Journal of the Society of Arts.

FRIDAY, DECEMBER 10, 1858.

SOCIETY OF ARTS EXAMINATIONS.

The Council have much pleasure in announcing that Mr. George Harrison, of the Young Mens' Christian Institute, Leeds, and Mr. George Best, of the Mechanics' Institution, Leeds, who distinguished themselves at the Society's Examinations in May last, and who had been nominated by the Council to compete for Supernumerary Surveyorships of Taxes, have obtained appointments, being placed first and second respectively in the list of successful candidates.

There were on this occasion five vacancies and fifteen selected candidates, two nominations having been placed at the disposal of the Council by Lord Derby.

The following letter has been received from the Secretary to the Treasury:—

Treasury, S.W., 7th December, 1858.

Sir,—I find, from a report I have this day received from the Civil Service Commissioners, that Mr. George Harrison and Mr. George Best, have succeeded in obtaining the first and second places respectively in the late competition; and I have had much pleasure in giving directions for their appointment as Supernumerary Surveyors of Taxes accordingly.

I have the honour to be, Sir,
Your obedient servant,
(Signed) W. J. HYLTON JOLLIFFE.

P. Le Neve Foster, Esq.

FOURTH ORDINARY MEETING.

Wednesday, Dec. 8, 1858.

The Fourth Ordinary Meeting of the One Hundred and Fifth Session, was held on Wednesday, the 8th inst., Thomas Dyke Acland, Esq., Member of the Council, in the chair.

The following candidates were balloted for and duly elected members of the Society:—

Chance, George | Terry, Alex. Robt., C.E.

The Paper read was—

ON GUIDEWAY AGRICULTURE: BEING A SYSTEM ENABLING ALL THE OPERATIONS OF THE FARM TO BE PERFORMED BY STEAM-POWER.

By P. A. Halkett.

In bringing the subject for this evening, "Guideway Steam Agriculture," before the members of this distinguished Society, I feel that it is incumbent upon me to give as full a description of the plan and machinery as possible, but as the details are numerous, and I shall not, in the space of time allotted to me by your kindness, be able to enter into an explanation of all its parts, I hope that I may be permitted to refer members desirous of further examination of the subject to that which was published last year, namely, a letter to the Secretary of the Royal Agricultural Society, which appeared in your Society's Journal, to the published accounts of the system in the professional papers and to the reports of a meeting at Freemason's Tavern; since which time, however, some very important improvements have been invented, and amongst others, a new system of guideways by which the cost per acre may be considerably reduced, and a new cultivator suitable to small holdings.

My invention, comprising a system of permanent way which is fixed to the ground, renders me unable to exhibit for competition at the annual shows of the Royal and other Agricultural Societies, and the amount of publicity which it would in consequence obtain, is lost; but I may truly say, that notwithstanding this, there is a fast growing opinion that the system which I bring before you this evening is the one which, in all respects, best fulfils the wants and expectations of the agricultural community upon the subject of steam cultivation.

The great advances which have been made by Messrs. Smith, Fowler, Romaine, Boydell and others, in ploughing and breaking up the land within the last year or two, have schooled the mind to the possibility of steam being eligible for use in the field, and prepared the agriculturalist to expect a system that shall perform more than one operation.

Another important change has taken place in the mind of the public, relative to the source from which the profits are to be looked for in steam cultivation; this arises from the belief that the commercial advantages gained by Mr. Smith and Mr. Fowler are not so much in the less cost of the operations themselves as in the increase of crops resulting from those operations, and in some collateral economic advantages to which I will refer again; but it is this better cultivation and consequent larger amount of produce which is the most important consideration to hold in view, and the point in which I maintain that my system has its greatest strength; and I may say, without fear of contradiction, that there has not been a competent judge, who has seen my operations, who has not given it as his opinion that much larger returns will be obtained by my system. Let us for one moment look at the question of profit by means of produce, and profit by saving on labour and it will be seen in which direction the most is to be expected; in the one case let us suppose produce to be increased, merely for illustration, 50 per cent., or from, say, £8 to £12, and in the other let us suppose the cost of field labour to be £3, and to be decreased in the same proportion, namely, to £2; in the one case a profit will be made of £4, and in the other of £1.

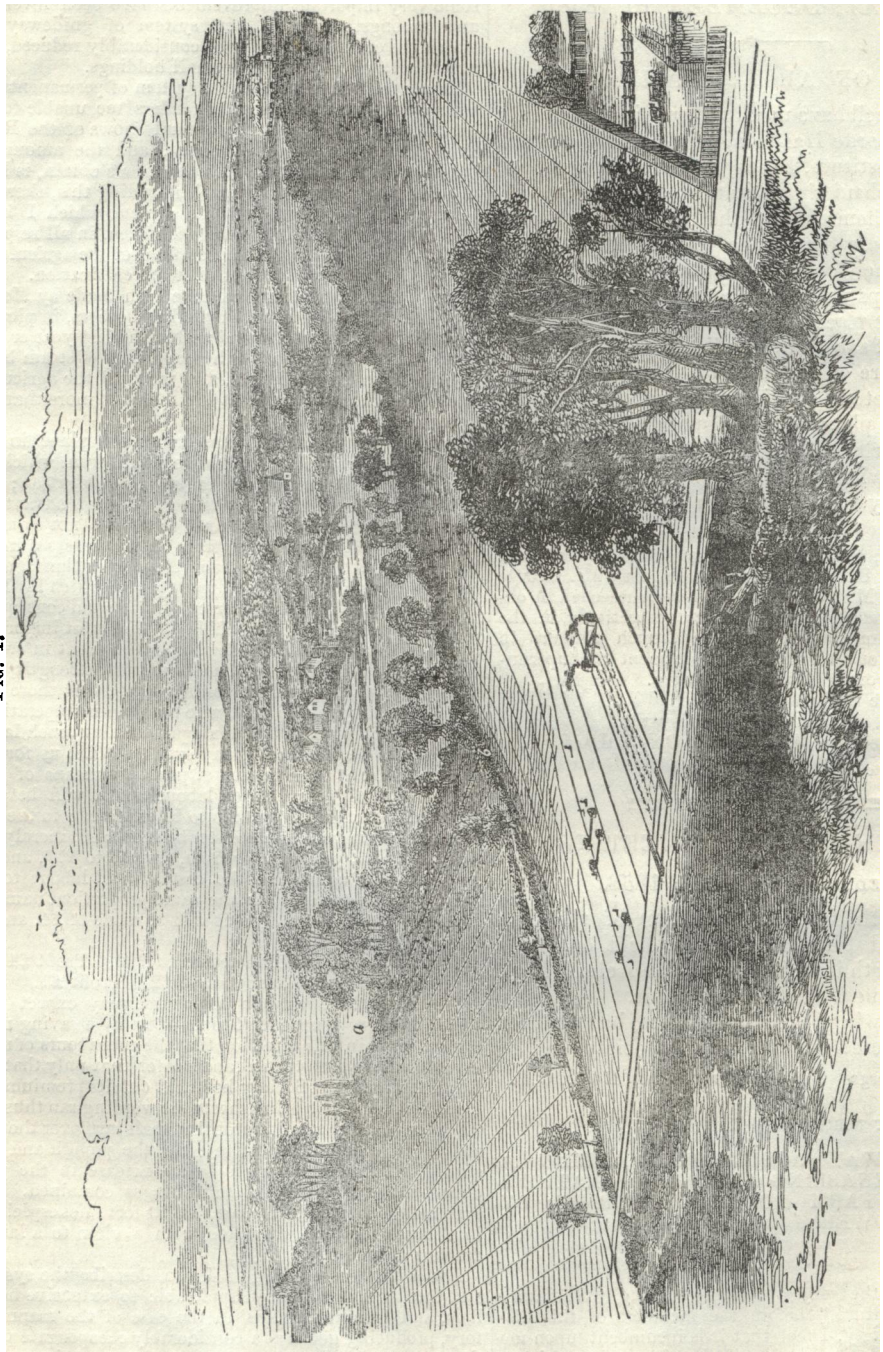
Present produce £8, increased to £12. Profit £4.
Present labour £3, reduced to £2. Profit £1.

There are three ways in which we may expect that steam may prove beneficial to us—first by a saving upon labour. It is in this direction that the endeavours of most inventors have been turned, and it is for that only that the Royal Agricultural Society has held out its premiums to inventors. In their prize sheets the wording ran thus:—"For the best steam cultivator that shall turn over the soil and be an economic substitute for the plough and the spade." The second way is by an increase in the produce—and the third both advantages combined. My system is conceived in the last, but its forte lies especially in a much better cultivation with a view to a larger amount of produce.

I will now, as shortly as I can, describe the system and the large machinery applicable to extensive holdings, and from which, as in the case of the manufactory, producing goods at a considerably cheaper rate than the cottage loom, we may expect the most important commercial advantages. I will then describe the smaller cultivator, on a perfectly different construction, and for which I have very much to thank the engineer, Mr. Grafton. Although it will not carry out the operations at so small a cost as the large cultivator, yet, by

its being applicable to small holdings, it will enable land to be laid down with this system which before could not be thought suitable for it; and I will, when describing the prominent subject of the invention, the guide-ways or rails, invite your attention to a system of rails which was not brought before the public last year, and which will reduce the cost of the system by one-half per acre what it then was calculated at.

FIG. 1.



View of a Farm laid down with Guideways, showing the Cultivator ploughing; a number of trucks taking off produce; the headland rails upon which the Cultivator is moved from one set of rails, or from one part of the farm to another, and a level crossing at the road, to enable it to communicate with the adjoining fields.

The diagram (Fig. 1) will convey some idea of the Guide-way system of steam agriculture. This invention consists in the application of motive power to the cultivation of the land, by attaching the implements required for the various operations of ploughing, scarifying, sowing, hoeing, reaping, or other operations of culture, beneath a travelling carriage, which moves on rails placed in parallel lines across the fields to be culti-

vated, by which the implements are always kept from swerving to the right or left of the line of onward motion, and the friction of the machinery is considerably reduced.

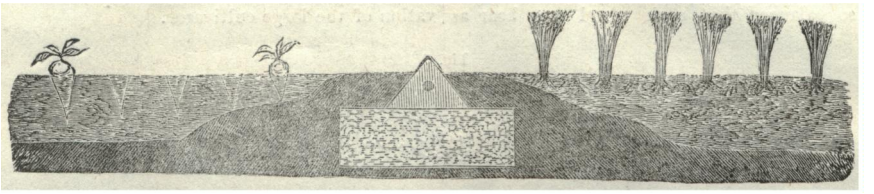
The gauge or space between the lines should be as wide as possible, consistent with the practical application of the travelling carriage or cultivator, in order to diminish the cost of rails by reducing the number per acre as also the extent of space occupied by the permanent way. The width between the lines I have in use upon my land at Wandsworth, or upon the piece of ground at Canning-place, Kensington toll-gate, is thirty feet, but there can be no difficulty in extending it to fifty or more feet.

At right angles to those rails along the headlands, separate railways are made on a lower level than the former rails, and upon each headland railway a carriage is placed, the top surface of which is on a level with the field rails, and upon this the cultivating machinery moves, and is transferred sideways from one set of rails to another, or home to the steading, where it may be used for barn operations; supposing, then, the ground between the two first rails to have been operated upon, the machine is propelled on to the headland carriage, and by it transferred or shunted in the manner that carriages are shunted on railroads, to the next breadth of rails down which the cultivator proceeds, and so on until it has passed over all the land to be cultivated.

The methods I have adopted for laying down the rails, varying in materials, &c., according to circumstances, are as follows :—

A hard burned brick with angle iron rail (Fig. 2).

Fig. 2.



A trench is cut fifteen inches at the top down to the subsoil. This is filled with burnt clay ballast or concrete, and on this are laid the angular shaped bricks, and the earth is then covered over nearly to the top of the rail. Angle irons, 17 or 20 feet in length, are laid on the top of the bricks. These are fixed down at the ends by strap pieces, as shown in fig. 3, and secured by bolts to bricks in the subsoil. The angle irons are not

Fig. 3.

secured to each other so as to form one continuous length, but are left unconnected at certain distances, in such a manner as to allow for the expansion and contraction resulting from the temperature.

To test the rails, I worked the cultivator backwards and forwards over a portion of them thus constructed, as often as would have been necessary in cultivating a piece of land for 10 years, and no movement or alteration of the materials took place, nor had any part to be repaired. Occasionally, when the machine travels over the ground, a brush is made, by self-acting means, to d eposit a coat of tar over the surface of the rails, thus giving effectually at a small cost a preservative coat to the iron.

In this system of rails, well adapted for clay districts, the materials being very durable, the per centage for renewals will be very small. In fact, the system may be considered of an almost indestructible character.

The surface of the iron rail being angular, the tires of the wheels of the cultivator have angular grooves, into which the rail fits.

Fig. 4.

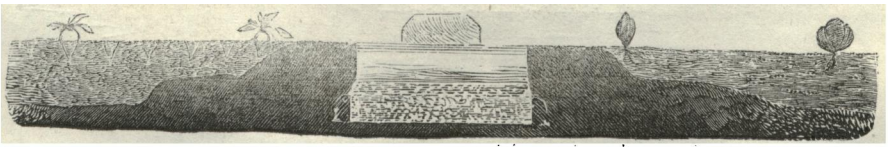


Fig. 4 shows the new system to which I alluded, namely, a flat surfaced wooden rail.

A trench is cut and filled with ballast, as before described; upon this are placed sleepers, 12 or 14 inches long, and formed of pieces of branch-wood, called "lop and top," cut up and split. Upon these are fixed the rails, which are constructed of creosoted timber. This system is well adapted for a wood district, and may be cheaply laid down.

When land is very highly rented, as in market gardens, the rails being placed upon posts or small piles of wood, driven two or three feet into the ground and subsoil, a less loss of land occurs than in the other system, for the land may be deeply cultivated close to the rails; but this arrangement is more expensive than either of those just described.

The space taken up by the rails is of necessity so much taken off from the cultivable soil of the farm. This, however, is comparatively insignificant in amount, for, taking the foundation of the rails at two feet and a half, it is only the one-twentieth of the land, a loss of about two shillings per acre, taking the rent, &c., of the land at 40s. But, after all, the space of land lost is much less than in ordinary cases, with the open furrows between stetches, besides which, no farm roads are wanted, as everything required is taken on to, or off from the farm, by the agency of the guideway machinery.

It may at first be supposed that a practical difficulty

lies in the maintenance of the permanent way from analogy with existing rails, and the keeping intact the width of the gauge; but it will be seen that there is a vast difference between the speed of the railway locomotive and that of my cultivator, the one travelling at a speed of 40 or 50 miles an hour, while the other travels at only 2 or 3 miles. Upon railroads the carriages and engines travel over the same ground in a year many thousand times, while in my system the carriages pass over the same spot in a year but 10 or 20 times. To allow for any slight variation in the breadth or gauge between the rails, running wheels are fitted on one side of the platform, so that they have sufficient play from side to side between the bearings, while those wheels on the other side of the cultivator have no similar play.

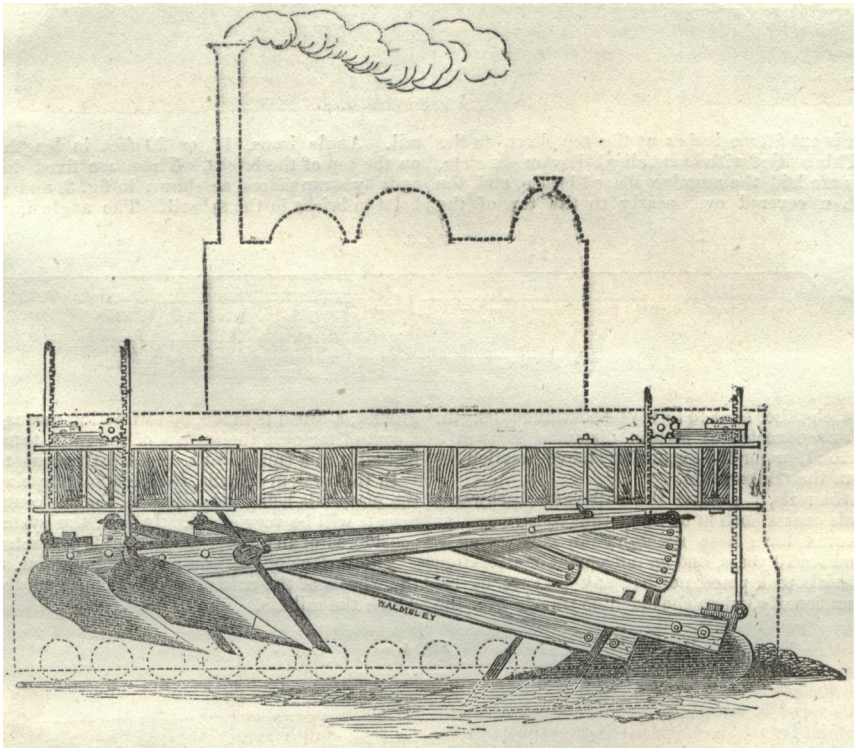
The bearings of the wheels are fitted to slide freely up and down, resistance to their moving upwards being offered by springs.

These springs are all of equal strength, and the machinery is so balanced that each wheel may bear as nearly as possible the same amount of weight, and the springs possess a considerable amount of elasticity, to permit the several wheels to pass over any undulation of the rails without transferring too much weight from some of the wheels to others of the series. The object in distributing the weight of the platform over a number of wheels is that the rails or permanent way may be of very much lighter construction than if the weight were made to rest on a less number of wheels.

The cultivator is driven by two engines, placed at the extreme ends or sides, which are geared together by an intermediate shaft, the ends being connected to the ends of the platform in such a manner that the whole set, 16 in number, act simultaneously as driving wheels. By being thus constructed, the machinery can ascend rising ground without difficulty, till the gradient reaches the point when iron slips upon iron, which is found to be one in five.

The diagram board before you represents a front elevation of the large cultivator.

Fig. 5.



Section of Steam Cultivator, showing one set of Ploughs in the Ground, and the opposite set raised and supported by the Racks and Pinions.

Fig. 5 is a transverse vertical section of the cultivator, showing the one set of ploughs in the ground and the opposite set raised and supported by racks and pinions.

The quantity of land that can be ploughed per day by machinery, suitable to a farm of 1000 acres, is 25 acres; and two, or at the most three, men are all that are required to conduct this or any other operation; and, when time presses, by a change of men, double this amount, namely, 50 acres, may be done in the twenty-four hours, because the operation can be carried on by night as well as by day. I have ploughed on a very dark and rainy night, and although it was too dark to see the ploughs, in the morning we found some excellent furrows turned. You will admit, I am sure, that it is of the greatest importance to be thus able to break up the land in unfavourable weather, or for a rapid autumnal cultivation. This great economy of time is also available for seed-time, reaping, and carting in harvest.

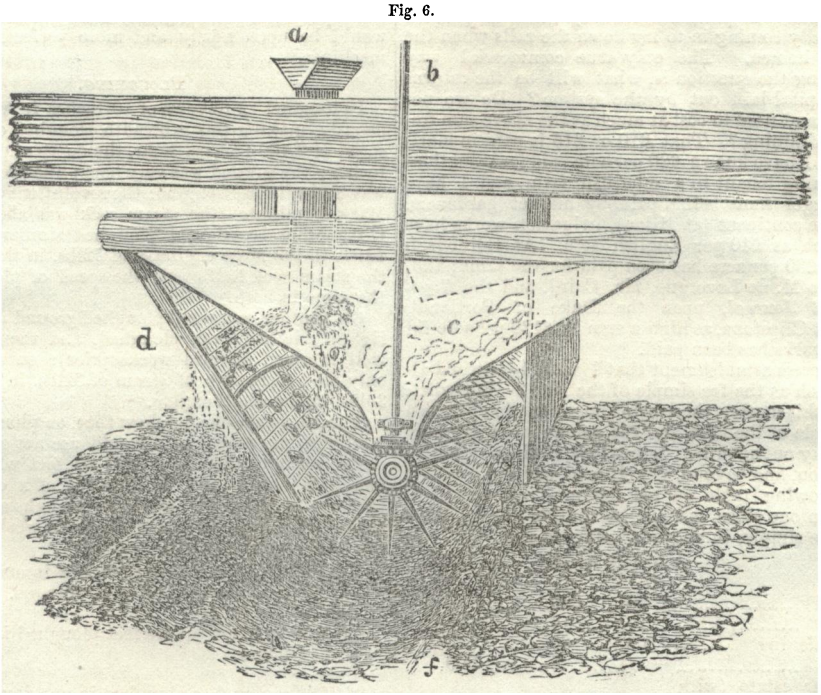
The plough having broken up the land, a "comminutor," or rotary implement, is used, fig. 6 (see next page), in character something like the Norwegian harrow, but driven at a high velocity. I have succeeded in obtaining some remarkable results in reducing obdurate clay to a state of the finest tilth. Its mechanism and operation I will explain as I proceed.

The soil having thus been brought to a higher state of cultivation than it is possible to produce even with spade labour, there can be no difficulty in keeping it in that condition, for it will be seen that, by the guideway system of steam culture, the whole weight of the ma-

chinery, engines, and implements, rests upon the rails, and that nothing touches the soil except the implements in operation; no horses will poach the ground with their iron-shod feet; the footprints of the guide and ploughman will no where be seen pugging the clay and treading into a solid clod that which has been reduced to the fineness of garden mould.

The destruction of weeds, earthing up, hoeing, and stirring the earth among growing crops, can only be performed at present during the earlier stages of the growth of the

Fig. 6.



plant, and unless executed by hand labour are always attended with difficulty, and more or less danger, from the impossibility of guiding the implements so as to operate in sufficient proximity to the plant, without running into and destroying some portions of the crop. By this system, however, I am enabled to adjust the implements and cause them to travel at the requisite proximity to the rows at all times during the periods of the growth of the plant. In fact, the hoes can be regulated to such nicety, that the operation may truly be called unerring.

All other operations, such as harrowing, clod crushing, &c., are effected by the different implements being adapted to the same, or to some other cultivator, and these are lifted and lowered, and worked by the machinery, as before described in the case of the ploughs, and may, therefore, be easily understood without further explanation. Independently of the machinery which carries the engines and implements, smaller ones are constructed for the purpose of carrying manure, the produce, water, &c. They are of the same width as the large one, from rail to rail, but much lighter and shorter, and the boxes or cart-bodies used are placed at either end, directly over the wheels, of which there are four, two on each side. These small carriages or trucks are drawn by the cultivator, and, when required, are furnished with tanks for the conveyance of water or liquid manure; and this may be distributed among the growing crops, either independently, or during the time when any of the other operations are in progress. For instance, the operations of stirring and distributing water, or liquid manure, to the growing crops, may be performed simultaneously by one implement, in the form of a hollow bar or coulter, stirring the ground to a moderate depth, whilst the water, &c., passes out at the extremity of the bar. By this means the fluid is economized, on account of the evaporation from the surface being prevented; the soil is not caked, nor are the roots drawn to the surface in search of the moisture, afterwards to be injured by the parching of the ground.

The next important operation to be noticed is reaping, which is performed by a machine constructed on the principle of Bell's or Dray's, or it may be of any other good reaper. It is attached by suitable stays to maintain it at the proper level, perfectly independent of any support from the ground, and has the necessary gear for communicating the motion to the cutting knives and other parts of the machine by the steam power; and the depositing of the crop after cutting, is effected by a back delivery.

When manual labour is required for the purpose of weeding, transplanting, or any other light operation, the labourers are carried on to the ground by means of the trucks, upon which they sit or stand while the work is being performed, or while the crop is transferred from the ground to the truck, and by it taken away to the homestead. Thus, it will be perceived that even the injury resulting to the ground by men treading on it is obviated. These trucks may be propelled either by horses or by manual labour if desired.

THE COST.

Having described generally the system, before proceeding to the facts and results derived from my own cultivators, we may consider the cost of the whole system.

First. The cost of machinery, implements, and trucks is equal to that of horses and horse implements required for similar work, and the interest per annum may be taken as the same; but in general I think a less interest would be sufficient. In my case, for instance, with the trucks, the travelling being

upon a hard smooth surface, there would be considerably less wear and tear than in carts and waggons in a field.

Secondly. The cost of the rails. The wood system, Fig. 4, is £10 per acre, and the brick and angle iron system, Fig. 3, is £20 per acre.

When we consider the much larger sums than £10 or £20 per acre which have been expended upon land, we shall see that no practical difficulty exists to prevent money rapidly coming in to lay down the rails when the profits are known. The only true commercial way of considering the question is, what will be the returns upon the capital laid out by the system? Do we not know that land used to cost as much as the above sum frequently in draining? That £10 or £15 is paid in marling land? I have known £20 per acre paid for valuations to an incoming tenant in a suburban farm, and I have heard of larger sums being paid by market gardeners. Even on the continent (at Milan), irrigation works have cost as much as £40 per English acre. At Edinburgh more than £30 per acre has been paid for the same; and, according to M. de Lavergne, Mr. Caird, and the *Royal Agricultural Journal*, upon the Duke of Portland's meadows at Clipstone, as high a sum as £120 per acre for irrigation works has been paid.

Some express astonishment that I want to expend almost as much as the fee simple of the land? But what, I ask, does this matter, there being no connection between the fee simple of the land and the amount that you may profitably lay out upon it. Let us look at different modes of cultivation, and beyond, as well as in, our own country. In the following table we see the most extraordinary variety. In one place we see the outlay 15 per cent. upon the fee simple, in another 1,500 per cent.

	Fee simple.	Outlay	Per centage upon fee simple
In England	£ 30	£10	33
,, ,,	15	5	33
Market gardening	200	30	15
In America	1	3	300
On a sugar estate (with slaves)	6	90	1500

Thirdly, the cost of the operations.

The reduction in the friction of the machinery in consequence of travelling on a hard road, the large breadth of land possible to operate upon at once, and the few men required to attend the machinery in proportion to the work performed, greatly reduce the cost of the operations, while cartage is reduced in the proportion of the difference between drawing a weight on a ploughed field or upon a railroad.

Ploughing is 1s. 7d. per acre; hoeing the whole breadth of 50 feet at once, 3d. per acre; drilling seed the whole breadth, 5d.; harrowing and rolling, 5d.; scarifying and grubbing, 8d.; reaping, cutting, and delivery, 10d.; carting crops off, and manure on to, the land, ½d. per ton per mile.

FACTS AND RESULTS OF THE MACHINERY.

The engines of my large cultivator are a Garratt's 6 H. P. and a Barratt and Exall's 4 H. P. They are old second-hand engines, and, being unequal in power and in weight, are not well-adapted to work together; and the pistons are not tight in the cylinders. Indeed, though I have had the metal packings looked to, and taken in hand by a millwright and engineer, yet are they very imperfect, allowing a considerable escape of the steam. When Mr. Amos, the consulting engineer to the Royal Agricultural Society, saw them on one occasion, in a casual visit, (but no trial taking place,) he thought that a considerable per centage must be taken off in any calculation for arriving at a conclusion on the merits of my system, in consequence of their condition. What the per centage was that he stated at the time I do not now remember; but this is not of any moment, for in my calculations I have made no deduction on that account.

In this paper it is my purpose chiefly to deal with facts; but it is nccessary, in considering the future of this system, to be informed that the engines of my cultivator are of a wrong construction for the purpose, and very leaky; next, that the frame-work and wheel-work are very ill-made, and the friction consequently very great; and thirdly, that the weight of the whole is, per horse-power of the engines, nearly double of what it would be upon newly and more perfectly constructed machines.

PLOUGHING.

I ploughed 12 furrows of 10 inches in width simultaneously, making thus a breadth ploughed of 10 feet, at a speed of 2,400 feet per hour, the depth of ploughing, five inches; the ground was very hard; the pressure of steam was 50lbs. in each engine; the revolutions of the engines, 120 per minute—the steam-cock was about half open. On another occasion, I ploughed similar ground with 48lbs. in the large engine, and 52lbs. in the small one—the steam-cock half open; the speed of ploughing being the same in both.

On another occasion I ploughed ground that was much lighter; it had been ploughed, and then levelled and well rammed (several weeks prior); on this ground I only used a pressure of steam of 32lbs. in the large, and 35lbs. in the small engine.

The above statements show that, on ploughing average land with my machine, I should use not quite 10 horse-power when turning over soil 10 feet wide and 2,400 feet per hour; and, taking out of a day's work of 12 hours one hour for change of ploughs and shifting at headlands, I have 11 hours' effectual work, which gives the following result:—

2,400 feet, the length ploughed in one hour.
10 feet, the breadth of 12 furrows.

24,000 feet, the square feet ploughed in one hour.
11 hours.

264,000 square feet ploughed in one day.

And $\frac{264{,}000 \text{ square feet,}}{43{,}560 \text{ square feet in an acre}} = 6$ acres per day.

Now, 10 horse-power, multiplied by 5·7 lbs. of coal per horse-power per hour, (which is Mr. Amos's estimate used at Chelmsford, for calculating Mr. Fowler's steam-ploughing, and which was deduced from trials upon a number of steam agricultural engines, and the coals at 20s. per ton) gives 57 lbs. per hour, which, multiplied by 12 hours' consumption, is 6·1 cwt. per day = 6·1 shillings; to which add 3s. 6d. for one man for wages, and 2s. for another, and 6d. for oil, waste, &c., and we have 12·1 shillings for six acres, which gives 2s. per acre.

For a farm of 1000 acres, 25 H. P. would be required, and, taking the above as a standard, we should have 15 acres ploughed per day; and the calculation would stand 25 H. P. × 5·7 lbs. × 12 hrs. = 15·2 cwt. of coals, to which, add 4s. for one man's wages, 2s. another, 1s. boy, and 1s. for oil, waste, &c., we have 23·2 shillings, which, divided by 15 acres, gives the cost at 1s. 6½d. per acre, with a 25 H. P. cultivator.

If a larger amount of horse-power be thought necessary for more extensive cultivation, the cost will be lessened. With a 40 H. P. cultivator the amount of ploughed land would be 24 acres per day, and the cost would be 1s. 5d. per acre.

If, instead of 5·7 lbs. per horse-power per hour we take the coals at 6 lbs., it would make the ploughing, in the case of the 25 H. P. machine, 1s. 7½d. per acre; if we take the estimate at 7 lbs. of coal, it would make it 1s. 9d. per acre. If we were to suppose that coals were only half the price, namely, 10s. a ton, the last estimate, taken at 7lbs. per horse-power per hour, would sink from 1s. 9d. to 1s. 2½d. per acre.

There is one fact with respect to the ploughing trials above mentioned, to which I would beg to draw es-

pecial attention—a fact which appears to me of great importance, namely, the small amount of force with which the 12 ploughs were drawn through the ground when the land was comparatively light, because I think that this will show how, when the cultivation of a farm is carried on without in any operation treading upon the ground, we may expect that ploughing and other acts of cultivation will be performed by my system at much less draught and power, and at much less expense even than is deduced from my own trials. With horse cultivation in my field, had the land been previously ploughed, it would still have required 2 horses to plough it again —the horses would certainly have performed a small per centage more in the day's work—but in the example referred to, we see much more than a small additional advantage. It was there stated that I ploughed 12 furrows with a pressure of steam in the large engine of 32 lbs., and in the small engine of 35 lbs., or say 33½ lbs. in each. Now I found upon trial that it required 20 lbs. of steam to move my machine at its regular speed, without any implememts being in the ground, and it therefore required only 13½ lbs. additional pressure of steam to draw the 12 ploughs. A further pressure of 13½ lbs. (which would have raised it to 47 lbs.) would have drawn another set of 12 ploughs, had I had them to put on, and the amount of ground ploughed would have been 12 acres in the day, with engines working up to 10-horse power. Had I raised the steam another 13½ lbs., namely, to 60 lbs., at which I often work the machine (and with which pressure the engines are working at 13 H.P.) the cultivator would have been capable of drawing another set of 12 ploughs, thus turning over 18 acres per day, with engines only working up to 13 horse power.

In reference to the above, I may remark that ploughs drawn in the usual manner have evidently a very considerable resistance due to their weight on the ground, irrespective of the resistance due to cutting the sod. In Mr. Pusey's experiments this resistance is put down with an average make of plough at 33 per cent. of the whole draught, but it is evident that this resistance, which is a constant quantity, will, in its per centage to the whole draught, vary according to the nature of the soil, whether stiff or loose. The lighter the soil, the greater in proportion to the whole draught will be the per centage due to the weight dragging on the ground. In my case, however, the weight of the ploughs being transferred to, and borne by, the rails (for the plough is suspended to the cultivator, with the point of the share rather lower—½ an inch—than the heel), the resistance due to the weight of the implement pressing on the ground is taken away; and if the soil be very light or loose, only a very small resistance will take place in opposition to the pull or draught of the motive power. This, I think, will explain the remarkable result of the third set of ploughing trials above mentioned.

Where the side of a field or piece of ground is crooked (see Fig. 1), and the line of hedge cannot be straightened, the crooked part is fenced off and used for pasture or in cultivation as usual. This is shown between (*a*) and (*b*). If roads or lanes intervene between different fields, a "level crossing" or moveable rails will enable the machinery to pass from field to field. This is shown at the left-hand corner. If a farm abuts on a railroad, it may communicate with it, and by this means the produce may be sent to towns, without, in its transit, being off a rail; and marl, clay, sand, or other soils, may be brought from distances, and be deposited at any period at a very small comparative sum; by this alone a *permanent* increase in value may often be given to estates. Also manure may be brought from towns and distributed over the land at a very advantageous cost in comparison with that on farms at present.

SMALL CULTIVATOR.

The small cultivator, to which I before alluded, for the light operations of a farm, or for the total cultivation of a market garden, would be constructed with a 3 or 4 horse-power engine. It is shown in Fig. 7, and is in two parts. The engine portion is distinct from the carriage, but is connected with it by two bars with hooks at the ends, and diagonal chains, which also hook and unhook readily. The diameter of the cylinders of the small engine on the Kensington Cultivator is only two inches, and the pressure of the boiler is generally 40lbs. This is only one-half, or at the best three-quarters of one horse power, and we may well conceive that if so small an engine as this (a mere toy) be considered sufficient to work a Cultivator of a breadth of 30 feet, together with its second carriage, its weight of water, men, &c., how much larger a breadth may be worked by powerful engines.

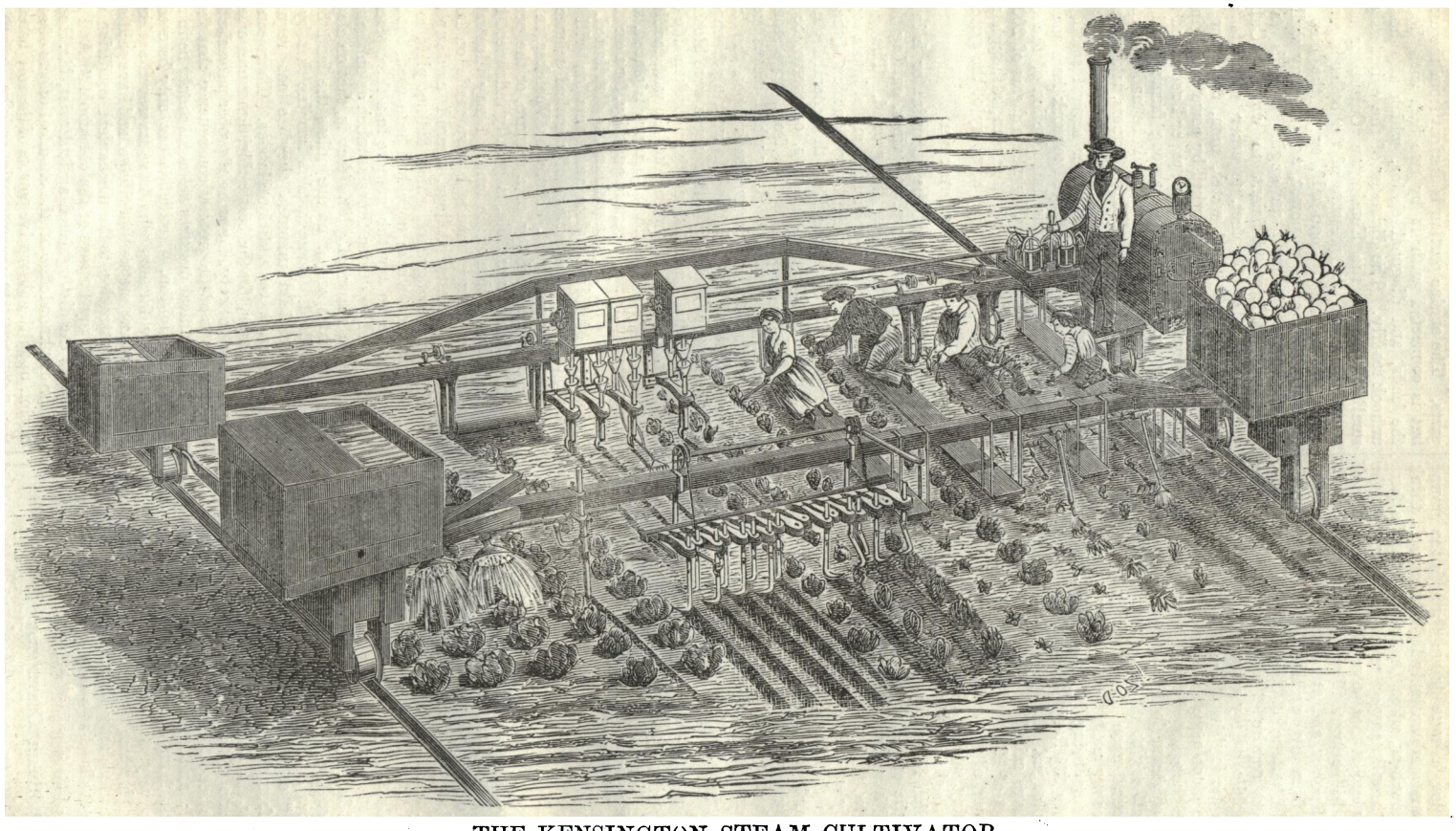
In the commencement of this paper I remarked that it was a fast growing opinion among farmers and many others that steam should and would be made to supersede horse labour in the field. Many farmers, taking the view that my system realizes this opinion, have suggested that the rails might be laid down over several small farms, and the machinery be employed to work from one to the other, but I think that the introduction of the smaller arrangement of machinery, by which farms of 200 acres may be worked, will be a better plan, although not so likely to develope the fullest economy of the system.

THE COMMINUTOR.

The onward motion of the comminutor is in a line with the axis of the revolving tines, cutting furrows parallel with the rails on the ground. The ground, which is previously ploughed, is made into a seed-bed as fine as the soil of a molehill by the action of the tines, for a depth of five or six inches; the general depth of the ploughed or broken ground may, of course, be much greater. When the soil is free from large stones the screen *d* (Fig. 6. p. 45) is used, by which means the clods not at first broken are thrown back upon the tines for a second or third blow. I found, in working the machine, that the roots of couch and other weeds were blown over towards *c*, *c*, and deposited on the unbroken side of the land at *f*, *f*, where they were raked up with facility.

In the hopper at *a*, artificial manure is placed, and by a manure distributor, a certain quantity, for a certain distance passed over by the machine, is distributed. The importance of this complete amalgamation will be appreciated when the bearings of chemical science upon the point are perceived. Professor Voelcker, in a lecture, says, "The efficacy of a manure, or the practical effect of which it is capable, is greatly influenced by the mechanical condition of the land. I may illustrate this by referring to experiments I have made on land attached to Cirencester College, where I used superphosphate on a piece of ground which did not yield so much as another piece where none had been used, but I took the precaution to try the manure in a third place, and here the yield was three times as much as on that which had not been manured. The fact is, that on clay land superphosphates are of no use unless the land be properly pulverised. Some farmers imagine that by using the best artificial manures they do not require so much labour, or any additional labour. There can be no greater mistake, for the best artificial manures often fail, more or less entirely, for want of proper pulverisation of the soil. It is of the greatest consequence that the land on which artificial manures are used should be in a high state of subdivision. Artificials can only be used with advantage by farmers who have improved agricultural implements and methods of tillage, and have paid a great deal more attention to the mechanical condition of the land than many farmers of the old school." And I may also quote the distinguished agriculturist, Mr. Hoskyns: "Now our knowledge of the chemical effects of comminution upon the absorptive powers of the soil (based upon the most accurate demonstration of the lecture-room, and speaking to the eye and to the mind as plainly and

FIG. 7



THE KENSINGTON STEAM CULTIVATOR.

Halkett's Guideway Steam Cultivator of small horse-power, for the light operations of a farm or for market gardening, showing:—

Machine Operations:—Drilling corn; drilling seed between the rows of plants; hoeing; rolling; surface watering; watering in rows upon seed and upon young plants; underground watering between rows of plants; carrying crops; carrying water.

Hand Operations:—Weeding, transplanting, dibbling, cross-hoeing, without injury to the soil, or to young plants already upon the ground.

irresistibly, and by the same evidence, as any fact observed in the field can do,) is already far in advance of anything which our present means of mechanical division enables us to realize, even on the smallest practical scale."

If, in looking forward to the future, agriculturists and landowners would take an enlarged view of the past and present state of things, they would perceive that not much new land has been added to cultivation during the last fifty years, nor have the imports of food been large in proportion to the consumption, whilst, in addition, the population is a more meat-consuming one. On the other hand, the population during that time has doubled itself; and, perceiving this, they will see how rapid must have been the tendency to increase in intensity the cultivation of land. It is not too much to suppose that on an average the produce per acre has nearly doubled itself.

One principle upon which I base the profits of my system is simply this: spade labour is sometimes used to cultivate farm crops; it is more costly than horse labour by £3 an acre, and more productive by £3 or £4. And this is true with the same amount of manure in both cases. In testimony of this I refer to many well-known experiments by industrial societies. To "Morton's Cyclopædia of Agriculture," to Cuthill's pamphlets, the "Penny Cyclopædia," the "Spade Husbandry in Flanders," by the Society for the Diffusion of Useful Knowledge; the works of Cuthbert Johnson, &c. Now I can perform the operations by steam and guideway in a manner superior to spade labour at less considerably, after paying interest for rails, &c., than the cost of horse labour; the difference, therefore, in produce becomes wholly a profit.

It may be, however, desired to consider a balance sheet for the year; I have, therefore, introduced two for farms of 1,000 acres, and also one for a market garden of 50 acres.

STATEMENT OF A 1000 ACRE FARM ON GUIDEWAYS OF CREOSOTED TIMBER, AT £10 PER ACRE.

Rail, capital, &c.:—		ANNUAL.
(*a*) Interest at 10 per cent., thus—	Capital for rails £10,000.	
	Interest on capital at 4 per cent. £400	
	Repairs and renewals at 6 per cent. 600	
		£1000
Farming capital, &c.:—		
(*b*) Capital for stock, £2500.		
(*c*) Locomotive cultivator, with 25 h.p. engines and shunting machinery complete, £1900; implements £300, at 15 per cent.		330
(*d*) Ten trucks £300, at 8 per cent.		24
Coal, at 20s. per day, and 250 days		250
Oil, &c.		10
Engine driver at 4s. per day, man 2s. 6d., boy 1s.		117
5 constant labourers		155
*Labourers for hand operation upon the crops ...		50
Farmers' annual field expenses		£ 936
Add interest for rails		1000
Cost of cultivation by steam		£1936

Labour at homestead, expenses for marketing, and all other labour which is paid for as in the present system, need not be here alluded to.

* This item refers to such operations as hand hoeings and weedings, *combined* with the travelling machinery. Hand operations are in this manner more cheaply performed than they are at present. The above includes 250 acres weeded once, and 250 acres weeded twice.

STATEMENT BY MR. W. REX, VALUER TO MESSRS. CHINNOCK AND GALSWORTHY, LAND AGENTS, LONDON, AND A FARMER, FOR A FARM OF 200 ACRES, WELL TILLED LAND.

			ANNUAL. £	s.	d.
Capital:—8 horses, 4 ploughs, harrows, horse hoes, scarifiers, 2 waggons, rollers, 4 carts, £500.					
Depreciation of stock at 15 per cent.			75	0	0
Horse-keep, corn, 100 qrs., hay 30 tons ...			245	0	0
Labour, 4 carters, at 12s. per week	£124	16			
1 Horse keeper extra	31	4			
3 Labourers	105	6			
			261	6	0
100 acres corn hoeing, 4s.			20	0	0
Cutting 50 acres of corn at 8s.			20	0	0
			621	6	0
Multiply by 5 for 1,000 acres.....			5		
			3106	10	0
*Deduct.....			30	0	0
Farmers' annual field expenses for ordinary cultivation on the fourth or fifth shift system, exclusive of all extra labour for harvest, &c., but including all that can be done by the machinery in the field ...			3076	10	0
Cultivation by steam			1936	0	0
Difference in favour of steam.....			£1140	10	0

Which is equal to 11 per cent. upon capital for rails, and, when added to 4 per cent. (already allowed), gives a profit of 15 per cent.

The difference between spade labour and horse labour is given in Morton's "Cyclopædia of Agriculture," p. 388, article "Capital," at £3 per acre in favour of the spade, when £8 per acre is average produce. If only £1 extra per acre be allowed, the present horse farming, the profit will be 24 per cent.; if £2 be allowed it will be a profit of £34 per cent. In the above estimate, extracted from Morton, no crops sold off the land, or gardening ones, are considered, only grain and cattle feeding ones.

The balance-sheet of a farm laid down with the brick and iron rails at £20 per acre, will be as follows:—Interest of money and depreciation, £1200; annual field expenses (deducting £96 due to less friction by this one over the other system of rails) £840, which subtracted from £3076, gives a saving of £1036, equal to 5 per cent., and which, when added to 4 per cent. already received, makes a profit of 9 per cent. by saving on labour alone; to which, if £1 for extra produce be added, we have a total profit of 14 per cent.; if £2 for extra produce, we have a profit of 19 per cent. on capital for laying down a most permanent system of guideways; in fact, one of an almost indestructible character.

EXPLANATION OF BALANCE-SHEET.

In line noted letter (*a*) I say "Interest on capital at 4 per cent." This I suppose to be sufficient interest, the investor being supposed to withdraw the money from the funds or other good security. If the money is borrowed, the interest must be larger, but it will be seen that this makes no difference in the result.

Line (*b*) "Capital for stock £2,400." No account is taken of the profit or interest the agriculturist makes upon the £2,500, as the same amount of capital is required for horses and horse machinery on the opposite side. Only the interest for depreciation and wear and tear is put down here.

* There will be a saving of £200 in machinery in a large farm over a small one proportionably, therefore deduct at 15 per cent. on £200.

Line (*c*) "Locomotive cultivator with 25 horse-power." A steam engine will always work up to a higher power than is denominated by its nominal horse-power, and I could easily make 25 horse-power engines work up to 40 horses (the amount of horses given on the opposite side) but this is not why I have put 25 horses in engine power as sufficient against 40 horses on the opposite side; on the contrary, for every one horse-power used in flesh I intend to place one horse power in steam. My explanation is this. 25 horses working 12 hours for 250 days, and 12 hours extra for 20 nights, are equal to 40 horses working 8 hours for 250 days.

Line (*d*), "Ten trucks, &c." The interest for depreciation and wear and tear is put at 8 per cent. in this case, the wear and tear not being great.

I have gone upon the broad principle of putting one horse-power working in steam for every horse working in flesh, but I have overestimated very much, for one horse will cart only one ton with the load running upon the ground, while one horse-power will cart several tons with the load running upon my guideway. I have the advantage of the less draught of the ploughs by their not resting upon the bottom of the furrow-pan, which in Mr. Pusey's experiments was found equal to fully one-third loss of power; and the draught of all implements will be less from the looseness of the soil, from not consolidating the ground by treading upon it; in fact, when we see that market gardeners plough land often at 10 and 12 inches deep with one pair of horses, this will become very apparent, but I think it better to take to myself the advantages which will accrue from better tillage and more frequent hoeings, &c., than to reduce the horse-power of the engines; in fact, practical knowledge will point to the reverse of a reduction being the proper direction. But, howsoever this may be, there is a commercial advantage due to the above facts in my system for which I have not given myself credit in my balance-sheet.

If land is undulating or hilly, it necessarily requires for its cultivation more horses than the same acreage does upon the flat. In the case of my system, I should require the same increase of power; but, inasmuch as the labour bill on my scale is so small in comparison with the labour bill on the opposite side, namely, as £936 is to £3,076, any per centage increase of labour on my side tells considerably less upon profits than it does in horse farming. It may still be objected that the weight of the machinery (the engines and cultivators) being considerable, an amount of waste power will occur greater than that with horses. Now, this will not be the case, for my machinery, including the engines, girders, wheels, and all other parts, can be manufactured at the weight of not much more than one horse for every horse-power of the engines, and as the power expended in rising a hill resolves itself into two elements, the one the draught upon the implement or the load, and the other the rise of the whole weight a certain number of feet perpendicular height in a certain number of minutes; and since, in both cases, the elements are nearly the same, the power expended will also be nearly the same; but as, on my side, the advantage is found, that for every expenditure of one horse-power in horses I can do the same at one-fourth the cost, so whether the land is undulating or flat, I can do the work at a great commercial advantage.

But let me take a question of still greater importance. If it is true that a large amount of cultivation is beneficial, or if a soil be so stubborn as to require an extreme amount of labour, how easily I can give it. For instance, if I employ half as much more machinery, men, and coals, and give an amount of cultivation equal to 50 per cent. more, I can do this at the increased cost of £468, namely, half of £936; while to do the same on the opposite side, would require an increased cost of £1538, which is the half of £3076.

If the amount of labour is increased on a farm, we shall find that on account of the cost of my operations being so small, while the interest upon the rails is a fixed quantity, the advantages on my side rapidly increase. This, which is so much the tendency of the day (especially in an increase of work requiring care), is well met in my system, by its being so admirably adapted to assist in performing and in cheapening the more delicate operations, thus facilitating double croppings, increasing largely the cattle feeding produce, the head of cattle for sale, the manure raised upon the farm, the richness of the soil, and the production of corn.

PROFITS.

In consequence of the small cost of each operation, it is found that after paying the interest on the money for laying down the rails, and an annual charge per acre for their constant renewal, a saving of from 20s. to 24s. per acre will be effected in the case of well-cultivated farm land. If to this is added from £1 to £2 per acre as the increased value of produce on account of superior cultivation, which is considered by competent judges due to the guideway system, these two sums will form an extra profit of nearly £3 per acre. In the case of a more laboured and profitable cultivation, such as rough gardening and market gardening, the additional profit will rise as high as from five to six pounds per acre. These sums form a profit of from ten to forty per cent. on the capital laid out for rails, which will be shared between the landowners and their tenants primarily, but eventually the benefits will go wholly to the landowners.

At first sight, the advantages in a commercial point of view in the accompanying sheets are apparent as producing a large interest for the necessary outlay for rails, &c.; but not only is this true, but to the landlord the system holds out the greatest benefits, either with or without outlay on his part, by increasing the value of the fee simple of his land, an increase in value which holds to all the future.

For, allowance having been made for interest and depreciation on capital in laying down the rails, the profit becomes in effect an increased rent, and being a permanent increase of double and treble the present rent, it will increase the fee simple of the land to double and treble its present value, in the same manner as the value of land is increased by drainage, or as the improved system of husbandry introduced into Norfolk, and copied into other counties, raised its value from five to tenfold. I have said *permanent* increase of value, for this increase is evidently not only irrespective of the source from whence the capital comes to lay down the rails, but of the depreciation and wear and tear of the rails.

It is evident that the tenant under a long lease will receive all the advantages and profits arising from the system throughout the whole of his term.

MARKET GARDENS.

Market gardens may be admirably cultivated by this system, three-fourths of the present very costly hand-labour being performed by the guideway machinery, with far more benefit to the land, as is testified by competent judges who have seen it in operation, and those very portions of the labour necessary to be performed by hand, such as planting, cross-hoeing, &c., are executed in a far more efficient, systematic, and economic manner. By the avoidance of walking amongst the plants for that purpose, no consolidation of the ground or breaking of the young plants can take place; and the soil is always in a loose and friable state. That most important and now expensive operation to a market-gardener, watering, may be done at a small cost and a greater economy of time and water, without the injury attending the use of water carts, or of a pipe and hose, with their unavoidable injury to young plants. The crops will, from the above reasons, attain a more rapid maturity, and thus an earlier produce, with consequent larger prices, will be obtained by the market gardener.

A respectable and intelligent market gardener, who has often witnessed my operations, writes in a letter:—"I have inspected the guideway on many occasions, and find it most efficacious. There is not an operation which this machine will not do, whether it is trenching, hoeing, drilling, or any other nice work; and there is nothing, in my opinion, so agreeable to the eye as work when thus well done, and with economy, for that is the secret of large profits and small outlay. Clays could be rendered comparatively light, and a season got in a few hours. The 'comminutor' cleans the ground of that dreadful couch in one single operation, the land being ever so foul and stiff, leaving the soil a perfect seed-bed, casting the couch on one side, the stones on the other. * * The crops can be carried without injury to the soil, for carrying crops and distributing manure are two operations very difficult to appreciate, as there are many who have grown large root crops, and suffered greatly from the removal of those crops. I have known many instances in market gardening where a season has been lost owing to the weather being wet at the time of carting. I happen to know a market gardener who grew 50 tons of mangold wurtzel per acre, and sold it on the ground; the person who bought it cut up the land into ribbons, so that the gardener lost the next crop. Had the guideway been there the crop would have been carted off, manure at the rate of 40 tons returned, and the land tilled, and a fine crop of cabbage growing for early spring." I have often had labourers upon my cultivator, and they always appreciated the ease and correctness with which they could perform operations.

Rough gardening, in which the cultivation is on an extended scale, for the growth of potatoes, mangold wurtzel, cabbages, and sometimes corn, with its laborious and very costly culture, and its large cartage, will receive the same advantages.

BALANCE-SHEET (MARKET GARDEN).

Statement showing the Cost at which Vegetable Produce is now raised for the London Markets, and the Cost at which the same could be done by the Guideway System for a Holding of 50 Acres:—

A Steam Cultivator, like the small one above described, and of 2 horse power, but capable of working for many more hours in the day than horses do, would cost £120, two trucks would cost £40, and all the implements £50; total, £210. The wear and tear of this, at fifteen per cent., would be 12s. 6d. per acre.

'In the following Table all the operations that are performed in the same manner in both systems, and therefore amount to the same cost, are not put down.

POTATOES AND COLLARDS—(1st Year).

	Cost on the present System, per Acre. £ s. d.		Cost by Steam per Acre. £ s. d.
Trenching at 3d. per rod	2 0 0	.....	0 10 0
Cartage of manure, 40 tons, exclusive of filling, &c.	0 10 0	.....	0 5 0
Hoeings and earthing	1 0 0	.....	0 4 6
Taking up	1 5 0	.....	0 5 0
Collards, digging, 2d. per rod	1 6 8	.....	0 6 0
,, hoeings	1 0 0	.....	0 2 0
	£7 1 8		
Hand operations		.....	0 5 0
			£1 17 6
Interest on machinery		.....	0 12 6
Depreciation, wear and tear of rails			1 0 0
			£3 10 0

Advantage in favour of steam, say, £3 10s. per acre.

LETTUCES AND SAVOYS—(2nd Year).

	Cost on the present System, per Acre. £ s. d.		Cost by Steam per Acre. £ s. d.
Cartage of manure	0 10 0	.....	0 5 0
Trenching	2 0 0	.....	0 10 0
Forking, 1d. per rod	0 14 0	.....	0 3 0
Treading and raking	0 10 0	.....	0 2 0
Hoeings	1 10 0	.....	0 4 0
Savoy digging	1 6 0	.....	0 6 0
Three hoeings	1 0 0	.....	0 2 0
	£7 10 0		
Hand operations		.....	0 5 0
			£1 17 0
Interest on machinery		.....	0 12 6
Depreciation, wear and tear of rail			1 0 0
			£3 9 6

Advantage in favour of steam, say, £4.

In market gardening watering is only practised with some crops. It is performed sometimes by watering-pots, for the injury to the land is considerable when it is carried out with horses and carts. The value of such an operation, if done to the extent of ten waterings to a crop, may be computed at from £2 to £10, according to the nature of the plants and the season. It will be a small advantage if this value be taken at £3 per acre. From £4 to £6 per acre is paid by many market gardeners when watering is performed. This is for eight or ten waterings, and is an amount which could be done by the steam engine for 10s. an acre.

The case would then stand thus:—

Advantage in favour of steam	£3 15 0
Add value by watering	3 0 0
	£6 15 0
Deduct cost of watering	0 10 0
	£6 5 0

Leaving £6 5s. per acre, equal to 45 per cent. profit on the total capital, for rails (at £10 per acre), and implements, engines, &c.

LOYS WEEDON.

The Loys Weedon system of cultivating wheat is also one which could, with great facility, be carried out by my system. I know that scientific men are divided in opinion upon the practicability of Mr. Smith's cultivation being carried on long without exhausting the land, but it, nevertheless, is a fact that for 13 years he has done so, and, certainly, we may say that that which has been done before may, in like circumstances, be done again. The large profit to be derived by carrying it out by my system must be my excuse for bringing the subject before you, and I must add that I do not see how it would be practicable to carry it out by any other system of steam cultivation. The rails forming guides to the implements, and the implements being suspended from above, would enable me to cultivate at all times between the rows of growing corn.

By my steam cultivation, (after paying interest for money, rent, &c.), £5 per acre would be cleared per annum, with wheat at its present low price, and without taking any value for the straw. If such profits could be obtained for only 13 years, the fee simple of average priced land would have been paid twice over. By hand labour the profits are considerably less, and not easy of attainment on a large scale, while, by horses, it is hardly practicable.

THE WEST INDIES.

The power which the guideway culture has for working between the rows of the standing sugar cane (which in some soils remain for many years undisturbed), for the purpose of ploughing, earthing the crops, and for per-

forming the hoeings which are so constantly required, renders my system invaluable for this laborious cultivation. The cartage of crops (a very heavy and constant operation) would also be performed. A plantation would thus be rendered, in all its field labours, independent of the inconstant and irregular attendance now obtained, and the crops would in consequence be greatly increased.

The capital required may be thought too great for proprietors in the colonies, but this is erroneous, the cultivation of sugar being one of the most costly and the most profitable in the world.

The money necessary to carry out my system is less than half that required to purchase the slaves for the field work of an estate in America or in Cuba, the daily cost of the work is far less than the keep of the slaves, and as slave estates can compete with free labour estates in our colonies, and the proprietors succeed in making large profits, the system which I propose would evidently give a very large interest for the money laid out, and would free the land of the difficulty attached to its cultivation from the scarcity of labour, or as has been the case in many parts of the West Indies, of having no labour at all to put upon it, and in consequence losing its entire value.

CONCLUSION.

It must be admitted that the disadvantages under which a new principle of steam cultivation labours in its development by means of *home-made* instead of factory-made machinery is great, but it surely tells much for the probable future of my principle, that with all such disadvantages I had still, in a few months from the time of completing my cultivator, performed the whole range of the operations of the field, and at a cost very small in comparison with that by horses, while, on any of the previously invented principles, after more than thirty years of trial by men, some of large means and well established talent, not one operation has yet been effectually performed by steam power but that of breaking up the land; while, moreover, as I before mentioned, it is hardly in the cost of the operation itself of breaking up the land by steam power in comparison with ploughing with horses, that any claim can be made of a saving; for instance, Mr. Fowler's average ploughing is, by the judges' report, about seven shillings per acre versus seven shillings by horses, and Mr. Smith's breaking up land is computed at a fraction more; but it is rather in some accompanying circumstances that a commercial advantage is gained, such as not treading on the ground during the ploughing operation, and a concentration of power at suitable seasons, enabling a reduction of horse-power, all of which I gain in a higher ratio, for I never tread on the ground in any one operation during the year, and I can concentrate power in a double degree, for I can plough, hoe, drill, seed, &c., at night as well as in the day. In fact, Professor John Wilson, who, you are aware, was one of the judges appointed by the Royal Agricultural Society to award a prize of £500 for the best steam-plough, at Chester, did me the honour to visit my place, and witnessed the various operations, remarked upon the point, when I alluded to it, in these words:—"Of course that which they gain in a degree you gain in the extreme; in fact, your system would make farming operations equal to market gardening."

The following is a list of the operations which I have performed by my cultivators:

I have ploughed, subsoiled, harrowed, rolled, used the clod-crusher, used the Norweigan harrow; I have drilled seed dry and with liquid manure, hoed the crops, used the scarifier, reaped corn, carried crops, carried water, I have watered crops over the surface of the ground and plants, and watered in rows upon rows of seed or young plants to economise water or liquid manure; I have drilled the seed between rows of standing plants, and I have performed the new operations of the "comminutor," weed root extractor and artificial manure distributor, already explained; the underground watering between rows of standing plants, and ploughing by night.

I have enabled the following hand operations to be performed with greater facility to the labourer, great economy in time and cost, and greater regularity than can now be performed, namely, dibbling seed, transplanting, hand-weeding, cross-hoeing, and taking off crops —without, in any case, treading upon the ground or spoiling rows of growing plants interlined between other rows.

Besides these operations, there are many others which are not now performed by machinery or horses, which I expect to accomplish by steam machinery. For instance, I have no doubt of being able to perform dibbling seed, and also, when required, cross-hoeing; and the following very important operation—which cannot be effected by horses—could be easily done by my system, from the fact of being able to pass repeatedly over the same ground without treading or touching the land, and from the facility which I have of concentrating a large amount of power upon any one portion of land at one time.

The ground is first ploughed one deep furrow, say, in autumn. It is then lifted by a suitable broad-lifting plough, and laid in wide ridges, leaving broad pans of about four feet in width. The pan is then ploughed and sub-soiled, part of the mould at the same time becoming mixed by the operation with the bottom soil, it is then left for the weather and the winter's frosts to act upon it. Afterwards the ridges are split down and the land levelled for forming the seed bed, or the sides may be split down and the operations reversed, and that part lying under the first ridges be sub-soiled and exposed. By such operations, in the course of a short period, without bringing to the surface any of the sub-soil, or any more of the sub-soil than is desired, land may be reduced to a fine deep mould.

Taking a review, therefore, of all the advantages of the system, comprising the ability of concentrating a large amount of power, as shown in the bouting of land, and so far as time is concerned by working twenty-four hours in the day; the advantages of my "Comminutor," the facility for performing the most delicate operations, the absence of all treading upon and consolidating the soil, and thereby the avoidance of injury to growing plants; the ability to water growing plants without injury to them and at a small cost; the ability to cart at all seasons and in all weathers; and, lastly, that this can be done at a considerable diminution of cost, all interest on rails and machinery being much more than covered by the saving on labour; do we not see the vast power which steam has, not only to master all the difficulties and effect all the operations of agriculture, but also greatly to improve the processes, proving the truth of the writings of Mr. Wren Hoskyns, in which such a result is foreshadowed, and in whose more eloquent words let me conclude a paper, far too long, I fear, for the patience of my hearers. "Circumstances, (says that gentleman) likely to form hereafter an important feature in the history of the present time—an unprecedented expansion in the trade of the country—emigration on an extraordinary scale to the gold-fields of America and Australia, acting almost simultaneously with a serious reduction in the population of the Sister-kingdom, and all tending to the same result, a home for the scarcity of labouring hands, have created a demand for agricultural machinery heretofore unknown, and revived the half-abandoned question of the application of the steam-engine to the culture of the soil. The long cited example of its general use in manufactures, and the revolution it has wrought in every other branch of art, has given place to the closer argument of the actual and now familiar appearance in the farm-yard itself.—The mere habituation of the eye is the best of all arguments in cases of this kind; the farmer who has once had a travelling steam thrashing machine in his field or yard, is pre-

pared to hear, if not to ask the question, why its services should not be extended further; he sees the simplicity of its workmanship and the ease and docility of its movements, and its striking concentration of power into small compass. If it is to be expected, as most of those who have given any notice to the subject appear to admit, that the steam-engine, whenever it is successfully applied to cultivation, will cause a revolution, as well from the manual as from the horse-power methods of effecting it, it is not less likely that it will in a corresponding degree improve the process itself, and present a result comparatively perfect. Given the accomplishment of the act, the rate of intrinsic improvement in the act it almost foredetermined."

DISCUSSION.

Mr. W. SMITH begged to ask Mr. Halkett whether he had correctly understood him to state that the proportion of power required for moving the machinery itself really was five-eighths of the whole power exerted in the performance of the work, as stated in the paper. Another point was, in taking into account the interest of the capital invested, Mr. Halkett merely referred to the cost of laying down the rails. He (Mr. Smith) wished to know whether he had included the cost of the machinery, and the entire apparatus; because, if the calculation referred merely to the cost of the rails, he considered that a very material element had been omitted.

Mr. Alderman MECHI said—Having had an opportunity of examining the operation of Mr. Halkett's system of cultivation in very bad weather, he had no hesitation in stating his impression that all the statements which Mr. Halkett had just made would be borne out by the results when put into practice. He knew that that was not the opinion of many of his practical friends; but there could be no doubt that what had been done by the locomotive engine on railways, might in some degree be taken as an example of what was possible under the proposed system. They found that engines drew after them, at high velocities, trains of 200 tons, at a cost of not more than half-a-crown per mile for the working expenses. Might not a similar reduction of cost be hoped for in agricultural operations? If he had correctly understood Mr. Halkett, £10 per acre was the cost of the wooden rails, and he (Mr. Mechi) believed they could be laid at that price. The interest of that and the wear and tear he would take at 15s. per acre. He believed it was well understood that the cost of horse and manual labour upon a farm was something like £3 per acre as regarded the arable portion of the land. If 20 per cent. on that was saved by the plan now proposed, that would be 15s. on the £3, which would pay for the interest of the rails. He also understood Mr. Halkett to say that the cost of his machinery might be set against the ordinary cost of the horses and the usual farming implements, which he (Mr. Mechi) believed to be quite true; and this, he thought, would be an answer to the gentleman (Mr. Smith) who had just made some remarks on that subject. They all knew that, practically, wherever they could bring steam to bear, horse-power could not in any way compete with it, either with regard to economy, endurance, or opportunities for cultivation. Therefore, the whole question might be said to depend upon whether the annual saving under this system would be equal to the interest on the amount of the fixed capital laid down in the rails. That, he thought, was the essence of the question. But when they considered the numerous advantages of the plan which he had witnessed—that it could be used in all weathers, except in hard frost, and used untiringly, and also at night—there could be no doubt that the opportunity of doing the work at the very time that it was wanted, and, above all, the superior manner in which the work itself was done, would more than compensate for any loss of interest upon the cost of the rails. He could only say, that he had witnessed the machine at work with eight ploughs and two subsoil ploughs, and the soil was lifted and thrown over in a manner which exhibited a most favourable contrast to the ordinary mode of ploughing. The ploughs, hanging as they did from the framing of the machine, acted with perfect accuracy, and nothing could move them from their line of working. The implements might break, but they could not alter their position, and would perform the work with an accuracy unknown to horse power. He had no doubt some of his friends would put him down as being rather "fast" upon this subject, but he had applied common sense and calculation to it, and he would say that he felt personally indebted to Mr. Halkett for the lucid manner in which he had brought forward his system, and the evidence with which he was prepared to prove that which he had stated.

Dr. MATTHEW TRUMAN remarked, that according to the statement of Mr. Halkett, large farms of 1,000 acres or more presented the greatest facilities for the full testing of this system of cultivation; but farms of that extent were not to be found in all parts of the country, nor were the fields joined together in the manner best calculated for carrying out this operation. He should be glad to know what was the minimum quantity of land to which this system would be applicable. Mr. Halkett had spoken of market-gardens, but those were cultivated in a very different manner to the generality of farm land throughout the country. It appeared that it was not adapted to every form of cultivation, and if the employment of horses was necessary for exceptional cases there could not be sufficient occupation for them throughout the year. He apprehended that, unless the entire estate were laid out very much in the form they saw in the diagram exhibited, the business of a farm of 1,000 acres could not be conducted entirely without horses; and he thought that was so much deduction to be made from the profit that was supposed to accrue from the adoption of this system. It appeared to him to be a most important subject and one in which all agriculturists must feel great interest.

Mr. WILLIAM HAWES would raise a question or two, which had nothing to do with the actual machinery employed, but rather with the cost at which it could be applied. He regarded it as next to impossible that tenant farmers could incur the expenditure necessary to carry out this system whilst they stood in the position of tenants-at-will, or on short leases. The question of long or short leases was a vexed one amongst the agricultural community, and he thought it one of the legitimate objects of this Society to look at the question not merely as to the pecuniary cost of cultivating the land, but, having ascertained the fact that a great improvement could be introduced into our agricultural system, it became them to inquire whether an antiquated system of legislation had not tended to retard improvements, and and check that which might otherwise be a great public and national benefit.

MR. MECHI wished to ask Mr. Halkett whether he had ever worked the engine at a higher pressure than from 40lbs. to 50lbs. to the square inch, seeing that railway locomotives would commonly work at as high a pressure as 120lbs. to 140lbs.; and also, whether he did not think advantage would be gained by working at a higher pressure than that mentioned, making the relative cost less for wear and tear?

The Earl of CAITHNESS remarked that 120lbs. pressure was only an average one for railway locomotives, and a pressure of 140lbs. might, in his opinion, be as safely employed in steam culture as in any other operation. He would ask one question of Mr. Halkett with regard to these rails. It appeared, from the diagram exhibited of the machine in operation, that the rails were laid down in long lengths, and that all such obstructions as hedges and ditches were removed. Such a course, he believed, was attended with great advantages in farming;

but it would be a matter of considerable expense, either to the proprietor or the tenant, to fill up the ditches and clear away the intervening hedge-rows. That was an item which he suggested ought fairly to be added to the expense of introducing the system of cultivation now under consideration. He would also ask, in what lengths the rails were laid down, and how they were fastened at the junctions—whether fished, or in what way they were put together; and further, whether they were intended to be permanent rails? A friend of his had remarked that this system would be a most disagreeable accompaniment to a farm, inasmuch as the laying down of these rails would effectually destroy foxhunting, as horses would not like to go across the fields in which the rails were laid. Knowing that John Bull was very fond of foxhunting, and the English farmer liked good horses, he would almost be sorry to see the country spoiled for this old English sport. At the same time, he was a great advocate for anything which would enable farmers to employ steam as the means of cultivating land. He believed it was capable of being done. Whether Mr. Halkett had exactly propounded the way in which it was to be effected remained to be proved. Mr. Smith's mode of steam ploughing, from what he had seen of it, was exceedingly good, and he was sorry he had not had the opportunity of witnessing it upon a large scale. He had seen it in operation at Windsor, on the occasion of Mr. Fowler exhibiting it to the Prince Consort, and the experiment was quite sufficient to demonstrate that ploughing could be done well by steam. He had this year given to Mr. Fowler the offer to plough 200 acres of land for a friend of his, but he received an answer from Mr. Fowler to the effect that he did not undertake ploughing himself; but his advice was that the farmers of a district should club together for the purchase of an engine and apparatus for steam ploughing. If that could be done, he (Lord Caithness) believed it would be a most advantageous plan. He believed if any one would establish a steam plough in a district, and let it out, although there might be some loss in the first instance, yet, if the practicability and advantage of ploughing by steam were demonstrated, the great difficulty would be got over. The great objection to this system was, that he was afraid they would not get persons, especially farmers, to lay out the large sum that was required to carry out Mr. Halkett's plan of culture. The system itself was extremely beautiful, and, with the rails properly laid and fish-jointed, he had no doubt excessively good work could be done, without that detriment to the land which was occasioned by the trampling of horses' feet. With regard to the operation of hoeing, he felt interested in that process, particularly with reference to turnips; but the objection to this plan, as applied to turnips, he apprehended would be, that when the hoeing was done by machinery, the healthy plants might be hoed up and unpromising plants left behind. When the hoeing was done by hand, the strongest plants were allowed to remain. Upon the whole, he thought farmers generally would not regard this system with a favourable eye, more especially as it appeared by the diagram that there was a little corner which, from its shape, must be cultivated by the ordinary means.

The CHAIRMAN said, that the noble lord who had just sat down had spoken most favourably of the use of steam, but his lordship appeared to think the farmers were so benighted a class, that they had not the spirit to club together to raise a few hundreds to bring it into operation. He (the Chairman) might appeal to Mr. Shuttleworth and Mr. Howard, whether, when farmers were convinced of the advantages of employing a steam engine, they did not at once procure one. He could mention the fact, that in one locality, with which he was well acquainted, the farmers had formed a company, and had purchased and set to work four of Hornsby's engines

Mr. GEORGE SHACKEL remarked, that this subject had been alluded to by the noble lord as a tenant's question. He (Mr. Shackel) would rather it had been introduced as a landlord's question, as that was certainly the light in which he regarded it. It was not to be imagined that a farmer with 7 or 14 years' lease, would embark in the necessary outlay. It was not his wish to throw any obstacles in the way of this plan; for with wheat at 40s. a quarter, it would be a great desideration with the farmer to have a system introduced that would enable him to obtain a fair profit. With regard to the hoeing of turnips, the farmers were only too glad to get plants at all, without exercising any great nicety in selecting the strongest plants in the operation of hoeing.

Mr. HOWARD would say one word with reference to what had just fallen from the Chairman. He (Mr. Howard) could answer for the tenant farmers, that they were not wanting in spirit in adopt any system that was proved to pay. The farmers were a very calculating class, and he was convinced that if they were made acquainted with the existence of a really good invention they would not be slow to try it. He (Mr. Howard) had been a good deal connected with Smith's steam ploughing tackle, and could state that there had been no trouble in disposing of 40 sets of the steam cultivating apparatus, upwards of 30 of which had been sold to tenants. That fact was alone sufficient to redeem them from the aspersion that they wanted spirit to adopt inventions which they knew to be really good and practically valuable. He agreed with Mr. Shackel in considering the introduction of this system as a landlord's question, and if the proprietors of land would go to the expense of carrying out this plan of Mr. Halkett's, the tenant farmers would only be too happy to make use of it. With regard to the power of traction exerted by the machinery, he believed the London and North Western Railway Company had not an engine that would take a load up an incline of 1 in 15, at the rate of 10 miles an hour.

The Earl of CAITHNESS said, with reference to the remark of Mr. Shackel, that the farmers were only too glad to get turnip plants of any kind, and were not careful to select the stongest plants in the hoeing, he (Lord Caithness) would say that that was not the plan adopted in Scotland. He did not mean to assert that the English agriculturist was behind the Scotch, for they all knew what the English farmer could do, but in Scotland the practice was to select the finest plants in hoeing.

The CHAIRMAN took the liberty of suggesting that this was not the time to discuss the comparative merits of Scotch and English farming.

Mr. S. SIDNEY had the opportunity of knowing that the farmers of England were rather in advance than behindhand in the desire to employ steam in the cultivation of the land. It was in fact the want of the present time, and if one thing was more remarkable than another in the progress of agriculture during the last ten years, it was the extreme rapidity with which the farmers had come to make use of steam, if they had anything offered them that they were sure would pay. Large sums of money were waiting to be invested in that way, when once the farmers were sure that an implement had been produced which would not be rendered valueless by after improvement, or reduced in value and utility by modifications from time to time. With respect to the interesting paper of Mr. Halkett, he had waited in the expectation of hearing farmers present speak upon the subject, but he feared the time had scarcely arrived when farmers were prepared to give an opinion upon it; and, with regard to those who were engaged in designing improvements in the application of steam to agricultural purposes, they were so much engaged in trying to perfect their own inventions that they were not prepared to say much about other plans. They must all thank Mr. Halkett for the way in which he had brought this subject before them. He confessed that when he first saw the plan, the difficulty which presented itself to his mind was

that the sinking of a large capital in the land would not be received in a favourable manner. It was only due to Mr. Halkett to say that his paper possessed the advantage of being so clear and so lucid that they could not fail to understand his system; but at the same time it was evident that it could only be applied to certain forms of culture. But, putting aside that minor point, it was impossible not to see that the difficulties were not mechanical, but financial. It was not easy to find persons prepared to sink so large a capital in the soil as this new system called for. He drew a broad distinction between the farmer who was prepared to lay out from £500 to £800 for a steam engine, which was applicable to the operations of the farm generally, and him who might be inclined to lay down the permanent system of works advocated by Mr. Halkett. It was his (Mr. Sidney's) hope that ere long they should find another Mechi, prepared to invest capital, as that gentleman had done in trying a great experiment. Mr. Mechi had obtained a reputation and a good name in the agricultural world, which he (Mr. Sidney) hoped would fire the enterprise of some younger man to take a farm, and lay down Mr. Halkett's system: and he felt convinced if that were done, such crops would be grown as would astonish not only those who were unacquainted with farming, but also surprise those who were practically engaged in agriculture. In the present day, in consequence of the necessity which had arisen for obtaining increased production from the land, and in consequence of the improved condition into which the strong clay lands had been brought by drainage, attention was turned to more completely cultivating the land than had hitherto been done; and they would imagine what a demand there was for efficient cultivation, when he told them that a friend of his, who held a strong clay land farm, informed him that he was driven to the adoption of steam ploughing in carrying out the autumnal preparation of the land, so as to make the best of his farm, for it was not in such cases so much a question of economy as between horse-power and steam-power, as a question of time, and the taking advantage of the seasons. If farmers desired something which economized time, and enabled them to get through, before Christmas, that which was formerly spread over the greater portion of the year, it only became a question what system they should adopt. He did not despair of seeing Mr. Halkett's plan adopted in some places; but it must first be done by some gentleman who went into the matter to make for himself a reputation without any hope of profit. He thought the calculation of percentages as brought forward by Mr. Halkett was a delusive one. There was no comparison between the case of land worth £6 an acre, with an outlay upon it of £90 per acre, or 1,500 per cent. and Mr. Halkett's system. In the former case the culivation was by slaves, who were a saleable property, and not invested capital in the soil; therefore that 1,500 per cent. did not in fact represent the capital sunk in the land. The difficulty in Mr. Halkett's system was that the capital was not invested in a class of property which could be sold or mortgaged but which stood in the same position as the working plant sunk in a mine. The suggestion was made by the noble lord who had addressed them, that the features of the land in most parts of the country would require to be altered in order to adapt it to Mr. Halkett's system; the plan of levelling large hedge-rows, however, was now being carried out to a considerable extent in several parts of the country. They must at least give Mr. Halkett the credit of having brought forward a perfectly feasible plan, which he (Mr. Sidney) would like to see carried out by some of those landed proprietors who from time to time fortunately come forward to employ their capital for the public good.

Mr. BAILEY DENTON said he, like Mr. Mechi, had paid some attention to what Mr. Halkett had been saying. He could not help expressing some regret that Mr. Halkett still adhered to figures in estimating the cost of the rails, which he (Mr. Denton) believed were too low. He entirely echoed the statement of Mr. Mechi as to the beautiful manner in which the different operations were executed by Mr. Halkett's machinery, but in the introduction of that system they must not only knock down the hedges and fill up the ditches, but it would also be necessary to level the surface of the country similar to the fen lands of England. He could add, that the system of Mr. Halkett was peculiarly suited for market-garden purposes, and the great reason why it had not been introduced upon those occupations was owing to the small scale on which they existed in this country, but were it possible to construct market gardens of a size to make it worth while to try this system, he believed it would answer very well.

Mr. HENRY SMITH, as a practical farmer, wished to know whether, presuming these rails were laid down upon certain lands upon a farm of 1,000 acres, horses could be entirely dispensed with as regarded the apparatus itself. He would also be glad to know by what means the produce was conveyed from the fields to the homestead; also, how the manure was carried from the farm-yard to the land.

Mr. CORNELIUS WALFORD urged the desirability of rendering the discussion of this subject as practical as possible. With the present low prices before shown, it would be necessary for farmers to adopt some other system than the present one for cultivating the land. Looking at the tone of the discussion, he was led to the observation, that whilst the meeting saw the necessity for the introduction of some new method of culture, they were not at present in a position to pledge themselves to this or any other scheme. His opinion of the tenant farmers was, that they would readily adopt every real improvement that was introduced into the science of agriculture.

Mr. HALKETT said, in answer to Mr. Smith, that the interest on machinery and implements was the same as that for horses and horse machinery. In answer to the question as to the size of the farm, he said that the system might be used with the small machinery for farms of only 200 acres. In reply to Mr. Mechi, he thought that the question of increasing the pressure of the steam was quite an engineering one. In his own opinion it would, perhaps, be better, but if the pressure was increased, and the cylinders were the same size, the boiler must be enlarged; in fact, the power of an engine very much depended on the size of the boiler. With regard to an observation made by Lord Caithness, in reference to hedges, he (Mr. Halkett) always understood that taking down a hedge paid for itself. He believed that it was his lordship who remarked that by this system larger crops would be obtained. He (Mr. Halkett) felt sure that one had but to see the fine crop of mangel wurtzel grown by Mr. Smith with his steam plough, to be convinced of the advantages which were to be obtained by not treading on the ground during the ploughing, while in his (Mr. Halkett's) system the ground was not trodden upon at all in any operation. In reply to Mr. Howard, of Bedford, he said, that locomotives could be made to go up a steep incline if they were, by a proper arrangement of machinery, made to reduce the revolutions of their wheels to the proper speed. They would then be able to go up much more than 1 in 15, even as much as 1 in 5. But locomotives were made for speed—to go 40 or 50 miles an hour. He did not mean to say, that in any case they would be able to draw a train up a steep incline, for the wheels would slip; but in his case it was quite different, for, as he had before explained, all his wheels were driving wheels. He begged to thank Mr. Sidney for the flattering terms in which he had spoken of his paper; with reference to the remarks upon the 1500 per cent. of outlay upon the fee simple of land upon sugar estates, he was only stating a well-known fact; this included slaves, buildings, and machinery, and he

(Mr. Halkett) could see no difference in the case. If the one was mortgageable property, so were his rails. He of course only argued upon the supposition that the system had been proved to be valuable. Mr. Halkett agreed with Mr. Bailey Denton in considering the brick and iron rail, which was the most costly of the two, the best. With reference to the cost at which they could be laid down, he had had them actually constructed, and the entire cost of material and labour had been noted.

The CHAIRMAN, in closing the discussion remarked that they should not encourage in that room the notion that farmers were, for the most part, the stupid, benighted race which some persons chose to designate them. No doubt there were many uneducated farmers, as well as poor farmers, and many tenants probably held larger occupations than their means justified. They did not want the Society of Arts to tell them these facts. What they wanted on the part of this Society was to point out the importance of mechanical principles, and to call to the aid of the farmers the application of those mechanical principles. The position in which this question stood was this—In the first place, farmers, from the north to the south, and even including the benighted west, were alive to the importance of steam cultivation. In the agricultural exhibitions of the country it was found that nothing tended to attract so large an attendance as the announcement that a steam engine, working a large number of ploughs, would form a feature of the exhibition. At present there were three systems of steam cultivation before the country, two of a locomotive character, and the stationary system. There was the locomotive system upon a moveable railway, introduced by Mr. Boydell. Then there was the system that had been explained that evening, of a fixed permanent line of rails; and thirdly, there were several forms of stationary engines, acting upon machinery by means of long wire ropes. All these were now before the mechanical and agricultural world, and they only awaited the getting over of some practical difficulties, which they looked to the engineering talent of the country to surmount. His friend Mr. Mechi, had opened the discussion in a thoroughly practical manner. The simple question was, whether the saving effected by Mr. Halkett's system was greater than that of horse-power, or rather, whether the comparison of interest upon the fixed capital invested would show a balance for or against the former. He might be allowed to say, that he came into the room with some prejudice against Mr. Halkett's system, and he was even disinclined to take the chair, lest it should be regarded by his friends as an indication of his approval of the plan; but he felt bound to say, that what he had heard that evening had led him to take a much more favourable view. If Mr. Halkett wished to win the agricultural mind to his plan he must show what was the utmost amount of capital necessary to be invested, not only in the first outlay for the rails, but also in getting the whole system into operation. These were matters which the agricultural mind was apt to overrate, and which, on the other hand, the engineering mind had a tendency to underrate, for they knew very well that English engineers were ready to undertake anything, if the money was only found them. In the same way, he believed, the farmers were ready to adopt any change, if it was shown, not merely upon paper, but in the field, that it would pay them. He begged to propose a vote of thanks to Mr. Halkett for his valuable and highly interesting paper.

The vote of thanks having been passed,

Mr. HALKETT, in acknowledging the compliment, remarked that he was willing to submit his system to the severest tests that could be applied to it. He had invited the examination of the most eminent engineers of the day, amongst others, Mr. William Fairbairn and Mr. Amos. He was open to the most searching investigation with reference to cost, and was ready to test his system in any locality in which it might be deemed desirable, in order to prove the correctness of the whole of his statements.

The Secretary announced that on Wednesday evening next, the 15th inst., a Paper, by Mr. E. J. Reed, "On the Modifications which the Ships of the Royal Navy have undergone during the Present Century, in respect of Dimensions, Form, Means of Propulsion, and Powers of Attack and Defence," would be read.

MEETINGS FOR THE ENSUING WEEK.

MON.....London Institution, 7. Prof. Tyndall, "On Light."
British Architects, 8. Mr. John Bell, "On the Geometric Treatment of Sculpture."
Geographical, 8½, at Burlington House. I. MM. Peschusof Vasilief, Radde Usoltzof, Pargtchefoki, &c., "Notes on the River Ameir and the adjacent districts." II. Mr. G. J. Pritchett, "Explorations in Ecuador, 1856 and 1857."

TUES. ...Syro-Egyptian, 7½. I. Mr. Marsden, "On Certain Discrepancies in the Reading of Hieroglyphs." II. Mr. Sharpe, "On the Date of the Crucifixion."
Civil Engineers, 8. Annual General Meeting. Reading of the Annual Report, and Ballot for Council.
Med. and Chirurg., 8½.
Zoological, 9.

WED. ...London Institution, 7. Conversazione.
Society of Arts, 8. Mr. E. J. Reed, "On the Modifications which the Ships of the Royal Navy have undergone during the Present Century, in respect of Dimensions, Form, Means of Propulsion, and Powers of Attack and Defence."
Geological, 8. I. Sir R. I. Murchison, "On the Old Red Sandstone of Elgin and the Neighbourhood." II. Prof. T. Huxley, "On Some Reptilian Remains from the Old Red Sandstone of Elgin."

THURS....Chemical, 8. I. Mr. F. Field, "On some Minerals containing Arsenic and Sulphur." II. Mr. E. Riley, "On the Detection and Distribution of Titanic Acid." III. Dr. Medlock, "On the Presence of Ammonia in Ice, and on the Action of Ice-Water upon Lead."
Linnæan, 8. Mr. D. Hanbury, "On Two Insect Products from Persia." II. Mr. D. Oliver, "On the Indian Species of *Urticularia*," On the Structure of the Stem in *Caryophyleæ* and *Plumbagineæ*."

PATENT LAW AMENDMENT ACT.

APPLICATIONS FOR PATENTS AND PROTECTION ALLOWED.

[*From Gazette, Nov.* 26, 1858.]

Dated 8th November, 1858.

2497. W. Hale, John-street, Adelphi, London—Imp. in rockets.
2499. T. B. Marshall, Queen-street, Cheapside—Imp. in drums.
2501. J. F. Amblet and A. Polart, Amiens, France—Imp. in the manufacture of elastic fabrics.

Dated 9th November, 1858.

2503. J. S. Dawes, Smethwick-house, near Birmingham—A new or improved machine to be used for cultivating land, and which may be made applicable as a hoe, a skim, a turf or peat cutter; and a new or improved method of actuating the said machine and other machines used for like operations.
2505. J. L. Jullion, Aberdeen, N.B.—Imp. in the manufacture of paper.
2507. A. Henderson, Gloucester-place, Portman-square—Imp. in vessels, and in applying rudders thereto.
2509. C. A. Burkley, New York, U.S.—Imp. in the apparatus for ginning and cleaning cotton. (A com.)
2511. S. S. Marling, Stanley-park, and J. Apperley, Dudbridge, Stroud, Gloucestershire—Imp. in the construction of fulling machines.
2513. A. V. Newton, Chancery-lane—Improved apparatus for obtaining extracts or decoctions. (A com.)
2515. B. A. Brooman, Fleet-street—Imp. in electric telegraphing. (A com.)

Dated 10th November, 1858.

2517. J. Norman and R. Hannah, Glasgow, Lanarkshire, N.B.—Imp. in furnaces.
2519. J. Buchanan, Greenock, Renfrew, N.B.—Imp. in propelling vessels, ships, and boats.
2521. G. Schmidt, Caroline-street, Bedford-square—Imp. in the construction of core bars.
2523. G. Schmidt, Caroline-street, Bedford-square—Imp. in the manufacture of cast-iron pipes.
2525. G. Schmidt, Caroline-street, Bedford-square—Imp. in ladles employed when casting metals.
2527. C. T. Judkins, York-road, Lambeth—Imp. in gas regulators.

Dated 11th November, 1858.

2529. J. and W. Lees, Oldham, Lancashire—An imp. in the construction of oil-cans.
2581. E. H. Maberly, Stowmarket, Suffolk—Imp. in the construction of ships of war and other vessels, their machinery and appurtenances.
2533. A. V. Newton, Chancery-lane—Improved apparatus for securing doors of safes, closets, and apartments. (A com.)
2535. J. Rae, Alpha road, New-cross, Kent—Imp. in cisterns suitable for containing water for household uses.
2537. J. Buchanan, Greenock, Renfrew, N.B.—Imp. in propelling vessels, ships, and boats.

Dated 12th November, 1858.

2539. J. Ogden, Liverpool, Lancashire—Imp. in shuttles for looms.
2541. D. Turner, High-street, Whitechapel—Imp. in the manufacture of wood soles for clogs, boots, and shoes.

Dated 13th November, 1858.

2543. M. N. Mills and N. Sidebotham, Ashton-under-Lyne—Certain imp. in looms for weaving.
2545. J. Wadsworth, Salford, Manchester—Imp. in the construction of moveable or adjustible heels for boots and shoes, and of spurs adapted thereto, to be used therewith.
2547. J. Courage, Horsleydown, Surrey, and F. Bennett, Holywell, Flintshire—Imp. in furnaces for reducing and smelting ores, scoria, slag, and waste.
2549. D. Auld, Glasgow—Imp. in furnaces and boilers, and in the generation and treatment of steam.
2551. L. Petre, Hatton-garden—Imp. in the application of glass to ornamental and useful purposes.
2533. M. L. J. Lavater, Strand—Imp. in the manufacture of mats, coverings for floors and other surfaces, and other cellular articles when india rubber compounds are used.
2555. A. B. Woodcock and J. M. Dunlop, Manchester—Imp. in covering rollers, shafts, and tubes of any figure or material, with elastic shells or covers of vulcanised india rubber, or other elastic substance, and in turning or grinding the surfaces of such elastic covers or shells.
2557. M. Pullan, Horsforth, near Leeds—Imp. in machinery for drying yarns and other materials.

Dated 15th November, 1858.

2559. S. St. Clair Massia, Welbeck-street, Cavendish-square—A new economical guard for candles and wax lights.
2561. A. Dick, Holywell, Flintshire—A new or improved manufacture of a yellow pigment.
2563. B. Predevalle, Hart-street—Imp. in producing or obtaining motive power.
2565. M. G. Deschamps and A. J. Quinche, Rue Beaubourg, Paris—A new compound metal called lutetia metal.
2567. W. Clark, Chancery-lane—A new mode of advertising. (A com.)

Dated 16th November, 1858.

2560. J. Brennand, Manchester—Imp. in the method of effecting the locomotion of carriages, which impoovements are also applicable to other similar purposes.
2571. J. C. Boigneau, Chatelleraut, France—An improved horse-mill or gear.
2573. J. Samuel, Great George-street, Westminster—Imp. in sleepers or bearers of rails.
2577. T. Knauth, New York, U.S.—Imp. in fire-arms and ordnance. (A com.)

Dated 17th November, 1858

2579. F. A. Gatty, Accrington, Lancashire—Imp. in producing certain colours on cotton, linen, and silk fabrics.
2581. M. A. Muir and J. Mollwham, Glasgow—Imp. in looms for weaving.
2583. C. F. Vasserot, Essex-street, Strand—A flat clothes smoothing-iron, with moveable handles. (A com.)
2585. D. W. Hayden, Coleman-street, Arlington square—Imp. in apparatus for heating water and other liquids.
2587. J. Robertson, St. Ninians, Stirling, N.B.—Imp. in musical instruments.
2589. E. Mellor, Rochdale, Lancashire—Imp. in mules and other machinery for spinning cotton and other fibrous substances, whereby the cop will be built much firmer, and prevent snarls in the yarn.
2591. J. Brennand, Manchester—An imp. in ploughs, and in other agricultural implements, and in the method of driving the same.
2593. S. Wheatcroft, Brudenell-place, New North-road—Improved apparatus for uniting lace to blonde and other fabrics.
2595. W. Clark, Chancery-lane—A process of thickening, strengthening, and improving tanned hides. (A com.)
2587. W. Clark, Chancery-lane—An improved bit or bridle for horses. (A com.)

[*From Gazette, December* 3, 1858.]

Dated 17th September, 1858.

2102. C. Hadley, Lower Hurst-street, Birmingham—Imp. in omnibuses, cabs, railway carriages, waggons, and other similar vehicles.

Dated 6th November, 1858.

2483 A. Fryer, Manchester—An improved method of supplying the tenders of locomotive engines, and of supplying boilers with water.
2484. W. Green, 21, King William-street, Strand—An improved harness trace coupling. (A com.)
2486. Baron D. Webster, Penns, Warwickshire, and J. Horsfall, Birmingham—An imp. in the manufacure of steel wire.
2488. M. Matley, H. Miller, and T. Hall, Ashton-under-Lyne—Imp. in the construction and arrangement of steam boilers and furnaces, for the purpose of consuming smoke, economizing fuel, and heating the feed water, and also imps. in certain valves connected with steam boilers.
2490. T. Platt, Oldham—Imp. in machinery or apparatus for preparing, spinning, and doubling cotton and other fibrous materials.

Dated 8th November, 1858.

2492. M. Osborne, Birmingham—A new or improved method of ornamenting fenders, stove grates, tables, chairs, and couches made of cast-iron.
2954. A. H. Dendy, 27, Fortess-terrace, Kentish-town—Imp in the construction of breakwaters or wave screens, applicable also in constructing bridges, roadways, piers, jetties, landing-stages, and other structures.
2496. T. MacSweney, 25, Rood-lane—Imp. in steering apparatus.
2498. W. Smith, Little Woolstone, Buckinghamshire—Imp. in apparatus for supporting the hauling ropes when hauling ploughs and other agricultural implements by steam power.
2500. W. C. Cambridge, Bristol—An improved manufacture of tubular iron, applicable to the construction of whippletrees, and to other uses.

Dated 9th November, 1858.

2504. J. E. Dickson, 6, Russel-street, Litchurch, near Derby—Imp. in the construction of railway chairs and other details connected with the permanent way of railways.
2503. J. Felix, 54, Rue Croix Nivert, at Grenelle, near Paris—Imp. in castors for furniture and other similar purposes.
2510. W Clark, 53, Chancery-lane—Imp. in signals for railways and in apparatus for actuating the same. (A com.)
2512. V. Newton, 66, Chancery-lane—Imp. in the construction of stairs. (A com.)
2514. V. Newton, 66, Chancery-lane—Certain imp. in electric telegraphs. (A com.)
2516. R. M. Ordish, Great George-street, Westminster—Imp. in constructing the permanent way of railways.

Dated 10th November, 1858.

2520. W. Taylor, Ashby-de-la-Zouch, Leicestershire—Imp. in removing the fur from skins and preparing said skins for tanning.
2522. E. Humphrys, Deptford—Imp. in steam engines and boilers.
2524. A. J. Brooks, Southsea—An imp. in screw propellers.
2526. E. Locke, Newport, Monmouthshire—Imp. in the construction of gas meters.

Dated 11th November, 1858.

2528. J. Blethyn, Swansea—Imp. in the manufacture of fuel.
2530. R. Wright, Openshaw, near Manchester, and T. J. Mercer, jun., Coventry—A new or improved motive power engine.
2532. M. Benson, Newcastle—An improved manufacture of rails for railways. (A com.)
2533. T. Gray, Bride-lane—An imp. in separating wool and animal fibres from vegetable fibres contained in mixed fabrics.
2536. A. Mickelthwaite, Sheffield—Imp. in treating and manufacturing buffalo and other horn, so as to be used as a substitute for whalebone and for other useful purposes.

Dated 12th November, 1858.

2538. T. F. Cocker Sheffield—Imp. in the manufacture of steel and iron wire, also of sheets and strips of steel.
2542. G. T. Bousfield, Loughborough-park, Brixton—An improved apparatus for illustrating conic sections and the lines of the globe. (A com.)

Dated 13th November, 1858.

2544. J. Benyon and J. W. B. Bowden, Swinton, near Manchester—Certain imp. in looms for weaving.
2546. W. Ashton and T. Cartmell—Imp. in air pumps, part of which improvement is also applicable to the pistons of other pumps and of steam engines.
2550. M. Swan, Henstridge-villas, St. John's-wood—Imp. in the construction of floating docks and other floating structures.
2552. I. Livermore, 5, Shrubland-grove, East Queen's-road, Dalston—An imp. in the manufacture of shuttlecocks.
2554. C. J. Thomas, T. Thomas, H. Thomas, and C. Thomas, Bristol—An imp. in the manufacture of caustic alkaline lees.
2556. D. Frodsham, Rose-cottage, Gurney-road, Stratford—Imp. in apparatus used in combination with fire boxes of tubular steam boiler in order to supply air and steam thereto.
2558. J. A. Hopkinson, Huddersfield—Imp. in steam boilers.

Dated 15th November, 1858.

2562. G. Davies, 1 Serle-street, Lincoln's-inn—Imp. in the process of finishing piled fabrics, and in apparatus employed in such process. (A com.)
2564 W. G. Armstrong, Newcastle-upon-Tyne—Imp. in the manufacture of ordnance.
2566. W. Clark, 53, Chancery-lane—Imp. in colouring, preserving, and dessicating wood and marble, and in apparatus for the same. (A com.)
2568. J. G. Bunting, Trafalgar-square, Charing-cross—A mechanical horse-tamer or brake.

Dated 16th November, 1858.

1570. J. H. Johnson, 47 Lincoln's-inn-fields—Imp. in machinery or apparatus for kneading dough or working and mixing plastic materials. (A com.)
2574. S. Taylor, Temple—Imp. in fountain pens.
2578. A. M. Bruere, Paris—The novel application of hydrogen gas to various purposes in the arts.

Dated 17th November, 1858.

2580. S. Hoga, 14, Nassau-street, W. P. Pigott, 16, Argyll-street, Regent-street, and S. Beardmore, 37, Upper Berkeley street West—Imp. in electric telegraphs.
2582. C. F. Vasserot, 45 Essex-street, Strand—A waterproof coating. (A com.)
2584. T. J. H. Tuck, Great George-street, Westminster—Imp. in the mode of laying and securing telegraphic cables, and in apparatus for the same, and for carrying on other operations under water.
2590. M. Caton, Preston—Imp. in the treading motion of looms for weaving, and also in shuttle boxes and swells connected therewith.
2592. R. A. Brooman, 166, Fleet-street—Imp. in apparatus for the manufacture of lace and net. (A com.)
2594. J. Platt, Oldham, and H. Chubb, Brecknock-crescent, Camden town—Imp. in machinery or apparatus for making bricks or tiles. (A com.)
2596. H. Douglas, Bart., Green-street, Grosvenor-square—Imp. in screw propellers.

Dated 18th November, 1858.

2598. S. Riley, Oldham—Imp. in the manufacture of hats, bonnets, and caps.
2599. C. Cowper, 20, Southampton-buildings, Chancery-lane—Imp. in assorting and separating combed fibres, and in machinery for that purpose. (A com.)
2600. E. Briollet, 58, Torrington-square—The obtaining of caloric by a new chemical and mechanical process. (A com.)
2601. Sir C. T. Bright, Harrow Weald, Middlesex—Imp. in insulators, and an improved mode of connecting insulators to posts and other supports.
2602. J. and H. Sharp, Bradford—Imp. in Jacquard machines employed in weaving.
2603. H. Stott, Greetland, near Halifax—Imp. in warping mills or apparatus connected therewith.
2604. J. Leslie, Conduit-street, Hanover-square—Imp. in the manufacture of gas.
2605. J. Oakes, Exeter-row, Birmingham—Imp. in the manufacture of spurs.
2606. J. M. Miller and J. Fear, Barnstaple—Imp. in machinery for winding fibrous substances or materials when in the form of thread or yarn on to the bobbins or wheels used in lace machinery.
2607. D. Stoten, Ponders End, Middlesex—Imp. in ploughshares.
2608. E. T. Archer, Bridgefield House, Wandsworth—Imp. in hat ventilators, and for appliances connected therewith.
2909. B. Rider, 61, Red Cross-street, Borough—Imp. in ventilating hats and caps, and in the preparation or manufacture of the material of which those articles are made.

Dated 19th November, 1858.

2611. J. Brown, Bolton-le-Moors—Certain imp. in index and Jacquard machines.
2613. G. Howe and J. Norton, Sheffield—An improved method of boiling water or warts for breweries, distilleries, &c., by steam, or for heating rooms, public buildings, churches, chapels, factories, &c.
2617. J. Edwards, 77, Aldermanbury—Imp. in the manufacture of trowser buttons.
2617. C. F. Vasserot, 45, Essex-street, Strand—An improved apparatus for condensing and cooling vapours and liquids. (A com.)
2619. W. Ramscar and J. G. Scott, Manchester—Imp. in fire-arms.
2621. H. Bailey, 35, Golden-square—Imp. in heating razors.
2623. A. Felton, 184, Brick-lane, Spitalfields—Imp. in fastening buttons and studs to dress and other articles.
2625. W. Marshall, Leith Walk, Mid-Lothian, N.B.—Imp. in steam-engines.
2627. A. J. Thorman, 8, Lime-street, City—Imp. in chain cables and chains.
2629. A. V. Newton, 66, Chancery-lane—Improved apparatus for transmitting motive power. (A com.)

Dated 20th November, 1858.

2631. R. Warry, Chatham—Loading cannon at the breech.
2633. C. F. Vasserot, 45, Essex-street, Strand—Imp. in fire-arms and ordnance, and in projectiles to be used therewith. (A com.)
2635. H. Ellis, Holbeach, Lincolnshire—Imp. in machinery or apparatus for cultivating, cleaning, and pulverizing land.
2637. C. Cuit, Paris—Imp. in railway brakes.
2639. R. A. Brooman, 166, Fleet-street—Imp. in the manufacture of dolls, statuettes, figures of animals, and others, and toys. (A com.)
2641. D. Evans, Chobham-cottages, New-town, Stratford—Imp. in tubular steam boilers and fire-places, or furnaces used therewith.
2643. J. Young, Wolverhampton—Imp. in fastenings for window sashes and casements, and in chain used for suspending window sashes.
2645. H. Boden, Crescent-cottage, Cambridge-heath, Hackney, and T. Cooper, Ann's-place, Hackney-road—Imp. in plaiting or braiding machinery.

Dated 22nd November, 2858.

2647. C. H. Mellor, Oldham—An improved manufacture of woven fabrics.
2649. F. A. Therould, 67, Rue Caumartin, Paris—Imp. in obtaining salts and products from the ashes of marine plants.
2651. A. V. Newton, 66, Chancery-lane—Improved apparatus for propelling and steering vessels. (A com.)
2653. T. Spencer—Imp. in the manufacture or construction of springs.

INVENTION WITH COMPLETE SPECIFICATIONS FILED.

2675. J. Luis, 1B, Welbeck-street, Cavendish-square—A safe guard against burglars. (A com.)—25th November, 1858.

WEEKLY LIST OF PATENTS SEALED.

[*From Gazette, Nov.* 26, 1858.]

November 25th.

1182. W. Bayliss.
1186. S. C. Lister and J. Warburton.
1188. F. Bouquié.
1207. E. Bond.
1210. W. Hodgson and H. Hodgson.
1215. M. A. F. Mennons.
1220. J. Barker Thornber.
1240. H. Brown, B. Hodgson, and J. Carter.
1270. R. Orr.
1283. J. B. A. Lombard and X. T. Esquiron.
1290. W. Clark.
1292. J. Bunnett.
1349. L. C. S. Masson and F. de la Morinière.
1400. W. E. Newton.
1404. H. Deacon.
1495. S. Lees.
1778. J. Luis.
2079. C. J. Redpath.
2128. F. F. Emery.
2149. W. Richards.
2183. J. J. Russell.
2265. A. von Schuttenbach.

[*From Gazette, Nov.* 30, 1858.]

November 30th.

1232. R. W. Chandler and T. Oliver.
1245. R. Owen.
1246. W. Clayton and J. Goodfellow.
1247. J. Bethell.
1252. R. Owen.
1253. H. Edwards.
1271. A. Manbré.
1275. G. Hadfield.
1351. G. Adshead.
1383. S. Hewitt.
1398. W. C. Wilkins.
1449. W. H. Preece & J. L. Clark.
1459. W. E. Newton.
1485. F. Richmond & H. Chandler
1509. J. Hodgkinson.
1643. E. Hardon.
1681. C. De Jongh.
1765. C. De Jongh.
2053. J. P. Koenig.
2117. T. Cook.

[*From Gazette, Dec.* 3, 1858.]

December 3rd.

1248. T. Scholefield.
1254. T. Wilson.
1268. C. Hancock.
1277. J. Ferrabee.
1282. E. Vigers.
1284. R. Hicks.
1307. H. Rollinson.
1336. W. Clark.
1338. W. Clark.
1442. W. E. Newton.
1450. C. Erhard.
2067. R. Frost and A. Rigg.
9144. E. T. Wright.
2182. G. Uhlhorn.
2198. B. Samuelson.
2206. S. Stimpson.

[*From Gazette, Dec.* 7, 1858.]

December 7th.

1978. J. J. Rowley.
1280. J. M. Dunlop.
1281. H. Wimball.
1285. J. M. Dunlop.
1288. J. C. Quince.
1301. E. C. Grimshaw.
1304. J. Easterbrook.
1305. P. Dumont.
1308. T. Robinson and H. Ogden.
1319. J. S. Crosland.
1321. G. Hall.
1322. H. Reynolds.
1330. S. Cheavin.
1335. J. Hall.
1350. B. Pitt.
1368. T. Steven.
1407. W. and J. Galloway.
1489. W. Sellers.
1511. M. Nelson.
1514. J. Dodd and T. Phillips.
1665. H. J. Giffard.
1743. G. S. Hill.
1772. W. Clay.
1853. J. H. Johnson.
1883. R. Anderson.
2134. J. Spence.

PATENTS ON WHICH THE STAMP DUTY OF £50 HAS BEEN PAID.

[*From Gazette, Nov.* 26, 1858.]

November 23rd.

2657. J. Wilkes.
2667. W. E. Newton.
2699. P. L. Bergeon.
2705. E. J. Davis.

[*From Gazette, Nov.* 30, 1858.]

November 25th.

2662. G. E. Dering.
2676. J. H. Johnson.
2745. A. Paget.

November 27th.

2687. R. A. Brooman.

[*From Gazette, Dec.* 3, 1857.]

November 29th.

2706. S. C. Lister.
2708. W. Ward.
2719. W. Rowan.

November 30th.

[*From Gazette, Dec.* 7, 1858.]

December 3rd.

2727. J. Barling.
2594. J. Murdoch.

December 4th.

2732. J. Moffat.
2735. T. M. Fell.
2751. T. Chaffer and J. Ellis.
2753. R. Bodmer.
2756. F. S. Thomas and W. E. Tilley.