

His statements in regard to gravity are correct. Let us apply the latter and see where it will lead us. If a resistance P, be moved with a uniform velocity v , then would the work done in a unit of time be

$$Pv \text{ and in a time } t, \text{ it would be } Pvt = PS \quad (1)$$

But in a falling body the resistance overcome is the weight, and the velocity is uniformly increasing; so that the work done during any element of time, Δt , is by (1)

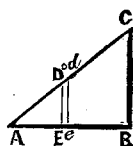
$$W v \Delta t \quad (2)$$

But from a law of falling bodies,

$$v = gt \text{ or } \Delta v = g \Delta t,$$

which in (2) gives $\frac{W}{g} v \cdot \Delta v = Mv \cdot \Delta v,$

This solved by the calculus gives $\int M v dv = \frac{1}{2} M v^2$, but as I wish to make it intelligible to those who do not understand the calculus, I will give the following way of finding the sum of all the products of $v \cdot \Delta v$ between 0 and v . Let any ordinate, as DE, represent the velocity, v . Since the velocity uniformly increases, the line AC will be the limit of the ordinates. Let $Ee = \Delta v$, then will the vanishing trapezoid be ultimately equal the rectangle of which DE is the base and Ee the altitude; hence DEed = $v \Delta v$. The sum of all the infinitesimal rectangles will equal the area ABC. The sum of all the altitudes of the rectangles becomes AB = v ; hence the area equals $\frac{1}{2} v^2$ and the expression becomes $\frac{1}{2} M v^2$.



My attention has been called to several other points, but they indicate too limited knowledge of the subject, or too little thought bestowed upon it to make a reply to them profitable in this connexion.

Momentum has no reference to the *resistance* to be overcome, but to the *motion* which a body of known mass and velocity will induce in another mass free to move, when the former impinges upon the latter. As the expression indicates, it pertains only to the relations between masses and velocities of different bodies. Momentum may be considered as the measure of an impulsive force; one-half the vis viva, the *sum* of all the energies (or forces) exerted to cause a velocity v . I trust that the relation between momentum and work, in the example used in my previous article, is sufficiently explicit. I will, therefore, drop the subject until circumstances induce a further consideration of it.

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The Forces ; Slave Labor ; Working Land by Steam ; A Cycloidal Cultivator.

Of mundane agencies FORCE—physical energy or power—is unique and supreme. All that we see, and feel, and hear, and do; light and life, forms, qualities, and motions, proceed from it. Its proper use comprises the whole economy of life. It is emphatically *the* talent given to men to profit withal. It places the destiny of every people in their own hands, for the amount at their disposal is not limited, nor are the

means of employing it. If it had nothing to do in originating differences between races, it is an imperishable criterion of their varied conditions. While the foremost keep startling the world with wonders wrought by it, others sleep on unconscious of its value. A generic term, it consists of various forces, animate and inanimate; and as the more the latter are brought into play, the less become demands on the former, hence they who add to our working stock of insensible energies, and they who extend their applications to great industrial interests, are, or ought to be, classed among public benefactors. In cheapening force (by increasing its amount) they cheapen its products, and by lessening human drudgery, they help to secure for their species, as respects food and raiment, that condition which is essential to mental and moral culture.

The forces constitute a series that grows with man's growth. They lift him from one stage to another. Taking him up on the lowest and bearing him along towards the highest. We know what the former is, but of the latter we catch only glimpses. With his own strength only man is, and has always been, a savage. The ass and the horse raised him a degree, the ox and the buffalo another. Yet from our standpoint how low appears the status of the Arabs, the Tartars, and others, and with the additional elephant and camel, that of the people of India and of Asia generally. In running and falling water, and subsequently in wind, forces very different from the former were realized. Inanimate and therefore insensible to hard usage, and requiring neither food nor rest, they added vastly to his working capital. What the result was, we have a graphic representation in the oldest of existing people—the Chinese. They, of course, are considered as having acquired only a partial civilization, but we apprehend that it is as complete as those forces could effect. With the same, no people have surpassed them. We doubt if any have equaled them. The next movement was the greatest, and is recent. The agent, as may be supposed, was not, like the foregoing, derived from bodies put in motion and kept moving by nature. The advance of modern society could not have been effected by one, nor by all of them: they prepared the way for the leap, but could not take it. It was the result of the advent of a higher class of agents; such as demand a further stretch of intellect to evolve and control—such as man himself is to call forth for himself from bodies at rest.

Competent (as far as reason can reach) to meet the expanding wants of society for all time, they may be the last as they assuredly are the greatest in the series. Varied and palpable proofs we have of national prosperity and power in the augmentation of their leading representative, *Steam*. Look abroad and see if the first nations are not its greatest consumers. The richest they must needs be, since wealth arises solely from productive labor, and they the chief dealers in it. Close the coal mines of Great Britain, or let the fires of her steam motors die out, and she will descend at once from her high position among the nations. No possible amount of human ingenuity and industry and of animal power, could arrest her declension. No, not the living

twelve hundred millions of human beings could do the work which steam is doing for her. And what it is doing is but a fraction of what it is destined to do for her, and for all who choose to employ it. There can be no monopoly of it, no quarreling about it. Free as air, cheap as wood and water, those who have it not have themselves to blame.

[*En passant*: Had the study of nature's laws respecting the Forces she has provided for man, by which to work out his destiny, been included, as it ought to be, in College instruction, this terrible war that is converting whole States into graveyards, might have been postponed—perhaps had not broken out. At all events, if its authors and abettors had been impressed with the fact that there are forces ten times less costly than negro labor, and ten thousand times more abundant and effective—that one of them can do more work in a week than their slave population in a year; that, in short, inanimate powers are ordained to supersede human slavery, and even to ameliorate the labor of animals, they surely would have paused ere calling up the demons of rapine and blood—they would have been reminded that the vast amounts of slave labor already displaced by steam are an earnest of more, and possibly have been disposed to wait for further developments of a power that seems all but omnipotent for human affairs, and only waiting to be applied to them. It is true that great social elements make themselves felt slowly. They must do so if genuine, for nature produces nothing abruptly; but steam has been growing upon us for a century or more, and has now become widely acknowledged as prominent among productive forces.

If there is anything made manifest in the economy of the planet, it is that living forces are weak, irregular, and quickly consumed—that they are introductory to the powerful, untiring, and exhaustless inorganic energies—that it is by these the work of the world is to be done, and that compared to them the amount of animal labor is a trifle, and that of human toil—a nothing. Slavery, irrespective of the habits it imparts, is purely a question of labor. When it becomes less profitable than other forces at hand, that is the signal for its dismissal. Its upholders may object, but it must yield to the law, and give place to inanimate power: the world is moving and is not to be stayed by them or for them. Hence, secessionists have undertaken something like an impossible problem in attempting, at this day, to raise a new political structure with negro bondage for its basis and corner stone—and this too in immediate contact and competition with free white institutions. The time for it has passed. The world has outgrown it. But such is not their belief. Reared in an atmosphere of slavery, they do not perceive why other people should object to live and move and have their being in it. There have been old hospital patients that preferred the tainted air of the wards to fresh breezes outside.

It is one of the thousand proofs of the support-enlightened Christianity receives from the doctrines of science—every one of which is divine—that the Creator does not appear in His works in the character of a Moloch on whose shrines negroes are to be perpetually offered up, but

in that of a tender and impartial parent, who has made the amplest provision for relieving every race from oppressive labor.

It is vain to wish the South had been willing to resolve the difficulty into a simple question of labor. Perhaps it is equally futile to wish the North would offer a premium for a practical demonstration that slave labor can be replaced by other agents with advantage to the planters. The offer of a single day's cost of the war would be more than sufficient to set the keenest of the world's engineers at work to extend the application of steam to out and in door labor, and to stir up the leading chemists in every country to hasten the birth of forces awaiting their assistance—among them *atmospheric pressure*, the use of which as a popular motor, and the most popular one, seems only held back as by a thread. A cheap device by which to decompose or otherwise promptly to get rid of air or vapor under a piston is all that is wanted. That gained, slavery could not survive it an hour—and it is one of those things that may be hourly looked for.]

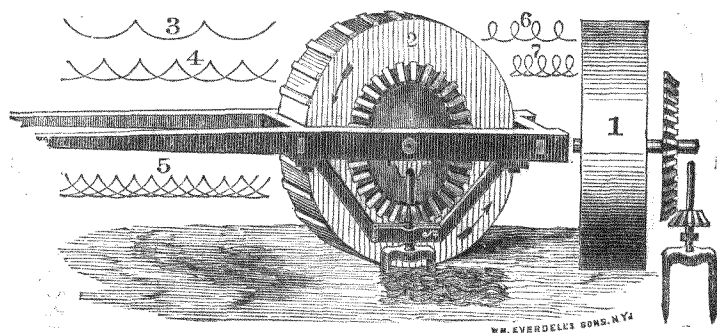
The superiority of modern arts is due to the introduction of steam power. It has diminished the cost by increasing the products of industry—it has added to the elegances and multiplied the conveniences and comforts of life, wrought a revolution in almost every department of manufactures, and established a system of traveling by sea and land that would have been deemed miraculous a century ago. It has sown knowledge broadcast by making books common as waste paper. Yet on one great division of labor it has scarcely entered. It has done nothing, or next to nothing, in tilling the land. Not a tithe of it has anywhere been brought under culture. True, an adequate force was long wanting, but one is now sufficiently developed, nor is there room to doubt that steam is ordained to rival in the field what it has accomplished in the factory: that is, to double and quadruple the earth's harvests—to provide, and keep providing, breadstuffs for a population destined, through cycles of ages, to increase in numbers and intelligence. Why has it not been pressed into this service? Are the arts not sufficiently matured properly to apply it? Or is not the delay rather due to attempts to work an old implement with it—one to which it cannot be profitably adapted?

The plough arose from attempts to substitute animal for human labor, and certainly a device better adapted for the purpose, in the simplicity of its form and action, and in the direct application of the power, it would be difficult if not impossible to name. It belongs however to living forces. It came in with them and cannot long survive them. It has been the subject of numerous modifications without affecting its cardinal features, and these it must retain as long as it is associated with draught animals.

We all know that as the arts mature, modes of employing Force become more and more varied. To the extensive adoption of circular for straight motions may be ascribed, in no small degree, the progress they have made in our times; and no one needs reminding that the general effect of steam on transmitting and operating mechanisms has been the substitution of continuous-rotary for alternating-rectilinear

movements—a change to which the plough cannot conform without itself being changed. Effectually to cultivate the soil by steam, the working implements must, we apprehend, be revolving ones, and their action, instead of being derived from the forward movement, be independent of it.

Suppose a modern engineer who had never turned his attention to agriculture was employed to bring extensive tracts of wild land into cultivation—to break up the soil and comminute it to the depth of 8 or 12 inches, how would he thus prepare it for seed? I venture to say that he would no more propose any thing analogous to the plough than he would reinvent the flail for thrashing, wait for a wind to separate chaff from wheat, or pound rice into flour in a mortar. Steam would be his power, and to it the form and action of his implements would have to accord. Their movements would be rotary. They would pare away the soil to the requisite depth before them, and leave it thoroughly lightened up behind them. This they would effect, instead of a partial disintegration by dragging a blunt instrument horizontally through it. In brief, I suppose he would develop something more or less allied to the following device.—Though designed to be worked by steam, it is figured as adapted to horse power, on which account the shafts and large drum are introduced—appendages useless when steam is used.



It consists simply of two perpendicular prongs with flattened or sharpened edges—or strong narrow knife blades—formed on the lower end of a short vertical axle, with a pinion which, by its connexion with a bevel wheel, rapidly revolves them. See fig. 1. One side of the bearing piece that supports them is hinged and fastened by a hasp, to allow them to be readily slipped into and out of their place. See fig. 2. Such is the implement, and the whole of it. All the rest is merely to work it. It is little else than a revolving edged fork. The length of the prongs or cutters is of course determined by the depth of soil they are to stir up. As their cost is trifling, three might be kept on hand—a 4-inch, an 8-inch, and a 12-inch one.

In some cases one, but in almost all cases two prongs will be sufficient. If three are required they should be arranged triangularly—that is, at equal distances from the axle. By no possibility can one run

into the track of another. The ordinary tracks of a single prong are represented at 3 and 6, of two at 4 and 7, and of three at 5.

The tracks are cycloidal curves, which may be varied from undulating or wave lines to intersecting circles, or figures approaching circles.

The action of the ploughshare is well known to be that of a wedge pressing on the soil beneath it, and with a force equal to that which displaces what is above it.—Every year's ploughing adds to the compression, since every force brought to act on the surface reacts on the undisturbed base. The effect is obvious in old fields. Gravelly and sandy bottoms have become hard and compact almost as stone, and subsoils so dense as to exclude the circulation of air through them. With this cultivator nothing of the kind can occur, since the acting parts transmit not a particle of pressure below. Moreover, neither the feet of the ox or horse, nor the wheels of a steam motor, travel over the ploughed ground. Every thing moves over the unploughed surface except the prongs, and they are suspended from above.

As there is no dragging action there can be no slipping of the wheels of a steam motor—that which has given experimenters most trouble—for the force given to the prongs reacts *within* the carriage—not without. Hence the forward force has only to move them up to their work—not to do it. Their action may be likened to the teeth of circular saws cutting their own way through a log, and only requiring it to be kept up to them. As the prongs act equally in any direction, their motion has only to be reversed at the end of a furrow or field.

I may be wrong, but I suppose any required depth of fair soil may be as completely loosened, lightened up, and prepared for seed, *at one operation*, by this cultivator, as by any one now in use, and with a smaller outlay of force. That which is required to cut 12 inches deep can, I think, be little more than half what is consumed by subsoil ploughs. It is known that thin soils, resting on hard pan, yield greater crops if the pan be loosened to permit the roots to shoot into it. Now these revolving prongs can readily work into it, and without mingling it with the soil, while a succession of roots will gradually fertilize and enrich it.

With the exceptions of breaking up new lands, and working among stones and roots, there seems to be few operations of the old plough which this cultivator cannot perform. It appears to be well adapted to give an intimate and perfect stirring up to light and medium soils; and such is said to be the general character of those of England and France, and of other parts of Europe—also of India, and the sugar and cotton lands of our Southern States.

The hold the cutting prongs take, can, of course, be regulated to slice off portions of any determined thickness—and as they can be arranged that even a man's power could work them in fine soils, possibly market gardeners may find an implement of the kind more economical than their ordinary apparatus.

After citing supposed points in this Cultivator, it would be just to indicate its weak ones. But what they are, practical men must deter-

mine. It is not supposed to be free from defects, nor do I think, as already intimated, that it is calculated, in its present form, to supersede the plough, except in fine, light, and loose medium soils. Still, where it cannot act the part of a principal, it may serve as a useful accessory. The question turns on the value of this *cycloidal movement of vertical blades or cutting prongs*. The principle is a novel one in agriculture, and may, at least, suggest an improvement in working the soil, if it be not itself one. E.

New York, Dec. 21, 1863.

On a new Method of Casting Guns Hollow. By Mr. OUBRIDGE.

From Newton's London Journal of Arts, December, 1863.

The author remarked that the subject which he proposed to consider that evening was one upon which much had been already said and written. He believed, nevertheless, that it was not exhausted; for it was a fact that, as yet, no heavy gun had been produced which answered all requirements. Brass guns had had their day, cast iron guns had been long used, were at one period almost totally condemned, but were now cropping up again, and much might be adduced in their favor. Wrought iron, in multiforms, had been employed in the manufacture of guns, each form having peculiar advantages; but the results, on the whole, were not satisfactory. Steel had also been introduced for the purpose; but in spite of its great cohesive strength, it had been found impossible hitherto to make from it good, sound, and serviceable guns of large calibre. Many practical difficulties stood in the way of its employment in this direction, although certainly some very successful efforts had been made to construct light and small pieces of ordnance of that material. Compound guns, composed of cast and wrought iron—the one encasing the other—had also been tried, with variable and uncertain effects; but as yet no absolute rule had been deduced for the guidance of those whose duty it was to manufacture heavy guns. Time, and the expenditure of much more of the public money, might effect this great desideratum; but it had not yet been achieved; and it was, therefore, the duty of practical and scientific men to endeavor to solve the problem “how best to manufacture heavy guns?” He (Mr. Oubridge) intended to contribute a few items to the mass of existing information on the subject; and he might state that such knowledge as he had to impart had been gained from his own experience and experiments in the iron foundry. It was required, in the production of large pieces of ordnance, that the material used should be made to offer the fullest possible resistance to the bursting strain to which it would eventually be exposed, and that the cohesive strength of that material should be completely maintained. Perhaps, before advancing his own views, he might be permitted to refer to the method of casting heavy guns, which had been largely practised during the unhappy contest which still raged in America. The name of Dahlgren would no doubt be familiar to his hearers in connexion with the American civil war, and the guns which