THE MODERN ELECTRIC MOTOR FOR AUXILIARY DRIVE IN THE CANE SUGAR INDUSTRY

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Introduction.

These notes have been prepared primarily, with a view of providing reference and suggestions to those, whose duty it is to issue specifications for electric motors, for the multifarious applications to auxiliary drive in the Sugar Industry.

The choice of the term "auxiliary drive" in the title is deliberately made, so as to exclude main motors driving crushers and mills from the discussion. The author feels that this application is special, and deserves to be dealt with in a separate paper.

At the outset, it should be stated, that these notes are based on the hypothesis, that an electric motor, properly selected, is capable of displacing steam driven units to the benefit of the user.

Steam engines and pumps require careful handling while starting, and constant attention when running. Condensation in the steam line and cylinders will break cylinder heads and pistons, unless the pet cocks are opened, the water drained, and the engine or pump brought slowly up to temperature and speed. Reciprocating steam pumps will knock when they lose their suction, and steam engines which are commonly run without speed governors, will race when the load is thrown off. The fluctuating pressure will cause proportionate changes in the flow of the liquid pumped, and in the speed of the driven machinery. A larger number of attendants is required to prevent damage to the pumps and engines, and to maintain constant the flow of the material. In order to ensure that the pumps will deliver the required pressure in the liquid with reduced steam pressure, the steam cylinders are made oversize. Care must be exercised in closing the discharge valves in connection with the throttle valve, or a high pressure may form at the liquid end, sufficient to blow the packing, start leaks or even break the pump.

The electric motor requires no careful handling at starting, nor attention when up to speed. Protective devices shut off the electric power in cases of overload on the driven machines or electrical faults. The overload devices can be adjusted to operate only after a sustained overload on the motor, or to act instantly in limiting, for example, the pump pressure. This latter feature finds a valuable application in filter press pumping, and results in considerable saving in damaged plates.

The majority of centrifugal pumps and mechanical drives are operated at constant speeds. The speed of the constant speed motor does not materially change with a change of load, since it is primarily dependent upon the speed of the electric generator, controlled by a sensitive engine governor, and under the watch of trained power house attendants. The amount of liquid discharged by a centrifugal pump, can be closely regulated by throttling the discharge. This does not materially increase the pressure at the pump; in fact, the discharge valve can be entirely closed, without producing a dangerous pressure. The power required is approximately proportional to the liquid delivered, so that as the discharge valve is closed, the load on the motor decreases.

When the pumps are electrically driven, the flow of the liquids through the pipes is steady, instead of pulsating, as with steam pumps. As the friction of liquids in pipes increases with the square of the velocity, a greater average pressure—and therefore power—is required of the steam-driven pumps than of the motor-driven pumps.

Although special pumps are being placed on the market, it is the opinion of many engineers that a certain class of pumping is more reliably performed by plunger pumps, namely, liquids of a viscous nature as, scums, massecuites and molasses. The three pistons of the triplex single acting pump produce an approximately uniform crank effort, with consequent smooth flow of liquid, and the drive is eminently suitable to the motor with integral gearing.

Advantages of an electric drive could be further stressed. Suffice it to say, that the mill is cooler, cleaner, less congested, better lighted, and freer from those undesirable overhead steam pipes, with their inevitable leaky joints.

These more favourable working conditions conduce to the comfort of operatives, increase their output and act as an inducement to continuous and contented employment.

Another aspect perhaps should not be overlooked. The days are past, when inefficient steam units can be tolerated and even condoned, on account of their contribution to the supply of process steam.

With the advent of soft canes, it is becoming increasingly difficult to maintain a heat balance in our Natal factories. The electric motor draws its energy from the Mill Power House, where high pressure steam can be most efficiently used, and the exhaust readily fed to the process system, resulting in an overall saving of fuel. It is not for the author to deal with high efficiency furnaces, superheat, increased pressure, air heaters, back-pressure turbines and the other methods which are being exploited to produce the maximum quantity of the required steam, with the minimum of bagasse burned. It is, however, being most emphatically stressed, that in the good work of saving still further bagasse, the electric motor has its undisputed place.

Systems of Supply.

In Natal, unfortunately, from the point of view of standardisation, systems of supply vary with individual mills, the definite tendency being to standardise on an A.C. circuit of 500/550 volts, three phase, 50 cycles for power, with 220 volts single phase for lighting.

Both 110 volts and 220 volts D.C. systems have, however, survived, and been extended from the original lighting installations.

There is much to be said for the 220 volt D.C. system for a small mill, which does not propose unduly to extend; but who can put a limit to the ambition of a Sugar Factory Directorate?

The 110 volt D.C. system labours under a heavy burden when even moderate extensions are taken in hand, and it were well to make a change at the earliest possible opportunity.

The principal disadvantages of the above D.C. systems are the high initial cost of motors, and the heavy cables required.

The author proposes mainly to discuss alternating current motors with their necessary control gear, in the light of modern practice and development.

Standard Types of Motors.

Dealing briefly with D.C. motors, the standard motor is a constant speed machine, but can be specially ordered as a variable speed unit controlled by a field rheostat.

It is not always realised that the motor frame size and price, is fixed by the minimum speed required, and that the field rheostat is only capable of increasing the speed. The motor is capable of developing its full rated horse power throughout the speed range.

A.C. motors, neglecting for the moment special types, are of two main types (a) squirrel cage (b) wound rotor, usually termed the slip ring type, both being constant speed machines.

The squirrel cage motor is noted for its simplicity, robustness and high efficiency and is almost exclusively used in the smaller sizes. Its limitations lie in the high current taken at starting, if a starting effort equal to or approaching full load torque is desired; also the limited torque obtainable, if starting current is throttled by star-delta switching.

As a great number of the drives in a sugar mill, however, start light the disadvantage is not serious; the relative cheapness of this motor, combined with its reliability, making it eminently suitable.

A higher starting torque with lower initial rush of current, may be obtained by the use of a special high torque motor with a double squirrel cage rotor construction. The cost is from 10% to 15% higher than a standard motor.

Average values of starting torque and current for medium size motors of the standard and high torque type with different starters, are as follows:—

Standard Squirrel Cage Motor.

Direct starting: Torque, 140% full load: Current, 500% full load.
Star delta: Torque, 40% full load: Current: 150% full load.
Auto-transformer (75% tap): Torque 60% full load: Current 250% full load.

High Torque Squirrel Cage Motor.

Direct starting: Torque, 225% full load: Current, 400% full load.
Star delta: Torque, 70% full load: Current, 150% full load.
Auto-transformer (75% tap): Torque, 90% full load: Current, 250% full load.

The wound rotor differs from the squirrel cage motor, as its name implies, in that the rotor is provided with an insulated winding, the connections to which are brought out to slip rings. If required this type will develop, at starting, twice full load torque with 2½ times full load current. Acceleration can be carried out very smoothly by gradually cutting out resistance in the rotor circuit. If only required to start against full load torque, the starting current will not exceed 1¼ times full load current, while at lower starting torques, the starting current will be comparatively less.

On a 50 cycle system, it is important to note, only certain definite speeds can be given, the actual full load speeds being approximately 4% below the following principal synchronous speeds—3,000, 1,500, 1,000, 750, 600 and 500. Lower speeds than these are possible by increasing the number of poles, but are seldom a commercial proposition, except in large sizes. In such cases, geared motors, later described in this paper, are particularly suitable. Chain drive and endless Vee belt drive also provide an efficient and cheap form of speed reduction.

Special Motors.

(a) Motors having variable speed characteristics.
(b) Power Factor Correction Motors.
(c) Geared Motors.

(a) **Speed Variation.**

The simplest method of obtaining speed variation is by using a standard slip ring motor, with a continuously rated variable resistance in the rotor circuit. The speed so obtained will vary with load, the efficiency decreasing with the speed. This restricts the use of the method to steady load applications, small reductions of speed or larger reductions for a limited period. A suitable application is in connection with the control of crane motors.

Another possibility is the use of the change pole squirrel cage motor, giving a choice of a number of synchronous speeds, usually up to four. This, obviously, can only have limited applications.

However, both of the above methods have been applied with marked success to the drive of centrifugals. A vertical motor is used with base suitable for connection to the centrifugal base. The motor shaft drives the centrifugal shaft direct through a flexible coupling. No belts or clutches are employed. The motor control switch is combined with the brake lever, all operations being controlled through one handle. For low speed operation for mechanical discharging, resistance is inserted in the rotor circuit. The motor is designed to operate on a 4½ minute cycle. Alternatively, a change pole motor is employed to give the low speed for mechanical discharging.

With this method of drive, the output per centrifugal is increased considerably on final sugar, above that possible with other types of drive. A smaller number of units is thus required. The direct coupled drive requires 10 per cent. less power than the belted group drive, and 20 to 30 per cent. less than the water drive.

The absence of belts and clutches removes the greatest sources of trouble found with centrifugal drive, maintenance expense being practically eliminated. The initial cost is greater per machine than with group drive; but considering the smaller number of centrifugals required, lower cost of operation, labour, and maintenance, it will be found that direct drive will prove cheaper even for the first year of operation.

First introduced many years ago, the A.C. variable speed commutator type of motor has since proved the ideal drive for many industrial purposes. It can with advantage be applied to sugar mill auxiliaries, such as fans and pumps, where output is being frequently varied over wide ranges. The main objection against its more extensive use is its high initial cost, but it must be noted that its operating characteristics give results, such as are impossible to obtain with any other type of self contained A.C. motor:—

(a) Speed once adjusted practically unaffected by change in load.

(b) Wide speed range; may be 16 to 1 or higher, but normally a much smaller range is all that is required, with consequently a cheaper and more efficient machine.

(c) Uniform and smooth acceleration by change of position of brush gear driving running.

(d) High efficiency over the whole speed range. The Power Factor throughout a considerable portion of the speed range is high. To gain this advantage, it should be noted, that a motor obviously of a greater horse power than is necessary should not be installed.

(e) Ease of starting; normally the brushgear is set in the minimum position, and the primary switch closed.

The motor consists briefly of an ordinary slip ring motor, with the position of the primary and secondary windings reversed, and the addition of a regulating winding with commutator and brushgear. They are normally only manufactured for use up to 600 volts.

The most economical sizes of machines are those where the output is directly proportional to the speed, which coincides with the majority of industrial applications. Other torque speed characteristics can, however, be designed, and have been successfully applied to fan and pump drives, where the torque is approximately proportional to the square of the speed.

Power Factor Correction.

Power Factor Correction apparatus is necessary, primarily to increase the capacity of generating plant, transformers, transmission lines, cables, etc., and to give better voltage regulation; in effect, to neutralise the unwanted wattless lagging current, by injecting a leading component into the system.

Low power factor conditions are caused principally by the use of low speed motors, and motors running considerably under-loaded.

Improvement in power factor may be accomplished by installing static condensers, or by the use of special motors.

Static condensers are sometimes connected directly across the motor terminals, or across the station bus bars. Static condensers are highly efficient, but have the disadvantage of high cost. Without careful consideration of the conditions of service, they are also likely to cause transient rises in voltage during switching and fault conditions, and magnetic slot disturbances in motors having unskewed slots.

Where there are reasonably sized motors, say, 30 h.p. and upwards, power factor correction can usually be obtained more cheaply, by the use of special motors.

The synchronous motor is the simplest form of motor of this type, but owing to low starting torque has practically no industrial application.

The more extensively used machine is the synchronous induction motor, or auto-synchronous motor. It is virtually a slip ring induction motor with a direct current exciter, possessing all the advantages of the wound rotor induction motor, plus an ability to operate at a leading power factor. It can thus compensate for low power factor in other apparatus, and should be designed for most economical operation at 0.8 leading power factor.

Other special types of motor, known as the power factor compensated type, notably the "No-lag," "Kosfi," etc., are in general use, and successfully meet the above conditions. They differ primarily from the synchronous induction type, in that they dispense with the separate exciter, and include an integral auxiliary winding and commutator on the machine itself.

A separate phase advance, either separately driven, or directly coupled to a slip ring motor, has a useful application, but is not so popular.

It would appear that the power factor compensated type of motor competes successfully for medium sized high speed drives, while the synchronous induction motor is cheaper for low speeds, high power factor correction and larger sizes.

The control gear for both types is practically standard slip ring motor practice, the synchronous induction motor being somewhat more complicated.

The following typical example of a factory installation, will serve to show the economies which can be effected, by correcting low power factor. More clearly to illustrate the example, the author has converted the KVA output into terms of amperes at 500 volts.

The factory in question had already installed induction motors totalling about 300 h.p., the average maximum current demand on the generating plant being 185 amperes. Additional motors were required for driving new plant, these motors being of 50 h.p., 15 h.p., and several smaller sizes, aggregating 15 h.p., making 80 h.p. of new motors in all.

Squirrel cage motors were used for the smaller powers, while the 50 h.p. and 15 h.p. motors were of the power factor correction type, designed for 90% leading power factor. In addition, two existing induction motors of 50 h.p. and 15 h.p., were replaced by similar power factor correction machines. After the new motors had been added and the conversion made, the current demand on the generating plant was found to be still 185 amperes due to the better power factor, although the total installed horse power had been increased from 300 to 380 h.p.

An interesting fact is the purchase this season, by two different sugar mills, of a 20 h.p. power factor compensated type motor at 1,500 r.p.m., and a 80 h.p. synchronous induction motor at 300 r.p.m.

(c) **Geared Motors.**

Standard induction motors designed for low speeds have a poorer efficiency and power factor performance than high speed motors. In addition they are large and costly. Hence, there has been developed a combination of high speed motor and reduction gear unit in a single carcase, commonly known as a geared motor. The gearing has a high efficiency, with the result that the overall efficiency is comparable to that of the slow speed motor, but the power factor is considerably improved. In addition, the space taken up is reduced, a saving in capital cost is effected, and often a final drive can be avoided, by increasing the gearing ratio, to enable a direct coupled application to be made. The geared motor must consequently be regarded as a very useful development.

Motor Enclosures.

Modern motors may be obtained with various forms of enclosure.

For normally clean situations, screen protected motors provide protection of the moving parts against interference by unauthorised persons. These motors are usually held in stock by suppliers, and supplied against indent, unless instructions are otherwise given.

A visit to any sugar factory will reveal this type, subsequently fitted with home made sheet metal "umbrellas," to protect the motor from overhead drips; in many cases with essential ventilating openings closed, causing deleterious heating. For these situations, drip proof motors should be specified, the manufacturers supplying louvred covers with effective ventilation. The increased cost is usually very small.

Where it is preferable to use clean air from outside the building for the ventilation of the motor, a pipe ventilated machine is suitable. The ducting should be not less than 1.5 times the area of the inlet opening, as straight as possible, and not exceeding 50 feet in length. The rating of the motor is generally reduced 10%, depending on the frame size, owing to the restricted air path.

For dirty or exposed situations, the most satisfactory protected machine now on the market is the totally enclosed motor with fan cooled frame. Except in the smaller sizes, this has displaced the ordinary totally enclosed machine, which cost three to four times the price of a standard open type motor.

The totally enclosed fan cooled motor consists essentially of a totally enclosed machine with an internal air circuit, surmounted by an additional casing, through which air from the outside atmosphere is circulated. No outside dirt or moisture can reach the windings and vulnerable parts. Efficient cooling is effected by providing fans for both air circuits, the air flowing in opposite directions through special ducts in the iron. In the latest designs, dust traps are provided to trap incoming impurities to the outer air circuit. The cost of these machines above that of the open type motor, for example, in the 10 h.p. and 20 h.p., 1,000 r.p.m. sizes, is approximately 50 per cent.

Motor Starting Apparatus.

The chief division between types is again dependent on the class of motor.

For squirrel cage motors the following common types are available:—

(a) Direct starting.
(b) Star-delta starting.
(c) Auto-transformer starting.

Direct Starting.

In most factories with limited capacity power stations, the starting current is too high, and use is confined to small motors up to 5 h.p.

Star-delta starting.

58 per cent. of the line voltage is applied to the motor at starting, with 40 per cent. torque. This starter is widely used, and is suitable for most industrial applications.

Auto-transformer starting.

A choice of tappings in this type of starter is provided, the higher tappings passing sufficient current to get the motor away with increased torque. Compared with direct starting, the reduced current on each tapping is proportional to the reduction in voltage, while the starting torque will decrease as the square of the reduction in voltage.

Slip Ring Motor Starters.

These consist of two electrically separate parts, though these may be combined in a single mechanical unit. One part comprises the stator control switch, and the other, contacts, to cut out gradually the rotor resistance. Both parts are electrically interlocked, and the interlock may be extended to the brush lifting and short circuiting gear on the motor.

Protective Features.

All the above types should have under voltage and three over current releases, the latter preferably fitted with time lags. A later development is the thermal bi-metal strip over current release, which heats up at the same rate as the motor windings.

An ammeter is a most desirable fitting, but is seldom supplied unless specially called for. For instance, in a pump drive, the ammeter gives indication both of overload conditions and loss of suction.

Control Gear Enclosure.

Apart from special types, starters are of the iron-clad, totally enclosed pattern, either air break or oil immersed. In all, except the smallest sizes, they can be supplied suitable for wall or floor mounting.

For severe duty and even for ordinary duty, the oil immersed type is strongly to be recommended. The contacts work under ideal conditions, speedily extinguishing the arc, and making for long life and reduced maintenance.

Special Starters.

There is a definite tendency towards the employment of air-break push button contactor type starters, which automatically accelerate the motor, under the most favourable conditions. Control can be had from several points, an undoubted advantage for many applications. Cost is perhaps 50 per cent. higher than manually operated types.

Selection of Starters.

Probably no piece of electrical apparatus in the factory is more conducive to trouble, and has to stand more rough usage, than the average starter. Money is well invested in purchasing the most reliable and robust article on the market. Separate prices should always be obtained for the starter, apart from the motor, with full particulars of the type offered.

In a recent report issued by the British Engine, Boiler and Electrical Insurance Co., the incidence of break-downs in service, during the year under review, was segregated as follows:—

Starters	30.0%
Armatures	24.8%
Stators	9.7%
Commutators	9.0%
Field Coils	6.5%
Brush gear	5.6%
Rotors	5.3%
Miscellaneous	4.0%
Bearings	3.2%
Shafts	1.9%

The above figures speak for themselves. Competition has forced into the market a type of starter, low in first cost, but definitely not built to withstand severe service and unskilled handling. If buyers will call for starters to meet expected service conditions, and accept the higher priced oil immersed type (push button contactor type excepted), the break-downs in service will be considerably reduced.

Conclusion.

The author trusts that these notes will induce a greater interest in the correct specifying of motors and control gear, with due consideration to the location and duty entailed.

This applies also to the correct specifying of electrical equipment, included with machinery, imported direct from England. The machinery manufacturer will, too often, give full details of his products, and dispose of the electrical equipment with the cryptic remark, "Coupled to suitable electric motor and starter."

The attached model specifications cover possible requirements, and may be added to or modified as conditions of service demand.

In conclusion, a few general remarks may prove of interest.

Development in motor manufacture under the stress of intense competition, has produced machines having better efficiency and power factor performance, and at the same time, lower cost.

The output of a basic frame size, for which a machine can be designed, has been increased due to a number of factors. Utilisation of special iron in the construction of the magnetic circuit has played an important part. The dissipation of heat from the windings has been carefully investigated, and more effective results obtained by the avoidance of trapped spaces. Impregnating material and insulation, having a high heat conductivity, is now standard practice.

Perhaps, the greatest advance may be recorded, in the substitution of axial ducts through the iron cores, superceding the radial ducts hitherto standard. By this method, the edges of the laminations are brought in direct contact with the cooling air, definitely producing cooler slot temperatures.

Mechanically, the motor should possess the most modern features, forming a basis of comparison in considering competitive offers. In order to produce competitive machines, manufacturers have often made ill advised savings in the mechanical features, from the point of view of the sugar mill engineer and his maintenance costs. Shafts should be of ample size, and ball and roller bearings, except perhaps in large sizes, offered as standard. Ball and roller bearings should be enclosed in cartridge type housings, enabling the end brackets to be removed, without interfering with the races on the shaft. Terminal boxes should be large and accessible, and when cable boxes are fitted, allow the motor to be disconnected, without breaking the compound filled joint. A considerable improvement has been effected, by bringing the rotor leads of a slip ring motor, into the same terminal box as the stator leads. This allows the slip ring cover to be readily removed for inspection, usually by the simple unscrewing of two wing nuts.

In a paper of this description it is difficult to gauge, not so much what to include but what to omit. The author trusts, however, that he has covered a sufficiently wide field, and has been able to collect both useful and interesting data.

Bibliography.

Metropolitan Vickers Technical Pamphlets.
Articles by D. B. Hoseason, R. C. Mortimer and E. Collins, etc.

APPENDIX A.

Specification of an Induction Motor.

Circuit: — volts, — phase, — cycles.
Number required: —.
Horse Power: —. This should not be over estimated, bearing in mind that an induction motor is capable of 25 per cent. overload for two hours.
Enclosure: Screen protected, drip-proof, pipe ventilated (preferably with free outlet), totally enclosed or totally enclosed, fan cooled.
Type: Squirrel cage, double squirrel cage, slip-ring or power factor correction type.
Brush gear: (Slip ring type only): Continuous rating or provided with brush lifting and short circuiting gear with interlock.
Power Factor: (Power Factor Correction type). Value of leading power factor required. Where power factor of existing system is good, specify unity power factor; moderately good, 0.9 leading; poor, 0.8 leading.
Speed:—. (High speed motors cost less, have good efficiency and power factor).
Geared motors: Speed of low speed shaft.
Drive: Direct coupling, belt drive, chain drive or gear pinion.
Third bearing for special drive.
Pulley or coupling: As required.
Slide rails or base plate: As required.
Foundation bolts: As required.
Terminal arrangements: V.I.R. cable, conduit or pipe glands, cable boxes.
Duty: Type of driven plant and any special torque requirements.
General: Motor to conform to British Standard Specification 168/1926, and to have windings specially impregnated for use in a tropical and humid atmosphere.

Example.

Required a 10 h.p. motor for direct coupling to a pump starting light.

Circuit: 500 volts, 3 phase, 50 cycles.

One—10 h.p. drip-proof squirrel cage induction motor, with tropically impregnated windings, running at 1,450 r.p.m., of the two end shield ball and roller bearing type, with bare shaft extension keywayed.

Rating, torque and overload: In accordance with B.S.S. 168/1926.

Terminal arrangements: Terminal box for V.I.R. cable in tubing. Six leads to be brought out for star-delta starting.

Specification of Control Gear.

Circuit: — volts, — phase, — cycles.

Number required: —.

Horse Power of Motor: —.

Type: Direct starting, star-delta or auto-transformer for squirrel cage type.
Stator and Rotor starting switch for slip ring type. Contactor type.

Protection: Under voltage and three over-current releases preferably with time lag devices.

Ammeter: Inclusion recommended.

Mounting: Wall or floor.

Terminal arrangements: V.I.R. cable, conduit or pipe glands, cable boxes.

Enclosure: Air break or oil immersed (preferably oil immersed for severe duty).
Contactor type: Air break in weatherproof case.

General: Starter to be of ironclad totally enclosed pattern and to conform to British Standard Specification 587/1935.

Example.

Suitable starter for 10 h.p. motor in previous example?

One—10 h.p. oil immersed star-delta starter suitable for wall mounting. Starter to be equipped with correct sequence device, under voltage and three over-current releases with time lags, also suitable ammeter.
Terminal arrangements suitable for V.I.R. cable in tubing.
Staster to conform to British Standard Specification 587/1935.

APPENDIX B.

Suggested Applications.

Drive.	H.P.	Motor.	Enclosure.	Starter.
Cane handling crane	10/25	Slip-ring	Totally Enclosed Fan Cooled	Drum Controllers
Cane Conveyor	15/50	Variable Speed or Slip Ring	Totally Enclosed Fan Cooled or Pipe Ventilated	Stator and Rotor Drum Controller
Cane Knives	50/120	Slip-ring or Power Factor Correction	Screen protected in separate cabin	Stator and Rotor control
Pumps: Up to 3/5 h.p.		Squirrel Cage	Drip-proof	Direct
Up to 10 h.p..		Squirrel Cage	Drip-proof	Star-delta
Medium size		Slip-ring	Drip-proof	Stator and Rotor
Larger sizes		Slip-ring or Power Factor Correction	Drip-proof Drip-proof	Stator and Rotor Stator and Rotor
Irrigation	50/150	ditto	ditto	ditto
Injection water	50/100	ditto	ditto	ditto
Air phmps	25/80	ditto	ditto	ditto
Fans (induced draught)	25/75	Slip-ring or Variable Speed	Totally Enclosed Fan Cooled Pipe Ventilated Pipe Ventilated	Stator and Rotor ditto
Crystallisers (each)	3/5	Squirrel Cage	Totally Enclosed Fan Cooled Drip-proof or Totally Enclosed	Star-delta or direct
Centrifugals (direct drive) ..	10/20	Slip-ring Change Pole	Totally Enclosed Fan Cooled ditto	Stator and Rotor (Special) Direct (Special)
Workshop	As required	Slip-ring	Totally Enclosed Fan Cooled	Stator and Rotor

Mr. WILSON: I am sure we are all very much indebted to Mr. Wyles for his interesting paper. There are quite a number of points of great interest to the electrical and mechanical Engineer.

One point struck me in his paper in connection with his remarks regarding the power factor. Previous to this year, the power factor on the Generators at the Refineries was 0.8. This year we brought it up to 0.86 and by so doing we increased our output of surplus power. We hope to get that up to 0.9. In making a test in connection with the power factor in the Refinery, not on the Generators but in connection with the motors used in the Refineries, we found it was 0.72 to 0.75. We propose to put in a Synchronous motor this year; by so doing we hope to still further increase our output of power.

There is one point also, I am in entire agreement with Mr. Wyles and with his remarks in connection with the starters and the selection of starters—that is a very important point.

Mr. GODFREY: I wish to congratulate Mr. Wyles on his instructive paper.

Regarding power factors, I agree with everything that Mr. Wyles has written. As Mr. Wyles has pointed out, with increased power factors you get more out of your Generators and so on. That actually took place at Natal Estates three or four years ago. We wanted to put in 3 or 400 h.p. additional load. After going carefully into the different gear we could instal, we finally decided to put in Static Condensers which increased the power factor of the transformers. We were thus able to put the load on the original transformers and we saved the Company thousands of pounds which they did not want to spend at the time.

Regarding the Auto Synchronous Motor, we are also installing a 100 h.p. Auto-Synchronous Machine.

Quite a little usefulness of this paper has probably been lost by Mr. Wyles not giving graphs of starting torques, etc., and that would enable the proper type of Motor to be selected. One must have the data and characteristics of the Machinery before deciding on the type of Motor to be purchased, and if we had had a few graphs of the characteristics of different types of Motors it would have been very useful.

Mr. McNICOL: Mr. President, Mr. Wyles makes a reference in his conclusion to sugar machinery manufacturers. To prove to you we are not such duds you think we are, we are importing this year a 250 h.p. Auto Synchronous Motor.

Mr. HESLOP: I have no criticism to offer. I would like to endorse the paper, and say if everybody followed and carefully noted the points in the paper in the selection of switch gear and motors, we should be very much better off in the Sugar Industry. I think these points should be elaborated, and more descriptive details given of the different switch gear and starters so that there should be no mistake in the selection. More help could be given if more details were given for each individual type of Motor, so that there could be no mistake in the selection. They are certainly excellent as far as they go, but they should be elaborated.

Mr. WILSON: That might come up in the following report by the Electrical Committee. Their report follows this paper, and I believe there are some remarks in that report dealing with the drawing up of specifications and a certain amount of regulations in connection with wiring, which ought to be adopted by the Sugar Factories.

Mr. CAMDEN SMITH: I propose we have this report read now, so that we can discuss the two papers together.

Agreed.

Mr. WILSON called upon Mr. Heslop to read the paper.