difficulty in determining this point accurately. Mr. Pusey, in his trials, took off the wheels from a wheel-plow, and made the comparison between that plow, thus used as a swing-plow, and the same plow used with the two wheels which belonged to it. Now it is obvious that a plow properly constructed for use with wheels, and, of course, to rest a portion of its weight upon them, might be increased very much in its draft, by throwing that weight upon the sole of the plow, or otherwise gauging its furrow by the mode of holding, or of attaching the team to it, to prevent its burrowing too deep. On the whole, it is believed that the draft of the plow can be very little effected by the use of wheels. Most American sod-plows are used with a single small wheel, or truck, to gauge the furrows. Sometimes this is directly under the end of the beam, and sometimes by its side, and, so far as gauging the furrow is concerned, is almost indispensable, but it is not apparent why the draft of a plow should be diminished by throwing a weight on the wheels, if the plow could be so constructed as to run at the desired depth uniformly without such wheels.

It is manifest that with the wheels, or without, there is the same cutting process to be performed, which, as has been seen, causes more than half the draft; there is the same friction upon the mold-board, which must cause nearly, if not quite, the same pressure and friction on the sole; there is the same weight of the implement to be dragged, and, certainly, it would move more easily on wheels, if the plow were so constructed as to rest part of its weight on the beam, when not at work, which is not ordinarily the case. What gain that can be by so arranging the parts that the draft of the team shall bring a weight down upon the wheels which support the beam is not perceived, but it seems that the force which thus bears down upon the beam were better applied in overcoming the legitimate and unavoidable resistance of the soil to the plow in its proper work. If the wheels are useless, it is sufficient objection to them that they increase the weight and cost of the implement. If they are useful merely as a gauge of the depth of furrow, the single wheel, as being more simple and easily adjusted, and as being a lesser obstacle in handling the plow, especially in short work, seems preferable.

SIXTHLY. *The effect of the length of the various parts, as the beam, the mold-board, and the handles, on the operation of the plow.*

The English plows are, on an average, two fifths longer than American plows. There is an obvious reason why short plows must be used in the new lands of our country, and in the stony and uneven lands of New England. Where a stump is to be avoided in every ten feet, or a stone to be scaled at every rod; where the share catches a hinder root, and the team is to be backed every five minutes through the day, and the plow dragged backward by main strength; where it is to be set in again as often as it is thus thrown out, with a precision of aim equal to that required in rifle-shooting, manifestly nothing but a short, stiff, strong implement can possibly be used. For such land the long English plow has no pretense of fitness. But upon the old fields and bottom lands, upon the prairies, after they are once broken, there seems to be no reason why the same plows which would really be most suitable on English farms should not be here most serviceable.

The additional length of the English plows seems to be pretty equally distributed between the handles, the mold-board, and the beam.

Great length of handles gives greater power in controlling the movement of the plow, and greater length of beam gives greater steadiness to the draft; yet the increased length of both these parts necessarily increases their weight, upon the principle of the lever, the greater the length the greater the strength to resist the power applied.

As to the length of the mold-board, it is frequently contended that the longer the curve which turns the furrow the less the resistance, the mold-board being regarded as operating as a wedge; but this idea is open to many objections.

This part of the subject, however, involves so many considerations, which belong rather to the plow-maker than the farmer, that it is hardly appropriate for discussion here. Whatever may be the true theory as to the length of the mold-boards, its increased length does not necessarily involve the increase of the length of the other parts. To the practical working of the long English plows, there is an obvious objection in the minds of all who have seen them at work in small fields. Horses are almost exclusively used there upon the plow, and are harnessed one before the other, and with greater length of draft-chains than we are accustomed to use.

As a consequence of this "long drawn out" establishment, a wide headland is left, utterly beyond the reach of the plow, so that where, in America, we back up and set in our short plow close to the fence, the English farmer sends a man with a spade to work a half day in finishing up the land. Where labor is cheap, as in England, this is of much smaller importance than it would be with us.

As a general summary of the matter, as to the comparative merits of the English and American plows, it is believed that we have improved greatly upon the models, in the lightness of our implement, in the less cost of it, and by dispensing with their more complicated arrangement of wheels. Whether, by shortening the whole implement about two-fifths, we have not sacrificed to our peculiar wants upon new fields something of the nice control which the length of beam and handle gives to the English plowman, is, at least, questionable. Whether we have gained or lost by our changes in the length and form of the mold-board, is still undetermined, and must remain so till both implements are tested, in the same field, by the dynamometer.

Finally, there can be no doubt that, generally, their plowmen have more skill in their business than ours in New England; and he must be a careless observer, or blinded by prejudice, who does not see that their labor in this important department is better performed than in our own country.

STEAM PLOWS IN ENGLAND.

Fowler's Steam Plow.

Steam cultivation is attracting great attention among the foremost agriculturists in England. The two steam implements which seem

now to dispute for supremacy are Fowler's plow and Smith's (of Wolston) cultivator. The former performs its work strictly by plowing, the latter, as the inventor elegantly expresses it, by "smash ing up" the soil, by means of teeth operating like a spade to stir, without subverting the soil.

To Fowler's steam plow was awarded, at the exhibition of the Royal Agricultural Society, at Chester, in England, in 1858, the grand prize of £500, and at Warwick the new prize of £50, in 1859, which furnishes the best evidence we can have of the comparative merits of English implements, and entitles it to a prominent place in any article on the subject. At Ipswich, in England, on the 4th of July, 1857, I saw in operation Fowler's steam plow. Having previously seen, at the workshop of Ransome & Simes, the same implement, and having had its principles of operation carefully explained, I spent several hours with it, while actually at work upon a large field, where it had already plowed many acres. It was, while I observed it, turning furrows seven inches deep, by about ten in width, carrying three at a time, and performing its work as well as it could be performed in the usual way with horses. I carefully paced out the length of the furrows, and measured their depth and widths, and, with my watch in my hand, timed the operations. The machine was then plowing one acre per hour.

The arrangement was to use four plows and open four furrows at each passage across the field, and in that way the labor accomplished would be one third more. It is difficult, without drawings for illustration, to describe intelligibly the details of such an implement, but its general plan of operations may be readily understood. The plows are arranged in two gangs, of three or more, one gang at each end of a heavy framework, which is balanced across an axle, supported by two large wheels, like those of a heavy gun-carriage. This framework, with the plows, is drawn across the field by a stationary engine. As it is drawn northerly, for example, in its work, the frame which carries the plows is borne down, so as to lift the gang of plows at the northerly end high into the air, bringing down the southerly end, with its plows, so that they enter the soil for plowing. The depth is gauged, mainly, by a large wheel at each end of the framework, opposite the plows, which wheel is, in turn, lifted into the air or brought down to the surface, with the gang of plows to which it belongs.

Two men sat upon the machine, one to guide its motion, by appropriate machinery, the other to make signals with a flag, or do any other useful work that occasion might require. The engine in use was upon one side of the field, and was called a stationary engine. It was drawn to the field by horses, but had powers of locomotion sufficient, I think, to run itself along the headland. The plow was drawn *toward* the engine by a wire rope, which passed across the field, round a pulley, made fast at the opposite headland. This pulley was held by what was called an anchor, which anchor was in the shape of a four-wheeled low cart or car, loaded heavily with stones. The wheels of this car were of iron, and sharp at the edges, so that they cut down nearly to the axle. This anchor was drawn along the headland by a windlass,

worked by a man, in a direction at right angles with the furrow, so that the strain upon the pulley was at right angles with the track of the wheels. In justice to the inventor, it should be stated that he had already, it was said, constructed machinery, to be worked by the engine, to move the anchor, and so dispense with the man at the windlass.

It will be seen at once that this machine could only be of practical utility on level, clear fields, of large extent. It could only be used upon level fields of uniform surface, because the plows are set in an unyielding frame, and must run at the same level, thus running deeper across a hillock, and more shoal in a small depression. They are arranged not so as to be raised and depressed, each separately, as the machine is moving, but the whole gang is acted upon at once. Again, the machine would be of no use in a small inclosure, because of the broad headlands requisite to accommodate the engine on one side, and the anchor on the other.

It could be of little use in a field obstructed by stones, because of the inequalities of surface produced by them, and because, if one of the plows meets an obstruction too obstinate to yield, the power of the engine must generally be sufficient to break the plow, or, what is more common, the rope. The breaking of a plow must involve, at least, the necessity of a delay sufficient to detach it and substitute another, and such a delay of so large and expensive a force as we shall presently see is employed, must be of considerable importance. The breaking of the rope, which I was informed by the workmen was of frequent occurrence, is soon remedied by splicing it, but is, probably, a constant source of annoyance. As, however, it is impossible to foresee all obstructions, and the engine must exert great power, it is, perhaps, best to make the rope the weakest part of the machinery, as it is the most easily repaired.

The force employed in this operation, as I witnessed it, beside the engine, consisted of five men and a boy, namely, the engineer, who remained by the engine, a boy to carry coal, one man upon the plow to manage it, another man, who rode part of the time on the plow, and who ran along before it to remove pulleys or rollers over which the rope traversed, to keep it from friction on the ground, another man to tend the windlass and anchor, and the other to keep the rope in place, with a crowbar, that it might wind properly round the drums of the engine.

In estimating the value of such an implement as this, there are certain elements always to enter into our calculations. First. The amount of labor performed. A span of horses and a plowman would, in England, as a regular day's work, plow one acre of such land as that under experiment. They would work six hours, without feeding, and in that time complete the day's work. This is the practice, I think, in most of England as to working horses. Six plowmen and twelve horses would, for six hours, perform the same work as the five men and boy, and the engine, and all the machinery. But the engine would not then be fatigued, but might labor on, while the horses must rest. Still, taking into account the liability of complicated machinery and of so great a length of rope to accidents which must cause delay, perhaps the steam plow could hardly be expected to be actually at

work nine hours per day, any more than the horses. Second. The expense and time employed in moving the engine, and plow, and anchor to the fields of operation, and placing them in position. I did not see the engine or machinery moved with horses, but this item is worth a place in our estimate, both as to expense and time. Third. The cost of working, which has been already considered, but there is to be added to the cost of the labor already named, the expense of supplying the engine with fuel. Both the coal and water are of heavy freight, and must be conveyed to the engine by horses and men. Their cost, at the field, must depend so much on the locality that it is useless to attempt an estimate. Probably an additional pair of horses and a man would be usually employed to supply the meat and drink of the steam giant. Fourth. The cost of machinery, and of repairs upon it. It was said that this engine and plow could be furnished, ready for use, at £500, or $2,500. It would require an engineer to estimate the cost of repairs. Unless the machine could be kept in constant use, the interest on the cost would be a heavy item, and, in all cases, must be a constant element to be regarded. The engine would be adapted to other farm labor, such as threshing, grinding, and the like. Such engines are in constant and extensive use for threshing, through England, on large farms. The inventor of this steam plow had taken a large contract to plow for several proprietors, a practice which, perhaps, should be kept in view in this discussion, though the difficulty of moving the engine from farm to farm, in this country, would be far greater than in England, because our roads are not so well made.

Upon the best estimate that I have been able to make, it seems to me that Fowler's steam plow can never be made an instrument of general practical utility, either in this or in any other country. Perhaps a more competent person, with such data as has been furnished, may form an estimate more favorable.

Simplicity is usually economy, in agriculture especially, and there does not seem, upon the theory of this machine, any such promise of performance as to compensate for the great expenditure in its structure, and the numerous obstacles to its practical operation.

Since 1857, Fowler's plow has been extensively used in England, and may be said to be fairly introduced there, but it may be inferred, from the tone of agricultural writers and speakers as gathered from newspapers, that it is quite doubtful yet whether it is really a valuable acquisition to agriculture. Subsequent experiments seem to indicate that my own estimate of the performance of the plow was too large. A recent writer in the Mark Lane Express states that at one trial, which he witnessed, the plow turned seven acres in twelve hours, and another account gives ninety-six square rods per hour as the result of its labor.

It is claimed, however, that Mr. Fowler has recently greatly reduced the weight and cost of his machinery. The essential principle of a stationary engine and plows or cultivators worked by means of ropes and pulleys remains.

Boydell's Patent Traction Engine.

The question in England between stationary and locomotive engines for cultivation seems strangely enough to be going almost by default in favor of the former, while in this country there appears to be a general consent that only a self-moving engine is worthy of notice. Boydell's elephantine engine attracted great attention, and disputed the prize with Fowler's plow, at the Salisbury exhibition in 1858. It has, apparently, fallen far behind in the face of competition, and in a respectable English journal has been lately spoken of as a mechanical absurdity, which wears itself but hourly as it travels. This brief condemnation is full of import to American inventors, who are giving attention exclusively to locomotive engines, and whose chief embarrassment thus far has been that their machines all break down in every attempt at public exhibition. A brief description of Boydell's implement may be useful to us for warning as well as example.

This engine, as exhibited at Salisbury, was operated to draw six plows, opening six furrows across the field. It is distinguished from the other steam plows that have been mentioned by being worked by a locomotive, instead of a stationary engine, which works on the earth like some huge animal, puffing and snorting, and taking along its six plows with no apparent consciousness of effort. It possesses another peculiarity: that of laying down an endless railroad track for its wheels to run upon, and taking it up as it proceeds. Attached to the wheels of the engine are large flat blocks, six to each wheel, like rackets on a horse to keep him from sinking in soft ground, which are laid down in turn by the wheel in its revolution, and on which the iron rim of the wheel runs. This engine works about in a very intelligent sort of way, comes to the field from a common road, drawing its tender with coal and water, and even carries the extra clothing and dinner of the laborers. It turns readily at the end of the furrow, stalks off to its water tank when it is thirsty and helps itself to water, and when it is hungry or fatigued, goes for its own coal for refreshment. It is claimed that the same engine can draw your timber to market or the mill upon common roads, haul in your hay and grain, work your threshing machine, and, in short, do most of the work of the farm instead of horses. This machine was not, at Salisbury, doing such good plowing as Fowler's, but the quality of the work is not at present of such importance. It is not a question of mere plowing, it is a question as to the best mode of applying the power of the steam engine, whether as a stationary or locomotive engine, for it is obvious enough that when we have once found a convenient and economical power, plows, harrows, digging machines, or anything else may be worked by it. Boydell's engine is guided by a driver, who sets on the forward part, while the engineer rides, like a footman behind. Three double plows were, at Salisbury, attached to it by chains, and these were held by three men, who walked, following and holding the plows in the usual manner. Many of the objections to the stationary engine are obviated by this invention. No horses are required to move it from place to place, or draw its supply of food and water. The cumbrous

"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