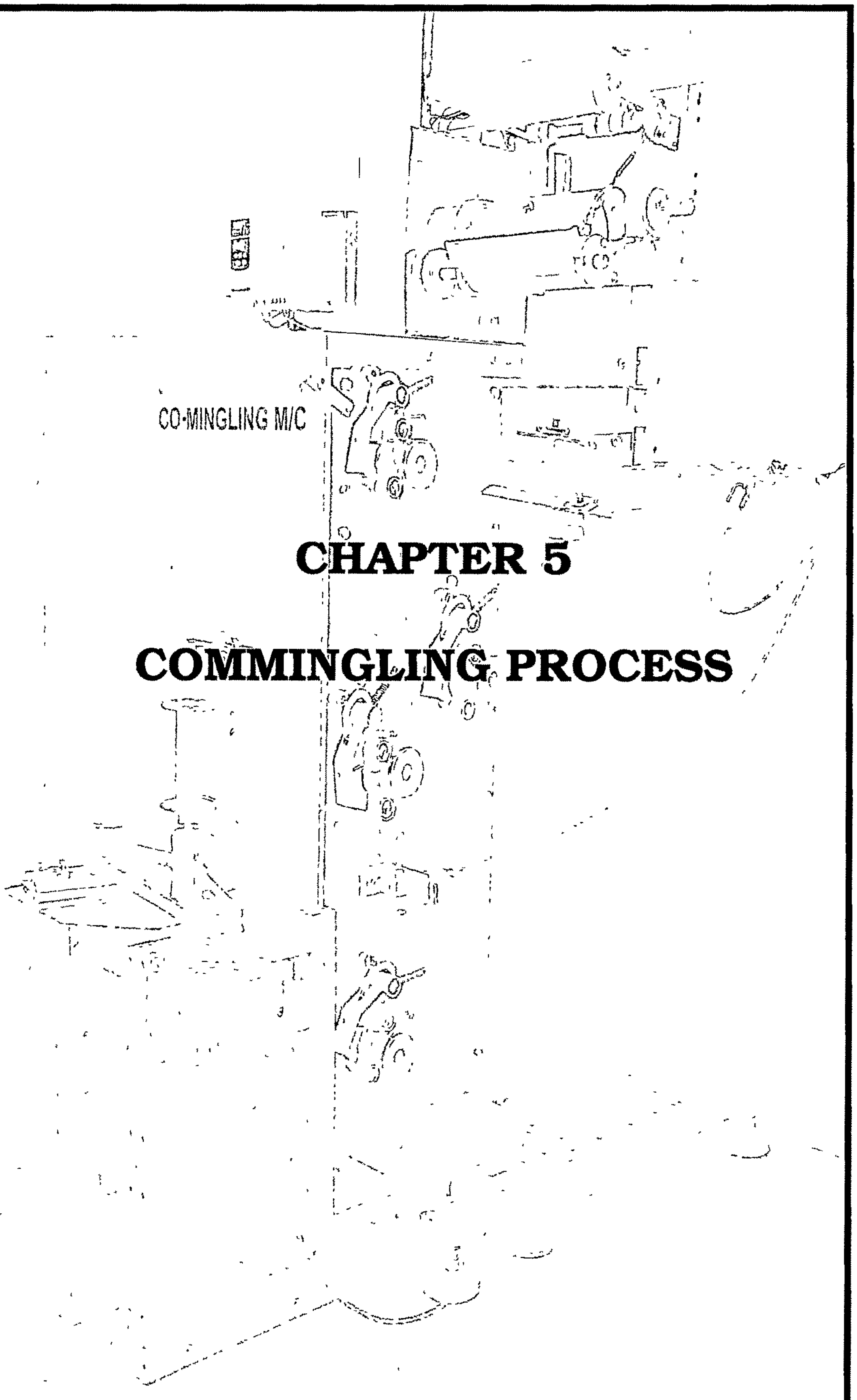
CHAPTER 5

COMMINGLING PROCESS



Study on Different Yarn Passages and Modification in Commingling Machine to Produce Hybrid Yarn

5.1 INTRODUCTION

Recent trends in case of technical textiles shows, that engineers and researchers have concentrated on various types of hybrid yarns especially for applications in textile composites. The hybrid yarns can be made from two different types of filament fibres using the commingling process. This process is not new for the textile industry. For past many years various studies have been carried out on interlacing of various yarns for general textiles but the present study is carried out on mingling behaviour of hybrid yarns comprising of Glass/Polypropylene filaments. In case of hybrid yarns, the properties of resultant yarn mainly depend on pre-opening and intermixing of component elements. As the commingling characteristics of the yarns are important for its end use, the effect of process parameters on structure and properties of the hybrid yarns has been studied. The main parameters of commingling process are design of jet, air pressure and different yarn passages through the machine and yarn take-up speed.

A commingling machine has been fabricated to produce hybrid yarnfor this purpose. The various factors pertaining to the difficulty in processing (Glass/Polypropylene) hybrid yarn using commingling process are discussed in Chapter 4. Hence, following factors are considered for the studies of various parameters.

- The shape of filament cross-section influences the area dependent mechanical properties of the filaments and accordingly change in amount of force is required to deflect the filaments.
- The force acting on the filaments varies due to its surface characteristics and projected area arising from non-circular cross-sectional shape. These factors mainly affect the nip formation in case of glass filament leading to poor nip stability.

- The higher drag force acting on the elliptical cross sections gives better nip formations. The glass filaments, having rod like structure, smooth surface and perfectly circular in cross section, resist the bending of filament and hence the nip formation.
- Due to high bending stiffness and torsional rigidity, the glass filament is difficult to bend and mix with polypropylene.

5.2 MATERIALS AND METHODOLOGY

5.2.1 Raw Material

The raw materials used are commercially available continuous glass filament roving and fully drawn polypropylene filament yarns. The various specifications of these parent yarns are given in Table 5.1. The properties of glass filament such as stiffness, density and melting point, are higher as compared to polypropylene filament. On the other side glass filament has very poor bending strength. In the feed section, two yarns of polypropylene each of 840 denier and a glass yarn of 1350 denier have been used to obtain mingled yarn of 3030 denier.

Table 5.1 The Raw Material Characteristics

Material	**Glass roving**	**Polypropylene filament**
Manufacturer	Twiga	Filament India limited.
Yarn fineness (denier)	1350	840
Number of filaments	-	140
Filament diameter (mm)	0.274	0.363
Bulk density (g/cm^3)	2.54	0.90
Breaking stress (N/mm^2)	1210	458
Breaking elongation (%)	2.70	22.20
Young modulus (N/mm^2)	51775	67207
Stiffness (N/mm)	10.16	2.32
Melting point: T_m (°C)	900-1300	160-175

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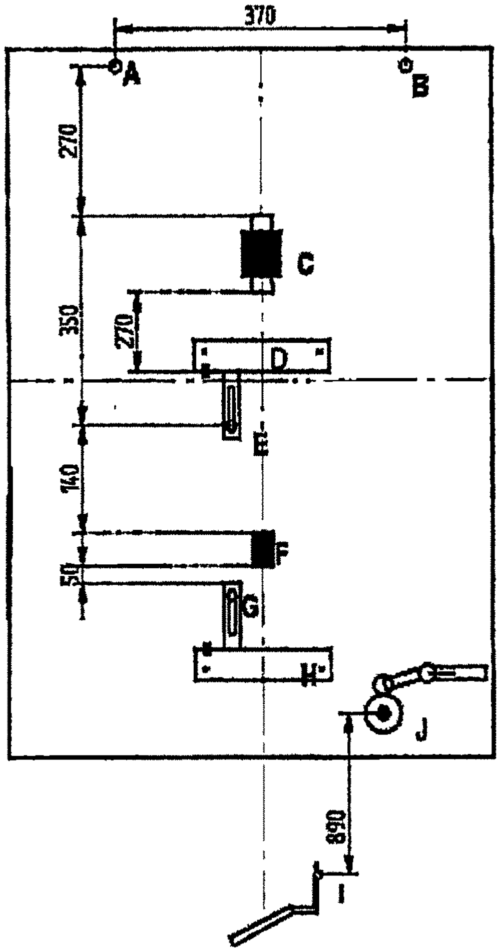
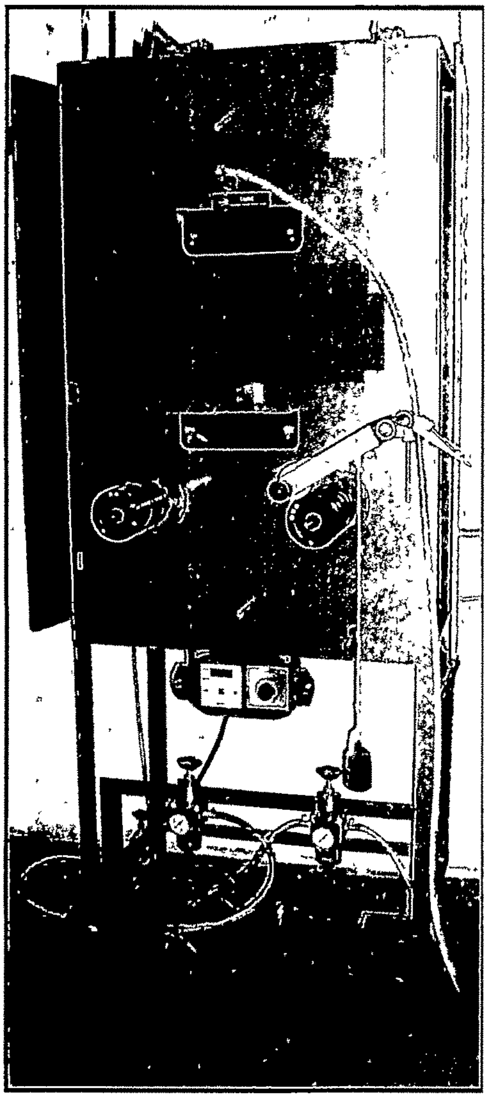
5.2.2 Fabrication of Equipment

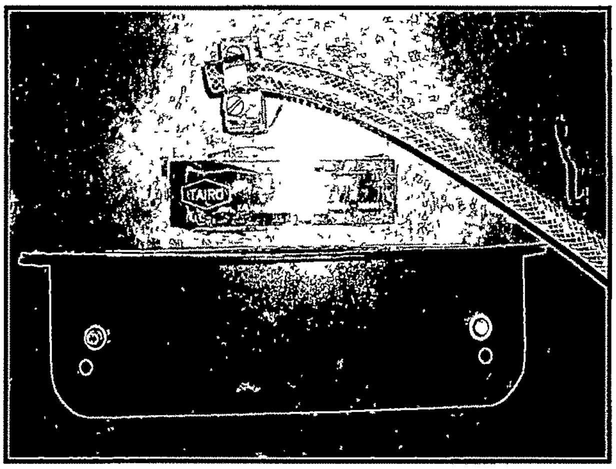
The existing set up for draw winding machine is modified for the preparation of commingled yarns. The equipment is fabricated at Textile and Allied Industries Research Organization (TAIRO), Baroda. In preliminary trials, the processing of glass filaments posed difficulty in handling due to lower bending strength and transverse compressive strength. Moreover, friction and deflection of the filaments with metal parts lead to the filament damage, which affect the mechanical properties of hybrid yarn. Hence, the machine is modified in such a way that the yarn path becomes as straight as possible to minimise bending of yarn. The schematic diagram of the commingling machine set up is shown in Fig. 5.1(a). The machine is modified by addition of yarn guide, air nozzle and control units as shown in Fig. 5.1(b). The two nozzles viz. pre-opening nozzle(pre-opening jet), main nozzle(mingling jet) are taken for studies.



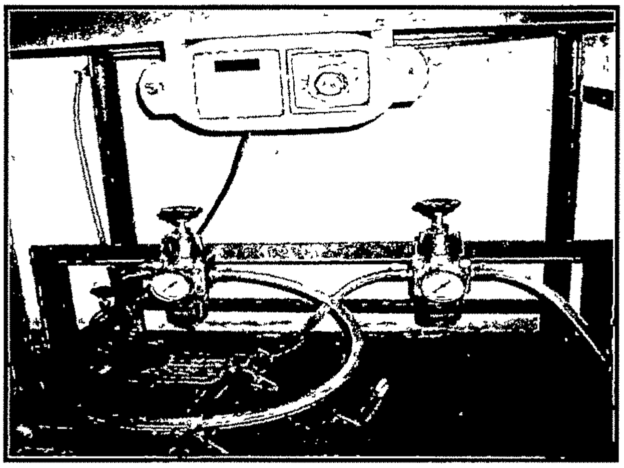
A, B – Creel guide
C – Pre-opening Jet (Jet1)
D, H – Rotating guide assembly
E, G – Rotating guide
F – Mingling Jet (Jet 2)
I – Bottom guide
J – Winding drum
AB – Distance between two guides
AC – Distance between guide and Jet1 inlet
CD – Distance between Jet1 outlet and guide
EF – Distance between rotating guide and Jet2 inlet
FG – Distance between Jet 2 outlet and rotating guide
IJ – Distance between bottom guide to winding drum
(All dimensions in mm)

Fig. 5.1(a) Schematic diagram of commingling machine set up





Nozzle attachment



Control unit

Fig. 5.1(b) Nozzle attachment and control unit for commingling set up

Following are the important elements used in the commingling set up:

a) Guide

The main problem in processing the glass filament is the filament breakage due to abrasion of the filament with metal guides. Ceramic guides are used to minimize the abrasion between glass filament and machine parts. The guides used near the inlet and outlets of nozzle are adjustable mainly to control the tension in the yarn during the process which decides mingling characteristics of yarn. The adjustable guide assembly is equipped with angle bracket and sliding bracket, design specification of which are as shown in Fig. 5.2.

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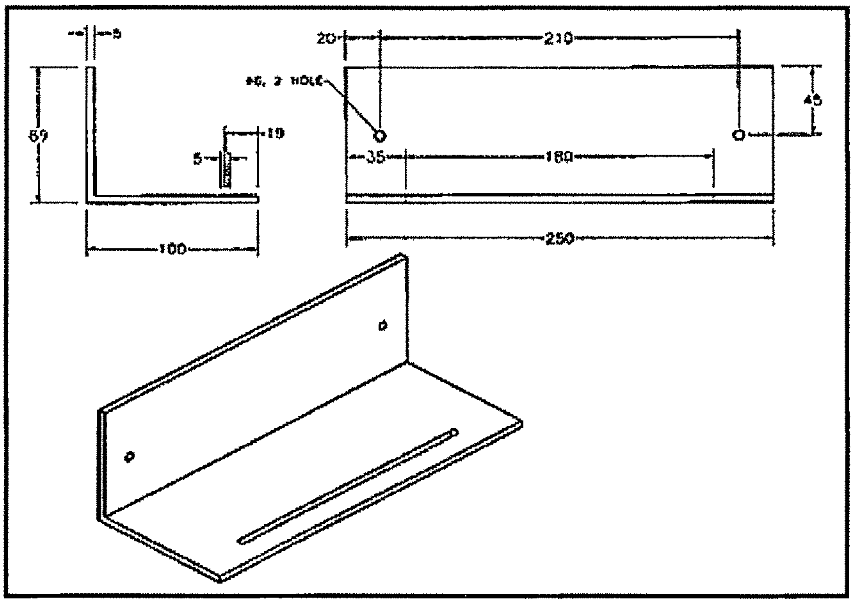
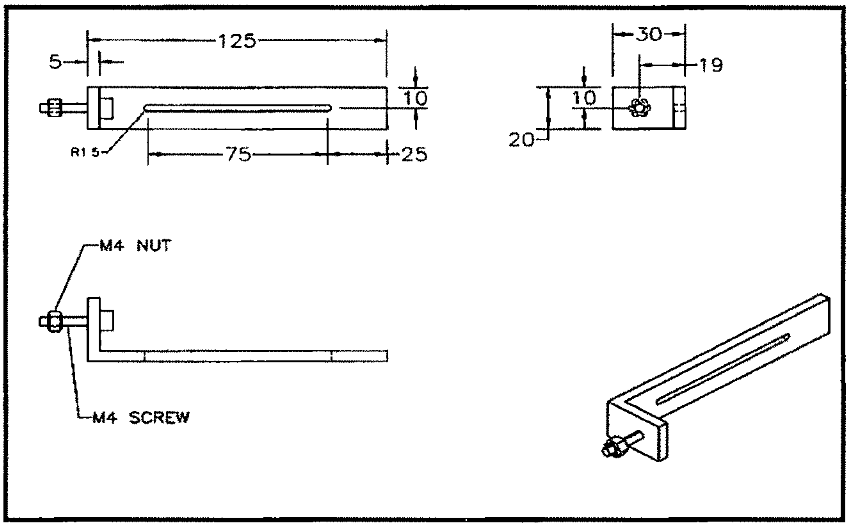


(a) Angle bracket

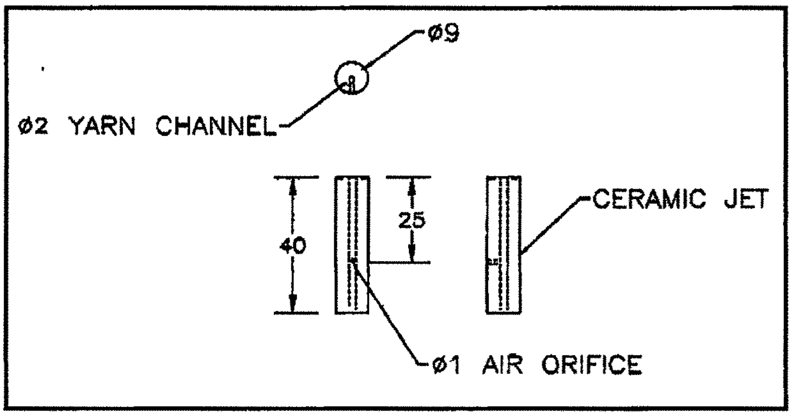


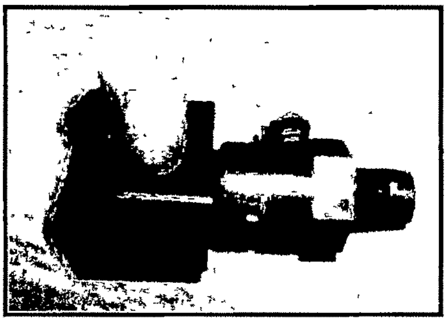
(b) Sliding bracket

Fig. 5.2 Design specifications of guide brackets

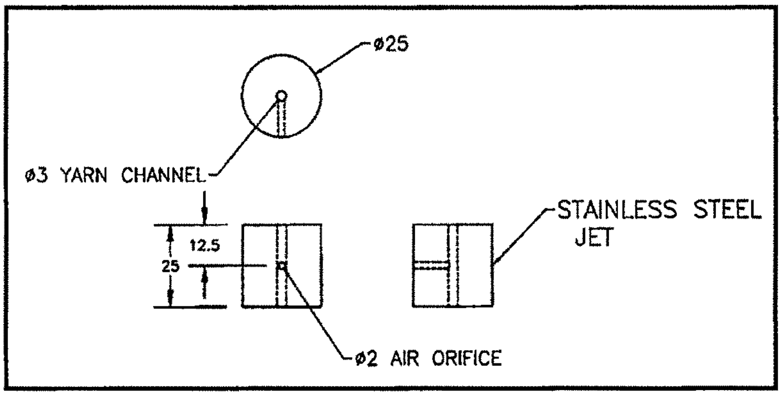
b) Nozzle

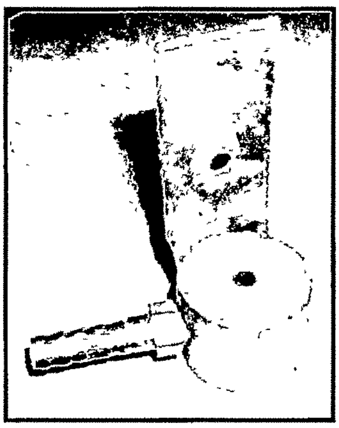
The two different nozzles are used in the machine viz. pre-opening jet and mingling jet design aspects are shown in Fig. 5.3(a) and Fig. 5.3(b) respectively. The pre-openıng jet is made-up of ceramic material while mıngling jet is made of stainless steel. Mounting of each jet is design for easy fit using nut-bolt arrangement. As supply yarn is very coarse (3030 denier), it has been decided to use larger yarn channel diameter and air orifice of mingling jet .





(a) Pre-opening jet





(b) Mingling jet

Fig. 5.3 Various design aspects of mingling jet

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c) Winding Device

Conventional surface driven winder was used to wind the delivered yarn into cross-wound bobbin. The speed-regulating device and pressure valve are provided to control the take-up speed and air pressure respectively.

5.2.3 Yarn Passage Through Machine

Two polypropylene filament yarn bobbins and a glass filament yarn bobbin are kept in the creel. The constant air pressure at pre-opening jet has been kept at 1.5 bar to open up the filaments upto a certain level. Commingling of glass/ polypropylene takes place in this zone. The yarns are then fed to the mingling jet through the two adjustable rotating guides. The pressure at this jet can be adjusted by pressure valve in the range of 2 bar to 6 bar. The resultant commingled yarn can be wound on paper tube by surface driven winder.

To study the effect of amount of pre-opening of parent yarns passages and processing parameters, three different yarn paths have been selected viz.

- ***Passage 1 (P_1),*** glass filament yarn and one strand of polypropylene yarn pass through Jet_1 and Jet_2 and another polypropylene yarn directly pass through Jet_2. Jet_1 both glass and polypropylene filaments get pre-opening treatment (Fig. 5.4).
- ***Passage 2 (P_2),*** only glass filament yarn passes through Jet_1 and two strands polypropylene yarn directly pass through Jet_2 , there after all three ends pass through Jet_2 (Fig. 5.5).
- ***Passage 3 (P_3),*** all the three filament yarns pass through Jet_1 and Jet_2. There is no supply of air at Jet_1, which works as yarn guide therefore at Jet_1 pre-opening treatment is not given i.e single jet passage (Fig. 5.6).

5.2.4 Sample Preparation

The different hybrid yarn samples from glass/polypropylene are produced at Textile Engineering Department, M. S. University of Baroda using machine set up shown in Fig 5.1. Different yarn passages have been used to produce yarn at different air pressure and take-up speed. Total of ten commingled hybrid yarns have been made using following variables(Table 5.2).

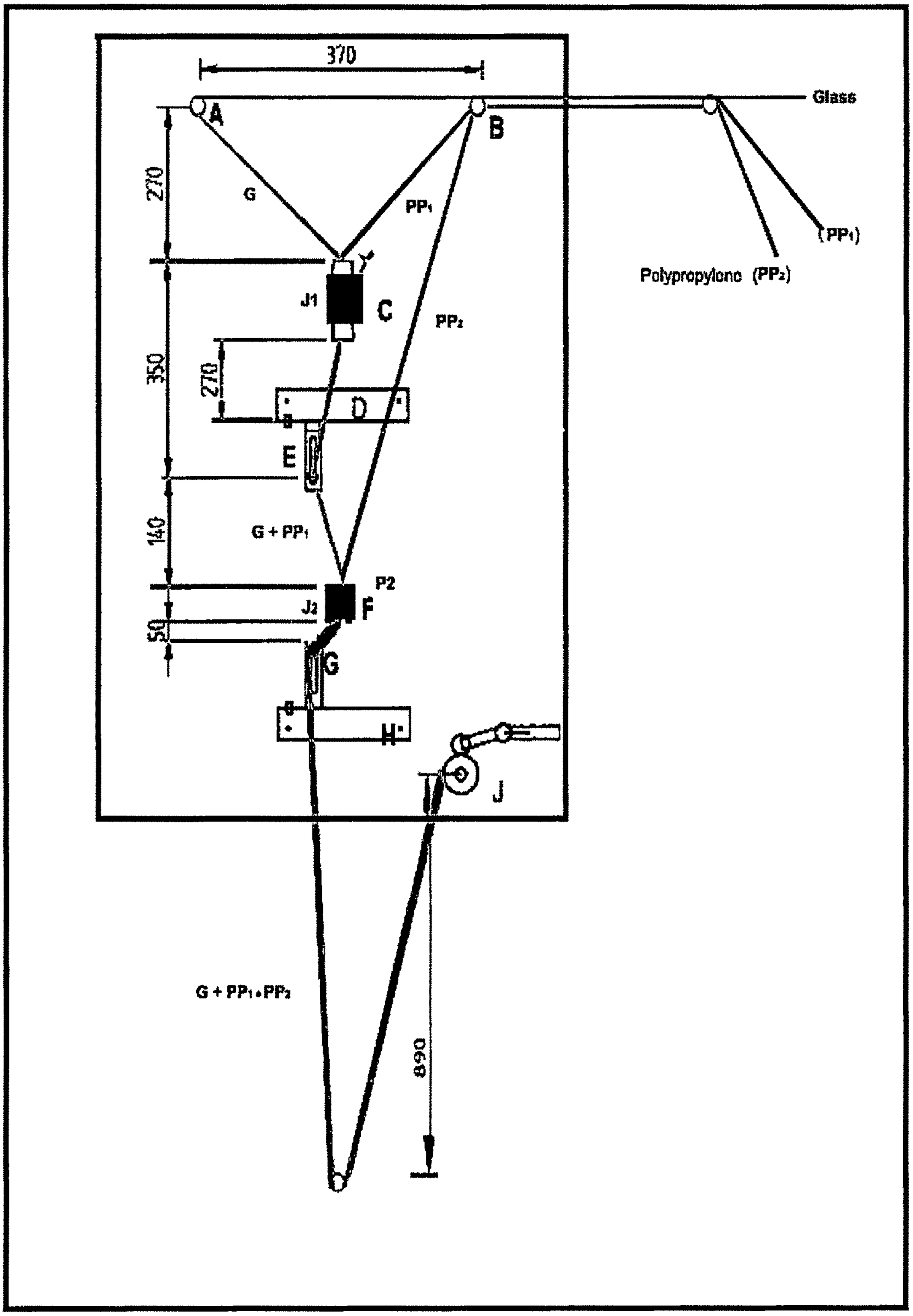

Fig. 5.4 Schematic diagram showing yarn passage with glass yarn and one polypropylene yarn passing through pre-opening jet (P_1)

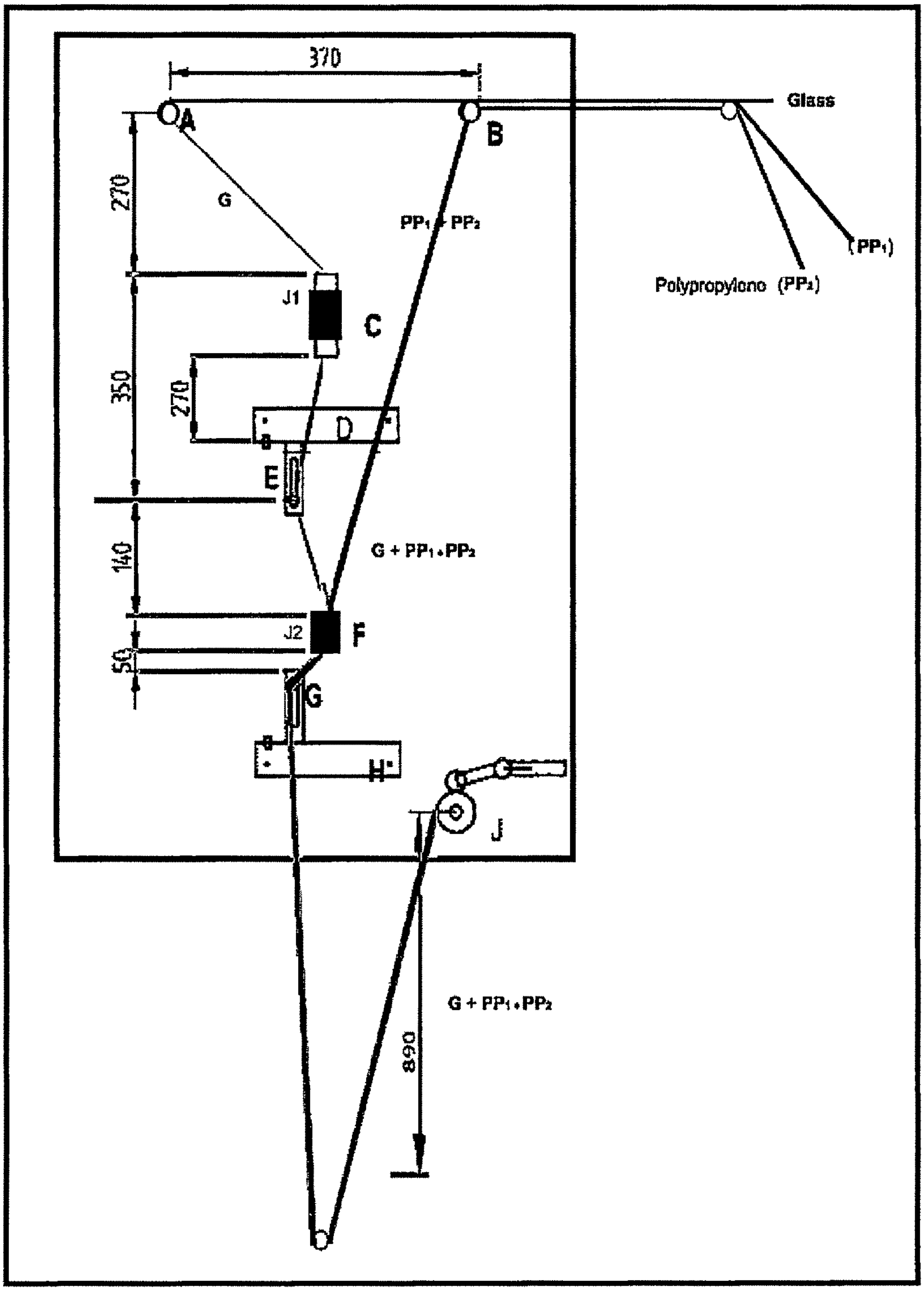

Fig. 5.5 Schematic diagram showing yarn passage with only glass yarn passing through pre-opening jet (P_2)

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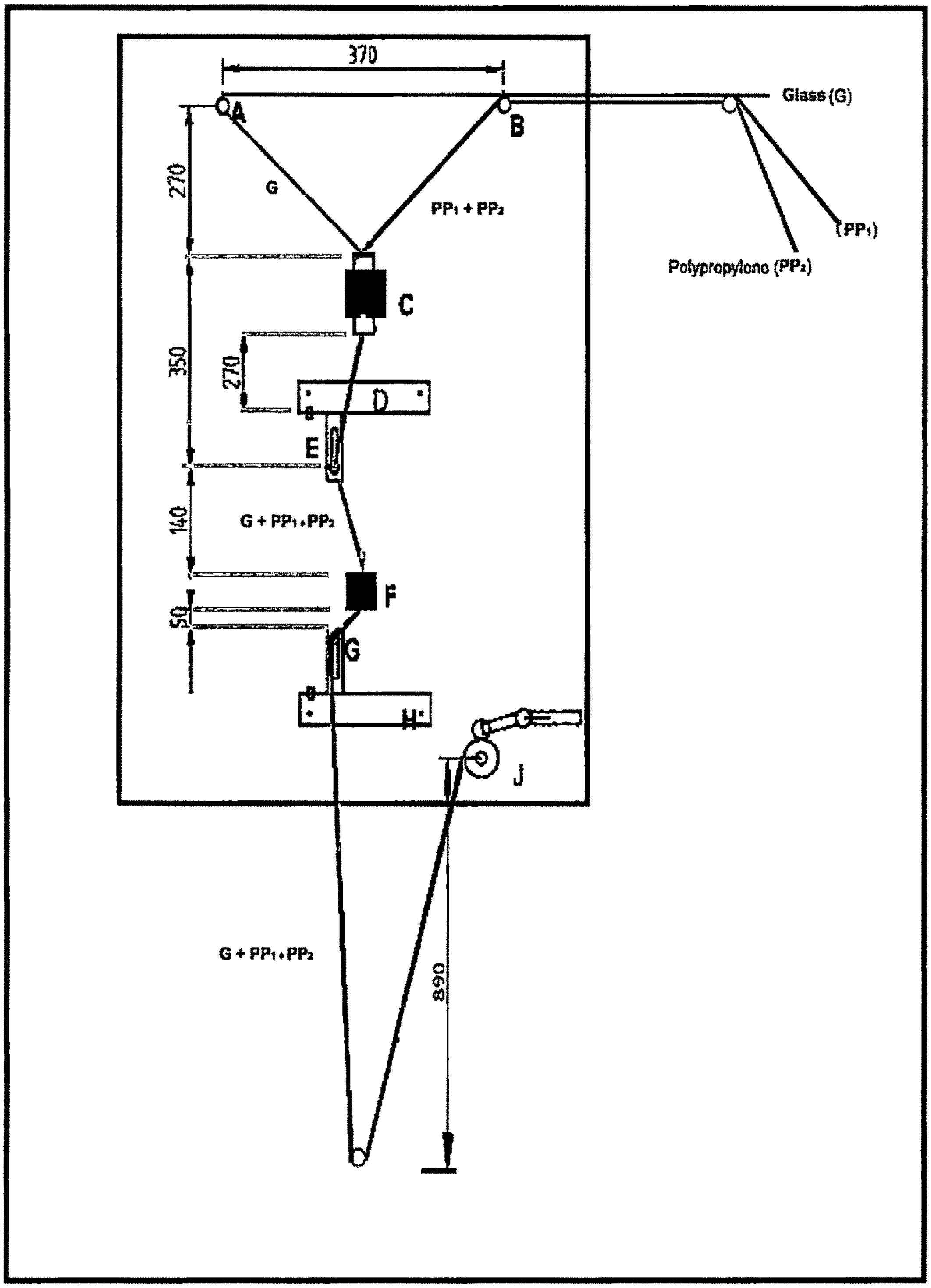

Fig. 5.6 Schematic diagram showing yarn passage with glass yarn and two polypropylene yarns passing through only mingling jet (P_3) (Single Jet Passage)

Table 5.2 Various Commingled Hybrid Yarns Produced Using Different Yarn Passages and Process Parameters

Sr. No.	Yarn path	Air pressure (bar)		Take-up speed (m/min)		Sample code
		A_1	A_2	T_1	T_2	
1	Passage 1 (P_1)	5	-	50	-	$P_1A_1T_1$
2		5	-	-	100	$P_1A_1T_2$
3		-	6	50	-	$P_1A_2T_1$
4		-	6	-	100	$P_1A_2T_2$
5	Passage 2 (P_2)	5	-	50	-	$P_2A_1T_1$
6		5	-	-	100	$P_2A_1T_2$
7		-	6	50	-	$P_2A_2T_1$
8		-	6	-	100	$P_2A_2T_2$
9	Passage 3 (P_3)		6	50	-	$P_3A_2T_1$
10			6		100	$P_3A_2T_2$

- Different yarn passage: P_1, P_2 and P_3
- Pre-opening jet J_1 and Main jet J_2
- Air pressure at $J_1 = A_0 = 1.5$ bar (constant)
- Air pressure at $J_2 = A_1 = 5$ bar

  $A_2 = 6$ bar
- Take-up speed $T_1 = 50$ m/min
- Take-up speed $T_2 = 100$ m/min

5.2.5 Testing of Commingled Yarn

In order to study the qualitative and quantitative effect of process parameters on various properties of the hybrid yarns, different samples of hybrid yarns have been made by commingling of glass and polypropylene filaments. The properties that have been studied are mechanical properties (tenacity, modulus), mingling characteristics (nip frequency, nip stability, nip regularity), and yarn structure (blending homogeneity and damage to filaments).

a) Tensile strength measurement

Tensile strength of yarn has been measured on Lloyd® Universal Machine as described in Chapter 3.

b) Commingling characteristic

1) Nip frequency

Nip frequency is measured in terms of number of nips formed per unit length of the commingled yarn (nips per meter), which is indication of interlacing density. The nip frequency is measured by microscopic examination method in which one-meter length of commingled hybrid yarn is kept under microscope and nips are counted manually. Ten tests are carried out for each sample and the average values are reported.

2) Nip stability

The nip frequency does not alone describe the extent of nips in commingled yarn; other parameters viz. nip stability and nip regularity is also important factors. The nip stability is determined in terms of number of nips/meter before and after applying, a certain load for a pre-decided time. It can also be determined by the number of cycles required to remove the nips by applying cyclic loads.Depending on its end use, the yarn is tensioned with 0.3 and 0.5 cN/dtex. The nip stability % is calculated by using the formula:

$$\text{Nip stability \%} = \frac{\text{Nips per unit length after applying load}}{\text{Basic Nips per unit length}} \times 100$$

3) Nip regularity (Nip uniformity)

In a hybrid yarn, the nip regularity can be evaluated by measuring the open lengths between two successive nips under microscope. The open length in yarn is measured randomly at different places. It is easy to distinguish various interlaced yarns with equal interlacing density by their nip regularity.

c) SEM (Scanning Electron Micrograph)

Scanning electron micrographs of various yarn samples have been obtained using SEM equipment described in Chapter 4.

5.3 RESULTS AND DISCUSSION

Various types of glass/polypropylene hybrid yarns have been prepared using three different yarn passages and evaluated for its characteristics viz. tenacity and modulus. The effects of processing parameters on mingling behaviour and blending homogeneity of these yarns have been studied. The average value of fifteen samples is recorded in Table 5.3.

The effects of processing parameters air pressure and take-up speed on glass/polypropylene yarn properties viz. tenacity and modulus using different yarn passages have been discussed. The comparative analysis done by using simple bar charts is also given in the following sections.

Table 5.3 Mechanical Characteristics of Hybrid Yarns at Various Process Parameter

Type of yarn path	Air pressure	Tenacity (N/mm^2)		Modulus (N/mm^2)	
		T_1 (50m/min)	T_2 (100m/min)	T_1 (50m/min)	T_2 (100m/min)
Passage 1 (P_1)	A_1 (5 bar)	883	784	40053	40707
	A_2 (6 bar)	807	683	34464	39195
Passage 2 (P_2)	A_1 (5 bar)	755	534	37034	37404
	A_2 (6 bar)	793	680	38048	39317
Passage 3 (P_3)	A (5 Bar)	743	-	36340	-

5.3.1- Effect of Processing Parameters on Tensile Properties

The tensile properties of hybrid yarns are influenced by nip characteristics and filament damage during the mingling process. The processing parameters viz. air pressure and take-up speed affects the tenacity and modulus of commingled hybrid yarns. Generally tenacity and modulus are expressed in $gf.tex^{-1}$ or $gf.den^{-1}$. In this case, the tensile test machine is interfaced with computer, hence the tenacity and modulus values are obtained directly from the tensile test output in terms of N/mm^2. The specification of each yarn sample viz. yarn diameter in mm is given as input before the test. The average values of tenacity and modulus have been used for the comparative analysis.

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a) Tenacity

The tenacity of commingled yarn processed at air pressure of 5 bar and 6 bar using two different take-up speeds have been compared in Fig. 5.7(a) and Fig. 5.7 (b). The effect of two level of air pressure viz. 5 bar and 6 bar on hybrid yarn tenacity shows less significant for Passage 1 and Passage 2. The results of hybrid yarn that have been obtained in case of yarns produced using Passage 2 with the same air pressure and take-up speed, shows lower tenacity value compared to that of Passage 1. This shows that the yarn path also affects the final yarn characteristics inspite of having the same process parameters. Also at higher air pressure for the Passage 1 and Passage 2, there is not much change in tenacity values at take-up speed of 50m/min and 100m/min respectively.

It is clearly seen from Fig. 5.7(a) that yarn tenacity is higher at lower take-up speed due to better mingling of filament. At low take-up speed, breakage of filament is less, so the effective number of filaments in yarn cross-section are more, which shows the improvement in yarn strength for Passage 1. Tenacity is increased 14% in case of Passage 1 and 40% in case of Passage 2 at take-up speed of 50m/min as compared to that of 100m/min. Therefore, at higher

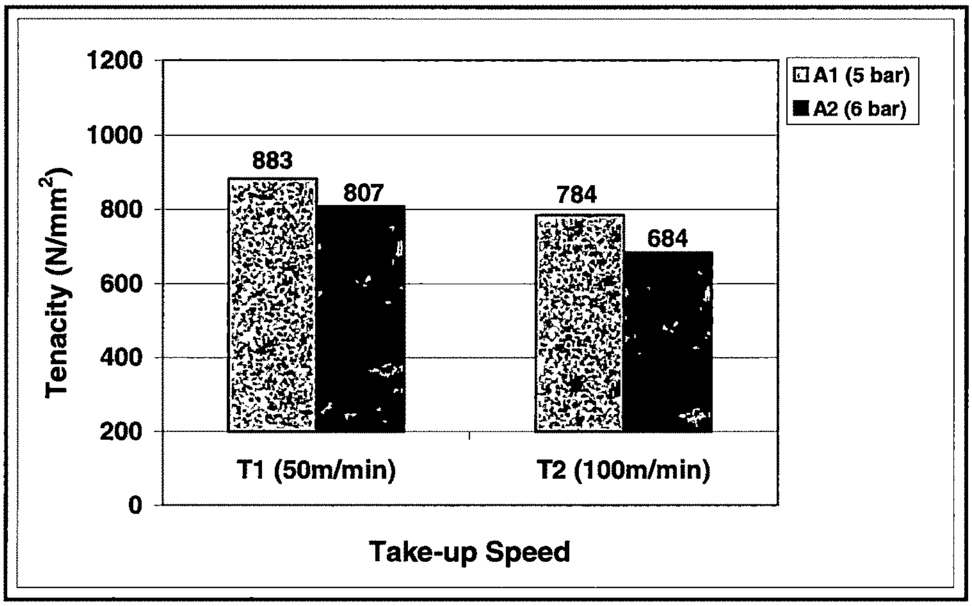

Fig. 5.7(a) Effect of air pressure and take-up speed on tenacity of hybrid yarn (Passage 1)

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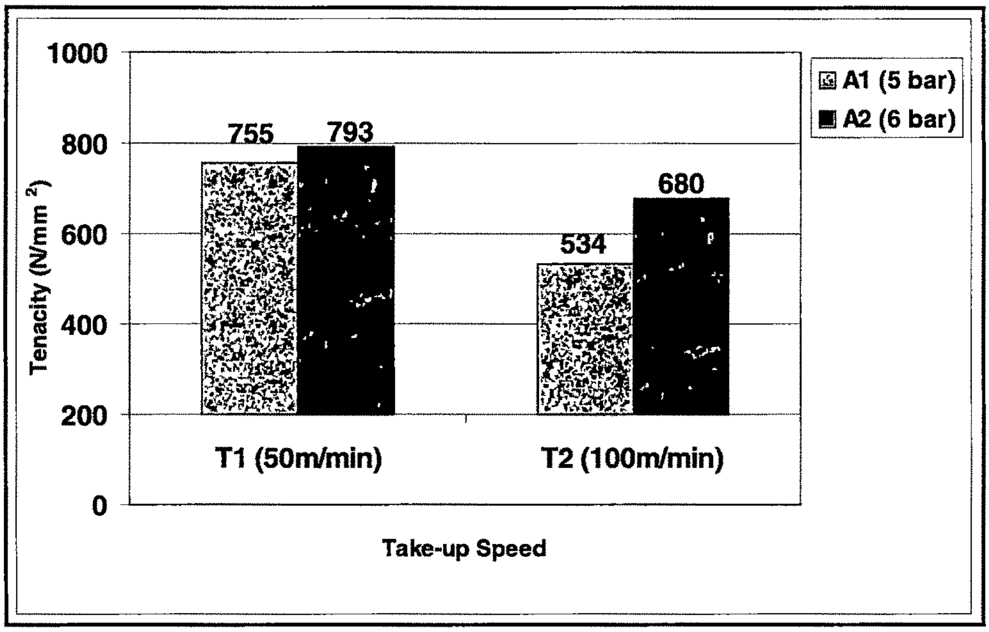

Fig. 5.7 (b) Effect of air pressure and take-up speed on tenacity of hybrid yarn (Passage 2)

air pressure and lower take-up speed, yarn obtained is stronger as compared to that of lower air pressure and higher take-up speed. There is significant drop in yarn tenacity value at higher take-up speed, which may be due to more filament breakages observed during the experiments.

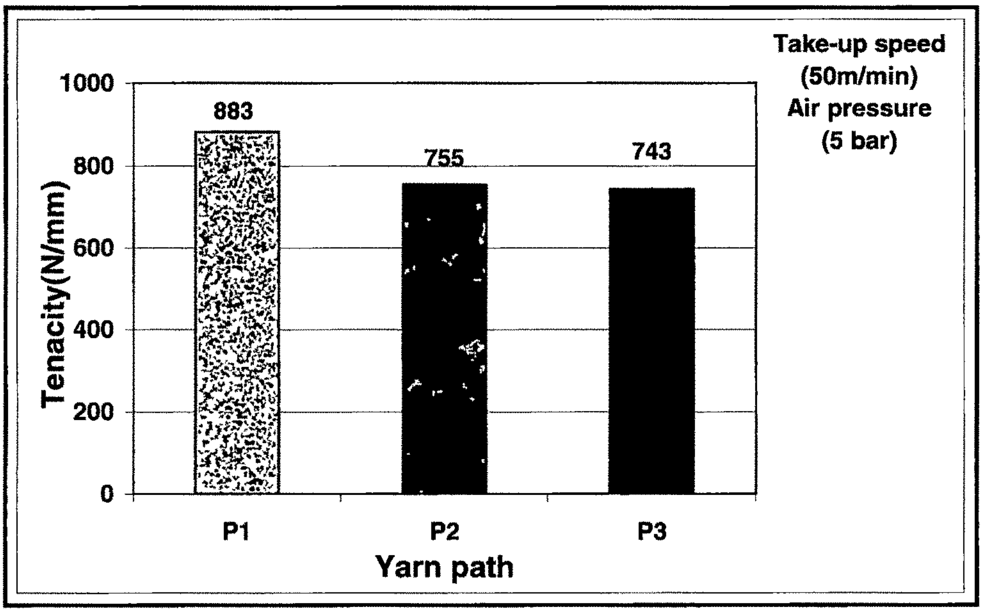

Fig. 5.7 (c) Effect of yarn passages on tenacity of hybrid yarn

The comparative analysis of all three passages are done at air pressure of 5 bar and take-up speed of 50 m/min, as the effect of air pressure on hybrid yarn properties are very prominent at 6 bar. Fig. 5.7(c) shows that in case of Passage 1 and Passage 3, tenacity is higher due to less filament breakages; while in Passage 2 there is a significant lower value of tenacity, which means greater filament damage.

b) Modulus

Modulus is a measure of toughness of the product. In hybrid yarns the reinforcing component, decides the performance of hybrid yarn in final composite. Hence, the modulus of hybrid yarns is one of the important mechanical properties. A table 5.4 shows comparative value of hybrid yarn modulus, at different air pressures and take-up speeds.

Fig. 5.8(a) clearly shows that in case of Passage 1, with increase in the air pressure from 5 bar to 6 bar, there is a significant decrease in yarn modulus; but no such change in modulus is observed with increase in take-up speed. Fig. 5.8 (b) shows that with an increase in air pressure from 5 bar to 6 bar, there is marginal increase in modulus. Hence, there is no considerable effect of take-up speed on modulus especially at take-up speed of 50 m/min.

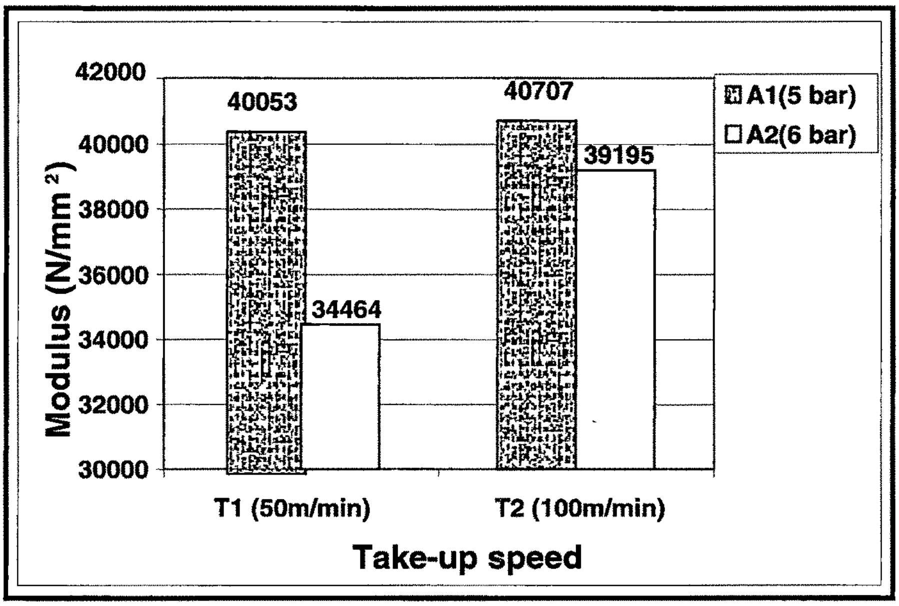

Fig. 5.8 (a) Effect of air pressure and take-up speed on modulus of hybrid yarn (Passage 1)

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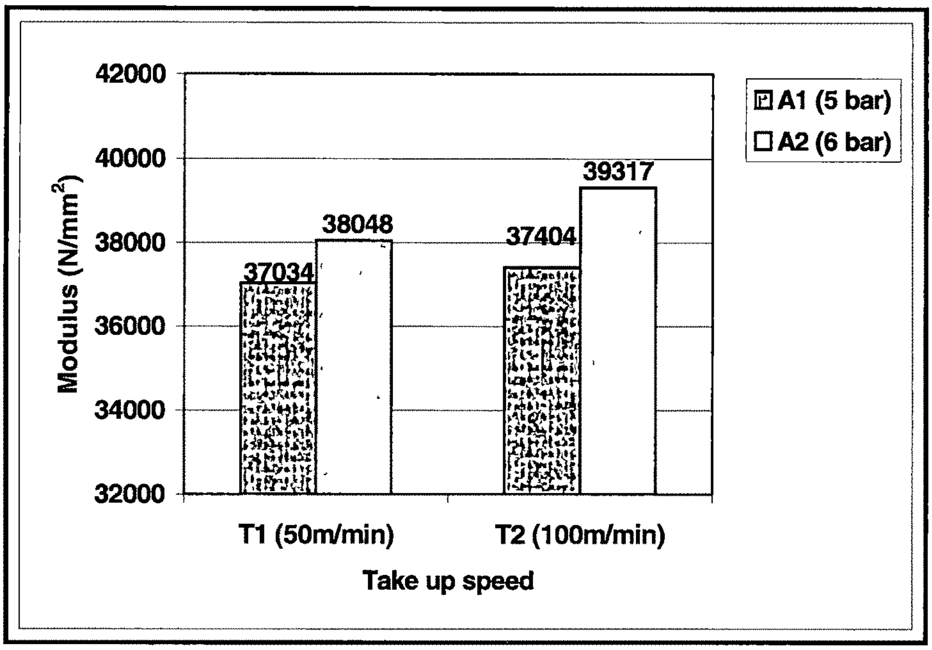

Fig. 5.8(b) Effect of air pressure and take-up speed on modulus of hybrid yarn (Passage 2)

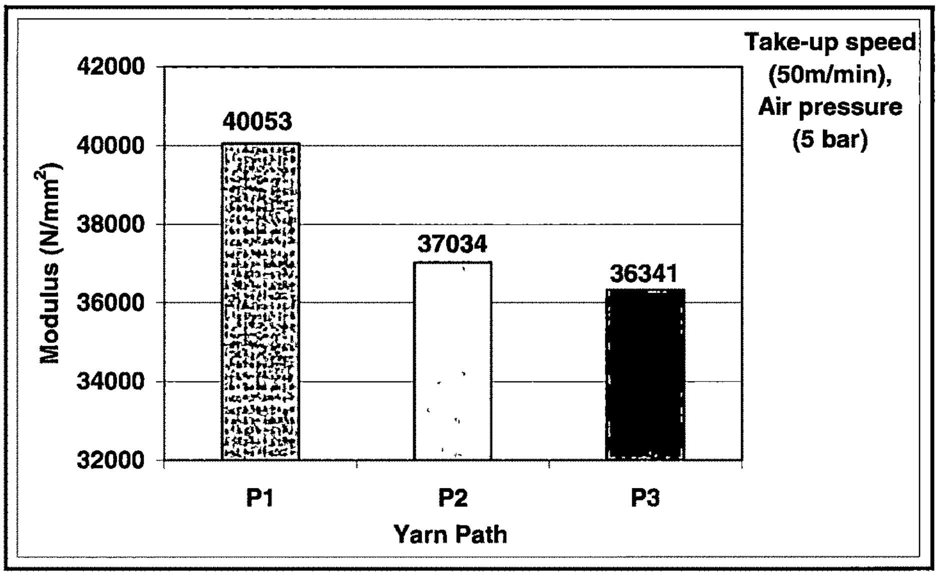

Fig.5.8(c) Effect of yarn path on modulus of hybrid yarn

Fig. 5.8(c) shows the effect of yarn path on modulus. In case of Passage 1, yarn shows much higher modulus. There is lower modulus in case of Passage 2 and Passage 3, due to effect of filament breakage at the pre-opening stage. It is observed that when glass and a strand of polypropylene filament are pre-opened at Passage 1, the filament breakages are less due to the combine yarn effect. However, in Passage 2 only glass filaments are pre-opened, which gives higher filament breakages at the initial stage and further effect is dominated at high pressure. It is observed during the experiment that the Passage 3 does not show proper mingling performance and gives poor mechanical properties and improper mingling with high breakages.

5.3.2 Effect of Processing Parameters on Mingling Characteristics of Hybrid Yarn

The main aim of commingling process is to give proper binding of matrix filament and reinforcing filament with homogeneous mixing. Nip formation of glass with polypropylene is difficult due to difference in their stiffness and bending properties. However, there are possibilities of nip formation by selecting proper combination of processing parameters. Mingling behaviour of various hybrid yarn samples using different yarn paths has been evaluated in terms of nip frequency, nip stability and nip length. Results obtained from various nipping characteristics have been analysed and the average values are given in Table 5.4.

Table 5 4 Mingling Characteristics of Hybrid Yarns Produced Using Various Parameters

Type of yarn path	**Air pressure**	**Nip frequency (Nips/meter)**		**Nip stability (%)**		**Nips regularity (cm)**	
		T_1 (50m/min)	**T_2 (100m/min)**	**T_1 (50m/min)**	**T_2 (100m/min)**	**T_1 (50m/min)**	**T_2 (100m/min)**
Passage 1 (P_1)	A_1 (5 bar)	31 9	17.9	69 0	59.2	0.95	1.07
	A_2 (6 bar)	33.1	22 2	77 8	64 1	1.22	1.24
Passage 2 (P_2)	A_1 (5 bar)	30.3	23 9	76.6	60 4	1.13	1 64
	A_2 (6 bar)	44 4	23.7	85 9	73 7	1.03	1 11
Passage3 (P_3)	A_1 (5 bar)	28.8	-	74.0	-	1 13	-

The test results show that various nipping properties viz. nip frequency, nip stability and nip regularity are significantly affected by take-up speeds and air pressure used during the process. The effect of air pressure and take-up speed on various nip characteristics have been discussed in detail in this section.

a) Nip frequency

The effect of air pressure on nip frequency in case of different yarn passages have been given in Fig. 5.9(a), Fig. 5.9(b), Fig. 5.9(c). The Fig 5.9(a) clearly indicates that at high pressure the nip frequency value and filament breakages increases. There is a significant effect of take-up speed on nip frequency. At low take-up speed the filament gets more time in the jet, which gives better and higher number of nip formations. The higher take-up speed (100 m/min) decreases the nip frequency as in case of Passage1. Similar trend is observed for Passage 2 at 6 bar air pressure and 50m/min take-up speed, which gives higher nip frequency with higher stability(Fig.5.9 (b)).

The maximum possible take-up speed upto 250 m/min can be achived using highly sophisticated machine set up. There is no considerable effect of yarn path on nip frequency as shown in the Fig. 5.9 (c). However, Passage 1 gives maximum nip frequency in the yarn at same take-up speed and air pressure, but stability of yarn is more in Passage 2 (discussed in next section).

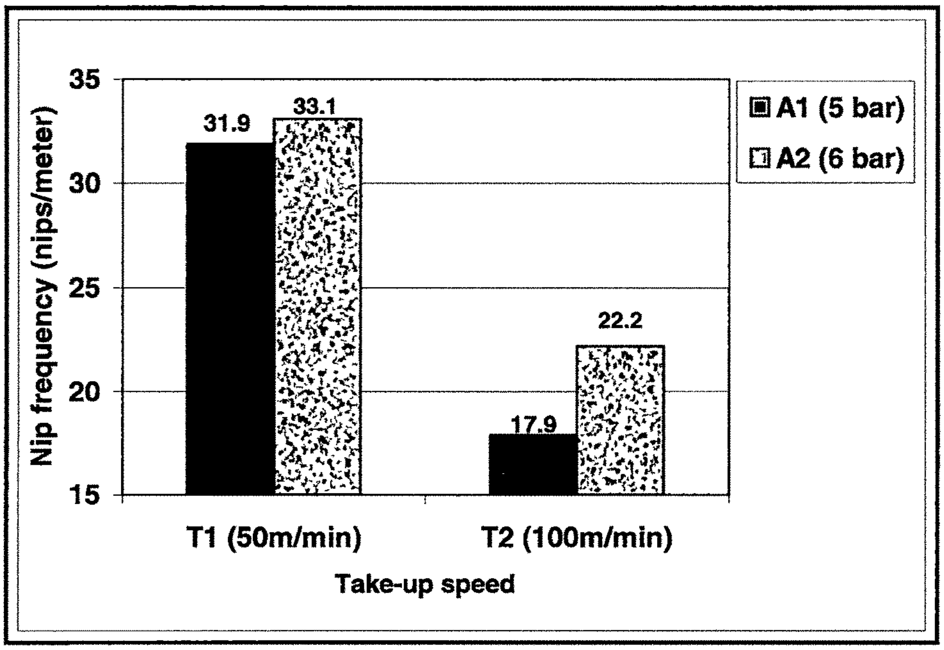

Fig. 5.9 (a) Effect of air pressure and take-up speed on nip frequency of hybrid yarn (Passage 1)

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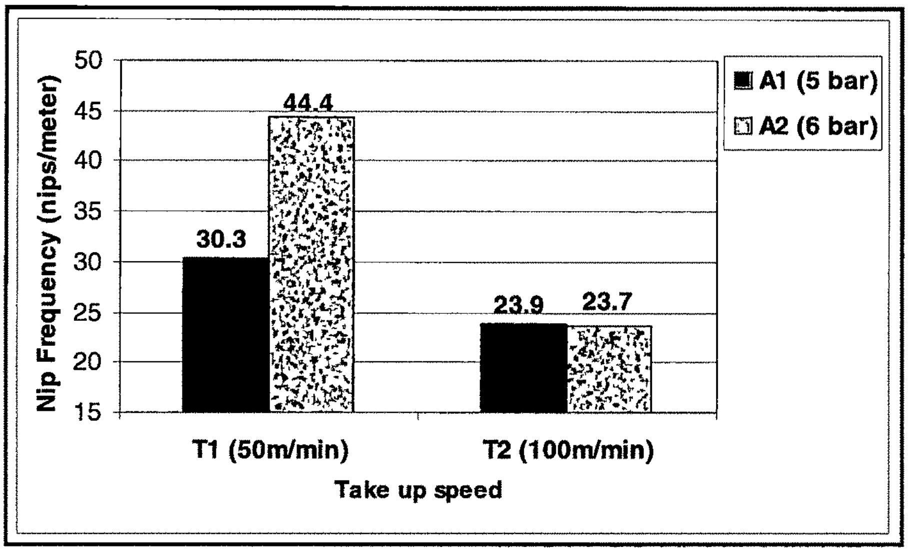

Fig. 5.9 (b) Effect of air pressure and take-up speed on nip frequency of hybrid yarn (Passage 2)

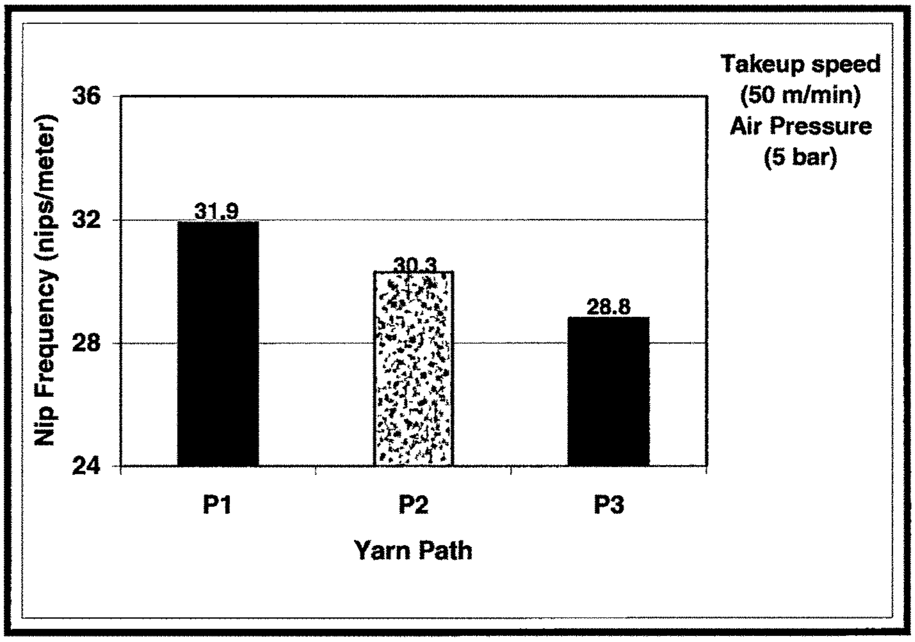

Fig. 5.9(c) Effect of yarn path on nip frequency of hybrid yarn

b) Nip stability

The nip stability is the measure of number of loops that remains in hybrid yarn after application of load. The higher nip stability value gives better performance of hybrid yarn in actual application. Both air pressure and take-up speed alter the nip stability considerably.

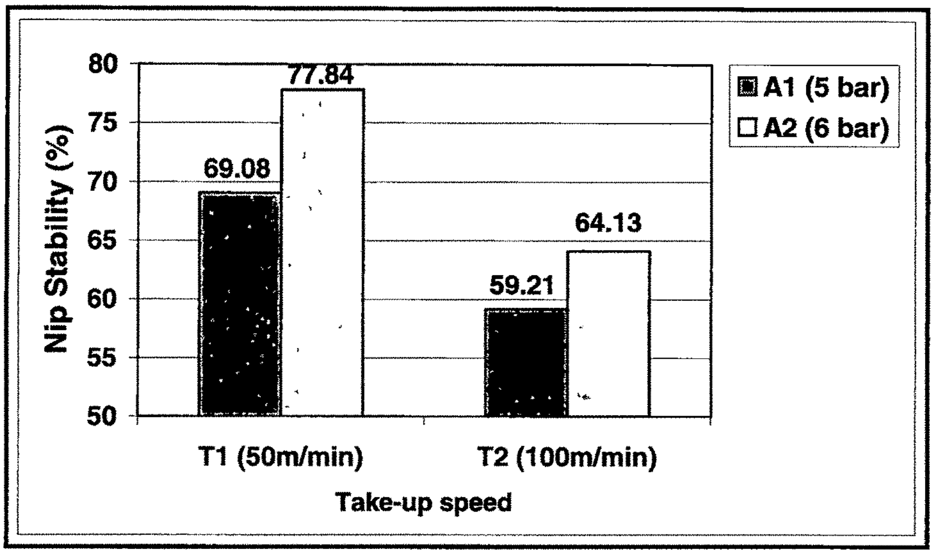

Fig. 5.10 (a) Effect of air pressure and take-up speed on nip stability of hybrid yarn (Passage 1)

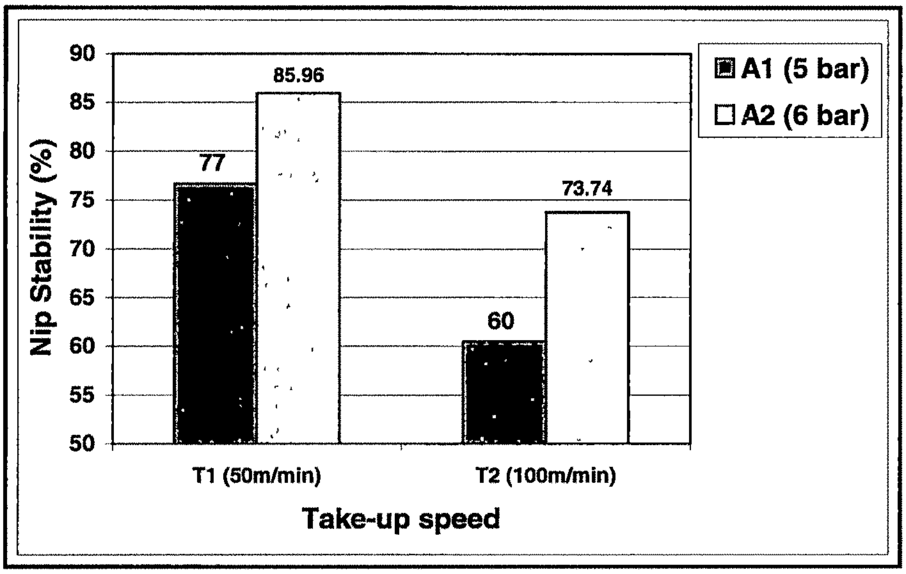

Fig.5.10 (b) Effect of air pressures and take-up speed on nip stability of hybrid yarn (Passage 2)

Fig. 5.10(a) and Fig. 5.10(b) show that with increase in air pressure, the nip stability of yarn increases due to better mingling of yarn at higher pressure. The nip stability decreases with change in take-up speed from 50 m/min to 100 m/min, due to less time available for mingling of yarn.

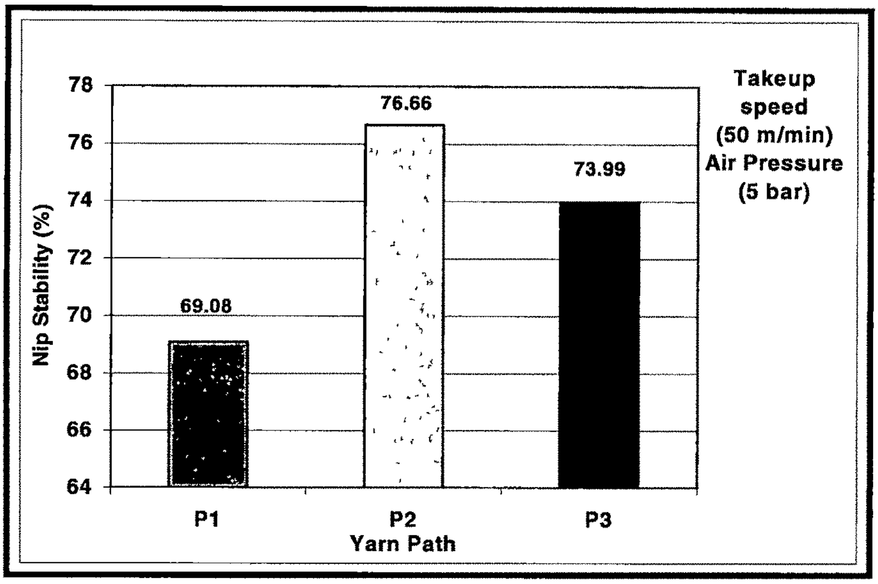

Fig. 5.10 (c) Effect of yarn path on nip stability of hybrid yarn

Similar trend is observed for Passage1 and Passage 2; but Passage 2 gives higher value of nip frequency and nip stability. Yarn path affects nip stability. The yarn produced using Passage 2 shows higher nip stability compared to other two yarn paths. The reason may be that there is better nip formation as pre-opening has been given only to glass filament. The nip stability values show similar trend as nip frequency, but nip stability values are greatly affected by yarn path. A yarn produced using Passage 2 gives greater nip stability value.

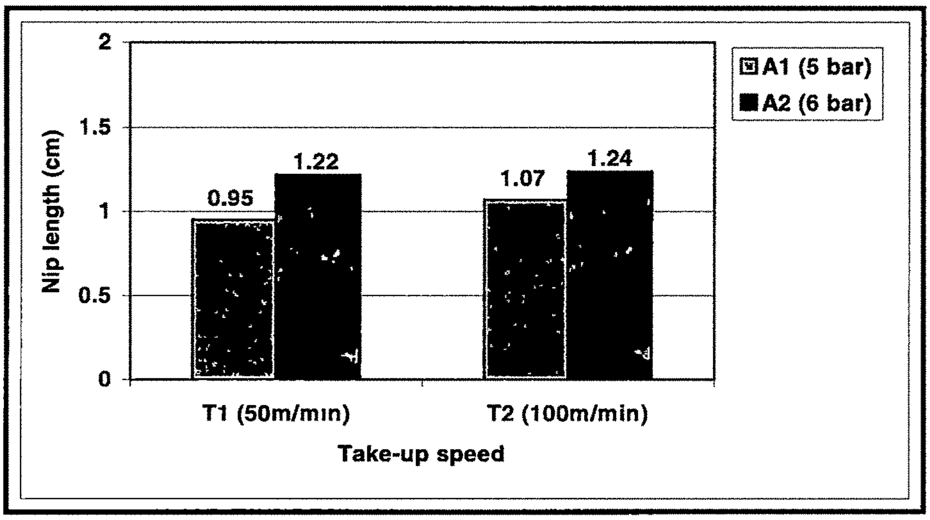

Fig. 5.11(a) Effect of air pressure and take-up speed on nip length of hybrid yarn (Passage 1)

c) Nip regularity

Nip regularity is the measure of degree of opening length in mingled yarn. The openings of nips depend on air pressure and take-up speed during process. Fig.5.11(a) and Fig.5.11(b) shows length of opening in commingled hybrid yarn. It clearly indicates that at higher pressure (6 bar) opening length of nip is more in Passage1. Similar trend has been observed for Passage 2. At low pressure the nip length is more, but the difference is not significant between changes in air pressure from 5 bar to 6 bar.

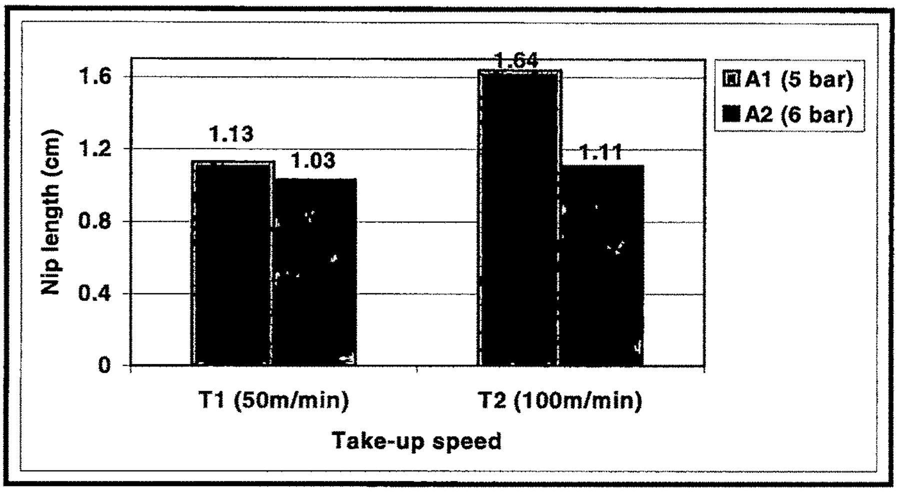

Fig. 5.11 (b) Effect of air pressure and take-up speed on nip length of hybrid yarn (Passage 2)

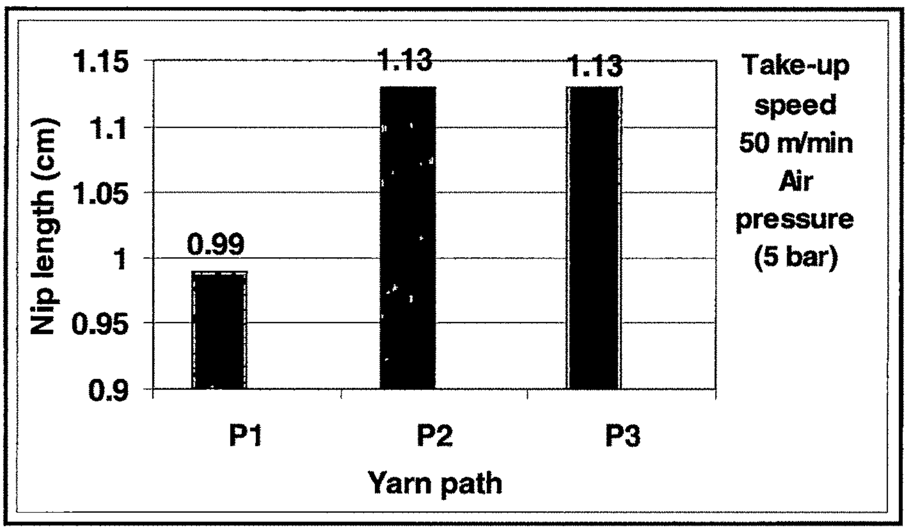

Fig. 5.11 (c) Effect of yarn path on nip length of hybrid yarn

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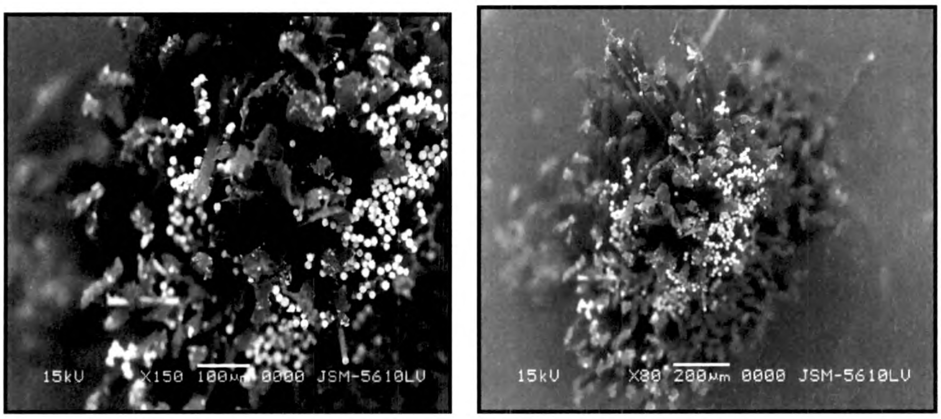
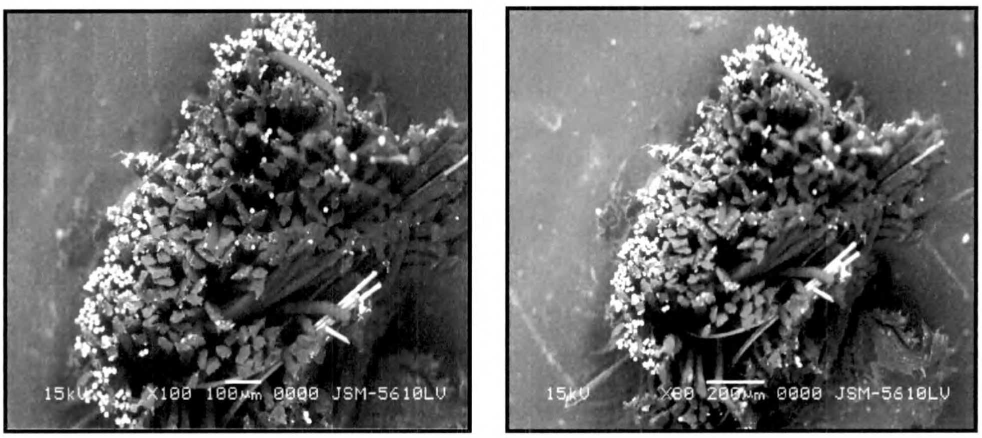
5.3.3 Effect of Different Yarn Passage and Processing Parameter on Blending Homogeneity of Hybrid Yarn

The blending homogeneity of glass/polypropylene hybrid yarn has been studied with Scanning Electron Micrograph. The cross sectional views of various hybrid yarns have been taken using SEM. The micrographs of selected yarn samples are shown in Fig. 5.12(a)-Fig. 5.12(e). In all micrographs, as bright filaments are glass and dull filaments are polypropylene, it is easy to distinguish them from each other. Also the diameter of glass filaments is smaller than polypropylene filaments.



(i) (ii)

Fig. 5.12(a) SEM of hybrid yarn sample: Passage 1 (100 m/min, 6 bar)



(i) (ii)

Fig. 5.12(b) SEM of hybrid yarn: Passage 3 (50 m/min, 6bar)

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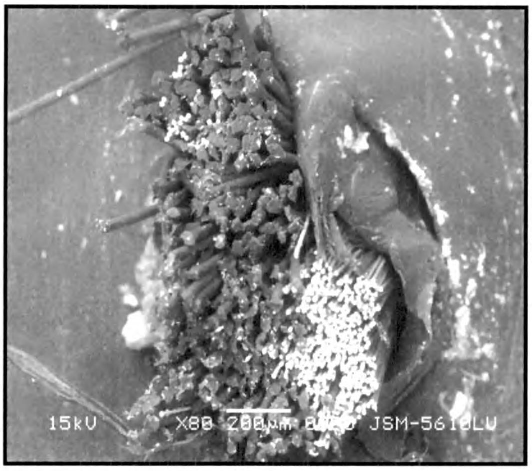

Fig. 5.12(c) SEM of hybrid yarn: Passage 2 (50 m/min, 6 bar)

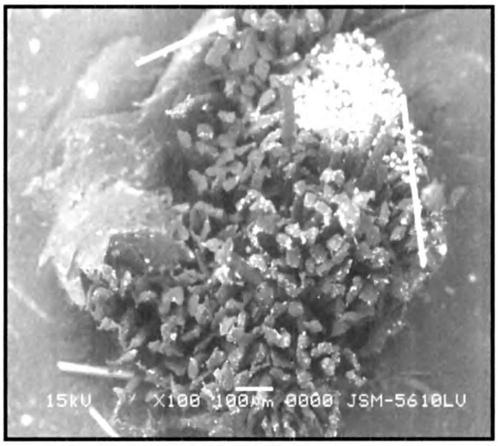

Fig. 5.12(d) SEM of hybrid yarn: Passage 1 (50m/min, 6bar)

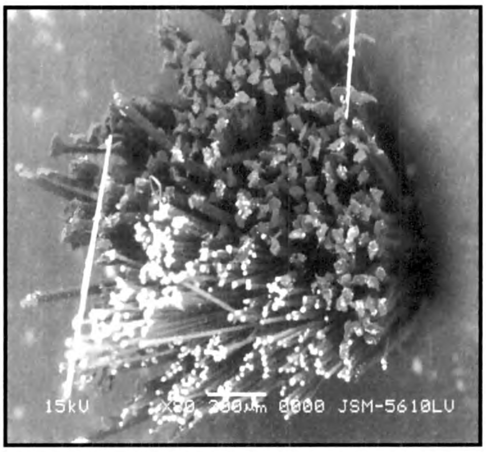

Fig. 5.12(e) SEM of hybrid yarn: Passage 2 (50m/min, 6 bar)

Fig. 3.12(a) shows fibre distribution in cross section of the yarn produced at 6 bar air pressure and 100 m/min take-up speed using Passage 1. It reveals very prominent distribution of glass filaments over cross section of yarn. The polypropylene filaments are seen to be interlacing with glass filaments in the core. The reason may be that in a pre-opening jet, glass and one thread of polypropylene has been passed through Jet 1 where they mix properly. Fig. 5.12(b) shows the cross sectional view of yarn produced by Passage 3 at the take-up speed 50m/min and 5bar pressure. Due to negligible opening of glass filament they are grouped on one side of yarn cross section. The reason is that, at very high pressure and lower take-up speed the glass filament may get damaged due to high air pressure. The similar effect is observed in yarn produced at take-up speed of 50m/min and air pressure of 5 bar using Passage 2. Fig. 5.12(c), Fig. 5.12(d) and Fig. 5.12(e) shows the cross sectional view of yarn samples through Passage 1 and Passage 2 at 50m/min take-up speed and air pressure at 5 bar.

SEM analysis of cross sectional view of these yarns, shows that the yarn produced using Passage 1 and Passage 3 gives better opening of glass filament and also certain level of distribution over the cross section of yarn. This may be due to pre-opening of glass and polypropylene at pre-opening jet. The homogeneity is found to be poor in some of the samples. Proper opening at pre-opening jet can improve the distribution of glass filament across the yarn section. The denier per filament in case of glass should be low for proper blending of both types of filaments.

5.4 CONCLUSIONS

The following conclusions can be made from the work carried out on commingling of glass/polypropylene commingled hybrid yarns

1. The study shows that there is a high potential for commingling technique in manufacturing of filament hybrid yarn.
2. It is difficult to mingle reinforcing and matrix filaments at lower pressure. In case of glass/polypropylene hybrid yarn, the mingling behaviour can be improved using air pressure of higher than 6 bar.
3. The hybrid yarn produced using pre-opening of glass and polypropylene shows higher tenacity value at lower air pressure and lower take-up speed. At higher pressure, the tenacity drops considerably, while in case

of pre-opening of only glass filaments, with the increase in air pressure, tenacity increases.

4. Hybrid yarn produced with pre-opening of glass and polypropylene filament shows better nip frequency. There is no significant effect of air pressure on nip frequency, but take-up speed significantly influence the nip frequency of yarn. Similar effect of air pressure and take-up speed is observed in case of nip stability, where with an increase in air pressure nip stability increases.
5. At higher take-up speed nip length increase but there is no significant effect of yarn path on nip regularity. However, hybrid yarn produced using single jet shows better nip regularity at higher air pressure.
6. Hybrid yarn produced using pre-opening of both glass and polypropylene filaments shows good distribution of glass filament across the yarn cross section at lower air pressure and higher take-up speed.
7. The glass filaments need polished yarn guides or ceramic guides and proper handling during processing.
8. The yarn path through the machine should be as straight as possible with minimum bending of the yarn to avoid breakage of the glass filaments.
9. The mingling jet should have proper core diameter according to the denier of the resultant hybrid yarn required.

5.5 FABRICATION OF COMMINGLING MACHINE

Based on above study the commingling machine is modified to produce hybrid yarn. The following changes are incorporated and the machine is fabricated at Bhargesh Industry at Surat. Some of the features of the modified commingling machine are:

- Single machine with two different processes
- Positive feeding arrangement for two strand of yarns
- One feed roller with overfeed arrangement
- Simple threading through machine to minimize fiber damage
- Polished roller surface with rubber cover and ceramic guides

- Inverter drive for commingling unit and Individual drive for hollow spindle unit
- Machine can run upto 150m/min for commingling hybrid yarns but for other yarns it can go upto 800m/min.
- Overfeed adjustment upto 4%

Fig.5.13(a) shows the details of commingling machine having two process units viz. commingling unit and hollow spindle wrapping unit for producing hybrid yarns, using two different techniques, with a single machine. The main sections of this commingling unit are:

1) Creel
2) Feed roller
3) Overfeed roller
4) Attachment of jet with jet insert, pressure gauge and pipes
5) Output roller
6) Take-up unit
7) Inverter

In commingling process, three processing parameters viz. air pressure, overfeed and take-up speed are important to decide the characteristics of hybrid yarn. In this machine, air pressure can be controlled by pressure gauge, overfeed by changing surface speed of overfeed roller and take-up speed by using inverter.

Fig. 5.13(b) shows the details of drive to the different parts of commingling unit. To drive the commingling unit, 3 phase AC motor with 1420 rpm is installed and the further drive to feed roller, overfeed roller, output roller and winding drum is transmitted by belt and pulley drives (see photo of Driving unit). The 3-phase AC inverter is installed to regulate the machine speed (see photo of Inverter drive).

Fig. 5.13(c) shows the hollow spindle unit is attached with commingling unit. The individual motor drive is installed to drive the hollow spindle unit (see photo of hollow spindle unit).

Fig. 5.14(a)-Fig. 5.14(e) photographs shows the stages of fabrication of machine, different parts installed along with drive and attachments. The machine is fabricated and for further experimental work, to investigate the effect of processing parameters on hybrid yarn.

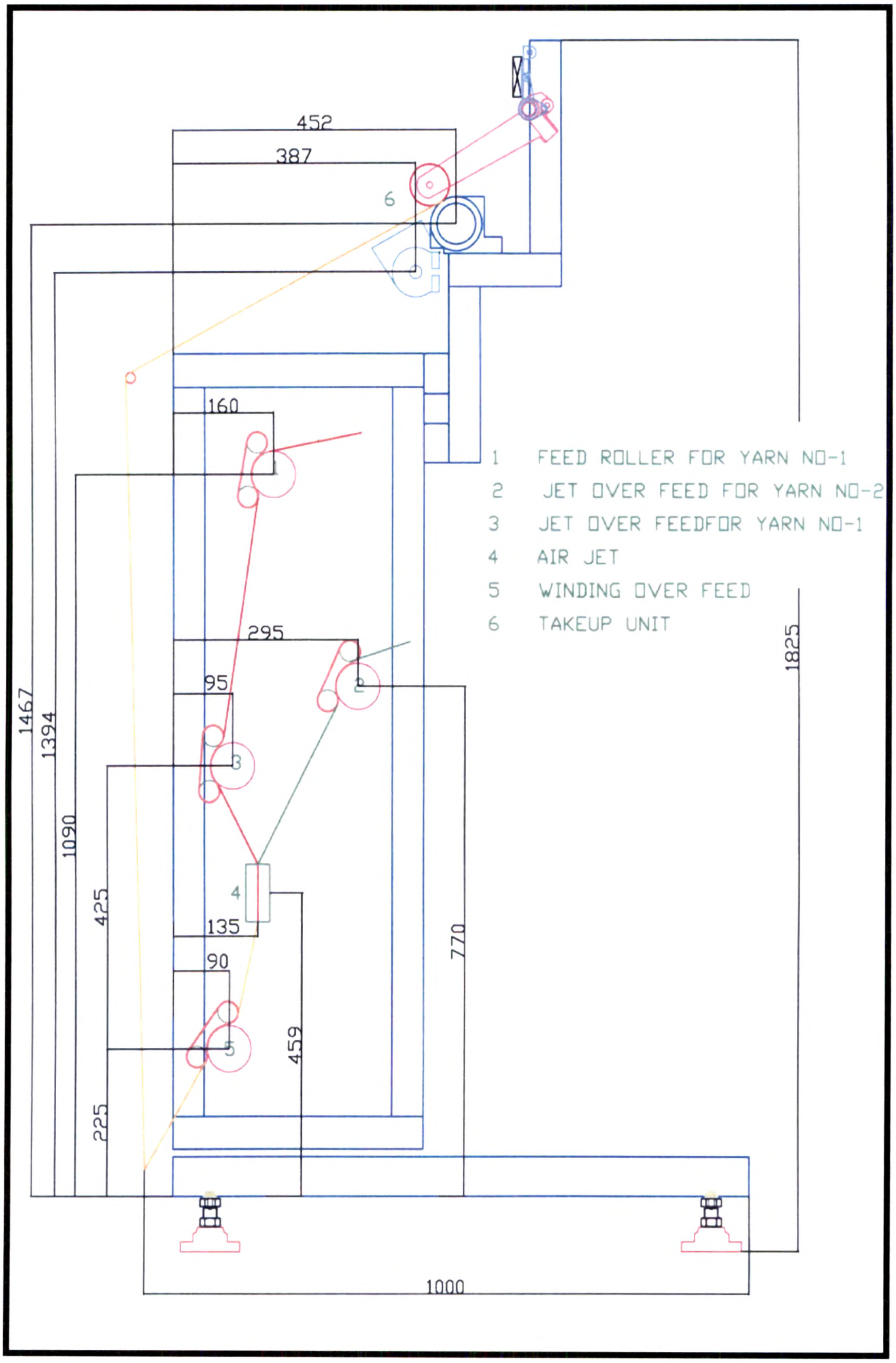

Fig. 5.13(a) Schematic diagram of commingling machine

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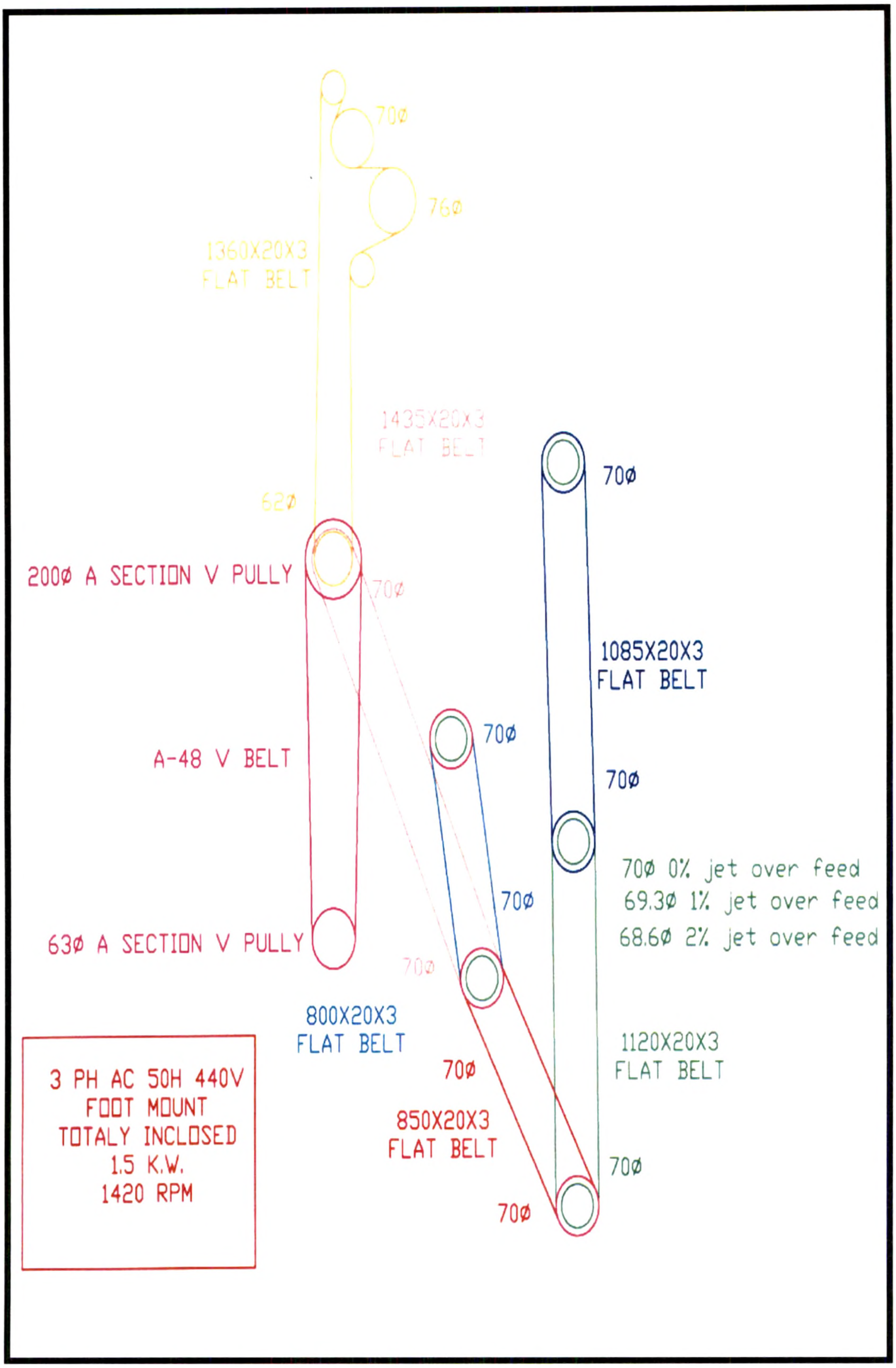

Fig. 5.13(b) Details of driving unit

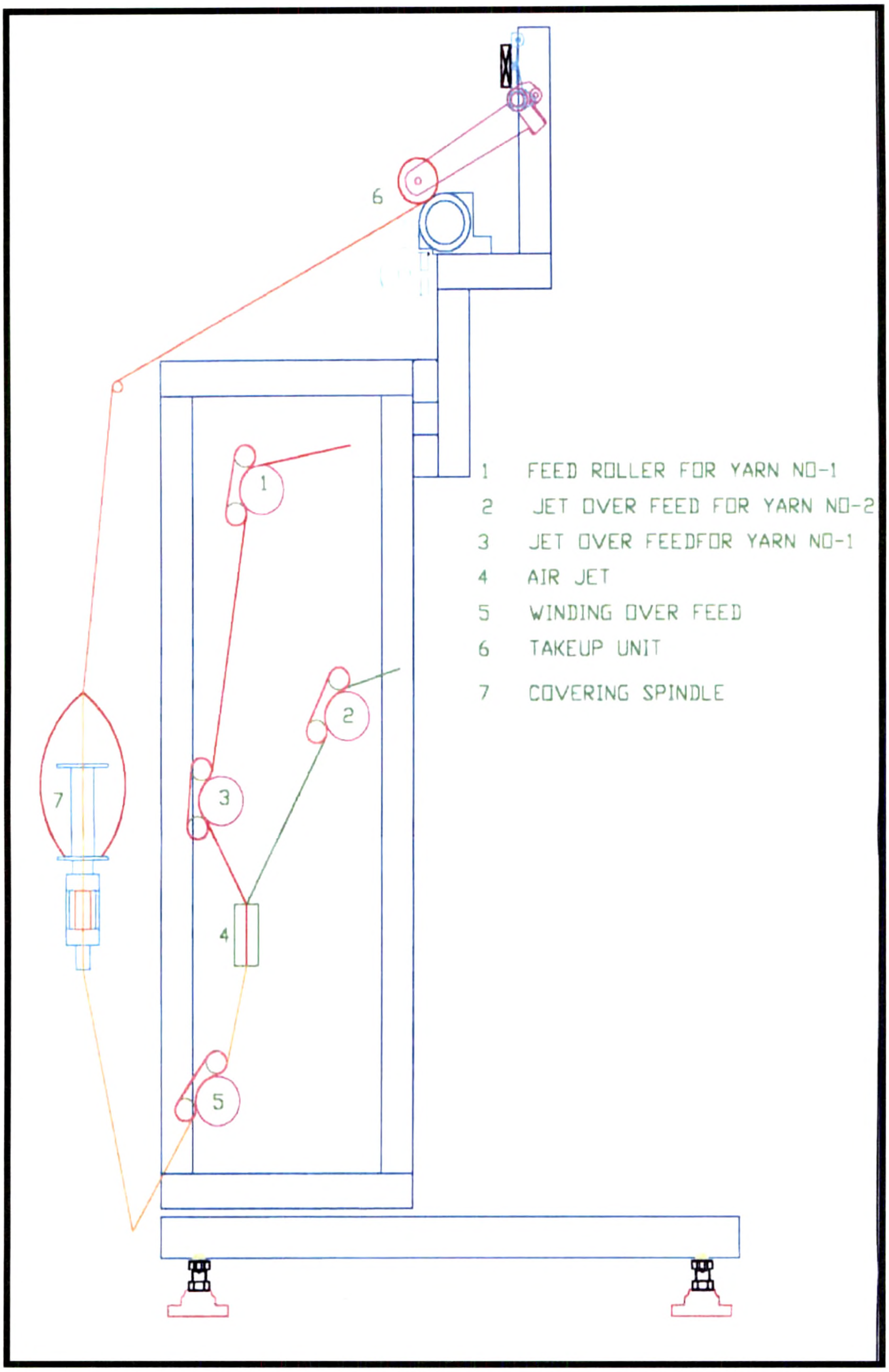

Fig 5.13(c) Commingling machine with hollow spindle unit

Fig. 5.14 (a) Frame Work

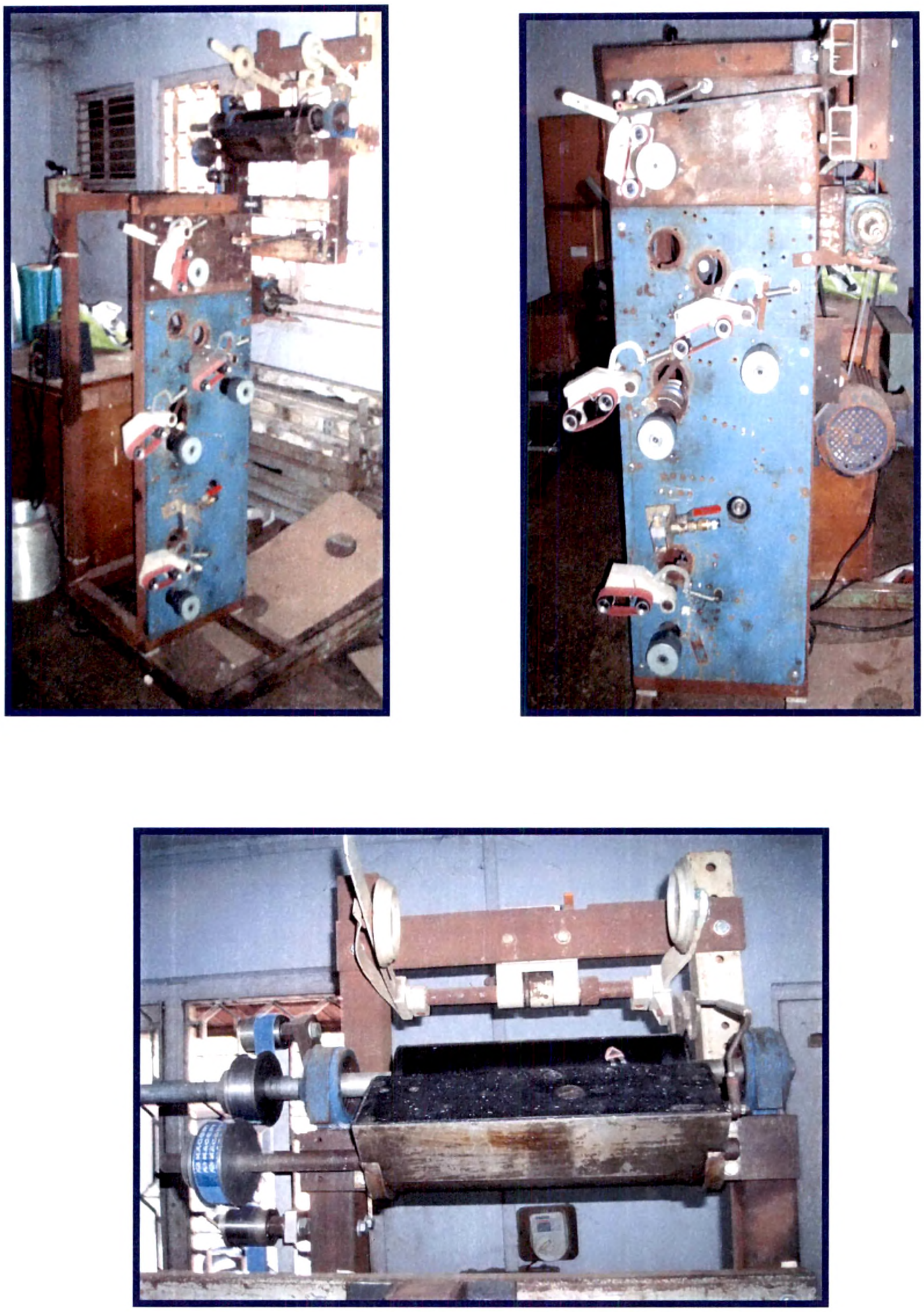

Fig. 5.14(b) Assembling

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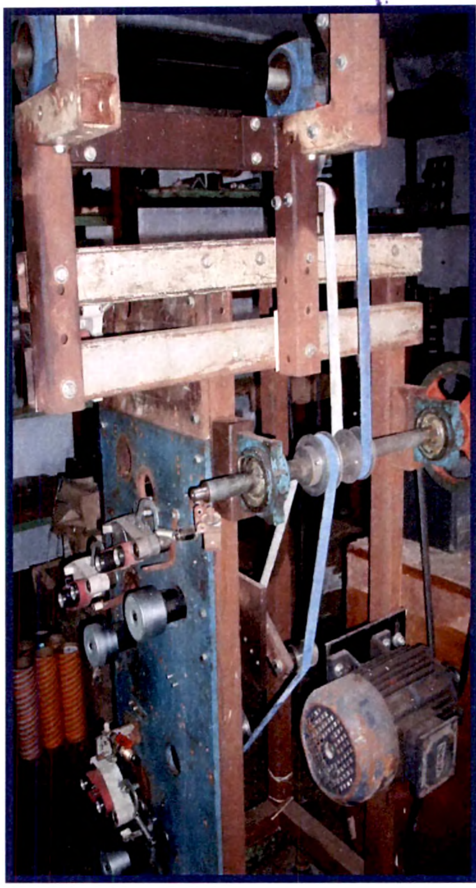

Fig. 5.14(c) Inverter Drive

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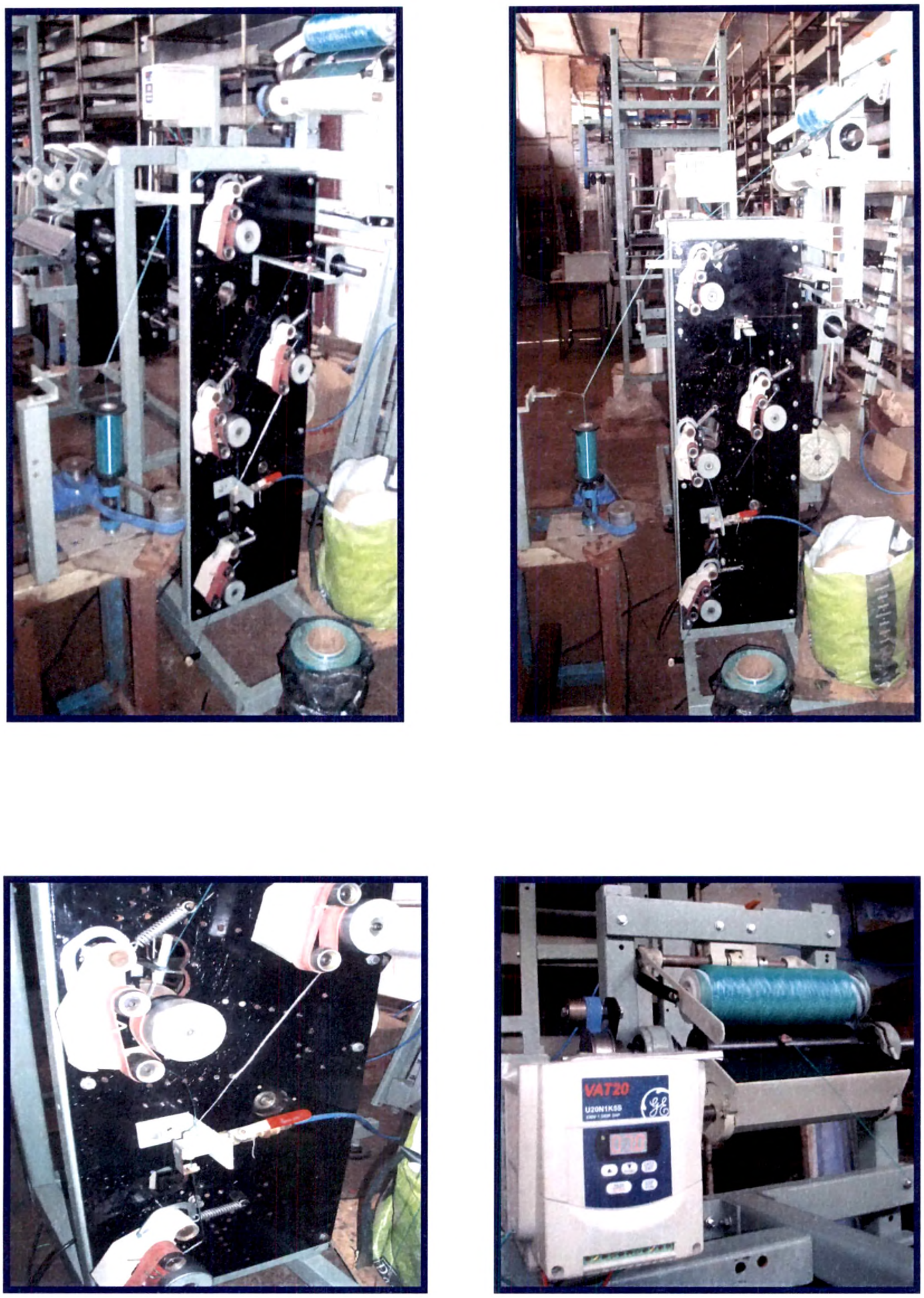


Fig. 5.14(d) Final Finishing

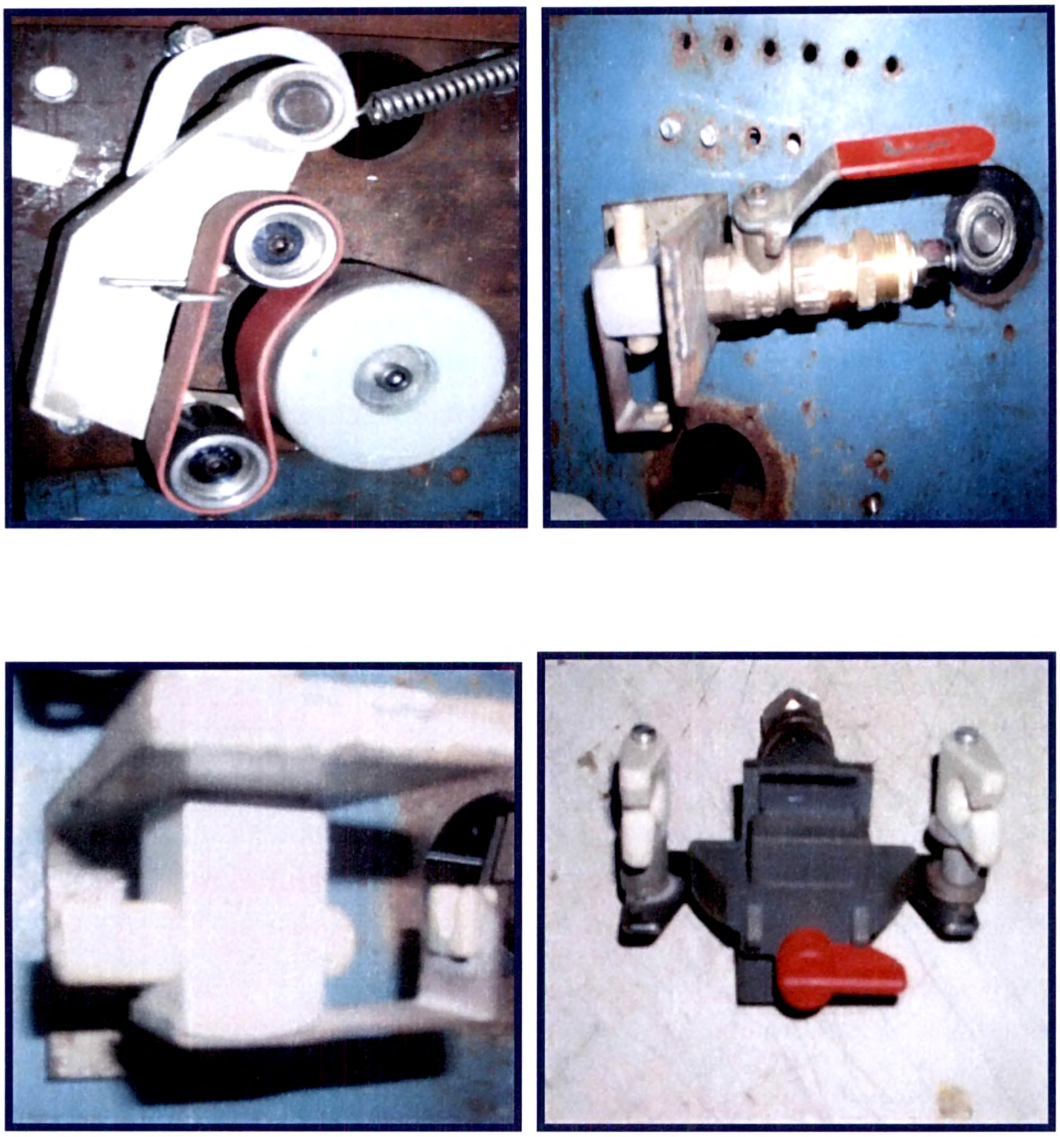
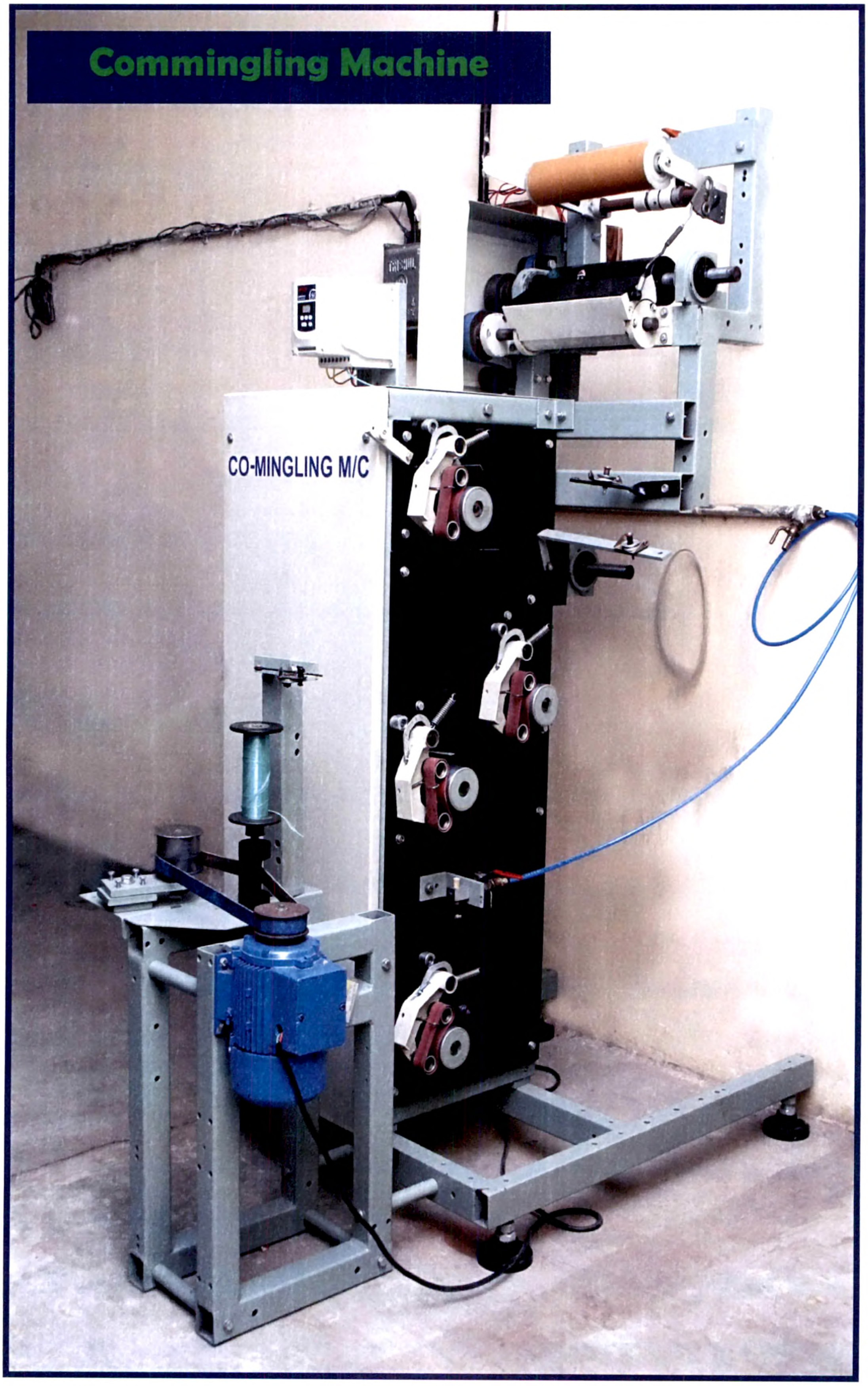


Fig. 5.14(e) Attachments



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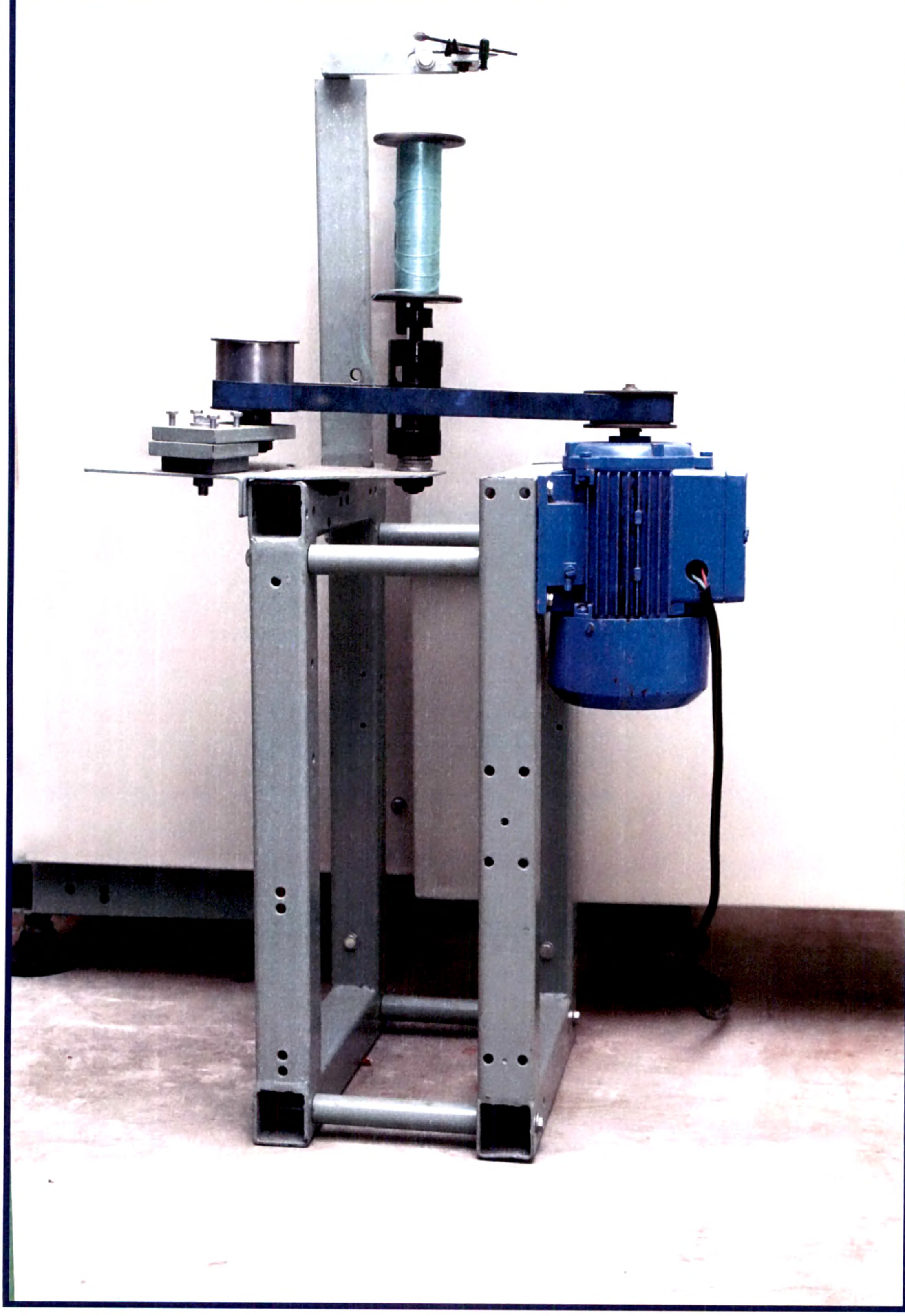
Hollow Spindle Unit



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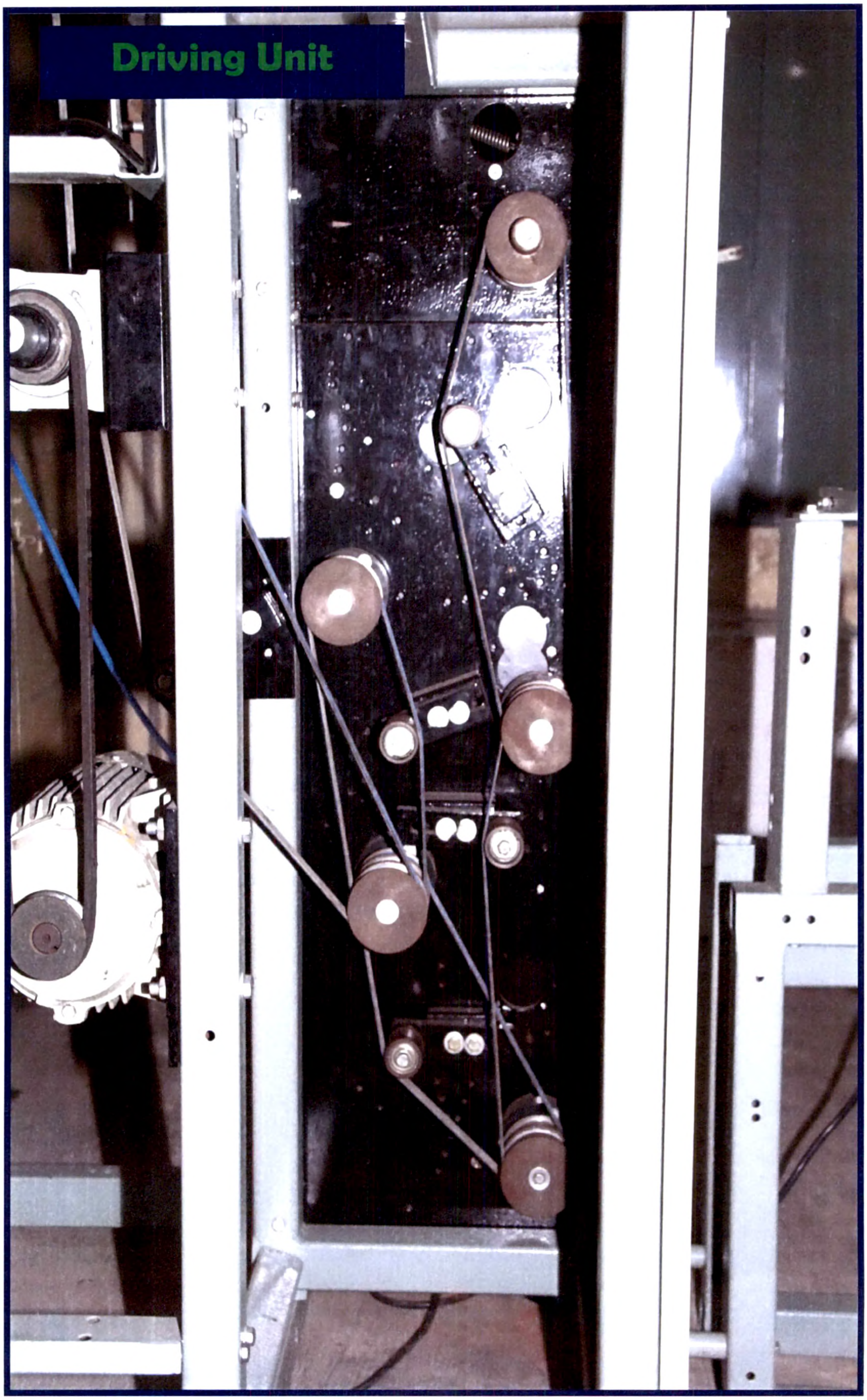

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