

Design and Manufacture of Electrical Equipment By HEL Factory for Paper Industry

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1.0 Introduction :

While presenting this paper which details the contribution which Heavy Electricals India Limited are now in a position to make as regards the supply of electrical drives and controls for the paper Industry. It is interesting to recall that a paper on similar lines entitled "self sufficiency in supply of electrical drives for paper machine," was presented by us at a Seminar on "IMPORT SUBSTITUTION" held by the Indian Pulp & Paper Technical Association at Bhubhaneshwar in 1967.

It has been very encouraging for us to see the progress that has been made as regards both our capability for supply of equipment and equipment actually supplied and commissioned by us from that day to this.

Briefly the position in 1967 was that we were then in a position to design and manufacture electrical drives for Paper Machines though not entirely from indigenous resources. We envisaged supplying drives using MG sets with thyristor converters controlling generator fields. It was felt that although machines and contactor gear for these drives could be supplied by us, the ampli-

fiers, particularly if they were required to supply the armature power of the motors directly, would be required to be imported from abroad. At that time we had received no orders in any such drives and of course none have been manufactured or commissioned by us.

As against this today we have already in hand seven orders valued at Rs. Fortytwo Lakhs for various drives for different customers. Of these two orders, valued at Rs. Thirteen Lakhs have already been manufactured, erected and commissioned and the balance are in the process of manufacture and expected to be delivered and commissioned within the next six months.

We have successfully overcome the defects we have encountered during commissioning of the drives supplied by us and equipment supplied so far has been operating satisfactorily. It may also be stated that we have been keeping abreast with the latest developments as regards Paper Machine Drives and are no longer offering MG Sets or Magnetic amplifiers. Our standard practice is now to offer thyristor converters feeding directly the section motors and their helpers in the various sections. Secondly, although, the first few drives supplied by us were

with imported thyristor converters, we have been increasingly replacing these by indigenous ones manufactured either by ourselves or by other reputed indigenous manufacturers. At present we can only offer indigenous thyristor converters for powers of 200 KW or so, but we are confident that this limit will be steadily pushed up and in the not too distant future, we hope that we will be able to manufacture and supply thyristor equipment of all sizes from entirely indigenous sources.

To give a clear and concrete idea of what HE (I) Ltd., is in a position to do for the Paper Industry, we intend in this paper to describe to you the equipment which we shall be supplying for various Paper machine drives already on order with us. We will also give you information regarding the equipment which has been supplied and commissioned so far and difficulties which we have encountered in commissioning the same.

Then we shall deal with the important enquiries at present with us for which we have already or shall shortly be sending our quotations to the parties concerned. Finally we will give some informations regarding imported raw materials and components which are used in the equipments being supplied by us, our capacity for meeting the demand

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for Paper Machine Drives and any gaps envisaged between our capacity and the expected demand on the same.

2.0 Electrical Equipment Being Supplied by HE (I) Ltd., Against Various Orders :

2.1 Thyristor controlled sectional drives for MG Paper Machine for M/s Ballarpur Paper & Straw Board Mills Limited., Maharashtra (Fig. No. 1).

The yankee machine supplied by

Main Drives and Controls data :

Number of Drive Motors	—Nine—4 HP to 168 HP.
Number of gear units	—Nine
Number of Thyristor Power converters, operating and control unit panels.	—Eleven—incorporating 3 nos. of power converters—57.5 KW, 382 KW and 225 KW,
Number of control desks	—Three (kept at one place).

the drive and control system used for this is given in Fig. 1.

The MG cylinder is provided with a sundry drive. This consists of 10 HP, squirrel cage induction motor gear unit and Jaw clutch and is meant to rotate MG cylinder for warming up during shut-downs and for maintenance purpose.

2.2 Drives and Controls for slitter/rewinder (2-orders) M/s Straw Products Ltd. Raya-

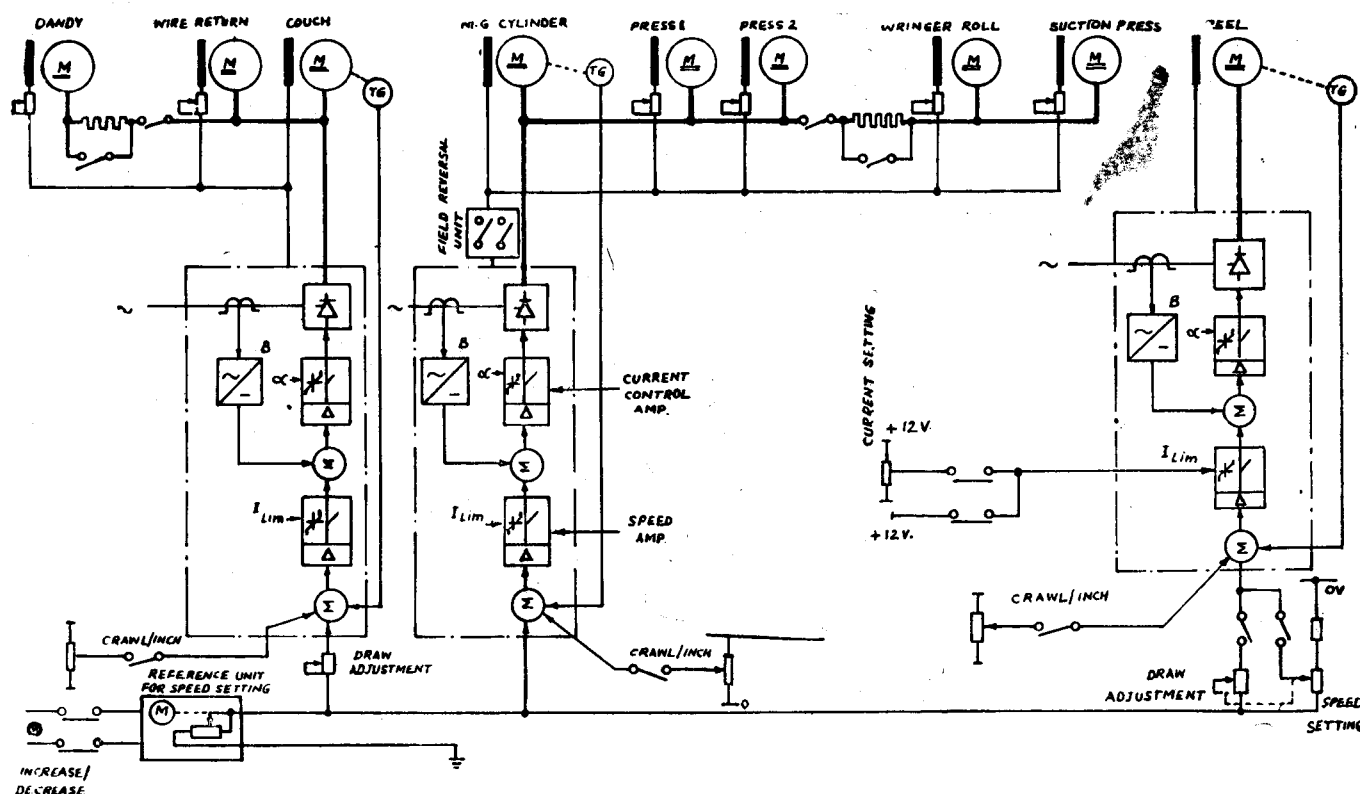


Fig. 1 Block Diagram Of Control Paper Machine (M/s B.P.S.B. Mills Ltd.)

M/s Bertrams Scott (I) Ltd., has an operating speed of 200 to 800 ft./min and produces upto 40 tons of various types glazed MG tissue paper per day.

All of the nine DC motors obtain their supply from the 415 volts system through thyristor power converter in fully controlled three phase bridge connection. Key diagram of

gada :—(Fig. no. 2 & 3)

The mechanical equipment for the above orders supplied by M/s J. M. Voith GMBH, West Germany reels have trimmed widths of 3600 mm

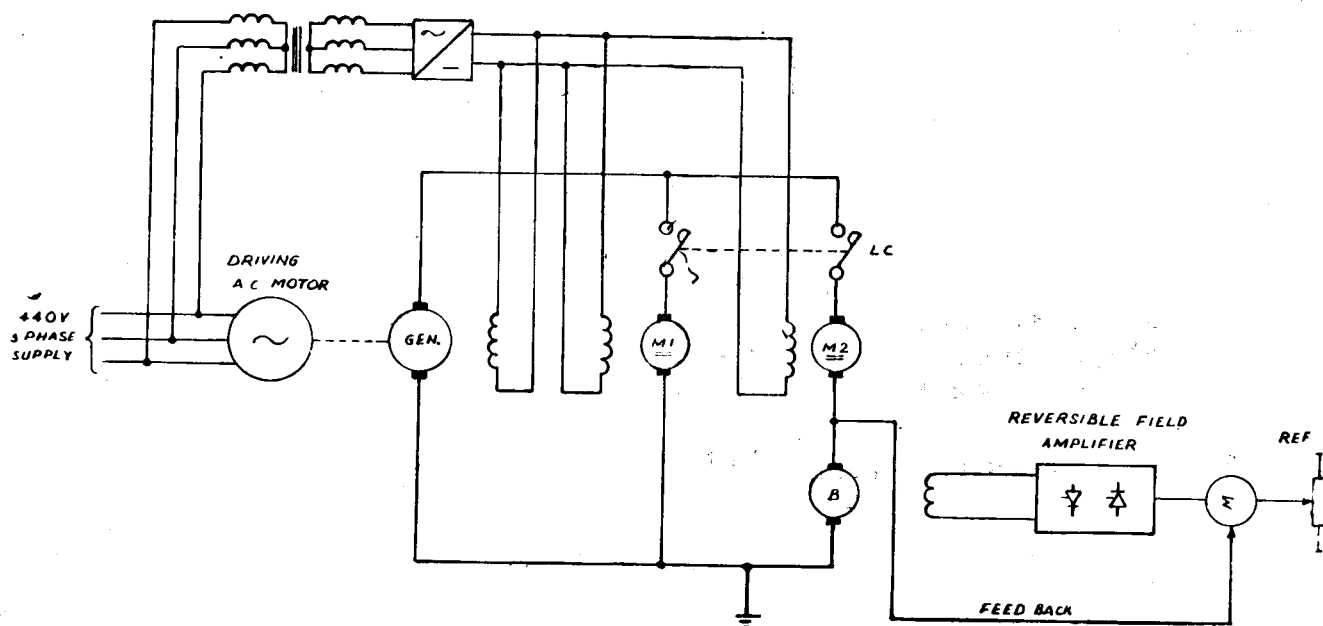


Fig. 2 Slitter And Rewinder Ward Leonard Control For M/s Straw Products Ltd.

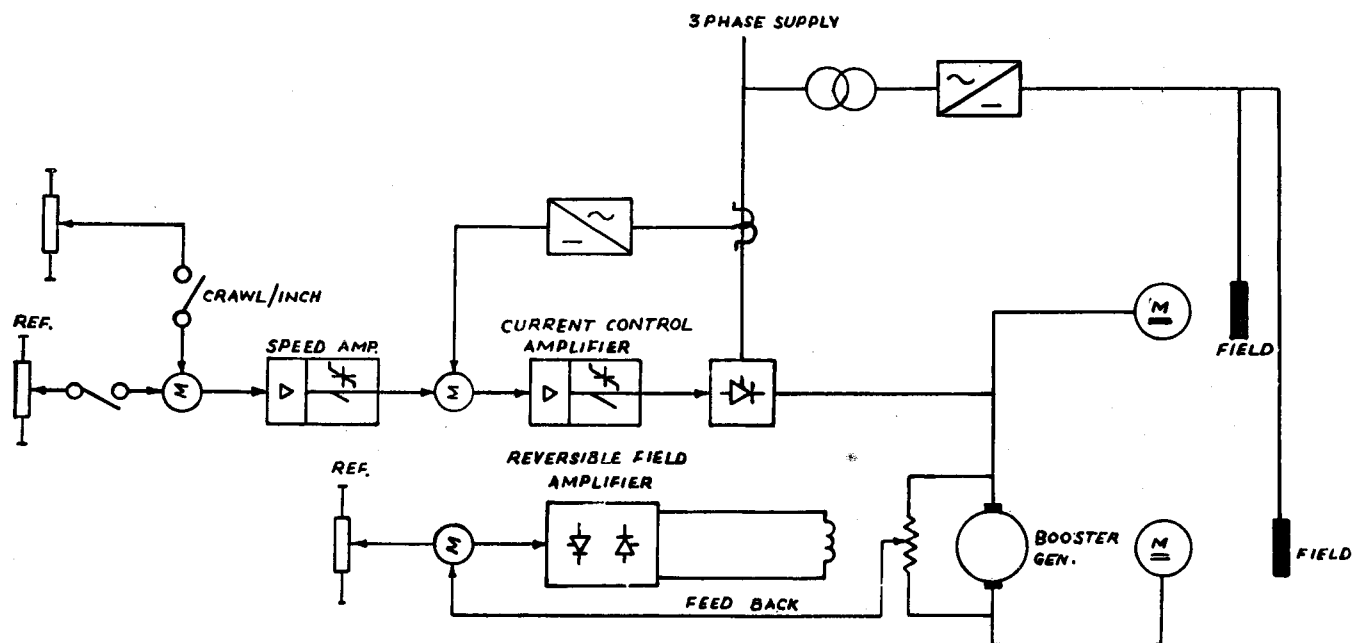


Fig. 3 Block Diagram of Slitter And Rewinder Drive For M/s Straw Products Ltd.

and 1900 mm. Maximum operating speed 750 m/min and paper grade of 20 g/m to 60 g/m. The drives for 3600 mm slitter/re-

winder consists of 2 nos. 43 HP DC motors 40 KW motor-generator set, contactor type control cubicles, one 5 KW Booster whose field is fed

from a thyristor field supply amplifier, one operator's control desk. The key diagram of the drive and control system is shown in Fig. 2.

The drives for 1900 mm slit/re-winder consists of 2 nos. 18 KW DC motors, one 5 KW Booster whose field is fed from thyristor amplifier, one thyristor power converter set to feed power supply to 2—18 KW motors, and control desk. The thyristor converter is fully controlled with 3 phase bridge connection. The key diagram of the drive and control system is shown in Fig. 2.

Each rewind drum is driven by a DC motor. Both the drum motors are fed from a common DC source. Relative motor load torque adjustment is made possible by motor field control. The Booster is connected in series with one of the drum motor. The main purpose of this Booster is to obtain the speed differential between two carrier drum motors. Variation to the extent of $\pm 5\%$ in RPM can be achieved. By this arrangement, the tension with which

the Paper is wound can be varied. Normal practice is to have hard winding initially upto say 60% of final diameter and soft winding for remainder. A gradual change from hard to soft winding can thus be achieved by varying the Booster output voltage.

2.3 Thyristor Controlled Single Motor Drive for Paper Machine—M/s Orient Paper Mills Ltd.,—Brajrajnagar, (Orissa) (Fig. No. 4).

The DC motor and thyristor converter are meant for stand by duty and are used to drive and control the speed of the line shaft from 250 to 1500 RPM. The motor is rated at 64 HP and the thyristor power converter is rated for 60 KW. All the operator's controls, indicating meters etc. are mounted on the front of the cubicle. The DC motor obtains its power supply from 440 V AC system through thyristor con-

verters which is designed for 6 pulse fully controlled 3 phase Bridge connection. Key diagram of the drive system is given in Fig. 4.

The thyristor converter controls the speed of DC motor by armature voltage variation at constant torque.

2.4 Thyristor Controlled Drives & Controls for a Super Calendar—M/s. West Coast Paper Mills Ltd., Dandeli, (Mysore State) Fig. No. 5.

The mechanical drive for super calendar supplied by M/s John Kleinfefers Sohne Kriebel, West Germany has an operating speed of 500 m/min, Trimmed width of paper 3330 mm, paper tension 20 to 80 kp/m and paper weight 60–225 g/m².

The drive includes one 470 HP DC main motor for driving the calendar stack, 50 HP unwind brake

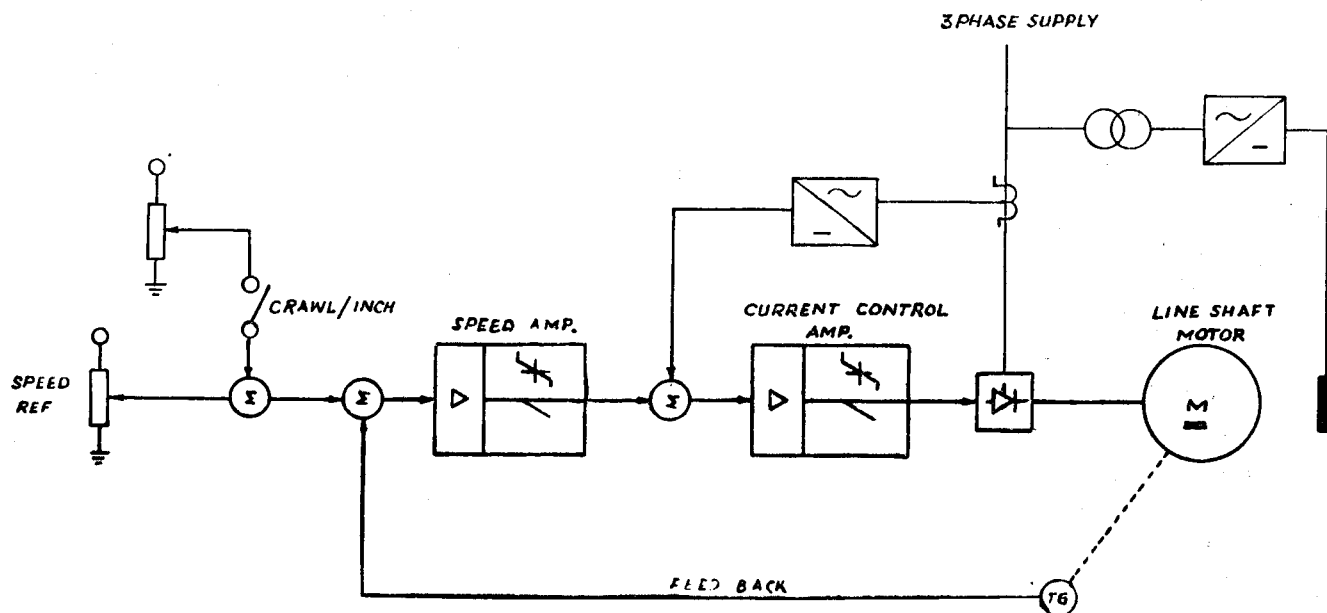
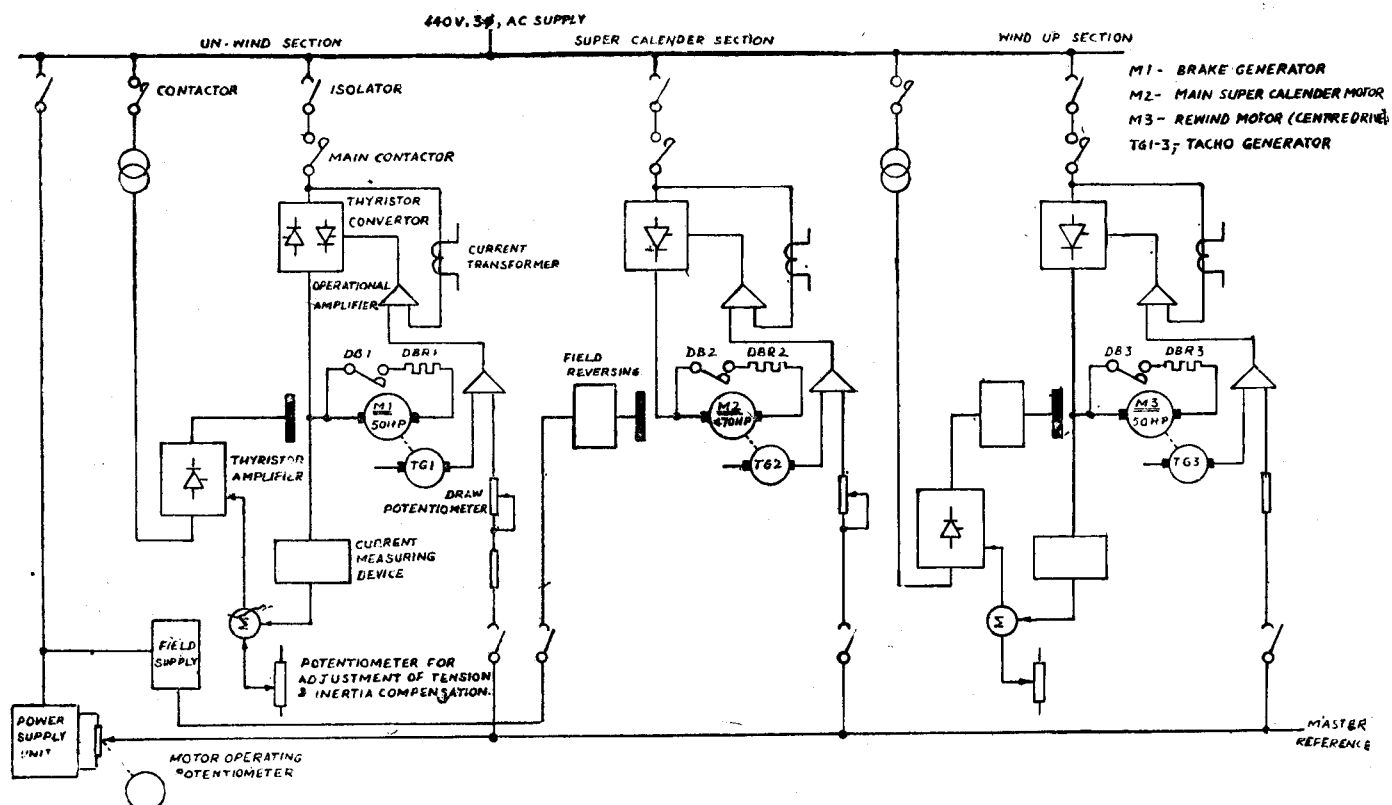


Fig. 4 Paper Machine Line Shaft Drive For M/s Orient Paper Mills.



**Fig. 5 Thyristor Controlled Drives & Controls for a Super Calender
M/s West Coast Paper Mills Ltd., Dandeli (Mysore State)**

generator and 50 HP Electro reeler for rewind. Both the unwind and wind drums are centre driven.

Three individual power converters of rating 352 KW, 37.5 (2 nos.) to feed the above motors together with necessary operator's control station have been provided. Operating and control relay unit panel is provided to meet the drive requirements, interlocking devices etc. The key diagram giving the drive and control arrangement is shown in Fig. 5.

The brake generator automatically controls the set tension. As such the brake generator is fed from an antiparallel converter to provide regenerative braking. Since the wind and unwind are centre driven the motor fields are automatically

controlled by means of thyristor field amplifiers to control the surface speed variation due to change in diameters. Other salient features provided in the controls are dynamic braking in case of emergency stop, reel diameter inertia compensation, paper breakage detection.

2.5 Thyristor Controlled Drives for Line Shaft Motor & Helper motors for a Paper Board Machine—M/s Sirpur Paper Mills Ltd., (Andhra Pradesh) Fig. No. 6).

Sirpur Paper Mills presently has a board Machine of production capacity of 60 tons/day. By adding MG cylinder and other additions the capacity of the plant would be increased to 100 tons per day. The trimmed width of the plant is 106".

Maximum speed 500 ft/min. The mechanical parts are supplied by Bertrams Scott of U. K.

Our scope of supply includes one 450 HP DC motor to drive the line shaft, three auxiliary motors each of 20 HP for 3rd primary press top Roll and one 7.5 HP DC motor for suction return drum. These motors are arranged into two groups to meet the operational requirement of the board machine. One 337.5 KW thyristor power converter feeds 450 HP DC motor in group one and another 50 KW thyristor power converter feeds the remaining motors in group —2. Key diagram giving this drive and control features is shown in Fig. 6.

The thyristor converters control the

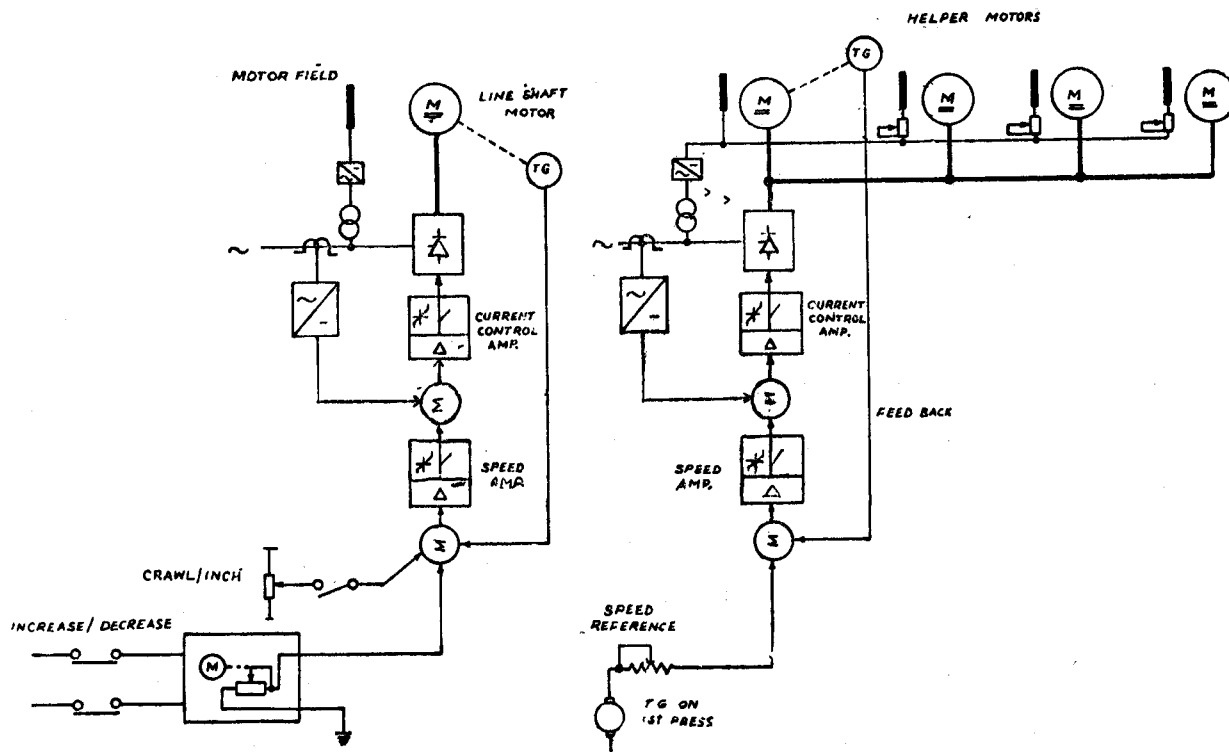


Fig. 6 Block Diagram For 100 Tonnes Board Machine Drive For M/s Sirpur Paper Mills Ltd.

speed by armature voltage variation. Field regulators are provided in the auxiliary motors for load sharing. The auxiliary motors derive their speed reference from a Tacho-generator mounted on the first press. Necessary operating and control relay panels, operator's control station have been included in our scope of supply to meet the operational requirement.

2.6 Thyristor Controlled single motor Line Shaft drive for a Paper Machine—India Paper Pulp Company Ltd., (Calcutta.) (Fig. 7)

The 450 HP DC motor being supplied by us is used to drive the Line Shaft of the Paper Machine. Since the motor is driving the line shaft through 'V' Belts, suitable pedestal bearings, jack shaft, couplings and

common base plate are also included in our scope of supply. This arrangement eliminates the end thrust generated by the belt and pulleys being transmitted to the motor bearings.

The above motor is supplied from 440 V system through silicon controlled rectifier (thyristor) 6 pulse fully controlled. The thyristor rated is for 337.5 KW and the motor speed is controlled by varying its armature voltage. Field strength of the motor is kept constant and the motor is capable of giving constant torque over its entire speed range of 150 to 1500 RPM.

Key diagram used for the drive and control arrangement is shown in Fig. 7.

3.0 Equipment Manufactured, Erected and Commissioned :

3.1 Sectional drives for MG paper machine at Ballarpur Paper and Straw Boards Mill Ltd., (Maharashtra).

The sectional drives and converters mentioned in item 2.1 of this article have already been supplied and commissioned at the above works. Delivery of the manufactured equipment commenced 18 months after the receipt of the technically clear order and the entire equipment was supplied in 24 months. The erection and commissioning work under the supervision of HEL Engineers commenced in December 1971 and completed in 3 months time. Although the thyristor converter for this job was imported from ASEA Sweden, Our Engineers commiss-

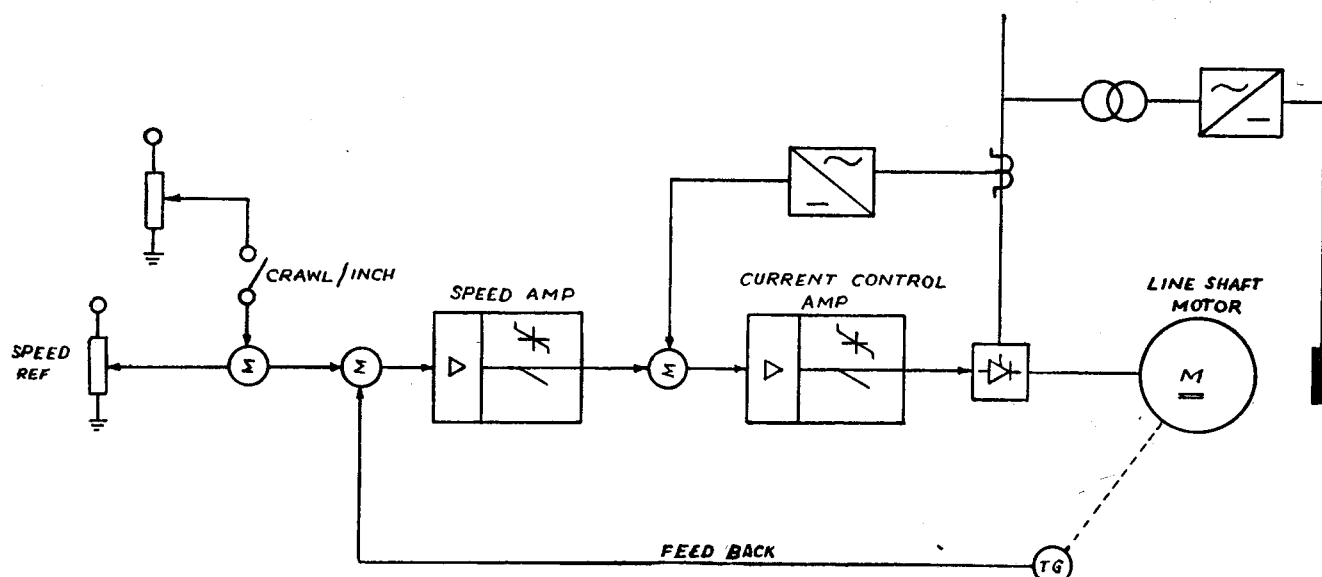


Fig. 7 Paper Machine Line Shaft Drive For M/s India Paper Pulp Co. Ltd., Calcutta

ioned the entire equipment for this mill without any assistance from abroad.

In the early stages of production we had experienced two small troubles. One was that one of the smaller bought out motors for the reel section had to be rewound due to failure of Insulation. The other trouble noticed was some unusual noise in one of the reactors provided in the small motor armature circuit. This is due to loose stamping assembly and this will be set right during paper machine shut-down. Otherwise the paper machine is working satisfactorily and steady production of paper has been maintained.

3.2 M. G. set Drives and Controls for slitter/rewinder at Straw Products Ltd., Rayagada (Orissa).

The MG set, drive motors and controls as listed in item 2.2 of this article for 3600 mm slitter/rewinder has also been successfully commis-

sioned at the above work. The entire equipment was delivered in 24 months after the receipt of the technically clear order. Preliminary commissioning work commenced in Sept/Oct. 1972 and the drive was handed-over to production by end October 1972. Supervision of erection and commissioning works were carried-out by H. E. Engineers. During load test certain adjustments had to be made to meet the operational requirement. The Generator compound winding field strength which was designed for level compounding was taken out and made pure shunt generator. For smooth acceleration from zero to set crawl speed and also for smooth change over from crawl to run position suitable variance have to be provided in the generator field circuit.

3.3 Manufacturing Position of other Orders :

Drive motors for all paper machine drives described above except one

have already been manufactured and tested The exception being for India Paper Pulp Factory Company for which the motor is in assembly stage and expected to be ready for despatch by Feb./March 1973. As regards thyristor converters, for Straw Products and Orient Paper Mills these are indigenous converters and are in final stages of assembly. It is expected to be ready by December 1972/January '73. The large thyristor converters required for Dandeli & Sirpur were ordered from abroad and these have already been received at site. The thyristor converter for India Paper Pulp Mills which is also imported is under despatch.

In all the above cases the entire drive equipment would be delivered within a period ranging from 18 to 24 months, after placement of order. Erection and commissioning of the drives will be carried-out under the supervision of H. E. Engineers.

4.0 Enquiries Received from Paper Industry and Details of Equipment being offered by HE (I) Ltd., Bhopal.

At present we are offering electrical drives and controls for the following type of plant and equipment :

- i) Chippers
- ii) Refiners
- iii) Pumps and compressors (large size)
- iv) Paper making machines
- v) Paper winders, slit/rewinder
- vi) Supercalender
- vii) Coating plants.

In some cases we have also quoted high voltage switchgear for sub-stations, HV stator controls for motors and power factor improvement capacitors.

Some of the major plants and machinery for which drives and control enquiries sent to HE (I) L are listed below together with a brief description of the equipment being offered by us.

4.1 M/s West Coast Paper Mills Ltd.,—Dandeli (Mysore State)
Type of equipment :—Thyristor controlled sectional drive for a Fourdrinier type paper machine.

Number of drive motors Eleven-18 HP to 185 HP.

Number of thyristor converters operating and control unit panels. } Ten-20 to 200 KW

Number of Desks Three

Alternatively we have also offered one 100/1000 HP 120/1200 RPM DC motor to drive the main line shaft drive with smaller helper motors (3 nos.-20 HP). One suitable power thyristor converter to meet the capacity of the above motors along with operating and control relay units, one control desk are also offered.

4.2 M/s Rohtas Industries Ltd.—Dalmianagar. Type of equipment :—Thyristor controlled sectional drive for a M.F. paper machine.

Number of drive motors Fourteen-75 HP to 450 HP.

Number of thyristor power converters, operating and control unit panels. } Six-80 to 1000 KW.

Control Desk There Numbers.

4.3 Nagaland Pulp and Paper Project :

4.3.1 Alt.—1
Type of equipment } Thyristor controlled sectional drives for type MF and MG Paper machines.

Number of drive motors. Twelve-4 HP to 750 HP.

Number of thyristor converters, operating and control unit panels } Ten-5 to 800 KW.

Control Desks Four Numbers.

4.3.2 Alt.-2 Type of equipment

Number of drive motors

Number of thyristor converters, operating and control unit panels

Number of control desks

4.3.3 Winder Drive

Four numbers of 3 HP to 70 HP DC motor fed from one common thyristor converter of 200 KW rating. One common operator's control desk.

4.3.4 Sheet Cutter Drive

One 40 HP DC motor, 35 KW thyristor converter and one operator's control desk.

4.4 Indravati Paper Mills—Bastar (M. P.)

4.4.1 Type equipment

Number of DC motors (for Each Machine).

Line Shaft drives for MF & MG Paper Machines.

Five-350 HP & 565 HP for Line Shafts. 3 HP for Dandy rolls, 2-30 HP Helper motors.

Five-65 to 600 KW

Two.

Thyristor controlled sectional drives for two numbers paper machine.

Twentythree-7.5 KW to 610 KW.

Number of thyristor converters, operating and control unit panels (for Each Machine)	} Sixteen-250 to 800 KW.	4.4.4 Type of Equipment	Thyristor fed drives for Fan Pump of Paper Machine and high density stock pump.	Suitable starting equipment, field application cubicles and operator's control stations for the above drives.
Control Desk (for Each Machine)		Three Numbers.	Fan Pump	
4.4.2 Type of equipment	} Thyristor fed drives and controls for paper winder and slitler/re-winder.	Number of DC Motors	Two-1000 HP, 1000 RPM Each	Number of slipring/squirrel cage Motors
Number of DC motors/brake generator		Alternately	Two-400 HP DC motors and Two-150 HP DC motors.	Suitable starting and control equipment for the above motors.
Number of thyristor converters, operating and control unit panels	Ten-4 KW to 155 KW.	Suitable thyristor converters, operating and control unit panel and operator's control Desks for the above motors.		
Control Desks	Eight-30 to 450 KW.	Stock Pump		
4.4.3 Type of equipment	Two Numbers	Number of DC motors	Six-Each 125 HP.	
	Thyristor fed drives for a super calender. One 340 KW DC motor supplied from suitable capacity thyristor converter unit, operating and control unit panel and one operator's control desk.	Number of Thyristor-Converters	Six-Each 100 KW	
		Number of control-desks	Six.	
		4.4.5 Type of Equipment	AC motors, starters and controls for Chippers, Pumps and Compressors.	
		Chippers		
		Number of synchronous motors for chippers	Eight-900 to 1250 HP, 375 RPM, 3.3 or 11 KV.	

In addition to the above projects we are also working-out our budget proposals for the drives and controls required for some of the plant and machinery required for the new paper mills being established in Assam and Kerala by M/s Hindustan Paper Corporation Ltd.

5.0 Import Content :

At the annual General Meeting of IPPTA held at Bhubaneswar (Orissa) in July 1967 we had pointed-out the import content for various items of equipment being manufactured by us and the problems faced by us in reducing the imported content.

We have already developed the thyristors field supply amplifier. With this new development we can offer complete drives and controls using D C motors, MG sets and controls for closed loop speed control system. This system can easily be adopted to meet most of the closed loop drive system required in Paper Industry.

We have also taken in hand the

development of power thyristor converters upto 200 KW capacity. Plans are already afoot to undertake manufacture of still larger capacity thyristor converters to meet the growing demand of paper and other industries. We expect that this would be established in the near future. A 60 KW thyristor converter for M/s Orient Paper Mills Ltd., Brajrajnagar is in an advanced stage of manufacture and we expect to commission the same in December 1972/January 1973. Except for the thyristor cell and thyristor fuses, which are not available at present in the country, the entire converter cubicle including the operational amplifiers, firing circuit, mixing modules, power packs etc. are manufactured in our works. The imported parts constitute approximately 20% of the total cost of the converter cubicle.

As regards import contents of raw materials and components for machines we are still importing electrical sheet steel, Ball bearings, shaft forgings, class B duty insulation for large size machine, Ingot copper for conductors, commutator segments, heavy duty contactors (600 amps DC and above). Tachogenerators used for high accuracy speed control system are still not available in the country. Efforts are constantly being made by us to replace the above mentioned imported items by indigenous one of acceptable quality.

6.0 Available Capacity and Possible Gaps :

H. E. (I) L's present manufacturing

capacity and the project engineering division are now not only in a position to meet major requirement of electrical plant and machinery for Paper Industry but can also render the Engineering services required for this sophisticated Industry i. e. we in Heavy Electricals are in a position to undertake turn-key jobs of providing Electrical drives and controls system engineering, Erection & Commissioning, after sales services and coordination work with the mechanical machine builders. Given below is the production capacity available for the various products now being manufactured by us.

6.1 Large Machines :

Range of Manufacture :

i) A. C. Synchronous Motors:—

Rating—400 HP to 10,000 HP, Horizontal mounting, 3.3, 6.6, or 11 KV SP/DP, CACW, CACA Enclosure. Motors upto 2500 HP have already been manufactured and supplied.

ii) A. C. Induction Motors :

Rating:—Upto 13000 HP, Horizontal mounting (also vertical for sq. cage machine), 3.3, 6.6, or 11 KV, SP/DP CACW, CACA enclosure.

iii) D. C. Machines :

Rating—400 KW to 5000 KW, 440 to 1200 volts, 1200 RPM max. Maximum HP of Machine manufactured—3000 HP, 750 RPM, 850 Volts Maximum HP de-

sired and quoted—5000 HP, 40 RPM, 1000 Volts.

Delivery & Manufacturing Capacity :

Due to Electrical design involved, manufacturing limitation and the long procurement cycle involved for procuring raw materials and components, we can at present manufacture in the above size only at the rate of one machine per month and the delivery period for these machines varies from 24 to 36 months depending on the size and type of machine required.

6.2 Small and Medium Range Machines :

Range of Manufacture :

i) A. C. Induction Motors:

Rating—110 HP to 1400 HP, 500 to 1500 RPM, 415 V/3.3 KV/6.6 KV, enclosure SP/DP, pipe ventilated, TEFC and CACW. Motors for operation at 3000 RPM and lower than 500 RPM can be offered in special cases.

(ii) D. C. Machines—(Industrial Type)—For General Industrial Application.

Rating—10 to 600 KW, upto 600 volts, max. RPM—1800. Speed variation upto 1:30 by combined field and armature control.

Delivery & Manufacturing Capacity: The manufacturing capacity for above size of machine is 250 numbers AC machines and 100 numbers DC machines per year. Delivery period for AC machine varies from 10 months to 22 months and for DC

machine 18 months to 30 months depending upon the sizes and type of machine required. So far 957 numbers AC machine corresponding to a total of 326760 HP and 241 numbers of DC machine corresponding to a total of 16000 HP have already been manufactured and supplied by us.

In view of the limited number of enquiries received for synchronous machines in this range manufacturing capacity for the same has not been established.

6.3 Controlgear :

For all large, medium and small range machines HE (I) L has capacity to supply the complete starting, operating and control equipment. Operator's control Stations as required can also be supplied from our shops. Delivery of control equipment would in general matches the motor deliveries.

6.4 Possible gaps:

It may be noted that the manufacturing capacity as stated above has

been established in HE (I) L to meet industrial drive requirement of various Industries (i.e. Steel, Cement, Paper, Sugar, Machine Tools etc.). Hence for the Paper Industry if all the Paper mill projects, both new mills and expansion of existing mill — envisaged by the public as well as private sector undertaking come to fruition simultaneously H E. (I) L may not be in a position to meet the entire demand for plant and machinery falling in their range of manufacture since part of our capacity may have already been loaded by other industries. However, if a phased programme of paper production is planned or advanced placement of orders for electrical plant and machinery is resorted to then it should be possible to reduce the gap between production and demand to a very great extent.

7.0 Conclusion

It is heartening to note that by and large most of the Electrical Plant and Machinery required by the Paper Industry are available in

the country. Keeping in view of the large anticipated demand of Electrical equipment for Paper Industry, H. E. (I) L in particular have geared up to meet this challenge. It is now for the paper industry to take full advantage of this indigenously available resource to the maximum extent possible to save valuable foreign exchange for the country. If the paper industry associates us from the beginning when new mills or expansion of existing mills are planned then it will greatly assist us not only to plan our manufacturing capacity to meet the paper industry demand but can also deliver the equipment within the scheduled period.

In conclusion the authors would like to thank the Management of Heavy Electricals (India) Limited for the permission to present this Paper, and the Indian Pulp and Paper Technical Association for giving us the opportunity to present it at this Seminar.