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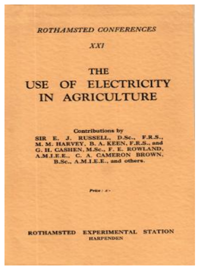

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FARM WIRING and EARTH LEAKAGE

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It is a remarkable fact, but none the less understandable, that the average farmer pays more attention to the purchase of a minor implement than to the quality and kind of his electrical wiring installation. The installation on a fair-sized farm will have a cost many times that of most implements and may be as much as or more than that of a tractor. It will be expected to outlast the implement or the tractor by many years and will be expected to give no trouble. Notwithstanding this, the farmer often pays but perfunctory attention to the choice and layout of the installation and contents himself, where he has gone so far as to invite alternative estimates, with choosing the lower.

I wish that this state of affairs was due to well-placed faith in the integrity of wiring contractors and their materials, but this is not the case. Perhaps this should be explained by saying that where a firm has reached the status of " contractor " it has usually a reputation to maintain and that satisfactory dealing may be expected, but that there are everywhere small firms who are capable of only inferior work—sometimes unscrupulously so but often through well-meant incompetence.

There are certain fundamental rules in approaching this problem of wiring :

(1) Always get two or more alternative estimates.

(2) Always suspect the all-in estimate. A good estimate should be detailed. The smart estimator who gives the buildings a hurried look and produces a figure while you wait may impress but it would be unwise to trust him. If he has over-estimated he nets a good profit, but if he finds that costs are mounting, he takes steps to skimp the job. The good firm does not gamble but measures up the job, apportions the cost and adds a standard percentage for profit. By detailed estimates we do not necessarily require that every wiring point should be priced, but every point should be specified for both position and for material.

(3) Always go over the ground with the firm's representative and show him where you want the various points and outlets to be : if he should suggest modifications, take the trouble to be satisfied that this will suit you.

(4) Always check over the estimate on the site and see whether the points and services scheduled agree with your original understanding with the firm's representative ; even a good firm may make a mistake.

(5) Never accept the lowest estimate blindly without ascertaining in writing that the materials used are of equal standard to those

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specified in the higher estimates. Suspect any estimate appreciably lower than the rest ; it may be genuine, but be sure.

In very many cases where the contracting firm has a high reputation and experience in farm work, there should be no occasion for the farmer to interest himself in either the materials or the application of them. Unfortunately, however, there are firms capable of excellent workmanship but having no experience of farm work, and small electricians who have no ideas beyond conventional lead wiring. It is as well, then, for the farmer to have some idea of the materials best suited to his circumstances and on which he can insist.

It is essential to be clear as to the main conditions and functions of a wiring system. We may assume that all farm supply is alternating current at 230v. single phase and 400v. three-phase. For technical reasons the supply company connects one side of the single phase (i.e., one wire) and the neutral wire of a three-phase supply to earth. This means that one wire—the live wire—of the pair in every single phase circuit and the three live wires in the three-phase circuit are at a pressure of 230 volts above earth ; there is also, of course, a pressure between the wires themselves. Unwanted and dangerous current will flow if either of the wires are brought into contact or if a live wire touches earth or any part of a building or structure which is in through contact with earth. In a dwelling house there require to be water or gas pipes in the room or a stone floor before this condition is possible but in the farm buildings there are usually stone walls or floors throughout, or bare earth, so that contact with " earth " is an imminent possibility.

The wiring system must provide insulation to prevent such unwanted contact and in all modern systems this consists of a thin coating or shell of rubber round the wires. This may be of pure rubber or of vulcanised india-rubber or of a combination of both. To meet the temperature conditions over the farm, vulcanised indiarubber (V.I.R.) is preferable. Any other wrapping or sheathing is extra to the insulaton and is for some other purpose, such as mechanical protection. A wiring system which confines itself to its primary function, that of insulating its conductors, is known as an " all-insulated " system and is supplied by wiring carried out in one or other of the family of tough rubber-sheathed cables known generally as cab-tyre sheathed (C.T.S.) cable, and used in conjunction with fittings and switches of insulating material such as bakelite or porcelain. A lighting system can be all-insulated but where there are motors a hybrid system is used and is described later. Another " all-insulated " system which is suitable for special conditions is taped and braided V.I.R. insulated cable carried on porcelain cleats.

The " earthed " system of wiring is based on the principle that if there should be a breakdown of insulation it is better to afford it an immediate and certain path to earth and so blow the fuses than to leave it to a casual and perhaps dangerous contact on the part of a workman to do so. For this purpose the insulated conductors are themselves enclosed in a metal casing which is made electrically continuous throughout the system and at one or more points brought into good contact with the ground. This is, in theory, an excellent idea, but depends for its success and its safety on the metal casing being in proper electrical continuity. The conditions on a farm are such—damp, fumes, cold and heat—that everything tends to destroy or at any rate to spoil that electrical continuity ; metal rusts or corrodes and high resistances are introduced at every join. An "earthed" system with an imperfect earth casing is more dangerous than an all-insulated system ; when a leak takes place the leakage potential is spread out over an exposed area between two bad joins and there is more chance of accidental contact.

Generally speaking, then, an earthed system is to be avoided on the farm but if the idea of continuous earth protection appeals it can be achieved in one of three ways :

(1) By a tubing system in which V.I.R. cables are drawn into galvanised steel tubes or zinc impregnated rustproof (Z.I.R.) tubes and all pipe joints *screwed*.

Any sort of grip joint is to be avoided as is black-enamelled tubing. The joint boxes, etc., should be cross-bonded to avoid the effect of rust in the cut thread. Only a first-class firm can make a good job of this system as the lay-out must be planned to prevent free moisture entering the system and yet to allow ample ventilation to carry off condensed moisture.

The big advantage of this system is that the cables are almost completely protected from mechanical damage and on a fault developing, a section can be easily withdrawn and replaced.

(2) By a metal-sheathed cable system incorporating a continuous bonding wire inside the metal sheath. This is jointed up inside the joint boxes when the power wires are joined. This makes a more permanent earthed circuit than relying on the sheathing itself, clamped at the various boxes. This system depends for long service on keeping damp out of the ends of the cut cables and to do this each joint box should be packed with plastic compound ; the number of cut ends should be kept to a minimum by "looping-in."

This system is generally regarded as being strong mechanically but this is a mistaken view, the lead offering little real protection from mechanical impact and is subject to corrosion from stable fumes, etc.

(3) By a C.T.S. system with a third continuous earth wire run inside the sheathing and jointed inside the joint boxes, and with plastic compound packed into the boxes.

It will have been gathered that an earthed system is not recommended for farm wiring and this is actually so. The conditions are so likely to cause deterioration in the earth circuit that it is felt that even a well-built installation would sooner or later become dangerous from that cause. An improvement is effected by using the internal earth wire but it is considered that this step is quite unnecessary. It is recommended that for the wiring of farm buildings an " all-insulated " system be installed, using C.T.S. or similar type cable and all fittings and fixtures of bakelite or similar insulating material ; all joint boxes or switch boxes should be packed with cold plastic compound. The cable used should be of 600 megohm grade—the 2,500 meg grade is unnecessary—and should be of " Vicma " standard, this indicates the Cable Makers Association grade, using V.I.R. for the insulation, which is preferable to pure rubber for farm conditions. If this is specified and carried out there need be no fear of the materials being faulty.

If power is used the installation cannot be altogether " all-insulated " since the motor casings and starter boxes will be of metal which must be earthed. This can best be done by running an individual earth wire to a separate earth on each group. If there is any difficulty in making a good earth—or indeed in any case—an earth leakage switch should be fitted to the motor. This will not add so very much to the cost but will add considerably to the general safety.

The C.T.S. covering the cable is very strong indeed and affords substantial protection from mechanical damage as well as being impervious to damp or the effect of ammonia fumes. Intelligent running of the cable and placing of the switches—admittedly breakable if of bakelite or porcelain—will add considerably to freedom from damage and inconvenience.

It is probably the one real drawback to C.T.S. that on exposure to daylight it hardens and ultimately cracks, a condition which only becomes serious if the cable is moved or if there is much damp about. Then, too, most farm-building interiors are far from enjoying a state approaching anything like honest daylight. To be on the safe side and to make the very best job, use should be made of a type of C.T.S. cable having an outer braiding which obviates the difficulty raised by exposure to light.

All flexible leads to appliances *must* be of C.T.S. cable and all suspended light flexes *should* be. The ordinary twisted silk-covered flex is quite unsuitable. Before accepting the materials, inspect the type of plug offered. You will have to wire in most of the portable appliances for yourself and some types of plug are very difficult indeed to wire properly. Choose a type which is easily wired. These plugs will have three pins, the large one being that connected to the earth wire. Unless the casing of the appliance is made of insulating material, bakelite for instance, a three-wire flexible will be required and should be specified when the appliance is bought. The plug, when opened, will probably have a label showing which of the pins is " live " and which " neutral "—alternatively the live pin may be coloured red for part of its length. The red covered wire in the flexible should be connected to the " live " pin and the black to the neutral pin. The white wire goes to the earth pin.

So far as the farmhouse is concerned, there is no difference from any other type of residence and any of the standard systems, in first-class materials, of course, may be used. Enamelled tubing or lead-sheathed systems are probably more generally preferable. The use of Nonazo (Non-Association) grade of cable is allowable and effects a small economy.

Amateur wiring is strongly to be discouraged ; so many attempts result in appalling results, and it is, indeed, often difficult to point out the defects to the proud perpetrator. But that should not discourage taking an interest in the installation, both before and after its execution. Trouble will often be minimised by anticipation if regular insulation tests are carried out. This should be done once a year and the cost of bringing a man out to do it can be reduced by arranging with one or two neighbours to have theirs done at the same time. In the same way, since travelling is one of the serious expenses in the contractor's estimates, a substantial reduction in wiring costs can usually be arranged by one or two adjacent farms having their wiring done at the same time by the same firm.

Leakage Protection

Raising the question of protection from leakage potentials is not, as so often assumed by the lay press, to draw attention to the dangers of using electricity. It is merely to explain how one source of danger, inseparable from the use of electricity—as there are equal dangers inseparable from the use of gas, oil, petrol, etc.,—is being met and overcome.

Wherever there is metal work, the casing either of a wiring system or of an appliance, likely to be charged with a dangerous potential on a breakdown of insulation taking place, it is necessary to provide some means of cutting off the supply to the weak point. The established method has been to connect all exposed metal work to earth so that when the fault develops the resultant rush of current blows the fuse and so isolates the faulty section. Unfortunately in rural areas where resort must be made to local " earths " the resistance of these is often so high that sufficient current will not flow to blow the fuse. The maximum pressure to earth is 230 volts and as it is nothing uncommon to have earth resistances of 50 ohms and more in dry weather, it is obvious that a leakage current of only some 4.5 amperes will flow ; this is insufficient to blow the so-called 5 amp. fuses which are usually fitted to lighting and light appliance circuits. It will be seen how little chance there is of blowing the bigger fuses on the power circuits requiring 20, 30 or 40 amps.

Of recent years, however, there has been developed the " earth leakage trip " which is a device actuated by the potential impressed on the metal work by the leakage so as to bring out the switch when a certain potential on the exposed metal work is reached. The leakage circuit incorporates a very sensitive trip coil which requires only a few milliamperes to flow before bringing out the switch and

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so rendering the defective section dead. The coil itself requires a potential of some 20 to 30 volts and a circuit of 20 to 30 milliamperes to actuate it ; this means that with a 50-ohm earth resistance the switch will operate with a leakage potential of about 30 volts. In practice, however, there is much more likelihood of encountering a full pressure to earth of 230 volts, which means that the trip will operate even if the total earth resistance, including the substation resistance, is something over 5,000 ohms. Thus the use of one of these switches procures absolute safety under practically every rural condition.

The use of the earth leakage trip has a bearing on the wiring system to be installed. If an all-earthed system is used and if it is in good condition, any leakage potential on one part of the casing will immediately be spread over all the system and every leakage trip will come out. In practice on a system of this sort only one leakage trip would be fitted at the mains end. This would mean, however, that if any leak took place the whole installation would be out of action, which might be highly inconvenient. With the all-insulated system, however, each motor or appliance would have its own leakage trip switch and a fault developing in the apparatus and causing a leakage potential on its casing would only cut out the supply to the apparatus. There is a strong possibility that leakage trip switches will have their value more fully recognised and their application extended. Keeping this in mind as a future, if not an immediate condition, one would certainly specify an all-insulated installation using a C.T.S. or other tough rubber cable.