self sufficiency in the supply of electrical drives for paper industry

J. MUKHERJEE AND
R. R. SULE *

The amount of Electrical Equipment required by Paper Industry in India for the modernisation of the existing mills and for the future expansions required in order to keep pace with the increasing demand for paper in the country is estimated. The type of electrical equipment that can be supplied by Heavy Electricals (I) Ltd. against this requirement is described. It is also explained that Heavy Electricals can now take up the job of supplying all the electrical equipments required by a paper factory on a "turn key" basis. The approximate imported content of equipment that would be manufactured at Heavy Electricals is given.

Requirement of Electrical Equipment by Paper Industry :

At the end of our Third Five Year Plan i.e. in 1965 the production of paper in this country was 600,000 tons. This was produced in 56 mills, of which 17 could be regarded as large mills having production capacity of more than 10,000 tons per annum. However, this production was insufficient to meet the demand of country and in addition 125,000 tons of paper and newsprint had to be imported during that year. Hence it can be seen that there is already a shortfall of more than one lakh tons per annum in the indigenous production of paper as compared to the country's needs. The demand for paper for the country has in fact been steadily increasing and has gone up from 250,000 tons in 1955 to 725,000 tons in 1965. Originally it was expected that this demand at the end of Fourth Five Year Plan (i.e. by 1970/71) would be of the order of 3 milion tons per annum. Unfortunately our rate of industrial development in the Third Five Year Plan was disappointingly slow and so this figure has now been revised. The demand now expected to materialise by 1970/71 is of the order of 125 million tons per annum. However, even to meet this reduced figure of demand by 1970/71, we would have to increase our manufacturing capacity by putting up new paper mills having an annual capacity of more than one lakh tons every year for the next five years. This would involve putting up at least five to six large mills every year, having capacity of more than 10,000 tons per annum, besides a number of smaller mills.

To assess the amount of electriral equipment that would have to be installed to meet the expansion of paper producing capacity at this rate, it may be stated that it has been estimated that to produce 1 kg. of paper between 1.2 and 1.8 kilowatt hours of electrical energy are required depending on the condition in the mill. Even if we take the low figure of 1.2 kWh per kg., we find that if we increase the installed paper making capacity by one lakh tons every year, this would call for the utilisation of 120 million units of electricity. For this electrical plant of the capacity of 30,000 to 35,000 horse power would have to be installed every year.

This in itself represents quite a substantial amount of electrical equipment, but looking further into the future, we can only expect that the demand for the equipment will increase even further. For although it is difficult to predict the growth of demand accurately for the more distant future, it is worthwhile noting that our present consumption of paper of 1.3 kg. per head is barely 1/50th of that of Japan and less than 1/100th of that of many European countries. Should this figure even go up to a modest 7.0 kg./head in say 15 years from now, this would call for expanding paper manufacturing capacity after 1970/71 at the rate of nearly 400,000 (to 500,000) tons per year i.e. nearly 4 times the rate envisaged for the current five year plan.

Availability of electrical equipment from indigenous sources.

The electrical equipment required in a typical paper mill can be divided into three groups :

(a) Generating or Incoming equipment : which is the source of the electrical supply to the mill.

(b) Distribution equipment : which conveys this electrical energy to the point where it is used.

*Chief Applications Engineer H. E. (I) Ltd., Bhopal. Assistant Chief Applications Engineer H. E. (I) Ltd., Bhopal.

(c) Utilisation equipment : which converts the electrical energy into useful work.

Of the above equipment, the incoming and distribution equipment comprising Transformers, High and Low voltage Switchgear, distribution boards, cables etc., have for sometime now been readily available from indigenous sources. A substantial portion of the utilisation equipment consisting of constant speed A. C. motors of small and medium size has also presented no problems as there are a number of manufacturers for these motors in the country. However, driving motor for all machines requ ring high power or highly specialised controls have not till now been indigenously available. Since these machines form the most important part of the equipment of the paper mill, it was also, consequently, not possible for a paper machinery manufacturer or a paper mill to obtain all the electrical equipment required by them from any one indigenous manufacturer on 'turn-key' basis.

It was precisely in order to meet such requirements of Industry for large and highly specialised drives and also for drives for complete mills on a 'turn-key' basis that the Government of India decided to start a Heavy Electricals Factory. The First Heavy Electricals Project was set up at Bhopal and was established in technical collaboration with Messrs. Associated Electrical Industries Ltd., U.K., one of the leading electrical equipment manufacturers in the world. The collaboration agreement signed with Messrs. A. E. I. ensures that H. E. (I) Ltd., is able to draw upon the vast amount of experience and the wealth of technical and manufacturing knowledge available with this renowned firm. The construction of the factory started in the year 1956/57 and regular production commenced four years later. Besides, manufacturing turbines, generators, H.T. switchgear and power transformers for Electricity Boards all over India, the Heavy Electricals factory is equipped to manufacture large A.C. motors of the synchronous and induction types, D.C. motors of all sizes as well as control equipment required for these motors. An Applications Engineering Department has also been set up whose job is to design suitable drives and control schemes to meet the many and varied requirements of modern industry for specialised and sophisticated drives and controls of all kinds. In cases where 'turn-key' jobs of providing the complete electrical equipment for a factory are undertaken, this department also takes up the work of coordinating the procurement of many items that are not manufactured by Heavy Electricals themselves but are required to be supplied against such an order.

Heavy Electricals (India) Ltd. is thus now in a position to offer to various industries any type of electrical drive which they may require from the simple to the highly sophisticated. If they so desire, Heavy Electricals can also undertake to act as their main electrical contractors and supply them all the electrical equipments required for their mills on a 'turn-key' basis.

Type of Equipment that can be supplied by H.E.

Some of the specialised drives that can be supplied to typical paper mills would be as follows :

Drive for a Log Grinder :—For a log grinder, motors of 2000 H.P. to 5000 H.P. are quite frequently required. Induction, Synchronous or synchronous induction motors can be supplied for the above duty. The Synchronous Induction Motors can also be provided with automatic control of excitation if required . For electrically fed grinders, we can, as a further refinement, also supply automatic feed control which would ensure that the grinder motors operate at a constant load and high efficiency. This feed control scheme would operate as follows :

(Fig. 1 on next page)

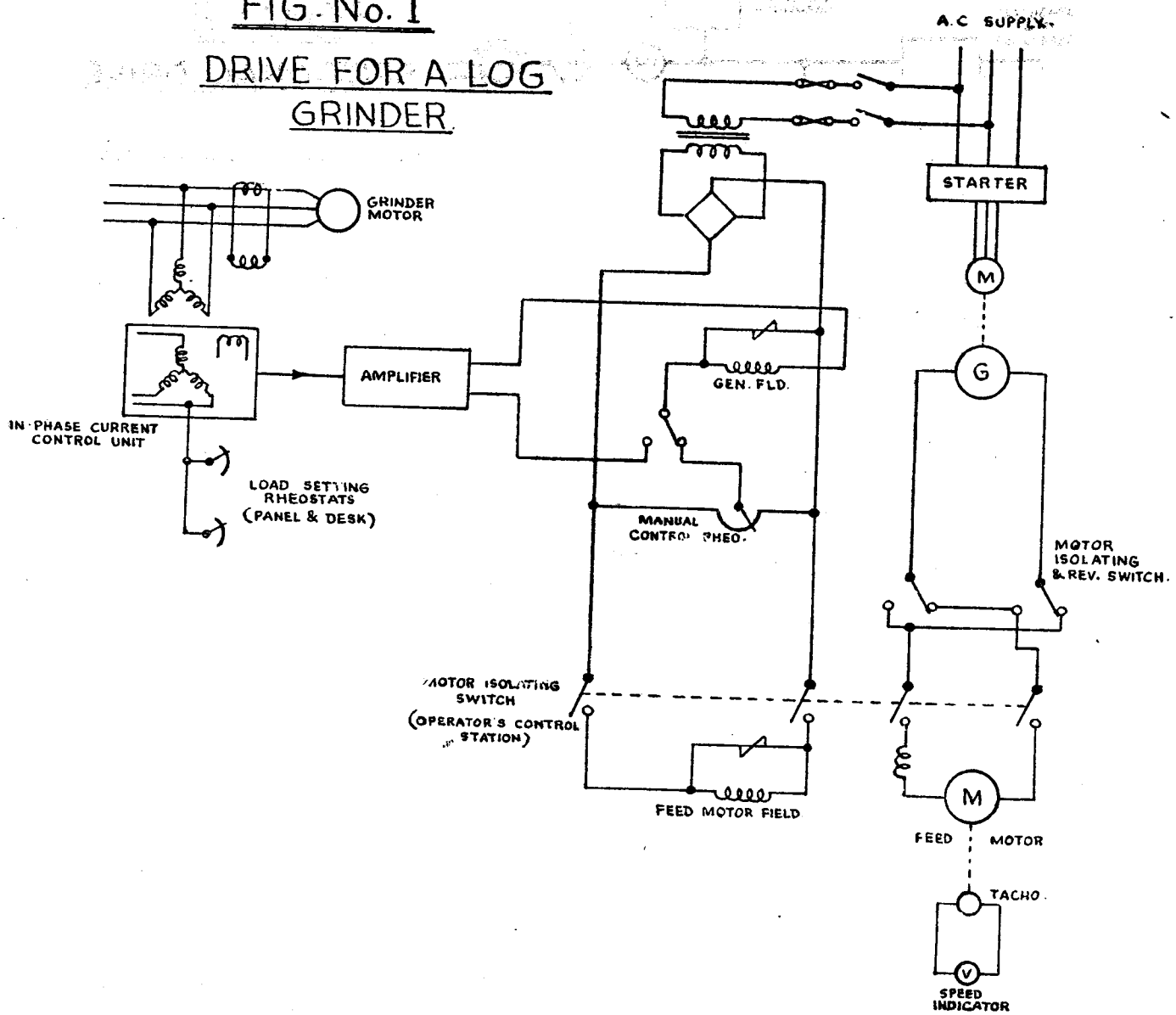
The rate of feed to the grinder is controlled by controlling the speed of a d.c. feed motor. The operation of the load control scheme is based on signals from a current transformer and a 3-phase potential transformer both connected in the supply circuit of the main grinder motor. These are fed into a bridge circuit which produces a d.c. voltage proportional to the 'in phase' current of the main grinder motor. This 'in phase' signal is then compared with a d.c. reference voltage which is preset by means of a rheostat in the operator's control station. The error voltage is then applied through suitable implifiers to the field of the feed motor generator.

Thus the feed motor speed is so varied as to ensure that the load on the grinder motor is maintained at a constant value at which the grinder motor works at high efficiency.

The above method of control is known as closed loop control. In this method of control the quantity that is to be controlled (in this case the load on the motor) is constantly being compared with its desired value and any error between the two values is constantly being used to correct any deviation from the desired value.

FIG. No. 1

DRIVE FOR A LOG GRINDER



Drive to the Main Paper Machine :—For a Fourdrinier or any other similar type of paper making machine, depending on its size and speed, one of the following kinds of drives can be suppleid.

(a) A single motor working under ward-Leonard closed or open loop control to power a line shaft drive.

Or

(b) A sectional motor drive with a separate motor driving each section of the paper machine. All the motors on the machine being fed from one generator.

Or

(c) A sectional motor drive with each motor being fed from its own section generator.

For the last two drives a closed loop speed control would normally be used for ease of operation & greater accuracy of control. This would also ensure maximum output for the paper machine. A typical closed loop sectional drive for a paper machine is shown in fig. 2.

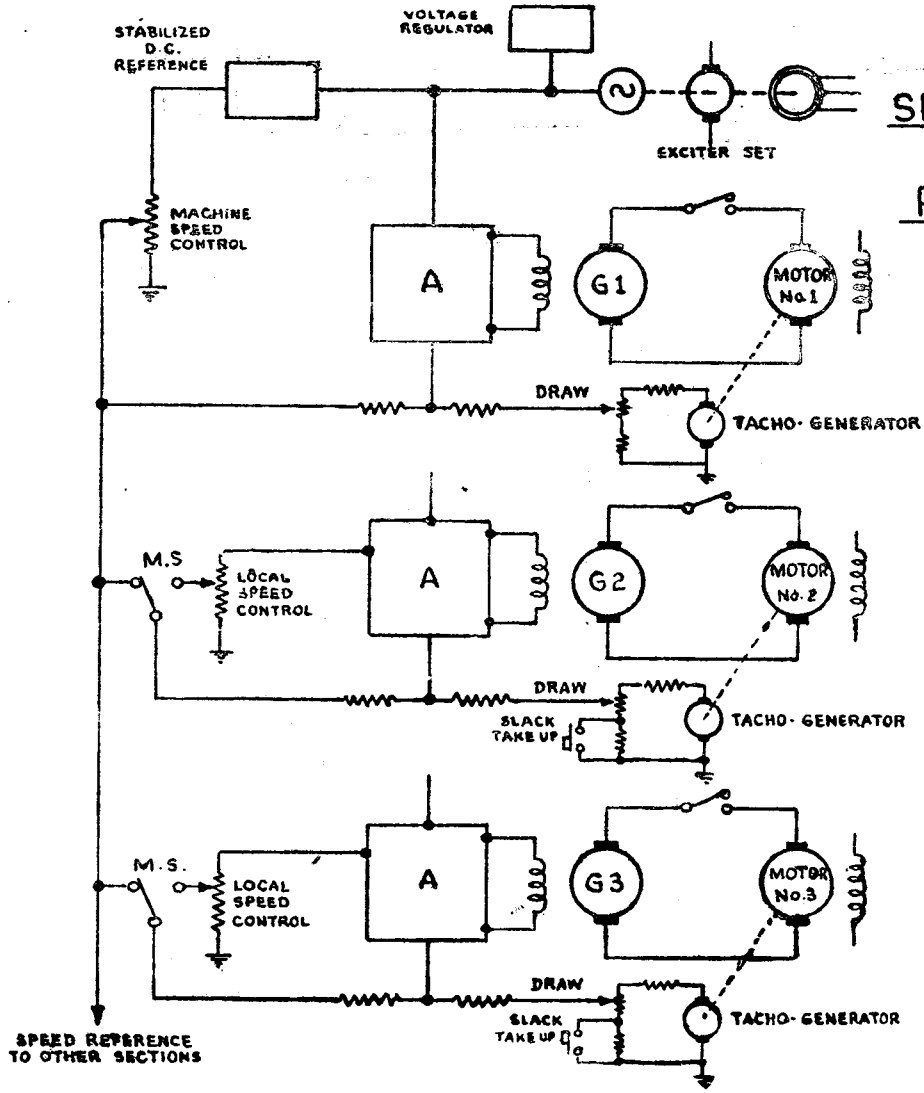


FIG. No. 2

SECTIONAL DRIVE FOR PAPER MACHINE

A - ELECTRONIC AMPLIFIER
G1-G3 GENERATOR
M.S. MASTER / LOCAL SWITCH

The sectional drive consists in essence of,

1. The Section motor.
2. The Sectional generator feeding the section motor.
3. A reference voltage : giving desired value of motor speed.
4. A reset voltage proportional to actual motor speed.
5. An amplifier for amplifying the error voltage (i.e. difference between 3 & 4).

} for each Section at the paper machine.

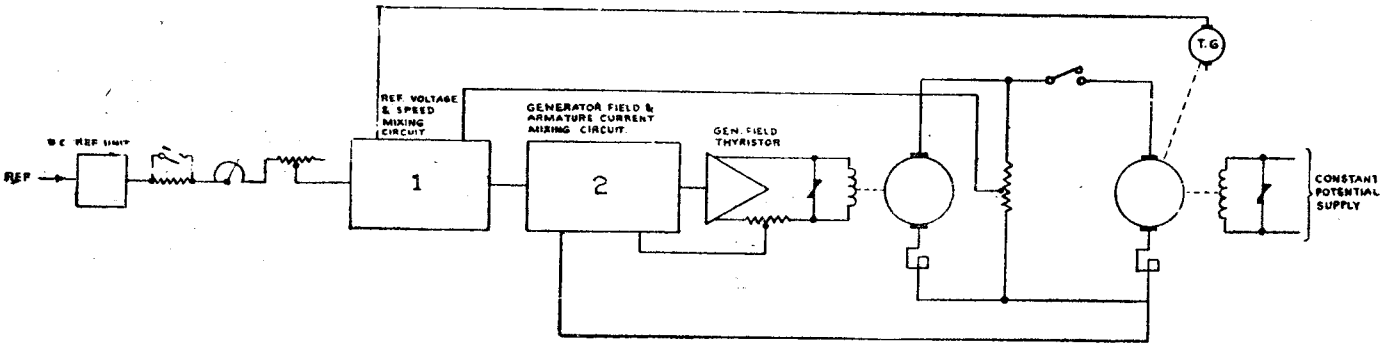
and

6. A master speed reference for the machine. In the sectional paper machine drive, the speed reference voltage for the machine is derived from the main speed control potentiometer which is fed from a stabilized voltage source and is adjuted according to the desired machine speed. This 'Master', reference voltage is fed to every section amplifier.

In every section, the speed reset voltage is derived from a Tacho-Generator directly coupled to the section motor. This voltage is adjusted to give the required 'Draw' and then fed to the amplifier, where it is compared with the preset Reference voltage, the difference between these voltages consituting the input to the amplifier. The output of the amplifier is used to control the field of the section generator and through this the speed of the sectional drive motor in such a manner as to reduce the difference between reference and reset voltages. Thus any deviation of the motor from the set speed causes a correction signal to be applied to the amplifier, which results in a correspond-

FIG. No. 3

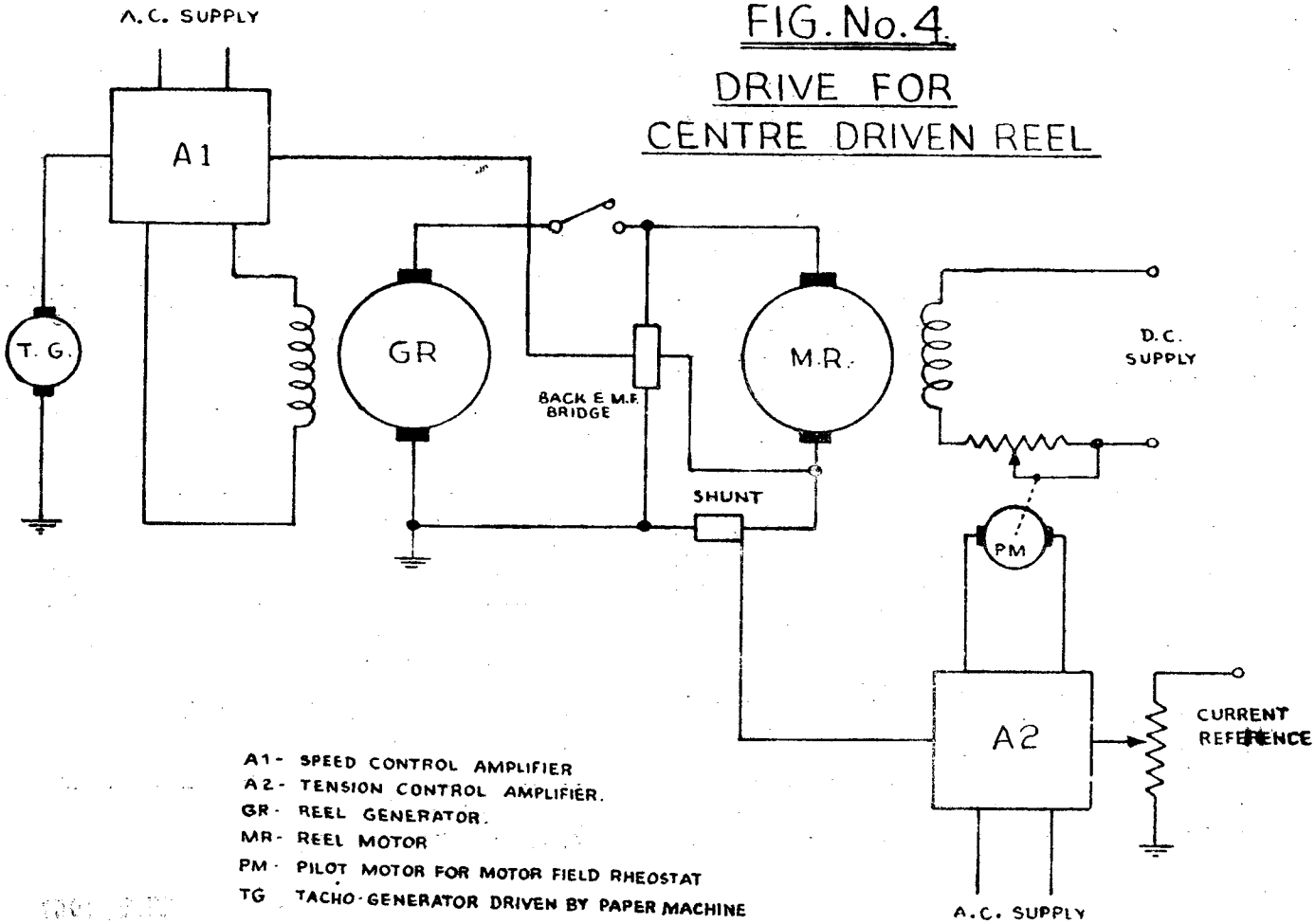
SCHEMATIC DIAGRAM OF W. L. DRIVE USING MODULOR THYRISTOR AMPLIFIER



1:- VOLTAGE AMPLIFIER
2:- FIELD & ARMATURE CURRENT LIMIT AMPLIFIER

FIG. No. 4.

DRIVE FOR CENTRE DRIVEN REEL



A1- SPEED CONTROL AMPLIFIER
A2- TENSION CONTROL AMPLIFIER.
GR- REEL GENERATOR.
MR- REEL MOTOR
PM- PILOT MOTOR FOR MOTOR FIELD RHEOSTAT
TG TACHO-GENERATOR DRIVEN BY PAPER MACHINE

ing change in the motor-armature voltage to restore the motor speed to very nearly its original value. By using a finely wound potentiometer as the master reference control, stepless adjustment of machine speed can be obtained. Variations due to changes in supply voltage and frequency are reduced to a negligible amount by supplying this potentiometer from a stabilized power pack. It is essential that the Tacho-Generator should give a voltage truly proportional to speed, as any fluctuation in output results in a corresponding speed change of this section motor.

A high accuracy permanent magnet Tacho-Generator is used to fulfill these requirements, and the speed accuracy can be maintained at better than 0.1%. The kind of equipment which could at present be offered for this kind of a drive is shown in greater detail in diagram 3.

The error signal corresponding to difference between the machine speed and its designed speed would be fed together with signals corresponding to the motor current, generator field current, etc. to a transistor amplifier built up using a modular type of construction. The output of this amplifier would control the firing circuit a bank of thyristors (Silicon Controlled Rectifiers) which directly feed the field of the section generator. By this means the error signal would directly control the section generator voltage and thus the section motor speed. Further, this would also be achieved without using equipment which requires much maintenance or regular replacement of parts such as Electronic Valves, Rotating Amplifiers and field Exciters.

A current limit feature would also be incorporated which would prevent the motor damaging itself during acceleration or overloads and a sabilizing circult would be included to prevent instability and oscillation.

Drives for Calenders, Super Calenders and Reels.

It would also be possible to supply similar drives for Calenders, Super Calenders, slitters and centre driven reels incorporating, where necessary, modifications for tension control, motor field weakening etc. to meet the specialised drive requirements of these machines.

A drive for centre driven reel for example would be as shown in fig. 4. This would incorporate field weakening as well as tension control and the drive would enable the tension to be maintained at a constant value throughout the reel build up and would also ensure that the speed of the leel varies with build-up so as to give a tightly wound reel with constant tension.

Imported Content:

From the above it may be seen that so many kinds of drives and controls are required in a paper mill that it would be difficult to give an accurate over-all figure for the percentage of imported content for the equipment which can be supplied to a Paper Mill. For example, the imported content for a drive consising of a simple motor and starter for a grinder would be much less than that for a complex drive for a high speed, high capacity newsprint machine. However, typical values of imported content for various items of equipment being manufactured at Heavy Electricals (I) Ltd. are given below :—

		Imported Content
1.	Large A. C. Motors ...	10%
2.	D.C. Motors and Generators ...	15—20%
3.	Open Loop control equipment ...	15—20%
4.	Closed Loop control equipment ...	40—45%
5.	Engineering : Done at Heavy Electricals :	

It is worthwhile remembering that in addition to the foreign exchange which would be saved on individual pieces of equipment as listed above, all the engineering work for an order for a drive for any machine or mill is done at Heavy Electricals itself. Thus the engineering fees which are normally charged by a foreign supplier as a part of this over all price and which may be quite substantial for a complex drive where a great deal of engineering is involved, do not have to be paid for in foreign exchange.

Now it may be asked what prevents the imported contents of the equipments listed before from being reduced below the given limits and in fact from being eliminating all together. The difficulties for this for the moment are as follows :—

(a) **Raw Materials :**—Of the raw materials used in the manufacture of our equipment the following still have to be imported as they are not indigenously available.

1. Electrical sheet steel of some kinds.
2. Ingot copper for conductors.
3. Insulated Copper conductor or Insulating material for class-B duty.
4. Electrical Carbon for brushes.

(b) **Components :**—In addition to the raw materials listed above, the following components are also not at the moment available indigenously and have to be procured from abroad.

1. Ball bearing larger than 2″ dia.
2. Resistances.
3. Heavy Duty contactors.
4. Amplifiers and other electronic equipment for closed loop control.
5. Tacho-Generators for indicator and control.

When these items of equipment become available from indigenous sources it will be possible to reduce the imported contents of this equipment further and efforts are constantly being made to try to procure this equipment from indigenous suppliers.

For example negotiations are being carried on with various parties to try and develop an Industrial electronic amplifier suitable for the requirements of a closed loop drive and it is hoped to get one developed in the country in 12 to 18 months.

Future Developments :

As regards the future, it should be remembered that the range of electrical goods being manufactured in the country is being continually extended and this is bound to have its effect on the kind of equipment being offered. For example in next five years, or possibly even in the next two or three, we may get in the country silicon controlled rectifiers with high current and voltage rating and the type of equipments which we would be offered from Heavy Electricals would make use of these. It may then be possible to offer D.C. Electrical drives in which the entire motor generator sets have been eliminated in favour of static rectifier banks and in the further future it may also be possible to offer such refinements as static switching, integrated circuits and so on. However, how soon this can be done, will depend to a great extent on a general development of Industry and Technology in the country.

In conclusion the authors would like to thank the Management Heavy Electricals (I) Ltd. for the permission to publish this paper, and the Indian Pulp and Paper Technical Association for giving us the opportunity to present it at their Seminar "Import Substitution".
