or lowered at pleasure, and the frame of plows is drawn by other chains, which are attached to the under side of the frame of the engine."

Waters's Steam Plow.

James Waters, of Detroit, formerly of Pennsylvania, is the inventor of a steam plow, which, at Chicago and elsewhere, has attracted much notice. It is thus well described by a correspondent of the "Country Gentleman:"

"This machine has four cylinders, 5¾ inches in diameter, the stroke of the piston being 12 inches. The boiler, which is the one used on locomotive engines, is 6 feet in length, with 100 flues, and can bear a pressure 200 pounds to the square inch. The driving wheels are 10 feet in diameter, and 26 inches on the face, each braced with two sets of iron spokes athwart each other. They are turned by means of a pinion connected with the main shaft or axle-tree, which works into an internal gearing of the size of the inside diameter of the wheels. On the outside pieces or ridges of iron are attached to prevent the wheels from slipping. There are two leading wheels, 5 feet in diameter, and 13 inches on the face. The weight of the whole machine is 7½ tons, which is applied on the front of the driving wheels to produce a steady motion. Two men are required to work this engine, one to steer and the other to attend to the fire. Its working power is 150 pounds of steam, while it can be moved with only 15 or 20 pounds. Underneath the boiler is an iron tank and a fire-box. There is also a tender, which is used for carrying both wood and water.

"Frye's gang plow, another Detroit invention of considerable merit, is the only kind of plow which this machine has drawn yet. The shares of this plow are fixed on a triangular frame, which supports two gangs, and runs on three wheels. They are made expressly for the prairies, and will cut a wide or narrow furrow according to their arrangement on the frame. Mr. Waters states that the width of the cut, counting thirteen shares, is 19 feet, and that he can plow sixty acres a day."

At the trial at Chicago thirteen plows in three gangs were used, hitched one behind the other, which with the engine, tender, and water cart, made a train of thirty-seven feet in length. The machine, after showing its locomotive powers on the track, was put to its trial on the prairie, and made an astonishing start turning a breadth of furrows of nineteen feet at one operation, and running three hundred feet in two minutes, or at the rate of an acre in sixteen minutes, when the performance came to an end by the breaking of a wheel. It seems manifest that Mr. Waters's machinery is cumberous and expensive, and equally manifest that he failed at Chicago for want of care or skill in operating his implement, rather than in the principles of his plow.

An obvious objection to this machine is its great length, which renders it unfit for small fields, and the fact that it does not finish up its work, but leaves a strip of fifty feet in the middle to be finished by horse-power.

By the report of the committee at the Chicago exhibition it appears that two other substitutes for the plow were offered for examination, but no account of the performance of either has been published. One of these was offered by John Van Doren & Co., of Chicago, and is described as "a rotary cultivator, driven by steam and self-propelling. Beside plowing, it may be applied to other uses, such as harvesting grain, cutting grass, and, having a pulley of suitable dimensions, may be used as stationary power for farm machinery. This machine was at work at various times on the fair grounds, but when the committee sent official notice that they were ready to test it in detail the

owner could nowhere be found, and no opportunity was afterward afforded until the close of the exhibition."

The other, offered by B. F. Field, of Milwaukie, Wisconsin, say the committee, is "a revolving plow and seeding machine, and is thus made: There is an outer slatted drum of iron, 4½ feet in diameter and 5 feet wide, made in three sections. Inside, on an eccentric shaft, are fixed three sets of 20 spades each, set 8 inches apart on 'spiders,' but all turning on one shaft. As they come in turn below, the spades project beyond the outer drum through the apertures, and the weight of the machine (2 tons) being thrown upon them, they enter the ground to the depth of 8 inches. The machine turning as it travels forward, the spades coming behind lift the earth as they emerge, and disturb its relative position as would a spade in the hands of a man, except that the soil is not inverted. Behind the spading apparatus, on the back part of the frame which surrounds the whole, is a row of ordinary drill sheaths to deposit the seed in the ground, which is fed to them by suitable hoppers with valves."

It is fair to conclude, from the facts thus brought together, that the subject of steam cultivation is attracting, both in England and America, the greatest attention. As yet, while we cannot admit that in either country any improvement has been tested, which so combines efficiency and economy as to give us assurance of its general adaptation, enough has been done to give us confidence that steam, especially on our broad prairies, must ere long render efficient aid to the farmer in tilling the soil.

CONSTRUCTION AND ARRANGEMENT OF HORSE STABLES.

(CONDENSED FROM DR. RUEFF, PROFESSOR AT HOHENHEIM, GERMANY.)

As most diseases of our domestic animals originate from the domestication to which they have been subjected, a condition often far removed from the natural one, it devolves as a principal duty upon the breeder and owner to take such care of them that this change of life, instead of an injurious, may have a beneficial result. Attention given to horses combines economical advantages, as feeding them in stables is not only a saving of fodder, but, under certain circumstances, also of labor.

The place where domestic animals are kept forms an essential consideration. In all countries, not sparsely settled, and therefore thoroughly cultivated, animals pass a great portion of the year, and even of every day, in the stable. This applies especially to horses, and easily explains the fact of more care and expense being bestowed on them than on any other domestic animals. Yet it is equally true that the labor and money expended for such stables are often insufficiently rewarded by the welfare of their occupants, because the construction

and arrangement are seldom executed with a degree of information corresponding to the importance of the matter, and for the special reason that the necessary knowledge of architecture and diet is rarely united in the builder.

In many cases, building a stable is left to the architect alone, who, when provided with ample means, is apt to indulge too much in his esthetic genius, often regardless of things appearing to be insignificant in themselves, though very important with respect to the principal object. Such things are often neglected, because of their being in contrast with his views of architectural beauty, and opposed to his plans. If, however, the means are limited, as generally happens, the building, notwithstanding the best wishes and knowledge, will often be erected in such a manner as will not answer even the most indispensable requirements.

On the other hand, the keeper of horses would not seem able of himself alone to arrange his buildings, as he has commonly no knowledge or experience in architecture. It would, therefore, always be best for the proprietor and the architect to exchange their ideas, and unite in carrying out such purposes. I have myself received numerous instructions from architects; had the experience of many years in keeping horses; examined plans of stables in various places and countries; and have been led by my position to a profound study of the diet; so that I entertain no fears of architects being dissatisfied at my undertaking to furnish some advice on the arrangement of stables. At the same time, I hope agriculturists and owners of horses will be pleased to receive such views as are based on my own experience.

In the first place, a stable should be protected from climatical influences, humidity, heat, cold, and winds. Again, it should afford security from all mechanical injuries, providing even for comfort, so that the animals, being left entirely undisturbed, may gather new strength for the performance of their services. Atmosphere, light, and heat, as the fundamental requirements of life, are entitled to the highest consideration in the arrangement of stables, and in their application they should be made capable of modification by man. The following points, individually, seem to deserve special attention.

Location.—In constructing a horse stable, the principal front should be to the west, so as not to be too much exposed either to the northern winds or the hot sun during the middle of the day. If, from want of room, any other locality must be selected, the stable should be protected from the above influences by the cultivation of trees, or shutters, blinds, &c. It would not be at all advantageous to locate a stable near a hill-side, or any other elevation, especially one consisting of a loose and porous soil, or, being of rock, if the layers should descend toward the stable, as, thus situated, the water will frequently find its way into the building; at any rate, the wall next the slope will be injured; and besides, such stables are, for the most part, humid and unhealthy. If such a position cannot be avoided, a trench should be dug around the stable at a distance of some four feet from the ground wall, the bottom of the trench to be always lower than the level of the stable floor; or a loam stamp may answer the purpose. These precautions are indispensable if a creek runs near, the surface of which is