# Design of Low Tonnage Paper Machine

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*Undertaking the design of a paper machine is an expensive and difficult job as each section of the machine has to be compatible with the other, if satisfactory results are to be obtained. We have strived, in the design of the 25 and 30 Series machines, to hold the same standards that Beloit Walmsleys have established for the wider and higher speed machines over the years. We have presently expended about 6 months of concentrated work and are just reaching a point where we can see the results of our efforts. Preliminary estimating just commenced and we would hope to be able to offer a complete machine very shortly.*

Paper Machine Design has traditionally been one of evolution. Narrow machines were made wider and the wide machines capable of higher production rates over the years. The problems of width and speed were met and solved one at a time, generally by modifying or in some cases completely redesigning one or two sections of the machine. It has, therefore, been seldom that a Company has undertaken to design a complete machine.

Jessop & Co. made the decision to design a low tonnage machine toward the end of May last year. This decision was made for several reasons:(1) The escalated cost of larger units increased the viability of lower tonnage machines (2) the desire to have components to offer for rebuilds to existing machines, (3) the desire to increase the indigenous content of the machine. When the idea was suggested to Beloit-Walmsley they were very co-operative and agreed to provide their most qualified engineer to head-up our machine design programme.

Mr. George Forrest, formerly Chief Engineer of Beloit Sorel Walmsley Ltd., and most recently Vice President of Engineering for Beloit-Walmsley has guided the application of design theories and data to practical machine design. Mill Visits were arranged through the courtesy of our Paper Mill friends, to see wire and felt changes as well as observing the operation of the machines and the manufacture of paper. We intend to continue and expand this programme as well as a programme to visit our own Works to see the manufacture of various components and study the various machine tools, their operation as well as their capacities. This programme combined with the training of personnel in the facilities of Beloit-Walmsley will not only strengthen Jessop's position in serving the paper industry, but will also help lead the way towards a closer relationship between the indigenous builders and the paper industry.

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## Objective

Our objective was to design a straight forward 25 to 30 tonne machine using to the maximum extent possible indigenous material and components. The machine is designed for installation in a building with or without a basement. The parameters of the design are set forth in Fig. 1.

## Establishing the Machine Gauge

The first thing that has to be established in the design of a machine is the gauge. The gauge dimensions are generally related to the wire or pond side width, but they are established by the dryer section. In other words, you have to establish your dryer cylinder design first. Our objective was to design a symmetrical dryer part, one in which the dryer shell as

| SERIES | 25 mm | 30 mm |
|---|---|---|
| WIRE WIDTH | 2800 | 3300 |
| POND SIDES | 2700 | 3200 |
| SHEET TO PRESS | 2650 | 3150 |
| REEL TRIM | 2550 | 3050 |
| WINDER TRIM | 2500 | 3000 |
| NET PRODUCTION | 25—30 TPD | 30—36 TPD |
| ASSUMED EFFICIENCY | 80% | |
| DESIGNED SPEED | 250 M.P.M. | |
| FURNISH | STRAW BAGGASSE RAGS & WASTE | |
| BASIS WEIGHT RANGE | 40—140 GSM | |
| NOMINAL BASIS WEIGHT | 60 GSM | |
| ASH CONTENT | 0—15% | |
| PAPER GRADES | WRITING, PRINTING, WRAPPING & 9 POINT | |

FIG-1

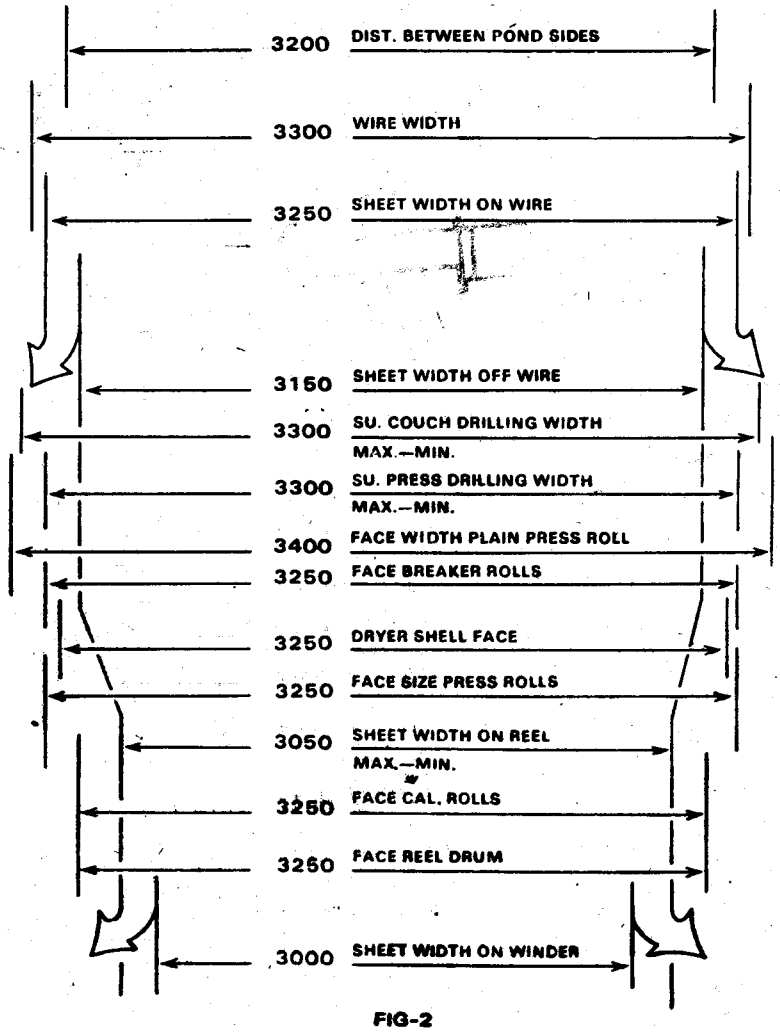



FIG-2

well as the bearings are symmetrical about the machine centerline. A gauge chart showing the relationship of roll face widths for the series 30 machine is shown in figure 2. Once these parameters are set, work can proceed on other sections of the machine.

**Headbox**

The headbox is considered by many to be the heart of the machine. The design goal is to deliver an uniform volume of stock to the wire at the proper velocity, fully mixed and dispersed, free from cross currents, turbulence and eddies.

The design objectives were to produce a headbox that would :

1. Have no surging at the entrance.
2. Have no dead areas.
3. Have no sharp corners or edges to catch stock.
4. To provide uniform delivery to the slice.
5. Maintain a uniform homogeous fibre dispersion.
6. Eliminate all cross currents and eddies.
7. Eliminate entrained air.
8. Produce a sheet with minimum cross machine profile variation.

We have closely followed the data provided by Beloit-Walmsley's years of experience in headbox design. The design features are similar to those found in wider, higher speed machines. All parts of the box coming in contact with the stock are stainless steel or other corrosion resisting materials.

With a view towards flexibility, to allow the box to be used for virtu ally any machine of compatible

width, it has been designed in both the open and pressure/ vacuum configuration. Figure 3 shows the open box which can be fitted with either one or two slices. Preparations are made in the side of the headbox to enable a rectifier roll and shower to be readily fitted when, and if the box is converted to the closed design.

Figure 4 shows the pressurized headbox which can be fitted with different sizes of rectifier rolls for the various pond depths required. The headbox is compact and the slice lip and slice body can be easily adjusted from the platforming across the back of the headbox.

To ensure an even stock distribution the stock enters through a tapered inlet pipe designed to allow up to 10% re-circulation. The stock then passes through a tube bank header, sized, for the gallonage range, to give a directional change to the stock entering the main part of the headbox.

It is intended that the box will be pressurized through the use of mill air, although a separate compressor could be provided. Control of stock level is maintained through a conventional air bleed level control.

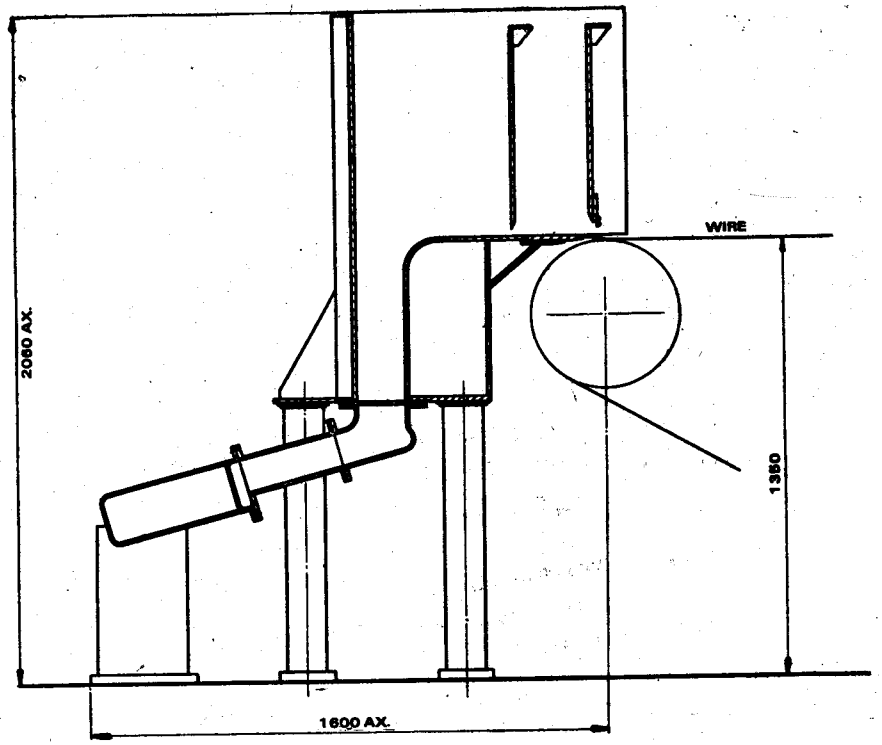


FIG-3

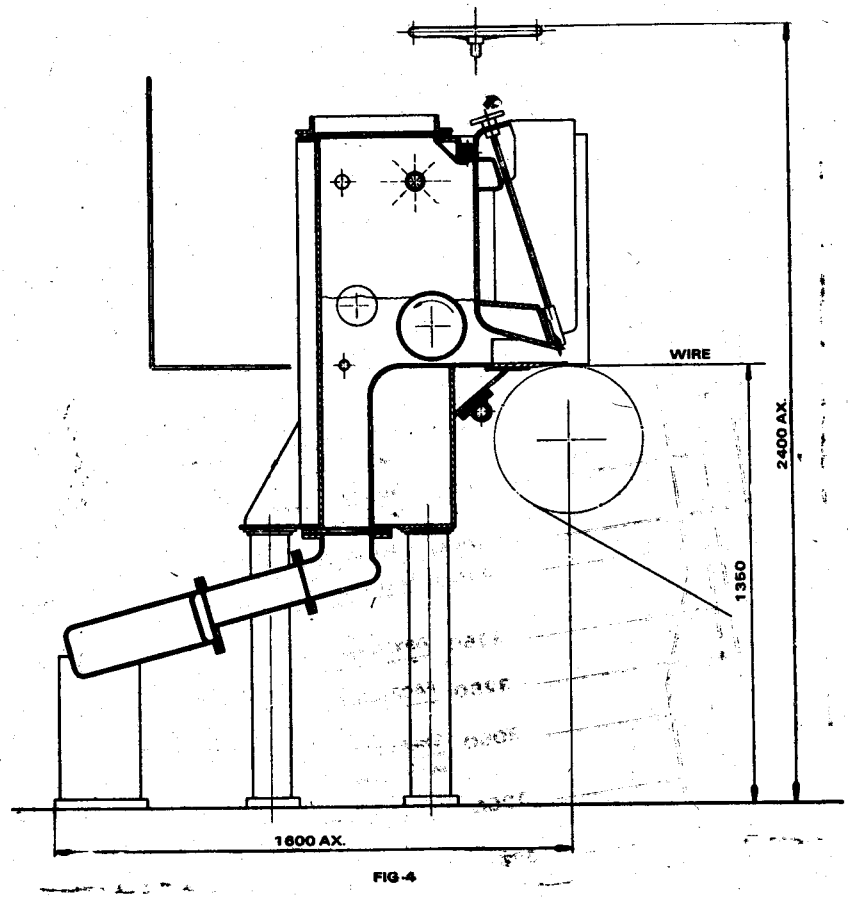


FIG-4

**Fourdrinier**

The Series 25 Fourdrinier is of the "Take Down" design and the Series 30 is Cantilevered. In choosing the Cantilevered design for the larger machine we not only considered the weight of the table components, but also greater susceptibility to damage during wire change.

Both designs will accomodate the

latest type of foil boxes, individually adjustable Arc foils, and either hard or HPD suction box covers. The suction box support is designed to accommodate either 8" or 12" wide suction boxes designed with large cross section discharge to eliminate the possibility of flooding. The table make-up would depend on the furnish and grade of paper to be produced.

For an MF machine a wire turning roll would not be provided, but for a light weight MG machine, however, a wire turning roll would be added.

Figure 5 shows the 11 meter take apart shaking fourdrinier. You will note that the savealls are designed to slide into the collector tray which is mounted on rollers. During wire change the collector tray is rolled into the aisle thus eliminating the handling of individual trays. The breast roll bearing mounting swings away on the bottom, thus facilitating the removal of the breast roll by roll dolly or on a roll board. The forming board can then be lowered and removed in the same manner. The single box, bronze shell suction couch roll is designed for cantilevering during wire change. The wire change procedure would be that conventionally employed for this type of fourdrinier.

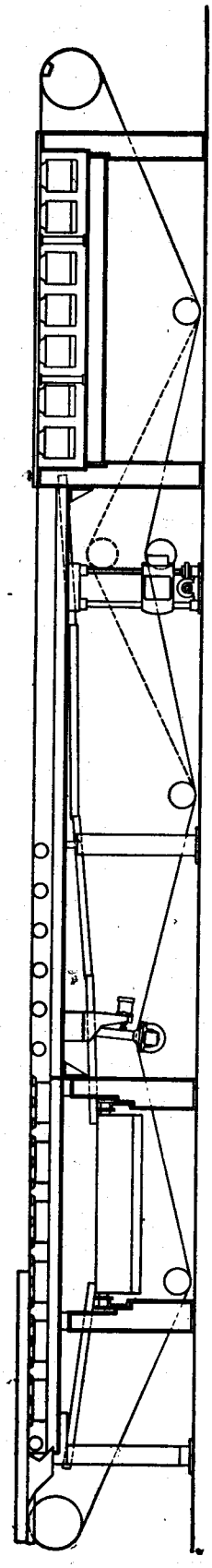
The turning roll would be interchangeable with the breast roll and will be of steel pipe construction. The breast and wire return rolls would normally be provided with hard rubber covers, although we also hope to be able to provide fibreglass covers if requested.

All rolls to be provided with grease lubricated antifriction bearnings. A manually operated wire stretcher and air guide with paddle assembly would be provided. The two outside wire rolls will be furnished with stainless steel doctor, blade holders and composition doctor blades.

**Press Section**

It is difficult to achieve a high degree of standardization on the design of a press section. The water removal requirements as related to sheet weight and speed, sheet finish vs. bulk vs. dryness and last but not least, the desires of the paper makers are difficult to rationalize. We feel, however, that two straight through presses are adequate for the majority of the paper qualities being considered. This conventional arrangement is certainly the most economical and every one these days is cost conscious, at least when talking to machine builders.

The normal arrangement would be a suction first press followed by a Venta Nip second press. The maximum design Nip pressures for both presses will be a 45 kg/cm. (250 PLI) with normal operating pressures in the range of 32 to 40 kg/cm. respectively. Top press rolls, in contact with the sheet, generally have imported covers. For this reason we are investigating the possibility of supplying granite rolls. The advantages are durability, from a wear stand point, and extremely good sheet release characteristics. The disadvantages are higher first cost, which should be largely off set by duty and freight of imported rolls and the



KNOCK DOWN FOURDRINIER
FIG-5

fact that they cannot stand too rough treatment. We are presently arranging to have samples of indigenous granite tested for sheet release, chemical resistance, and foreign inclusions.

The success and, therefore, general acceptance of high synthetic content felts and the very high pressure needle jet showers have made a straight through press section on a machine without a basement a more practical consideration. Felt lengths can be shorter and periodic felt washing is no longer necessary. The felt handling equipment will have rubber covered felt rolls with anti-friction bearing designed for grease lubrication. A convention at air guide and a hand operated screw type felt stretcher will be provided.

Figure 6 shows the arrangement of the straight through press section. Design work is also progressing on a second inverse and smoothing press.

**Dryer Section**

The design of a dryer section appears to be very straightforward and simple, but in reality a lot of thought and engineering hours are required to achieve a satisfactory result.

The drying cylinder for the Series 25 and 30 dryer section is designed to ASME Standards and we are presently working with inspection authorities to receive an ASME code approval. The designed operating steam pressure is 3.5 kg/cm² (50 PSI) or alternately 5.3 kg/cm² (75 PSI) by increasing the number of cap screws in the heads. The hydraulic

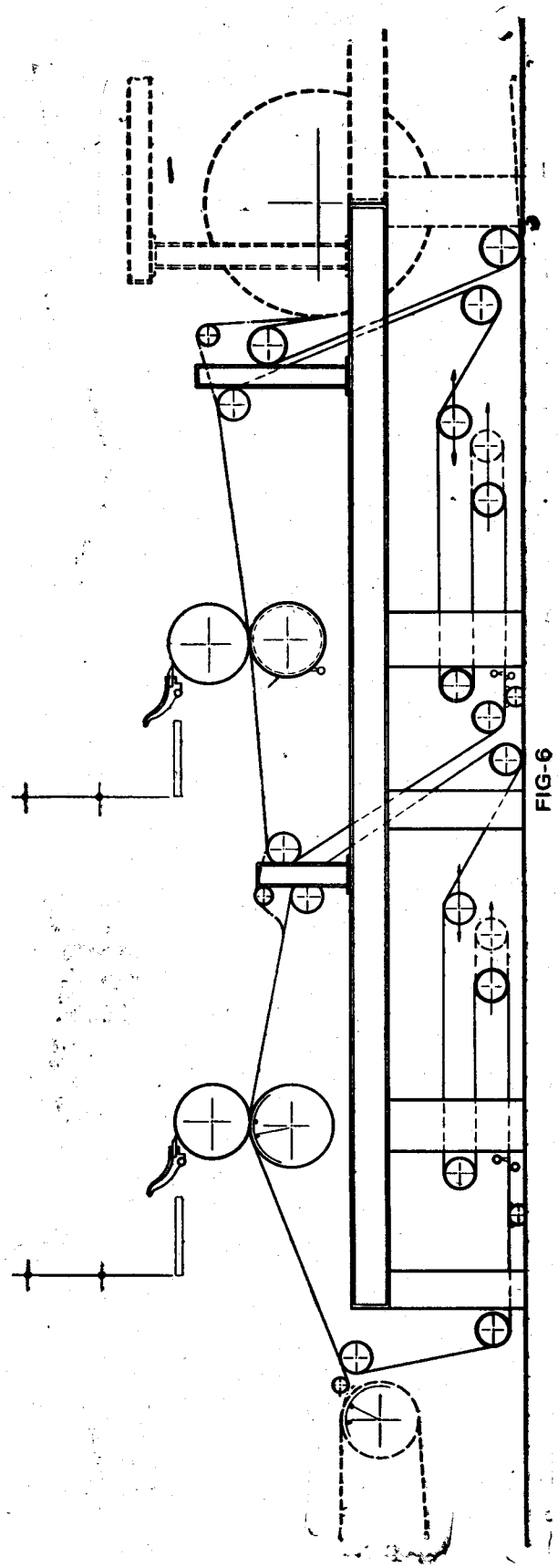


FIG-6

test pressure is twice the above operating steam pressure.

The open gear type dryer frame Fig. 7 is designed without hand i. e. the front and back frames are alike. This has been done to reduce engineering time and could theoretically allow you to cast and machine framework when production capacity exists rather than to order. The dryers can be provided with plain or anti-friction bearings designed for static or continuous oil lubrication. Normal cast iron or a combination of cast iron and filled gears can be furnished.

The ideal clothing for a dryer part is fabric or dryer screens, but as far as we know they are not indigenously produced as yet. We are, therefore, working on a baby dryer and also a hot air drying system which will utilize ducts or possibly pocket ventilating rolls.

The felt handling equipment will be similar to that provided for the press part and will include an air guide, and a hand operated screw type stretcher. A spring accentuated tension roll will be furnished before the size press and calender.

A Sheahan rope system, of double rope design, will be furnished to carry the tail from the press section through the dryer part. Rope tension will be maintained by counter weights.

Each dryer will be fitted with a duplex stream fit and stationary condensate removal syphon.

The preferred stream system in our opinion is the cascade type utilizing blow through steam.

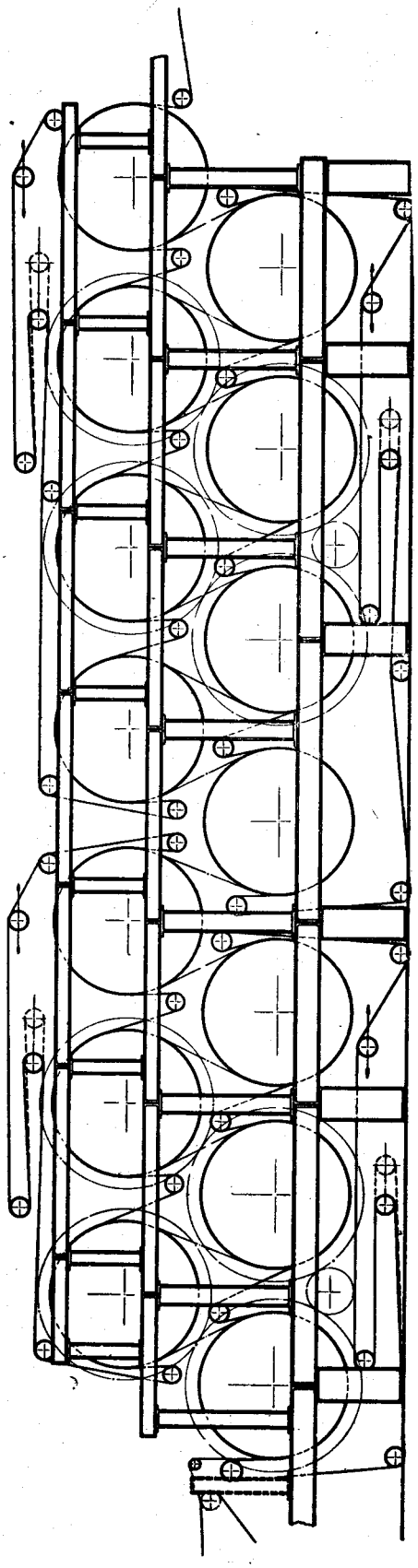


FIG 7

Space and height restrictions in a basementless mill, however, present many problems. A trap system is also being investigated but we feel that there is loss in drying efficiency with this arrangement.

A continuous oiling system can also be offered but the total installed cost is appreciable.

**Size Press**

A modified horizontal size press will be offered for printing, writing and other grades, if requested. The frame work will be of welded steel construction and loading will be provided by air cylinders.

We are investigating roll covers but a substitute for the present imported covers presents a problem that we have not solved as yet.

**Calender**

A six roll feature 8 roll open side calender is contemplated, although design work is in a very preliminary stage. Roll sizes will be based on achieving a certain bottom nip pressure rather than other considerations. All calender rolls will be mounted in static lubricated antifriction bearings, and may be bored for steam if desired. The king roll will be provided with an oscillating doctor, other doctors, if supplied, will be non-oscillating. Nip relief is not contempled at least on the 25 series machine.

**Reel**

The level rail reel with a 24" dia. drum is available for use on the 25 and 30 Series machines. The level rail reel design, although slightly more expensive than a Pope type reel, produces a parent roll of more uniform density with less operator attention. The secondary arms are motor driven or alternatively hand operated. A hand operated or motor driven hoist with one end supported from the calender frame can be provided for servicing the reel. The reel spools will be of heavy pipe construction with cast iron heads and steel journals. Antifriction bearings with dumb bell type housings designed for grease lubrication will be standard.

**Controls**

It is our intention to keep the controls as simple as possible and still allow efficient operation of the machine. Controls and interlocks are difficult to standardize or rationalize as everyone has his own view as to what is essential. Automation, however, is expensive and we intend to resist the temptation, both ours and the customers', to sophisticate and automate things that could and should remain simple.

**Acknowledgement**

We would like to thank IPPTA for giving us the opportunity of presenting our thoughts on Machine Design.

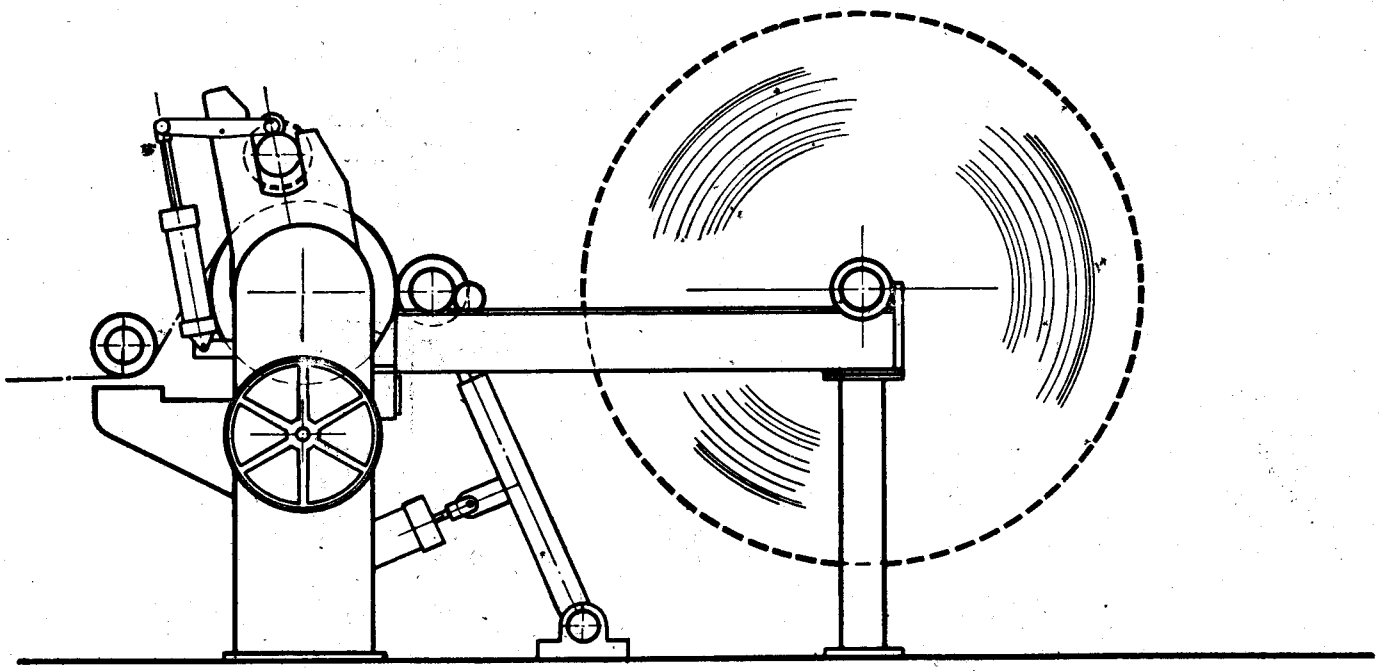


FIG-8