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Bei unserem Beispiel mit einer stündlichen Produktion von 800 – 1000 kg Faserband bedeutet das den Einwurf von vier bis fünf neuen Faserballen in der Stunde. Bei Naturfasern, wie Baumwolle, können die Fasercharakteristiken, wie Feinheit und Bauschigkeit, von Balle zu Balle mehr oder weniger grossen Abweichungen unterworfen sein. Die in die Anlage einlaufende Mischung kann dann von ihrer vorgeschriebenen Zusammensetzung abweichen, wodurch sich das spezifische Gewicht des Faserbandes leicht verändert. Da diese Regulierung – wie jede andere – auf konstantes Volumen reguliert, würde ein entsprechendes Abwandern des Laufmetergewichtes des Faserbandes die Folge sein.

Um diese Störgrössen wirksam auszuschalten, erfolgt am Austritt der Regulierstrecke eine gravimetrische Endkontrolle. Jede der durch den automatischen Kannenwechsler ausgestossenen Kannen, mit einem Inhalt von ca. 20 kg Faserband, gerät auf eine mechanisch arbeitende Waage, *Servo-Monitor* genannt. Selbstredend sind alle Spinnkannen auf gleiches Leergewicht tariert (Abb. 5).

Das durch die Waage angezeigte Nettogewicht ist auf einer Skala direkt ablesbar und wird gleichzeitig über ein leichtgängiges Potentiometer in eine proportionale Spannung umgewandelt, welche einerseits einen Punktdrucker aussteuert und anderseits mittels Messzeitgeber, Schwellwertschalter, Plus/minus-Schaltstufe auf die impulsgesteuerte Sollwertverstellung des Messorgans einwirkt.

Ansprechgrenze und äussere Toleranzgrenzen lassen sich nach Wunsch einstellen. Werden letztere überschritten, stellt die Anlage ab.

Wie die manuelle Verstellung des Messorgans, wirkt die impulsgesteuerte Sollwertverstellung ebenfalls auf die Kalibrierblende der Solarzelle 1 ein.

Aus konstruktiven und kostenmässigen Gründen erfolgt die Wägung der Kannen mit einer Zeitverzögerung von zwei vollen Kannen, was etwa einem Materialdurchlauf von 40 kg entspricht. Wie wir im vorangehenden erwähnten, handelt es sich um langwellige Abweichungen, so dass die relativ grosse Totzeit Z_2 weniger ins Gewicht fällt.

Die Optimierung der Nachregulierung mittels Servo-Monitor hat die Firma Zellweger AG auf ihrem Analogrechner durchgeführt und als Kriterium gefunden.

Schwellwerteinstellung = Nachstellgrösse = 0,3 %.

Nachdem die in einer Spinnerei-Automatiklinie auftretenden Regelprobleme behandelt sind, bleiben zwei Aspekte zu erwähnen, auf die aus Zeitmangel nicht näher eingetreten werden kann und der Vollständigkeit halber nur angedeutet sind.

Automation heisst nicht nur automatische Beschickung der Maschine und Abtransport des ausregulierten Endproduktes, sondern auch möglichst absolute Wartungsfreiheit. Dazu gehört auch die *automatische Entfernung und Verpackung der Abgänge* in Putzerei, Karderie und Regulierstrecke. Diese schmutzige, unangenehme Arbeit wird vom Personal gemieden, so dass man für Neuanlagen trotz den Kosten zu solchen Lösungen greift.

Auch dem *Anlageschutz* bei Brandausbruch in der Automatiklinie, z. B. durch Funkenschlag von mit der Baumwolle eingebrachten Metallteilen, widmeten wir unsere Aufmerksamkeit. In Zusammenarbeit mit der Firma Cerberus, Männedorf, entwickelten wir die *Feueralarmvorrichtung Ce-Ri-Fa*, welche in Rohrleitungen für pneumatischen Baumwolltransport eingebaut werden kann und die Transportluft mit einem Brandgasmelder auf Verbrennungsgase überwacht.

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The Technology of Automation of the Cotton System of Yarn Production

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Abstract

Automation on the cotton spinning system is defined and its development traced since the Industrial Revolution. The importance off process contraction in a continuous flow line, controlled by erroractuated mechanisms and incorporating automatic package transfer operation, is discussed.

Fibre arrangement in card sliver and its effect on subsequent processing, and on ultimate yarn quality is described, and the relationship between optimum pre-spinning draft and fibre length is defined. Technological evidence is presented to show how the minimum length of the process between carding and spinning is established.

A ring spinning plant is described which is automated up to the point of producing drawn sliver from bale material in a continuous operation, and the influence of Open-end spinning on the automation of processing subsequent to drawing will be described.

The possibility of automating the combing process is examined and equipment described which incorporates the basic technological requirements of a process for producing yarns of this type.

Zusammenfassung

Man definiert die Automation nach dem Baumwollspinnsystem und spürt ihrer Entwicklung seit der industriellen Revolution nach. Man bespricht die Bedeutung der Verfahrensverkürzung in einer kontinuierlichen Fertigungsstrasse, die mit durch Fehler betätigten Vorrichtungen gesteuert wird, mit Einschluss von automatisierter Uebertragung der Garnkörper.

Eine Beschreibung der Fasernanordnung in einem Kardenband wird gegeben sowie der Einfluss dieser Anordnung auf die nachfolgenden Verarbeitungsstufen und auf die Endqualität des fertigen Garns. Die Verbindung zwischen dem Optimal-Vorspinnverzug und der Faserlänge wird auch definiert. Man bringt technologische Beweisgründe vor, um zu zeigen, wie die Minimallänge des Verfahrens zwischen dem Kardieren und dem Spinnen festgestellt wird.

Eine Ringspinnanlage wird beschrieben, mit Automation bis zur Herstellung von Streckbändern in einem ununterbrochenen Verfahren aus unmittelbar vom Ballen herkommendem Faserstoff. Der Einfluss des OE-Spinnverfahrens auf die Automation der Verarbeitung nach dem Strecken wird auch beschrieben.

Man untersucht die Möglichkeit der Automatisierung der Kämmung und beschreibt die Anlage, welche die grundlegenden technologischen Erfordernisse eines zur Herstellung von solchen Garnen notwendigen Verfahrens einschliesst.

1. Introduction

Automation has been defined as the production of an article or the control of a process without human intervention; it is the replacement of human efforts and skills by mechanisms and control systems in a continuous flow operation. If automation is defined in this way, then in cotton spinning the evolution towards automation started with the Industrial Revolution when the hand operations of batting and carding were mechanised and the spinner began to tend the multiple spindles of the Jenny. In the space of 50 years from that date, the traditional structure of the spinning mill which remained unchanged for the next 100 years, had been established.

2. Early Cotton Spinning

The traditional mill was based upon low drafts and multiple doublings. Low drafts because drafting was by simple roller systems and because mechanical standards were low; multiple doubling to cancel out irregularities introduced by drafting mechanisms at earlier processing stages. This type of mill had eleven "break" points or manual transfer operations between bale material and wound yarn where packages had to be moved by hand from one machine to the next in the preparation of a carded quality yarn.

There are two obvious methods of automation by reducing labour requirements in a traditional type mill in the light of present-day engineering and technological standards:

(1) Mechanical transfer of packages or linking of machines to eliminate the operative work of handling, piecing and doffing.

(2) The use of fewer machines and fewer operatives to produce a given amount of yarn.

Mechanical handling is clearly too complex because of the large number of machines involved, and the obvious method is to reduce the number of machines required. That is how human effort was reduced by technological development in the first half of this century.

3. Vertical and horizontal Process Contraction (1920 – 1950)

In cotton spinning we have defined vertical contraction as a shortening of the process from bale to yarn, and horizontal contraction as the reduction in machine requirements by increased productivity of individual machines.

Vertical contraction started in the 1920's with the development of the Casablancas high draft system. Higher ring frame drafts allowed coarser roving bobbins to be used and therefore fewer speed frame spindles. High drafting at the flyer frame was also attempted in the pre-war and immediate post-war period with limited success due to the adverse effects of drawframe sliver irregularity which existed at that time.

During this period, a contraction in blowroom processing was developed – the so-called "single process lapping" system in which the 4-lap finisher scutcher was eliminated by improving the regularity of hopper feeding. This was an important development because it was the first attempt to link together processes which previously involved manual transfer of packages. In the single process Blowroom line the opener was linked pneumatically to the scutcher.

At this stage we can examine the progress made from the traditional mill of the 19th Century to the typical mill of about fifteen years ago. The process had been shortened by the elimination of a flyer frame and by machine integration in the Blowroom, but production rates of the individual machines remained unchanged, i. e. horizontal contraction had not been achieved. In a mill of this type, eight manual transfer operations were required between bale and wound yarn.

4. Recent Developments in Process Contraction

The next ten years saw some marked improvements in techniques, technology and machines. The introduction of multiple blenders and improved scutcher hoppers resulted in a marked reduction in lap irregularity, and new discoveries in fibre orientation at the card, formed the basis of new developments in comber lap preparation and in general cardroom practice. The work of the Shirley Institute demonstrated how drawframe sliver regularity could be improved by the elimination of roller slip and this was followed up by our own work at Helmshore on the application of single zone drafting to combers or to any machines where the fibres presented to the drafting systems are in a parallel condition. Improved engineering standards led to the development of high speed drawframes and large package high speed flyer frames.

This phase of development resulted in the establishment of the short process mill on a firm basis with only six manual transfer operations of packaged cotton between bale and wound yarn for a carded quality. Substantial increases in drawframe and speed frame production rates gave horizontal contraction of the process and the widespread adoption of larger packages resulted in impressive reduction in the labour required to produce a given amount of yarn.

5. Technological Requirements of an Automatic Cardroom Plant

To automate the spinning mill, the entire process should be continuous and controlled. The machines at each stage should be linked to those at the next stage, or packages should be automatically doffed, mechanically transferred and mechanically pieced at the next machine.

The equipment of mechanical transfer and process control is expensive. Thus the shorter the process involved and the higher the production rate of individual units, the less of this complicated equipment will be required.

On this basis, the technological requirements for automation in spinning are:

(1) A high production rate at each individual machine.

(2) The shortest possible process from bale to yarn.

It will be shown in subsequent sections of this paper that machine linkage in the spinning process is viable only up to the drawn sliver stage. It will also be shown that with ring spinning a roving operation should be included and this means that with cardroom automation of the type described, three manual package transfer operations will still be required, as illustrated below marked

- Opening, Cleaning, Mixing, Carding, Drawing
- Roving
- Ring Spinning
- Winding

With the advent of Open-End Spinning, a further shortening of the process may be possible. This will be discussed later.

5.1 Maximum Production Rates: This is determined by the weight per unit length of sliver and the delivery rate of the machine. At the drawframe, heavy slivers result in reduced fibre control, and this method of increasing production can be adopted only to a limited extent. At the card, heavy webs and slivers cause less efficient transfer of fibres from the cylinder to the doffer and this causes neps to be formed. Card production rate cannot be effectively increased by heavier slivers.

Drawframe speeds approaching 500 metres/min. are now possible due to improved methods of fibre and web control, and improved carding technology and higher mechanical standards have established the modern high production card on a firm basis where production rates exceeding 30 kilos per hour are now being achieved in mill practice. With these card and drawframe production rates, it is possible to think in terms of linking four cards to one drawing head.

5.2 Shortest Process: The present-day short process system consists of two passages drawframe and a single passage speed frame. An obvious step would be to eliminate the speed frame and spin from sliver, but we have found that cardroom processing is dictated by the arrangement of hooked fibres and the degree of fibre parallelisation in the card sliver.

These factors must be carefully considered in further shortening of the process, and we have found that the basic requirements for producing a satisfactory yarn are:

(1) A pre-ring frame draft of 20/30.

(2) A single reversal or a single machine between card and ring frame.

6. Cardroom Systems of Sliver Preparation for Spinning

If a single machine is used between card and ring frame it must produce a package for spinning.

We have seen that the drawframe has a high production potential per delivery; therefore automatic creeling can be considered and automatic doffing of full sliver cans will be economically viable. Figure 1 shows three systems of producing a sliver package for spinning. Each one could be termed a sliver preparation "cell" or unit for direct spinning into yarn with a single reversal and with a pre-spinning draft of about 30. All these systems satisfy the technological requirements of an automated sliver preparation plant.

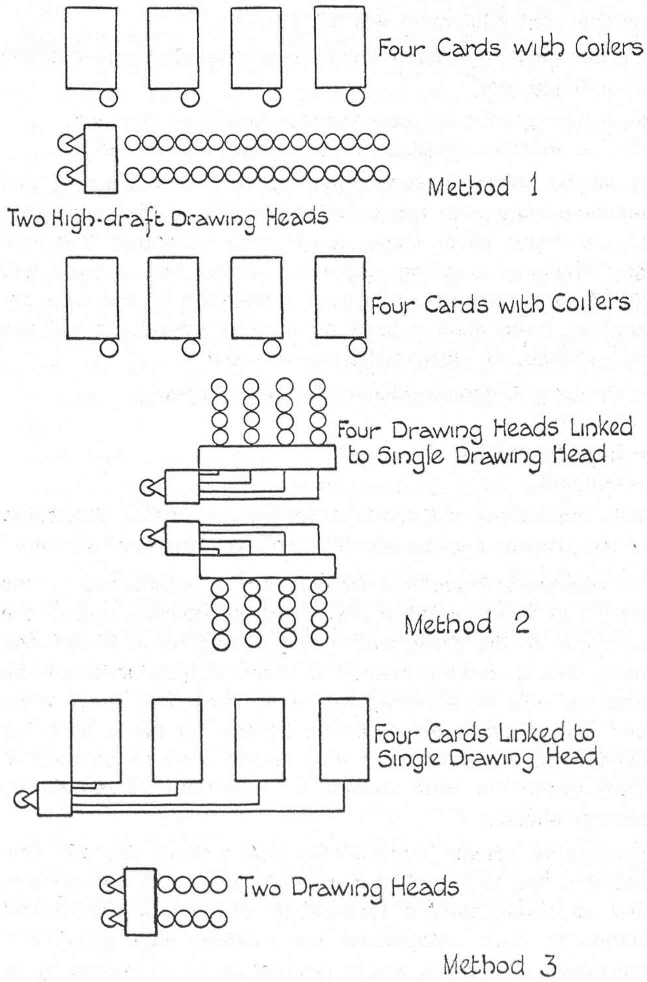
Four Cards with Coilers
Method 1
Two High-draft Drawing Heads
Four Cards with Coilers
Four Drawing Heads Linked to Single Drawing Head
Method 2
Four Cards Linked to Single Drawing Head
Two Drawing Heads
Method 3

Fig. 1 Three Systems of Drawframe Sliver Preparation

Methods 1 and 2 involve difficulties in package transfer and automatic creeling because of the large number of creeled cans. Method 2 has the disadvantage of two machines.

Both these systems insert the total draft all in the same direction, i. e. uni-directional drafting without an intermediate reversal. Method 3 is more attractive for automatic creeling because of fewer cans. It also has reverse drawing at a second stage which gives slightly better yarn than uni-directional drafting as shown in Figure 2.

Fig. 2 Directional Drafting Effects

Processing*	Major Hook Direction Drafting		Pre-Ring Frame Draft	Final Drawframe Sliver C.V. %	Yarn Strength Factor
	Draw Frame	Ring Frame			
Card DF RF	L	T	6.7	3.0	1750
Card R-DF-R RF	T	T	6.7	3.2	1710
Card R-DF-DF ** RF	TL	T	27.0	3.3	1830
Card R-DF-R-DF-R RF	TT	T	27.0	3.9	1800
Card DF-R-DF RF	LL	T	27.0	3.5	1810
Card DF-DF-DF *** RF	LTL	T	110.0	3.6	1820
Card R-DF-R-DF-R-DF-R RF	TTT	T	110.0	3.2	1860
Card DF-R-DF-R-DF RF	LLL	T	110.0	3.7	1850
Card DF-R-DF-R-DF-R RF	LLL	L	110.0	3.7	1470

*R Artificial Sliver Reversal. DF Drawframe. RF Ring Frame. **Preferred Automation Process. ***Conventional Sliver to Yarn.

7. The Implications of very short Cardroom Processing

If method 3 is adopted, the number of doublings in the cardroom is reduced to 16 against present-day standards of 64 or at the very least, 36. In the old fashioned cardroom, doubling was used to blend and cancel out long term irregularity. With only 16 doublings the effect on blending and regularity will be negligible.

This means that further technological requirements of the sliver preparation cell are:

(1) Adequate blending before the cotton reaches the cards.

(2) A method of maintaining the correct hank and regularity of the sliver.

7.1 Blending: This is the most important manually controlled operation in the entire mill, yet it is often the most abused. The most important feature of an improved blending system is not necessarily the elimination of human effort, but the elimination of human error.

7.1.1 Pre-Blending: This involves a separate blending operation in which several bales are blended, cleaned and the cotton re-baled. The pre-blended bales are then arranged in the normal way around a battery of hopper blenders. It is an expensive system involving an extra operation and has now fallen into disuse.

7.1.2 Bale Plucking: Machines have been developed to remove cotton from bales automatically in small tufts. The Trütschler and Rieter systems are the ones most frequently used. In an automatic blending system equal amounts of cotton must be taken from each bale and merged at a common blending point. A machine of this type should be followed by a large mechanical stack to hold a reserve of cotton and allow final mixing to take place, e. g. the Hergeth and the Platt/Memmingen systems.

7.2 Regularity Control: This can take two forms:

(1) Long term drift correction to keep yarn count constant day by day, e. g. a constant 1 % C. of V. on 6 metre wraps of sliver.

(2) Short term correction to give a better sliver regularity than can be obtained to-day, e. g. an Uster figure of 1.5 % instead of 2.5 %.

Drift correction is essential in any processing line where the pedal regulator has been eliminated by feeding loose fibres direct to the cards. It is a feature of chute feed to cards that short term card sliver regularity is better than lap fed cards, but long term variation is worse due to variation in blending and in bale density. This is illustrated in Figure 3.

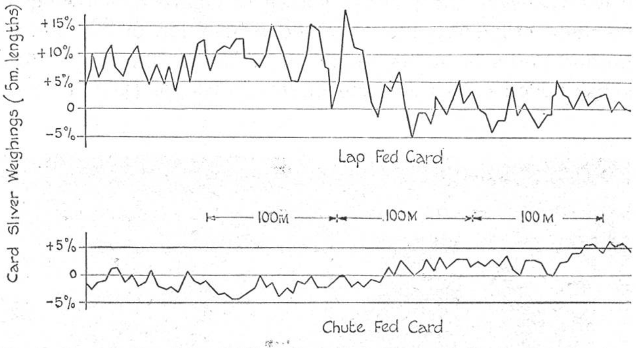

Fig. 3 Regularity of Card Sliver from Lap Fed and Chute Fed Cards

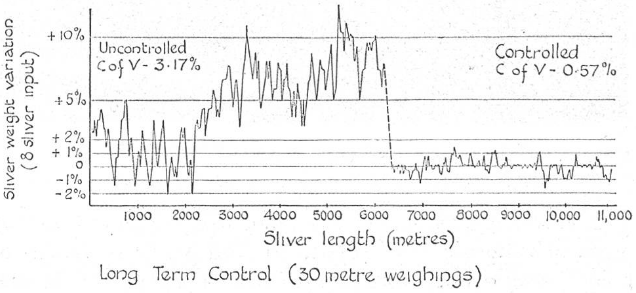

Fig. 4 Effects of Autoleveller on Regularity of Drawframe Sliver

Platts have developed an autoleveller which can be located behind the drafting system of a free-standing drawframe or between the cards and the drawing head of a linked system. Figure 4 shows the results of 30 metre wraps from a free-standing drawframe creeled with card sliver.

8. Basic Sliver Preparation Plant

We now have the basic technology required for preparing a spinning package for the automatic mill. The basic operations are: Blending, Carding, 1st Drawing, 2nd Drawing, followed by sliver to yarn spinning and for full cardroom automation we must consider:

(1) *Linking* together of machines into a continuous process.

(2) *Process Control:*
  (a) *Flow control* from one machine to the next.
  (b) *Quality* or regularity of product *Control.*

(3) *Continuous Operation* by automatic doffing of packages.

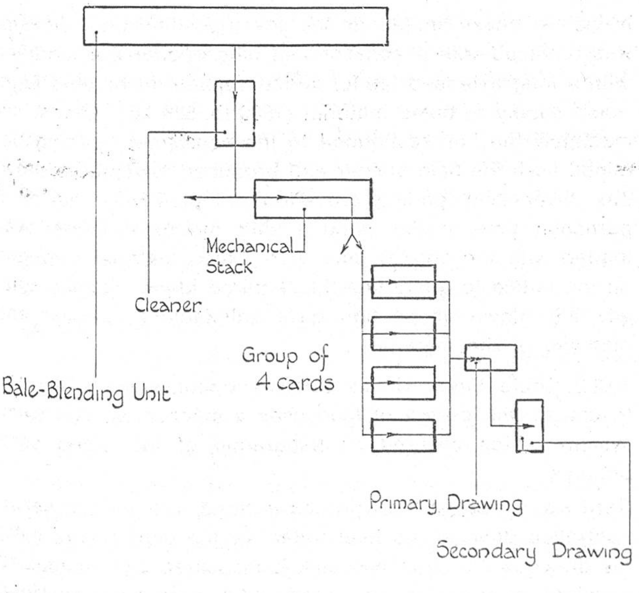

Fig. 5 Schematic Processing System from Bale to Drawframe Sliver

Figure 5 shows a line diagram of a sliver preparation unit to produce up to 450 kilos per hour. Pneumatic conveyance of fibres is used to the back of the cards; the card slivers are taken along a table to a drawing head with automatic can change; it is also possible that these cans may be transported mechanically to a second drawframe with automatic piecing and automatic can doffing for direct sliver to yarn spinning.

Systems of this type were developed by the Japanese, but in many cases they have been found to be overcomplex and to suffer from the disadvantage of having to use special ring frames with complicated and expensive drafting systems. In our experience better yarn can be spun with fewer end breaks when roving is creeled to the ring frame.

9. Semi-automatic Cardrooms (Bale to 1st Passage Drawn Sliver)

In the fully automatic cardroom, the 1st and 2nd passage drawframes are linked mechanically. This saves a negligible amount of labour and means that very complicated equipment must be used. In practice it has been found that it is preferable to transfer the packages by hand from the first drawing operation to the next machine which produces the package for spinning.

The following key operations are required in a plant of this type:

9.1 Feed to Cards: Several systems are now commercially available including Rieter, Trütschler and Platts. Cotton is fed from bale pluckers or standard blenders to an opening range and then distributed aerodynamically or aeromechanically directly to the back of the card instead of forming laps. The scutcher is eliminated.

9.2 Cards to Drawbox: Four high production cards with synchronised doffers linked to a drawframe fitted with automatic can doffing and autolevelling. This produces a can of first passage drawn sliver with a draft of approximately four and doubling of four.

9.3 Package for Spinning: There are two alternatives:

(a) Multiple slivers from the linked card drawbox can be creeled to a drawframe producing a small can to creel in at the sliver to yarn ring frame.

(b) Multiple slivers from the linked card drawbox can be creeled to a special speed frame, producing a standard hank of say 0.7 Ne (840 tex).

The sliver spinning alternative (a) has the disadvantages already described. Creeling to a roving frame (system b) means that conventional ring frames can be used.

10. Mill Experience with Automated Spinning

10.1 Introduction: In 1963 we decided to produce the first British automatic spinning plant in co-operation with Smith & Nephew Textiles Ltd., Brierfield. The plant installed was officially handed over to the mill on June 2nd, 1965. However, the unit had been running commercially under supervision for many months before that time.

The technological basis for this plant has already been described. The processing details are given in Figure 6 and the unit is shown diagrammatically in Figure 7. This diagram shows a subsidiary combing unit which will be described later in the paper. The baled material is prepared and opened by a simple bale digester followed by further cleaning using conventional machines. The material is conveyed by a belt conveyor into a large chute feed hopper which operates as a small mechanical blending stack. Material is processed through the hopper into the chutes and any excess chute material is returned to the blowroom conveyor belt which directs the material back into the chute feed hopper. The feed to cards is controlled to provide a feed weight of approx. 19 oz./yd. (600 grams/metre) and the resulting card slivers from the four cards are delivered into the drawbox positioned at the end of the unit.

Fig. 6 Automated Spinning Mill, Processing Details

Process Sequence	**Carded Yarns**
Card production	20 kg/h (44 lb./h)
Card sliver	4.9 K.tex (0.12 Ne)
Card feed	600 K.tex (19 oz./yd.)
Drawbox	
Doubling	4
Draft	5.7
Sliver produced	3.46 K.tex (0.17 Ne)
Production	80 kg/h (176 lb./h) at 100 % efficiency
Net wt. of sliver in one can	16.4 kg (36 lb.)
Time to fill a can	12.3 mins.
Roving Frames	
Spindles	48
Package size	431 mm × 178 mm (14" × 7")
Roving	840 Tex (0.7 Ne)
Doublings	2
Draft	8.2
Bobbin wt.	2.6 kg (5.75 lb.)
Ring Frames	
Spindles	400
Package size	202 mm × 44 mm (8" × 1¾")
Spindle speed	12 000 r.p.m. (average)
Draft	48.2
Average yarn counts	17.4 Tex (34 Ne)

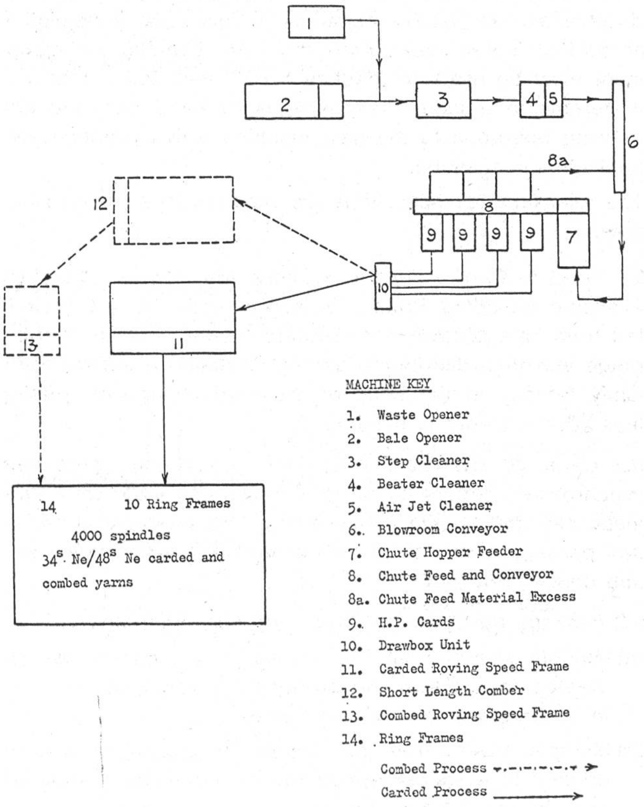

Fig. 7 Line Diagram of Mill Automated Plant

Sliver cans from the drawbox are placed behind the roving frame and two cans per spindle provide the input of sliver for each roving bobbin. The rovings from the speed frame are channelled to the ring frames for spinning in the usual way. A view of the plant is shown in Figure 8. Allowing for machine efficiency, the expected production of the unit for carded yarns is in the region of 12,000 lb./120 hours (5450 kilos) based on an average count of 34s Ne (17.4 tex).

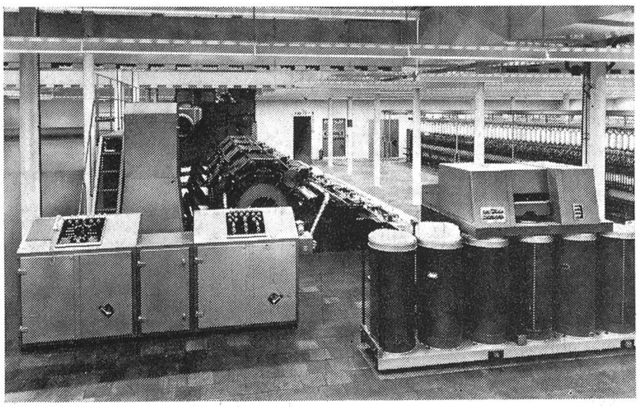

Fig. 8 View of Automated Spinning Plant

10.2 Technological Audit: The plant has processed various types of materials from Turkish to Giza 47. Observations of plant performance were made over a period of several months.

10.2.1 Blowroom Section: The Blowroom machinery is conventional except that in the original plant a seven-position bale digester was used for opening the bales. Technologically the bale opener met the requirements of satisfactorily breaking up the surface of the bales to provide small cotton tufts for further cleaning. However, there was considerable variation in the production rate from each of the seven cutting or opening units largely due to differences in bale characteristics which from a blending point of view was unacceptable. It was also found that bales because of their nature, tended to tilt, then uneven opening occurred and production rate and blend characteristics also become unacceptable.

In view of these limitations the seven-position bale digester was replaced with a conventional bale opener but modified with a long extended feeder lattice capable of holding eight hours supply of baled material (1500 lb./680 kg). Almost immediately the unit responded to the consistent opening obtained from the bale opener and produced acceptable drawbox sliver. The loading procedure adopted was that at a particular time in the working shift the bale opener was loaded with the correct amount of baled material arranged on the lattice to guarantee the required blend. Technologically the Blowroom section gave satisfactory opening and cleaning of the material.

10.2.2 Chute Feed: Unlike pneumatic convening of cotton to chutes, the design of feed uses a mechanical conveying system, which ensured no separation of the blend components.

Card No. 4 nearest the drawbox is fitted with a P.I.V. servo-controlled drive to the feed roller. As the card slivers enter the drawbox the combined bulk is measured and maintained constant by adjusting the speed of the feed roller on No. 4

card. Therefore, depending on the time delay in the autoleveller the card sliver on Card No. 4 could vary slightly in regularity and average thickness.

10.2.3 Drawbox Sliver: Short term regularity of the drawbox sliver is maintained to a satisfactory level by the drafting system and the long term regularity by the automatic control of the input bulk. The effectiveness of these is shown by the results given in Figure 9.

Fig. 9 Turkish Cotton
Drawbox Sliver Irregularities with and without Leveller

Drawbox Sliver	Saco-Lowell		6 m. wrappings (wt. in grams)		
	Mean R %	Max. R %	Mean	S.D. %	C.V. %
Controlled	28.2	41.0	18.5	0.41	2.2
Uncontrolled	29.1	42.1	17.9	0.67	3.0

Normally the short term regularity is unaffected by any inconsistency in input bulk. However, long term autolevelling is considered essential in providing satisfactory sliver regularity to correct for variations in bale density.

10.2.4 Roving and Spinning: In this section we should like to present general results to demonstrate that the unit produced satisfactory yarns and that these support the original laboratory technological results for this class of material and yarn count range. The roving frame processing comprises of feeding two slivers to each spindle and thereby ensures the required pre-ring frame doublings of 8 and a pre-ring frame draft of 30. The results of several roving samples for both Turkish and Giza 47 material are given in Figure 10, which apart from the indifferent U % values are satisfactory. The results shown are the average of tests taken over a six-week period.

Fig. 10 Turkish and Giza Cotton
Roving Regularity long and short Term

Period (Consec. Weeks)	Between Bobbin Analysis Mean N_e	C.V. %	Std. Dev.	Within Bobbin Analysis Mean N_e	C.V. %	Std. Dev.	Weight kg	U %	Material
6	0.720	3.51	0.39	0.76	2.23	0.379	2.6	4.7	Giza 47
3	0.740	3.87	0.386	0.718	1.7	0.190	2.6	5.6	Turkish

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11. Open-End Spinning

The first stage in the automation of the spinning process has now been described, and it is known from mill experience that the production of drawn sliver from bale material by a continuous process is technologically feasible. But with a system of this type involving ring spinning there are still three stages where packages must be transferred manually between the drawn sliver and wound yarn.

Bale to Drawn Sliver
Packaging for Spinning
Ring Spinning
Winding
← Package Transfer Operations

Open-end spinning systems are now well known and the most popular type is based upon the feeding of loose fibres to an assembly unit where the yarn is formed. Twist is inserted by rotating the fibre assembly unit and not by rotating the package as in ring spinning.

11.1 Elimination of Winding: Because the yarn package is not rotated to insert twist in open-end spinning, the yarn can be wound directly onto a cheese or cone at the spinning machine and this may eliminate winding as a separate operation. If this is proved to be possible, the complete process from bale to wound yarn will be shortened by one operation and we shall be a stage nearer the quest for continuous processing.

11.2 Fibre Preparation for Open-End Spinning: There are two major factors which must be considered:

(a) The fibres are not formed into a yarn in the same order as they are delivered from the drafting system as occurs in ring spinning.

(b) The fibres in an open-end spun yarn are not as parallel to the axis of the yarn as in a ring spun yarn.

In order to establish the degree of importance of these factors we have carried out experiments to examine the effect of fibre parallelisation before spinning and the direction of fibre presentation to the drafting system of the open-end spinner. Earlier in this paper, it was shown that a pre-spinning draft of approximately 30 was required to give adequate fibre parallelisation before ring spinning and that the fibres should be presented to the drafting system with the majority of hooks trailing.

Experiments with open-end spinning have shown that instead of yarn quality improving with more parallel fibres in the creel package, this factor is of very little importance; nor is the effect of hooked fibres and the direction of fibre presentation. From these results we can conclude that in preparing fibres for open-end spinning, fibre parallelisation and hooked fibre ends have no marked effect on yarn quality, and it is possible that one operation in fibre preparation can be eliminated.

We have also found that open-end spinning from roving has no technological advantages over direct spinning from sliver, and in this case it is possible that the roving frame could be eliminated from the type of automated plant described earlier in the paper. This means that it may be possible to reduce the number of manual package transfer operations between bale and wound yarn to one.

Bale to Drawn Sliver

Single Manual
Package Transfer →

Open-End Spinning direct onto
Cone or Cheese

We can assume that the first stage of automation bale to drawn sliver is now an accomplished fact and if open-end spun yarns are proved to be widely acceptable, this method of spinning may become the basis of the second phase of automation in the 1970's.

12. Automation in Combing

As for carded yarn, automation for combing must be associated with high production machines giving the shortest possible process. The length of the process depends on two main technological factors:

(1) Fibre arrangement before the comber.

(2) Sliver regularity after the comber when most if not all the fibre hooks have been removed.

For optimum combing conditions it is preferable to ensure that the majority of fibres should have leading hooks when presented to the comber cylinder needles which means that an even number of machines should be used for the comber preparation. An ideal technological process has three passages of drawing followed by a lap former, but this involves too many machines. The general process arrangement is to use only one passage of pre-comber drawing providing a draft range of 8 to 24.

The most economic system would be to comb card sliver by direct sliver feed to the combing heads. The major objection to this system is that the pre-comber draft is too low and poor combing results, also if card cans from high production cards are used in the comber creel, machine space becomes very great. These points may not be easily overcome and a two-machine sequence between card and comber may be the shortest practical process for comber preparation.

It would also be of benefit if the combed sliver could be fed direct to a speed frame because fibre hooks are not important enough at this stage in the system to adversely affect roving or yarn quality.

To test these proposals, a comber was installed in the automated plant as shown in Figure 7.

The experience gained with this equipment proved to be satisfactory and subsequently a new machine was developed with the following features:

(a) Large can creel holding 550 kg (1200 lb.) of cotton.
(b) High speed combing unit of 8 heads.
(c) Drawbox sliver with an Uster value of 1.5 to 2.0 % mean deviation.
(d) Automatic can indexing.
(e) Automatic waste removal.

To emphasise the importance of these items one only has to analyse the work elements on combing to realise that operative work may be divided as follows:

Creeling and doffing	17 %
Cleaning	28 %
Maintenance	10 %
Interference	25 %
Faults	20 %

These values vary according to individual mill conditions and machines, but are fairly typical. On this kind of basis a machine of the type embodying the above features would be capable of higher machine productivity, require less direct labour and possibly some of the work which is normally dealt with by the comber operative could be transferred onto an indirect labour force.

For the process to be applied for conventional processing, it is necessary to guarantee combed sliver regularity to the specified level. Therefore it was necessary that the comber drawbox should be fitted with a sliver autolevelling device. Such a unit was fitted and developed by Zellweger Ltd., Uster/Switzerland, in association with T.M.M. (Research) Ltd.

The creel supply was prepared by using a double passage of drawing, whereby the first passage was a standard machine, whereas the second drawframe in the process was a bi-coil machine, coiling two slivers into one can. In this way it was possible to reduce the creel size to five cans to each combing head provided with a 10-sliver feed, and a machine creel containing up to 550 kg (1200 lb.) of material. This large amount of material is 3 to 4 times that for conventional combers and piecing of ends and creeling of new cans may be done with the machine processing.

Two machines of this type were produced; one was used for mill trials and the other for laboratory work. Figure 11 shows typical sliver regularity figures from our technological work on the mill plant. Subsequent laboratory work is not yet available for publication.

Fig. 11 Combed Sliver Irregularity

Sample	U %	Saco-Lowell		Can Weight
		Mean R %	Max. R %	% Variation
Autolevelled combed drawbox sliver	1.9	21.3	32.3	± 2
Non-autolevelled combed drawbox sliver	3.2	30.0	41.0	± 5
2nd Pass. Post comber DF sliver from unlevelled combed drawbox sliver	2.1	21.0	30.6	

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An analysis of drafting behaviour of worsted slivers with particular reference to the automatic control of drafting irregularities

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Abstract

An analytical and experimental study has been made of the frequency response behaviour of a simple roller drafting system. It is shown, analytically, that closed loop automatic control of short term drafting irregularities is basically more stable when based on a measurement of drafting tension than when based on the measurement of sliver thickness. An analysis of such a control system, which includes a non-ideal drafting system, is then given. It shows that such a system has a characteristic resonant frequency which has been confirmed by experimental determinations of the open loop frequency response. Such determinations are difficult especially at high frequency due to the presence of a large amount of noise in the drafting tension signals and two methods for eliminating this noise are discussed. In conclusion the deviations, between the experimental results obtained here and (a) those obtained by other authors and (b) those obtained by analytical methods, are then discussed.

Zusammenfassung

Das Verhalten eines einfachen Walzenstreckwerksystems wurde hinsichtlich des Frequenzganges analytisch und experimentell untersucht. Es wird analytisch aufgezeigt, dass eine auf Messungen der Streckspannung basierende automatische geschlossene Regelkreiskontrolle von kurzfristigen Streckunregelmässigkeiten im Grunde konstanter ist als eine, die auf Messungen der Banddicke beruht. Es folgt eine Analyse eines solchen Kontrollsystems, das ein unvollkommenes Streckwerksystem einschliesst. Sie zeigt, dass ein derartiges System eine charakteristische Resonanzfrequenz aufweist, was auch durch eine experimentelle Feststellung des offenen Frequenzganges bestätigt wurde. Solche Fest-