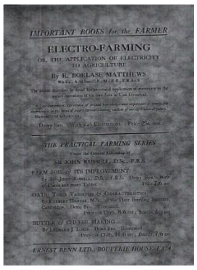
ROTHAMSTED RESEARCH

Power for Cultivation and Haulage on the Farm



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ELECTRIC PLOUGHING AND TRANSPORT

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Part I.—*Electric Ploughing*

Ploughing is one of the most important and heaviest of farm tasks and also the most expensive item on the arable farmer's bill. Opposition to mechanical power for ploughing is often met with in agricultural circles. It is claimed that the introduction of power-driven cultivating machinery, instead of reducing costs, would of necessity increase them, as the keep of the horses would be the same and the mechanical power would only be carrying out the work that the horses would otherwise be doing. There is, however, one fallacy in this argument, for the work of ploughing cannot be extended over a long period and horses can be used for this purpose only during slack periods. For land to be well cultivated the ploughing must be completed as early as possible in the autumn; and again, it often occurs in this country that long wet periods are experienced which delay work on the land, but, when a favourable opportunity presents itself, the farmer who has something quicker than the horse to carry out the work is in a very advantageous position. Further, the modern electric plough can now be adapted for all forms of field work—such as harrowing, rolling, harvesting, etc.

Another argument commonly used is that English fields are too small for this kind of work. This argument, however, is made on the assumption that all electric ploughs are very large sets, capable of covering an enormous area in one day. There are, however, the round-about and tractor types of ploughs, which are quite suitable for small fields—there are many in use to-day in vineyards in the South of France; these vineyards, it must be admitted, are a more difficult proposition than the smallest of fields. A great deal of the author's work has been in the direction of solving the problem of the ideal type of ploughing equipment for the small farmer of individualistic ideas.

It is doubtful whether the operation of ploughing, as at present practised, is really an essential part of tillage, and in this respect it is interesting to note the rapid progress made by the rotary cultivator during the past few years; these machines lend themselves extremely well to an electric drive. The flexible cable passes from

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a small mast on the machine through a pulley at the top of a pole fixed at the side of a field, it then hangs in a loop, the end of the loop passing to the mains being fixed to the top of the pole. In the loop there is a pulley carrying a weight, so that the cable is automatically paid out or drawn back at a constant tension, thus preventing it from being accidentally run over.

The 10 h.p. size can deal with an area of from 0·2 to 0·5 of an acre per hour, at a depth of from 4 to 10 in., travelling at a normal speed of 1½ miles per hour.

The 30 h.p. size can deal with an area of 0·5 to 1·5 acres per hour, working to a depth of 14 in.

There are a number of different systems of electric ploughing in operation to-day, though they practically all fall into one of two classes—viz. tractors or rope haulages. The capacity of the larger ploughs is enormous, many ploughing up to 30 acres in one day.

These sets are equipped with either 80, 100, 125 or 150 h.p., 5000 volt, three-phase, slip-ring induction motors, many of which are capable of a momentary overload of 60 per cent. The general design is based on British steam-plough experience, hence only the electrical features are really new. The main disadvantage of this equipment is the very great weight of the haulage sets, which is sometimes as much as 14 tons for each winder, thus large headlands are required. Many ploughs of this type are to be seen in France and Germany, and also in Russia. The method of operation is essentially the same as with the familiar steam-ploughing tackle. Two portable electric-motor haulages are placed, one at each side of the field, each haulage having a steel-rope drum, driven by counter-shafting through the electric motor. The average speed of the steel cable is about 1·66 yards per second, though it is possible to reduce the speed to 1·1 yards per second. With this equipment it is claimed it is possible to plough 30 acres per day, with a furrow depth of 9½ to 12 in. The power consumption per acre on heavy clay soil of average moisture content is about 15 units (kw.h.), while the speed of ploughing is 3⅓ miles per hour.

The majority of double-rope system haulages are similar in design, though many are equipped with auxiliary petrol engines of about 50 h.p. to enable the haulage to move from field to field and from farm to farm, while in others the familiar anchor-wagon device is used.

Continental manufacturers have realized that more attention must be paid to the need of the individual farmer, and have designed sets with this purpose in view.

The Estrade equipment has a number of novel features. The haulage cable passes through a pulley at the end of a pivot arm, whose movement is assisted by a series of oil dashpots. The resultant of the pull and the weight of the haulage always passes

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through the line joining the points of contact of the soil and the two inside wheels. These wheels are fitted with flanges, which, with the rims, enclose a prism of earth. In this way great stability is obtained, for, instead of depending on the friction of the iron arms on the earth surface, the much greater friction of this compressed prism of earth on that lying beneath is utilized. The manufacturers claim that this type of haulage gear can provide a pull of three times the weight of the set.

In another new machine, ramps, or inclined runners, are provided upon each haulage set, and when the plough reaches the end of its journey it mounts up on the haulage set, ready for transfer into position for the next set of furrows. Thus, headlands are reduced to a minimum and manœuvring is greatly facilitated.

Electric Tractor Ploughs.—One of the main problems is the method of dealing with the flexible cable connecting the tractor to the supply point. The best principle evolved so far is to mount the feed cable-reel on the tractor itself. In this way the cable is paid out and laid to rest on the soil instead of being dragged after the tractor, while on the return journey it is picked up and wound on to the drum. Various devices are used to ensure that the cable-reel winds and unwinds at the correct speed.

In Italy the ingenious method of attaching the cable to a small balloon (lifting power about 100 lb.), and thus raising it out of the way, has been employed.

Electric tractors fitted with a tramcar-type collecting trolley or bowl, picking up the current from a bare overhead conductor, have not proved satisfactory on account of the trouble in designing supports so as to maintain sufficient tension on the conductor and at the same time facilitate progressive movement at the end of each furrow.

Tractor ploughs are generally fitted with electric motors of from 20 to 30 h.p., and when equipped with three-share ploughs will plough, on an average, 6 acres per day to a depth of 8 in., the current consumption being about 28 units (kw.h.) per acre.

On the author's farm a 12 h.p. modified roundabout electric plough is employed.

The author considers that the double-winder rope system, with petrol engine for field transport, is the most satisfactory for large contractors working over large areas. The *ideal* plough for the farm of 200 acres and upwards has yet to make its appearance. The author suggests that it should be designed with a half-creeper track. The flexible cable should be raised above the ground, with automatic winding and an automatic-feeder cable, similar in design to that employed on the M'Dowall plough. A storage battery should be provided for moving the equipment from field to field, and when not in use on the land or within reach of overhead lines.

The main motor should be of about 25 h.p., while an additional winding motor of about 2 h.p., with an automatic hysteresis control, should be incorporated for operating the cable-drum. A mast should be fitted on the tractor to support the cable so that it hangs free in the air for a distance of about 30 to 40 yards. A plough should be mounted at both ends of the tractor so as to obviate the necessity of turning at the end of each set of furrows. A tractor of this type would plough from 40 to 60 acres from a single contact in the middle of the field. This tractor could also be used for such work as cultivating, harrowing, harvesting, rolling, seed-drilling, etc.

While it is not possible to give exact figures as to the cost of electric-ploughing, since so much depends upon special circumstances in each area, yet the author has calculated the cost of operating some of the machines from figures given by manufacturers and users. On the double-rope system with two haulages, the cost works out at 5s. 7½d. per acre, while the figure for electric tractors is 5s. 1d. per acre. These figures do not, of course, include overhead expenses, but include depreciation, interest, cost of cable, repairs, labour, and electric power at 1d. per unit, the depth of ploughing being from 6 to 8 in. When allowance is made for overhead charges these figures still compare favourably with the contract prices quoted for all other forms of ploughing. Another way of dealing with the cost is to mention that the consumption of electric current for ploughing varies from 15 to 22 units (kw.h.) per acre—a comparatively small sum at 1d. per unit, the usual charge.

There is, of course, still room for improvement in the design of electric ploughs, but it is rather refinement and evolution that is needed, coupled, of course, with the provision of an adequate distribution system to supply the large amount of electric power required.

For the supply of electricity to rural areas the usual type of overhead, three-phase transmission line will no doubt be used, and the only special feature introduced for field work is the method of connecting the high-tension lines to the portable transformer wagon. For temporary tappings it is often done by means of special hooks, having insulated handles and cable connected to the transformer cabin, though a better way is by means of permanent "fool-proof" pole contacts, of which special types already exist for pressures up to 10,000 volts. These are very easily operated from the ground by a long rod, and remove any possibility of wear and damage to the main transmission line.

Part II.—*Electric Transport*

An ample supply of power, which will be necessary for ploughing, will bring in its train many other electro-mechanical aids to the

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farmer, and chief among these will be comparatively simple transport equipment which will both expedite and facilitate the work on the farm, thereby reducing the amount of labour employed per unit of work performed.

Handling Crops.—A large proportion of the cost of hay and corn is accounted for by the high labour costs involved in handling the material both in the field and the buildings. A useful method of unloading the crops at the barns is to utilize specially prepared slings or automatic grab forks, in conjunction with an obvious system of ropes or nets, placed in the wagon before loading. The whole operation of unloading can then be performed by one man.

The method most frequently employed on farms on the Continent for hoisting these loads is a modified form of the Temperley transporter system, operated by an electrically driven hoisting gear provided with two hoisting drums and sets of brakes. The gear is conveniently located near the unloading point, thus giving complete control to the men in charge. When the load is hoisted to the top of the barn the pulleys jam, and the load can be traversed in either direction. The whole arrangement is of a very cheap and simple design, and can be operated by a 3-5 h.p. motor.

Transport equipment can also be used profitably at thrashing time—for instance, electrically driven chain-conveyers should be employed to transport the sheaves from the rick or barns to the thrashing-machine, with an automatic device incorporated on the thrashing-machine for cutting the bands on the sheaves and separating each sheaf before delivering it on to the drum. The thrashing-machine could then be permanently mounted on foundations about 4 ft. above floor-level. The installation of a permanent thrashing-machine would make it possible to deal with straw in the following ways: the straw could be (1) baled on leaving the thrasher, (2) passed through a sheaf binder, (3) blown to a straw-yard through a tube, or (4) transported by an inclined elevator. With methods 1, 2 and 4 the straw should be delivered on to a horizontal conveyor, so that at convenient intervals trap-doors can be placed in the run-way, which permit of the delivery of the straw at any desired point. When method 3 is adopted the delivery tube can be as long as 200 yards. It is usual to make up the length with 10 ft. lengths of light galvanized piping. At the end of the last tube an arrestor is fitted so as to collect the straw neatly at the desired point. For driving the grain a distance of 50 yards a 5 h.p. motor-driven fan is required, while an 8 h.p. motor-driven fan will double the distance, and a 10 h.p. size will carry it 200 yards. Where fans of efficient design are used, and attention is paid to the form of ejecting device, even smaller motors can be employed. The capital cost of these conveyors is not high, as they are of very simple design.

The grain can be moved by either "Jacob's ladders" or special worm-conveyers, delivering it on a horizontal or inclined belt-type conveyor direct to the granary.

With mechanical assistance of this nature one or two men only are needed at the thrasher, while other two pitch the sheaves on to the conveyor.

Central Manuring Plants.—A system of manuring market-gardens by means of stand pipes in the orchards has been carried out for quite a number of years on many Continental farms, especially those in Switzerland. The stand pipes are connected to a manure tank adjoining the main cow byres by means of underground pipes. The urine from the cowsheds flows directly into the tank, and when the plant is about to be used, old rotted manure is thrown into the tank and water added, and the whole contents agitated by means of revolving arms or by circulation through centrifugal pumps.

The question of the supply of electric current for transport purposes and for electro-mechanical appliances for work in the field and in the farm-buildings is relatively simple, if farming is carried on on modern lines, since the power demand would be so great that electricity-supply undertakings would be anxious to cultivate the rural load and would therefore be only too pleased to provide the necessary distribution system.

Recently the writer, in conjunction with Dr A. Ekstroem (the well-known Swedish authority on rural electrification), has prepared a scheme for completely electrifying the whole of Lincolnshire—which is typically an agricultural county. If the scheme can be carried through, rates as low as ½d. per unit will be offered for purposes where the current is used for long periods—such as thermal storage, electric cookers and water heaters. It is hoped to bring a supply of electricity to over 75 per cent. of the inhabitants of the county within six years. In each of the above-mentioned areas a number of typical farms will be completely electrified (including electric ploughs) in the reasonable manner that the farmers would do themselves if they had had many years of experience of the use of electricity, and also knew what farmers in other countries were doing.

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