MANUAL OF SHOEMAKING

PRODUCED BY THE TRAINING DEPARTMENT

Clarks Limited

New Balance - EX1016

First Published 1966

Second Edition 1976
2nd Impression 1977
3rd " 1978
4th " 1978
5th " 1980
6th " 1989

EDITOR : R.G. Miller

ASSISTANT EDITOR : S.R. Redwood

CONTRIBUTORS (2nd Edition) : N.J. Bonham
W.J. Burt
T. Hughes
C. Loader
E.J. Page
K.C. Dunthorn

ACKNOWLEDGEMENTS

Photography : M. Ray
A. Green

Book Production : D.E. Pring

Graphics : S. Persighetti

CREDITS

C.I.C. Ralphs Ltd.
British United Shoe Machinery Co. Ltd.
Avalon Chemical Co. Ltd.
Avalon Leatherboard Ltd.
Kochs Adlernähmaschinen Werke AG
S.A.T.R.A.
A.F.M.A.

Pp. 57-66 are extracted from "Speaking of Lasts, A Compilation of Last Terms" by permission of the American Footwear Industries Association

Printed by Clarks Ltd. Printing Department

Binding by Alfred Harris (Bristol) Ltd.

© C. & J. Clark Ltd. 1976

New Balance - EX1016

CONTENTS

Acknowledgements and Credits iii

CHAPTER 1 - PARTS OF A SHOE

Introduction	1
Elementary Shoe	2
Typical Ladies Shoe	3
Typical Men's Shoe	4
Uppers	6
Bottoms	18
Components	22

CHAPTER 2 - PRODUCT MARKETING

Introduction	25
Consumer Needs	25
Market Segmentation	25

CHAPTER 3 - FEET

Introduction	27
Bones	27
Joints	29
Ligaments	31
Muscles	31
Skin	32
Arches of the Foot	33
Changes during Growth	35
Functions of the Foot	38
Common Foot Troubles	40

CHAPTER 4 - FOOT MEASUREMENT

Introduction	44
Measurement for Bespoke Footwear	44
Foot Surveys	45
Size Systems	49
Fitting the Shoe	52

CHAPTER 5 - LASTS

Introduction	56
Materials	56
Definitions	57
Last Styling and Model Making	67
Co-ordination	67
Lasts and Feet	69
Last Manufacture	70
Hinging Methods	71

New Balance - EX1016

CHAPTER 6 - PRODUCT DEVELOPMENT

Introduction	73
Development Procedure	73
Pattern Cutting - Introduction	75
Forme Cutting	75
Standard Making	80
Working Patterns	85
Bottom Patterns	89
Grading	90

CHAPTER 7 - CUTTING

Introduction	91
Qualities required in a Clicker	91
Materials	92
Characteristics and Variations in Leather	94
Manufacturing Requirements	98
Methods of Cutting	104
Leather Measurement Systems	108

CHAPTER 8 - CLOSING

Introduction	113
Preparation	113
Topline and Edge Treatments	127
Fitting Together	134
Stitching Machines	134
Stitch Formations	138
Types of Seam	139
Finishing Off	147
Threads	148
Needles	149
Guides	155
High Frequency Heating (H.F.)	157

CHAPTER 9 - ORGANISATION OF CLOSING

Introduction	159
Sequence of Operations	159
Conveyors	160
Work Content	165
Work Potential Available	166
Balancing the Closing Room	167
Versatility	167
Training	168
Reserve Operative Capacity	168

CHAPTER 10 - COMPONENTS

Introduction - Stockfitting	169
Soles	169
Insoles	171
Stiffeners	176
Toepuffs	177
Heels	179
Sole Preparation for Cemented Construction	186
Single Sole Pre-finishing	189
Multiple Sole Pre-finishing	193
Insole Preparation for Cemented Construction	197

CHAPTER 11 - BOARD MANUFACTURE

Stock Preparation	200
Board Making - 3 Methods	200

CHAPTER 12 - INTRODUCTION TO MAKING

Introduction	203
Assembly	203
Lasting	204
Attaching	205
Methods of Construction	206

CHAPTER 13 - FLOW CHARTS FOR METHODS OF CONSTRUCTION

Introduction	209
Cemented/Pre-finished	209
Cemented/Finished on the Shoe	210
Direct Vulcanised	211
Injection Moulded PVC	212
Injection Moulded PU	213
Veldtschoen	214
Machine Welted	215
Slip Lasted	216
String Lasted	217

CHAPTER 14 - CONDITIONING OF UPPERS

Conditioning before Lasting	218
Heat Setting	219

CHAPTER 15 - CEMENTED CONSTRUCTION

Introduction	223
Lasting Operations	223
Attaching Operations	232
Summary of Advantages and Disadvantages	241

New Balance - EX1016

CHAPTER 16 - MOULDED CONSTRUCTIONS

Introduction	243
Lasting for Moulded Constructions	243
Direct Vulcanising	244
Injection Moulding PVC	250
Injection Moulding Polyurethane	255

CHAPTER 17 - VELDTSCHOEN CONSTRUCTION

Introduction	260
Lasting Operations	261
Attaching Operations	267
Finishing Operations	270

CHAPTER 18 - MACHINE WELTED CONSTRUCTION

Introduction	275
Insole Preparation	276
Sole Preparation	281
Lasting (Conventional)	282
Cement Lasting	286
Attaching	287

CHAPTER 19 - SLIP LASTED CONSTRUCTION

Introduction	299
Slip Lasted Forepart Type	300
Fully Slip Lasted Type	305

CHAPTER 20 - STRING LASTING

Introduction	308
Lasting	310

CHAPTER 21 - MACHINE SEWN CONSTRUCTION

Introduction	314
Sole Preparation	315
Lasting	317
Attaching	317

CHAPTER 22 - FINISHING

Introduction	321
Sequence of Operations	321

CHAPTER 23 - TREEING (SHOE ROOM)

Introduction	327
Sequence for Grain Leather Uppers	327
Sequence for Suede Leather Uppers	331

New Balance - EX1016

CHAPTER 1

PARTS OF A SHOE

Introduction

The variety of shoe styles is so bewildering that at first sight it seems impossible to establish the factors which they have in common. Yet these styles are obtained in fact by endless variations on comparatively few basic themes. It is important to determine which is the theme and which is the variation. In this the acid test is the function which each part fulfils - is it essential to the construction of the shoe and, if so, how and why? Has it a subsidiary function? Or is it merely put there for effect and decoration?

The parts of a shoe can be grouped broadly into those which make up the UPPER and those which constitute the sole and heel or BOTTOM.

The aim of this section is to identify the basic parts which go to make up uppers and bottoms and to illustrate these in various styles.

An Elementary Shoe

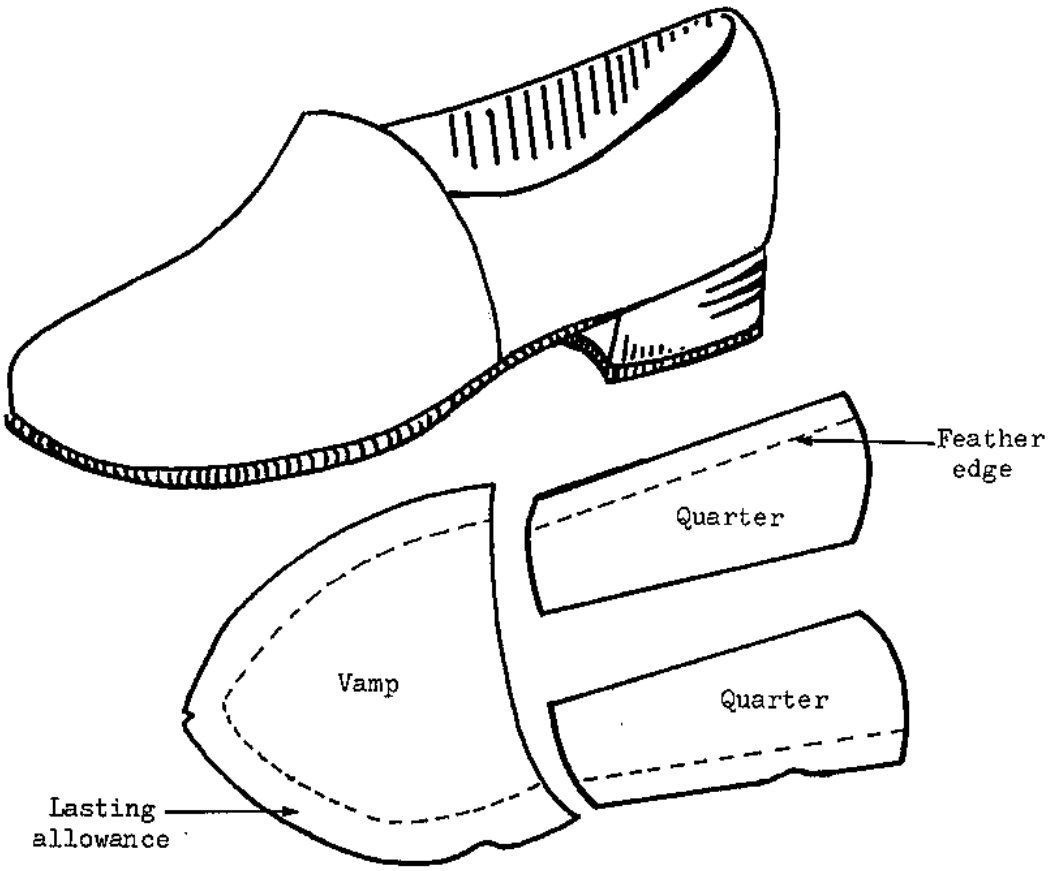
A basic upper -

A simple upper consists of three basic parts:-

The VAMP which covers the toes and forepart or front of the shoe.

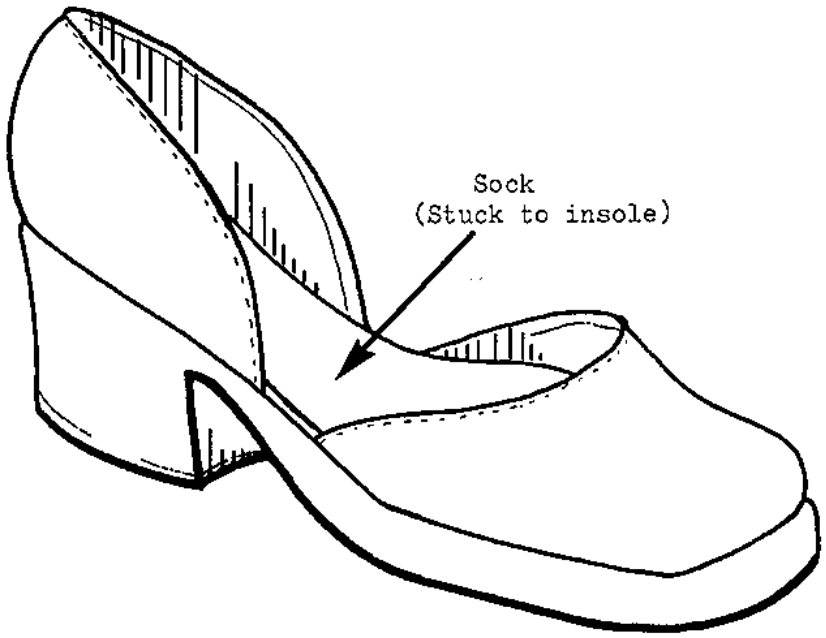
The QUARTERS which enclose the back of the foot.

The top of the shoe which surrounds the opening for the foot is called the TOPLINE. The lower extremity where the upper meets the sole or insole is called the FEATHER EDGE. When the patterns are cut an additional margin is added to the feather edge which allows the upper to be attached to the rest of the shoe. This is called the LASTING ALLOWANCE.



(1) Typical Ladies Shoe

The separate functions of vamp and quarters are best seen in an evening shoe with an open middle section or WAIST.



This also illustrates the importance of the INSOLE to which the vamp and quarters are lasted and to which the sole is attached. A SOCK is normally inserted over the insole.

In normal shoes the vamp is joined to the quarters by a seam. This is often at the waist but the position and method of seaming can vary and this will alter the style of a shoe.

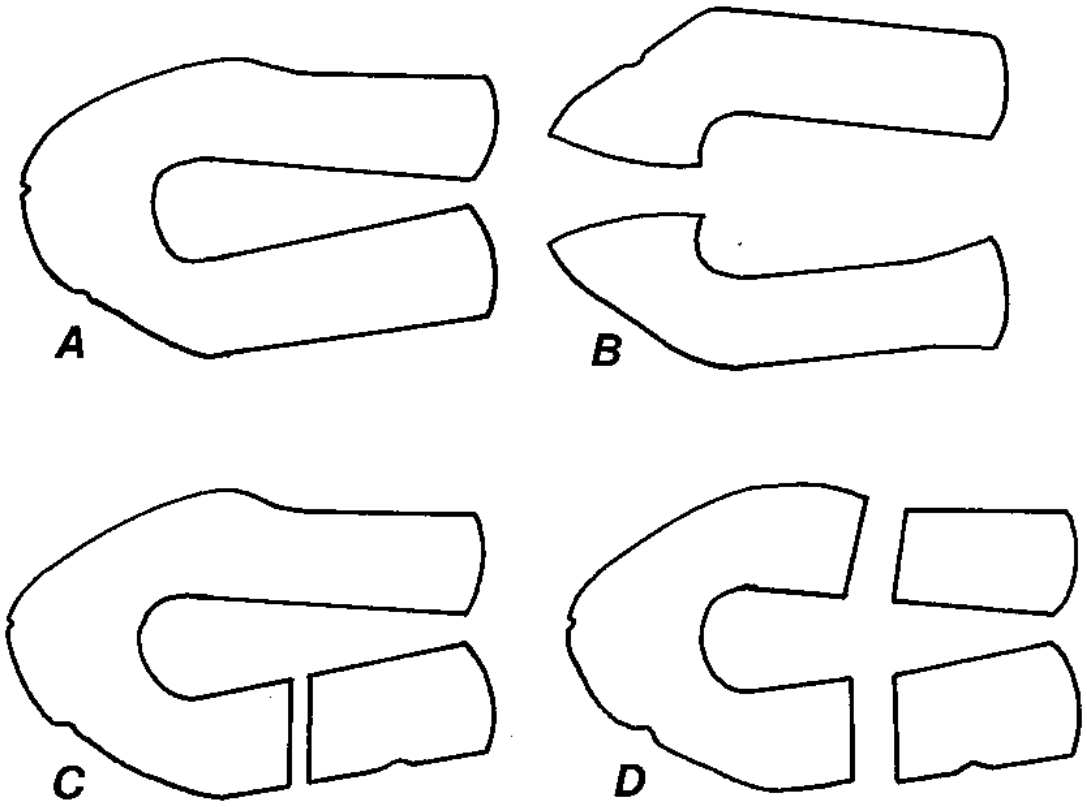
The one basic court shoe could be cut up in four different ways:-

(a) Shoe cut all in one piece (whole cut vamps).

(b) Shoe cut into two sides which will be joined with a front seam.

(c) Shoe cut in two pieces with the vamp running the full length of one side of the shoe and joined to a single quarter on the inside. This is called a three-quarter cut vamp.

(d) Shoe divided into three pieces, vamp and two similar quarters.

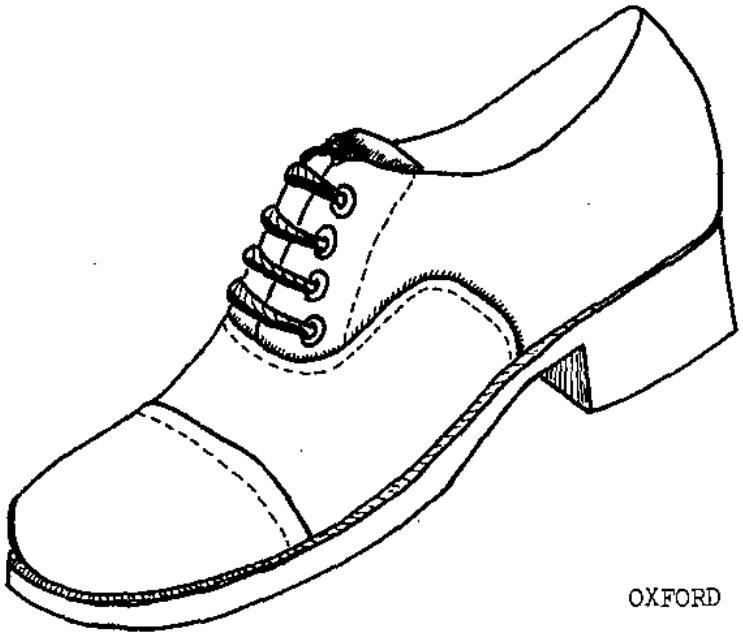


(2) Typical Mens Shoe

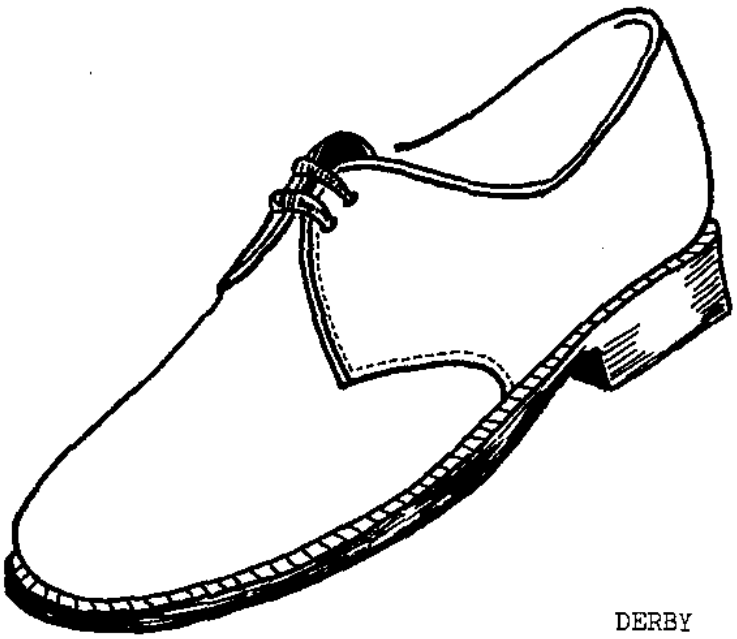
The theme outlined for the ladies shoe can be varied further by considering the angle and manner in which the vamp is joined to the quarters. The extent to which the vamp overlaps the quarter or quarters overlap the vamp will cause differences in style and fit. For example, men's lace shoes tend to fall into two categories:-

OXFORD shoes have the vamp overlapping the quarters with the tongue being separately attached.

DERBY or GIBSON shoes have the quarters overlapping the vamp which normally includes the tongue.



OXFORD



DERBY

UPPERS

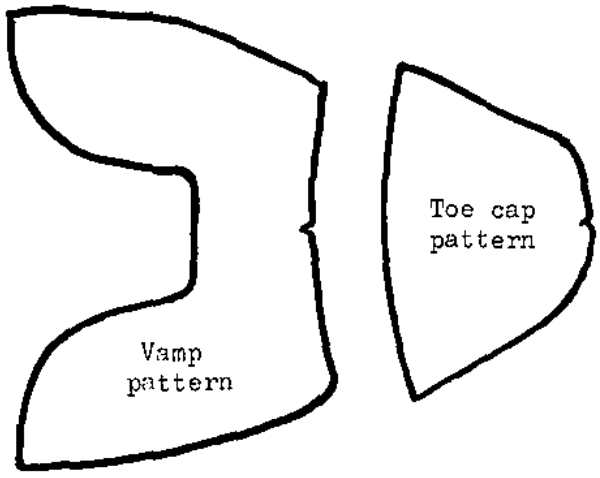
1. Vamps

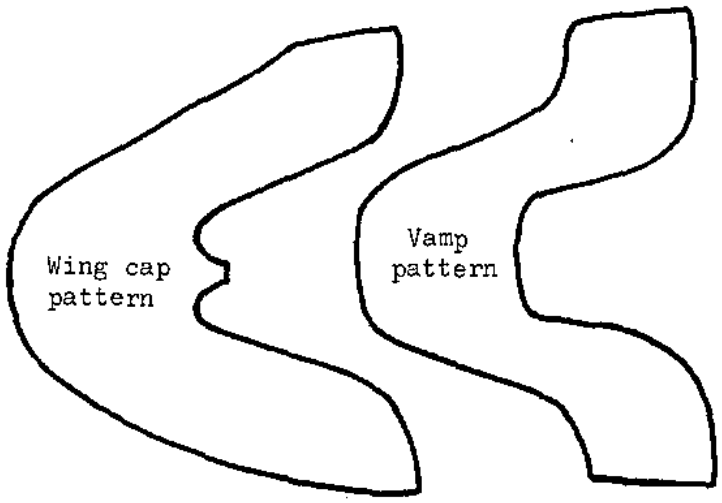
Vamps often consist of a single piece of upper material. They may, however, consist of two separate pieces stitched together to make a whole.

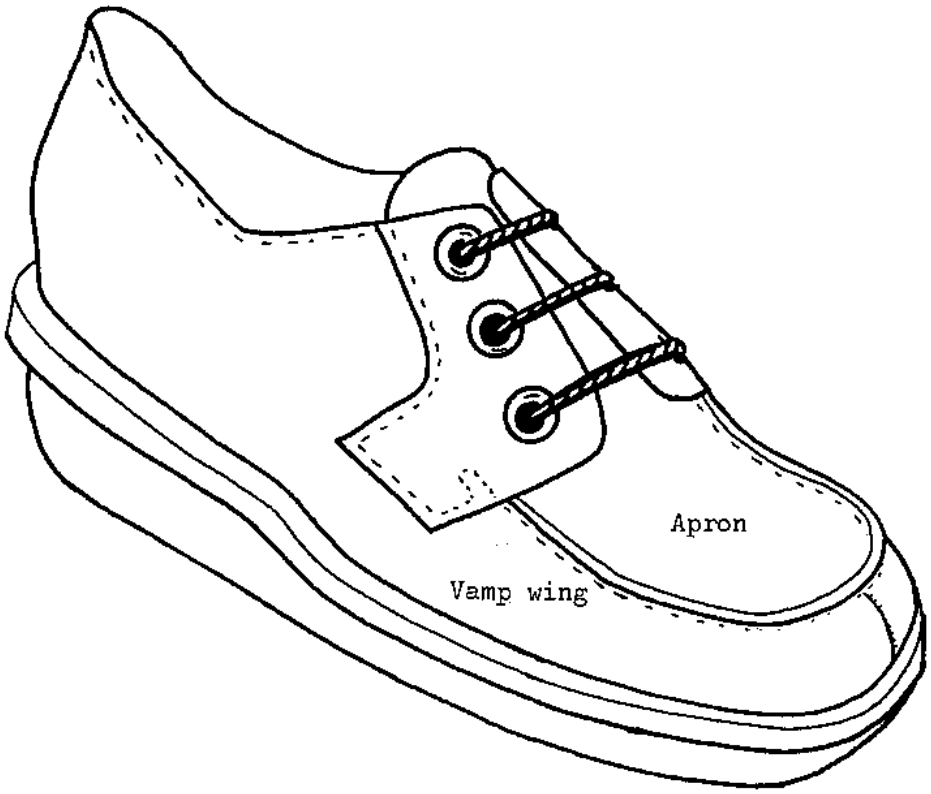
For example:

(a) Toecaps and Wingcaps

A conventional toecap is set squarely across the shoe. A wingcap is angled back to give a streamlined effect. This may cover the toes in an intricate flowing curve or may lie simply round the wall edge of the last. In both cases, however, the wingcap and vamp extend to the lasting edge.

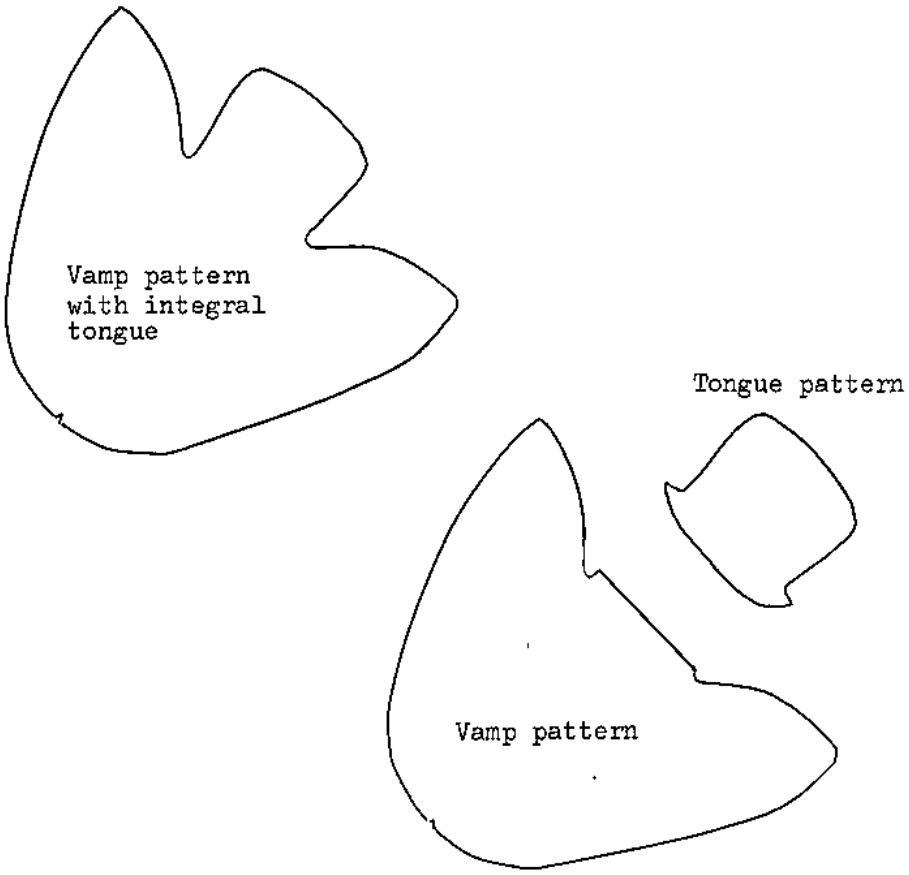






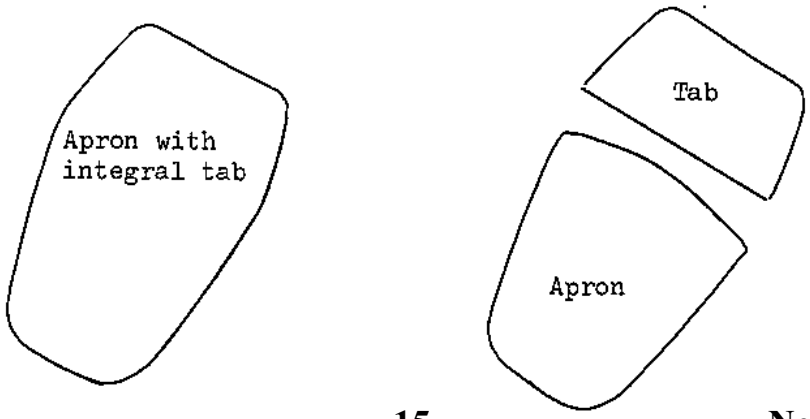
(b) Aprons and Vamp Wings

Alternatively, the vamp may be divided into an apron covering part of the top of the foot and wings enclosing the side wall of the foot. Although the relative positions of vamp and apron can vary, the seam joining them will follow more or less the wall edge of the last where it changes from the horizontal to the vertical plane. It will be noted that the wings alone extend to the lasting edge.



(c) Tongues and Tabs

A vamp may have a separate tongue or the vamp and tongue may be cut all in one piece. An apron may have a separate tab to cover the instep or the apron and tab may all be cut in one piece.





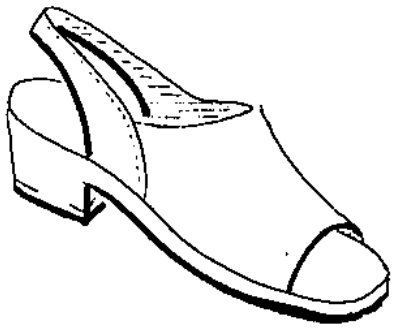
(d) Peeptoes

The toe can be left open and then the vamp consists only of a single strap or a series of interlaced straps.



PEEP TOE/SLING BACK
- 3 variations on a theme



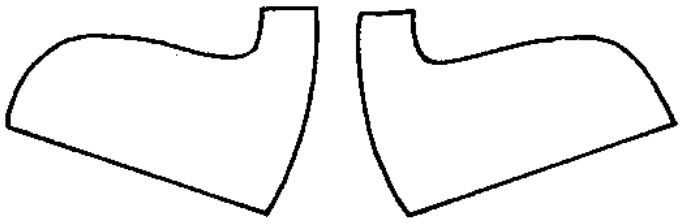


A common feature of peeptoe shoes or sandals is an open-back or "sling-back" upper, in which the quarters are replaced by a narrow strap to hold the shoe in position at the back of the foot.

2. Quarters

Quarters too may be simple or complicated. The front panels (where the eyelets of a lace up shoe are positioned) are often separate pieces called FACINGS. Even where the facings are not separate pieces, this area of the quarter is known as the facing area. Less common is the division of the quarter into FOXINGS enclosing the heel or seat and an INSERTION at the waist. This insertion will certainly comprise part of the topline and may or may not comprise part of the feather line. As an example, foxings and insertions are normal in BROGUED OXFORD shoes, of which the essential feature is the perforation along the various edges. (See photo on opposite page)

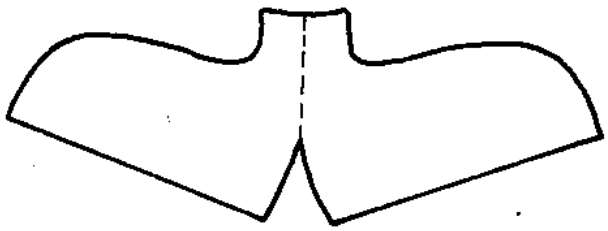




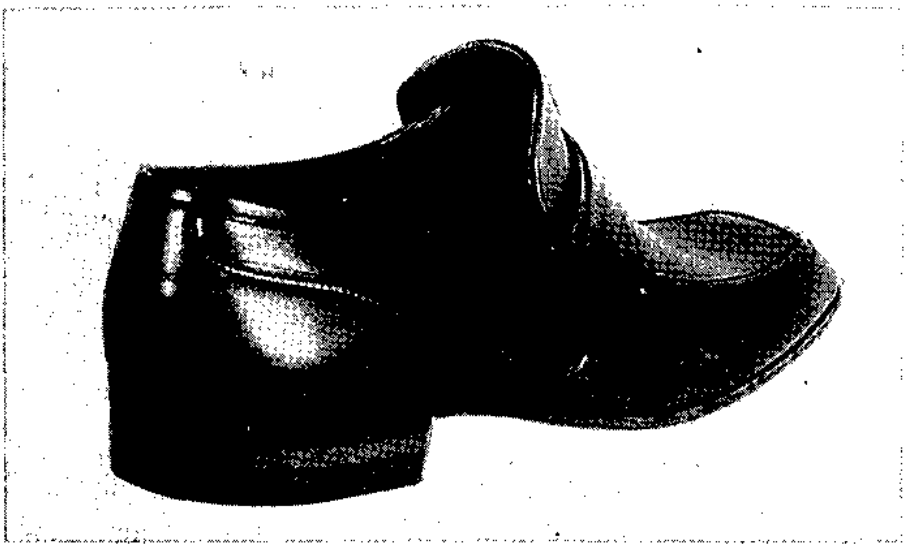
Foxing patterns

3. Counters

It has been stated earlier that an elementary shoe is made up of two quarters which are joined at the back. It is sometimes desirable to eliminate this heel seam so that the back of the shoe is cut as one piece. This one piece is called a COUNTER. This is normally joined at the waist to the vamp or wings but an insertion could be also included. Below is a pattern for a counter. Compare this with the foxing patterns.



Counter pattern



It will be noticed that even with a one piece counter it is necessary to have a small back seam to help shape the counter to the last shape at the back. Shoes are now being produced, however, which have this seam eliminated completely. The back is moulded to the shape of the last by a combination of heat and pressure.

4. Appliques

The essential fact about the different parts of a shoe described so far is that they are all separate pieces joined together to make a whole vamp or quarter. Each is performing an individual function essential to the composition of the shoe.

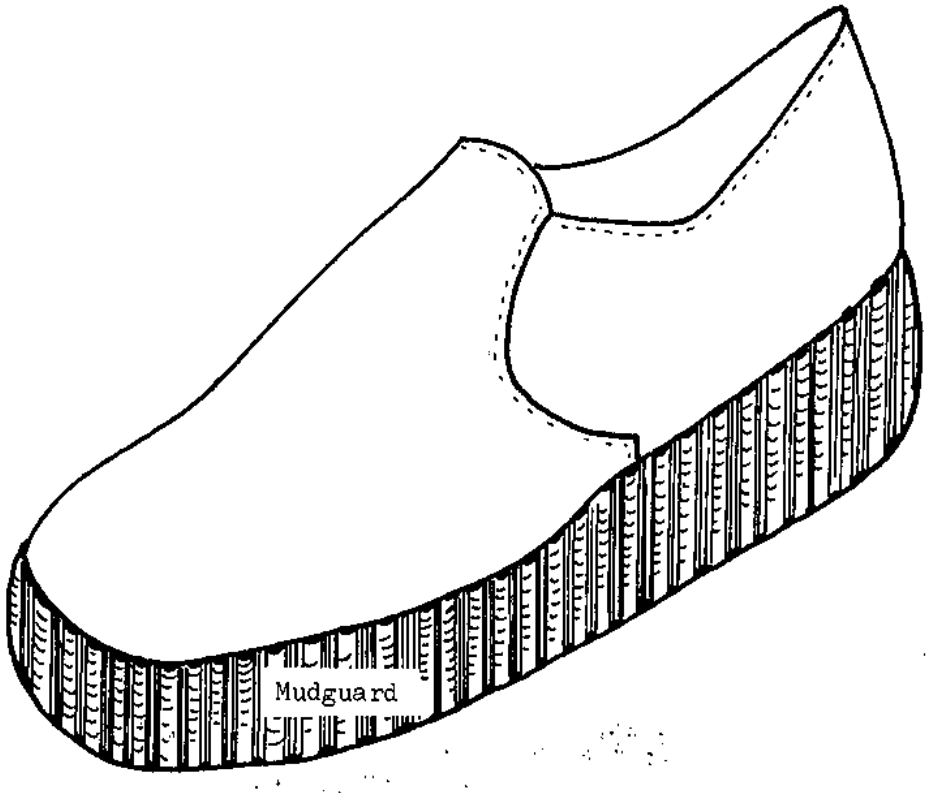
Different styles can, however, be achieved in an entirely different way. Duplicate pieces are attached to vamps or quarters which are already complete. These extra pieces - APPLIQUES - do not perform functions essential to the composition of the shoe although they affect its appearance. They add to the strength of a shoe by providing a double layer on the upper. They will cover seams which might otherwise be subjected to considerable strain in lasting and wear. Although more material is used this does not necessarily increase the cost as it is sometimes possible to make use of inferior parts of a skin under an applique.

Most parts of a shoe may, on close examination, be found to be appliques; i.e. toecaps, aprons, foxings and counters. Three other cases also need mentioning:

(a) Mudguards

These may be mistaken for simple wingcaps or for the wings of an

apron-fronted shoe. Essentially, however, they are designed to protect the side wall of the upper and to do this they are stitched to it, providing a double layer. When a rubber sole is vulcanized to the upper, a rubber mudguard may be included running the whole length of the shoe. The latter is quite commonly found with suede leather uppers to protect the suede from becoming soiled.



LIBRARY
Ohio College of Podiatric Medicine
10515 Carnegie Avenue
Cleveland, Ohio 44106

(b). Saddles and Bars

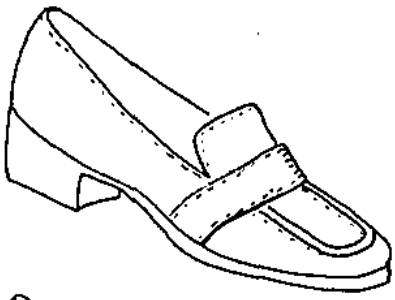
The vamp may have a saddle or bar across it from joint to joint. This may serve two purposes:

(i) To reinforce the shoe especially at the throat where it bears the continued strain of flexing.

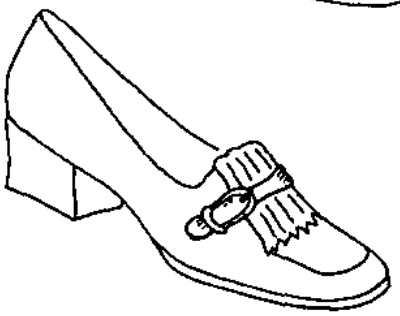
(ii) To cover a seam or gusset. This could be the vamp/quarter seam or could be the seam joining an apron to a tab or tongue.



Half-saddle



Full saddle

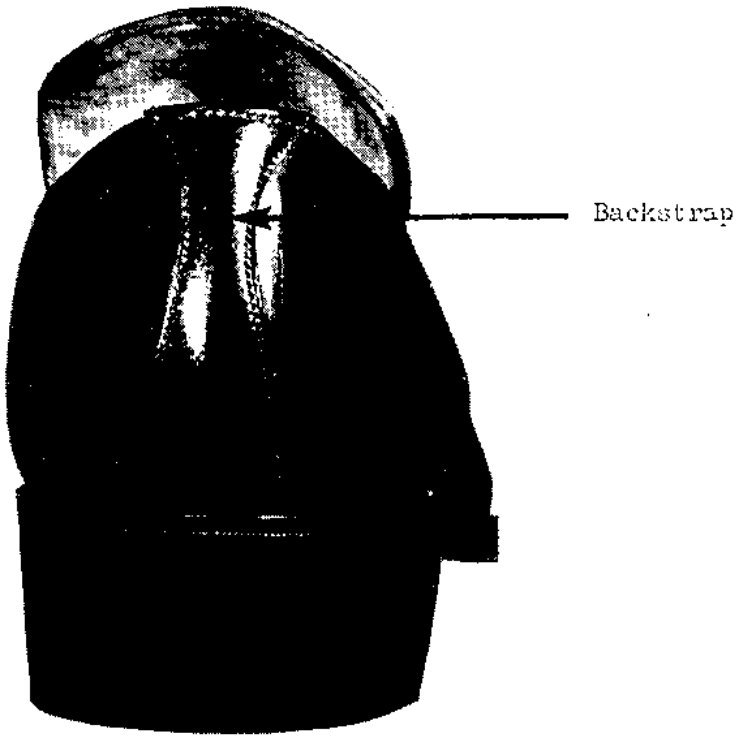


Bar

This should not be confused with a bar or strap used to secure the shoe to the foot, although this also may be used to cover the vamp/quarter seam.

(c) Backstraps

The heel seam is subject to considerable strain both in lasting and wear. It is common to reinforce it either with a counter or with a backstrap.



While these various appliques do serve a subsidiary purpose they are not essential to the composition of the shoe. In addition, appliques can be added which serve no purpose at all except to enhance the appearance of the shoe.

5. Fastenings

(a) Court Shoes

A court shoe has no adjustable means of securing and relies on an exact fit at joint and heel to keep it secure. It is essential that the topline should be taut with a tight clip around the back of the heel of the foot.

(b) Walking Shoes

Shoes with lower heels rely on support from the instep especially as they are less curved at the back than are high heeled shoes. The ideal is to have the topline sufficiently loose to allow easy entry for the foot, yet sufficiently tight to be secure in walking.

This problem can be overcome by:

(1) Introducing elastic into the topline

(2) Use of laces

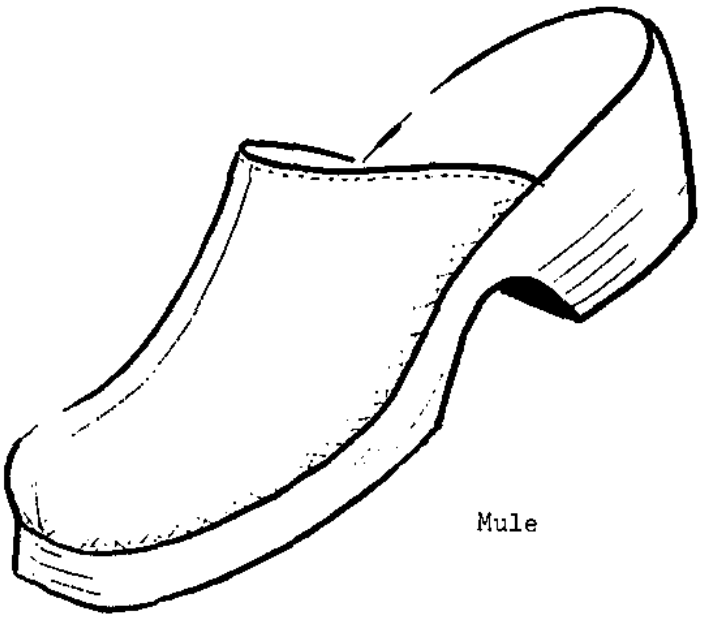
(3) Use of buckles

(c) Ankle Boots

The ideal of reconciling easy entry with security in wear is accentuated with ankle boots. It can be solved by elastic gussets, laces or zips let in at the appropriate place.

(d) Mules

It is possible to dispense with the quarters altogether and to rely solely on a vamp to hold the shoe on the foot. This style is suitable only for casual shoes and slippers as its security is doubtful.



Mule

6. Linings

(a) Counter Linings

A lining is inserted at the back of most shoes to cover the stiffener

or to help grip the back of the foot. The stiffener is inserted to give strength and shape to the back of the shoe.



(b) Quarter and Full Linings

More expensive shoes have a quarter lining extending to the facings or even a full lining for vamp and quarters.

(c) Backers

Certain parts of the shoe may need to be reinforced or given added substance. This can be achieved by sticking a fabric backer beneath the upper. This is stitched to strengthen the bond.

Examples are:-

(i) The throat of an apron-fronted shoe where the strain of flexing is most severe.

(ii) The facings of lace up shoes. These are normally supported with facing linings which are reinforced with a backer.

7. Ornamentations

The style of the upper depends essentially on the arrangement of the different parts described so far. These parts are all functional to a greater or lesser extent.

The appearance of the shoe can also be affected by the use of patterned leather for the upper material. Perforation or embossing the material will alter the look of the shoe. Trimmings (buckles, bows, etc.) which are decorative but serve no useful purpose also change the appearance. Mock stitching may be used to give a variation in design.

All these may catch the eye and enhance the sales appeal of the shoe. They are not fundamental to construction.

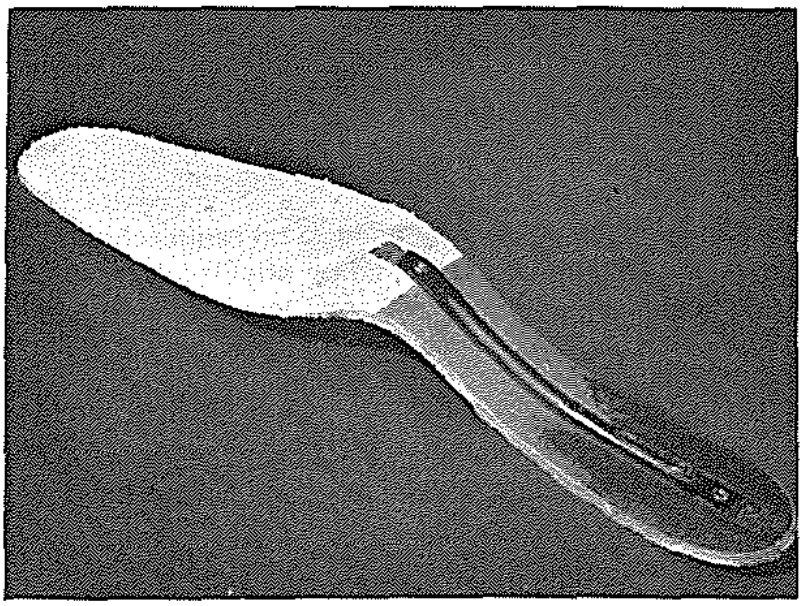
BOTTOMS

This is a term which refers to the whole of the bottom of the shoe as opposed to the upper. It generally includes some of the following, depending on type of construction.

1. Insole

This is the inner sole of the shoe which is next to the foot under the shoe sock. Insoles may be made all in one piece or, alternatively, in two pieces.

When an insole is made from two pieces it is known as a BLENDED INSOLE. The blended insole is made from a flexible forepart and a rigid backer.

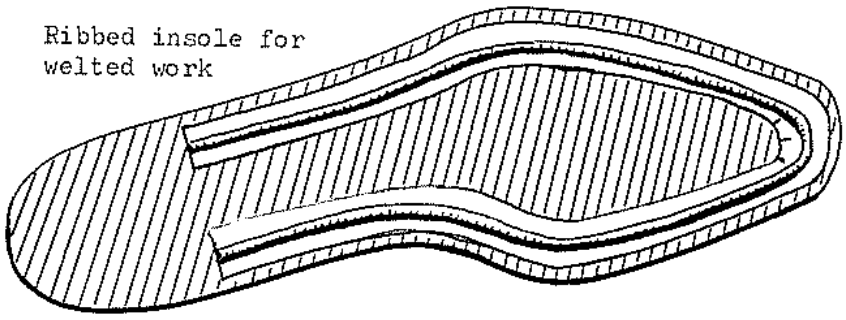


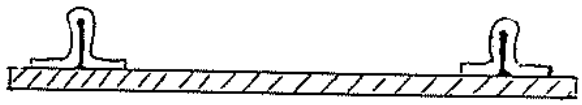
Blended Insole

New Balance - EX1016

The rigid insole backer maintains rigidity in the waist. This should not be confused with the term backer which is used to describe material suitable for reinforcing lightweight upper leather or fabrics.

Insoles prepared for use in WELTED construction may have a fabric rib attached, to which the welt is stitched.

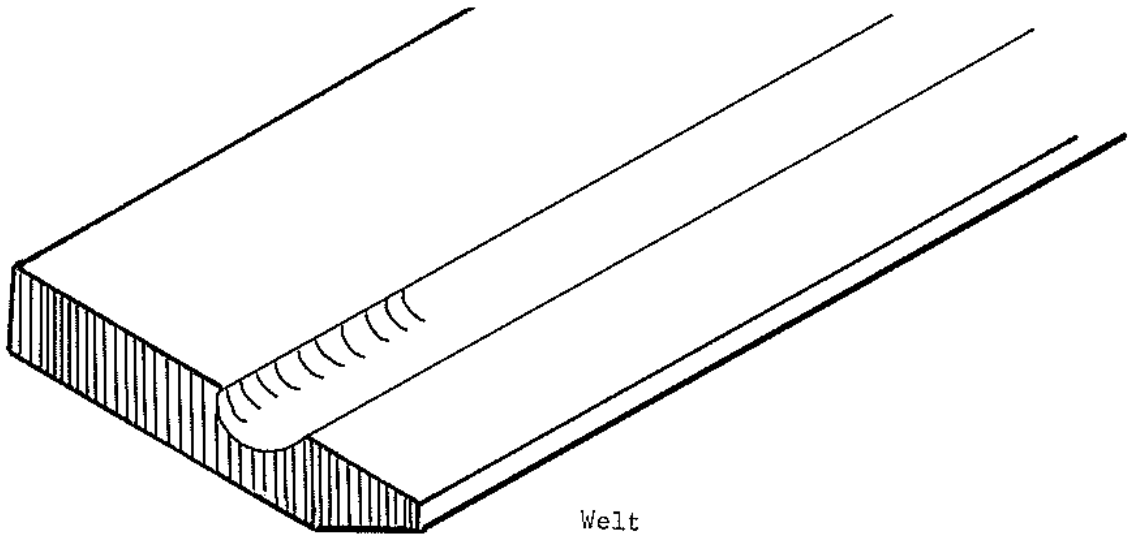




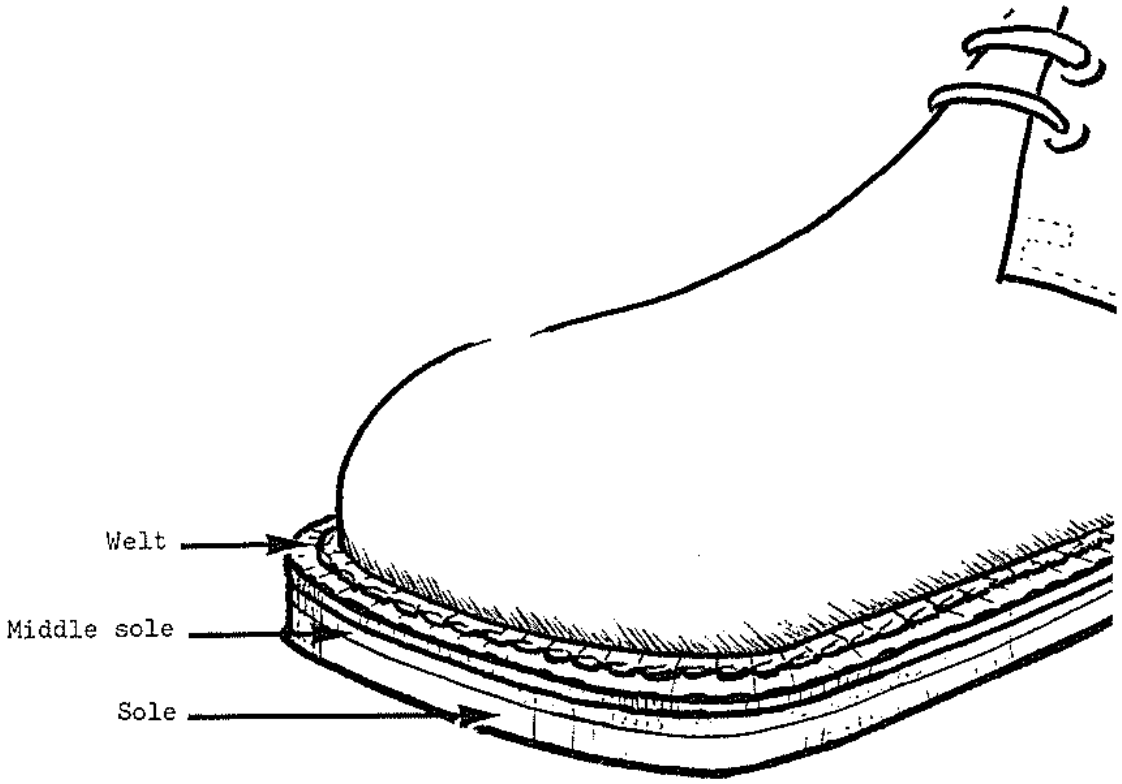
Cross section of forepart

2. Welt

A narrow strip of leather, sewn around the edge of a welted shoe, to the insole rib. The welt has a groove on its flesh side into which the welt sewing goes.



Welt



3. Bottom Filling

This is used to fill the cavity between the insole and the sole or middle sole. Bottom filling is usually made of a granulated cork mixture, leather or felt cut to shape. It is essential, as it goes in the forepart of the shoe, that whatever is used is flexible.

4. Through Sole or Middle Sole

An intermediate sole situated between the insole and sole. Usually to be found in sandals, heavy walking shoes and boots.

5. Runner

This is the name given to the insole of a sandal made by the Veldt-schoen construction.

6. Sole

The layer of material which covers the bottom of the shoe and is the walking surface of that shoe. The sole may be made of a diversity of material, i.e. leather, pure rubber, resin rubber compound, plastic.

7. Heel

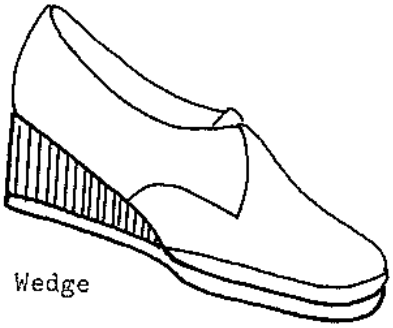
The under part of the shoe which supports the heel of the foot, and may be stuck or nailed to the shoe bottom. Can be made of leather, wood, plastic, rubber, leatherboard, etc. Heel shapes can be classified under these headings:-



Cuban Heel



Louis Heel



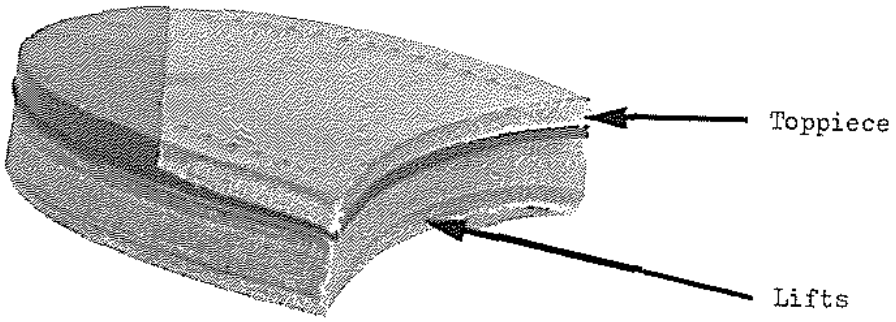
Wedge

The position of the sole in relation to the heel is the deciding factor when classifying a heel.

New Balance - EX1016

8. Heel Lifts

Layers of material such as leather or leatherboard which are built up together and shaped to form built heels.



BUILT HEEL

9. Toppiece

The top surface or walking surface of a heel.

COMPONENTS

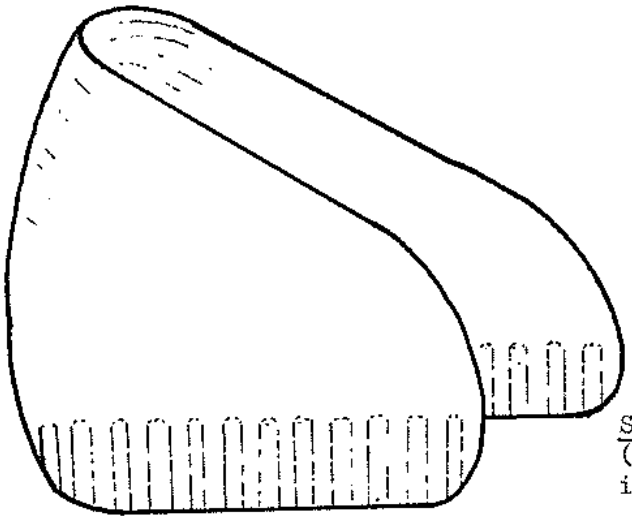
This is a collective term which is used to describe items which are incorporated in the shoe and includes the following:-

1. Toe Puff

A stiffening which is inserted beneath the upper and lining at the toe of the shoe. The purpose of this is to reproduce the shape of the toe of the last and to retain that shape throughout the life of the shoe.

2. Stiffener

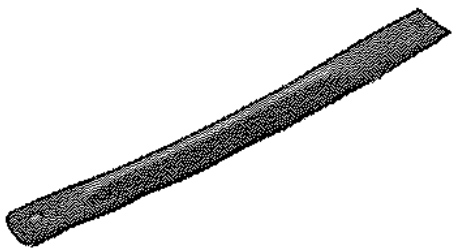
A stiff material which may be moulded to the shape of the last back-part or, alternatively, inserted flat and moulded during subsequent processes. It is normally inserted between the lining and outside to support the back of the shoe and to grip the foot.



Semi-moulded stiffener
(The final shape is imparted during lasting)

3. Shank

A strip of metal or wood used to reinforce the waist of the shoe. It is placed between the insole backer and the sole. Metal shanks will be premoulded to the last bottom curve.



Shank

4. Sock

A piece of material shaped to cover the whole or part of the insole. It is inserted into the completed shoe and usually bears the maker's name and the shoe brand name.

5. Eyelets

Tubular metal or plastic reinforcements inserted into lace holes.

CHAPTER 2

PRODUCT MARKETING

Introduction

When the economic climate in the industry is such that there is a Seller's Market operating (the consumer has limited choice so has to purchase what is offered or go without), the manufacturer designs and develops the products that he can produce most easily in the largest quantity with his available resources of materials, labour, machinery and plant. This situation existed in parts of the shoe industry in the 1950's but is unlikely to apply in most of the U.K. footwear market in the foreseeable future.

When the economic climate is such that there is, as now, a Buyer's Market operating (the consumer can choose between what is offered for sale by different manufacturers), the manufacturer, if he is to maintain or increase his share of the market, has to design and develop the products that satisfy the consumer's needs as well as, or better than, those products offered by his competitors.

Consumer Needs

The consumer, when choosing between alternative products, decides to buy the one that he believes will satisfy his needs in the following areas:-

i) Appearance and fashion content

ii) Fit and comfort

iii) Performance in wear

iv) Price

Some women, when buying court shoes, place the first priority upon fashion and are prepared to pay a high price for shoes of the right up-to-the-minute appearance, accepting that the particular fashion may compromise fit or comfort and that the shoes will have a limited life even when used for light town wear. When buying his shoes to be used on country walks or playing golf her husband may not be concerned greatly about the appearance but will spend the money that he considers appropriate to obtain the standards of comfort, water resistance and longevity that he needs. When they buy their children's shoes they may be prepared to pay a high price for fit and comfort, thus giving the maximum protection to the healthy development of the child's feet, not allowing current fashions to compromise this, but accepting that it is not necessary for the shoes to last longer than the six months that it takes for the child to outgrow them.

Market Segmentation

It follows from the above that, before designing and developing new shoes, it

New Balance - EX1016

is essential to have a clear idea of the needs of the potential purchaser when he or she is looking for footwear to fulfil a variety of purposes. The total market of shoe wearers is made up of individuals, no two of whom are the same. They differ both outwardly - sex, age, height, weight, foot dimensions and proportions - but also in their attitudes and behaviour, influenced by socio-economic factors - income, background, occupation, pastimes, family, etc.

In order that the economies of scale can be obtained, whereby large numbers of shoes of a limited range of styles can be sold, it is necessary to identify within the total population groups of people who have a common set of priorities. The shoe buying market, available to the manufacturer through the retail outlets that he services, can thus be split into a number of segments, defined by sex, age, attitudes, etc.

It is the job of the Marketing function to identify these market segments and then, using historic or motivational market research techniques to describe the footwear needs and priorities of the average member of the group in terms of the appearance, fit, performance and price he or she is prepared to pay for each item of footwear needed. If the design, development and production functions are then able to produce styles that satisfy these needs more effectively than the styles produced by the competition, their salesmen are in a position to be able to increase their share of the total sales to that segment of the market.

CHAPTER 3

FEET

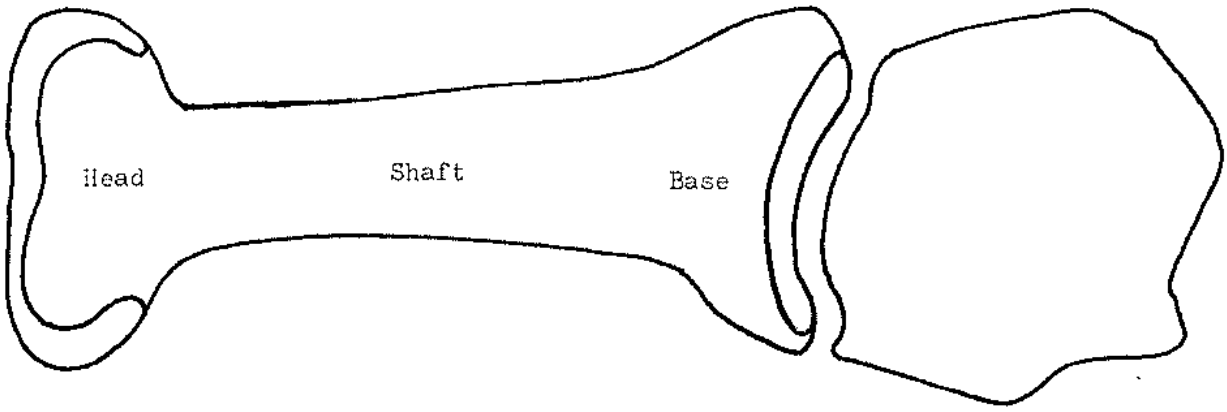
Introduction

When offering footwear to the consumer one of his needs that we are trying to meet is that concerning fit and comfort. Before designing and developing the styles for bulk manufacture it is helpful to understand the feet that they will go on, their structure, growth, functions and common troubles.

1. Bones

The skeleton of the body gives it strength, supports its weight and protects the more vulnerable organs.

Forming the skeleton there are short bones and long bones. These terms do not apply to the size of the bones but to their structure,method of growth and function. The short bones of the foot are mainly associated with weight bearing and the long bones with movement. The short bones usually have irregular shapes and interlock well with each other, but the long bones consist of a shaft separating a head and a base. The base is the end nearer the centre of the body.



LONG BONE (1st Metatarsal)

SHORT BONE

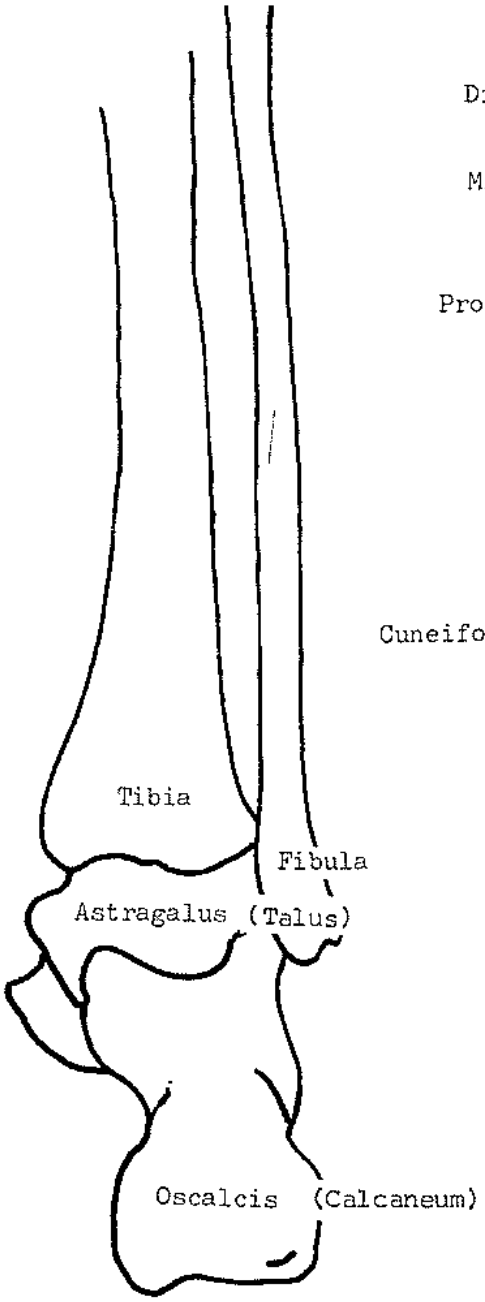
(Internal Cuneiform)

The foot is made up of twenty-six bones which can be divided into three groups, tarsus, metatarsus and phalanges.

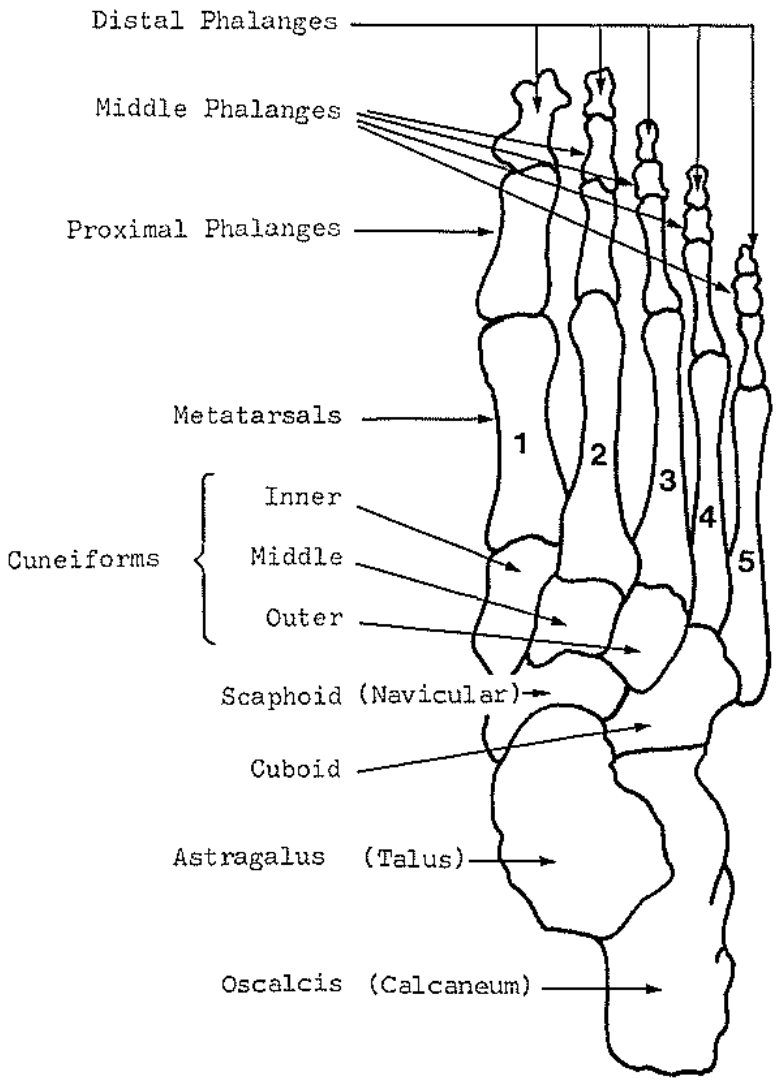
The tarsus group at the back of the foot has seven irregularly shaped short bones. The oscalcis (calcaneum) at the back is the heel bone

New Balance - EX1016

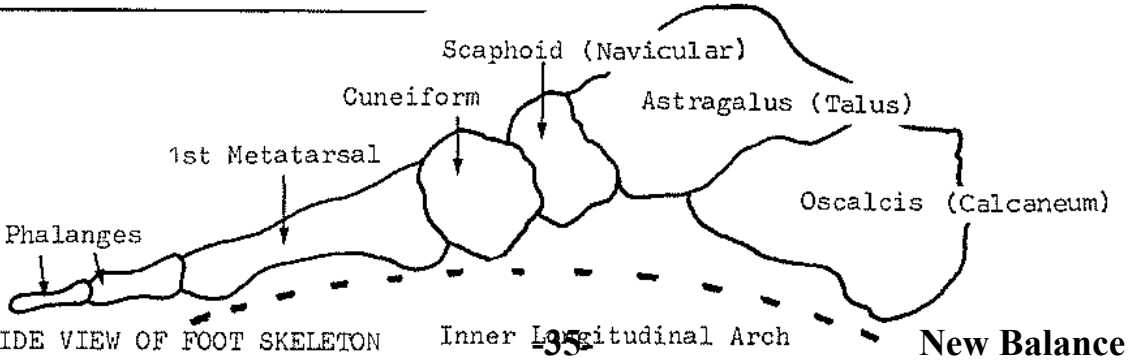
Bones of the Foot



REAR VIEW OF FOOT AND LOWER LEG



TOP VIEW OF FOOT SKELETON



INSIDE VIEW OF FOOT SKELETON

New Balance - EX1016

through which a large proportion of the body weight is transferred to the ground. On the top and slightly to the inside is the astragalus (talus) which links the foot to the leg, fitting between the two leg bones, and distributes the weight of the body to the forepart and heel. The astragalus is partly supported by a ledge (sustentaculum tali) on the inside of the oscalcis. In front of the astragalus is the scaphoid (navicular) and beside it and in front of the oscalcis on the outside of the foot is the cuboid.

In front of the scaphoid are the internal, middle and external cuneiforms, the external one lying beside the cuboid. The prominence on the middle cuneiform is used to locate the instep point.

The metatarsus group consists of the five metatarsals (long bones). The first three join the three cuneiforms and the fourth and fifth the cuboid. The first metatarsal is usually the thickest and the second the longest. The fifth has a tuberosity (prominence) on its base where it joins the cuboid.

The phalanges (singular phalanx) are the fourteen long bones forming the toes. The proximal phalanx of each toe is jointed with its appropriate metatarsal forming the main joint of the foot - the metatarso-phalangeal joint. Next come the four medial phalanges (not present on the big toe) and to them are jointed the five distal phalanges. Between the phalanges are inter phalangeal joints.

Almost always there are two small bones called sesamoids under the head of the first metatarsal. They help to protect the tendons passing under the big toe joint and improve the leverage of the big toe.

The lower part of the leg consists of two long bones, the tibia and fibula. The two bones are connected at each end and the thicker tibia is at the front and inside of the leg. At the bottom of each bone is a prominence (ankle bone) on the tibia called the inner malleolus and on the fibula the outer malleolus. The inner malleolus is slightly higher and further forward than the outer malleolus. The position of these ankle bones may affect the styling of footwear since a topline or seam that crosses them, or is just under them, often causes discomfort. The bases of the two bones together form a socket into which the astragalus fits - thus forming the ankle joint.

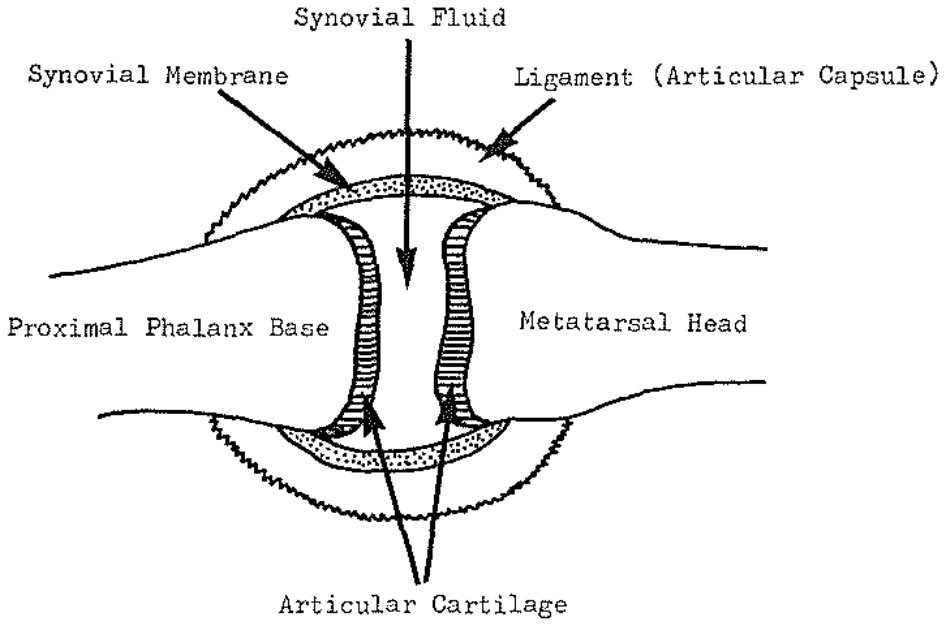
2. Joints

Some joints between two or more bones may require little or no movement so are held firmly together by strong inelastic tissues called ligaments.

Other joints where movement is necessary are called synovial joints. The mechanical movement at the joint could be:-

(i) Ball and socket, e.g. hip - movement in several planes
(ii) Hinge, e.g. knee - movement in one plane only
(iii) Gliding

The synovial joint provides lubrication (the synovial fluid secreted by the synovial membrane) and shock absorption and protection against wear of the bone (cartilage). The whole joint is then contained by ligaments.



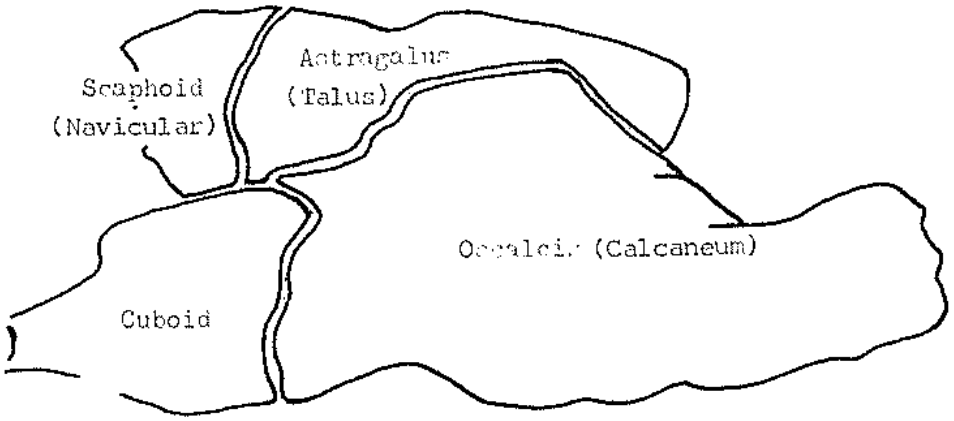
SYNOVIAL JOINT (Metatarso-phalangeal)

The main joints of the foot are:-

(i) Ankle joint - hinge
Tibia and fibula form a socket into which the top of the astragalus fits.

(ii) Sub taler joint - gliding
Astragalus glides on the oscalcis

(iii) Mid tarsal joint - gliding and ball and socket
Cuboid glides against the oscalcis
Scaphoid forms a socket for the astragalus



The ankle joint allows the foot to move up and down and the sub taler and mid tarsal joints allow it to move from side to side.

(iv) Metatarso - phalangeal joint - ball and socket during childhood - later hinge action only
Heads of metatarsal and bases of proximal phalanges

(v) Inter-phalangeal joints - hinge joints between toe bones

3. Ligaments

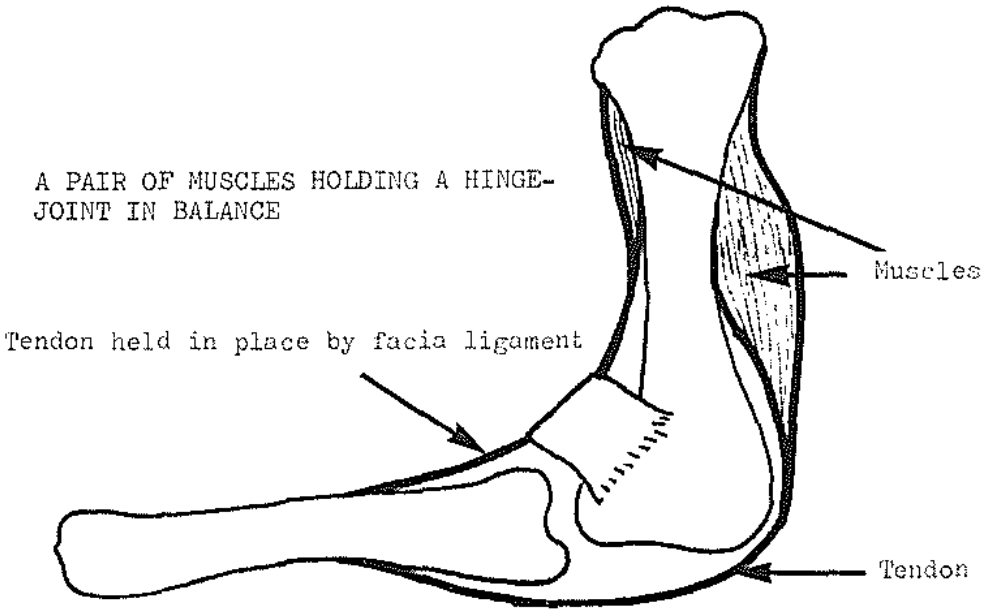
Capsular ligaments are made up of strong, fibrous tissue placed around the joints to prevent the bones from separating and protecting them from other than normal movement. When a joint has pressure on it to move other than within its normal range the ligaments help to prevent this movement. If the pressure is too great one of the ligaments is likely to tear. Where there is continued pressure the ligaments may stretch, resulting in the bones being displaced from their correct positions.

Articular ligaments cover the joint surfaces on joints where there is no movement.

Facia ligaments hold in the tendons, a spring ligament joins the oscalcis to the scaphoid and plantar ligaments connect the oscalcis to the under-side of the cuboid and the metatarsal bases.

4. Muscles

Muscles provide the force to move the bones. They are only able to contract or relax so there must be at least two antagonistic muscles controlling the movement at each joint and holding the joint in balance. Skeletal muscles consist of bundles of muscle fibres enclosed in a sheath. One end of the muscle is connected to a bone but at the other end the sheath is extended and becomes a tough non-elastic cord called a tendon. This tendon then transfers the power of the muscle to the point on another bone where it is to be applied.



Muscles that act on the Foot

There are four groups of muscles in the leg that act on the foot.

(i) The front group. Four muscles in front of and between the tibia and fibula whose tendons pass in front of the ankle joint. They raise the foot, turn the sole in and out and extend the toes up.

(ii) The outside group. Two muscles which join the fibula. The tendons pass behind the ankle joint so they bend the foot down and turn the foot out.

(iii) The surface back group (the calf). One muscle joined to the thigh bone (femur) and the other to the tibia and fibula. They pass, via the achilles tendon, over the back of the ankle and bend the foot down.

(iv) The deep back group. Four muscles under the calf whose tendons pass behind the ankle to flex the toes down and turn the foot in.

Of the muscles on the foot, one above the skeleton extends the toes. The others under the skeleton control the other movements of the toes.

5. Skin

The skin forms a complete covering to the body and varies in substance from 0.5mm on the eyelids to 5mm on the soles of the feet. The deeper 3/5 is the dermis and the outer 2/5 is the epidermis. The skin contains nerve endings, blood vessels, sweat glands and hair follicles.

(i) Nerve Endings

The nerve endings in the skin relay to the brain, via the spinal nerves, sensory messages concerning heat, cold, pressure and pain.

(ii) Blood comes from the heart via arteries which end by branching into thin hair like tubes called capillaries forming a fine network throughout the skin. The red blood cells transfer oxygen from the lungs to the tissues that they pass through and the fluid part of the blood carries in solution the chemical constituents of the food that is eaten. The blood also collects waste materials as it flows through the body. After leaving the capillaries the blood returns to the heart via the veins.

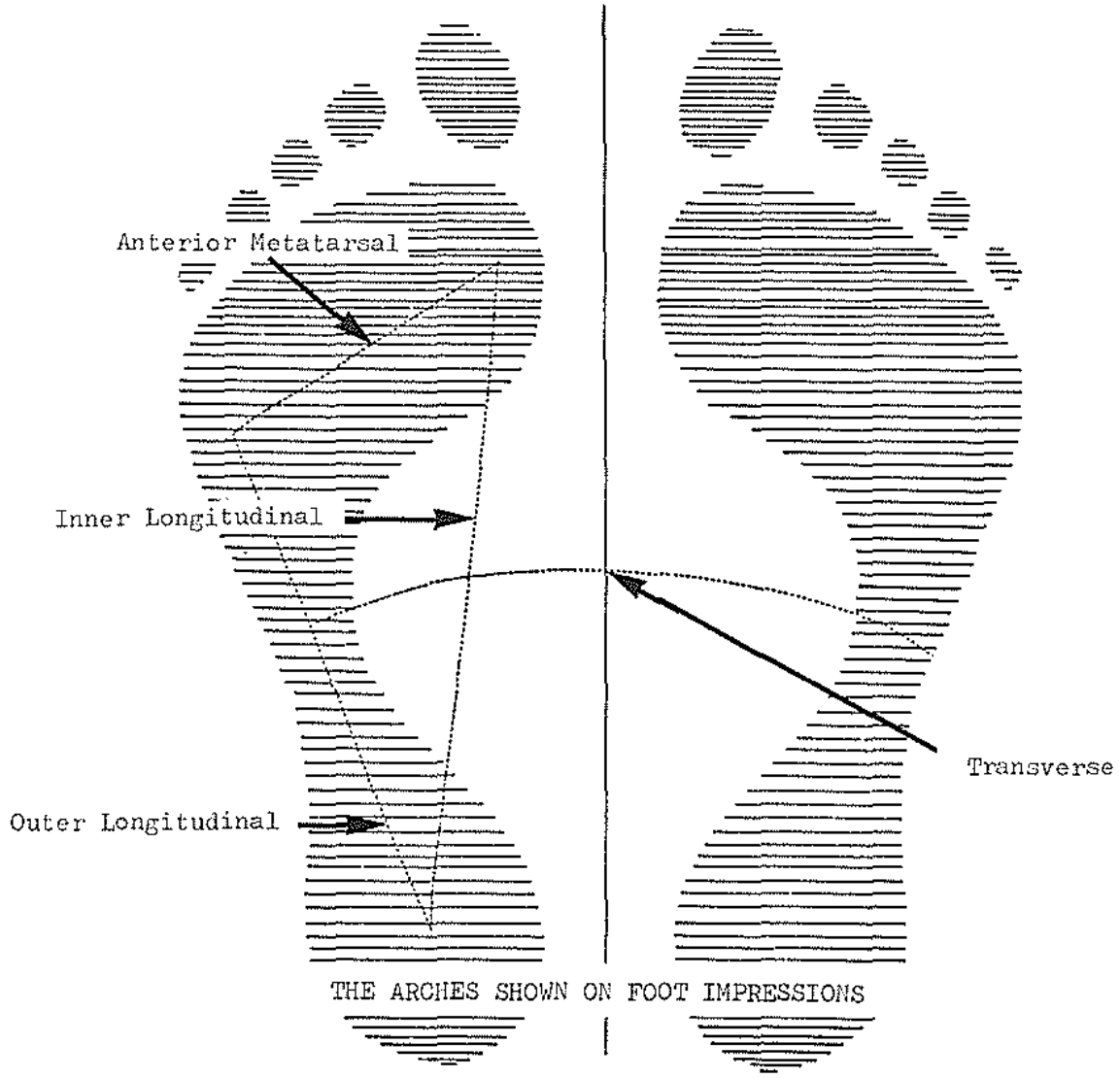
One of the ways in which the temperature of the body is controlled is by the capillaries preventing the blood from flowing to the surface when the outside temperature is low. (This may lead to frost-bite when the tissues on the surface are deprived of food and oxygen). When the body is over-heated the capillaries allow more blood to come to the surface, thus allowing heat loss. The feet contain much more blood than is necessary for their nutrition, thus allowing them to play a large part in this temperature control.

(iii) Sweat glands are present in larger numbers per square inch of the foot than in the skin of most of the remainder of the body. A duct leads from the gland and allows moisture to be passed out to the surface. This is one way of allowing the body to eliminate unwanted liquid but also keeps the skin supple and helps to control the temperature. There is a continuous low level of perspiration, but when the body becomes heated - from the sun, muscular activity or fever - a larger quantity is produced which cools the body as it evaporates.

Footwear and clothing should absorb this moisture easily and allow it to pass through to the outside. Where footwear is worn that has a closed style made from non-permeable materials socks of suitable fibres may allow some of the moisture to be lost past the topline by acting as a wick. Even this is cancelled out when some synthetic fibres are used or the style is a boot with a close fitting leg.

6. Arches of the Foot

The foot is arched longitudinally on the inside and outside and transversely at either end of the metatarsals. These can be seen when looking at the impressions made by a pair of feet.



THE ARCHES SHOWN ON FOOT IMPRESSIONS

(i) Inner Longitudinal Arch

From the oscalcis to the heads of the 1st three metatarsals including the scaphoid and cuneiforms. This arch has flexibility and provides for shock absorption and propulsion.

(ii) Outer Longitudinal Arch

From the oscalcis to the heads of the 4th and 5th metatarsals including the cuboid. This arch is nearly flat and lacks mobility and is suited for its function of supporting weight.

(iii) Transverse Arch

Interdependent with the inner longitudinal arch it forms the cross section across both the feet through the base of the 5th metatarsal, the cuboid and the cuneiforms. It is more rigid than the inner longitudinal arch and protects the main blood vessels and nerves supplying the sole.

(iv) Anterior Metatarsal Arch

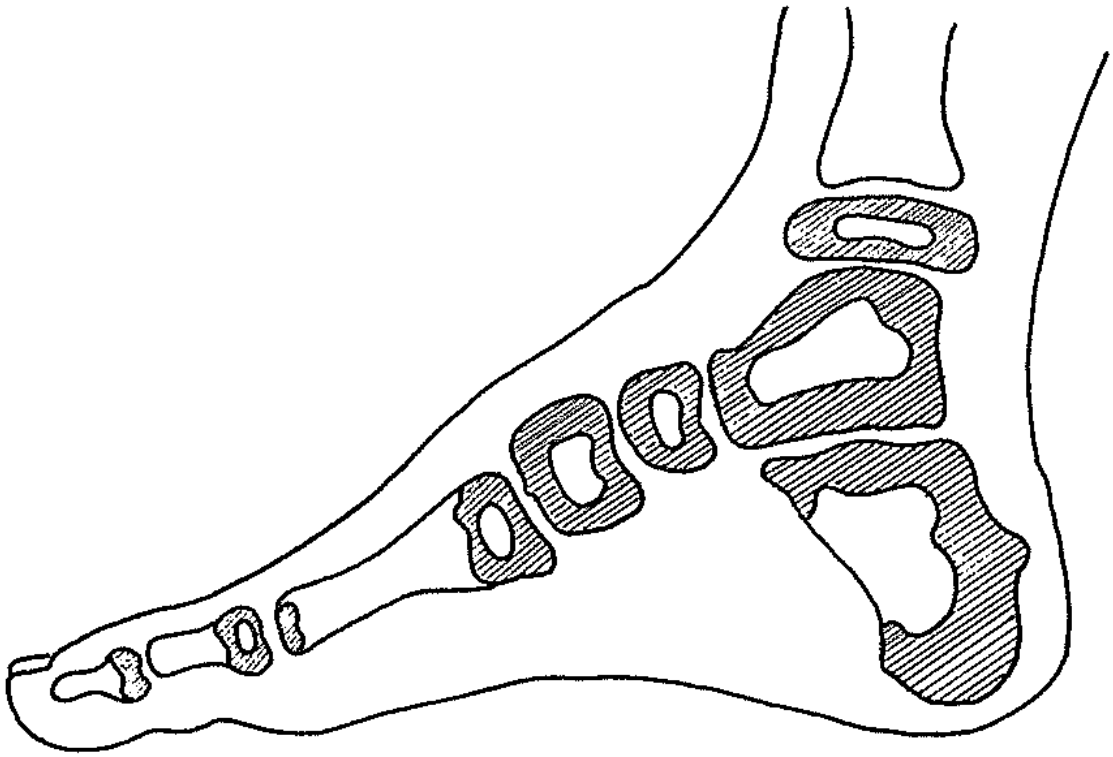
Only apparent when there is no weight on the forepart. This arch is formed across the heads of the five metatarsals. The strong ligaments joining them prevent the arch spreading too much and a disproportionate amount of pressure going on to the middle metatarsal heads when the foot bears the weight of the body.

7. Changes during Growth

During growth, changes take place in both the constituent parts of the foot - the structure of the bones and the amount of fat - and in the shape and proportions of the foot.

(i) Ossification

This is the term used for the development of the gristle-like cartilage into harder bone. The skeleton of the foot is of cartilage before birth and this is slowly transformed into bone, starting as early as the ninth week of the foetus and continuing until about the eighteenth year after birth.



SECTION THROUGH A FOUR-YEAR-OLD'S FOOT, SHOWING THE UNOSSIFIED CARTILAGE

The short bones each have a primary centre that starts turning to bone. When ossification is completed the short bones consist of a hard outer surface of compact bone and a spongy fibrous interior containing marrow.

New Balance - EX1016

The long bones of the foot develop from two separate pieces of cartilage each. The primary centre consists of the shaft and one end. The secondary centre consists of the other end which is similar to the spongy short bones and the two fuse together towards the end of the ossification process. The secondary centres of the phalanges and 1st metatarsal are the bases but the heads are separate on the other four metatarsals.

The long bones of the leg can be distorted if too much weight is applied before they are sufficiently ossified, e.g. by forcing the child to stand or try to walk too early. The usual distortion of the foot skeleton is when pressure from ill-fitting shoes or too tight socks force the bones to be incorrectly aligned at their joints. If the cause is not removed these misalignments can become permanent as the joints, ligaments and tendons grow and develop.

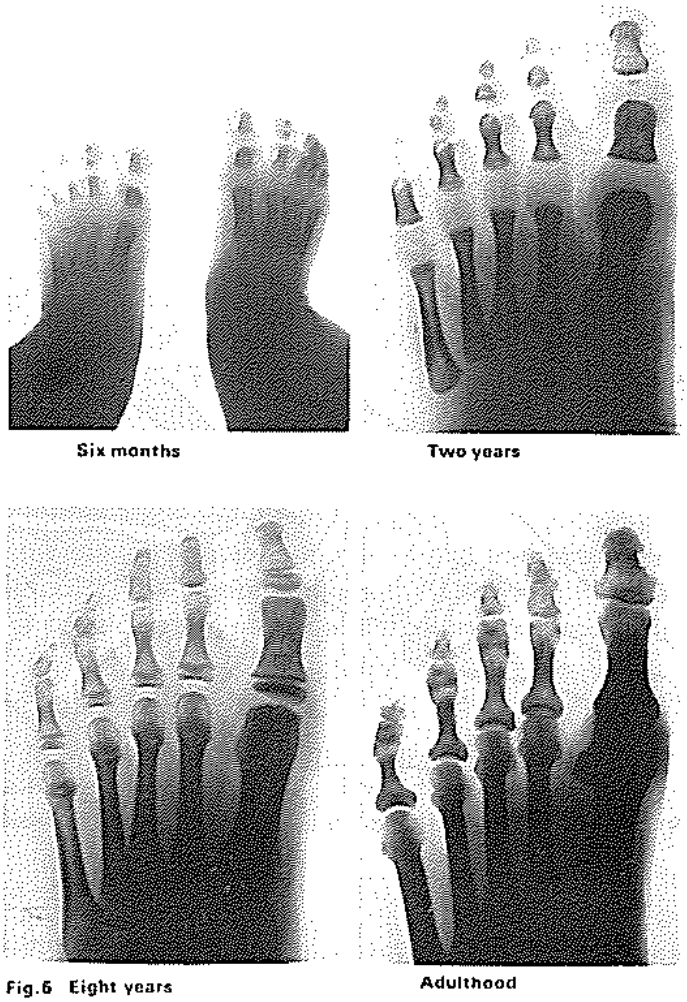


Fig.6 X-RAY PHOTOGRAPHS OF 4 STAGES IN FOOT GROWTH

New Balance - EX1016

(ii) Changes in Proportion

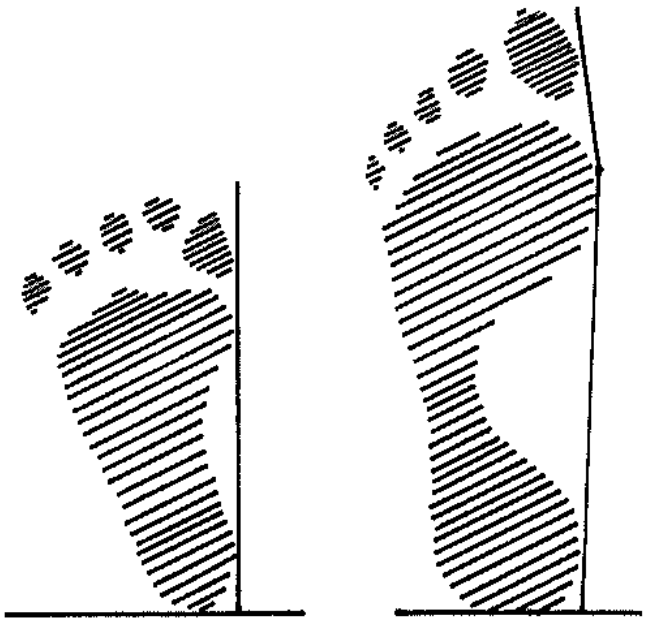
The infant's foot is not a miniature adult one but changes in proportion as it grows and develops.

The foot grows proportionately more in length than in width or girth. The growth is not even but the average sizes are:-

Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Boy's Size	5	7	9	10½	12	13	1	2	3	4	5	6	7	8	8½
Girl's Size	4½	6½	8½	10	11	12	13	1	2	3	4	4½	-	-	-

The rate of growth of the average boy's foot slows down from age 14 and ceases at age 17. For girls the average growth slows down from age 11 and ceases at age 15. It will be seen that the infants foot may grow 2 sizes (2/3 inch) in length in a year and the childs foot 1 size (1/3 inch) in length in a year. Knowing the expected life of the footwear we will, thus, be able to calculate the amount of space needed to provide for growth. The joint girth of the average foot increases approximately 3/16" for every 1/3 inch increase in length but the average foot continues to increase in girth and bulk for a few years after it ceases to grow in length.

At birth the foot is plump with a proportionately large amount of fat and fatty tissue covering the forming bone structure, giving an instep girth approximately 1/16" larger than the joint girth (size 4 at 1 year) and obscuring the inner longitudinal arch. The toes are separated and the toes and metatarsals spread out giving a fan like appearance which the narrow seat emphasises. The end of the toes are nearly level and the second toe is often forward of the big toe.



Comparison of child and adult foot impressions

During growth the fatty pads disappear and the fatty tissue does not grow in proportion with the skeleton. The metatarsals and phalanges become more parallel whilst the big toe grows longer than the other toes and an angle (the big toe angle) develops between it and the line drawn along the inside of the foot.

The metatarso-phalangeal joint line becomes less straight until it is at an angle of approximately 70° to the inside tangent line. The seat becomes proportionately wider so that the angle formed by the inside and outside tangental lines becomes more acute.

The instep girth of the mature females foot is approximately 3/16" smaller than the joint girth and on men's feet 1/16" smaller.

8. Functions of the Feet

Feet have to combine the two functions of:-

(i) Supporting the weight of the body and keeping it properly balanced in an erect position.

(ii) Propelling the body forward.

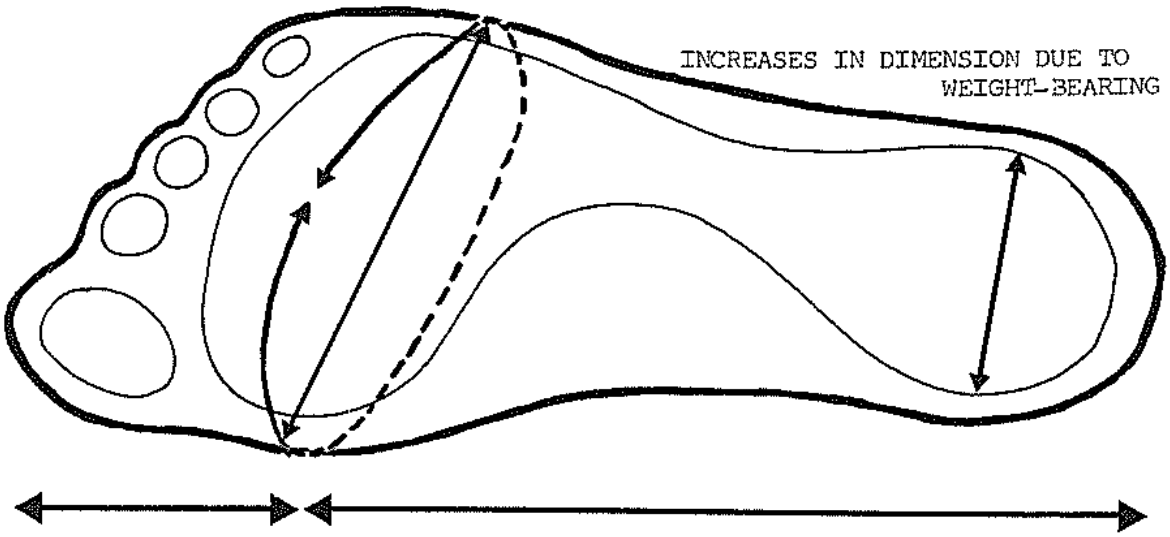
For the first they need stability and for the second flexibility.

(i) Weight Bearing

When the weight of the body is born by the feet it is distributed from the astragalus to the oscalcis at the heel, the heads of the meta - tarsals in the forepart and along the outer longitudinal arch.

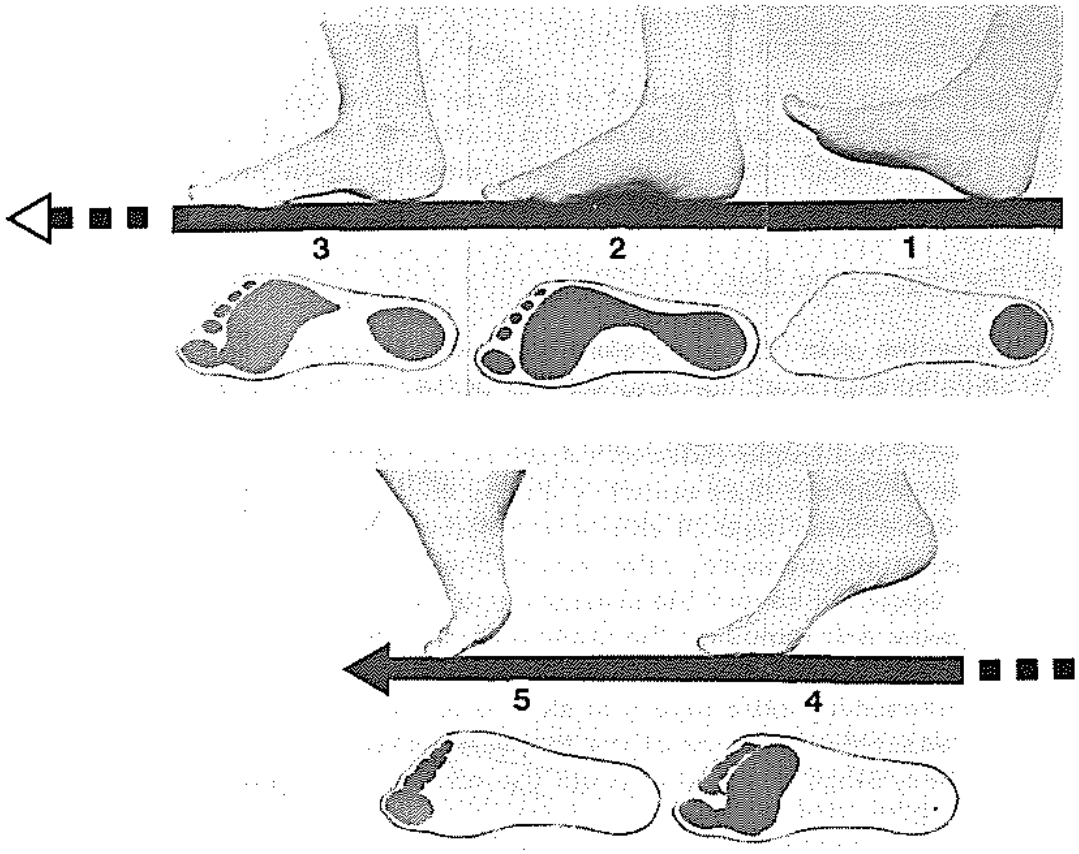
The inner longitudinal and anterior metatarsal arches become lower and longer. This results in the foot increasing in length from the heel to the metatarso-phalangeal joint and in the joint width becoming wider. The seat also becomes wider, the joint girth increases slightly and the toes lengthen as the great toes assist in providing balance. The length increase may be from ½ to 1 size.

New Balance - EX1016



(ii) Propulsion

During walking the whole body weight is taken by each foot in turn and is transferred from heel to toe as the centre of gravity of the body moves forward in relation to the foot on the ground.



The flexing of the ankle and metatarso-phalangeal joints, and the changing weight distribution during walking

New Balance - EX1016

The foot is lifted at the ankle joint as it leaves the ground and swings forward to stage 1, thus preventing the toes from touching the ground. The calf muscles later force the foot down in relation to the leg, lifting the body onto the forepart at stage 4.
In addition to this movement at the ankle joint the metatarso-phalangeal joint allows the toes to bend up as the heel is raised to stage 4 and then flexes them down as the foot leaves the ground at stage 5.

The dimensional changes noted when the foot is bearing the weight of the body whilst stationary also occur during walking but often by larger amounts as the whole weight of the body is concentrated on particular parts of one foot. The seat is at its widest at stage 1 but its narrowest at stages 4 and 5. The foot is lengthened at stages 2 and 3 as the longitudinal arches are flattened and the outer one takes some of the weight, but in stage 4 the inner longitudinal arch is heightened and shortened as the muscles tighten and it is used as a lever to lift the body from the fulcrum of the tread at the metatarso-phalangeal joint and the big toe in stage 5.

The joints within the foot, either moveable or not, all give slightly so that the shock as the foot comes to the ground is absorbed rather than transferred straight up the leg to the pelvis and spine.

9. Common Foot Troubles

Most babies are born with perfect or near perfect feet. For them the majority of foot troubles are caused by ill-fitting footwear or socks. If noticed early enough many of these troubles will correct themselves if better fitting clothing is worn.

(i) Damage to the Skin

When the skin is under pressure or mechanical stress there may develop a blister, callous, corn or bursa. A blister occurs when the skin is subject to unusual friction. There is a shearing movement in the deeper cells of the epidermis which causes them to break down and fluid builds up in the space. A callous is the build up of the outer layer of skin which becomes hard. This is caused by intermittent pressure, often around the edge of the insole at the seat. If it becomes severe the pressure should be removed by replacing the footwear and removing the outer layers of skin. A corn is formed by friction caused by localised pressure, often over toe joints, and again causing extra layers of skin to build up. The extra skin increases the pressure of the footwear causing pain as it presses nerve endings in the skin under the corn. The cause of the pressure

should be removed and also the thicker skin. Soft corns may form between toes if they are pressed together by narrow shoes and they require treatment to keep them dry once the pressure is removed. A bursa is a fluid-containing sac that develops over a bony prominence to protect the area. Bursae naturally occur in certain positions, e.g. between the achilles tendon and the oscalcis, but when they occur as a result of footwear pressure, e.g. over the big toe joint or the little toe, they are called bunions. Once the pressure has been removed, which in the case of the big toe joint may involve surgery as well as new footwear, the bursa can be incised.

(ii) Troubles of the Toes

Most of the deformities of the joints described below are caused by footwear that has insufficient space at the end and sides of the toes to allow for their extension during growth or when weight is borne by the foot or by footwear that does not hold the heel firmly in the seat but allows the foot to slide forwards.

(a) Hallux Valgus

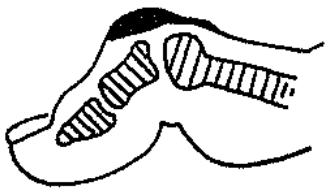


The great toe is forced over to the other toes at the metatarso-phalangeal joint. A bunion may form on the outside of the displaced metatarsal head. The short flexor muscle may shorten pulling the toe further round.

(b) Hallux Rigidus

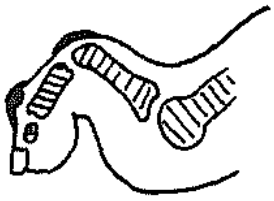
There is little or no movement of the great toe at the metatarso-phalangeal joint. In advanced cases the toe is flexed down permanently. This is usually caused by continual stubbing on the end of short footwear. To allow a more normal gait shoes may have a metatarsal bar fitted beneath the metatarsal heads under the sole.

(c) Hammer Toe



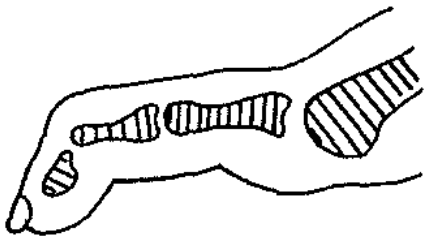
The first phalanx is extended and the second flexed down. A corn often forms on the first inter-phalangeal joint.

(d) Clawed Toe



As with hammer toe but the third phalanx is also flexed.

(e) Mallet Toe

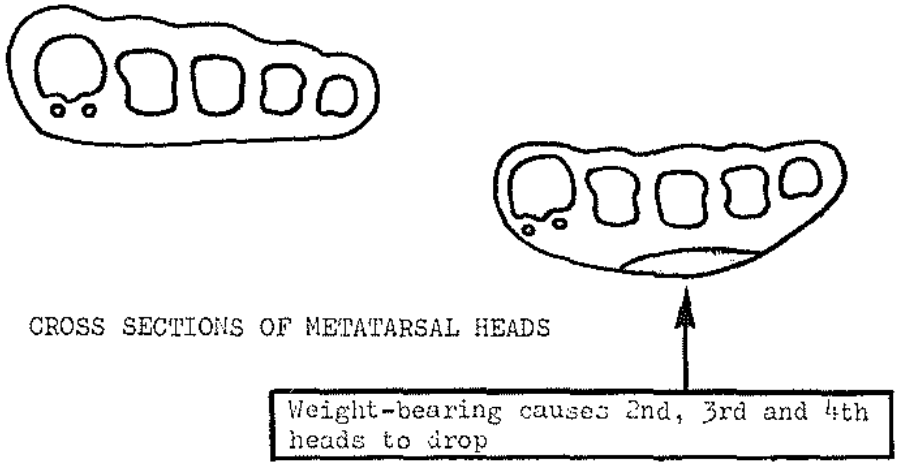


Only the second joint is affected and the distal phalanx flexed.

(iii) Troubles of the Arches

(a) Metatarsalgia

Pain under the metatarsal heads may be caused by dropping of the heads of the central metatarsals. This is often caused by an overloading of the forepart, e.g. wearing higher heels



than one is accustomed to, operating a machine with a foot pedal badly positioned or wearing narrow shoes cramping the metatarsal heads. A callous may form beneath the central

metatarsal heads, thus increasing the pressure. Metatarsal pads can be fitted in the shoes, either to provide a cushion under the central metatarsal heads or to take the weight on the forepart under the 1st and 5th metatarsal heads or on the shafts behind the central ones.

(b) Pes Planus (flat foot)

The inner longitudinal arch flattens as the oscalcis and astragalus tip forward and the forepart turns out due to the stretching of the ligaments and muscles, sometimes caused by the foot having to bear extra weight, e.g. after a long illness or during pregnancy, but usually this is congenital.

(c) Pes Cavus (humped foot)

The longitudinal arches are high with the arch visible on the outside of the foot increasing the weight borne by the forepart. Shoes with a high waist, generous in-step girth and cushioning under the arch are required.

(iv) Valgus Ankle and Pronation

The back of the the foot tilts inwards so that the weight is borne on the flattened inner longitudinal arch and the spreading forepart. In very young children ankle in-rolling is normally self correcting as the muscles strengthen and develop. If still present at about the fifth year corrective footwear is often used which tilts the foot by incorporating wedges to raise the sole, insole or heel on the inside.

CHAPTER 4

FOOT MEASUREMENT

INTRODUCTION

Feet are measured for a variety of purposes. A bespoke shoemaker requires information about his customer's feet so that he can either have lasts made or can fit up lasts chosen from his stock in order that the footwear made on them will satisfy the fit and comfort needs of that particular customer.

A manufacturer producing footwear in bulk requires sufficient information about the feet of the segment of the market that he seeks to satisfy, for him to be able to produce a range of lasts in sufficient sizes and fittings on which he can make a number of styles which will satisfy the needs of the largest percentage possible of that market segment for the lowest cost in last plant, equipment and finished stocks on the shelves of his and the retailers' stock rooms.

The retailer needs to measure his customers' feet in order that he can select from his shelves the footwear that, when tried on the customer's feet, will produce an acceptable fit.

1. MEASUREMENT FOR BESPOKE FOOTWEAR

The bespoke shoemaker would often require:-

i) A draft - outline plan of the foot with weight on.

ii) An impression - to show the distribution of weight.

iii) A profile - to show height of big toe and instep contour.

iv) Length (taken on a size stick).

v) Width (taken from draft).

vi) Girth measurements (locations markers on draft).

a) Joint - around metatarso-phalangeal joint.

b) Waist - smallest girth behind joint.

c) Instep - smallest girth passing over prominence on middle cuneiform.

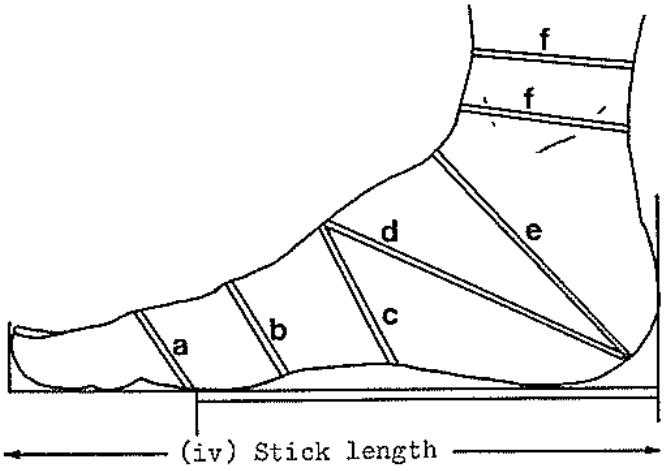
d) Long heel - seat to instep to give "pass line" in riding boot.) Required for Boots

e) Short heel - seat to lowest crease in front of ankle.)

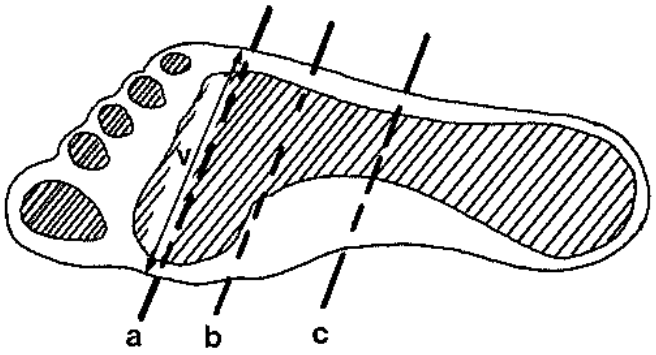
f) Ankle - around and above ankle bones.)

g) Calf, thigh as necessary.)

New Balance - EX1016



(iii) Profile



(i) Draft and (ii) impression

2. FOOT SURVEYS

A foot survey needs to provide the footwear and last manufacturers with sufficient information to allow them to:-

i) produce a pair of model size lasts on which footwear can be made which will give the required standard of fit to people whose feet are of the model size and fitting, and as large a range as possible of those with feet that are longer and shorter and wider and narrower.

ii) To select the people to try on the test footwear whose feet can be compared with the average feet of the size and fitting the model footwear is made to and whose feet can be compared with those of the segment of the market that the footwear to be made on those lasts will be designed for.

iii) To indicate the range of sizes and fittings required to satisfy the fit needs of that segment of the market.

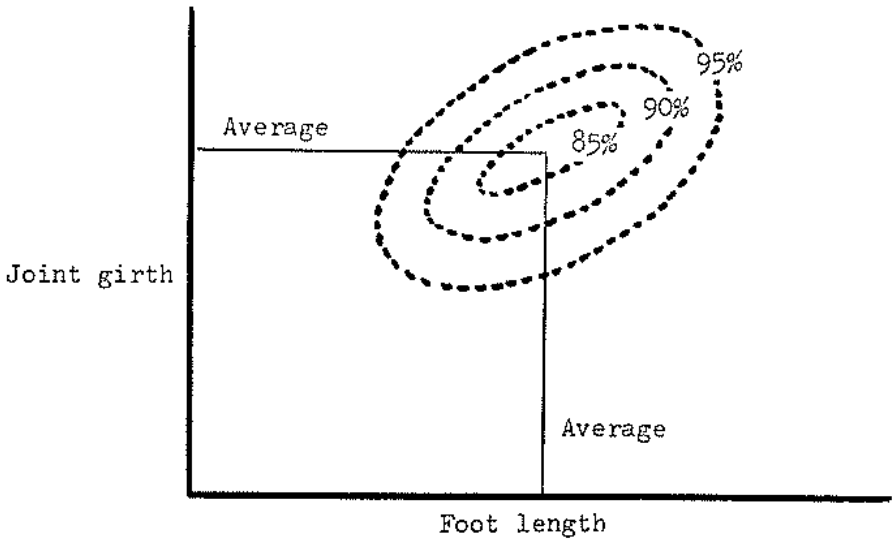
iv) To select the people as in (ii) above to try on the test footwear produced in the fittings and a selection of the sizes that will be manufactured after consideration of (iii) above and the cost of meeting those needs.

It follows from the above that a foot survey needs to be of a large enough sample to be statistically reliable. A typical one might have details of the feet of 8,000 each of the three groups, men, women and children. In order to relate this information to specific segments of the market (e.g. comfort shoes for women in the U.K. who are prepared to pay above average prices but want basic styling), the sample 8,000 women must be selected to give a representative picture of the feet of all women in the U.K. - women from different parts of the country, from different socio-economic levels and of different ages. The measurements of the foot of only those women who form the particular market segment can then be extracted from the survey data.

When making bespoke footwear the shoemaker will usually test his specially made or fitted up lasts by trying a pair of test shoes on his customer's feet and then modifying the lasts as necessary. The bulk manufacturer needs enough information to build up statistical models of the average feet of various sizes and fittings and the deviations from the average that he intends his footwear to fit. It is further necessary that the positions located on each foot, e.g. top of big toe or instep point on middle cuneiform - are measured in three dimensions, i.e. from the back of the heel, from a line drawn at a tangent to the inside of the foot and vertically from the base plane on which the foot is resting.

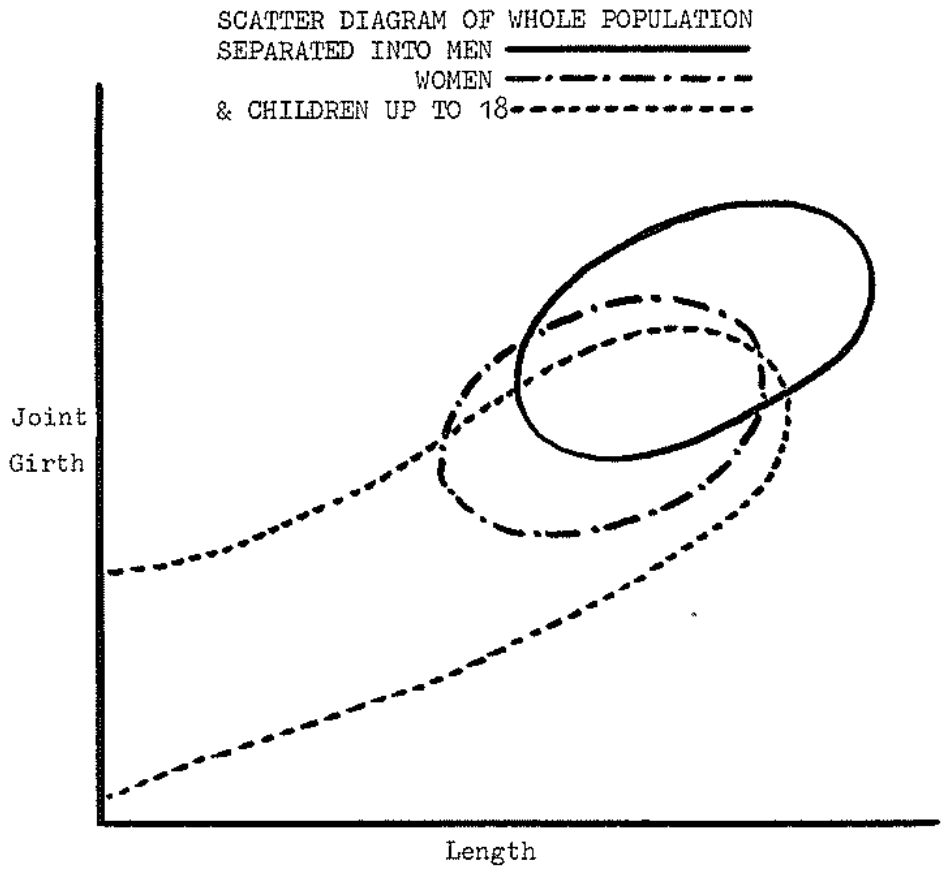
In a typical survey approximately 20 measurements might be taken and from the plan or draft of each foot could be measured the angles of the big and little toes and the metatarso-phalangeal joint to the tangents of the sides of the foot.

One of the ways in which the statistics gathered can be shown visually is by the use of "scatter diagrams" whereby the measurements of any two dimensions, e.g. foot length and joint girth, of each foot measured, are plotted on a graph:



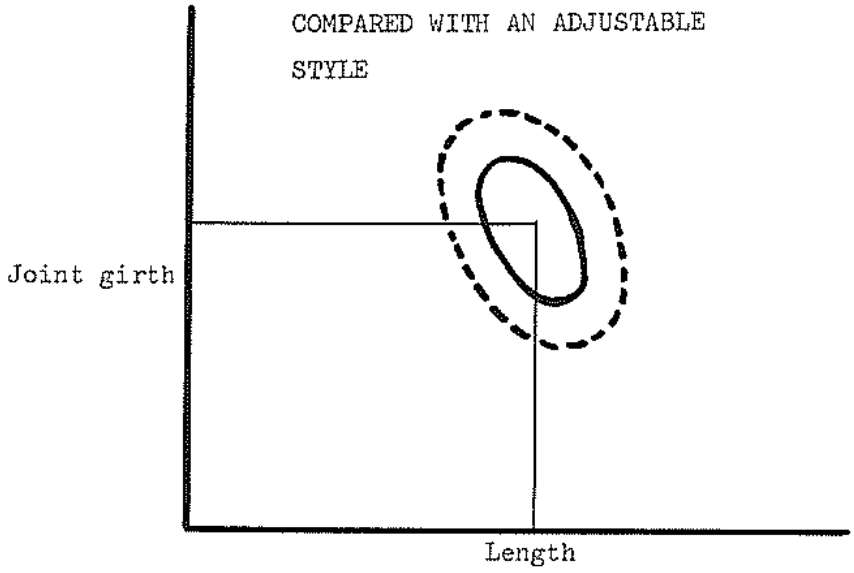
New Balance - EX1016

It is possible to see on the diagram the length and joint girth of the average foot and lines can be drawn to show the distribution of the two dimensions throughout the sample of varying percentages of the total number of feet measured. In the example above the two dimensions of 95% of the sample fall within the outer eclipse, 90% the next and 85% the inner one.

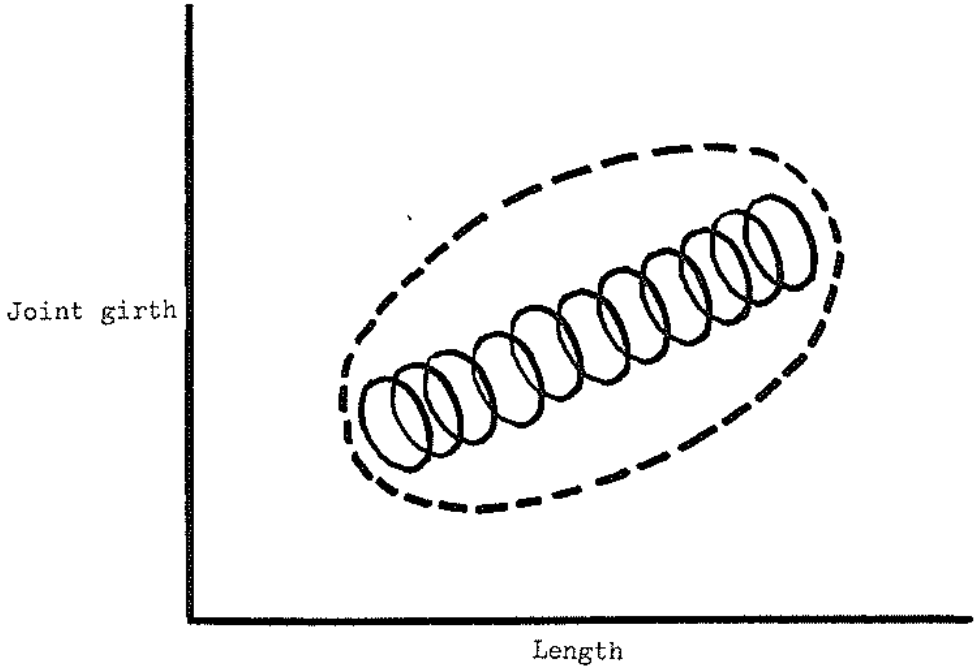


Different styles made on different lasts out of different materials vary in their ability to provide a satisfactory fit for people whose feet vary in length and joint girth. A court shoe made on a fashion last out of tight upper material with little "give" in it will not fit the same range of feet as an adjustable comfort shoe made from a giving material like a suede. This fit tolerance of any given style can be found by trying a range of slightly differing feet in the same model size shoes.

FITTING TOLERANCE OF A COURT COMPARED WITH AN ADJUSTABLE STYLE



By superimposing the chart showing the fitting tolerance of a style upon the scatter diagram which shows the range of length and joint girth dimensions of the segment of the market to be fitted, it is possible to see the ideal difference in the length of each size and joint girth of each size necessary to fit the largest percentage of the market with the smallest number of different sizes.



LENGTH AND JOINT GIRTH DISTRIBUTION OF 90% OF MARKET POPULATION

FITTING TOLERANCE OF STYLE BEING TESTED

New Balance - EX1016

From such tests it would be seen that ideally a style with a small fitting tolerance would need to be produced in more sizes each having a smaller increment than a style with a larger fitting tolerance. It may be that ideally a court shoe should be made with a length increment of 1/6" between sizes offered - a man's walking shoe 1/4" and an open back, open toe multi adjustable sandal 1/3".

3. SIZE SYSTEMS

The size systems that have evolved in varying parts of the world are not used as flexibly as this and at the present time are as follows:-

English A size increment of 1/3" in length with half sizes 1/6". Size O is 4" long and after size 13 at 8.1/3" the numbering starts again with 1 at 8.2/3".

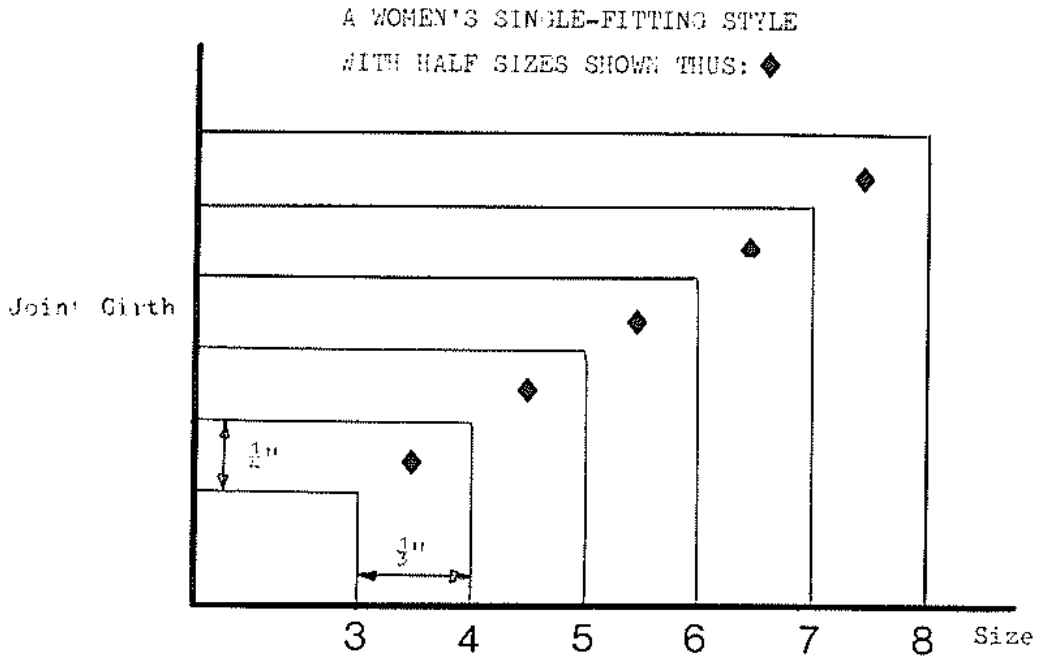
American Also a size increment of 1/3" with 1/6" half sizes but with zero at 3.11/12". After size 13.1/2" subsequent size notations are in tens starting at 25 the equivalent of English 1, 30 English 1½, 35 English 2, etc.

Continental A size increment of 2/3 cm known as a "Paris Point" or in Germany a "stitch" starting with zero at 0 cm and continuing up the scale without repetition. Since 2/3 cm is approximately 1/4" shoes are not usually made in half sizes.

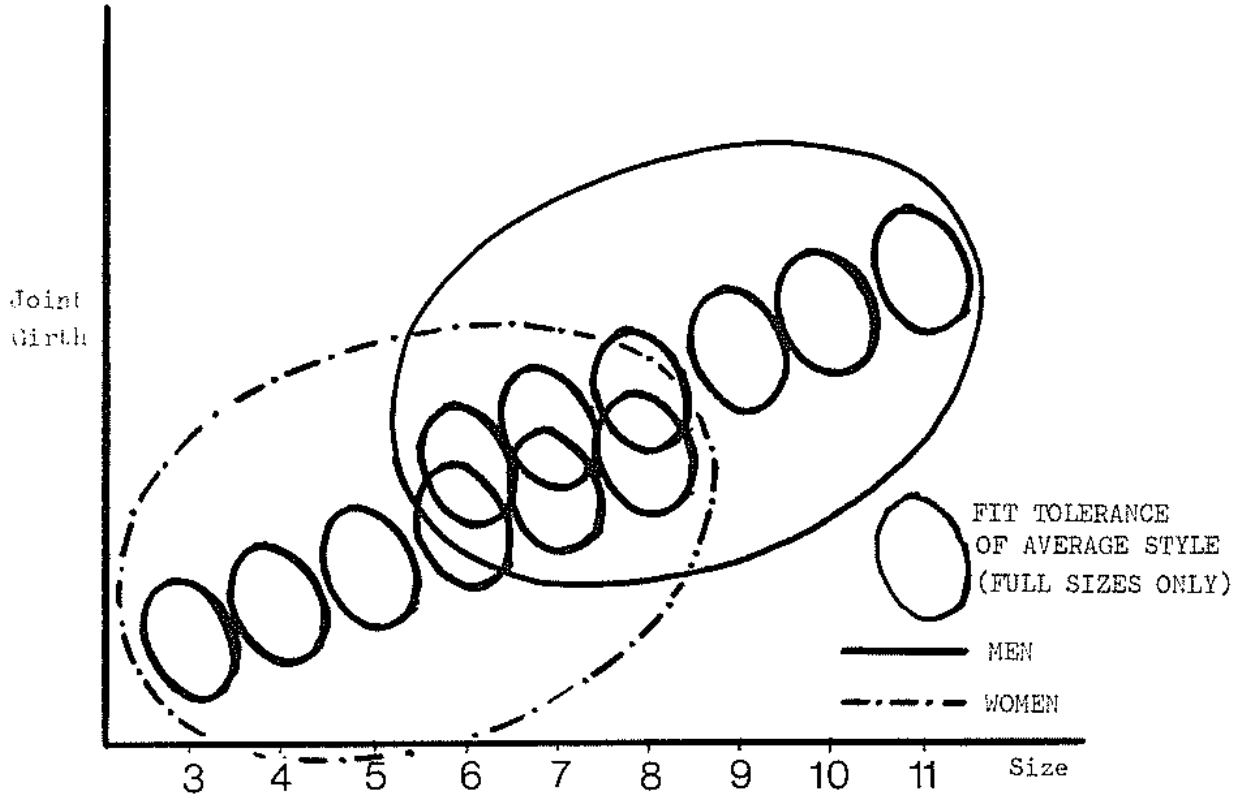
Centimetre System A size increment of 1 cm with half sizes of 1/2 cm. Used in some mid European countries.

Mondopoint Developed by the International Standards Organisation. The size marked is the length in millimetres of the average foot which fits the footwear, the foot measurement being taken with weight on and wearing hose. Size increments would be 5 mm or 7½ mm. The width of a shoe (also quoted in millimetres) is the joint width of the average foot which fits the shoe. In multi-fitting ranges the width interval between fittings should be either 3 mm or 4 mm.

The joint girth increment used above a childs size 12½ with the English 1/3" length increment is 1/4" per whole size. (See diagram overleaf).

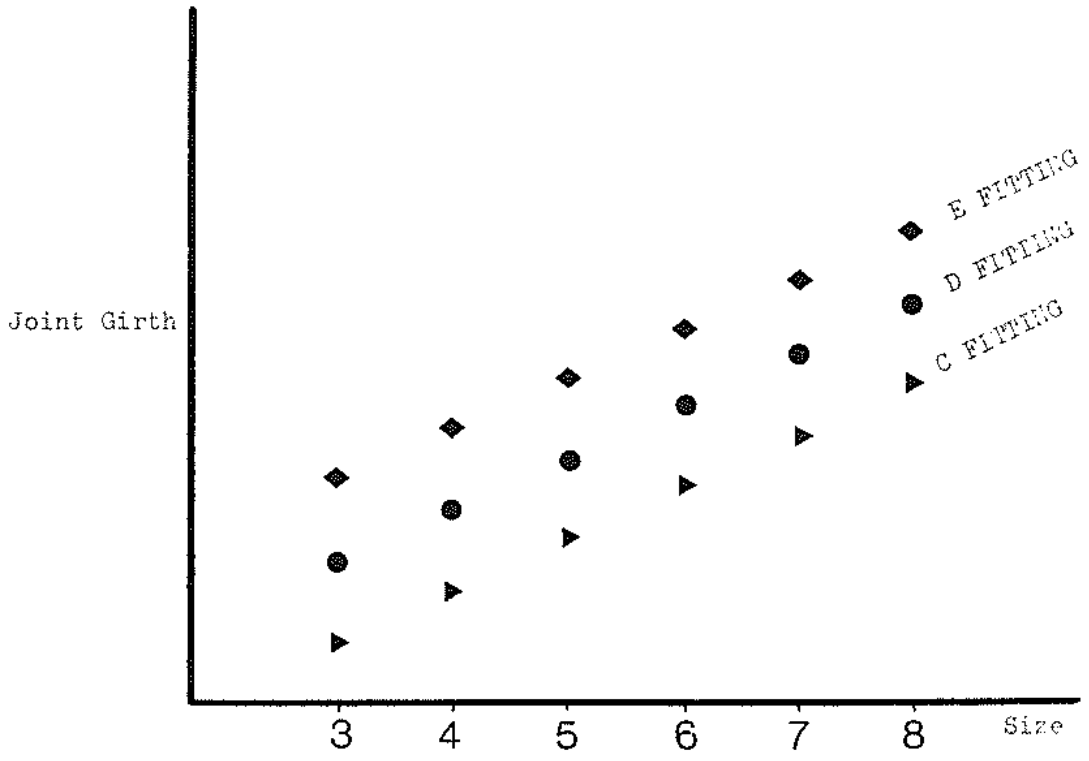


When the usual size ranges, Women's 3 - 8 and Men's 6 - 11 are superimposed upon the scatter diagram showing the distribution of length and joint girth in the adult population it will be seen that the increments of 1/3" and 1/4" match it fairly well.



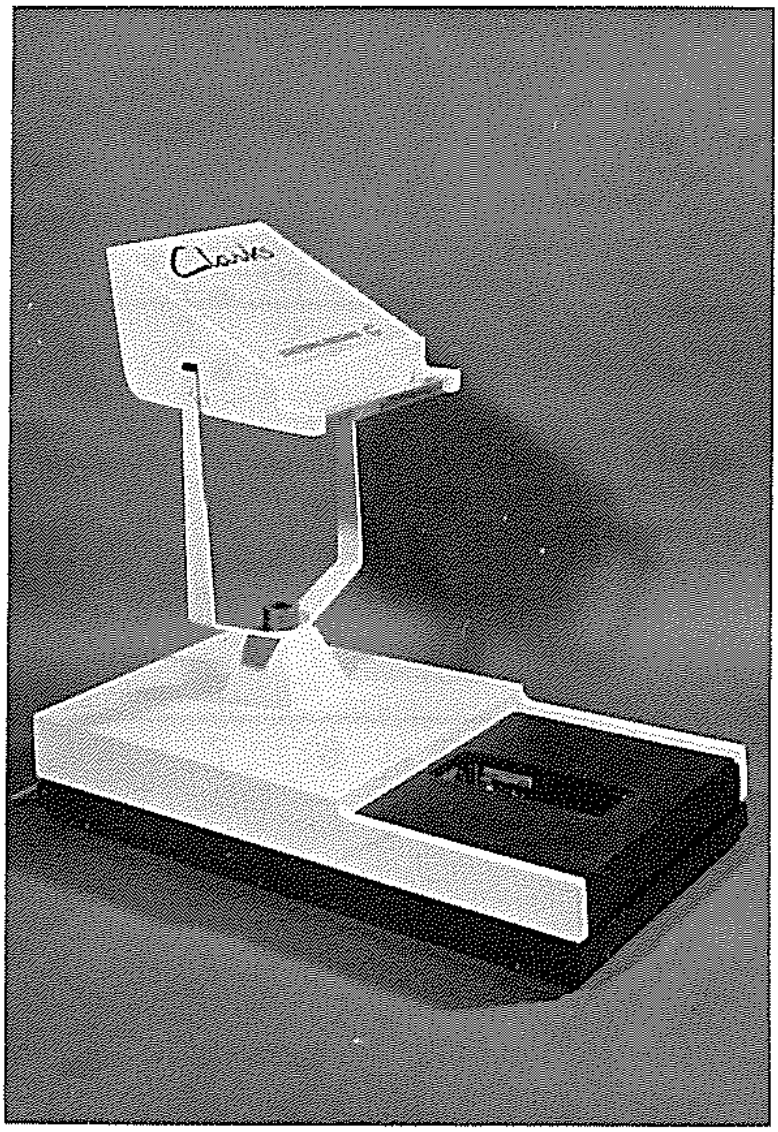
New Balance - EX1016

It will also be seen that the fitting tolerances of the average styles shown do not allow people with joint girths that are larger or narrower than average to be fitted. For this reason it is necessary to make footwear with alternative joint girths for each size in a range of fittings.



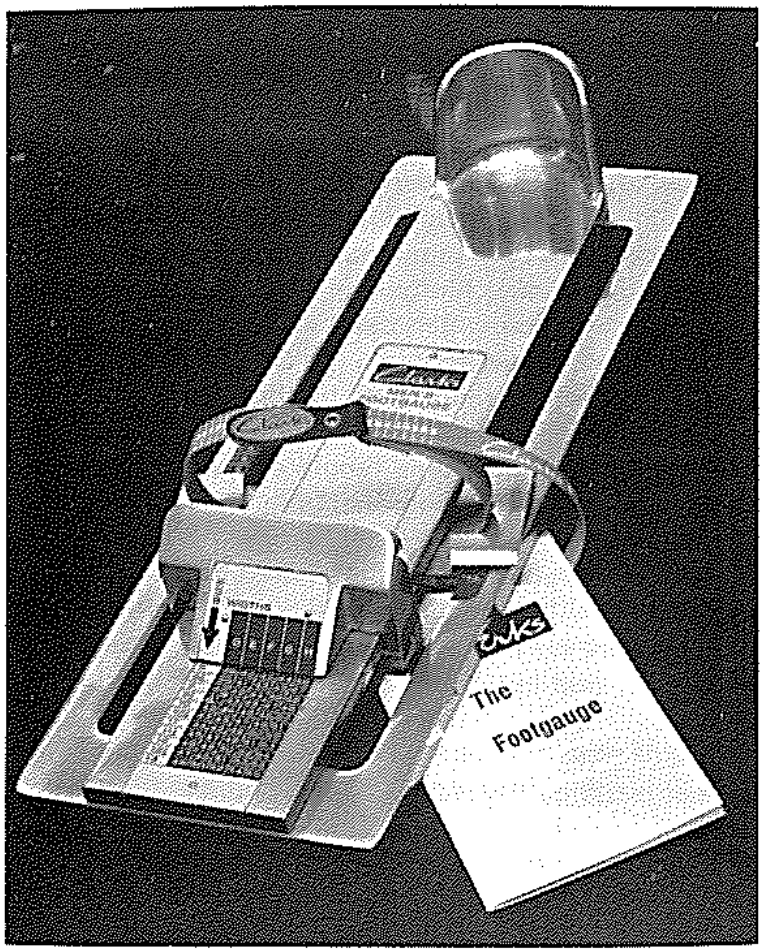
Current English fitting intervals are somewhat arbitrary and their coding is by no means standardised. However, in general one may accept that AA is very narrow (Women's), progressing through to G or H which is very wide (Men's). The most common fitting interval is 1/4" in girth measurement.

4. FITTING THE SHOE

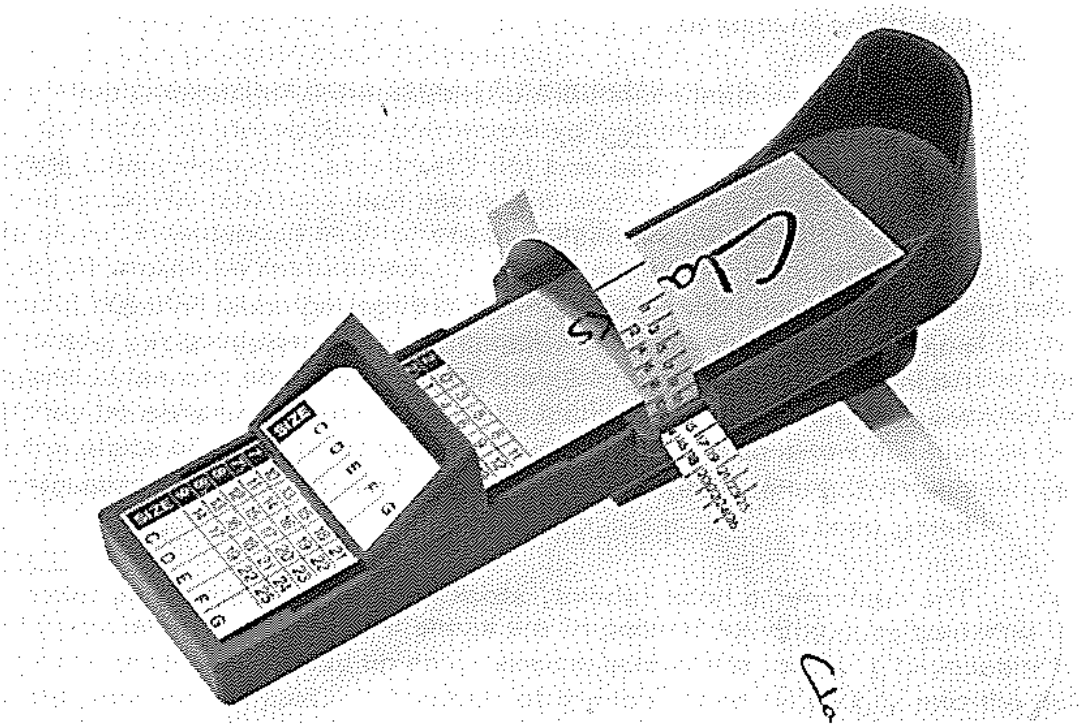


Clarks Ltd. Electronic Footgauge (Children's)

New Balance - EX1016



Clarks Ltd. Men's Footgauge (Manual - for mounting on a conventional fitting stool)



Clarks Ltd. Infants Footgauge (Manual - to be held in the hand)

New Balance - EX1016

When the retailer buys his stock he selects from the manufacturer's offerings a range of styles which, he believes, will meet the appearance, performance and price needs of his customers. He also chooses those styles in a range of sizes and fittings that will enable him to meet their fit requirements. To help him select quickly the correct size and/or fitting for a particular customer he uses a foot measuring device, or footgauge. A good manual footgauge includes a size (length) scale, plus a girth measuring tape which can be aligned correctly to the true joint angle of both left and right feet. On the manual gauges illustrated the fitter transfers the tape reading to the table of figures opposite the size indication and then reads off the appropriate alphabetical code. The electronic footgauge measures length and width automatically, displaying size and fitting on the panel.

The following set of rules should be applied:

1) Footgauges are only a guide. Remember, they measure only two dimensions, and indicate which size and fitting is likely to fit correctly.

2) Both feet must be measured, and .....

3) ..... the larger should be fitted.

4) When using a manual footgauge of the type illustrated, body weight must be off the feet.

5) When using the electronic footgauge, body weight must be on the foot being measured.

6) The sales assistant must carefully assess the fit of the shoes selected, with weight on, by examining such points as top-line "clip", heel grip, instep and joint tightness, toe room, etc. and by asking the customer how the shoes feel - sitting, standing and walking. (See "Footnotes" below).

7) If there is the slightest discomfort or niggling doubt in the customer's or the fitter's mind, alternative styles, sizes and fittings should be tried. Every badly fitted shoe means a painful foot for the wearer, and a lost customer to the shoe shop.

8) The fitting chair height must be correct for the type of footgauge being used.

9) The customer's hose (socks, stockings, tights) should be taken into account.

10) The customer's foot must be correctly positioned on the footgauge. In the case of the stool-mounted footgauge -

a) the stool must be in line with the leg.

b) the heel must be right back to the pillar.

c) the angle between leg and foot must be 90°.

d) the foot must be correctly aligned.

Footnotes

Infants

It is in the very first formative stages of growth that a good deal of damage can be done to children's feet. Harm can be done at this stage without causing actual pain to the child. Complete freedom of movement should be allowed for the infant's feet at all times.

First footwear should simply be for protection both in crawling and when the child begins to walk. Immature feet must be kept warm.

Shoes are worn for protection, not to assist or promote the natural development of feet. Lightness and flexibility are essential in children's shoes. The foot must always dictate to the shoe and not the shoe to the foot. A laced shoe is the best. The high cut front ensures that the foot is held firmly into the back of the shoe leaving plenty of room in the forepart for growing toes. At least 13 mm of growing space should be allowed for in front of the longest part of the foot.

It is also essential that hose should fit correctly.

Teenage

More style is demanded in this range of shoes but it is still essential that correct fit should be maintained. Shoes should be light and flexible, gay and colourful but still give the feet a chance to finish developing in the way nature intended. A good teenage shoe should be reasonably light, high cut in the front and sides and above all should have some sort of adjustment at the instep. This may be either in gusset form or by buckle. The gussets or buckles would take the place of laces in school laced shoes. These allow the toes to lie properly spaced to give at least 16 mm growth room in front of the toes.

Womens

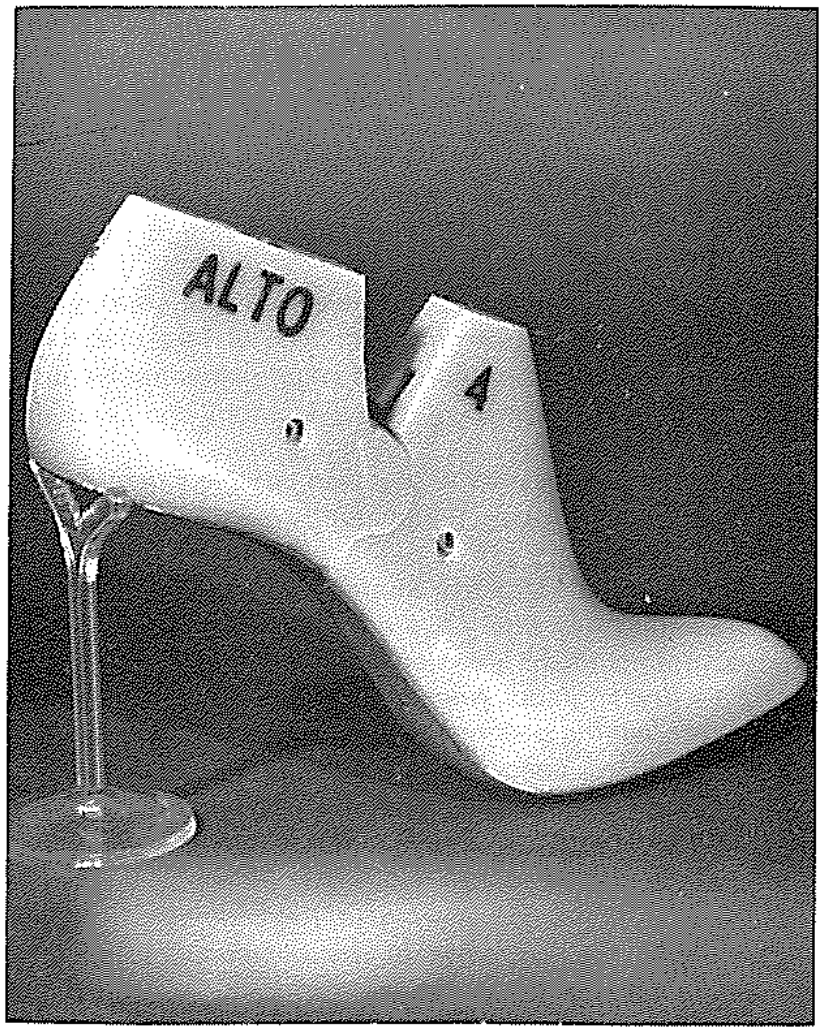
Fashion dictates that women's shoes are in general lower cut in the vamp than children's shoes. Thus, an easy tension across the joints is necessary to keep the shoe on the foot. The ball of the foot must fit snugly into the ball position of the shoe. Topline clip and heel grip must also be firm.

New Balance - EX1016

CHAPTER 5

LASTS

Lasts are fundamental to shoe manufacture since they dictate the exact shape, size and fit of the shoes made on them. Last design depends on fashion trends as well as on the anatomy of the foot.



A fashionable (1976) plastic last.

This chapter explains the terminology of lasts and the basic principles of last manufacture. It also discusses the relationship between lasts and feet.

MATERIALS

Traditionally, lasts were made from wood, namely maple, beech or horn beam. However, wood has largely been replaced by plastic for bulk last manufacture, with the result that wood is now popular only for model-making.

New Balance - EX1016

The plastic used is a high density polyethyl in a powder form. The powder is fed into an extruder which forces the hot molten plastic into moulds. When full, the moulds are cooled by a spray of cold water. The last block is then removed to a padded box to ensure that it cools slowly to avoid shrinkage. It stays in the box for approximately 24 hours and is then stored until required for turning.

DEFINITIONS

The following pages contain a brief dictionary of last terms. The terms are listed in alphabetical order and are keyed to illustrations at the end of the section.

Reproduced by kind permission of the American Footwear Manufacturers Association.

LAST TERMS

Diagram

B

BACK CONE — F

That portion of the cone surface between the 'V' cut and the back end of the last.

BACK CONE HEIGHT — F

The vertical distance between the heel featherline plane and the back cone top plane.

BACKPART — F

That portion of the last extending rearward from the break of the joint to the back of the last.

BACKPART WIDTH — F

The width of the heel end measured parallel to the heel featherline plane at a specified distance from the heel point.

BACKSEAM TACK HEIGHT — F

The vertical distance between the heel featherline plane and the backseam tack.

BASE PLANE — F

That plane to which the last in its proper attitude is referenced for the purpose of defining certain terms.

BREASTLINE — F

An arbitrary line defining the forward boundary of the heel seat.

C

CROWN — F

The lateral curvature of the bottom of the last.

Diagram

E

ENGINEERED LAST

A last which incorporates certain functional features (in addition to those found in conventional lasts) designed to facilitate shoemaking operations, e.g. standard heel seat shape, standard back cone height, standard plane relations, etc. such as,

Geometric System Last: An engineered last using a geometric proportional system of grading between sizes in a size run, and a geometric system between widths, designed to match the conventional arithmetic grading system as closely as possible. The increment between full sizes of all dimensions of a Geometric System last is ten geometric points, or approximately 0.03 times the original dimensions.

F

FERRULE C

A metal sleeve through the heel end of the last to permit temporary heel attaching on the last. This through sleeve may also be combined with the thimble for temporary heel attaching through the thimble hole.

FOREPART F

That portion of the last extending forward from the break of the joint to the toe.

FOREPART CENTRELINE B

The best line of symmetry of the forepart bottom pattern.

FRONT CONE F

That portion of the cone surface between the vamp point and the 'V' cut.

FRONT CONE PROFILE F

A side view profile of the front cone.

FULL IRON BOTTOM

A last with a full sheet metal bottom surface from heel to toe. D

G

GRADE

The change between sizes and/or widths of any portion of a last.

GRADE INCREMENT

The change per size and/or width of any last dimension.

New Balance - EX1016

Diagram

GRADE RATE

The ratio of the change in girth per size to the change in length per size.

GRADING SYSTEMS

Grade measuring schedules to determine grade increments and grade rates such as:

Arithmetic Grade: A grading system in which the increments per size and/or width of any particular dimension are specified as constants which are independent of the grade of any other dimension.

a. The grade increments currently used in U.S. and Great Britain are 1/3 of an inch in length and 1/4 of an inch in girth per full size within a size run. An increment in girth of 1/4 of an inch is usually used between widths, with modifications in the narrow and wide widths. at the option of the customer, a grade between widths of approximately 1/34 of an inch in length may be used.

b. Most European and other countries throughout the world use a grade called Paris points. This grade rate (ratio of length increase to girth increase) is equal to that of the U.S. and G.B. grades but the metric increments are specified as 2/3 of a centimetre in length and 1/2 centimetre in girth between sizes.

N.B. The "mondopoint" system is reviewed under "Foot Measurements".

Geometric Grade: A grading system in which the increment per size and/or width of any dimension is specified as a constant percentage of the dimension (not including margins or other areas which do not grade).

The increments of the principal geometric grade now in use are specified in geometric points. One geometric point is approximately 0.003 times the original dimension, which increases for each point as does compound interest.

Proportional Grade: A grading system in which the increments of all dimensions, per size within a size run, are a constant

Diagram

percentage, or proportion of the dimensions. For a geometric grade, this means that the number of geometric points per size specified for both length and girth must be equal.

H

HALF IRON BOTTOM — D
A last with a sheet metal bottom surface extending from heel to ball (joint).

HEEL CURVE — F
A side view profile of the back end of the last from the top of the last to the heel seat on featherline.

HEEL CURVE ANGLE — F
The angle between the heel featherline plane and a line drawn from the heel point which intersects the heel curve $2\frac{1}{2}$ inches (63 mm) up from the heel point.

HEEL ELEVATION — F
With the last positioned on the base plane, the vertical distance between the base plane and the heel point is the heel elevation.

HEEL FEATHERLINE — F
A line that defines the heel seat shape. In the Geometric last, the heel featherline plane is perpendicular to the last centreline plane and is, therefore, perpendicular to the thimble hole centreline.

HEEL PLATE — D
A sheet metal bottom surface cover the heel area.

HEEL POINT — E
The rearmost point of the heel featherline.

HEEL SEAT — B
The bottom surface of the heel end of the last from the breast line back.

HEEL SEAT WIDTH — F
The greatest width of the heel seat measured from featherline to featherline, perpendicular to the heel centreline.

HINGE — C
A metal piece connecting the front and rear sections of a last to provide a tensioning force to keep the sections together and

New Balance - EX1016

Diagram

in the desired position while "breaking" the last to foreshorten it and facilitate removal of the lasted shoe.

HINGE CUT C
The saw cut which provides for the two parts of a last to pivot when the hinge is "broken".

HINGE PINS C
Two pins, one in the front section and one in the rear section of the last, which secure the two ends of the hinge.

HINGE PIN HOLE C
The hole drilled to receive a hinge pin.

HINGE SLOT C
The internal slot in which the hinge operates.

I

INSTEP GIRTH E
The dimension around a last passing through the instep point. Measurement is determined by the use of a last tape as described under "JOINT GIRTH".

INSTEP POINT E
An arbitrary point established by the model maker for grading purposes. It is located at the approximate mid-point of the last length on the front cone profile. The instep point references the instep girth and the long heel girth.

J

JOINT GIRTH E
The greatest dimension around the last, passing through the joint break. Measurement is determined by a last tape positioned to allow the tape to lay flat while tracking exactly on itself as it is wrapped continuously around the last.

L

LAST JOINT BREAK F
A point located at the intersection of the shank and the forepart, tangent to a plane passing through the heel point, and perpendicular to the last centreline plane.

LAST BOTTOM CENTRELINE B
A line defined by the toe point and heel point.

LAST BOTTOM FEATHERLINE F
A line that defines the bottom shape of the last.

Diagram

LAST BOTTOM WIDTH — B
The width across the ball area of the last bottom at its widest point.

LONG HEEL GIRTH — E
The dimension around a last passing through the instep and heel featherline point.

LONG HEEL PLATE — D
A sheet metal bottom surface extending from the heel to midway of the shank area.

R

RIDGE — F
A well-defined intersection of the wall and the conical section of the forepart.

S

SHANK — F
The bottom area of the last between the breastline and the last joint break.

SHANK PLUG — D
A metal piece, usually circular in shape, inserted in the shank of the last in order to clinch a staple for purpose of fastening metal shank to insole of shoe.

STICK LENGTH — A
The over-all length of a last as measured with a last size stick.

T

TACK HOLE PLUG — D
A plastic insert in the bottom of last for receiving insole tacks.

TACK HOLES — D
Holes in the metal of iron bottom lasts to provide areas where insole tacks can be driven.

THIMBLE — C
The thimble is a metal sleeve inserted in the top heel end of a last, providing an opening for a mounting spindle or last pin.

New Balance - EX1016

Diagram

THIMBLE LOCATION F
A point at a specified distance along the heel centreline, measured from the heel point. Standardisation and accuracy are important here, particularly if the lasts are to be used on backmoulding machines such as the CIC/Ralphs 522.

THROAT OPENING E
The distance in a straight line from the vamp point to the back seam tuck.

TOE PROFILE F
A side view profile of the toe end of the last.

TOE RECEDE F
The slope of the top surface of the last, extending from the toe point to the point of full toe thickness.

TOE SPRING F
The vertical distance between the base plane and the toe point of a last having the desired heel elevation.

TREAD POINT F
The point of the bottom forepart in contact with the base plane.

V

VAMP LENGTH OR DEPTH F
The distance measured along the toe profile from the vamp tack to the toe point.

VAMP TACK F
A tack placed at a point on the top of the last forepart an arbitrary distance back from the toe, as specified by the shoe manufacturer.

'V' CUT F
The portion of the cone which is removed to permit 'breaking' of the hinge.

W

WAIST GIRTH E
The smallest dimension around a last between the joint girth and the instep girth. Measurement is determined by a last tape as described under 'JOINT GIRTH'.

New Balance - EX1016

Diagram

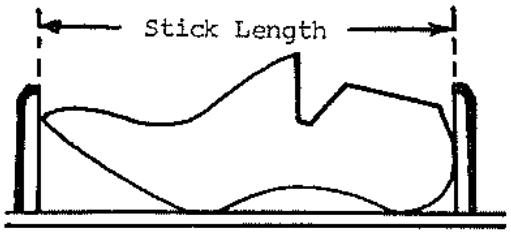
WALL F

The portion around the periphery of the forepart of lasts of a certain style characterized by relatively straight sides.

WEDGE ANGLE F

With the last positioned on the base plane, the angle between the heel featherline plane and the base plane is the wedge angle.

DIAGRAM A



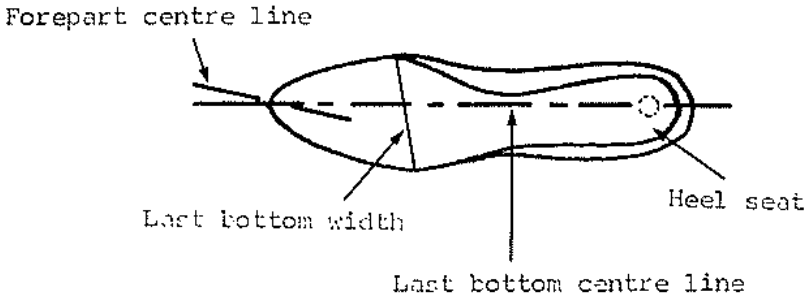


DIAGRAM B

New Balance - EX1016

DIAGRAM C

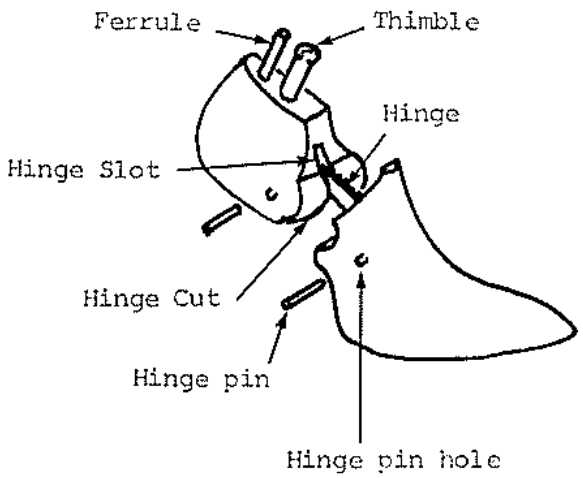


DIAGRAM D

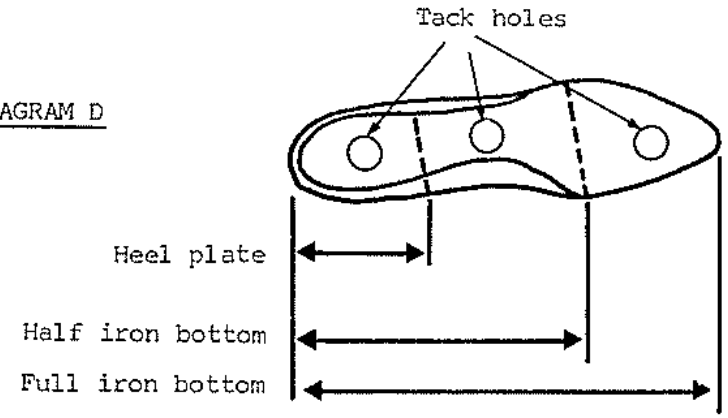


DIAGRAM E

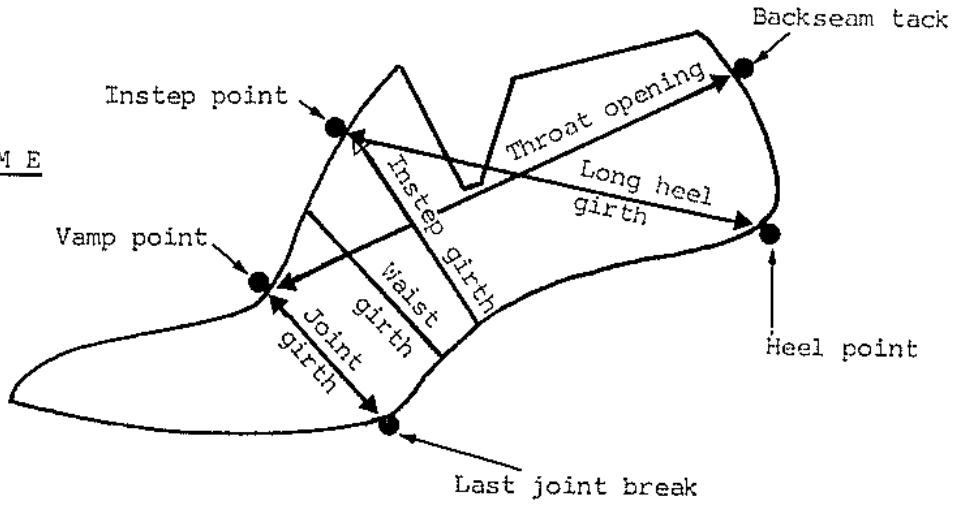
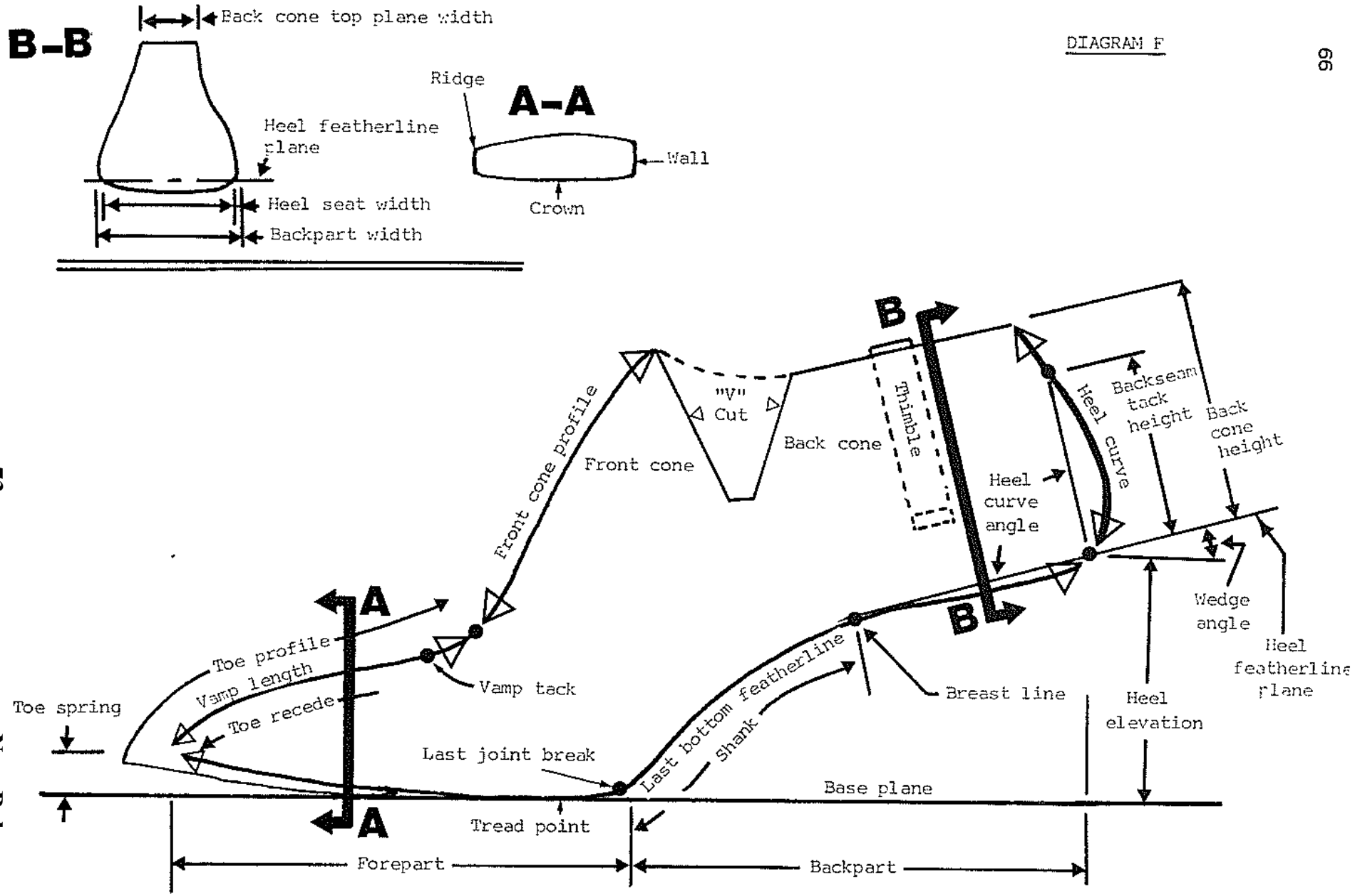


DIAGRAM F


B-B
Back cone top plane width
Heel featherline plane
Heel seat width
Backpart width
A-A
Ridge
Wall
Crown
B
"V" Cut
Front cone profile
Front cone
Back cone
Thimble
Heel curve
Backseam tack height
Back cone height
Heel curve angle
Wedge angle
Heel featherline plane
Heel elevation
Breast line
Last bottom featherline
Shank
Toe profile
Vamp length
Toe recede
Toe spring
Vamp tack
Last joint break
Base plane
Tread point
Forepart
Backpart
A

STYLING AND MODEL-MAKING

The last stylist must be able to forecast fashionable shoe shapes about one year before the shoes are to be sold in shops.

He may a) create his own style by moulding from a last with a smooth turned standard backpart and a rough turned forepart. The moulding is carried out by rasping, filing, sanding and packing.

b) obtain a wooden model from a leading last stylist, perhaps from France or Italy and copy the forepart shape for blending to his customer's standard backpart. This is done by copying the model in a lathe, cutting the forepart off the copy and attaching it by adhesive to a standard backpart.

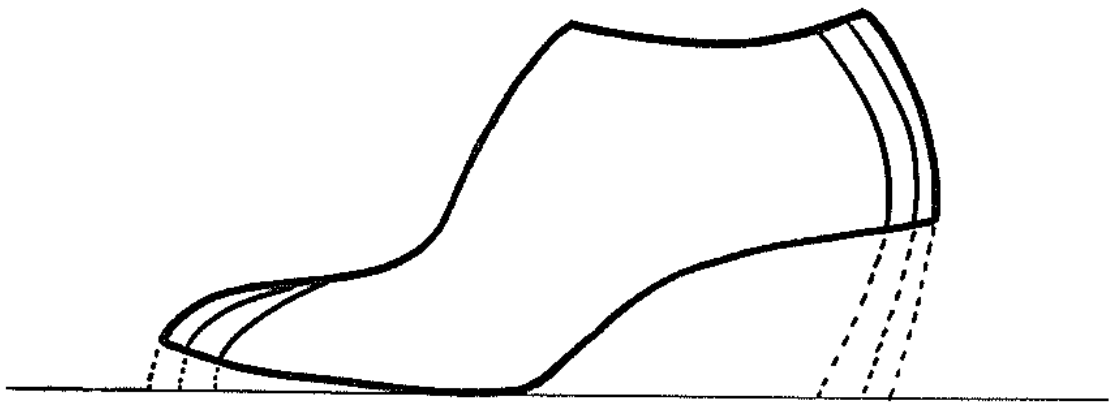
c) make a mould of the forepart of an actual shoe and then copy by hand onto a last with a standard backpart.

The model is then prepared for turning a pair of sample size lasts. The sample lasts are used for making sample shoes for fitting trials, etc.

Alterations are made as necessary until the lasts are satisfactory. Then the model is scaled up and down the size range for further tests before bulk production. In order to maintain the same heel height and toe spring throughout the range of sizes, the models are co-ordinated.

Co-ordination

As the lasts are turned in larger sizes from a sample size model, the heel pitch and toe spring increase as shown in the diagram below.

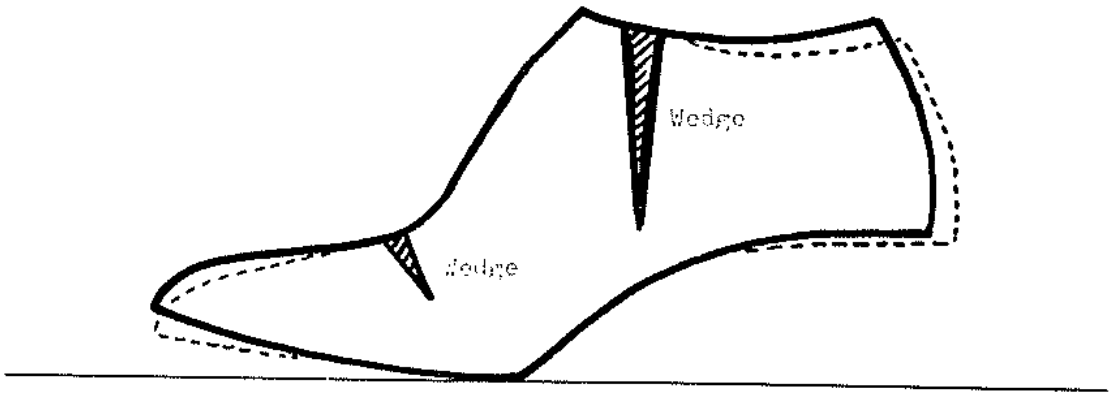


Thus, to maintain a constant heel pitch and toe spring, the last must be cut (a) to lower the heel, and (b) to lower the toe. Similarly, sizes below the model size will have a decreased heel pitch and toe spring, and it is necessary to cut the last in order to raise them to the model dimensions. Generally speaking, models are co-ordinated every $1\frac{1}{2}$ sizes (English),

e.g. From a size 4 model, size $2\frac{1}{2}$ and $5\frac{1}{2}$ lasts are turned and then co-ordinated.

From the co-ordinated size $5\frac{1}{2}$ lasts, the size 7 last is turned and co-ordinated, etc, etc.

Co-ordination is normally carried out by making saw cuts at the forward end of the back comb and at the bottom of the instep curve. Wedges are then driven into the saw cuts until the heel pitch and toe spring are correct. Any resulting holes are filled and smoothed, and finally the shank curve is re-adjusted to a template.



New Balance - EX1016

LASTS AND FEET

The essential differences between the human foot and the shoemaking last can be summarised as follows:-

1) Surfaces - last surfaces are smooth to enhance the appearance of the shoe and to enable the upper to be moulded more easily to shape. The surfaces of the feet are irregular and vary with individuals.

2) Outline - the outline of a last is regular and continuous with a sharp feather edge around the seat and forepart to assist lasting and give a clear defined edge to the finished shoe. The foot has no feather edge.

3) Substance - the last is hard and firm, while the foot is softer and more flexible.

4) Toes - the foot has separate toes; the toe end of a last is solid.

5) Heel curve - greater on the last to help the upper grip the foot.

6) Heel pitch - not present on the foot.

7) Comb area - thinner on the last to help the shoe grip the foot around the quarters.

8) Joint girth - sometimes greater on the last to allow the foot to flex in the shoe. This depends on the upper material and style.

9) Length - the last is longer than the foot to prevent pressure from the shoe on the big toe.

10) Toe profile - depth gradually decreases to a feather edge on most lasts, but not on the foot.

11) Toe depth - the last is normally deeper at the front than the foot to avoid pressure on toes.

12) Toe spring - not present on the foot.

13) Girth and size intervals - regular on lasts, irregular on feet.

14) Dimensions - identical on a pair of lasts; rarely identical on a pair of feet.

15) Styling - the foot is incapable of being modified to give a square or pointed toe shape, for example; so any last styling of this nature must be carried out outside the limits of the foot to be fitted.

16) Function - the last is used for shoemaking; the foot is used for weight bearing and propulsion.

LAST MANUFACTURE (Bulk)

A large stock of last blocks should be maintained to meet sudden demand, such as a radical change in fashion.

A typical sequence of operations for a standard hinge type last is:

1) Cut the last block to the rough shape of the required last, using a band saw.

2) Rough-turning. The latest "Incoma" machine turns two pairs (lefts and rights) at once.

3) Drill hinge pin holes and cut 'V' gap in comb (one machine does all this).

4) Using a jig, saw the circle and divide the last.

5) Cut the hinge slot.

6) Make up and insert the hinge.

7) Insert the hinge pins, knocking well in to prevent damage to knives on the smooth turning lathe.

8) Smooth turning (two pairs at a time).

9) Remove the toe stud.

10) Cut the toe plate rebate if necessary.

11) Remove the heel stud.

12) Shape heel to template.

13) Rivet on toppiece (back comb) and trim.

14) Drill thimble and ferrule holes (or combination thimble hole).

15) Insert thimble.

16) Rivet on bottom plates, mould if necessary and smooth edges.

17) Drill through seat plate in line with thimble or ferrule (if specified for temporary heel attachment).

18) Examine a) Accuracy of bottom - check with pattern.
b) Heel curve - check with template.
c) Stick length.

19) Scour (as little as possible).

20) Colour mark for size and fitting.

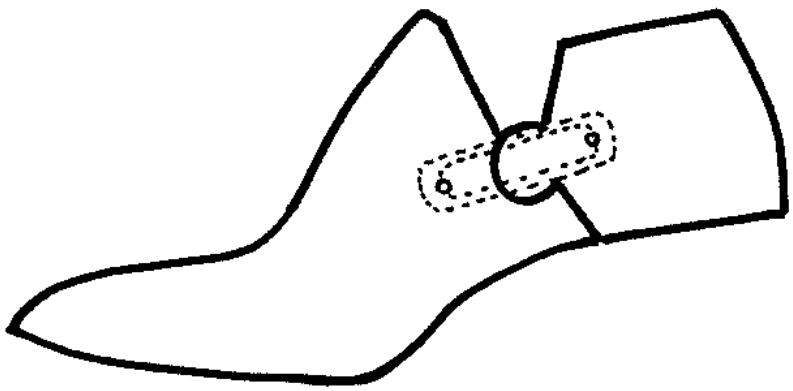
21) Stamp size, fitting and last code number.

22) Insert counter point and vamp point tacks. Locate the counter point by means of a template and the vamp point with dividers.

23) Check pairage, check colour coding and pack for despatch.

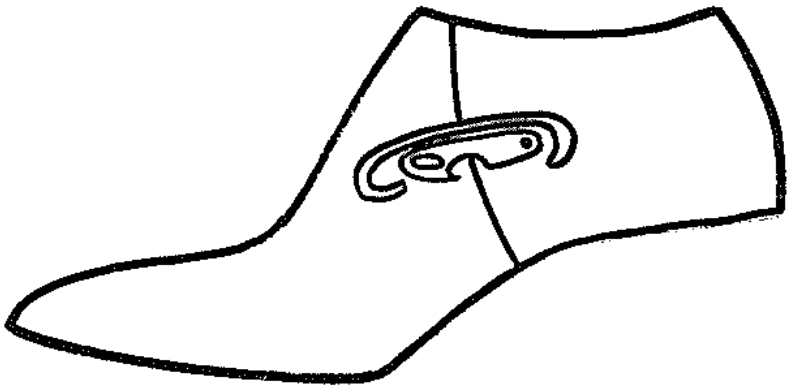
HINGING METHODS

The most popular hinge in current use is the standard two-pin type:



The degree of "self-shortening" action depends on the height of the hinge in relation to the last bottom, but in general very little length is lost when the last is "broken".

If more shortening is required, the ideal type is the "W" hinge:



The "W" hinge allows the last to shorten by as much as an inch when "broken". This type of last is popular for slip-lasted footwear.

It can also be used for string-lasted, polyurethane moulded shoes, since it can be mounted permanently on a metal block or 'leg' which fits the string-lasting and injection moulding machines in the Making Room.

New Balance - EX1016

CHAPTER 6

PRODUCT DEVELOPMENT

Product Development is the process of designing new styles or adapting existing or previous ones and then specifying the materials and components, providing the equipment and detailing the methods and processes to be followed in order that the styles can be produced in bulk and then will satisfy the needs of the consumer when purchased.

The following is a typical sequence of events taking place in a fairly large factory. The process begins with the original inception of the styles, and ends with bulk production.

Total time span is about four months.

1. The Product Line Manager plans the whole range to meet market requirements.

2. The Designer produces experimental designs to fit the P.L.M's plan.

3. The Range Developer produces the first set of patterns for each design, and the factory cuts, closes and makes experimental samples ($\frac{1}{2}$ pair).

4. The factory, represented by the Cutting Foreman, Closing Foreman, Making Foreman, Work Study Head and Services Head, analyse the experimental samples, paying special attention to costs.

5. The Service Head, together with the Factory Manager, review the range this far for acceptance or rejection.

6. The Product Line Manager releases the accepted styles for further development.

7. The Factory Development team is raised and briefed.

8. After patterns, etc. have been amended as necessary, production samples (1 pair, model size) are produced. These may be used for fit tests.

9. A Development meeting is held to review the situation and agree further action.

10. Pathfinder tests are produced (3 pairs, different sizes) and should be fit-tested. Specification sheets are drawn up.

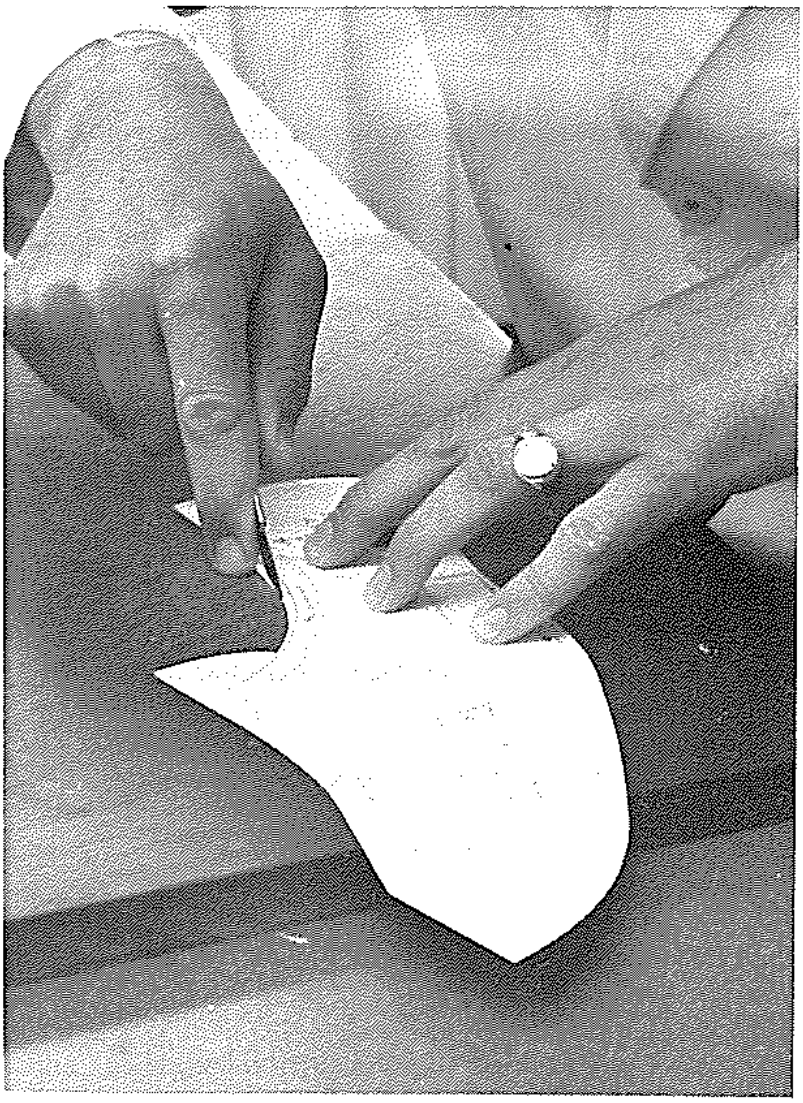
11. Second Development meeting.

New Balance - EX1016

12. Patterns are bulk-graded and bulk equipment is ordered, i.e. press-knives, dies, blockmarkers, buckles, etc.

13. A bulk test for each style (12 pairs of every size and material specified) is planned into the factory's routine input and cut, closed and made under bulk production conditions.

14. The range is finally reviewed at a post-development meeting.



PATTERN CUTTING

This section shows how a designer's ideas are interpreted by the pattern cutter, who then produces sectional patterns for the factory.

The pattern cutter is responsible for all patterns required for shoe production. These include patterns for outsides, linings, insoles, soles, heels, stiffeners, backers and toepuffs. He will also make patterns for fancy press-punch dies, block markers and jigs where necessary.

Pattern cutting is the foundation of all subsequent shoemaking operations. It is essential, therefore, that all patterns should be 100% accurate. Any inaccuracies at this stage can cause problems in all the departments of the factory.

The normal sequence is:

Forme cutting
Standard making
Net patterns
Working patterns
Linings

FORME CUTTING

Definition: A forme is a flat representation of the top surface area of the last.

The prime objective is to produce, in two dimensions, a forme of the top surface of the last (which is, of course, three dimensional) without any undue distortion taking place.

There are various methods of producing formes. Three main ones are explained.

Slotted Fabric

A pair of fabric castor shapes are stuck to the last. They are slotted where necessary to assist in getting a good fit to the last, but slots should be kept clear of the centre lines to avoid distortion when the formes are removed from the last. Centre lines are drawn down the back and the front, over the fabric overlaps, and a cross mark added at 76 mm (3") up the centre line from the toe. The two centre lines are cut and the two halves carefully peeled off. The two halves can now be superimposed (inside against outside) and an average or mean forme taken as follows:-

Mean forme - method of construction (may be applied to slotted fabric or vacuum 2-piece formes).

1. Draw around the outside forme, marking in the 76 mm-from-toe position and the counter point position.

2. Place the inside forme on the outside at the 76 mm-from-toe position and blend towards the toe.

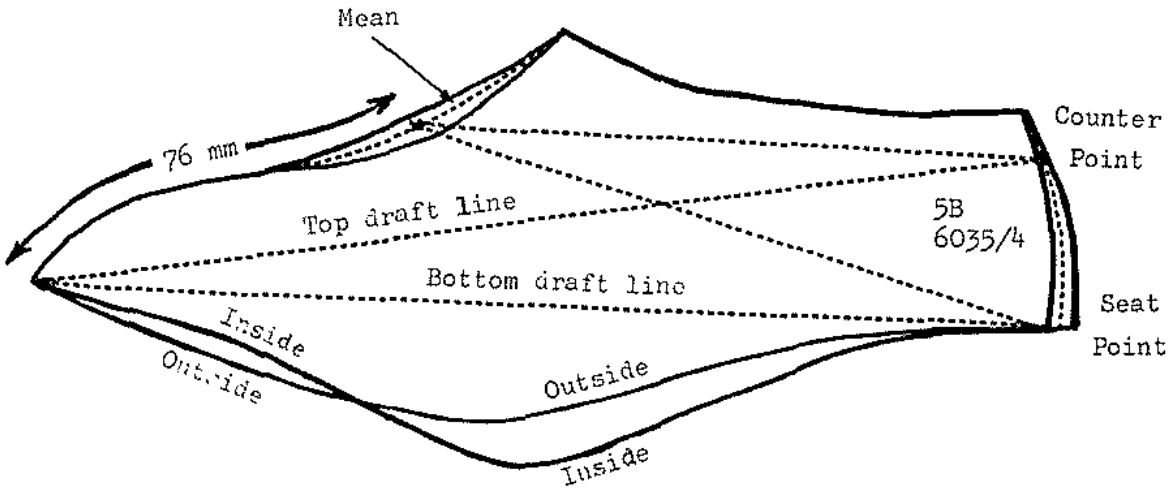
3. Try to place the counter points together. It might be necessary to make a slot at the inside waist to enable this to be done without undue distortion. This will result in adding a small "pocket" to the inside of the upper, which will help lasting.

4. Mark in the inside forme.

5. Certain differences between the two formes can be divided to obtain the mean forme line. (The differences along the feather or lasting edge should not be altered. Differences at the heel should be left until length checks are made of the forme against the last).

6. The forme should now be checked against the last for length, and, if required, width measurements.

7. Finally identification data, i.e. size, fitting and last number should be marked on, and a paper copy made. This will be the basis of a standard.



MEAN FORM SHOWING DIMENSIONAL CHECK POINTS

The slotted fabric method of forme production has several disadvantages:-

a) A tendency for the formes to be stretched on removal from the last.

b) Slots in the formes may close up on removal from the last.

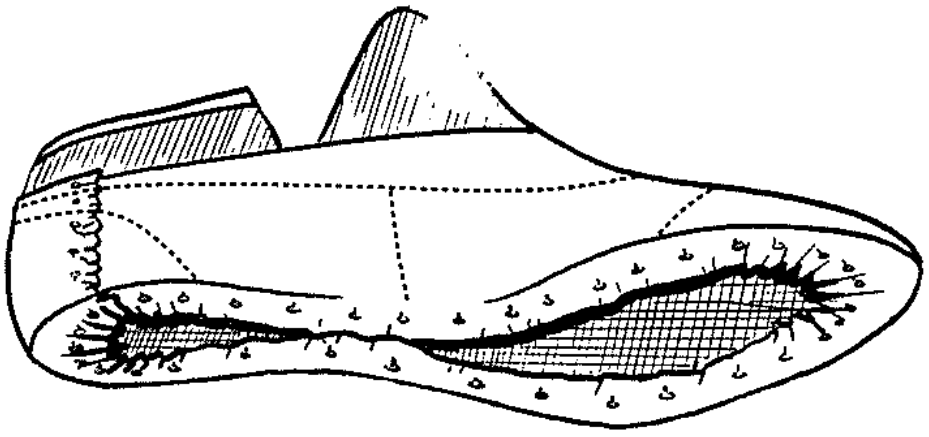
c) Designing must be done off the last.

d) The whole process is rather lengthy and can be messy.

Shell

This forme is made of a stiff plaster-of-paris impregnated cloth. A castor shape is cut and soaked in water until softened. In this soft state the shape is lasted, using tacks around the bottom and up the back of the last.

When the fabric has dried on the last it becomes stiff again. Now the designer can create a style directly on to the shell forme. Once the design is satisfactorily drawn on the last, the surplus material around the topline and the featherline is carefully cut away. The back seam line is then cut and the forme removed for flattening.



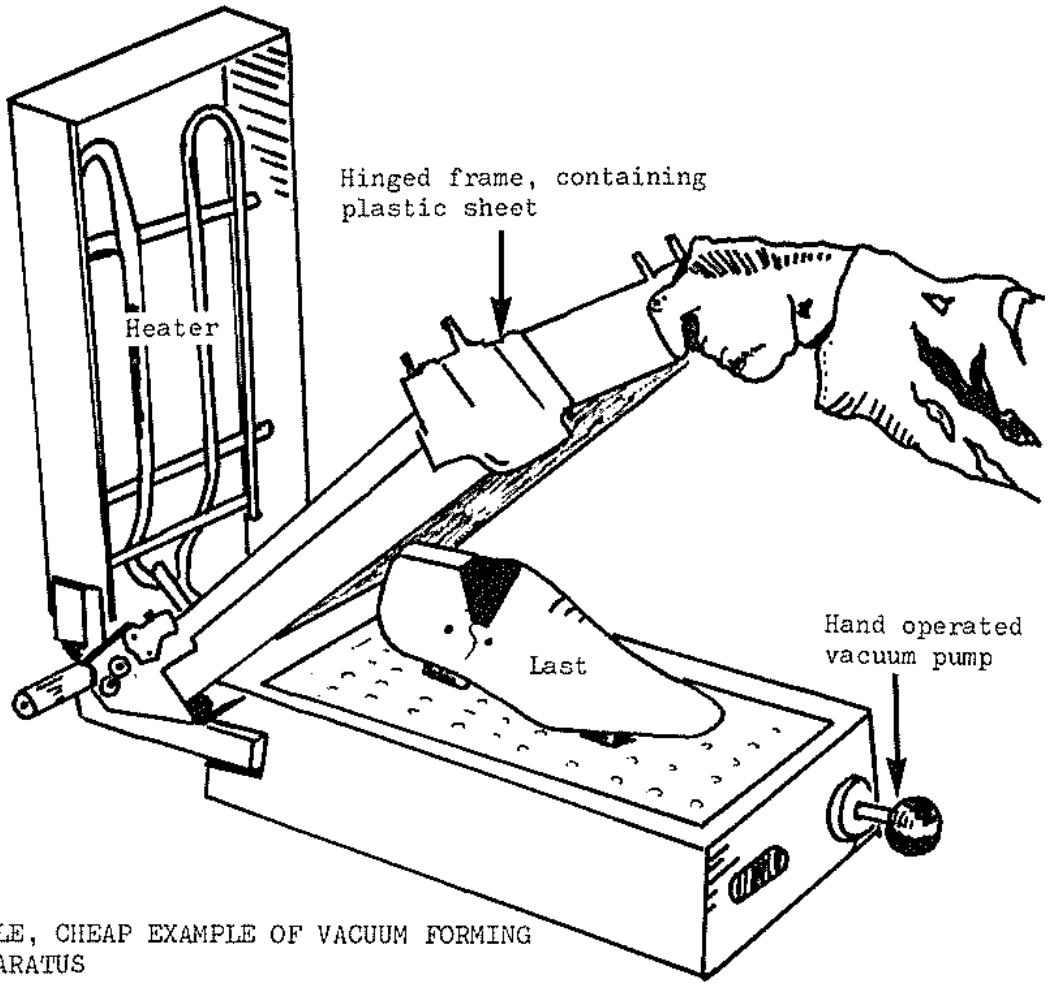
SHELL FORME ON THE LAST
(Design drawn on)

New Balance - EX1016

This method is better than the slotted fabric method. It has the advantage of allowing the designer to draw "on the round". It is not very practical with plated lasts, and it suffers in that each style is developed on its own new forme, and not referred back to a proven forme. It needs a good understanding and a fair amount of skill to produce good results.

Vacuum

Using the vacuum forme method, a sheet of plastic is heated until it becomes softened. The soft plastic is then drawn tightly over the last by means of a vacuum.



A SIMPLE, CHEAP EXAMPLE OF VACUUM FORMING APPARATUS

(The hinges of the last should be filled with a temporary filler such as "plasticine", before obtaining a moulding).

When the plastic has cooled the surplus below the feather edge is removed. The plastic covered last is now ready for a design to be drawn on it. Once the

New Balance - EX1016

design has been satisfactorily executed, the front and back centre lines should be drawn in, and the counter position and 76 mm-from-toe position marked. Some of the surplus plastic above the topline (the "cone") can now be removed. The front and back centre lines are cut and the forme removed in two halves.

The pattern cutter now slots the forme around the toe area to enable it to be flattened in a mangle. Before mangling, the topline, along with all laps, seams, fancy stitching or punch designs must be pricked through.

The two half-formes are laid on a sheet of carbon paper which is, in turn, laid on a piece of pattern paper, and all three are carefully fed through the mangle from toe to heel. The pattern cutter must try to ensure that the mangle flattens the formes without creasing or distortion.

The resulting carbon-prints, with laps, seams, etc. shown up by the prick marks, are then used to produce a standard, with the aid of the mean forme previously produced for this particular last, and held to be the master. The master forme provides a check for discrepancies on all future formes.

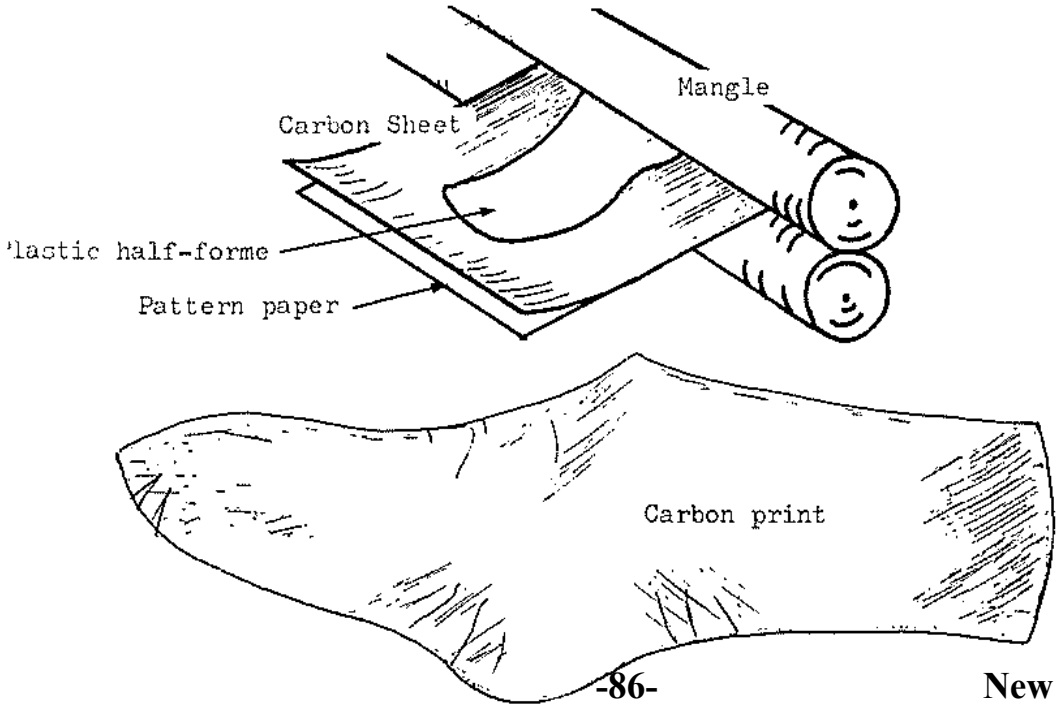
N.B. The importance of checking for distortions cannot be over-emphasized. It is vital to refer back to the last dimensions periodically to ensure perfect accuracy.

Advantages of vacuum forme:-

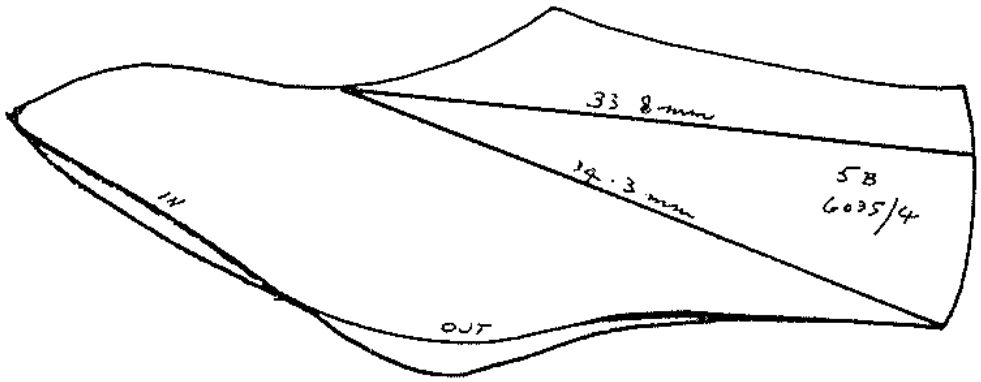
a) The method is quick and requires little skill.

b) The plastic is very suitable for designing on.

c) Slots cut in the forme show up on the carbon print, indicating where checks on distortion must be made.



New Balance - EX1016



Master mean forme

Other Types

There are about half a dozen other ways of making a forme. Most of these methods tend to be lengthy and are not always very accurate. The three methods described are the ones in most common use.

STANDARD MAKING

Definition

The Standard is the master pattern or blue print from which the upper and lining patterns are cut. It also shows the shoe style and design, and gives a break-down of the upper construction.

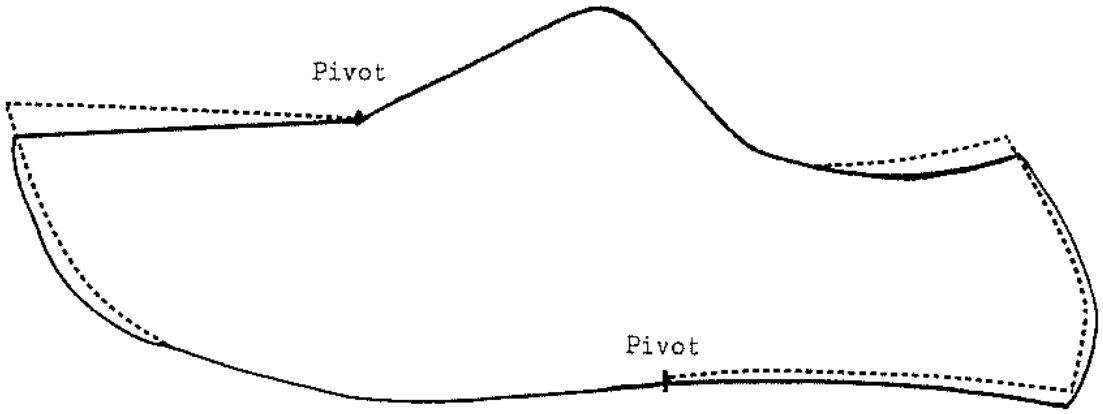
Standard making is basically the same for all three types of forme. The method of designing varies.

With the drill or slotted fabric forme the design is usually created "on the flat" (in two dimensions), by the designer using a mean forme or a previously constructed standard or a combination of both.

Shell or vacuum formes, on the other hand, are designed on the last and give the designer a much better picture of what he or she is trying to achieve. The designer then passes the designed shell or vacuum forme over to the pattern cutter, who translates it into a Standard.

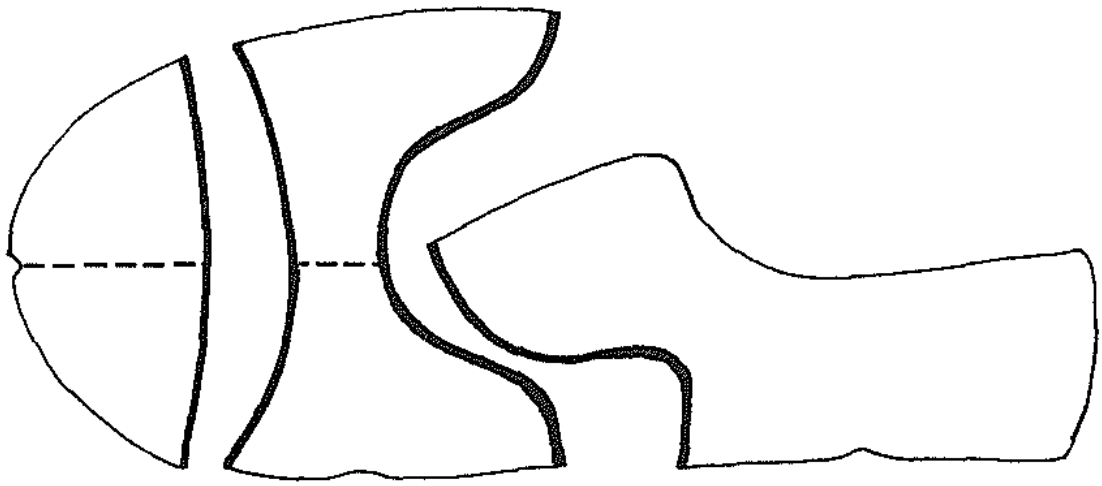
New Balance - EX1016

When the forme is flattened in two halves and a mean forme constructed, this is considered a flat or "dead" pattern, but if the counter point is raised or "sprung" above its normal position, or a general surplus is added above the front centre line, then this is deemed a sprung standard.



SPRUNG STANDARD

If the design is sectioned before flattening, this will result in sprung seams or laps. The effect is a pre-shaped upper, making lasting easier. This technique is used mainly in the men's shoe trade and is operated without a normal standard.



EXAMPLE OF SPRUNG SECTIONAL PATTERNS
(Note the unlike curves at side seam
and toe-cap seam)

Standard Making

(Three-quarter Court Style)

The mean forme is drawn around, marking in the difference between the inside and outside featherlines.

Correct counter or heel height is established according to the last size. Also established are "under ankle" measurements, which determine the height of the toplines at each side of the ankle (below the bone protrusions). Here a difference of 3 mm (1/8") between the inside and outside quarters is normally used - the inside quarter being the higher. The reason for this difference is the variation in ankle bone height on the inside and outside of the foot.

The Back Curve on the standard usually requires some adjustment. The top is brought in 4.5 mm (3/16") thus shortening the topline length and assisting in topline "clip", which helps the wearer retain the shoe on the foot.

The bottom of the back curve is taken in 1.5 mm (1/16") for thermoplastic stiffener types or let out 1.5 mm (1/16") to allow for a board-type stiffener.

The Vamp Depth, which is the distance the vamp extends up the front of the foot, is established. The specified vamp depth should be 3 mm (1/8") lower than that envisaged on the completed court shoe, to allow for material and insole substance. (This rule does not apply to sandal styles, as these are usually measured from the top of the insole).

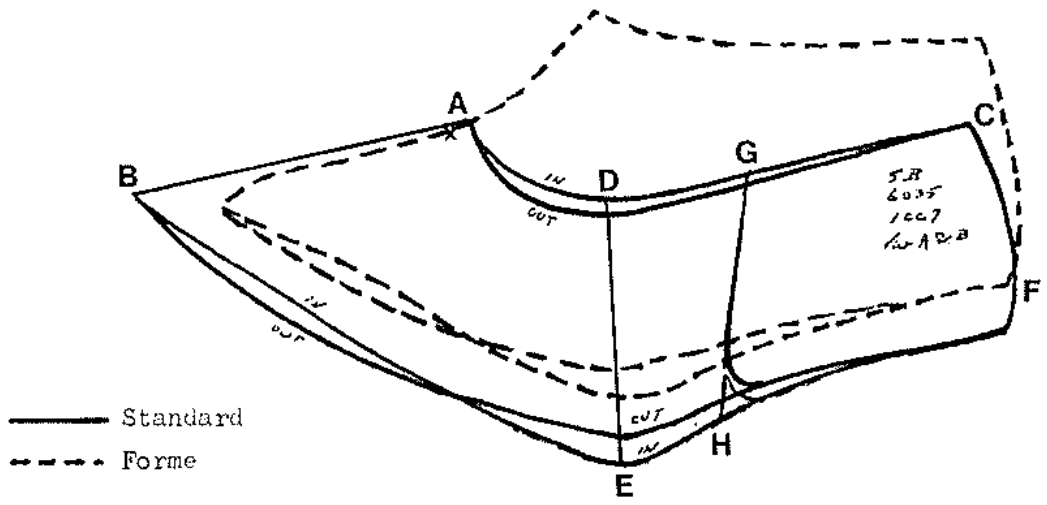
The formula for vamp depths was at one time considered to be one-sixth of the bottom draft line measurement (toe point to seat point doubled). Present day methods tend to allow the stylist to dictate the vamp depth, however, and its location is very much dependent on the cut of the topline. Care should be taken that the vamp is not so high as to restrict foot entry.

A Lasting Allowance is now added to the feather edge. The allowance may vary depending on the type of construction, making machinery used, type of material, etc. but conventional lasting allowance would be 13 mm ($\frac{1}{2}$") in the toe to waist area with 16 mm (5/8") in the seat. The pattern cutter must take into account the substance of the insole, which can vary from toe to heel, and also the lining materials, toepuff and stiffener substance. Recent developments of moulded backparts with pre-combined stiffeners now mean that less lasting allowance may be required in the seat area. However, if the insole is cut narrow through the inside waist (which it often is), extra allowance should be added for lasting in this area to enable the upper to be lasted without undue strain.

When synthetic materials are being used with modern lasting machinery, it is advisable to cut a pattern quite "dead" at the toe, since it is very difficult to last in surplus material without forming pleats. It will be seen on the diagram below that the front line of the forme has been straightened, thus allowing the vamp pattern to be cut from a folded piece of paper. If the designer has included a central front seam on his style, this straightening is not absolutely essential; but the pattern cutter must bear in mind that curved front seams, whilst giving a nicely shaped vamp, are not very practical where the Closing Room is using flat-bedded toepuff and lining presses.

The design of the shoe, in respect of topline, quarter/vamp seams and counter lining positions can now be established, and identification of last, size, fitting, etc. marked on the standard.

Finally, seams drawn on the standard may be slotted for future processing. The standard should now be cut out ready for production of sample patterns.



THREE-QUARTER COURT TYPE STANDARD

A	:	Vamp depth point
A - B	:	Front centre fold line
C	:	Counter point
F	:	Seat point
D - E	:	Side seam line
G - H	:	Counter lining line

IMPORTANT

The pattern cutter must remember to check dimensions frequently by referring back to the last at distances A-C and A-F.

Net Patterns

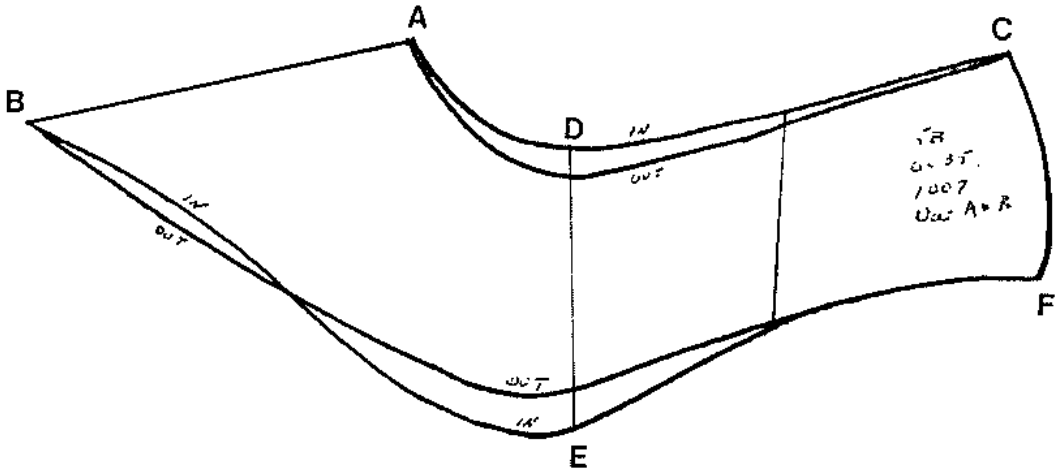
These are sectional patterns cut from the standard and, as the name implies, are patterns without any allowances added for edge treatments or seams.

Net pattern cutting is largely unnecessary in the case of straightforward court style production.

New Balance - EX1016

Working Patterns

(Ladies' Three-quarter cut Court Style)



The standard shows the differences between inside and outside at the topline and lasting edge. These differences must be shown in the three-quarter vamp pattern and the quarter pattern.

Schedule:

1) Lay the standard on a folded piece of pattern paper with A-B on the fold.

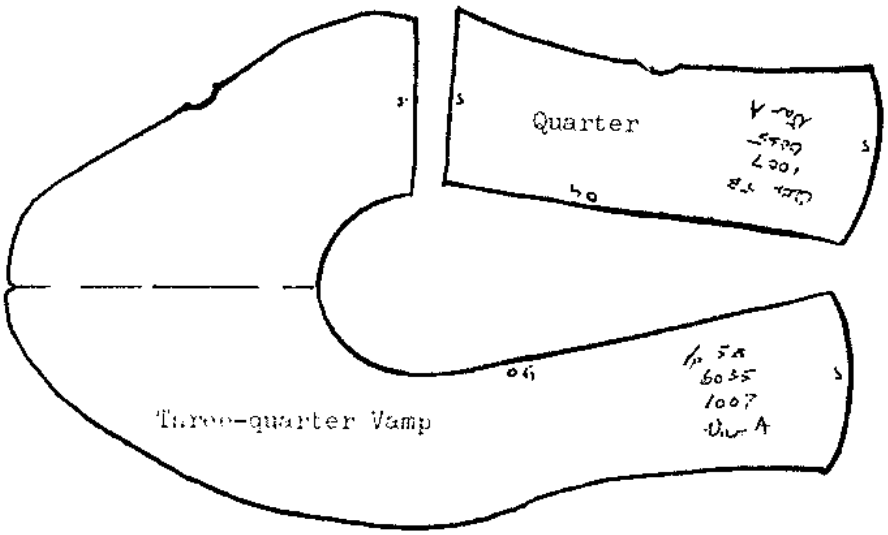
2) Cut around the lasting edge B-F, pricking in the differences between inside and outside.

3) Cut along the topline A-C, also pricking in the lower outside line.

4) Draw in back curve C-F and add seam allowance (normally 1.5 mm). Cut out (double thickness).

5) Mark in inside side seam D-E.

The standard can now be removed and the whole upper shape cut to prick-marked lines (topline and lasting edge) after the pattern is opened out. The inside quarter can now be cut off at the D-E line after allowing for the seam. The quarter pattern may need to be copied with extra side seam allowance added, depending on the type of seam specified.



Sample working patterns (Court style)

- 1.5 mm allowance has been added for closed seams at back and inside waist.

The topline has been left net, for galloon binding. For folded or beaded edge, add 4 mm.

New Balance - EX1016

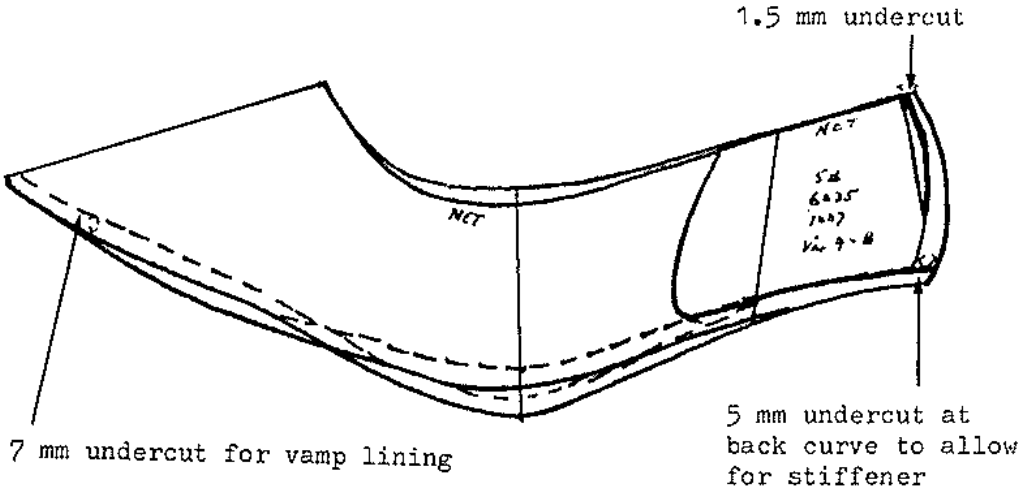
The amount of allowance to be added will vary depending on factory requirements and materials used. Typical allowances are:

Closed seam	:	1.5 mm (1/16")
Lapped seam	:	8 mm (5/16")
Gimped edge	:	1.5 mm (1/16")
Folded edge	:	4 mm (5/32")

Linings

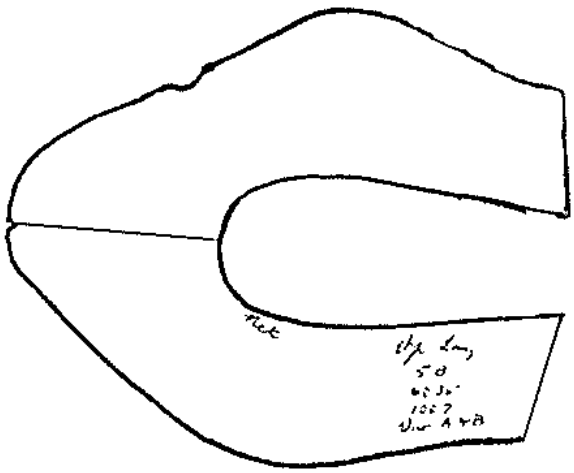
All lining patterns, including those with seams, laps or undercutting should be superimposed on the upper standard.

Thus our Court standard will look like this:

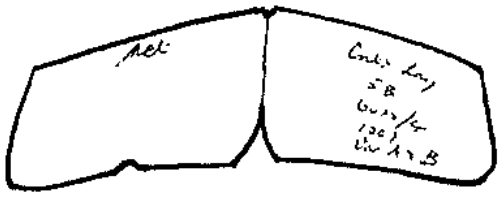


New Balance - EX1016

- and the resulting lining patterns will look like this:



Vamp lining
(foam-backed fabric)



Counter lining

The example linings above have net toplines, but in many instances a 3 mm (1/8") trim or shear allowance may be added, depending on Closing room practices.

A high proportion of modern shoes contain foam-back fabric full or three-quarter linings. These are invariably cut net to the topline and bound over with binding, but are cut under at the lasting edges to suit the machinery being used for lasting. This type of lining is also used in shoes with folded toplines, but a collar lining with a topline trim allowance is stitched on, and the surplus is then trimmed off at topstitching in the normal way.

New Balance - EX1016

BOTTOM PATTERNS

All bottom patterns are derived from the last pattern, which is an exact representation in paper of the bottom surface of the last. Pattern modifications naturally vary with style.

Insole

This is usually a copy of the last pattern with a 1.5 mm (1/16") margin removed from the inside waist. A wider seat may be required on sling back styles.

Sock

Using the insole pattern as a base, a sock pattern can be made by drawing round the insole and filling in the inside and outside waists so that none of the insole will show in the completed shoe. With a high-heeled, closed back style a little material can be saved by cutting back at the toe of the sock pattern. On open-back styles the seat of the sock should be reduced by a 3 mm (1/8") margin.

Heel Base

This is a copy of the actual heel base outline, made to fold in halves, (because the same heel shape is used for lefts and rights).

Tab (Louis Heels)

The tab pattern is another name for the heel breast pattern on a Louis heel. It is usually obtained by marking the heel breast with carbon and then covering the breast with strips of tape. The resulting carbon impression is copied on to paper and made to fold.

Sole

For a sole pattern the insole pattern is drawn round and the appropriate allowances added, depending on the construction, e.g. 6 mm (1/4") forepart and waists for a welted style, 1.5 mm (1/16") for a cemented court style.

In the case of a Louis heel style, the heel base pattern and tab pattern are used to determine the back shape of the sole. A sole for a Cuban heel style may be copied from the Louis sole, marking in the base line only and adding 8-18 mm beyond this line, depending on size. Corners should be rounded off.

The heel base pattern must also be used to complete a through sole pattern, with the heel outline blended gently into the waist outline.

Grading

Once a sample shoe has been approved for bulk production the paper sample patterns must be graded into sets of sizes. Grading is the proportional enlargement and reduction of all the sample patterns to make a complete range of sizes (and possibly fittings) which will fit the graded last size range.

The grading of bulk patterns is done by machine and the patterns so produced are made of stout board. These boards are brass bound and used for bulk hand cutting in the factory. If large bulk production is forecast, metal press knives can be made using the boards as templates.

One of the important features of machine grading is that all seam allowances, edge treatment allowances and lasting allowances can be maintained at a regular amount. This avoids the danger of having large allowances on large size patterns and small allowances on small patterns.

The importance of a correct shoe standard is realized when grading machine settings are being adjusted. The basic settings on the machine are obtained by accurate measurement of the standard. It is, therefore, obvious that the shoe standard must be accurately and correctly cut. Any inaccuracies will be magnified by the grading machine.

General Comments

The cutting of upper, lining and bottom patterns requires extreme accuracy. With the advent of more automatic methods of shoemaking, tolerances will become even smaller. New closing and making machinery has created new problems for the pattern cutter. The pattern cutter must keep himself abreast of new developments, both in machinery and materials, in order to overcome these problems. The keynote throughout all the pattern cutter's work should be accuracy and perfection.

New Balance - EX1016

CHAPTER 7

CUTTING

Introduction

Clicking is the traditional word for cutting.

Clicking Room is the name given to the part of the factory where the different parts for the upper of the boot or shoe are cut from leather or other materials.

Clicker is the name given to the operative who does the actual cutting out. The origin of the word is obscure but the most acceptable explanation is the fact that when a hand cutter's knife leaves the board on the completion of a cut it makes a distinct clicking noise.

1. QUALITIES REQUIRED IN A CLICKER

The work performed in the Clicking room is very important for two main reasons. Firstly, a clicker will be cutting up hundreds of pounds worth of material in any one week. It is possible by economical cutting or otherwise to show a large profit or a large loss. Thus, it can be seen that Clicking is an area that will greatly affect the profitability of a company. The second reason is that poor clicking can affect a greater number of subsequent operations than any other single operation.

Clickers, therefore, are generally above average ability operatives with inherent qualities that are necessary due to the nature of the work. The main qualities required are:-

i) Good Reasoning Ability

At the present time 41% of all shoe uppers are made from leather. No two skins are the same shape, size, substance (thickness) and no two skins have blemishes in exactly the same place. So you cannot give a Clicker a blue-print to follow when cutting up skins. He must be able to reason this out for himself.

ii) Spatial Perception

If economical clicking is to be achieved, a clicker must have the ability to interlock different shapes on to each other and also to plan ahead to achieve the maximum number of cut components from a skin. He must also have the perceptive ability to distinguish blemishes and defects on the surface of the skin.

New Balance - EX1016

iii) Colour Realisation

Due to the variation of colour shades within skins it is necessary to match many cut components. It is important, therefore, that Clickers are not colour-blind.

iv) Decision Making

Clickers must be able to make quick, accurate decisions. Each time a component is cut the clicker makes a decision as to its suitability for the finished shoe. If he was a poor or hesitant decision maker his output of good quality cut work would be very low.

Some of the larger shoe manufacturing companies employ selection tests for clickers to find out if new recruits have these inherent qualities before spending a great deal of time and money in training them to their maximum potential.

2. MATERIALS

Suitability of Leather for Upper Materials

Leather is the preserved skin of an animal. During the whole complex process of changing the skin into leather there are two stages of preserving involved. These are:-

i) A temporary preservation to delay putrefaction immediately the animal is killed.

ii) A permanent preservation made by tanning processes which changes the skin into leather.

There are several reasons why leather has been considered to be very suitable for shoe uppers, the most important being listed below:-

i) Elasticity and Plasticity

These two properties are often loosely described as 'give' or flexibility in leather. When a shoe is flexed it is expected to recover its original shape, without damage, when it is removed from the foot. The material must, therefore, have elasticity otherwise the shoe will rapidly loose its shape. The plasticity of leather is also vital to enable the shoemaker to mould the shoe into its required shape initially.

The plasticity, therefore, gives the shoe its shape and the elasticity ensures that it keeps that shape during wear.

New Balance - EX1016

ii) Strength and Stretch

Leather has both a very high tensile strength and good stretch properties before it breaks. The properties vary according to the type of animal and the method of tanning used.

iii) Permeability

Owing to its unique fibre structure, leather allows water vapour to permeate to the atmosphere. It does, however, remain highly resistant to the passage of liquid. This ensures that the foot will remain moisture-free despite outside agents such as heat or rain.

iv) Surface Characteristics

The surface of leather is very versatile and can be made into any colour or type of finish required.

v) Ease of Working and Maintenance

Leather can be stuck, stitched, tacked, split or cut easily to make it workable. It also lends itself to repair, holding new tacks and stitches well owing to its fibrous structure.

The main types of leather used for shoemaking are calf, cow, kid, goat, sheep, pig and unusual leathers such as snake, lizard and crocodile.

The Development of Artificial Leathers

In recent years, demand for leather has far outstripped supply and there is now a world shortage of skins and hides.

By taking into account the increase in world population and the increasing use of leathers in articles other than shoes, it is thought that the supply of skins and hides will be at least 30% less than the potential demand by the 1980's. This has led to the emergence of various forms of artificial leathers which are being increasingly used in footwear production.

There are two main types of artificial leathers at present available to the shoe industry. They are:-

1) Coated fabrics
2) Synthetic poromerics

1) Coated Fabrics - These materials were first developed by using a coating of linseed oil over either woven, knitted or non-woven fabrics. Linseed oil has now been replaced by thermoplastic coatings such as P.V.C., or curable coatings such as polyurethane.

2) Synthetic Poromerics - These materials have absorption and permeability properties similar to leather. The material consists of a surface of polyurethane film with either a microporous or microcellular layer beneath.

In addition to these two main types collagenous poromerics are being experimented with and being used to a small degree. With these materials tanners can use either of the following methods:-

a) The reformation of tanned leather fibres from leather scraps into fibrous sheets.

b) The dissolution of untanned leather fibres from the raw skin followed by the reformation into sheets which are then tanned to produce the finished product.

In view of the large range of artificial leathers available, it is difficult to summarise the precise advantages and disadvantages of them all. It is true to say that some artificial leathers lack some of the unique properties of leather, but in some you will find greater strength, more abrasion resistance and the ability to retain better shape and cleanliness.

3. CHARACTERISTICS AND VARIATIONS IN LEATHER

1.) Substance (Thickness)

The substance and quality of different parts of a skin are determined by the anatomy of the animal. As a guide, it is the areas which are subject to the least distention or stretch during the animal's life which are generally the best substance and quality.

The butt is composed of the stoutest leather as this covers the delicate organs along the back. This is also most even in quality and texture.

The middle and shoulders are of lighter substance but the quality remains good.

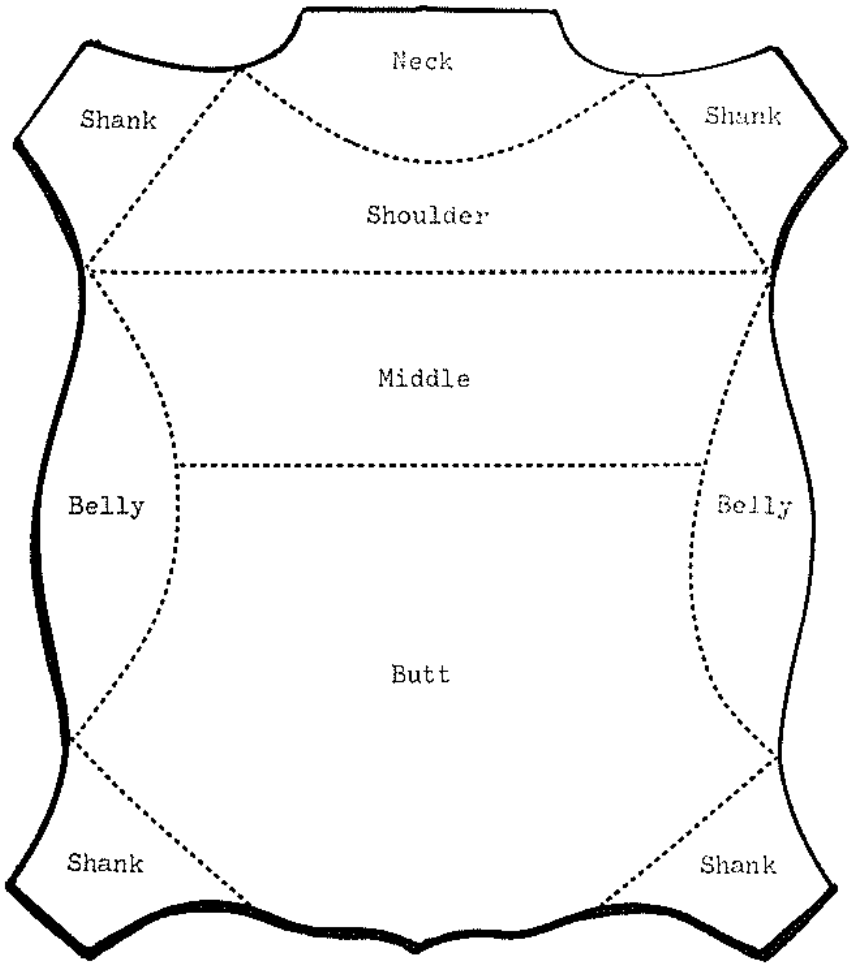
The neck varies considerably. Cattle, especially bull calf, and sheep, tend to be quite stout in substance but heavily lined with growth marks. This does not apply as much to goats.

The shanks are light but the quality is often quite sound.

The belly is the lightest substance and generally the poorest quality.

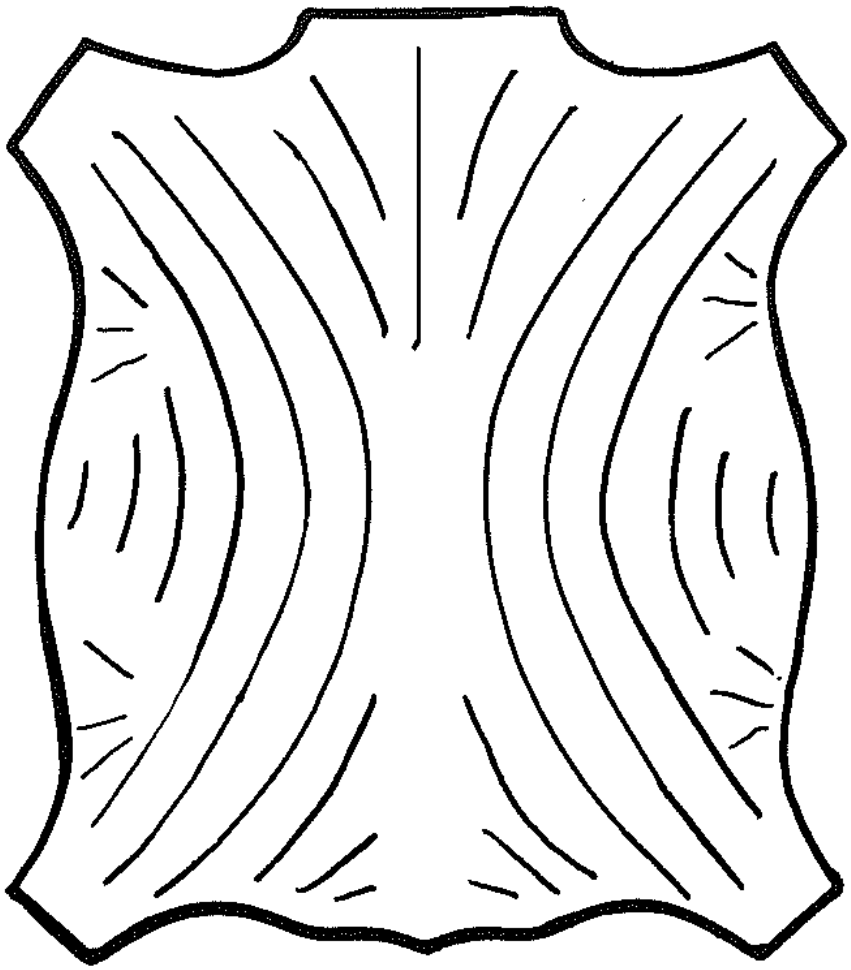
New Balance - EX1016

It will be realized, however, that each area merges into the next so that no rigid demarcation is possible. The substance is sometimes equalised by the tanner splitting, shaving or sectioning the skin.



2.) Tension and Stretch

The type of animal skin, the age of the animal, the type of tannage and the type of finish applied to the surface of the skin affect the degree of stretch within the skin. However, all skins will be consistent in their direction of stretch and the direction of tightness. Since the lines of tightness are those to be followed in cutting they are shown on the next diagram. The lines of stretch run directly at right angles to the lines of tightness.



Lines of tightness

3.) Texture

Texture is a matter of feel, dictated by the tightness of the fibre structure of a particular skin. Over the backbone of the animal, which is subject to little movement during its life, tight fibre structure and good texture are to be found. In the parts of the animal which is subjected to most movement, i.e. bellies, neck and legs, poor texture, compared with the skin over the backbone, is to be found.

4.) Colour

Within the skin there are variations of shade. This is due to the parts of the skin with loose fibre structure absorbing much more dye than the parts of the skin with a tight fibre structure.

This mainly applies to "drum-dyed" leathers - those leathers which have been completely immersed in pigment in a revolving drum. "Spray dyed" leathers tend not to show the same inconsistencies of colour.

5.) Quality

The areas of best quality in a skin generally correspond to those areas of best substance. However, other factors must be taken into consideration when considering the quality of a skin. These are:-

i) The proportion of prime material compared with the size of the skin.

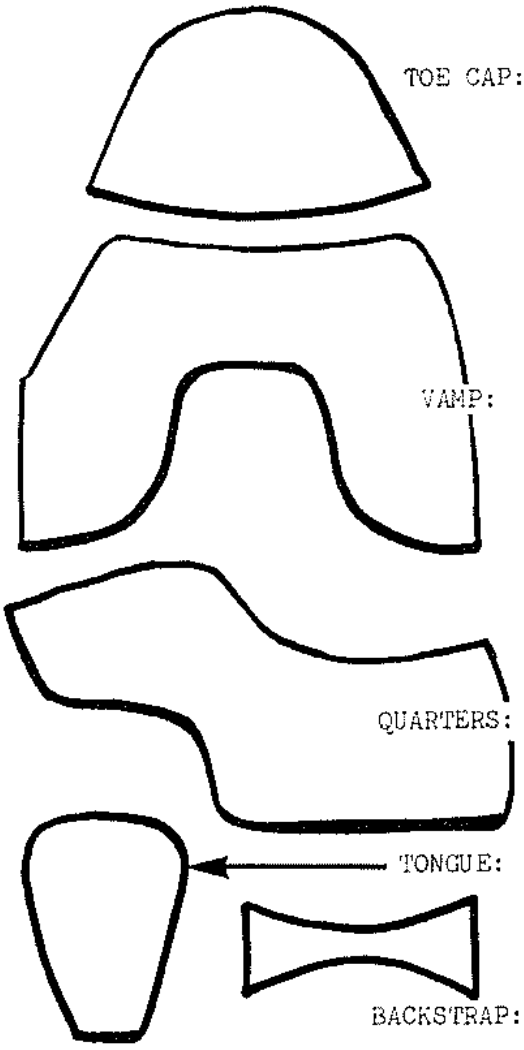
ii) The regularity of the substance.

iii) The shape of the skin - good square shape or narrow "poorly grown" shape.

iv) The defects within the skin, natural, mechanical and disease disfiguration which have occurred during the animal life.

4. MANUFACTURING REQUIREMENTS FOR UPPERS, LININGS, SOCKS AND FABRICS

The quality requirements for different parts of a shoe depend on their functions during wear.



The first requirement for a shoe is that it would retain its shape during making and wear. It is, therefore, most important to observe the lines of tightness when cutting to ensure that the requirements in the shoe are matched by the characteristic of the cut pieces. All components, therefore, are cut "tight to toe", i.e. with the lines of tightness running from heel to toe. This rule is strictly adhered to in cutting most types of footwear. It is disregarded only in special circumstances, e.g. when cutting open-toe sandals where the strain is across the fore-part sandal straps or when cutting women's fashion boot-legs where "tightness" is required up the length of the leg.

Uppers

Vamps must withstand great stress and strain from the flexing of the foot in walking. They are also the most noticeable part of the shoe. Both substance and quality are needed. Vamps, therefore, are cut from the butt and middle.

Toecaps are equally noticeable and first class quality is needed. They are not subjected to such hard wear and are supported by the toe-puffs. A lighter substance is, therefore, acceptable.

Quarters should match the vamp where they are joined and match each other at the back seam. Facings and top line should be firm but lighter substance may be included at the heel where the quarter is supported by the stiffener. Better quality is preferable on the outside of the shoe, as this is more noticeable.

Backstraps, Counters, Saddles, etc. must be won from usable leather which remains. Appearance is more important than substance, as these are stitched over the upper leather which can itself be of inferior quality as blemishes will be hidden.

Facings which are backed to prevent the eyelets from tearing through can also be light in substance, although appearance is important.

Tongues should be light in substance so as to avoid discomfort to the wearer.

Heel covers would have the substance reduced by splitting and are suitable from shank leather.

"Match Marked" Work

Adjacent parts of the same shoe and both shoes of a pair must match not only for substance and quality, but also for appearance.

Accordingly, a sound guide for cutting is to cut adjacent parts of the shoe from adjacent areas of the skin, when "match marked" work is being cut. Suede shoes should, therefore, be paired up as they are cut. This rule also applies to shoes cut from embossed and printed grain leathers and also to leathers that have been "drum dyed".

Matching for substance and shade is less of a problem today, since skins are usually pre-sorted into bundles of similar substance, and many are also pigmented to a uniform tone. With aniline leather, the clear finish allows the natural grain to show, and there can be considerable differences in tone between the areas of the skin. When the natural or artificial markings of a skin are used to give a distinctive appearance, for example lizard and crocodile skins, it becomes an intricate problem to match the markings.

Individual Blemishes

Problems of substance, tension/stretch and quality are common to all skins and follow the same principles for all. Variations in grain and colour are peculiar to individual skins but conform to some sort of pattern, which is easily recognisable. In addition, every single skin has its own defects which must be noted and avoided. It is, therefore, necessary for the cutter to examine the skin carefully when planning his pattern arrangement so that blemishes are not included where they will show.

Defects may be due to the anatomy of the animal, for example:-

A well-grown animal has little unusable leather whereas with a badly grown skin large portions of the belly and neck may be unusable.

If the animal has a prominent or weak backbone, the skin covering it may be of poorer quality than the remainder of the butt.

In addition, there may be flay cuts, scratches, tick marks, etc. at random on the skin. These may be comparatively inconspicuous yet would open up and become very noticeable under the strain of lasting. It is possible to include them in the lasting allowance or where they will be hidden by a lapped seam.

It is advisable for the cutter to cut a high proportion of vamps from the better skins in unmatched work to compensate for the poorer skins more suitable for quarters.

The principles already described must be borne in mind when cutting any skin -

match adjacent parts of the shoe for colour, grain, nap etc. (possibly by cutting them from adjacent parts of the skin);

cut each part of the shoe from the appropriate part of the skin with priority for the vamps;

cut quarters always and vamps as a rule "tight to toe".

Economy of Leather

Consistent with these principles the aim of the cutter is to use his leather as economically as possible by avoiding waste involved in uncuttable remnants.

He does this by arranging the patterns or knives so that they interlock closely. Inevitably some leather will remain between patterns which

New Balance - EX1016

do not quite interlock (first waste). Some must be discarded as unsuitable offal or cannot be used due to the irregular shape of the skin (second waste). The aim of the cutter is to reduce the waste as much as he can, although it would be quite wrong to do so by including leather which should not properly be used. Experience enables him to see exactly where and how each pattern should be placed. Some guiding rules are:-

1. Cut larger sizes first from the larger skins (provided the substance is also the stoutest).

2. Fit a straight line to a straight line : a curve to a like curve.

3. Never cut a section without planning the next.

4. Cut sections square across the leather, avoiding awkward angles.

5. With a small whole skin, cut right feet from one side of the back-bone, left feet from the other, in other words, cut across the skin cutting a pair at a time.

It will be obvious that there is a great difference between the systematic cutting of large sides with the same simple knives, time and again, and the arrangement of patterns of complex shapes to make best use of a small skin. Accordingly, there is a difference in skill between cutting for sandals and fashion shoes. With sandals, it is possible to work out a system which can be applied to skin after skin; with the latter, the arrangement of patterns for each pair of shoes may be a separate work or art.

To a large extent, the designer and pattern cutter can influence the economy which can be achieved. Small regular patterns are more easily interlocked than large irregular ones and blemished leather can be used where one part is hidden by another. The foreman too can help by pre-sorting the leather to suit the ticket of work and allotting to the cutter a range of sizes to be cut together, since a small size may be fitted in where a large one would not.

Linings and Socks

There are some considerations particular to the cutting of linings and socks:-

(a) Linings

The quarter linings are most important from the point of view of appearance and wear. They are, of course, most noticeable when the shoe is on display and any blemishes would show. They are also vital to the comfort of the wearer owing to the friction between the heel bone and stiffener. They should, therefore, be cut out of the better leather.

Vamps are often unlined; when they are lined with leather, the lighter substance of skin can be used. It is essential that they should be cut "tight to toe" so that all creases and bagginess can be taken out when lasting.

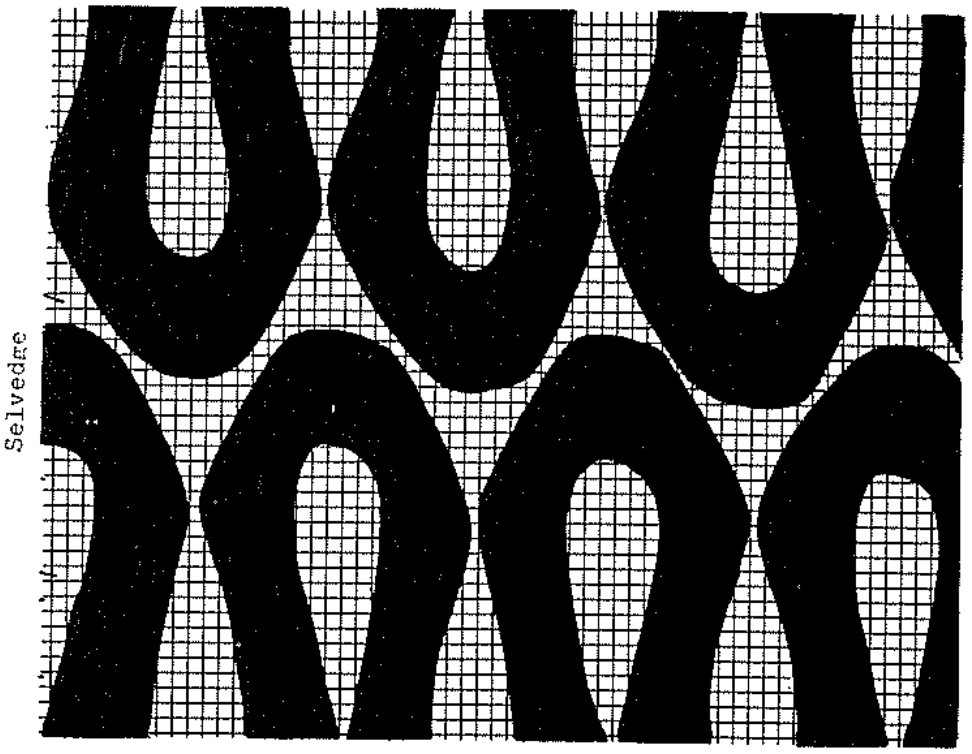
(b) Socks

The appearance of socks is especially important at the seat and waist where they show and where attention is drawn to them by the brand mark. Loose socks, for example woolly ones, must always be cut "tight to toe". Although there is no tension in wear when socks are stuck to the insole they are liable to be distorted when they are inserted unless they too are cut correctly.

Fabrics

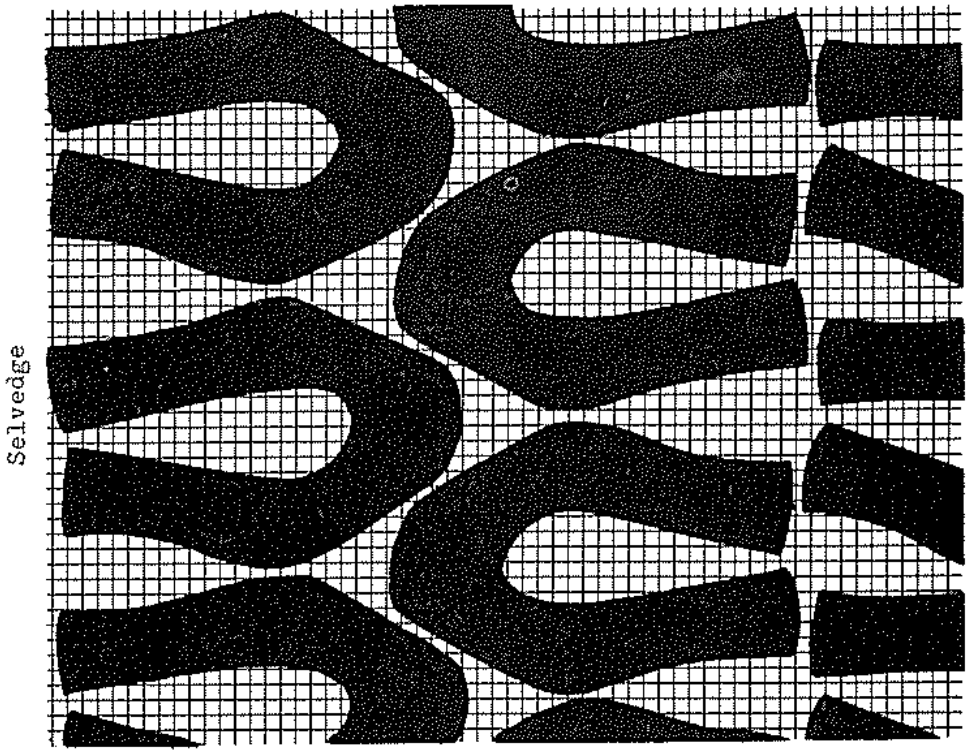
When fabric is used for upper material in place of leather, problems of substance and quality do not apply as these are uniform. The principle of tightness and stretch does apply, as the weft threads (those running across) are usually more stretchy than the warp threads (those running lengthwise). However, the lines of tightness are regular and consistent. Patterns can be cut on:-

The warp system (lengthwise); this is "tight to toe" but makes them liable to breakage in manufacture.

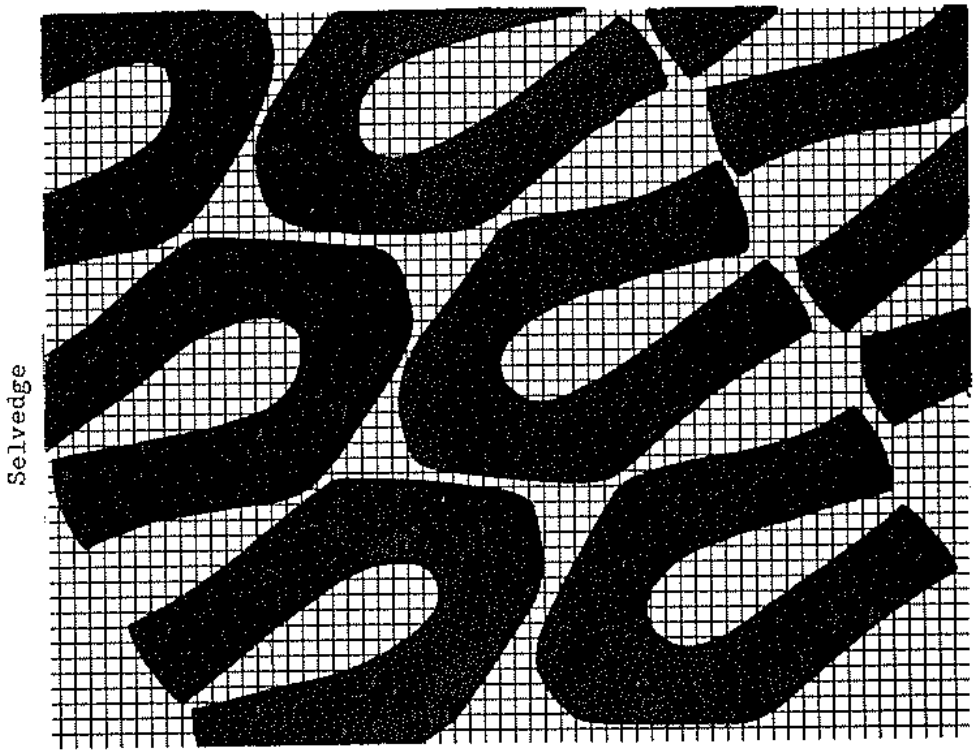


New Balance - EX1016

The weft system (across); this is more flexible.



This bias system (diagonal); this is usually employed when a vamp lining is combined to a plumper (or thickening layer) so that there is equal elasticity in each.



New Balance - EX1016

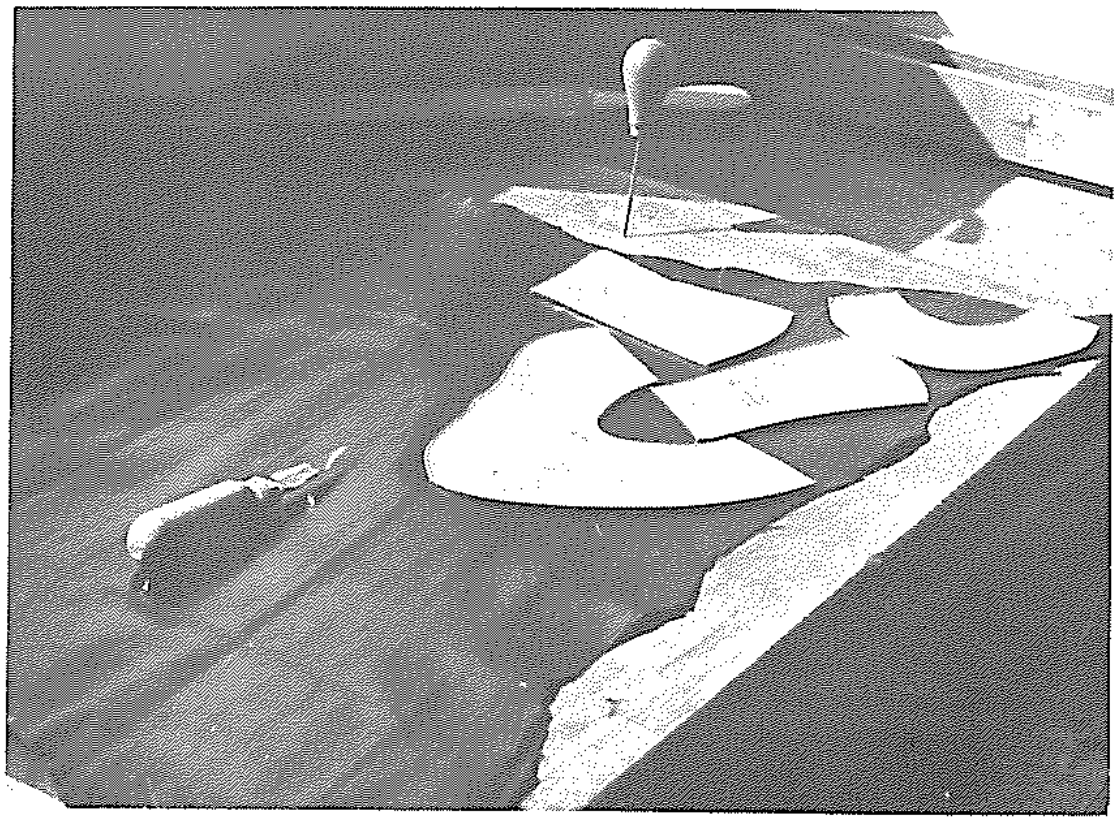
It will be obvious that fabrics (unlike leather) can be cut strictly to a system, so that waste is reduced to a minimum between patterns. When cutting uppers from fabrics which are decorated, it is necessary to match exactly the designs on both shoes of a pair.

5. METHODS OF CUTTING

The action of cutting the component can be either by hand or machine. Traditionally, cutting was done by hand, but today many of the larger companies use machine cutting. Whether it is by hand or machine the action part of the cutting operation is considered to be the easiest aspect of the job. Which method is chosen is largely a question of economics. If the pairage of shoes likely to be sold on any one style justifies the cost of a set of press knives, the shoes will be machine cut; if not they will be hand cut. Larger companies making many pairs of the same style are more likely to machine cut, while the smaller companies who make only a limited pairage of each style are likely to hand cut.

The quality of the finished upper should not be affected by the method used, whether it is by hand or machine. Man-made materials, because of their uniformity, can be cut multi-thick and need much less skill in cutting than leather.

(a) Hand Cutting



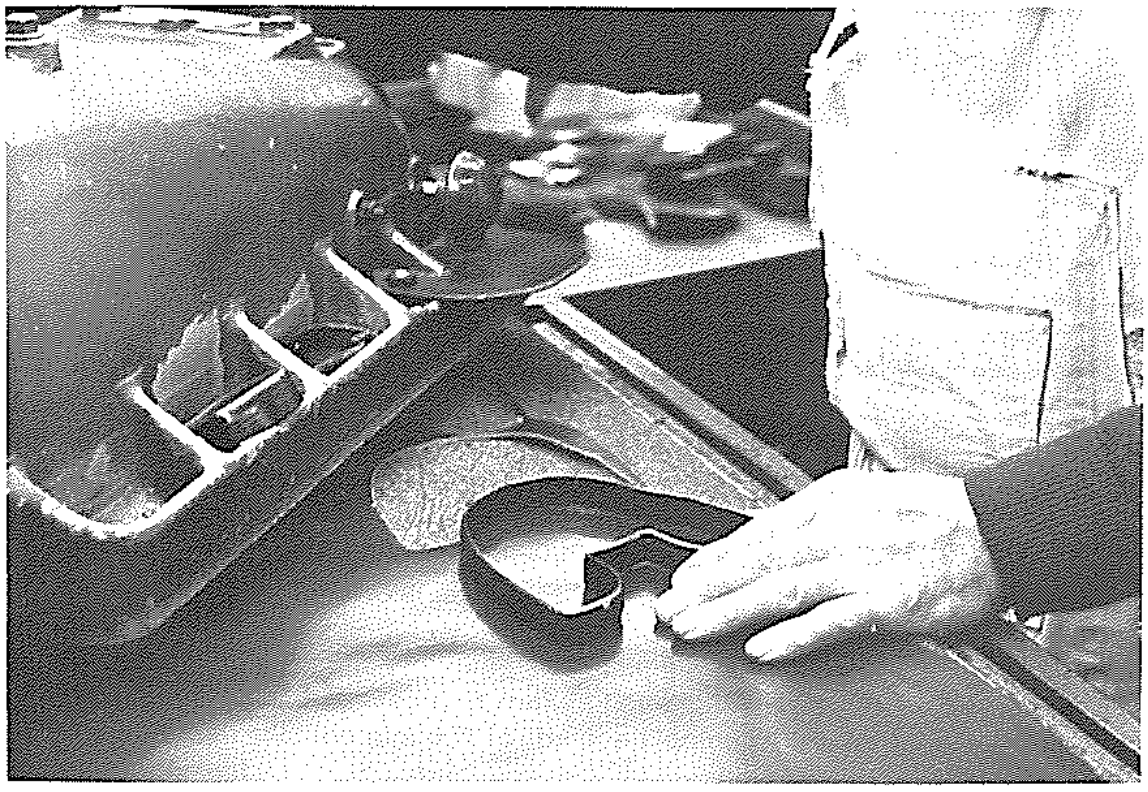
Rigid fibre board patterns with brass bound edges and hand knives are used. Curved knives with vertical cutting edges are best for leather, so that there is no need to over-cut at corners. A straight knife is best for fabric and very light leather as it cuts down onto the cutting block and holds the leather in position.

(b) Press Cutting

For speed and economy of effort, press cutting is used wherever the anticipated demand justifies the capital outlay on knives. Hand cutting is still used for samples, etc. and for fashion shoes when only a limited run is expected.

Beam presses are used, and these can be one of three types. Mechanical, hydraulic or electronic. Many newer machines are hydraulically assisted electronic machines and are known as hytronic.

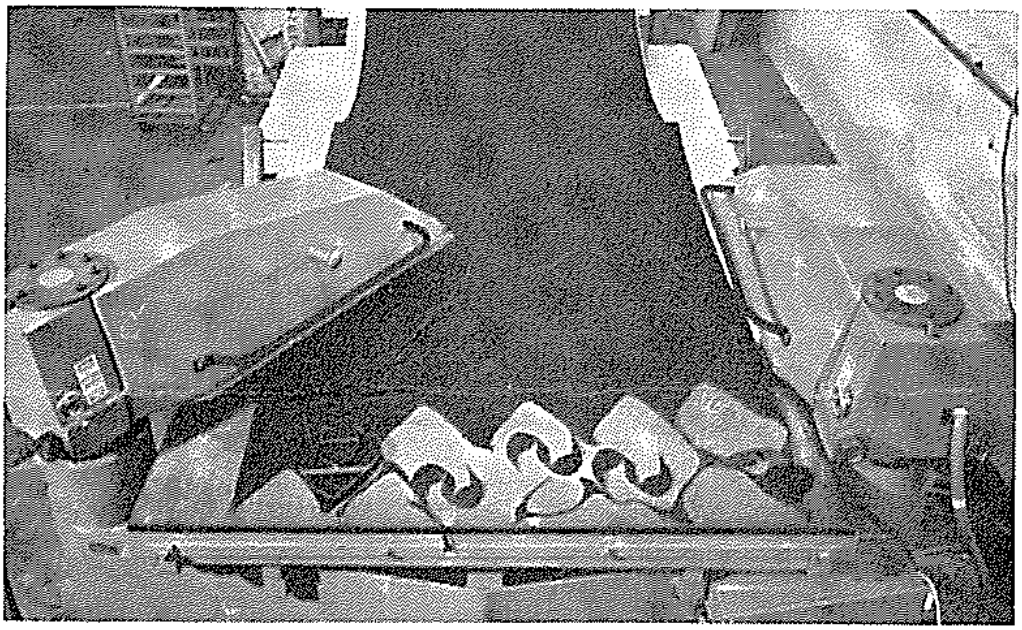
With mechanical and hydraulic presses, the cutting blocks may be of wood, fibre board or a synthetic rubber composition. With electronic and hytronic presses, the block is of soft metal covered with a thin layer of scotch tape. The possibility of driving the knife deeply into the cutting block is eliminated with the electronic and hytronic presses, since as soon as the knife comes into contact



Press cutting (leather)

with the metal block an electrical circuit is completed and the beam rises. "Crush plates" on the central column of the press also prevent excessive depression of the cutting head if the electrical circuit is not completed.

For the cutting of fabrics or rubber sheeting Twin Beam Presses are being marketed. These presses can cut materials up to 60 inches in width straight from a roll and have ample space behind the beams both for rolls of material and sheets of rubber or fibre board.

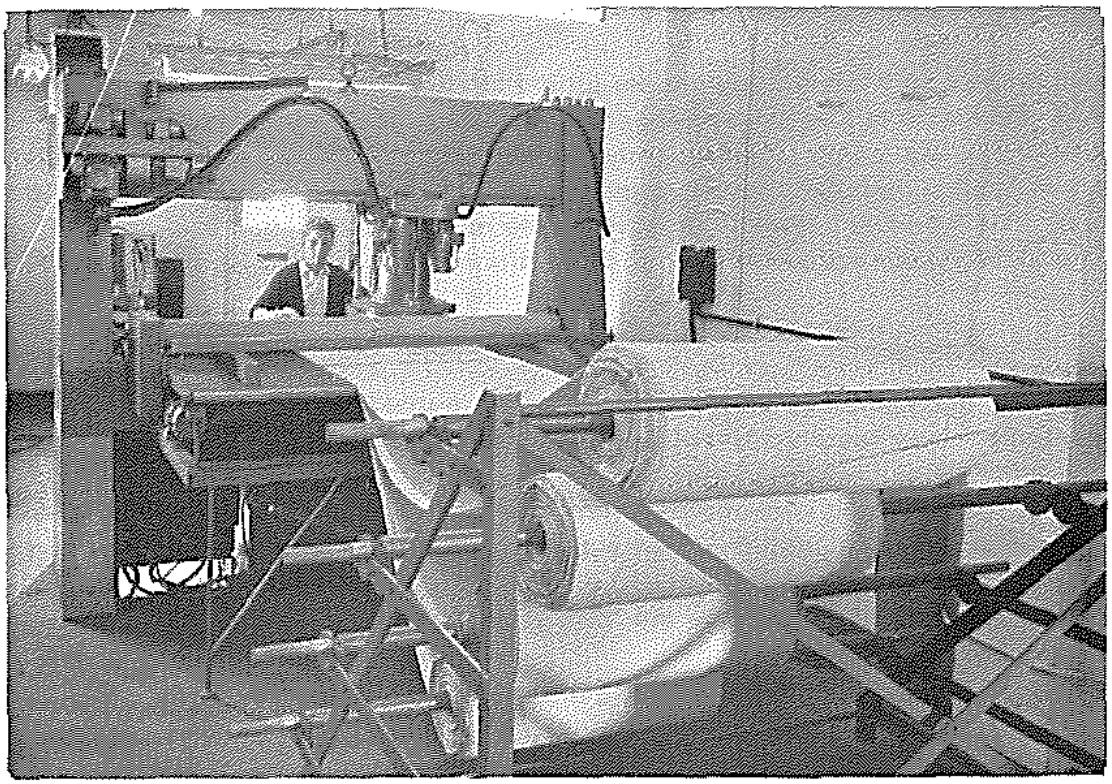


Hydraulic Twin Beam Press

With an eye to the future and the possibility that automatic or semi-automatic cutting will become far more important, and in view of the introduction of synthetic materials, new types of presses have developed.

Large beam presses with moving cutting heads have been developed. On these presses, the feed of the material, the movement of the cutting head and all other parts of the operation are controlled automatically from punched tapes.

New Balance - EX1016



"Daco" Automatic Press

Knives

Upper press knives can be single or double edged and are made from steel, cold-bent to the pattern required. It is important that the knives are checked frequently against a master pattern to ensure that the knife shape has not distorted.

Size notches are usually incorporated in the knife and any indication marks, such as prick marks for lapping allowances, are also incorporated.

Knives must be kept sharp to give a good clean cut, the number of sharpenings possible on any knife being limited, since the knives are shallow.

Provided the cut is clean, it makes little difference whether it is made by hand or by machine since it is the positioning of the pattern or knife that is important.

LEATHER MEASUREMENT SYSTEMS

Introduction

Since leather is the most expensive single item in a shoe, it is important that it should be cut economically and, therefore, the amount of leather necessary to cut a pair of shoes must be calculated as accurately as possible. Several leather measurement systems have been evolved over the years to do this. All, however, have their advantages and disadvantages and, as yet, no completely accurate method has been discovered.

"Marking Up" Method

In the very early days no allowances at all were used, and the cutters just drew what leather they required to cut the job in hand.

The first system used was one in which the cutting foreman selected an average skin from the bundle, and this skin was marked up with patterns at the average shoe size as they should be cut. The area of the skin was divided by the number of pairs which could be cut from it and this was used as the standard allowance.

Advantages

1. The cutters could be shown the marked skin to demonstrate the correct way.

2. Future deliveries of leather could be compared with the marked skin.

Disadvantages

1. Foreman biased to ensure room profit.

2. No real average skin.

3. Shoe size taken may not prove to be weighted average of size of shoes sold.

4. Not adjustable for size change.

Russ and Small Method

In 1922 two American accountants, Russ and Small, introduced their method of scaling. Their method consists of interlocking a pattern upon itself respectively, until 4 patterns are facing the same way and then joining like points on the patterns to form a rectangle, a square or a parellelogram which enclosed one complete pair of patterns plus the unavoidable waste, which is termed 'first waste'. This is then the smallest possible area in which one pair of patterns could be cut.

New Balance - EX1016

A set of tables were drawn up so that a percentage could be added to this area to allow for different materials which affects the positioning of patterns.

Advantages

1. Area of perimeter shape is related to allowance.

2. Differences allowed for that would affect layout of patterns.

Disadvantages

1. Not adjustable for size change.

2. Percentages added are based on past inaccurate records.

Square Board Method

Here a measurement board is used. This may be of wood, paper or hard-board and is rectangular 12" width, the length being immaterial, but 24" should be the minimum.

The board should be ruled each half inch and complete inch with horizontal lines, and each line will be clearly marked with the number of inches it is from base.

Then lay complete patterns for one pair on the board in the most compact and economical arrangement.

A reading can be made of the area covered, and since the board is one foot in width the figure reached will be the basic area for one dozen pairs in sq.ft. This, of course, includes the first or unavoidable waste.

Example:

12" x 14" = 168 sq.in. = 1.1/6 sq.ft. per pair

12 x 1.1/6 = 14 sq.ft. per dozen pairs

To adjust for the actual cutting allowance additions will have to be made for:

A. Average pattern area in relation to skin size
B. Leather type
C. Leather grade
D. Variations in size range and fittings

Check Method - Weight

Weigh a parcel of leather to be cut and by subsequently weighing the uppers cut from this leather the difference can be turned into a waste percentage.

As with the "Marking Up" method this depends on the human element in that it must be repeated with several different operatives to get a fair representation of the results to be expected. There is also the fact that cost estimates are required before cutting, hence the main value in this method is as a check on an existing costing.

Personnel Administration (1951 approx.)

The scaling method was scrapped and a method of measuring the pattern area was introduced.

From past records a relationship between the total figure used and the areas of the patterns was determined and a table of percentages with which to increase the pattern area for a pair of shoes was drawn up.

To this allowance a further 5% was added to allow for savings.

Advantages

1. Better records were available owing to previous systems making better use of leather.

2. Direct measurement gave a more scientific approach.

3. A level of savings built in to give more incentive.

4. Easy to apply.

Disadvantages

1. Each time a new leather was introduced it required top level discussion to classify for wastage put ups.

2. Different grades of leather quality were not taken into consideration.

3. Allowances were based on the average size of pattern to be used, giving high or low savings where size of shoe cut was above or below the average size.

Scientific Leather Measurement System (S.L.M.)

This system re-adopted the interlocking of patterns as a basis for cutting allowances. Old records were not used and its own records of usages and areas of waste were established scientifically. By the introduction of leather assessment and grading into the system, the material variable has, to a large extent, been eliminated. The system was set up to deal with

New Balance - EX1016

the shoe size variable, therefore, enabling a universal application which holds for all individual cutting jobs.

The system, therefore, is in two parts:-

1) Pattern Assessment

2) Leather Assessment

Pattern Assessment

The end product of this takes care of:-

(a) The waste thrown up by lack of interlockability of patterns upon themselves.

(b) The waste thrown up between different pattern items.

(c) The waste thrown up around the perimeter of the skin.

This gives an allowance per pair assuming that the leather is 100% usable.

Leather Assessment

The pattern allowance previously established is now varied according to the "leather co-efficient". This leather co-efficient is established by combining the "cutting co-efficient" and the "discrepancy co-efficient". The cutting co-efficient is the amount of usable leather in a skin of any one grade and is expressed as a percentage of the total area of the skin. The discrepancy co-efficient is the difference between the Tanner's quoted measure and the actual area measure established by means of a Turner Pin Wheel Measurement machine or similar device on the shoe manufacturer's premises.

Thus, for example, a pattern allowance which is to be used on a leather with 90 co-efficient would increase by about 10%, whilst if used on a 95 co-efficient leather would increase only by about 5%.

S.L.M. also recognises that the allowance should change according to the size of the shoe cut. Consequently, each allowance to the cutter is varied according to the weighted average size cut, and the calculation is based upon 5.3% change per 1 size.

Advantages

1. Eliminates anomalies due to varying shoe size.

2. Improved material utilisation giving substantial savings to management.

3. Has a scientific base and does not depend on part inaccurate records.

4. Can be applied to all styles and most leathers.

5. Provides an accurate system of shoe costings.

Disadvantages

1. Bonus paid on individual job "savings" means a cutter can lose more leather than he saves and still receive some overall bonus.

2. Overall maintenance cost of the system greatly increased.

3. No financial penalty for high savings coupled with poor quality work.

New Balance - EX1016

CHAPTER 8
CLOSING

Closing is the title given to the preparation, fitting together and finishing off of the cut components to produce an upper ready for lasting.

When the cut sections arrive in the Closing Room they are progressed through the operations in preparation, fitting together and finishing off in a particular sequence. The closing sequence will obviously vary from style to style.

PREPARATION

Preparation is, as the name suggests, a series of operations which prepare the upper sections for stitching. The preparation operations are sometimes attached to the cutting room but traditionally they belong to the Closing Room.

Work arrives from cutting in a box containing the upper components for a number of pairs, usually 10 or 12 pairs. The work is accompanied by a work ticket which gives the following information - size, fitting, style, material, last number, number of pairs and any other work specifications.

Checking

Before commencing any of the operations in closing, it is necessary to ensure that the upper components are correct by checking them against the work ticket.

Identification Marking

It is necessary to be able to identify any component and the completed upper. There are several ways in which this can be achieved. These are:-

i) Crayon Marking

This is where the cutter marks the reverse side of the material with a crayon indicating its size and ticket number.

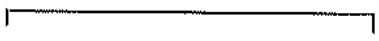
ii) Notch Marking

This relates to press cut uppers where a series of notches in the knife are transferred to the lasting edge of the component when it is cut, indicating its size.

One such code is as follows:-

New Balance - EX1016

TYPICAL SIZE CODE USED IN PRESS KNIVES

English Sizes	Code
1.....4.....9	
2.....5.....10	
3.....6.....11	
7.....12	
8.....13	
All ½ sizes	
Example:- Size 6½	

Notches can also be used to indicate inside components and fittings.

iii) Match Marking

Where fashion shoes are cut from skins which vary in grain appearance and colour a numerical/alphabetical code is printed onto the lasting allowance to identify each pair. For example: 4B 57 would mean size 4, pair B, ticket No. 57.

Unmatched shoes may have the quarters paired for substance and marked accordingly to ensure that the heel seam will rub out evenly.

iv) Colour Marking

This is carried out on a machine carrying several wheels all turning in different coloured paints. Each upper section has its lasting edge pressed against the appropriate wheel to transfer the colour applicable to the shoe size.

v) Lining Stamping

This is used for identification during manufacture, and also as

information for the wholesaler and retailer. It is necessary to provide certain details in a conspicuous position without detracting from the appearance of the footwear.

Essential details are the size, fit, last, shoe number and any other specifications to assist in repeat orders being executed correctly, or in faulty footwear being traced to its source.

vi) Coloured Tapes

Although coloured tapes are not used in the preparation section, they are worthy of mention while dealing with identification marking.

Coloured tapes are stitched into the toplines of shoes which have been matched for colour or grain. Matching tapes are stitched into a matched pair so that they can be paired-up after the sole has been positioned, when the lasting edge is no longer visible.

vii) Embossing

The brand name may be embossed on the sock by a transfer process.

Stitch Markings

It is usually necessary to mark the upper to enable operatives to position the upper sections accurately when stitching, etc.

The following methods of marking may be used to position: stitching, fitting overlays, laps, buckles, bars, trims and eyelets, etc.

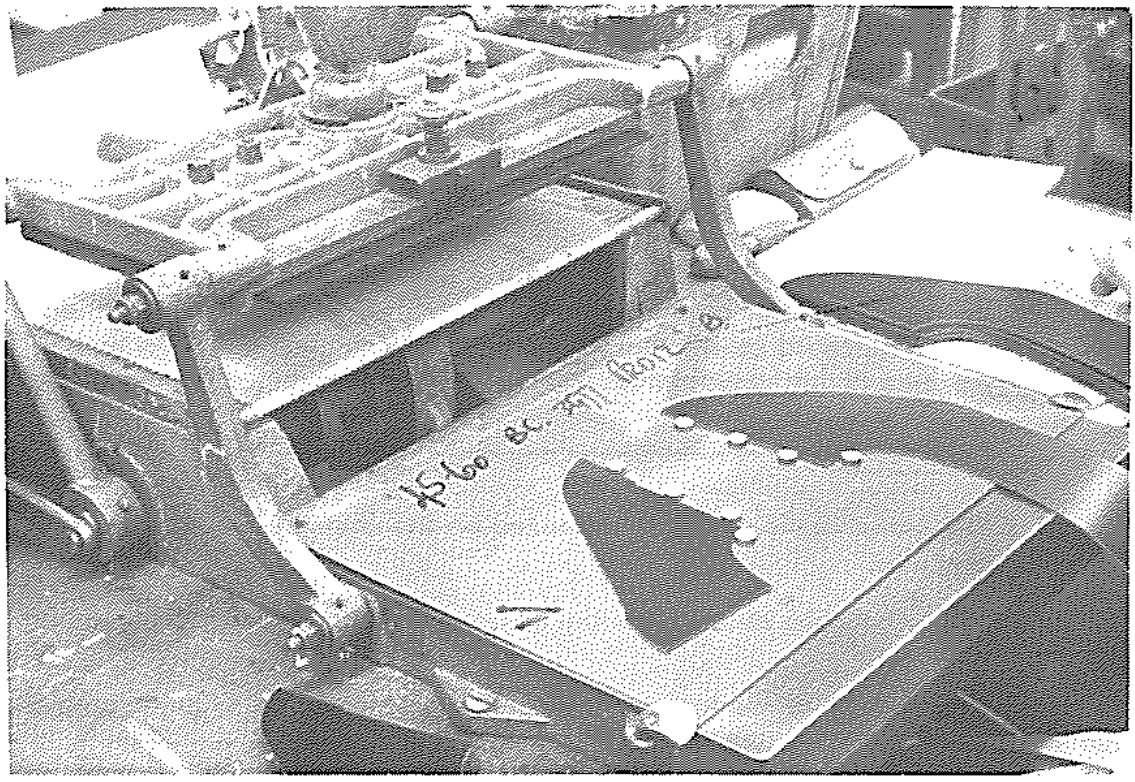
a) Handmarkers

These are fibre board patterns cut to the same shape and size as the upper section with a series of slots cut in positions where marking is required. The marker is placed on the material and a special marking pen is used to mark the appropriate positions through the slots.

b) Block Marking

This is carried out by a machine known as the Edwards Block Marker. The base of the machine holds a jig, which consists of a fibre board fitted with a series of brass studs in the shape of the edge of the upper section. The marker designed to go with the jig is placed in the top of the machine. The part of

the upper to be marked is fitted into the jig against the brass studs. The marker board travels to a tray carrying a marking ink. From there it swings forward firmly on to the positioned section of material, imprinting the required marks by pressure.



Edwards Block Marker

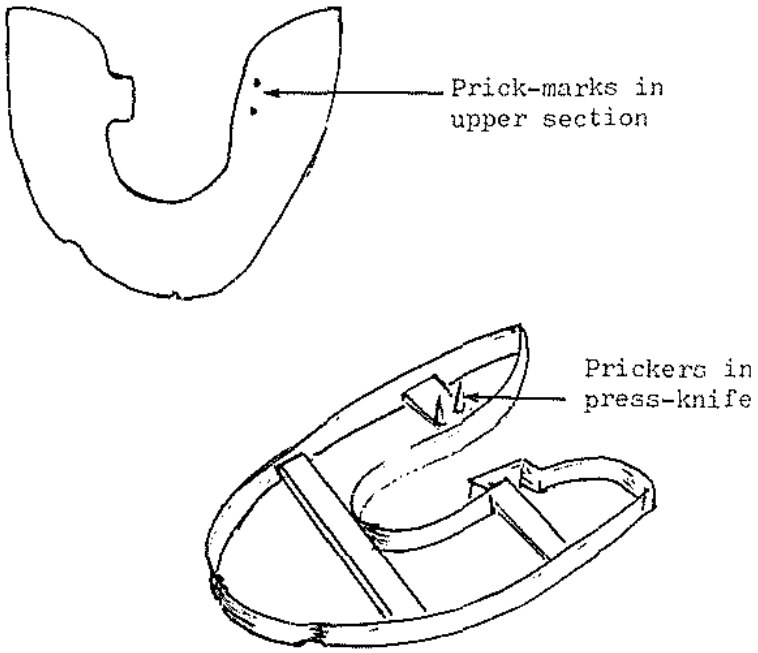
Both markers and guides have to be changed for each style and each foot but it may be possible for a marker to cover a range of sizes and fittings,

e.g. 2 - $3\frac{1}{2}$, 4 - $5\frac{1}{2}$, 6 - $7\frac{1}{2}$.

c) Prick Marker

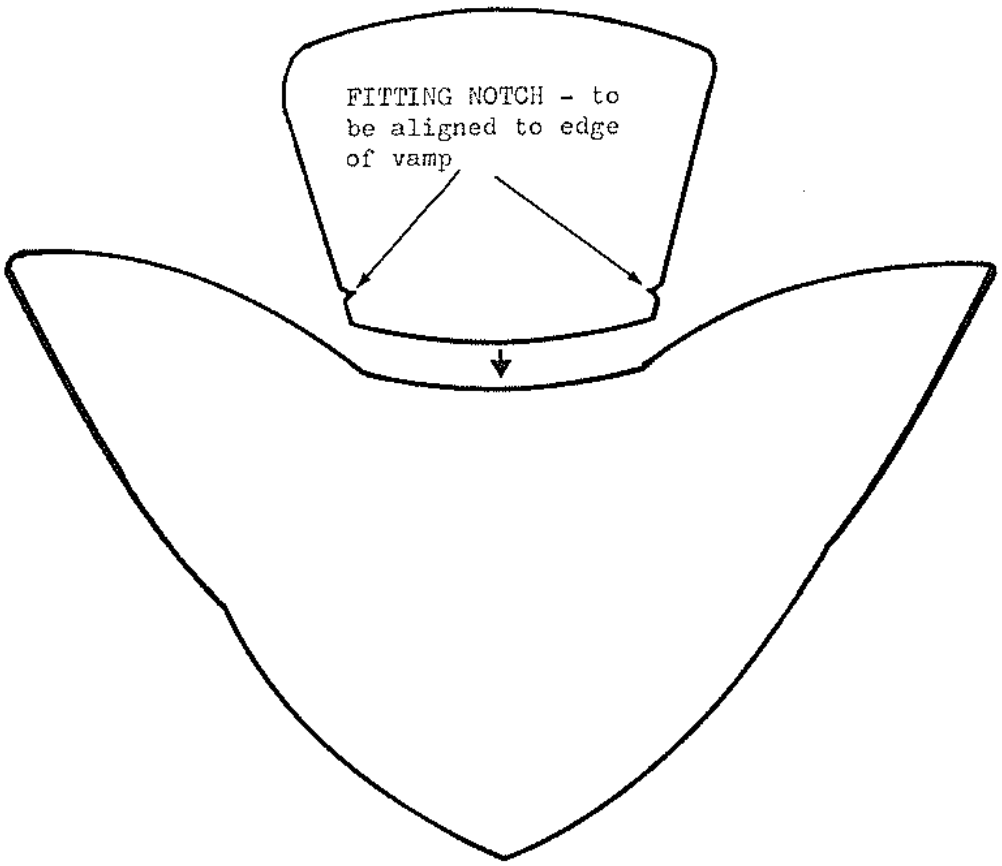
Prick markers are points fitted into the press cutting knives

which leave a mark as the upper section is cut.



d) Notch Marks

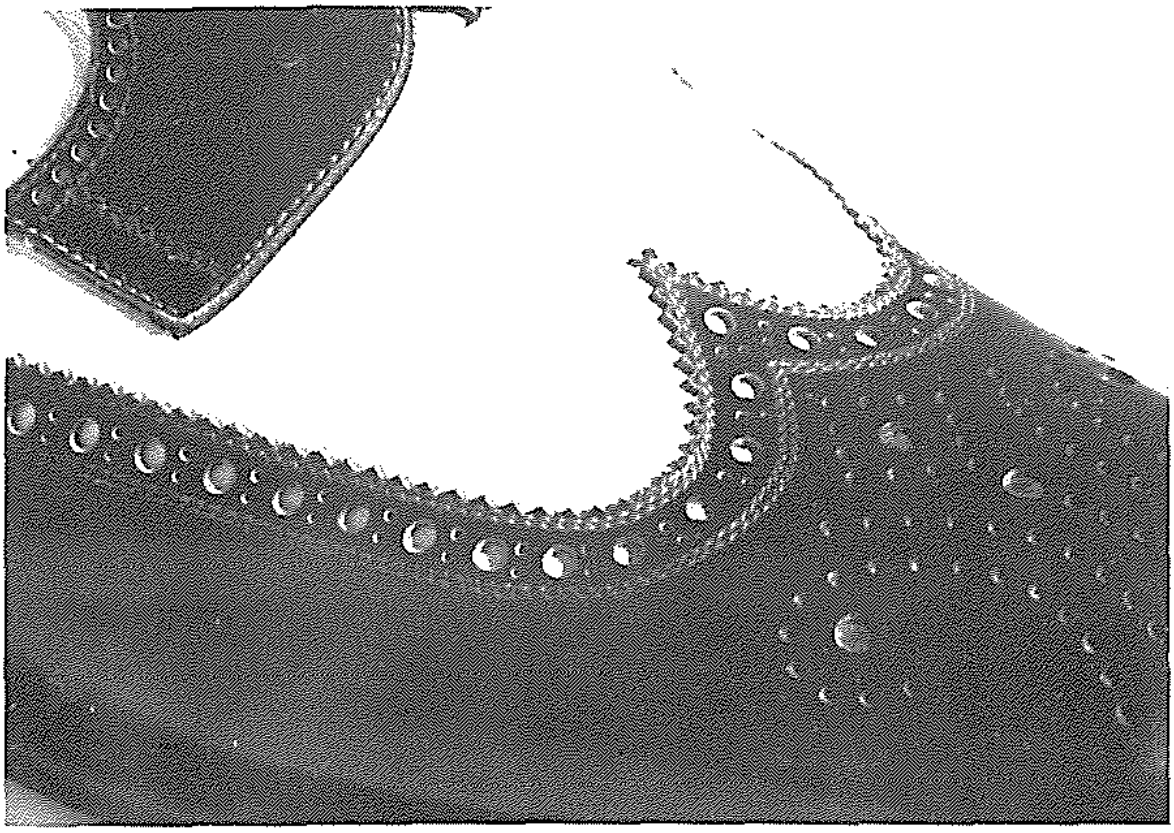
Notch marking is where there is a small notch built into the cutting knife which leaves a clearly defined fitting notch on the edge of the component.



Note:- Although these methods of marking are available it is probably better to fit a guide to the machine where possible.

Press Punching

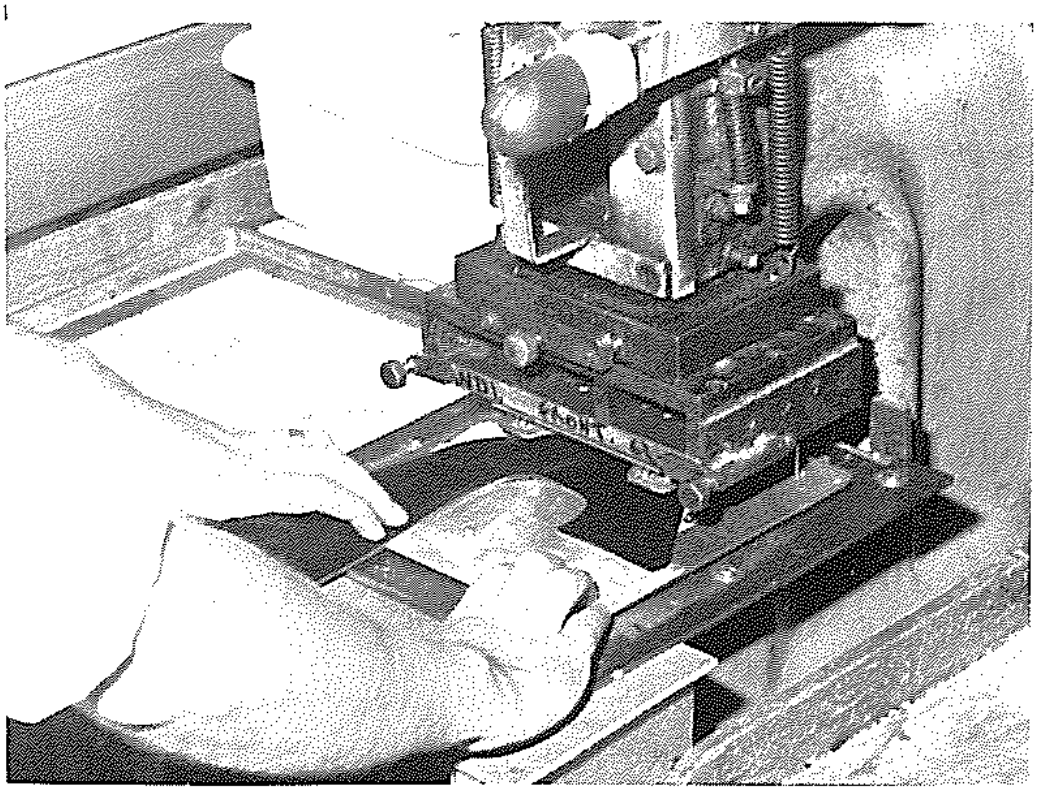
Decorative designs may be punched out of material - for example the open holes in sandal vamps or, alternatively, edges may need gimping in conjunction with a punched design.



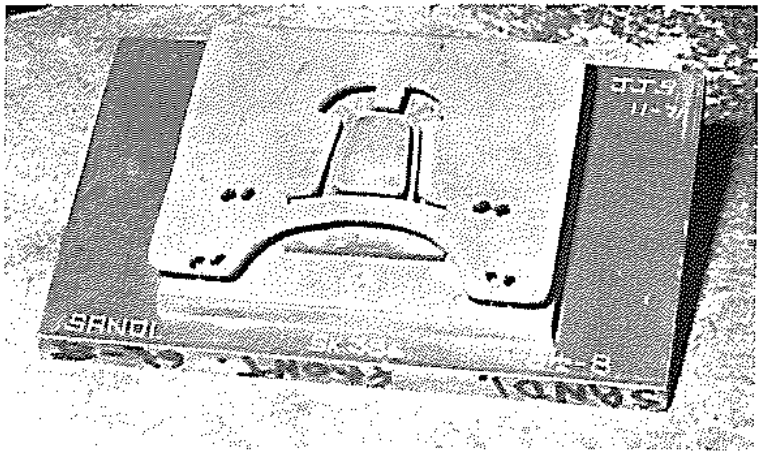
Press-punching,
perforating and
gimping
("brogue"
treatment)

The design is made up by using cutting tubes or knives which protrude from a metal die when pressure is applied.

The press punch die can be one of two basic types. In the first the die is fitted in the head of the machine and a jig or guard for accurate location of the component is fitted to the carrier. The component on the carrier is then pushed under the die and pressure is applied to punch out the design. This type of machine is often known as R.M.H.

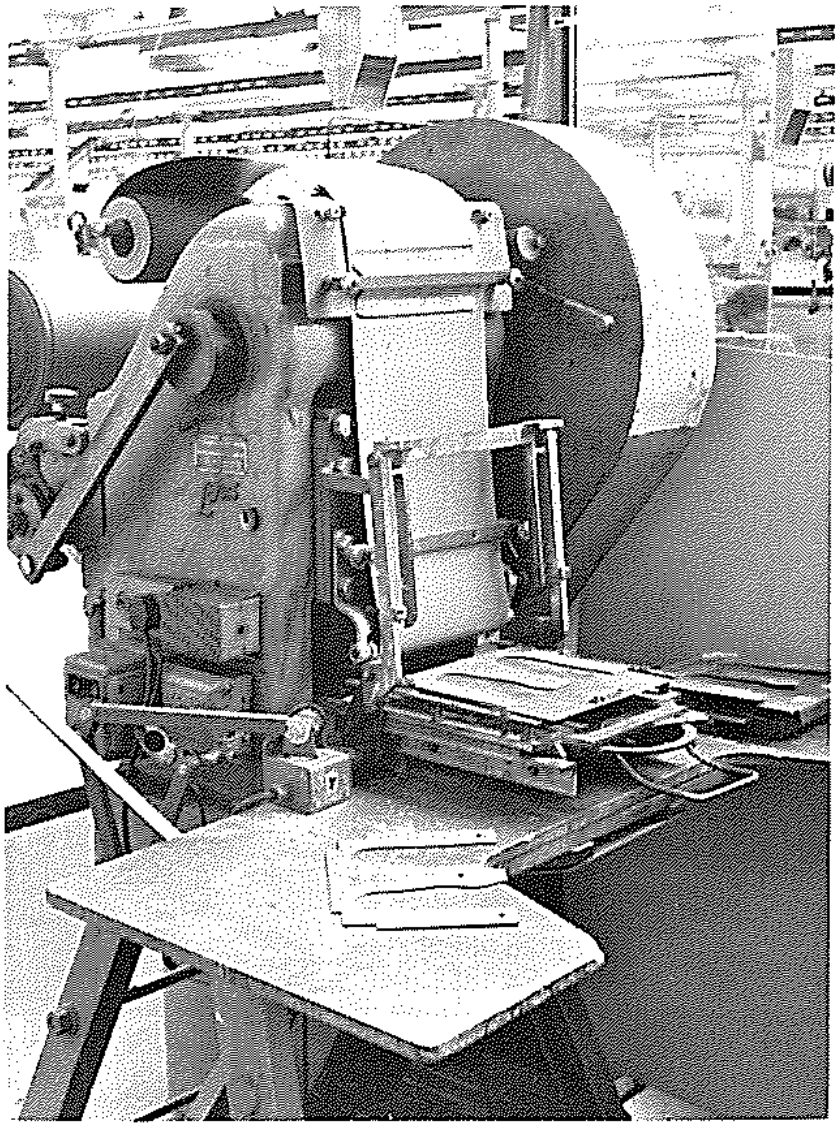


RMH press punch



RMH die

The other type of machine has the die and guard jig located in the carrier below the component, which is placed reverse side up and held in position by spring clips or double-sided tape. The component, guide and die are then pushed under the press together and pressure is applied. This type of machine is known as the W.S.M. or Western press.



WSM press punch

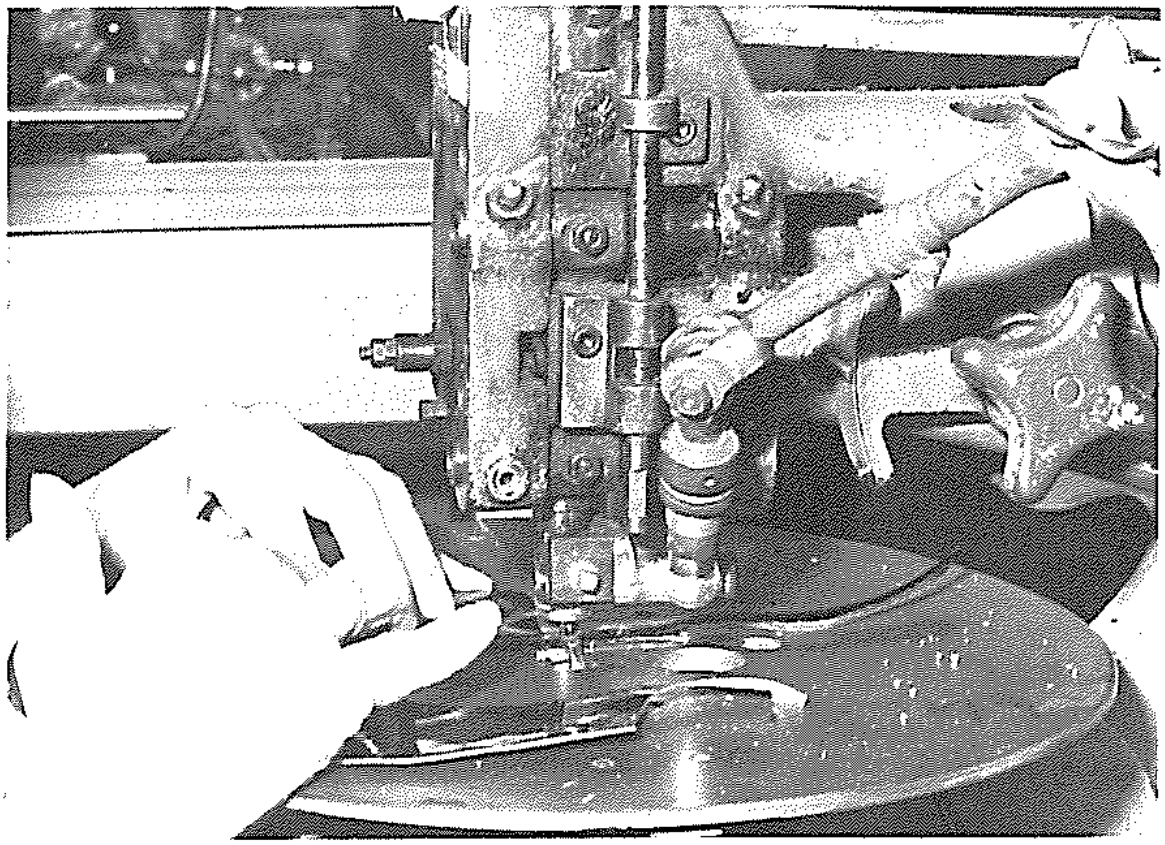
A simple block mark may be included in the die of either type of machine if stitching is to be incorporated in the design. This will ensure that the punching and stitching are perfectly aligned.

Perforating

An effect similar to press punching may be achieved by a different means. A single row of holes (or combination of holes) can be punched out individually. This is used along the edge of toe caps or foxings and is usually a distinctive feature of a brogue shoe.

The action of the punch is synchronised with the feeding through of material. Block marks or edge guides are normally used to locate

the position of the perforating, although the punch can be operated independently, positioning it either by eye or using a spotting device.



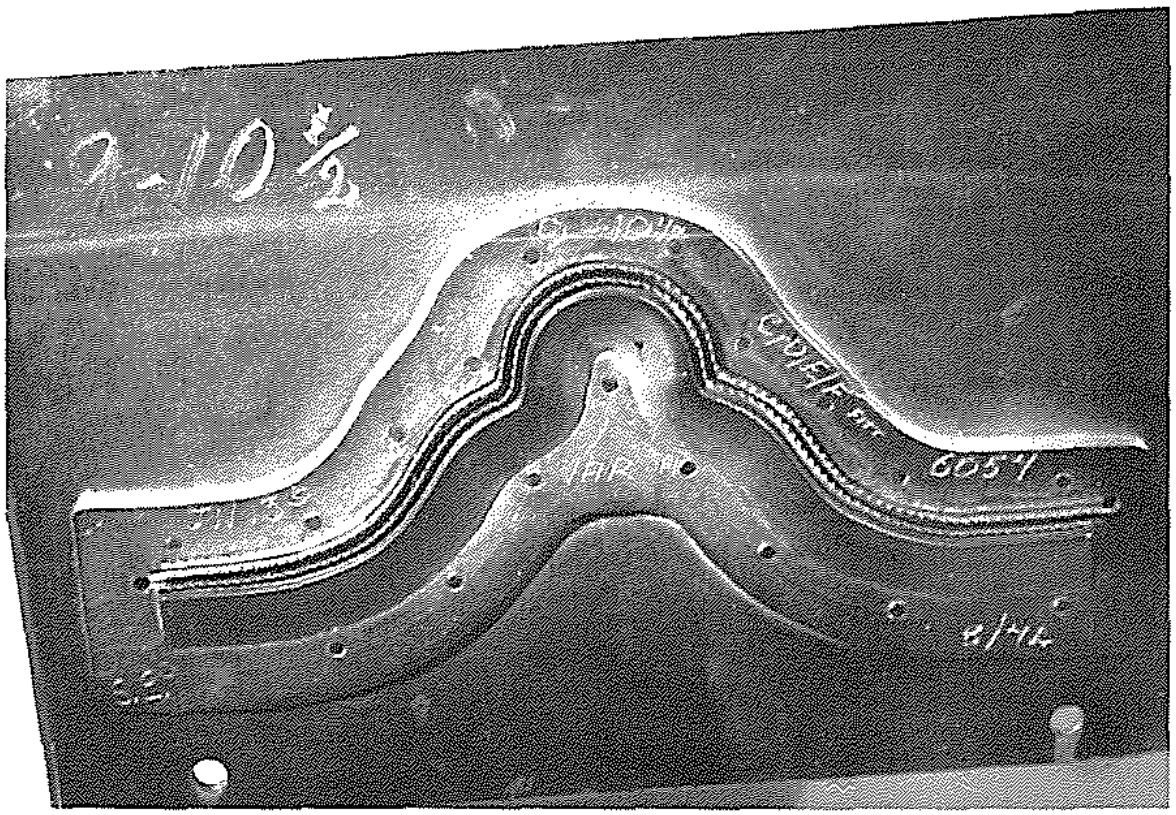
Perforating

Embossing

This is an ornamental treatment whereby designs are printed into, or raised up on, material by the use of heat and pressure.

Heated blocks are used for embossing. These may be of a single type which press the design into the material or of the type consisting of a male and a female mould which are used to raise a design in relief.

New Balance - EX1016



EMBOSSING DIE. With the aid of H.F. heat and pressure, this die produces a simulated twin row lap seam

Skiving

Skiving is the reduction in thickness of certain edges of upper components to:-

(a) Improve the appearance of the finished upper.

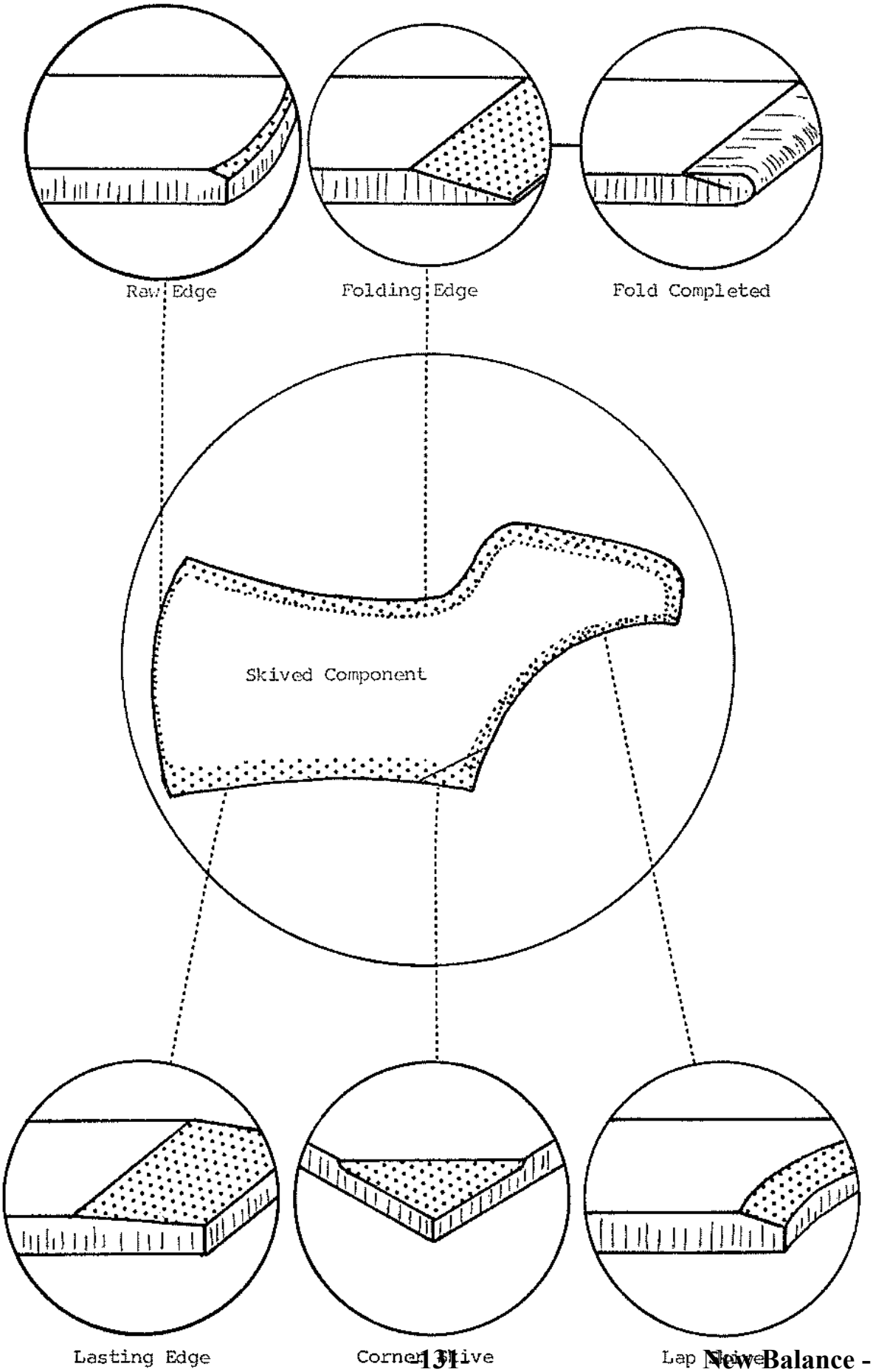
(b) To avoid discomfort in wear.

(c) Reduce bulkiness.

(d) To aid construction.

The reduction in substance is usually made on the flesh side of the material leaving the grain side complete. However, it may occasionally be necessary to remove the grain side of the material to allow an adhesive to penetrate where two parts are to be stuck, also some synthetic materials have a fabric backing which holds the material strength - here again the grain side would be skived away.

124 TYPES OF SKIVE



New Balance - EX1016

Types of skiving are:-

(1) Raw Edge

This skive may be used to -

i) achieve a neater, slimmer edge.
ii) reduce bulk.
iii) to equalise the topline substance.
iv) to reduce substance of closed seams.

(2) Lapped Skive

This is used on the component to be lapped underneath. It is skived to reduce the bulk which lies against the foot.

(3) Folded Skive

The edge of the material to be folded is skived to twice the width of the required fold so that it lies flat when folded over.

(4) Lasting Skive

The lasting allowance may be skived to reduce bulk beneath the insole, to ease pleating when the upper is lasted and to assist adhesion.

(5) Corner Skive

Used to reduce the substance on the corner of a component on the lasting edge, where a lap may be too bulky for good lasting.

Types of Skiving Machines

1. B.U. (Marvel) No. 8 & No. 9

The Marvel skiver produces a straight skive. It can be adjusted to vary the angle and the substance to be left at the edge, but it does not always give a uniform width of skive as this depends on the substance of the leather. This machine cannot be used for splitting. Both the No. 8 and No. 9 models can be pre set to give two interchangeable skives at the touch of a foot pedal.

2. Standard Fortuna

This machine may be set for only one skive at a time. It produces good specialist skives since the foot of the machine is easily changed or adjusted. The Standard Fortuna machine can also be set for splitting.

3. Fortuna 3 Step

The Fortuna 3S machine has a visual scale for setting and can be pre set to give three skives, the order of which can be permutated.

4. S.M.3

This machine has 3 pre set skives using two positions on the machine - one foot providing two skives and the second foot providing one.

5. Splitting

This operation is usually carried out on a band knife splitting machine. It reduces the whole area of the material to a given substance.

6. Matrix Skiving or Splitting

Matrix skiving requires a larger and much more expensive splitting machine. The component to be skived is fitted to a rubber matrix which is pre shaped to conform to the desired end result. The component and matrix are passed through the machine. The machine removes substance from the reverse side of the material where the thicker parts of the matrix have applied pressure.

Reinforcements

Certain parts of an upper may be reinforced to -

1. give strength.
2. prevent distortion by stretching.
3. give the material substance.
4. aid waterproofing.

It may be necessary to strengthen some parts of an upper to give better wearing properties. It is normal, for example, to use tapes along seams, and puffs to reinforce the toe areas. It is also essential to

reinforce eyelets, buttons and buckles etc. to ensure they are held securely. There are also a number of tapes and backers that will prevent stretch and distortion both during construction and in wear. These include topline tapes, stay tapes and backers for reinforcing press punching and perforating.

Some light weight soft materials will require to be combined to backers to increase their substance which, in turn, will improve its appearance and wearing qualitites. These are sometimes known as plumpers.

It is also possible to use a material to reinforce against water.

Trimmings

Preparation of trimmings may involve press-punching, perforating, skiving, folding, stitching, knotting, interlacing, moulding, etc.

TOPLINE AND EDGE TREATMENTS

Toplines and edges may be treated in various ways to improve their appearance depending on the style and price of the shoe.

(1) Raw Edge

The edge may be left raw as cut or inked to match the colour of the surface of the material. Contrasting colours may be used as a feature of the design. The edge is normally raw-edge skived.

Inking 1st Way

All parts are held together and the appropriate edges inked with either a spray, a brush or a sponge.

Inking 2nd Way

The edges are inked at a later stage, after top stitching for example, when the sheared edge of the lining needs to be coloured to match the upper.

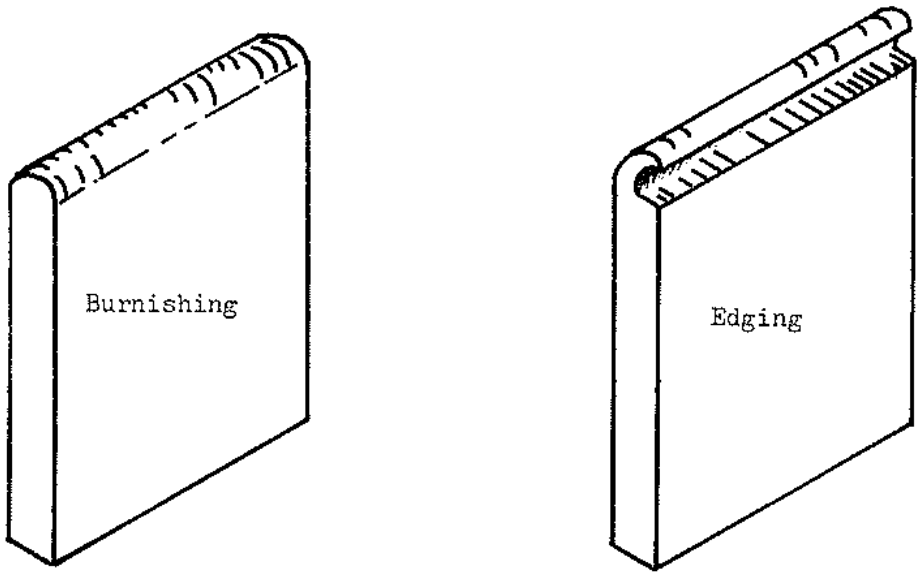
(2) Burnishing

Burnishing is the name given to the rounding off of the grain surface of a raw edge by means of a heated iron. Because of the heat involved, the method of tanning and finishing the leather is important.

(3) Edging

This treatment makes a raw edge resemble a folded edge. Toe caps, for example, may be edged.

The edge is stunt skived (40°) and passed over a heated iron which causes the leather to contract and the grain surface to fold over.



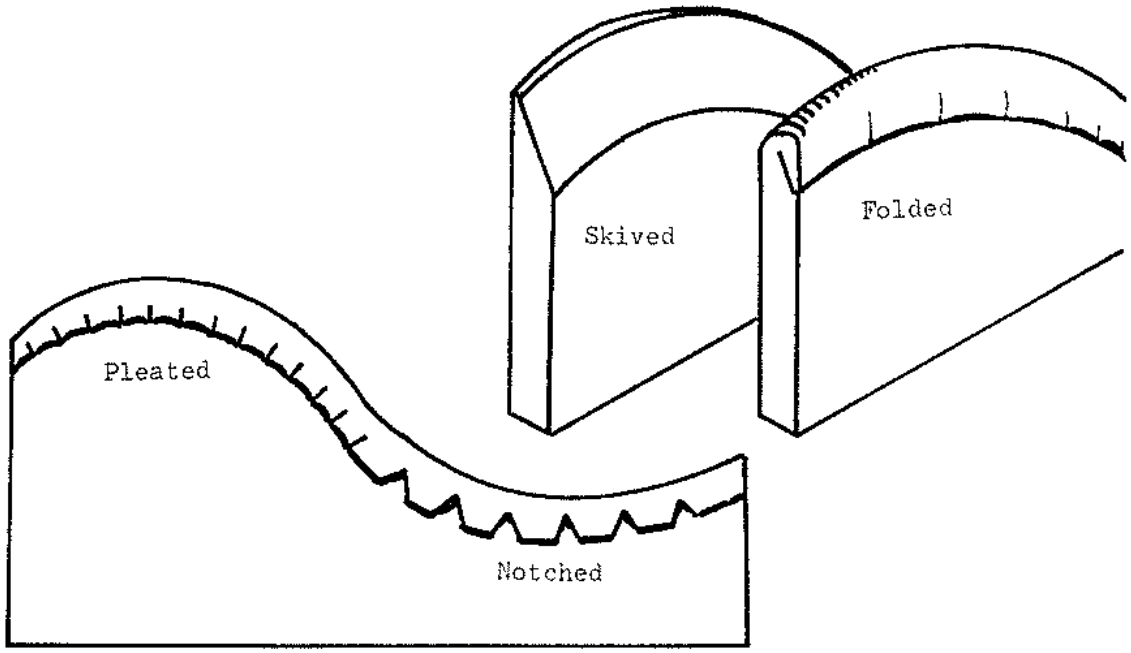
(4) Folded Edge

This is a common edge treatment for aprons, trims, caps, bars, straps and toplines.

The edge is given a folded skive. It is then folded over

New Balance - EX1016

and cemented down either by machine or by hand. A reinforcing tape may be incorporated to prevent stretch. To enable concave or convex curves to be folded neatly, the edge of the material must be pleated or notched.



(5) Form-Folded Edge

This is an accurate method of folding which is normally carried out on a bar-punch machine fitted with a jig. The jig determines the width of the fold, and may be made of metal or silicone rubber.

(6) French Bound Edge

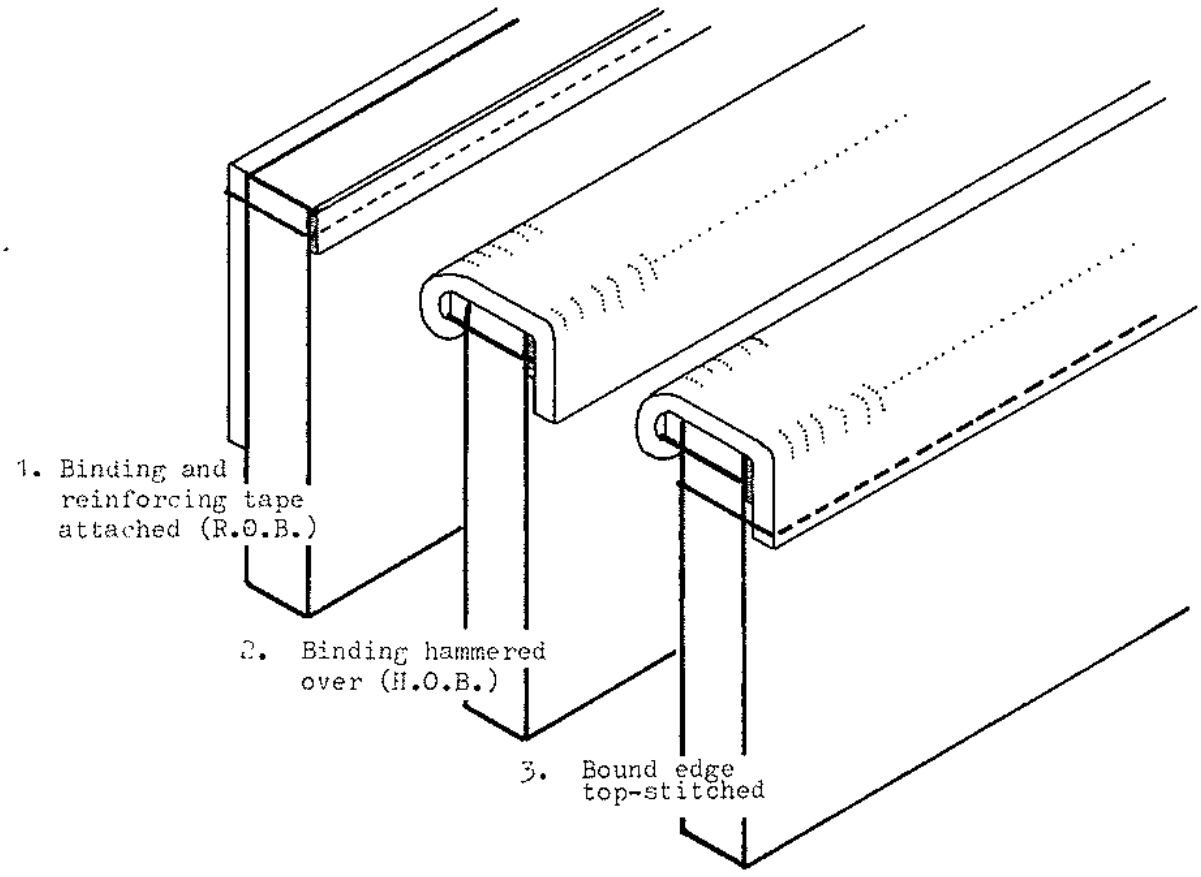
French binding may use leather, plastic or fabric (galloon) binding. It involves more than one operation.

(a) Run-on-Binding (R.O.B.)

The binding is stitched on to the edge of the material, with the face side of the binding against the grain side of the material. Using a binding tube fitted to the machine, a reinforcing tape may be stitched on at the same time on the flesh side of the material.

(b) Hammer-over-Binding (H.O.B.)

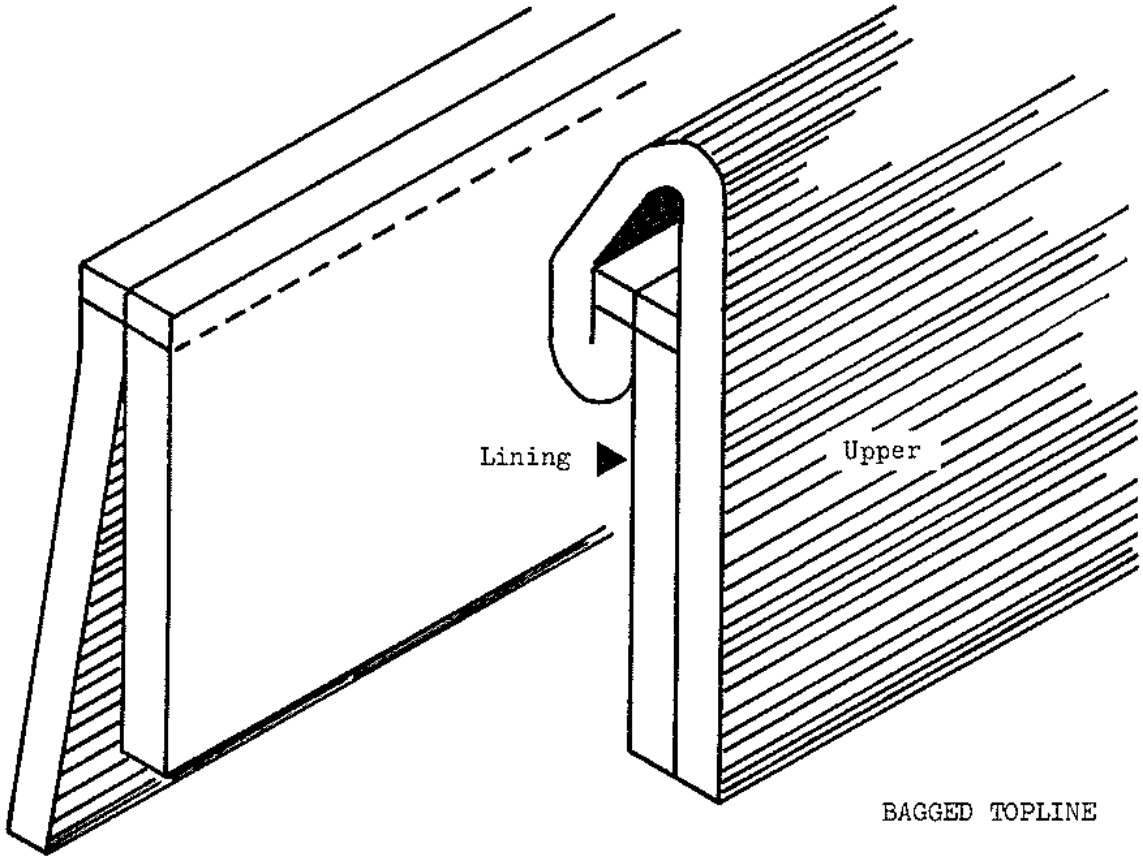
The binding is then folded over the edge, stuck and hammered down on the flesh side. The normal machine uses a thermoplastic cement to stick down the binding temporarily until it is stitched through.



New Balance - EX1016

(8) Bagged Topline

To achieve a bagged edge the lining is first stitched face-to-face to the outside of the upper as a closed seam. It is then pulled inwards over the topline so that the seam is below the edge of the upper, and stuck. This gives the effect of a closed seam just inside the upper. No further stitching around the topline is necessary.



BAGGED TOPLINE

New Balance - EX1016

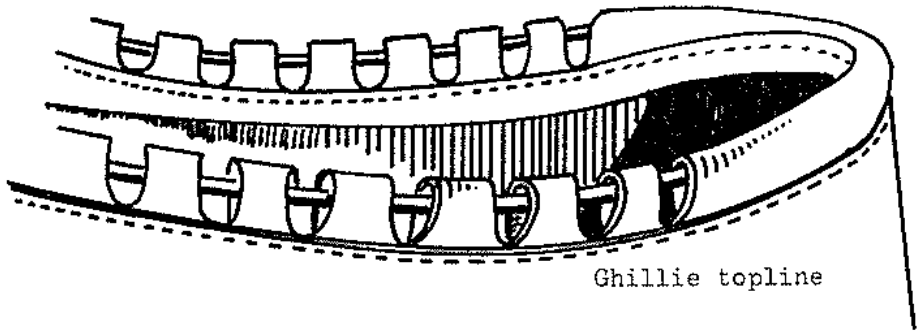
Collars

This is where a strip of material (usually "self" material) is stitched on the inside of a topline. It is then turned over the edge and stitched down on the outside.

Ghillie Toplines

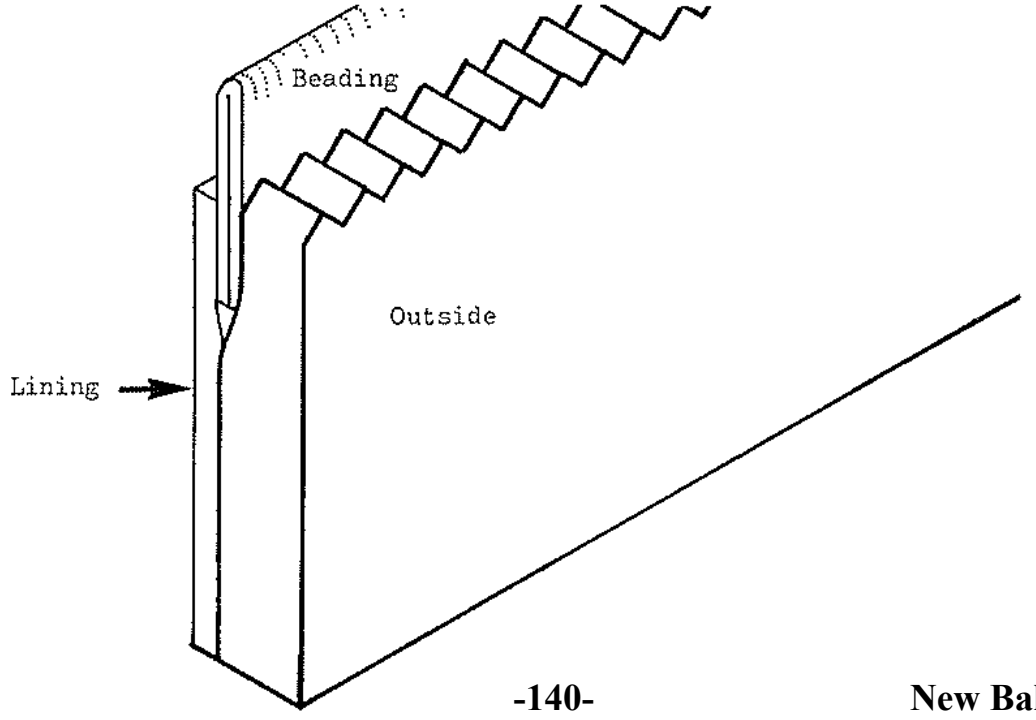
This is designed so that a lace can be threaded through the topline to allow it to be pulled to the required tightness.

The Ghillie is first prepared by folding the cut strip then it is stitched to the inside of the topline and the lace threaded through the resulting tubular section.



Slip Beading

A strip of folded material approximately 6mm wide is stitched between the outside topline and the lining so that the folded beading protrudes slightly. The beading is usually of a contrasting colour, and the outside is normally gimped.



FITTING TOGETHER

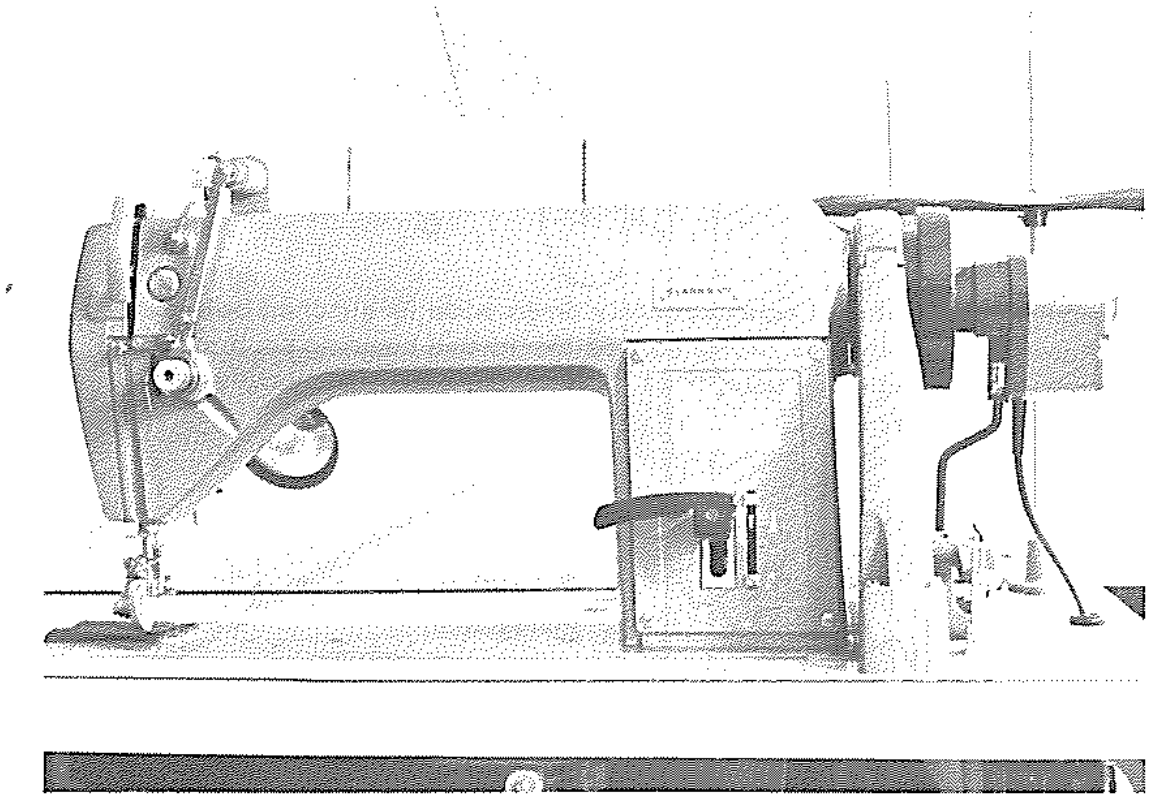
The majority of operations in this section involve stitching of one sort or another.

Before attempting to describe the stitching operations it is important that certain facts about machines etc. are explained.

STITCHING MACHINES

Stitching machines can be divided into four major categories:-

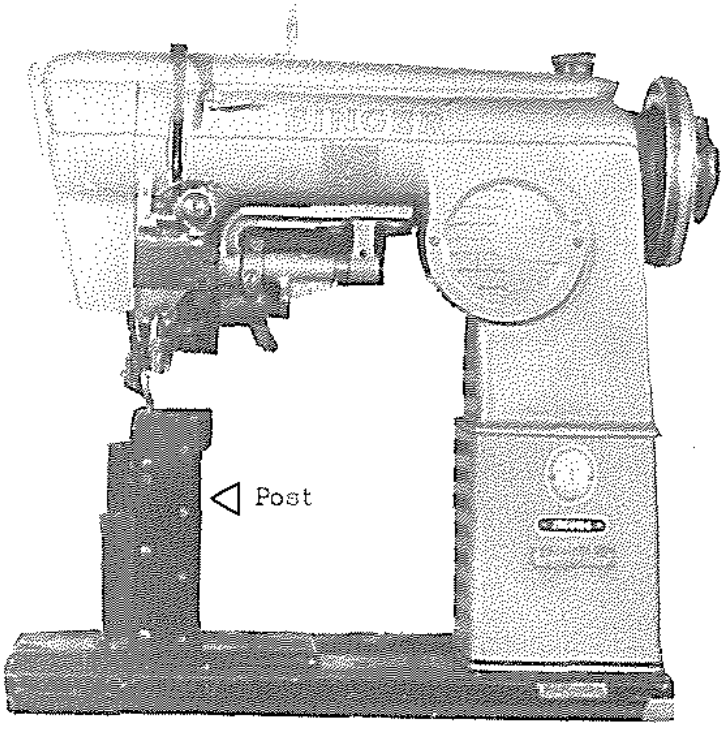
(1) Flat Bed - A machine used for stitching on a flat surface.



Flat-bed sewing machine

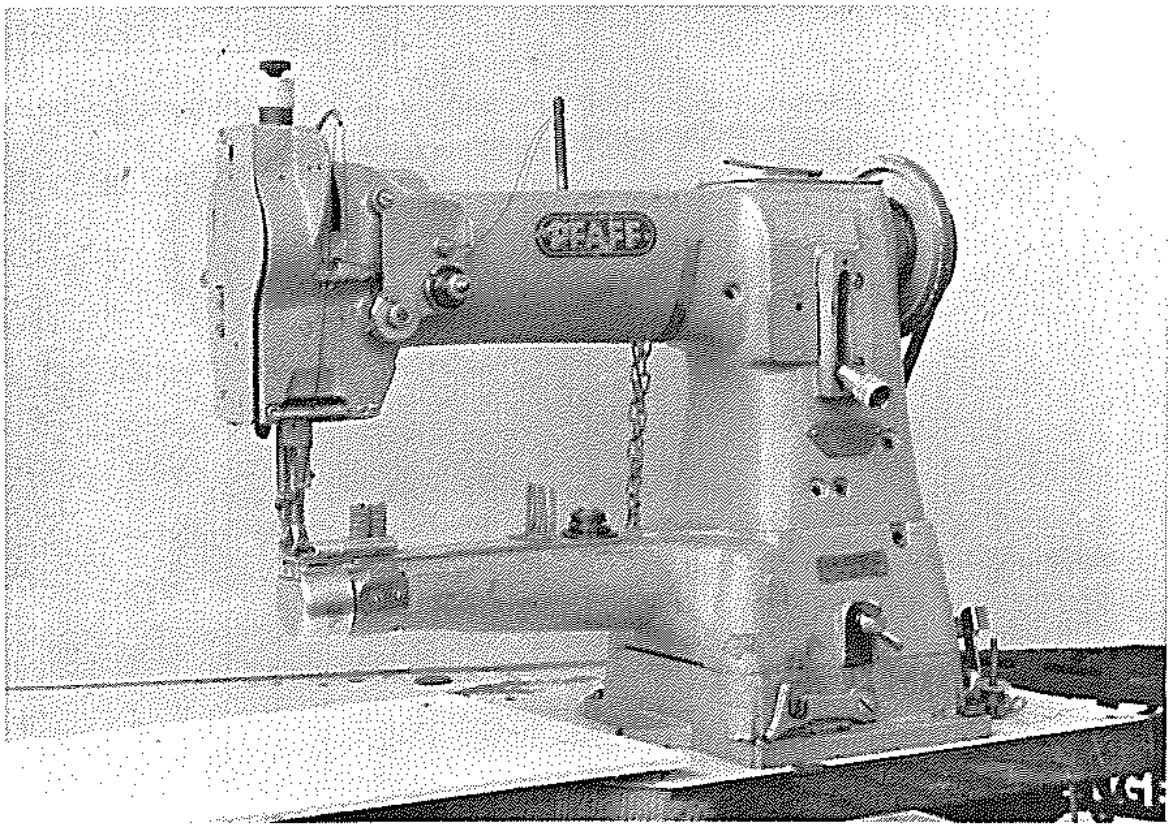
New Balance - EX1016

(2) Post - A machine having a small working area raised - to allow easier fitting and stitching on partially closed uppers.
(Uppers "on-the-round").



Post-bed sewing machine

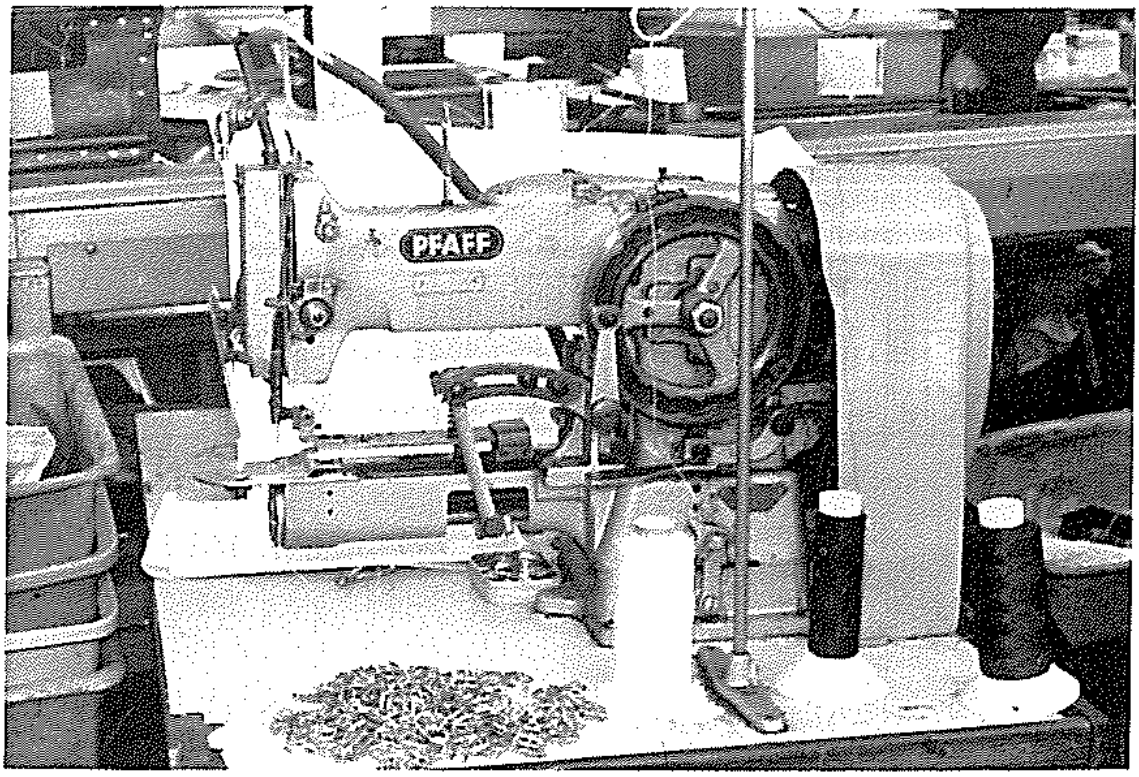
(3) Cylinder Arm - This has a horizontal cylinder arm or post which allows a closed upper to be moved around the working area freely.



Cylinder arm sewing machine

New Balance - EX1016

(4) Automatic - A series of machines which have been developed to carry out specific operations in a complete cycle, e.g. Stitch vees, Attach buckles, Barring, etc.



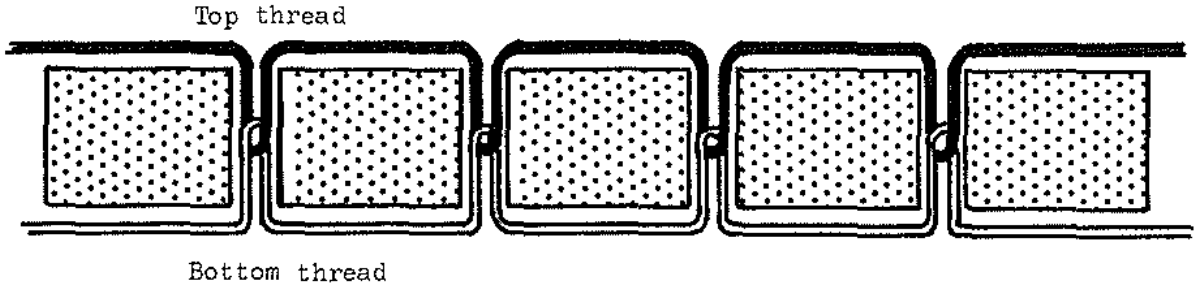
Automatic buckle attaching machine

STITCH FORMATIONS

Two main types of stitching may be used:-

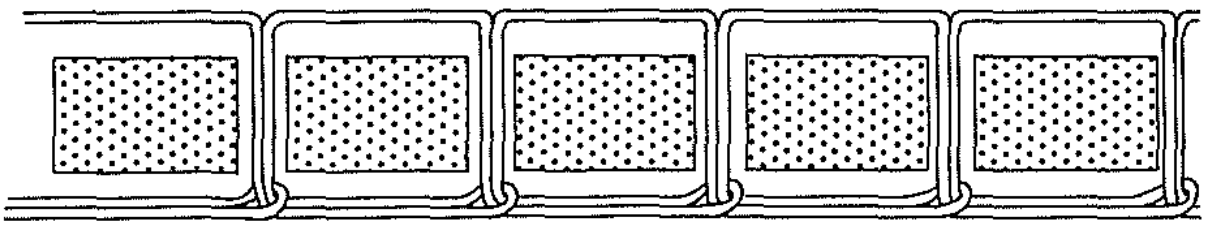
(1) Lock Stitch

This is made up of two threads. The top one feeds through the needle-eye and the bottom one from the spool in the bed or post of the machine. The stitch is formed by two taut threads ideally with the "look" embedded in the material.



(2) Chain Stitch

This has only one thread which forms a chain on the underside of the material.



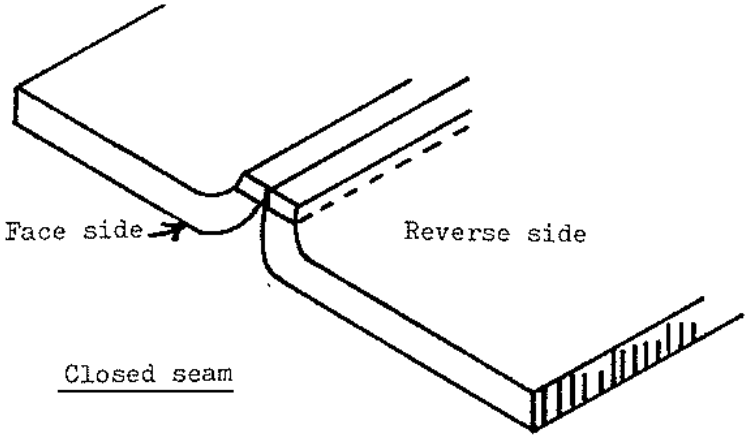
New Balance - EX1016

TYPES OF SEAM

(1) Closed Seam

Components are positioned face-side to face-side and stitched at usually 1.5mm (1/16 in.) edge distance.

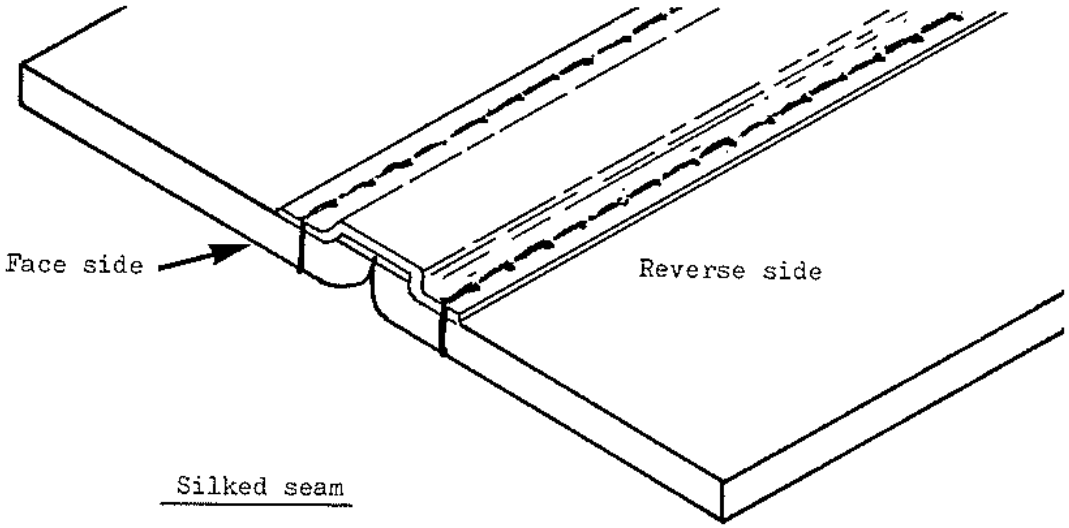
The seam is then opened and rubbed down.



Closed seam

(2) Silked Seam

A conventional closed seam is opened and rubbed down. A woven tape is then attached to the reverse side of the seam by two further rows of stitching (normally on a twin-needle machine with a tape guide).

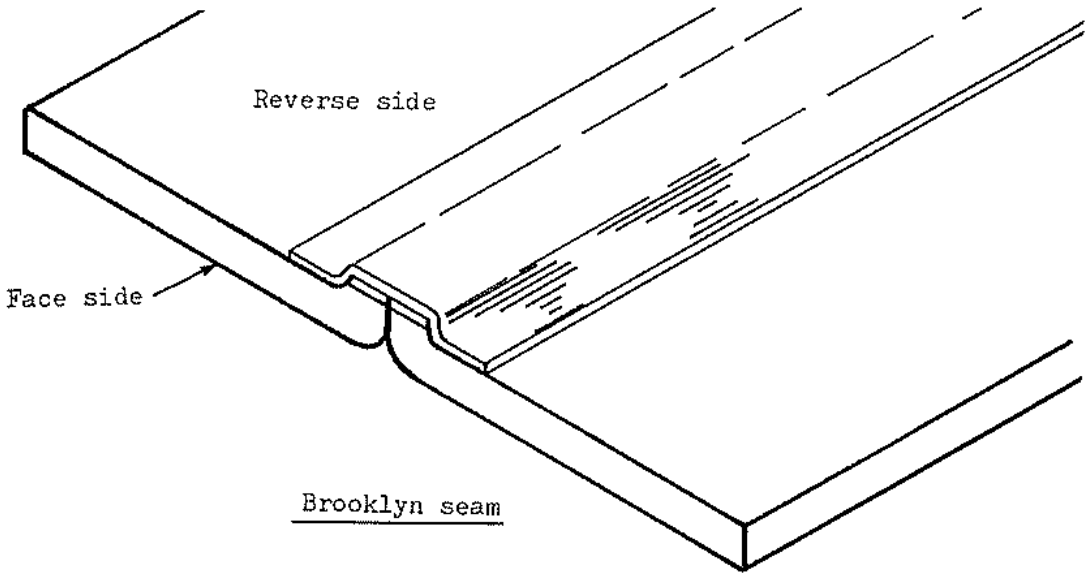


Silked seam

New Balance - EX1016

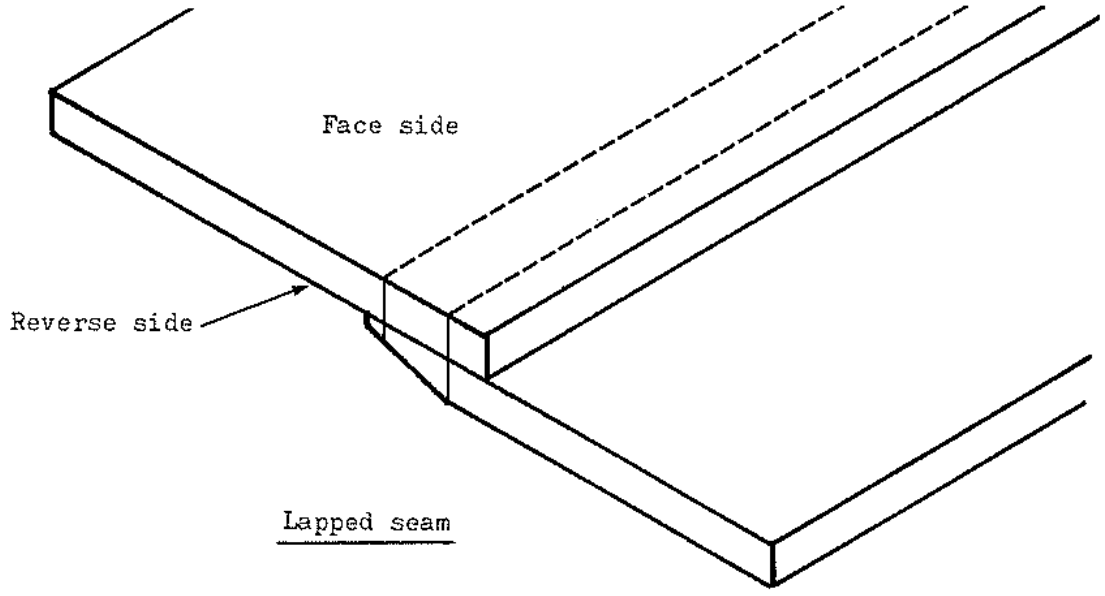
(3) Brooklyn Seam

Again constructed as a closed seam but then a paper or fabric tape is stuck over the seam.



(4) Lapped Seam

A lapped seam is constructed by placing the edge of one piece of material over the edge of another and stitching through them. The underpiece has first been skived.

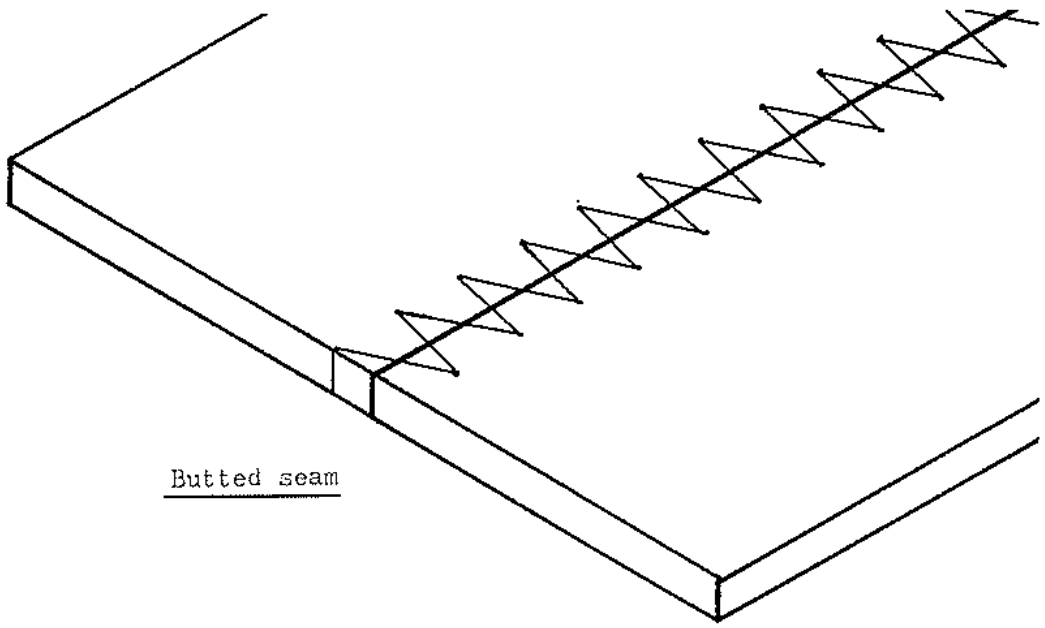


The allowance for lapping may vary between 6mm and 12mm. The stitching must go through the full substance. One or two rows of stitching may be used.

New Balance - EX1016

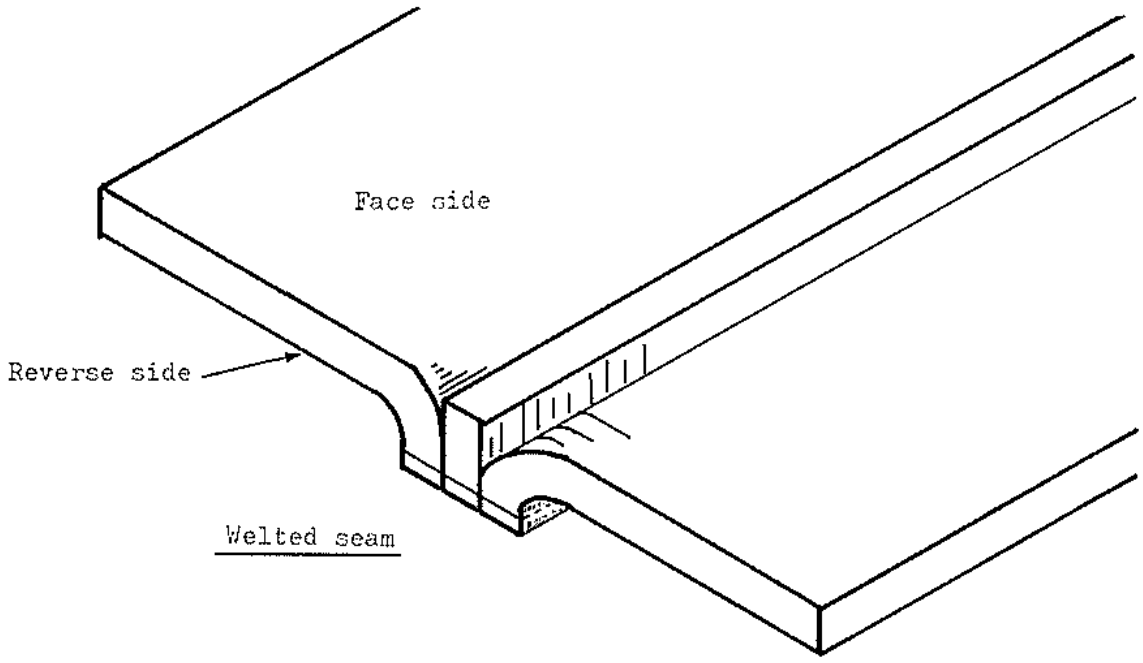
(5) Butted

The two pieces of material are butted together and stitched by a swing needle machine using a zig-zag stitch.



(6) Welted Seam

A welted seam is a variation of a closed seam used on heavy materials. An extra strip of self material is inserted between the two components.

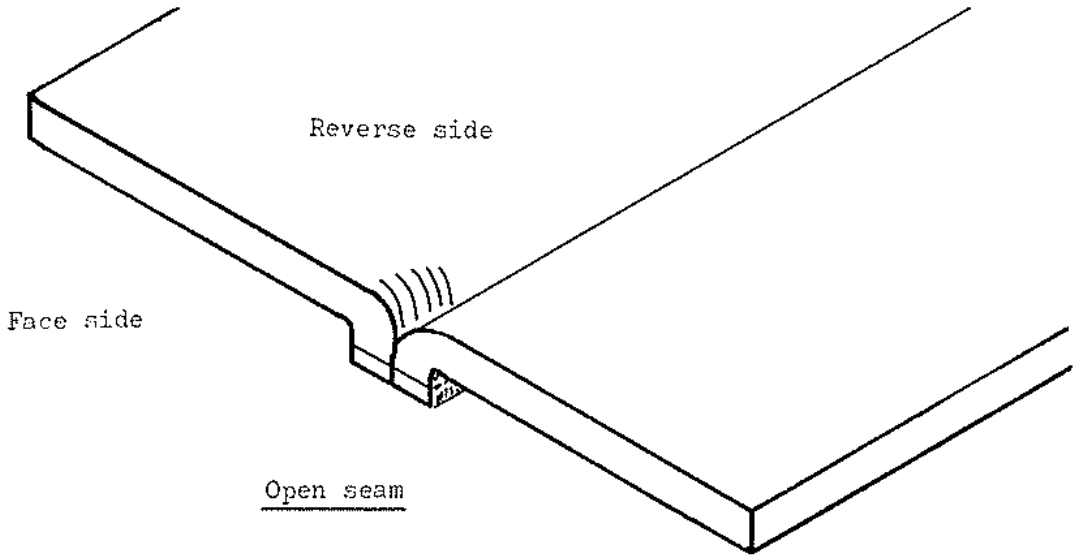


(7) Piped Seam

This seam is constructed in the same way as a welted seam except that a piping strip is inserted between the components instead of a welt. The piping is usually of a contrasting colour.

(8) Open Seam

An open seam is the reverse of a closed seam, the edges of the material showing on the outside of the upper.



(9) Bonded Seam

A bonded seam is constructed by applying an adhesive to the components in either a liquid or film form and sticking them together with the aid of conventional heat and pressure.

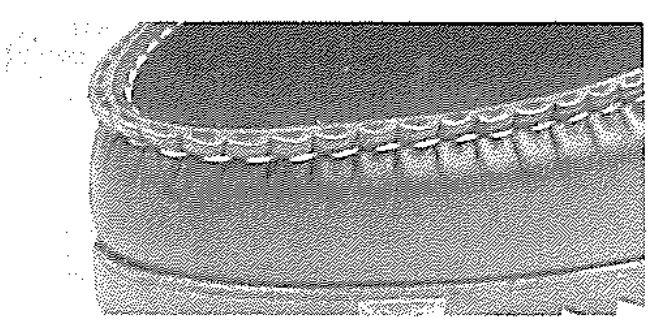
(10) Welded Seam

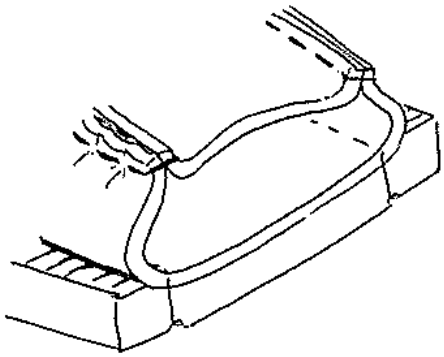
A welded seam is formed when two or more components are placed in a jig and fused together using high frequency heat.

(11) Moccasin Seam

This seam, which is similar in construction to the open seam, may be made by machine or by hand.

The objective is to present a bold, decorative effect.

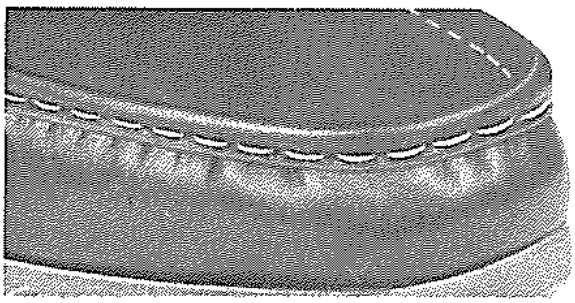


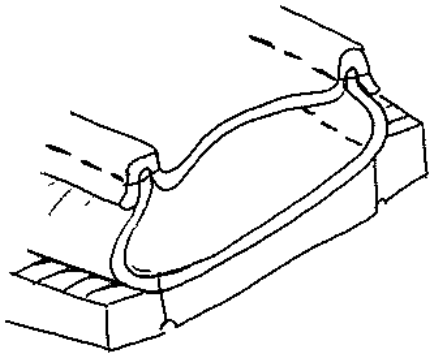


Open moccasin seam

A popular, more weatherproof version of the moccasin seam is shown below.

Both versions are normally stitched on an arm-type coarse-stitch machine.





Folded moccasin seam

(12) Sprung Seam

The theory of springing (see chapter on Pattern Cutting) can be applied to most types of seam. The two edges to be stitched together are of different shapes. They must be fitted together as the seam is stitched, so as to produce three-dimensional shape in the component or upper before lasting takes place.

Decorative Stitching

Fancy and Mock Stitching

The technical distinction between fancy and mock stitching is that the former performs a function while the latter is solely for effect.

Fancy Stitching

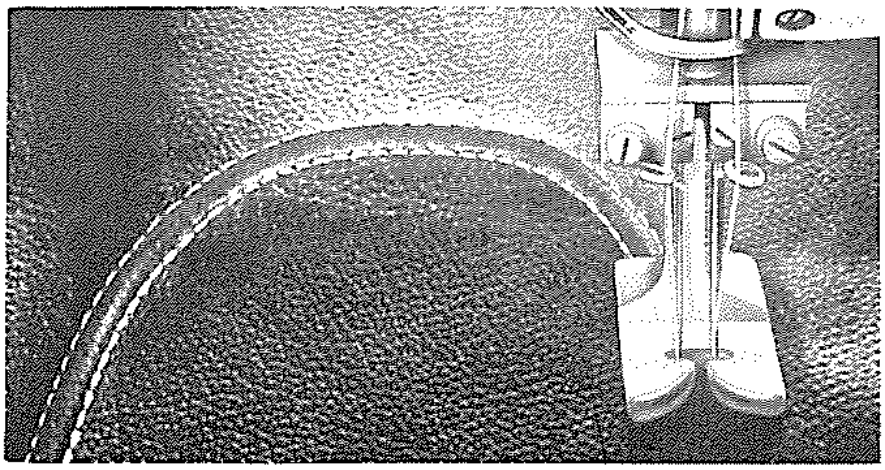
The thread and the stitch-length used for fancy stitching usually resemble that used for stitching on the remainder of the upper.

Cable Stitching

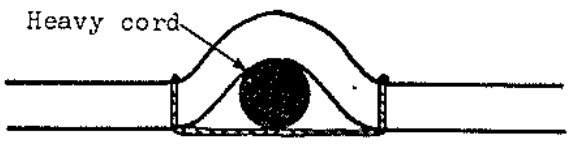
Cable stitches are much bigger (possibly 8 or 9 stitches to the inch) and a heavy cable thread is used to give a bulky cable-like appearance.

Glove Stitching

The machine has twin needles, but uses only one bottom thread. A heavy cord may be run in between the two rows of stitching to support the raised material.



Glove stitching



Cross section of glove stitching

New Balance - EX1016

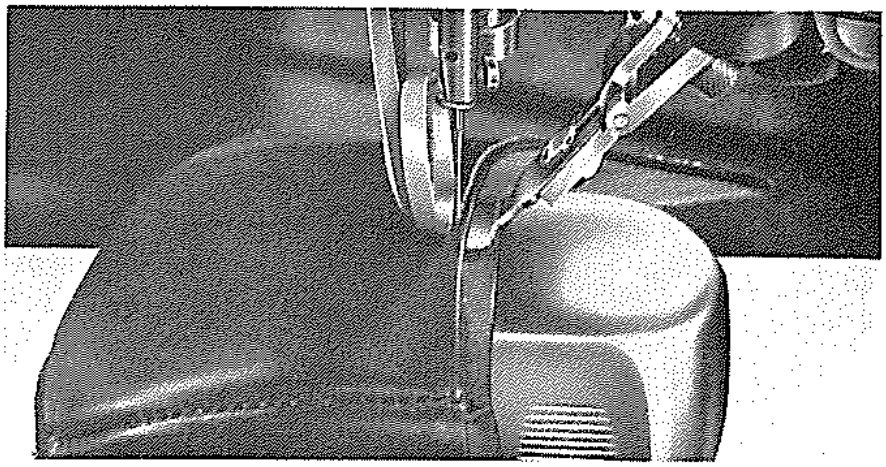
Top Stitching

This refers to the stitching around the topline of a shoe which performs two functions:

(a) It stitches in the lining.

(b) It stitches the binding or folding into its permanent position.

The machine used may have a knife attachment to trim away excess lining material - although a net lining guide could be used, particularly with combination counter/stiffeners which normally have no trim allowance added.

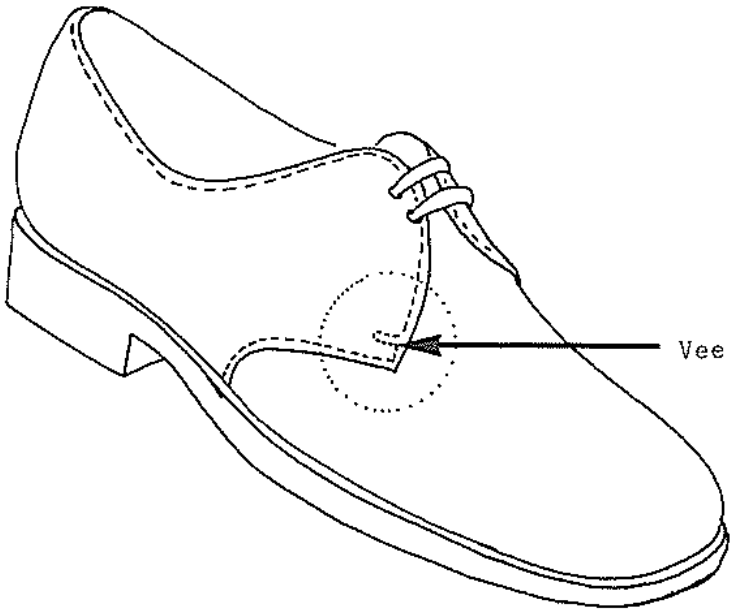


Top stitching (also known as Undertrimming)

Subsidiary Stitching Operations

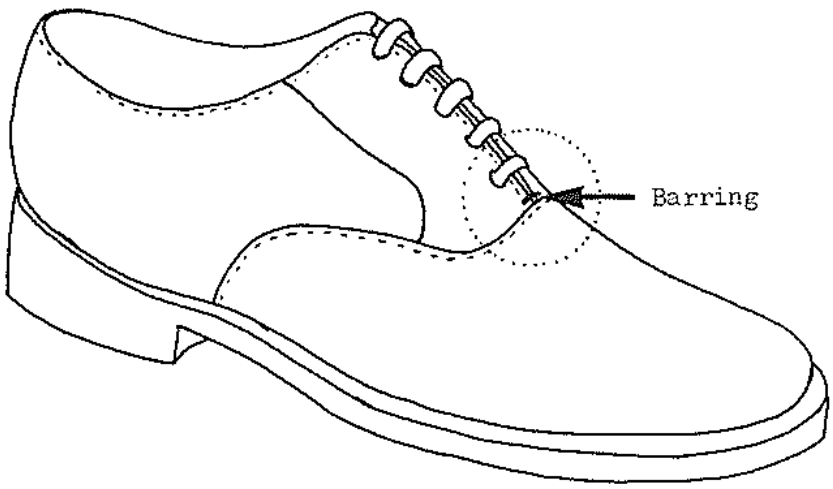
Boxing or Veeing

Additional stitching is needed to reinforce the facings of Derby shoes where the strain of lacing is taken at the front corners of the quarters.



Barring

Used to strengthen the facings of Oxfords or for attaching buckles. (Alternatively, buckles may be stapled on to the upper).

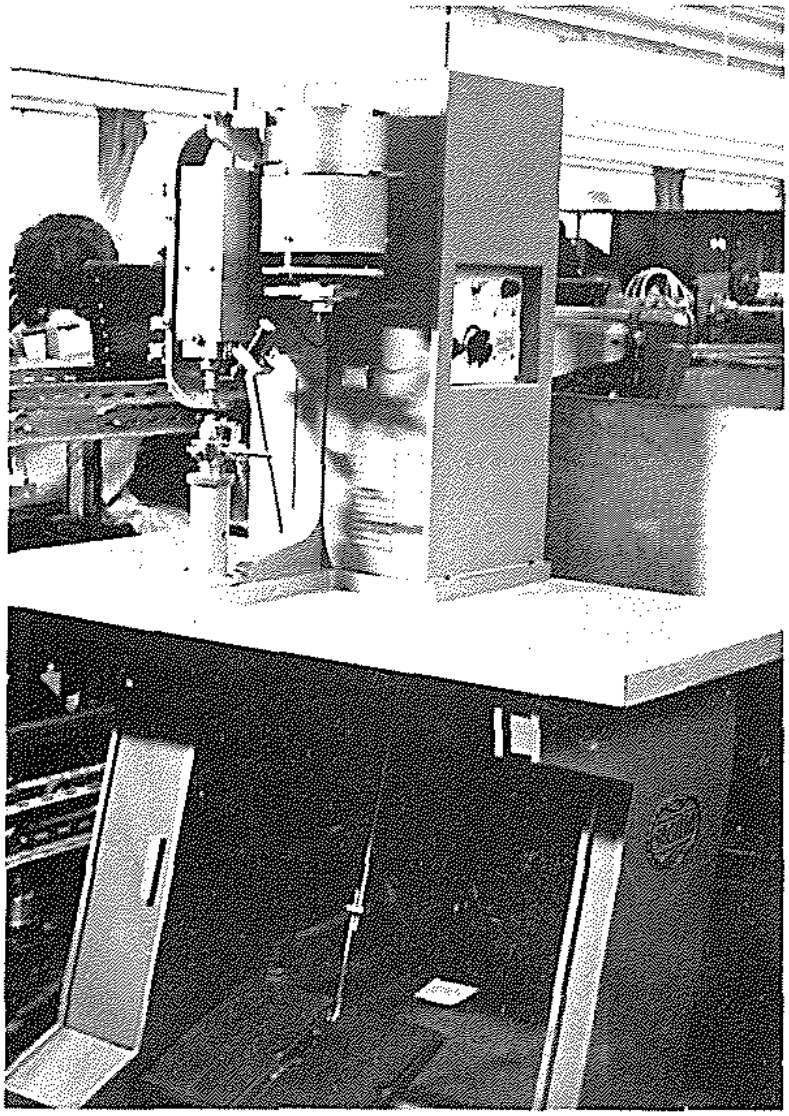


New Balance - EX1016

FINISHING OFF

Eyeletting

Eyelets are put into an upper by a machine which first punches a hole and then inserts the eyelet, clinting over the reverse side. The eyelet may be of the invisible or "blind" type, or it may have a visible outer rim which can be plain or decorative.



Eyeletting machine

Lacing

On Oxford or Gibson styles, facings are laced a pre-determined distance apart to ensure accurate lasting. This may be done by hand or with a machine.

Similarly, bars need to be secured - through the buckle with a pin.

Trims

Trims will have been prepared previously and can be stitched, stapled or stuck to the upper.

Some trims may be attached after the shoe has been lasted.

Passing

Some factories carry out an operation called Passing at the end of the closing sequence. This is where the uppers are checked for quality, counted and checked against the work ticket for correct materials, threads, bindings, etc.

Assembly

The work progresses to the assembly area where it is "married" to the components required for lasting.

THREADS

The choice of thread for closing any particular type of upper is governed by several factors:

1. Breaking strength
2. Elasticity
3. Appearance when stitched
4. Uniformity
5. Resistance to abrasion - bacteria - mould
6. Able to take lubricants
7. Cost

It is true to say that these factors are complementary, to some extent, to each other, but each should be considered separately.

1. Breaking Strength - is obviously of great importance, not only for the eventual strength of a seam, but also to withstand the production of the stitches by the machine.

2. Elasticity - allied with strength is an important asset in all threads, allowing a certain amount of give to the seam during lasting and wear. However, too much elasticity could result in gaping seams.

3. Appearance of the thread once it is stitched must be considered, especially where a neat orderly row of stitches is required, as in fancy stitching.

4. Uniform thread is essential if machines are to work without breakdown. The sewing machine being, in most cases, a delicate and finely adjusted mechanism will not work correctly if the thread is not uniform throughout.

5. Resistance to abrasion, Bacteria and Mould is necessary for a thread to be able to stand up to wear. It must be able to stand a certain amount of rubbing from the foot and a great deal of friction when it is being stitched.

6. A great deal of friction is caused when stitching some types of materials, a way of cooling down the needle is by use of a lubricant, therefore the thread must remain unaffected by lubricants.

7. Cost - if one is to produce good quality uppers the above factors must be examined first; once the correct quality is found, the cost can be considered. It is not always wise to go for the cheapest available.

There are 3 basic types of threads:

1. Natural Fibres
2. Synthetic Fibres
3. Blended Fibres

NEEDLES

Parts of a Needle

Shank : is the thickest part of the needle which is inserted into the needle bar of the machine. As the shank varies in shape, diameter and length, it is most important that the correct shank is used in each machine. For this purpose it is given a classification number : e.g. 16 x 246 classification number corresponds with a Singer 236 machine.

Shoulder : strengthens the needle. It is a gradual narrowing of the shank. Several needles now on the market have a supplementary shoulder which extends down to the eye of the needle for extra strength.

Blade : is the part of the needle that passes through the material. It has two grooves on opposite sides to one another - long - short.

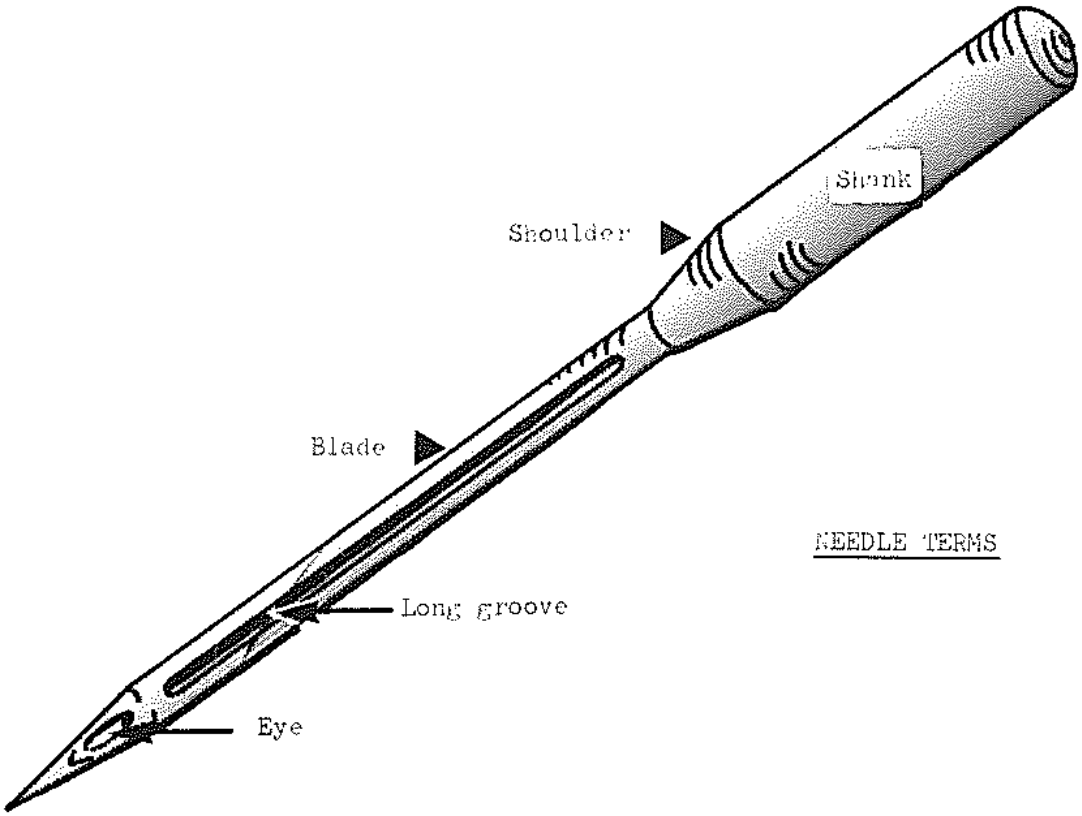
The long groove starts at the shoulder and continues to the eye. It has two purposes:

(i) It helps guide the thread to the eye of the needle.

(ii) It protects the thread which lies in this groove.

The short groove guides and holds the thread when the needle rises, thus forming a loop which is picked up by the hook.

Point : includes the eye and the tip. The point penetrates the material, forming a hole for the thread to pass through.



NEEDLE TERMS

There are many types of needles and two main reasons why the correct selection is important -

(1) To produce a strong seam.

(2) To obtain a good and correct appearance.

Consider:

(a) Size

(b) Finish

(c) Eye

(d) Point

(a) Size

The size of the needle depends largely on: (a) the type of work being stitched; (b) the type of machine and thread being used.

Typical box of needles

(1575)		16 x 246
NR	(80)	12

(1575) Catalogue number
16 x 246 Class number = type of machine
NR Narrow wedge = point
(80) 12 Size, which must be within the class

(b) Finish

There are four main types of needle finishes:-

(1) Standard

(2) Extra buff

(3) Nickel

(4) Chromium

Standard

Needles having a standard finish will withstand speeds up to 2,000 stitches per minute on light and medium weight cloth and up to 1,600 stitches per minute on light and medium leathers.

For higher speeds or for sewing materials which offer more than the ordinary amount of friction, needles with a special finish are recommended.

Extra Buff

These needles are given an extra buffing operation which makes them more adaptable for special materials. Speed up to 1,800 stitches per minute on light and medium material.

Nickel Finish

These needles are nickel plated and are given an extra buffing operation. Nickel plating gives needles a smoother surface than ordinary polishing and, consequently, reduces friction. Nickel does not oxidise or turn blue from heat as readily as ordinary steel; therefore, a nickel plated needle will stand up to much higher speeds than these with a regular finish. About 2,000 stitches per minute.

Chromium

Chromium plated needles offer less friction. This is the hardest surface of all finishes; therefore, they are suitable to withstand severe operating conditions. They are strongly recommended for use on hard and closely woven material. Also, for materials containing a lot of dressing. Chromium is recommended for all leather work and is the best finish for the smaller sized needles which are used in high speed machines at about 2,400 stitches per minute.

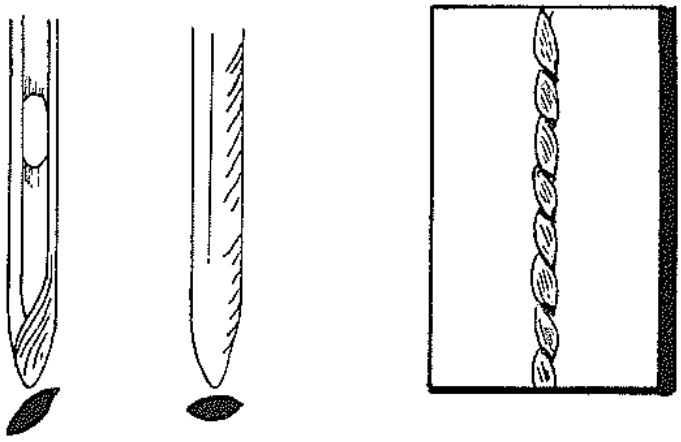
(c) Eye

This must be polished to a high degree of smoothness to prevent the thread from breaking or fraying. It must be the correct size for the thread used. During stitching one piece of thread passes through the eye of the needle 20 or 30 times. The size of the eye is in direct relation to the shank and the thread should be chosen accordingly. To know if the eye is the correct size, thread the needle, hold the thread in a vertical position; if the needle drops down slowly but easily the thread is correct.

(d) Point

The following are four fairly common examples of needle points:

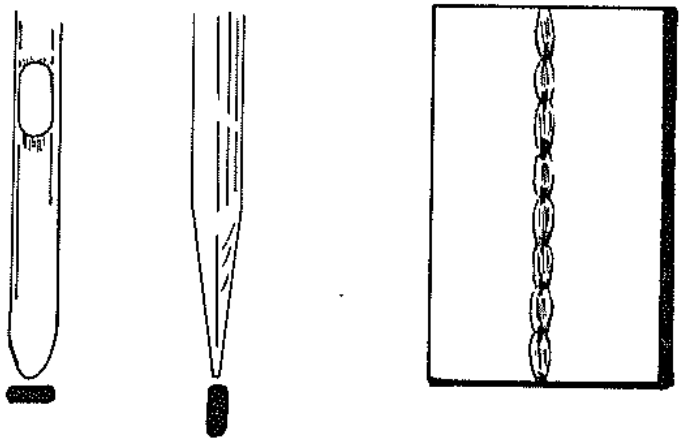
New Balance - EX1016



Twist

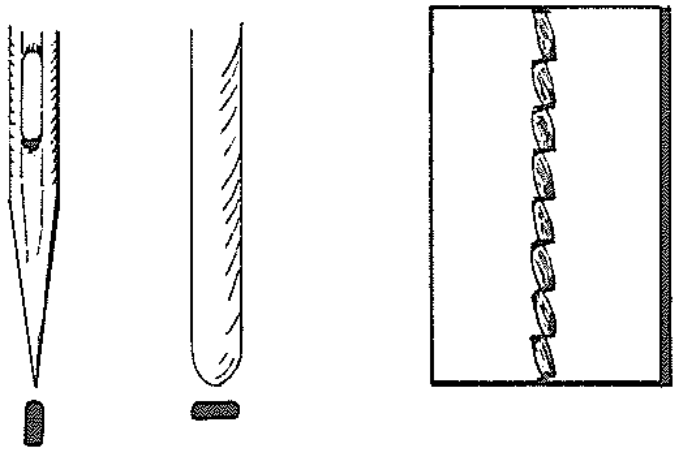
This needle perforates the material at an angle to the seam. The stitch produced is straight and slightly set into the material. 12 S.P.I. on heavy, dry and tough leathers.

The reverse twist is a variation of this needle point. This needle produces a well raised stitch and, therefore, would be useful for fancy stitch.



Cross

Cuts a hole in line with the seam, forms a stitch straight and deeply set into the material. 10 S.P.I. not used very much today.

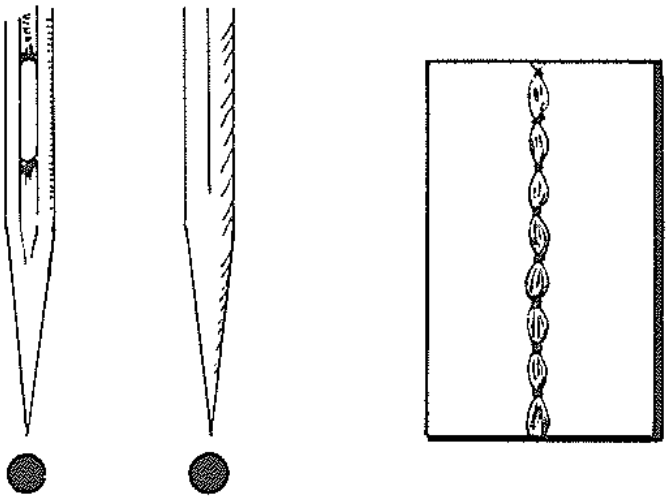


Wedge

This is the most widely used of all needle points. This point, because of its shape, cuts across the line of stitching.

(a) Produces a slightly raised diagonal stitch.

(b) The stitch produced is very strong and on soft heavy leathers a stitch length of 16 S.P.I. can be obtained. For medium weight leathers a narrow wedge can be used to obtain 20 S.P.I. and on very soft light weight materials an extra narrow wedge which will produce good results at 24 S.P.I.



Round

This needle is particularly useful for stitching synthetic and fabric materials, because it does not cut a hole, but pushes the fibres apart.

New Balance - EX1016

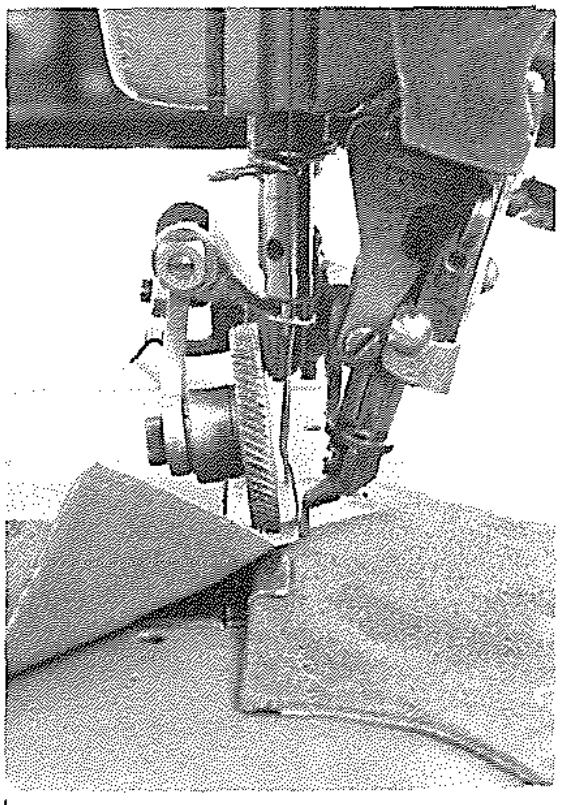
The stitch produced lies flat and straight in the direction of the seam. 18 S.P.I.

There is a variation of this needle point which is called round burring, which is a dulled round point. This needle is very suitable for automatic machines where the needle penetrates the same hole more than once, as it will not cut the previous stitches.

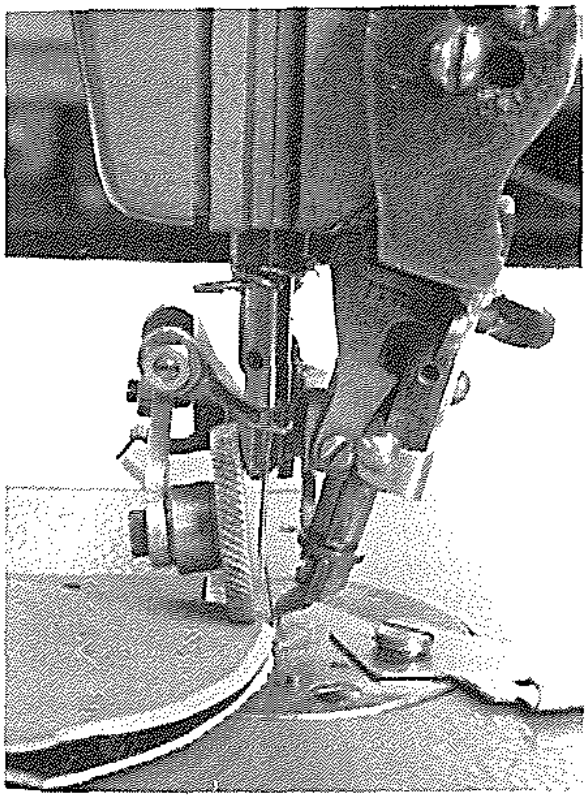
GUIDES

Wherever possible guides are fitted to machines to assist in accurate positioning of the work.

Example: Combination Guide, for lapping and closing on the same machine.

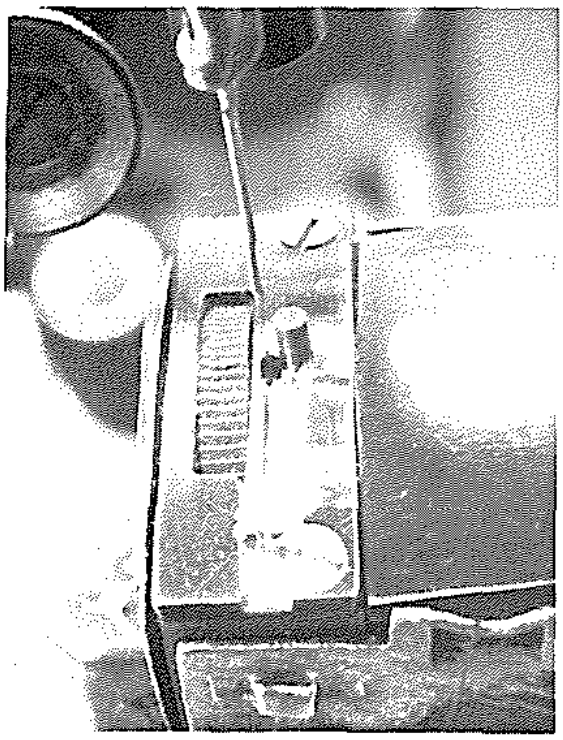


Lapping guide
(Drop guide used in conjunction with "U"-shaped guide)



Closing guide
(Drop guide used alone, - "U" shaped guide pushed aside)

Example: Peg Guide - for edge distance.



Peg guide

Guides are not infallible and it is possible to abuse them, for example, by feeding the work at an incorrect angle. Properly used, guides are invaluable. They are probably more efficient for stout firm leathers than for thin, soft leathers.

The use of guides enables a high standard of accuracy to be achieved with less training and experience than is otherwise needed. This is an important factor in training green labour up to production standards on specialist jobs. It is especially valuable in areas without long experience of shoemaking and where the turnover of young labour is relatively high.

New Balance - EX1016

HIGH FREQUENCY HEATING (H.F.)

Recent developments in Closing involve changes from conventional stitching to other methods of assembly. Most of these developments centre around a form of heating called High Frequency. Alternative names such as 'dielectric heat' or 'Radio Frequency' are used.

High frequency heating differs from radiant and conducted heat in that it raises the temperature of the material uniformly throughout its substance so there is no waiting for the centre to heat; therefore, very rapid heating is possible. This type of heat can cause severe burns to operatives, so every safety precaution must be taken.

Generating H.F. Current

H.F. current is generated in a similar way to radio waves. The generator is really a radio transmitter working under special conditions, but the principles are the same.

The generator consists of three main parts -

(1) Transformer - this raises the mains voltage to a high value.

(2) Rectifier - this changes the alternating current to a direct current.

(3) Oscillator Valve - this valve is arranged in the circuit to stop and start the current, millions of times per second.

The rapid stopping and starting of the current through the valve causes an alternating H.F. current. This can be coupled to any two electrodes and so establish an H.F. field, e.g. between two flat metal plates.

When a material is placed in an electric field the molecules of the material try to orientate themselves in the direction of the field. If the applied field is rapidly alternating in direction the molecules will be rapidly swung, first in one direction and then in the other. Collisions with adjacent molecules will occur and frictional heat will be generated. As molecules exist in uniform density throughout the material, the heat will be equal throughout the material.

Uses of H.F. Heat

Welding - is the fusing together of two pieces of material. Most synthetic materials such as P.V.C. lend themselves to welding. Poromerics, however, are a different proposition; each has to be tested on a trial and error basis. Leather will not weld.

Cut/Welding - cutting is a useful addition to welding, where components are automatically cut out immediately after welding. (The resulting

edge is neater in appearance than the conventional press-cut edge).

Embossing - Any pattern can be embossed on to materials that react to H.F. heat. Press punching, stitching, laps and interlacing can be simulated. The welding electrode is replaced by an embossing die of the required pattern, but the method used is the same as welding.

Bonding - Can also be done with the use of H.F. heat. Polyurethane cements are the best for bonding.

Applique Welding - Two contrasting materials are used for this method. The drop on the machine is controlled so that the top material is pushed just below the surface of the base material and welded in that position. As soon as the material is taken out of the machine, the excess top material is torn off. This is sometimes known as "tear-seal" welding.

Compression Skiving - Skiving by conventional means is carried out by removing part of the substance of the material and thus weakening the structure. Poromerics are unique materials in that the substance can be reduced by collapsing the cellular structure under H.F. heat and pressure. This produces consistent identical skives and the material in this area increases in strength.

Flow Moulding - A mould is made from a model component using silicone rubber, which is unaffected by H.F. heat. The mould is placed in the H.F. machine and into it is placed a blank castor component, normally of P.V.C. When H.F. heat is applied the material flows into the rubber mould taking onto itself the shape and surface characteristics of the original model including any stitching.



High Frequency Generator and Press

New Balance - EX1016

CHAPTER 9

ORGANISATION OF CLOSING

It is increasingly appreciated that the planning of work through the Closing Room is one of the major problems of efficient production. This is especially difficult where the operations involved differ from style to style and the work content even of similar operations varies widely. For example, at one typical factory 12 styles are produced.

Between them, 53 different operations are involved on 34 different types of machine. Of these operations, 33 require less than one whole time operative: 11 require less than two: only 9 require three or more. Each style involves 11 to 24 operations - the three best sellers involving 20/21 operations each and 29 between them. The average work content for twelve pairs is 4 hours, but individual operations vary in length from one minute to one and half hours.

The chapter explains some of the factors which affect the flow of work through the Closing Room.

Sequence of Operations

Each style has a set sequence of operations. This will be governed by certain factors for example:-

Skiving - This usually follows Blockmarking, press punching and inking, as these are better done with a firm intact edge. Conversely it must obviously precede edging or folding.

Perforating - Normally this would be done while the parts were still separate. It might, however, be necessary to wait until the upper had been closed, to achieve a flowing effect along the top line.

Run-on-Binding - The top line may be quarters only, or can be composed of vamp and quarters together. In the first case the binding can be run on and the shoe top stitched before vamping. In the second case, the vamp must be lapped to the quarters before the binding is run on, or top stitching takes place.

Insert Aprons - If the apron has a tab which protrudes above the top line at the throat it can be stitched to the wings after the binding has been run on and the shoe top stitched. If the apron forms part of a continuous flowing top line it must be stitched to the wings before the binding is run on.

Efforts should be made when the shoe is designed to arrange the sequence to eliminate back tracking in production. The work content of the different operations should also be taken into account so that these can be balanced as

far as is possible by standardisation. Such differences as remain will inevitably cause leap-frogging to a greater or lesser extent, as the work will not flow evenly from one operation to the next.

Conveyors

In recent years a variety of conveyor systems have been designed to help expedite work flow in Closing Rooms. No Closing Room conveyor is more than a work transporter. All that they aim to achieve is:

- to discipline the work flow so that it is easier to supervise the operatives.

- to eliminate the physical effort involved in moving the work from place to place and to reduce the cost thereof.

Indeed tight control is important as some show up deficiencies in planning very clearly and others disguise where these are occurring.

The choice of a conveyor depends ultimately on the variation of sequence and work content of the different styles involved. Where this does not vary greatly a direct flow conveyor may be best. Where it varies widely, as with fashion shoes, a feeder-operative-operative or a feeder-operative-feeder system may be worthwhile.

(a) Direct Flow Conveyors

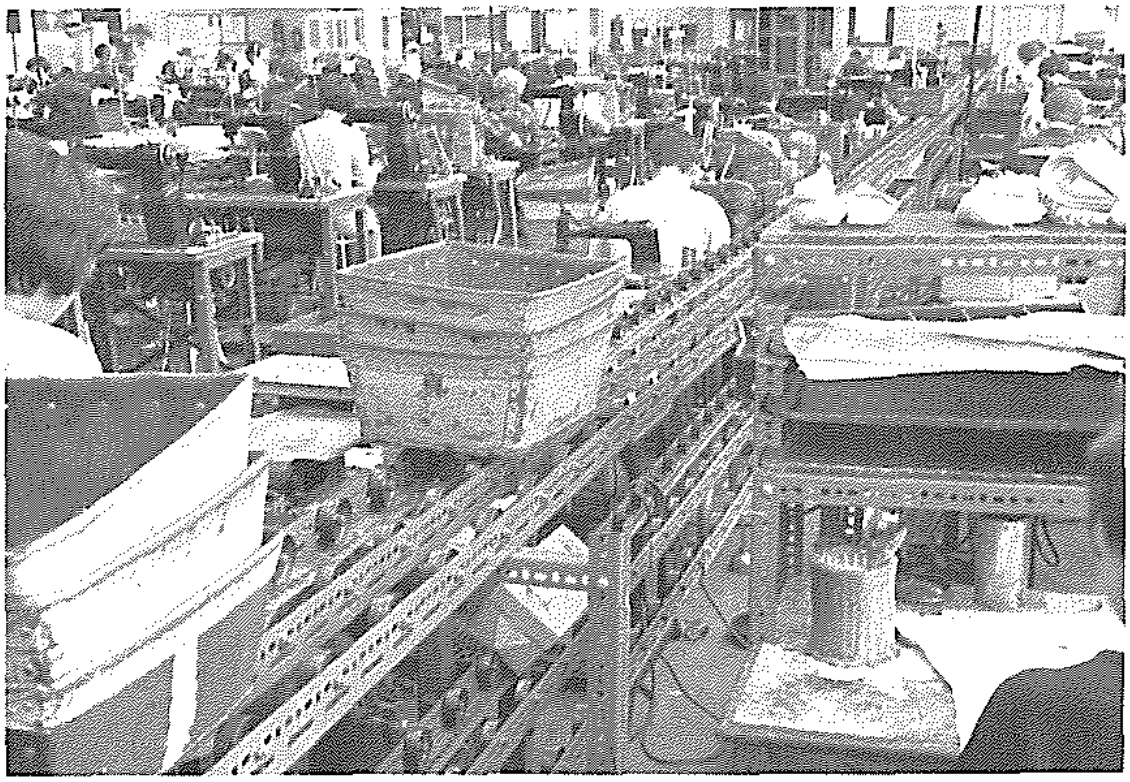
The essence of these is that the work is loaded on at one end, and off, completed, at the other, all tickets maintaining a set sequence. A two/three tier arrangement can allow some leap-frogging to take place so that a limited variety of styles can be accepted, but back-tracking is not easy. However, individual racks or trolleys can be superimposed for odd styles, samples, repairs, etc. The great advantage of direct flow conveyors is that a sense of urgency is imparted and that it is obvious where bottlenecks are building up.

There are two main types in use:

Gravity Feed

Dexion rollers can be laid out to suit most room shapes. They are very cheap to install and cost very little to operate. A system of linked stops can be incorporated to permit an even flow of work to several operatives on the same operation without involving buffer stocks.

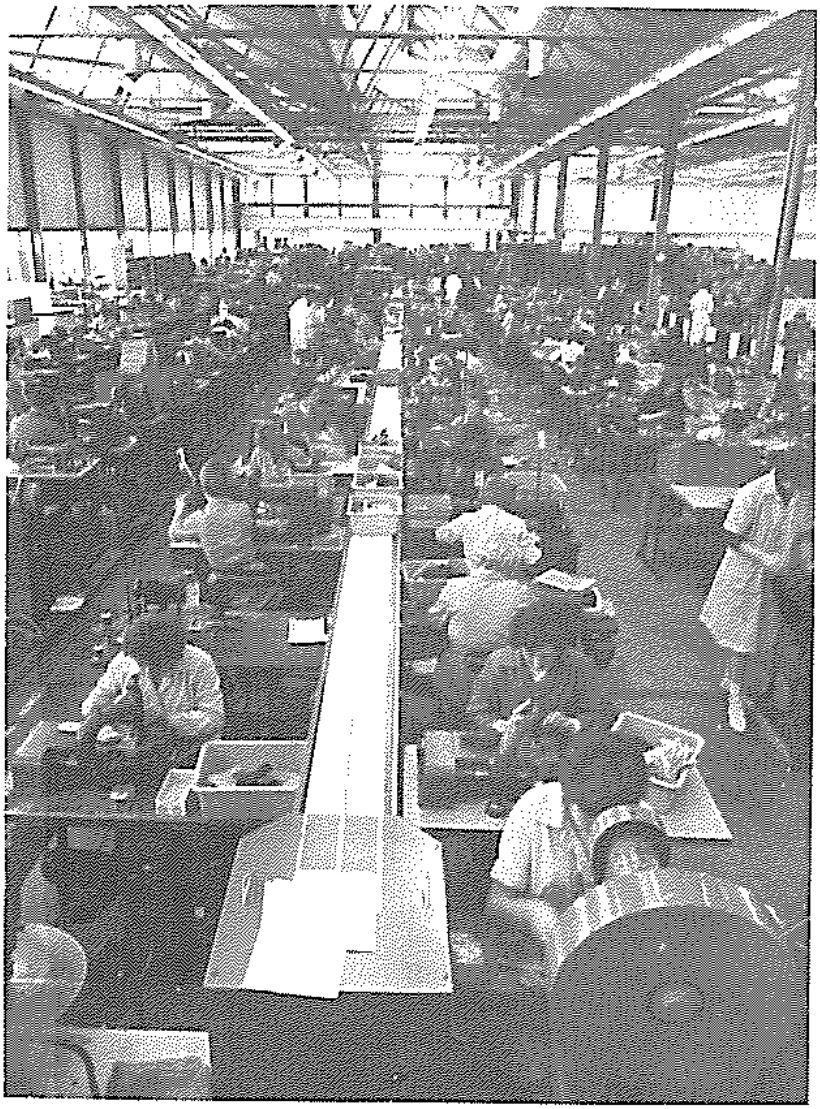
New Balance - EX1016



Direct Flow Conveyor : Gravity Feed

Powered Belts

These are more expensive than Dexion to install and to run. The boxes are halted by a stop beside each operative, while the belt slips underneath. As no linked system of stops yet seems practicable, an even flow of work cannot be assured to all operatives who are to some extent dependent on those in front.



Direct Flow Conveyor : Powered Belt

(b) Feeder-Operative-Operative Conveyors (Pfaff)

In these, the work once loaded onto the conveyor by the feeder can then travel from one operative to another. They attempt to retain the flexibility, as far as leap-frogging or back-tracking is concerned, which is the great virtue of the old rack or trolley system. Any number of variations in sequence and any degree of difference in work content can be accepted.

New Balance - EX1016

Against this must be set these drawbacks:

- it is difficult to tell at a glance where the bottlenecks are occurring. This can be countered by interposing check-points when the work is sent back to the feeder for her to check against the loading schedule.

- the work follows no set route, so that a particular box could circulate endlessly with no work done on it. However, this can be shown up by the use of coloured discs on boxes, so that after a time a rogue box will be obvious.

- it offers great scope for selectivity on the part of the operatives, who are tempted to reject difficult work in favour of that which they prefer.

Each operative must know the route taken by each style of work in order to route each box to the next operation.

Since the conveyor is slow moving, one full circuit takes 9 minutes.



Pfaff "Varion" Conveyor (Feeder-Operative-Operative)

These drawbacks can be minimised by restricting the work content loaded onto the conveyor according to hourly schedules. As a guide, it has been found that the conveyor works best if it is not more than one-third loaded. It is also valuable if, at the check-points, the work is reloaded as necessary, according to the priorities required.

(c) Feeder-Operative-Feeder (Satra-Eatough/Durkopp)

This system attempts to overcome the drawbacks of the feeder-operative-operative system, by having the work returned to the feeder after every operation. It is more suitable, therefore, for long cycle than short cycle operations,-the short cycle operations would be positioned nearest to the feeder. The productivity of the operatives relies to a great extent on the efficiency of the feeder, who must maintain the correct sequence for each style as well as physically handling the work. The work involved in loading and re-loading is very considerable. The speed of the belt is fast.

Pfaff, Satra-Eatough and Durkopp conveyors are expensive. This cost seems justified only where variation in sequence make flexibility essential and where it is impossible to achieve the desired effect by simpler, cheaper means.

(d) Feeder-Operative-Feeder (Clarks Ltd.)

This is a very flexible conveyor system. There are two belts, a fast moving one for work feed and a slower moving belt for return. When an operative pushes a lever out across the belt, the loader identifies the number and releases the appropriate box of work. The box is carried by the belt to the position of the lever and is ejected into the operative's work tray. This type of conveyor has much to offer.

Less work in process
No changeover of machines required for changes of sequence
Positive control of work by feeders
It is fast - on a 90 foot conveyor, a work box travels the full length in 16 seconds.

New Balance - EX1016



Clarks Ltd. "Feeder-operative-feeder"
conveyor

Work Content

Even if the sequence of operations remains the same, the work content may vary widely - some styles may have no work content at all for a particular operation (i.e. may not require that operation). It is, therefore, not easy to balance one shoe style against the next, as is desirable to achieve a smooth work flow, and can be done more readily in the Making Room. Even the lack of balance does not remain constant as this depends on the mixture of styles which is loaded into the room from week to week. For example, where two styles are involved the work content might be:-

Operation		A	B	C	D	E
S.M. Value	Style x	6	22	-	35	17
	y	7	15	8	28	22
		+1	-7	+8	-7	+5

Even though the total S.M. value is 80 in each case, no two operations have the same value for x and y. Assuming that 10 tickets of work are loaded each hour the work content might vary thus:

	A	B	C	D	E
All x	60	220	0	350	170
Half x/half y	65	185	40	315	185
All y	70	150	80	280	220
	+10	-70	+80	-70	+50

The variation becomes more complicated as more styles are involved, but not necessarily more extreme as the work load may tend to even out.

Work Potential Available

To set against the work content to be done is the potential work that is available from the operatives. It is important that this should be calculated according to the known performance of the individuals concerned. For example, three operatives who are assessed at 100, 133 and 150 performance should actually complete 60, 80 and 90 S.M's of work or a total of 230 per hour, compared to three at 150 performance who could produce 270 S.M's per hour. The estimated performance of the operatives tends to drop sharply if they are put onto unmeasured work because of the lack of direct incentive. It also tends to vary slightly from day to day as female labour is not always consistent. The work potential available will be altered if operatives are temporarily absent. It will also be affected by any breakdown of machines - indeed it is often the availability of machines that is the limiting factor, so that the provision of spares may be a worthwhile expense. Accordingly, the work potential available should be re-assessed daily according to the actual circumstances prevailing, or immediately there is any known change.

New Balance - EX1016

Balancing the Closing Room

It is not normally possible to balance one operation against the next, as in the Making Room. A balance of work through the Closing Room can be achieved, however, by comparing the work content to be done with the work potential available. If the work content exceeds the work potential for any operation, a bottleneck will occur. If the work potential exceeds the work content, those particular operatives may be short of work and, provided they are versatile, will be available for other operations. Bottlenecks will restrict the flow of work to subsequent operations.

They will also affect previous operations, as the completed work cannot be accepted, and the input will have to be re-balanced. Both are equally undesirable and may involve heavy "no work" or overtime payments. Possible bottlenecks should be noted daily after comparing work content to work potential and a close watch kept to see that they do not develop.

Versatility

It will be obvious that the Closing Room will be far more flexible and able to cope with variations if the operatives can do more than one job. This means that the work potential available can be amended to match variations in work content due to the mixture.

The question of which operatives should be trained to do which alternative operations depends on three factors:

- the extent to which the work content of operations makes them complementary to each other.

- the similarity of operations from the point of view of the machines involved and the skill needed.

- the proximity of operations so that subsequent operatives can move forward to help clear a bottleneck. This is especially important when a direct flow conveyor is used.

It is particularly important to eliminate bottlenecks from the early stages of the production sequence, i.e. in the Preparation Section. These operations are not highly skilled and do not need long training. However, they do require a high performance if the operative is to earn good money and this is not easy to achieve on an unfamiliar job. While there is no practical reason, therefore, why operatives should not become very versatile, there is some reluctance to do so as they prefer to remain on the job they know. In one typical factory, 88% of the operatives could do 2 of the 53 different operations; 45% could do 4; 15% could do 6; 6% could do 8. The solution to this problem of versatility is the key to efficient management of the Closing Room.

New Balance - EX1016

Training

Training is a continual headache owing to the comparatively high turnover of female labour. The problem is further complicated by the periodical changeover in styles. Not only may this require the re-orientation of existing operatives onto similar jobs on the new styles, but it may involve re-training them onto dissimilar jobs to achieve versatility and the balance of work potential available/work content loaded, which the revised mixture demands.

Each factory should have its own training centre, which is in the charge of an instructor.

To train a stitcher up to production performance takes 10 - 12 weeks or more for a higher skilled operation.

Reserve Operative Capacity

It would be optimistic to rely on 100% activity from all operatives, as unpredictable contingencies are liable to upset any loadings based on such an assumption. There are two ways of allowing for this:

- to have utility operatives who are uncommitted and whose potential performance is not taken into account when calculating loadings. They should be paid a special payment for exceptional versatility.

- to calculate loadings only for a $7\frac{1}{2}$ hour day, leaving the period 4.30 to 5.00 p.m. unloaded as a safety margin.

The extra capacity is necessary in either case. The first alternative attempts to prevent bottlenecks by using utility operatives to ease them as they occur; the second accepts that operations will get out of step and looks to the normal operative to effect the balance in the time allowed.

The latter seems as if it may be more flexible as it makes no difference which operations are affected, whereas it is difficult to match one utility to approximately every 16 operatives and it is impossible to predict that such bottlenecks as do occur will be evenly distributed.

Neither method detracts from the value of versatility amongst the ordinary operatives which remains the key factor. Both methods are equally vulnerable to exploitation by supervision either by including the utility operatives in the line instead of holding them uncommitted until the need arises; or by planning to steal the extra half hour instead of keeping it as a safety margin to balance the day's output.

New Balance - EX1016

CHAPTER 10

COMPONENTS

Stock fitting is the department for the preparation of all bottoming components. There is a growing tendency for factories to "buy in" ready finished components and these are held ready to marry up with the closed uppers.

Stock Fitting Components:

1. Soles
2. Insoles
3. Stiffeners
4. Toe Puffs
5. Heels
6. Shanks

1. SOLES

Leather was always the main soling material. In recent years this has been largely superseded by other materials, for example, rubber (both vulcanised and microcellular), crepe, synthetic resins and more recently P.V.C. (plastic) and polyurethane.

The ideal qualities for a soling material are:-

(a) Durability
(b) Flexibility
(c) Waterproof
(d) Lightness in Weight
(e) Non Slip
(f) Uniformity

Leather is accepted in the trade as the most suitable soling material for high quality footwear, because it has all the essential qualities of a good soling material except durability. The reason that it has now been superseded is due to the fact that it is too expensive for most types of shoes.

Most soles to-day are pre-finished and because leather is not a uniform material in texture or substance, it does not lend itself to pre-finishing.

Solid Rubber is mainly used in the trade for vulcanised footwear. The main attribute of solid rubber is that it can be compounded to any quality required. It tends to be rather heavy due to its density (specific gravity 1.2).

Microcellular Rubber is the same compound as solid rubber with a blowing agent added, which turns to gas at a certain temperature in the

vulcanising temperature range. The specific gravity of 0.85 makes it light in weight and cushions the foot better than solid rubber.

Plantation Crepe - This is a material made from pure rubber. It is produced by coagulating the rubber latex taken from the trees directly into sheet form.

It is not extensively used because it is expensive and cannot be bonded directly to leather uppers, although it is hard wearing. Other disadvantages are that it is adversely affected by oils and petrols and that it softens and spreads in wear.

Resin Rubbers - The introduction around 1950 of synthetic material manufactured from a combination of butadienes (synthetic rubber) and styrene (plastic) revolutionised finishing operations. This brought about a complete change in shoe manufacturing processes, in so much as old finishing operations have been eliminated by prefinishing the complete sole and heel unit before it is attached to the bottom of the shoe. The majority of resin rubbers are used for women's footwear but a proportion has been used for men's and children's styles. Resin rubber is a uniform material and so lends itself to prefinishing. It may be used in sheet form or as a moulded unit.

P.V.C. (Poly Vinyl Chloride) - The advent of P.V.C. as an injection moulded material for soles in the early 1960's was rapidly adopted by the footwear trade as an alternative to vulcanised rubber. It is suitable for direct moulding on to shoe bottoms or can be used to produce a wide variety of moulded unit soles.

Fairly soft grades of P.V.C. are used so that a good bond and good wearing properties (similar to that of a medium grade rubber) can be obtained. P.V.C. needs to have a patterned surface to overcome a tendency to slip.

E.V.A. (Ethylene Vinyl Acetate) - A chemically-blown compound which in appearance is similar to microcellular rubber. E.V.A. is used as a substitute for microcellular rubber as soling material for sandals in the cheaper end of the trade. It does not have such good wearing qualities as microcellular rubber, and good bonds to the shoe are difficult to obtain.

P.U. (Polyurethane)

Polyurethane was developed in the mid 1960's as a soling material which can be directly moulded on to shoe bottoms or produced as a moulded unit. It has proved to be the best man-made material for soles ever produced with regards to durability.

New Balance - EX1016

In the manufacturing process a hardener and resin are mixed in very exact ratios. This produces a chemical reaction, the result being a "blown" or expanded material. The mixing and metering of the hardener and resin is a highly critical process and is explained in more detail in the chapter headed "Moulded Constructions". An important factor to note is that when injecting directly on to shoe bottoms no adhesive is needed as the liquid has distinct self-adhesive properties. Further, when moulded units are used, considerable problems are experienced in bonding the units to the shoe bottoms.

P.U. is very light weight and mould contours can be used to simulate cork, resin rubber etc.

2. INSOLES

An insole (or inner sole) is the foundation of the shoe. Its function in the finished shoe is to take up moisture in the form of perspiration from the foot.

The ideal qualities for an insole are:-

a) To absorb moisture readily and dry out quickly

b) Sufficient durability to withstand friction from the foot

c) Flexibility

d) Firm enough not to spread in manufacture or in wear

e) Uniformity of substance

f) Lightweight

g) The ability to take an adhesive, tacks or stitches

There are a number of materials in use for insoles: Leatherboard, Cellulose board and leather are the main ones with various synthetic materials also available. A variety of grades and substances are produced to suit the type and price of shoe. The manufacture of leatherboard and cellulose board are described in a separate section (Board Manufacture).

Leatherboard (e.g. Articor and Ferrersflex)

S.A.T.R.A. (The Shoe and Allied Trades Research Association) specifies leatherboard as a material containing no less than 75% leather fibre. It is a compound of leather fibres bonded together with rubber latex to form a uniform sheet material which is the nearest in properties to leather. Because of the leather fibre present it absorbs moisture

and water vapour. The latex content makes it less permeable than leather. The leather fibre may be of vegetable-tanned leather but where more heat-resistance is required the fibre will be from chrome tanned leather. Many grades of leatherboard are available and this material is used extensively in the trade.

Cellulose Board (e.g. Texon and Bontex) This is made from wood pulp compounded with latex (Texon) or with resins and latex (Bontex and others). It is no cheaper than leatherboard because of the amount of bonding agent needed. Cellulose board does not stain, has a natural appearance and takes adhesives well. On some grades the edge compression is not satisfactory for some moulding operations.

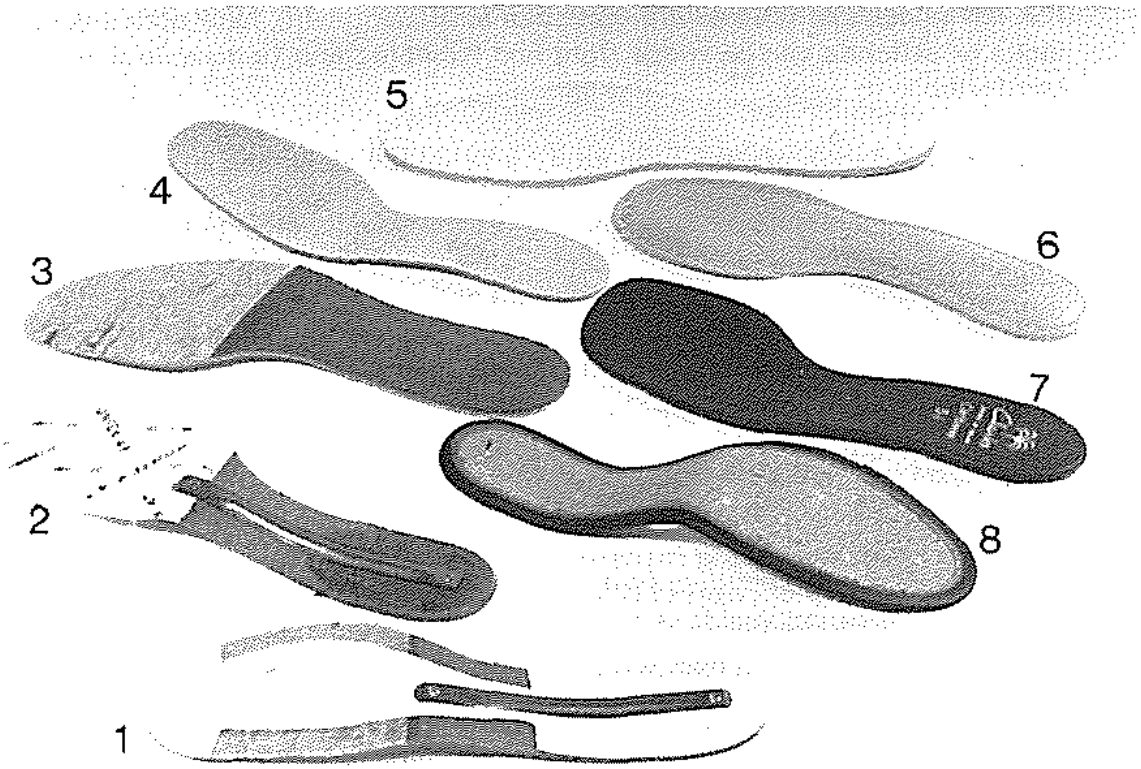
Backerboard

A cellulose fibre board which has little or no bonding agent but is compounded with water. This produces a rigid board in various grades and is used as backer board (i.e. the backpart of the insole).

Blended Board Strips

Board manufacturers supply "Blended Strips" having a rigid backer board blended to the flexible leatherboard or cellulose board. This produces in one cut an insole with a rigid backer and flexible forepart. To achieve a higher laminar strength with adhesives for lasting operations a "through" insole (full length) is used with a laid-on backerboard next to the foot. With this type of blending the adhesion at lasting then occurs directly on to the leatherboard or cellulose board giving a higher laminar strength than is achieved with lasting directly on to backer-board.

New Balance - EX1016



INSOLES (Various types)

Key.

1. Blended insole with 'skeleton' backing for lasting of strap sandal.
2. Blended insole - cellulose backpart - Bontex forepart.
3. "Through" latex-bonded insole with laid-on cellulose backpart.
4. "Through" chrome leatherboard insole.
5. "Through" insole bonded to fleecy sock for warmlined footwear.
6. &
7. Covered insoles for casual sandals.
8. "Bound" insole for sling-back, peep-toe open fashion sandal.

Leather

Insoles cut from leather are still used in the trade particularly for more expensive footwear, but the amount is diminishing because of the high cost of leather.

The leather is usually cut from the belly or shoulder of the hide and is split through its substance where necessary for the grade of footwear. Some heavy hides will give several "splits".

The advantages of leather are that it is absorbent, will take adhesives, tacks or stitches can be made light and flexible, and is durable and comfortable in wear.

The disadvantages are the high cost, a tendency to spread in wear and unless split it is not uniform in substance.

Recent Developments

Radoma

In 1973 B.U.S.M.C. brought a new insoling material on to the market known as "Radoma". This is a synthetic random fibre needled fabric.

The synthetic fibres are laid at random in a thick layer which is passed through a needle-looming machine. The needles serve to interweave the fibres. A thermoplastic resin bonding agent is added to the layer which is then passed through a calendering process, that is to say it is compressed to the required substance by passing through a series of rollers.

Radoma is claimed to have the following advantages:

a) High laminar strength (surface peel characteristics) of up to 30 lb. per inch width. This makes it specially suitable for cement lasting techniques particularly with hot melt cements.

b) Good dimensional stability.

c) Not affected by moisture or heat.

d) Readily absorbs moisture (foot perspiration).

e) Easy mouldability.

The disadvantages are:

a) There is some tendency for the material to compress in moulding to a small degree.

b) The surface characteristics necessitate the use of a full sock in the finished shoe.

Radoma is supplied as a blended strip, with the cellulose backpart section being put on the inner side so that the maximum use may be made of the surface characteristics in cement lasting to ensure a good bond of the lasting allowance to the insole.

New Balance - EX1016

At present there are some limitations on weights available.

Plastak

A development which originated in Italy in the late 1960's was that of the Plastak insole construction. This has since been taken up by two component manufacturers in this country.

The Plastak construction takes place in the following manner. A through (full length) insole is incised or split through from the seat to the joint line. An extremely accurate mould has to be made to fit the bottom contour of the last. The incised insole is fitted to the mould which clamps the insole across the joint line. Molten polypropylene is injected to fill the insole cavity by means of a hole in the bottom of the backpart.

This produces an insole having a very rigid backpart which requires no reinforcement with a shank. The accuracy of the moulding ensures an excellent fit of the insole to the last bottom.

A further advantage is that heeling nails and seat lasting tacks can be driven through the insole without causing any damage to the insole.

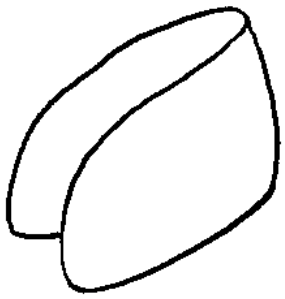
At present cost considerations due to high mould costs mean that it is necessary to restrict the grading of the insole backpart to a few sizes in a range.

3. STIFFENERS

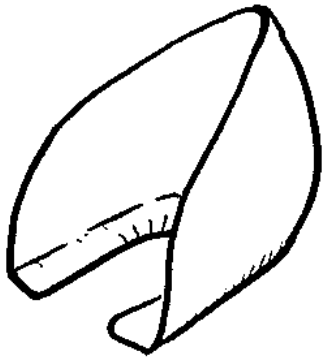
A stiffener is a material shaped to conform to the heel of the last, and inserted between the lining and the upper.



■ Flat stiffener



■ Semi-moulded stiffener



■ Fully-moulded stiffener

Stiffeners are mainly made from leather, leatherboard, P.V.C. and polythene, although many other materials may be used.

The ideal qualities for a stiffener are:-

(a) Strong and rigid to support the backpart of the shoe and keep the foot forward.
(b) Sufficiently yielding to permit the passing of the foot into the shoe.
(c) Easy to mould.

New Balance - EX1016

(d) Ability to skive to a knife edge so that it does not profile on the finished shoe.
(e) Ability to take an adhesive.

The length of the stiffener will be determined by the function of the shoe, for example, the stiffener must be longer for a ladies court shoe to help maintain the shape and good fitting of the topline.

Stiffeners are bought in pre-moulded to the shape of seat, partly moulded or flat.

Leather is an ideal material for stiffeners but it is expensive and, therefore, only used with high quality footwear. It is always flat (not pre-moulded), is skived to a knife edge, mellowed to ease moulding and an ahesive is applied. It is moulded to the shape of the last during the lasting process.

Leatherboard for stiffeners is made in many types and grades of material. It is usually pre-moulded to the shape of the heel, but nowadays is often partly moulded for use in the new backforming machines, and for veldtschoen construction.

The modern trend is to have stiffeners pre-cemented. These are reactivated by heat to enable the linings and quarters to bond to the stiffener, thus the uppers are kept cleaner during manufacture.

Thermoplastic - Various grades of board stiffeners are either coated with thermoplastic resins or the resins are incorporated into the board during the stiffener manufacture. These are for use with back moulding and seat lasting machines. They are pre-heated to a soft condition, moulded to shape on a mould or the last and seat-lasted. As cooling takes place the stiffener takes up the firm shape required. Thermoplastic resins may also be used with a fabric-based stiffener. As an alternative to inserting by hand, board or fabric stiffeners may be heat-laminated to a lining, and the whole combined unit stitched into the shoe.

Polythene is not used extensively for stiffeners as they are too expensive at the present moment. Since they must be pre-moulded to shape, unless they are accurately fitted, a badly shaped seat is inevitable because it is impossible to remould them. In wear, polythene is considered ideal, having all the qualities of an ideal stiffener.

4. TOE PUFFS

A toe puff is any suitable material which is placed in the toe of the shoe

to reproduce the shape of the last and to maintain that shape throughout the active life of the shoe. In its flat form the toe puff is shaped thus:



"Print on" toe puff

A toe puff must be:-

(a) Thin in substance, so that the profile of the puff is not visible through the vamp and does not cause discomfort in wear.

(b) Firm, so that good toe shape is maintained.

(c) Resilient, so that the shape is maintained after distortion.

(d) Hygienic, not a breeding ground for bacteria.

Celastic - This has been the main toe puff for many years but is now only used in children's and men's shoes. Celastic puffs are made from a cotton-based material impregnated with celluloid. They are activated by an acetone-based solvent, just prior to lasting, and set very firmly. The advantages are that they are not affected by damp or temperature. With cement lasting, this is not the ideal toe puff because the solvent used affects the cement around the lasting edge.

New Balance - EX1016

Rubber - This type of light, cheap puff consists of cotton scrims impregnated with rubber. The main use is in unlined casual footwear where a firm toe is not required.

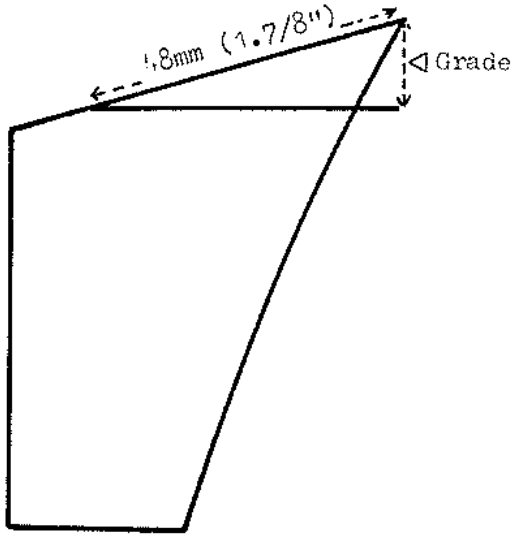
Liquid Painted-on Types - There are many variations in liquid form. These are simply painted onto the vamp.

Print-On - Thermoplastic resin is applied to the vamp in the toe area by means of a mould or matrix of the required shape. Alternatively, a backing-paper coated with resin may be employed, the resin being heat-transferred on to the vamp by means of a heated metal stamp. A good bond and correct substance are critical so these are pre-determined by the setting of the machine. Print-on puffs are softened by heat just prior to lasting. On cooling, this produces a resilient toe.

Heat Activated Thermoplastic - Cotton scrims laid in the required number of plies are impregnated with thermoplastic resins to form the toe puff. One of the most usual types is known as "Surlyn", developed by Dupont of America. Various trade names are used by the toe puff suppliers. The back of the puff is coated with thermo activated adhesive and heat fused to the reverse side of the vamp. The puff is softened by heat just prior to lasting and hardens on cooling.

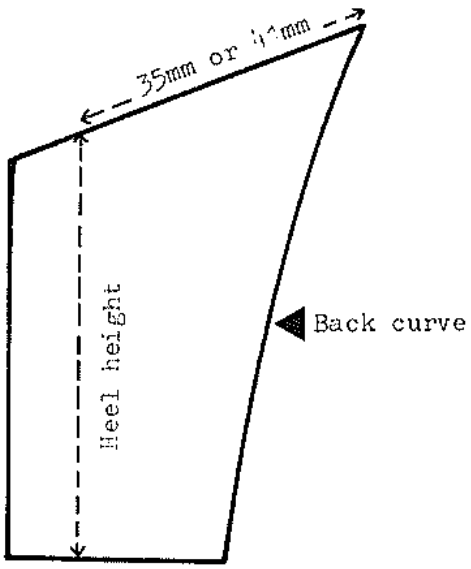
This type of puff has largely replaced the celastic puff as no solvent is required for re-activation.

5. HEELS - Terminology and Specification



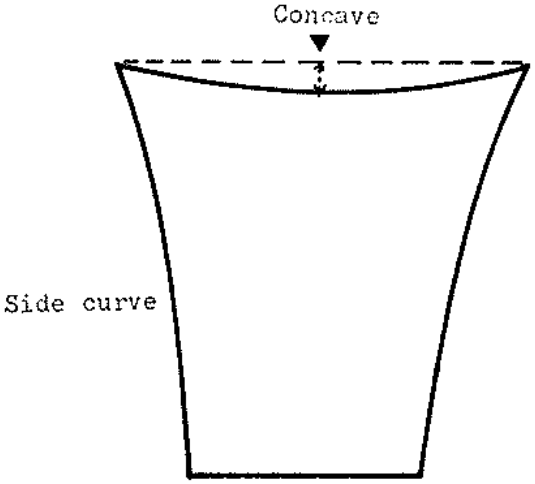
Grade

A method of determining the grade is to measure 48mm (1.7/8") from the back of the base. A line is taken horizontally to the back height line. The difference between this horizontal line and the top of the back height is known as the "grade" and expressed in 1/16ths of an inch, or in millimetres. Alternatively, more recently the angle of the seat portion of the last is known and this is used, being expressed in degrees.

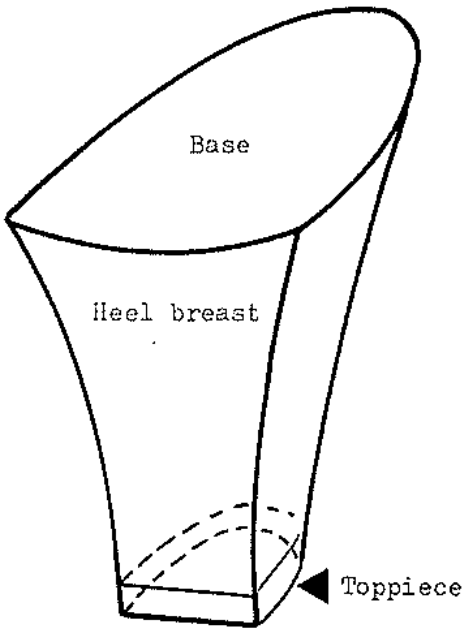


Heel Height

A measurement of 1.3/8" (35mm) or 1.5/8" (41mm) is taken from the back of the base. The measurement of a vertical line which meets this arbitrary point is taken as the heel height.



(Front elevation)



Heel Materials and Manufacture

Any variation from the three heel shapes illustrated in Chapter One are combinations or blends of these three basic styles. There are, however, four distinct types of heels:- plastic, wood, built and stacked. Plastic and wood heels can be covered in a number of different ways to relate to fashion requirements.

Plastic

This type of heel was developed in the early 1950's as a result of a breakthrough in plastic injection moulding. It involves precision engineering methods of mould making from a wooden model. High-impact polystyrene is the most commonly used material, heated to a molten condition and injected into the mould. When the fashion demand is for high slim heels, a metal tube or dowel is often moulded into the heel for strengthening purposes. Solid chunky heels, however, do not require this strengthening. Autoloc (push-on) plastic toppieces may be used in conjunction with plastic heels or, alternatively, toppieces may be nailed or stapled on. This type of heel can be covered or sprayed.

Wood

The wood used is mainly beech as it has a close fine grain which lends itself to good finishing. The heel making department receives wood in lengths, or billets, which are sawn and planed to the required size. These heel blocks are then cut and, by a series of wood turning methods, are shaped to the required size and style. The heels are now ready for covering.

Built

This method was traditionally used to make heels from layers, known as lifts, from leather and/or leatherboard. Originally this was done directly on the seat portion of the sole.

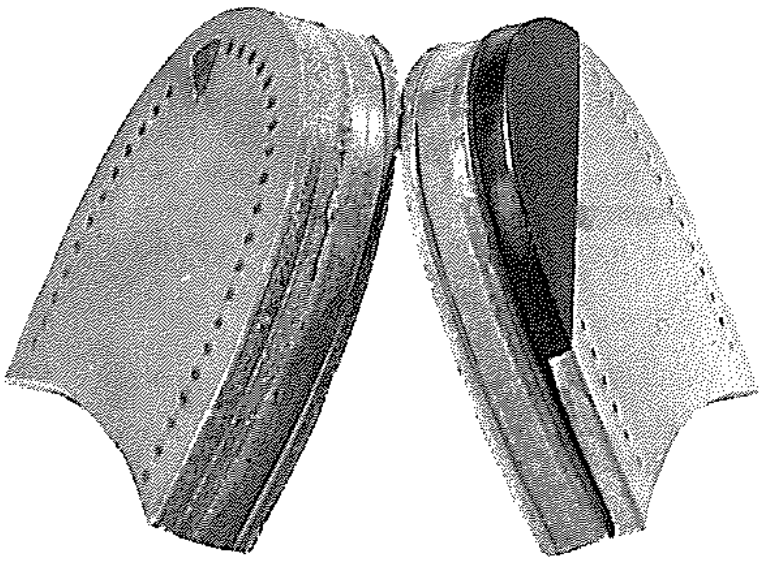
Today, the heel is made separately from the shoe. Vegetable-tanned leather and leatherboard lifts are used with some rubber toppieces. The leather comes from bellies, shoulders and other waste or offal parts of the hide.

The required sizes and shapes of lifts are press cut. The leather lifts are then split and graded to an even substance.

Most of the leatherboard lifts are already level in substance having been cut from sheets. There is one exception, "wedge lifts". Leatherboard is cut into strips and split diagonally along the length of the strip. The resulting "wedge strips", being thick on one edge and thin on the other, are cut by press into "wedge lifts".

One or two wedge lifts are used in the heel to impart the grade to the heel.

The required number of lifts are then assembled according to a pre-determined specification for substances and area. The lifts are nailed together, compressed, toppieced and compressed a second time to produce a compact built heel. The heel front or breast is chopped in a guillotine and scoured smooth. It is now ready for nailing to the shoe. Alternatively, it may be further pre-turned on a copying lathe and completely pre-finished.



BUILT HEELS (Unfinished)

New Balance - EX1016

Stacked

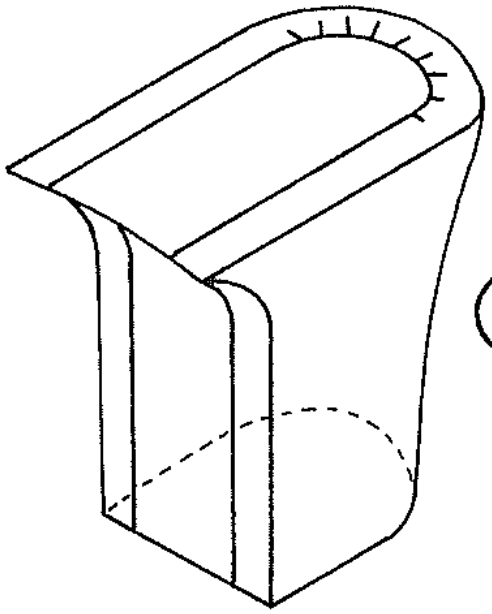
This method was also developed in the early 1950's but has since been modified and improved. It was evolved mainly as a replacement for the built heel, being lighter in weight and lending itself to more extreme shapes. Many different appearances can be effected simply by varying the nature of the heelboard and the cements used.

The sheets are stuck together to the required thickness. The sheets are then sawn into billets and further sawn into heel blocks. The blocks are drilled with two location holes for turning and a dowel hole into which a wooden dowel is inserted. The base of the heel is sanded, the heel is graded by sawing the toppiece end to the required angle. The toppiece and the heel block are cemented, the toppiece is attached and permanently secured by slugging. Breasting, turning and concaving are carried out on the turning machines. A screw is inserted for strength in the base of the heel, the heel is then scoured and sprayed, the number of spray coats varying according to the type and grade of the heel board. A polyurethane spray is often used, giving a hard durable finish.

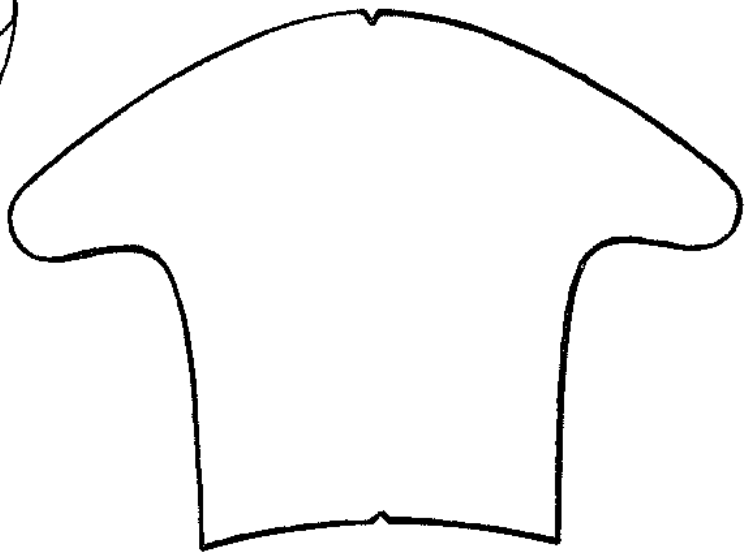
Heel Covering

Many wood and plastic heels are covered to effect different appearances according to fashion trends. The covering may be done by machine or hand. The cover is usually split to 0.5 - 0.7mm substance.

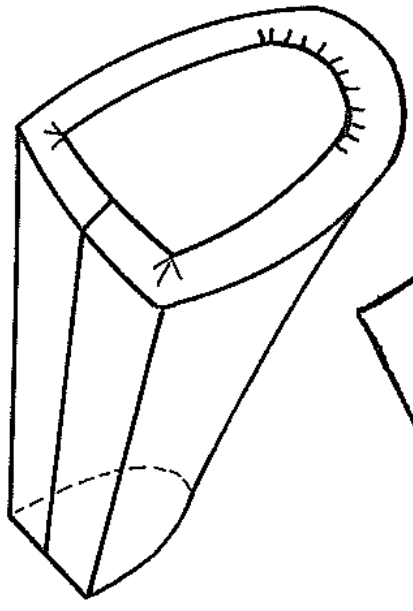
Prior to covering, the heel is dipped in a bath of adhesive and the cover is sprayed with adhesive. After drying the covers are stretched tightly around the heel. Cuban covers extend around the heel front, the edges being fitted into a slot. Louis and wedge covers extend approximately $\frac{1}{4}$" around the front corners of the heel. Any excess material over the base and toppiece ends are trimmed and stuck down securely. It is essential that the cover is tightly stretched over the heel, being stuck securely without creases or bumps under the cover.



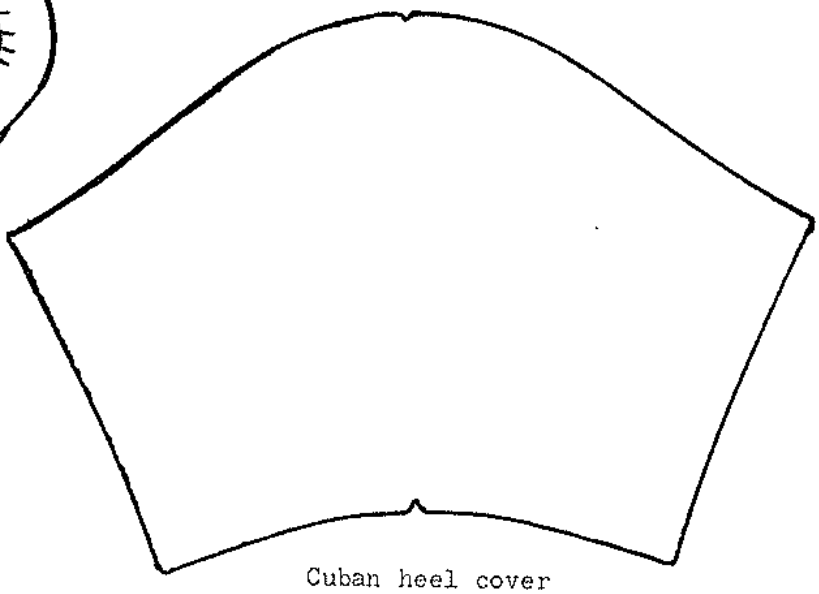
Covered Louis heel



Louis heel cover



Covered cuban heel



Cuban heel cover

HEEL COVERING

New Balance - EX1016

Heel covers may be cut from:-

Leather

Any type of grain or suede leather may be used for heel covers to match or contrast with the upper material. Certain of these are more difficult to process, i.e. patent and reptile leathers.

Fabrics

All types of fabrics used as upper materials can be used to produce covers. Care must be taken to avoid adhesive stains on the fabric as these may be extremely difficult to remove. The heel cover will always be cut on the bias to give maximum stretch in all directions.

Celluloid

Before spraying of heels became an accepted technique, covers were often cut from celluloid sheets. This was generally black or transparent which was later sprayed to the required colour. Embossed celluloid was used to simulate a built or stacked appearance. A particular development was the production of a photographic negative, simulating a stacked appearance on to the celluloid sheet. The negative in the shape of the heel cover was cut out for heel covering. This proved to be an expensive method. Celluloid covers are dipped in acetone to soften and then stretched around the heel. As the cover dries, it contracts, effecting a very tight cover.

Celluloid, however, is very little used today, the preference being for sprayed heels.

Laminated

This type of cover evolved in the middle 1950's, involves the use of strips of sole leather stuck together to form a solid block in the shape of a heel cover. The formed block is then fitted into a machine which cuts off a thin slice of approximately 0.5 - 0.7mm. This constitutes the heel cover. Where a cuban heel is to be covered, a separate block is made to give the shape required for the heel breast.

The cover is used in the normal way, except that it is steamed to make it pliable and workable. After covering, it is fine scoured and completely pre-finished. This gives a very good simulation of a stacked heel, and it is very difficult to distinguish the laminated heel from a stacked heel.

Sprayed

A popular treatment given to plastic heels is a coat of cellulose spray of the required colour. This development has been made possible by

improved methods of mould making and design. These developments have obviated mould lines which were a feature of the first types of moulds. Heels can be sprayed with any type or colour of spray as fashion demands.

6. SHANKS

The shank extends from just under the heel to a point just behind the treadline. Its function is to prevent the flexing of this portion of the shoe during walking.

The longitudinal curve of the shank must follow the curve of the last waist. It has a slight lift at the seat, known as seat spring. This has the advantage that in the finished shoe the shank pulls constantly at the heel portion, thus helping to ensure topline clip.

The two basic materials used are wood and high grade carbon steel. Both wood and flat steel shanks are used in flat shoes, but in ladies high heeled shoes only steel is used, and this is fluted to give added strength.

SOLE PREPARATION FOR CEMENTED (STUCK-ON) CONSTRUCTION

Introduction

The wide use of leather soles in the country up to the early 1950's demanded only the initial preparation of the soles prior to being stuck to the shoe bottoms. A series of highly skilled finishing operations were then employed to finish the sole edges and bottoms on the shoe. This was very costly and time consuming.

Machinery had been developed in America during the 1930's for the pre-finishing of soles but this was confined to slipper soles. Pre-finishing entails the complete preparation and finishing of the soles so that they can be stuck to the bottom of shoes and, thereafter, require no further treatment. Leather, however, did not lend itself to pre-finishing mainly due to a lack of uniformity of substance and texture and also because of a tendency to stretch.

As has been mentioned previously in this book, the advent of resin-rubber around 1950 as a soling material had a considerable effect on finishing operations. Resin-rubber was mainly produced in sheet form which was much more uniform in substance and texture. It could be reproduced in a variety of grades and colours.

New Balance - EX1016

A number of shoe machinery houses in this country, notably Ralph's of Leicester and British United Shoe Machinery Co. (B.U.S.M.C.) seized this opportunity to develop pre-finishing machinery. It was found that resin-rubber could be cut, shaped, reduced and finished to a highly sophisticated degree. Initially, individual machines were developed for a variety of pre-finishing operations but, as will be shown later in this chapter, these were further developed into a series of linked machines which were automatic or semi-automatic in their processing of soles.

Advantages of Pre-finishing

The advantages of pre-finishing soles as compared with the traditional methods of finishing soles on the shoe may be summarised as follows:-

(a) Reduced costs due to bulk processing.

(b) Less operating skills.

(c) Consistent results.

(d) Faster turnround of lasts due to fewer operations being performed while the shoe is on the last.

(e) Smaller last plant needed in the making room due to the increased usage of lasts.

(f) Cleaner shoes due to less handling.

Requirements for Accurate Pre-finishing

In order that pre-finishing may be carried out to a correct standard and so that the shoe will have a satisfactory final appearance, a number of factors concerning previous operations must be considered. They are:-

(a) Insoles must be cut accurately, the pattern must be correct to close tolerances.

(b) The insoles must be accurately moulded to the shape of the last bottom and correctly positioned on the last.

(c) Upper material substance must be consistent.

(d) The regularity of skiving, lapping and substances of toepuffs and stiffeners must be carefully controlled.

(e) Lasting must be of a good standard with a clearly defined feather edge.

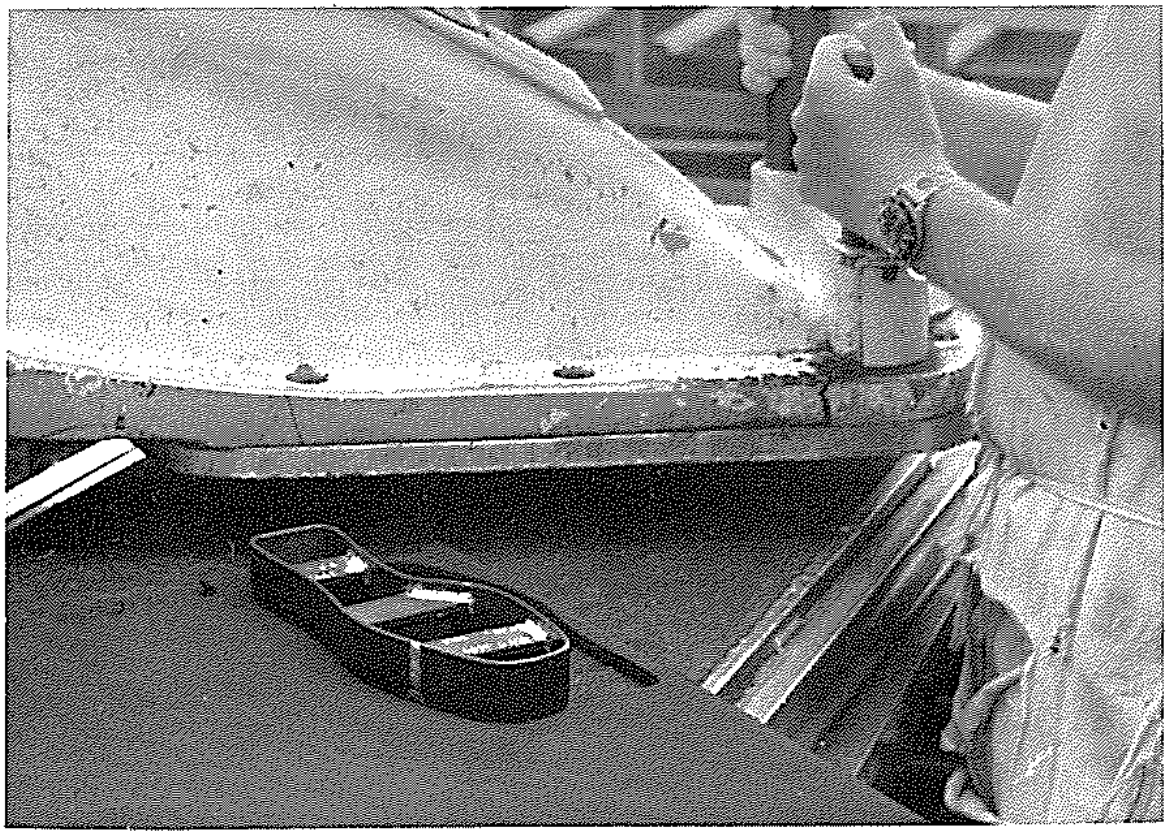
(f) The preparation of the shoe bottom is of great importance particularly with regard to correct bottom shape, good roughing and cementing.

Experience has shown that it is necessary to have a specially prepared insole pattern to ensure correct results in pre-finishing.

There are two main ways in which pre-finishing operations may be carried out. They are single-sole pre-finishing where the soles are treated singly or multiple pre-finishing where bundles of 12 pairs or more are processed simultaneously. In order to clarify these procedures each of these methods will be described separately, except for press cutting.

Press Cutting

A variety of cutting presses may be used, but one of the most popular is the hydraulic type of swing-beam press. Sheets of resin rubber are stapled together face-to-face. This has two advantages; first that a pair of soles is obtained with each cut, secondly, that the glossy face of the material is protected from damage by scratches from the press knife or the machine. So that maximum utilisation of material may be achieved, the cutting operator will be given an allowance with a subsequent bonus on material savings. In order to obtain this it will often be necessary to cut several sizes from the pair of sheets, "running in" the various shapes to get the best interlock of patterns. The sole pattern will normally have 0.3mm (1/64") allowance for the later operation of pre-trimming.



Sole cutting

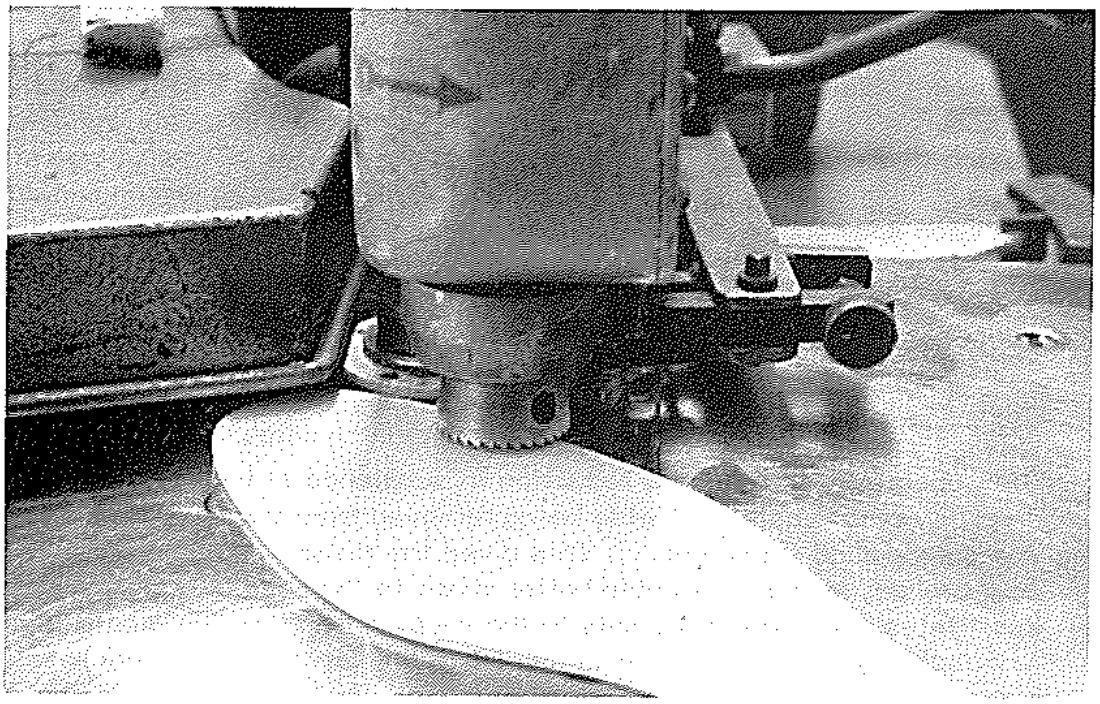
New Balance - EX1016

The cut soles are assembled in tickets of work and passed to either single sole or multiple pre-finishing.

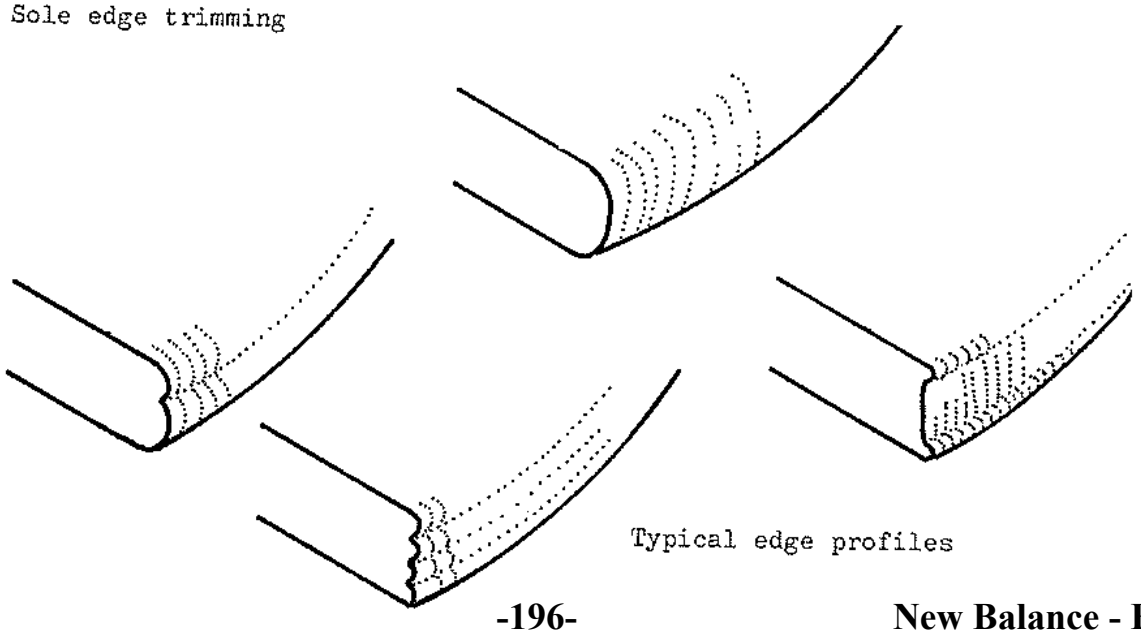
SINGLE SOLE PRE-FINISHING

1. Pre-trimming (Edge Profiling)

The sole edge is profiled to give the desired effect using a rotating abrasive stone. The sole traverses in the machine, being brought into contact with the stone by means of a presser foot. Where difficult toe-shapes are in fashion each side of the sole may be done separately, the trimmed profile being lined-up accurately at the toe.



Sole edge trimming



Typical edge profiles

It is general practice to remove only 0.3mm (1/64") of material from the sole edge. If more is removed, the sole will be too small for an accurate fit to the shoe.

2. Sole Edge Brushing

Trimming dust is removed from the soles by brushing on a rotating stiff-bristled brush. It is essential that the sole edges are meticulously cleaned before they are sprayed with edge finish as any residual dust will prevent the finish from adhering to the edge. Sometimes a strong air blast is preferred to brushing.

3. Spray Edge Inking

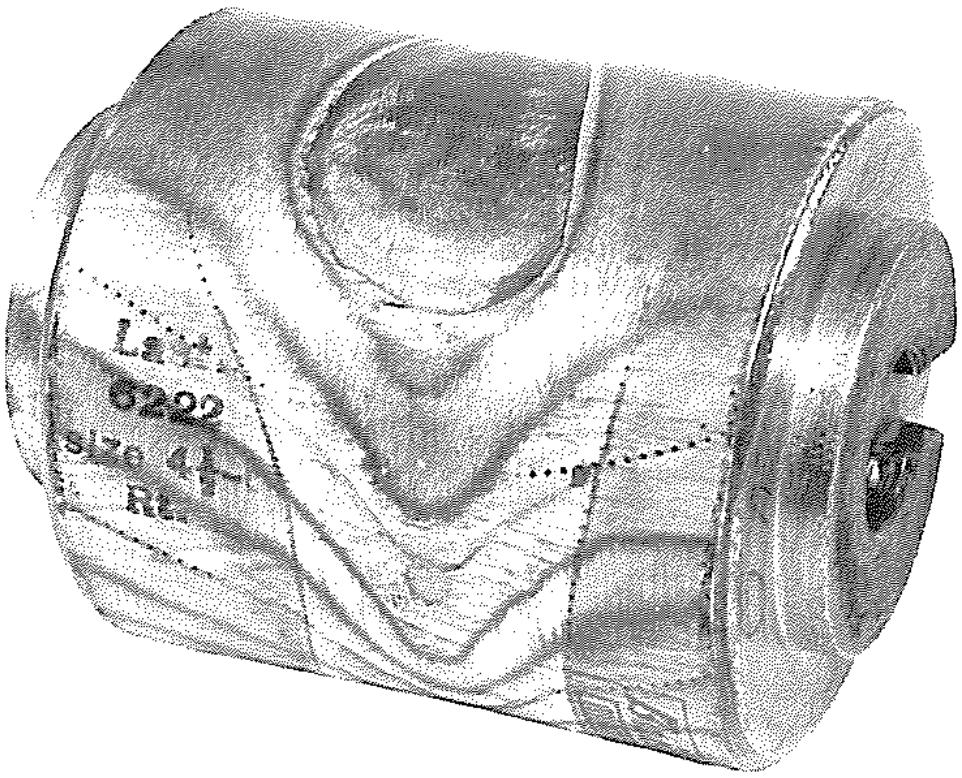
The brushed soles are stacked by hand, placed on a small turntable and clamped into position. A spray gun fed from a 5-litre can is used by the operator to coat the sole edges with a special resin emulsion finish. During the spraying the turntable is rotated by means of a hand-operated lever. This is much quicker than the original method, which was to ink each sole edge separately by brush or roller.

The edges are well coated and the finish dries in approximately 10 - 15 seconds. Very clean and satisfactory results can be obtained.

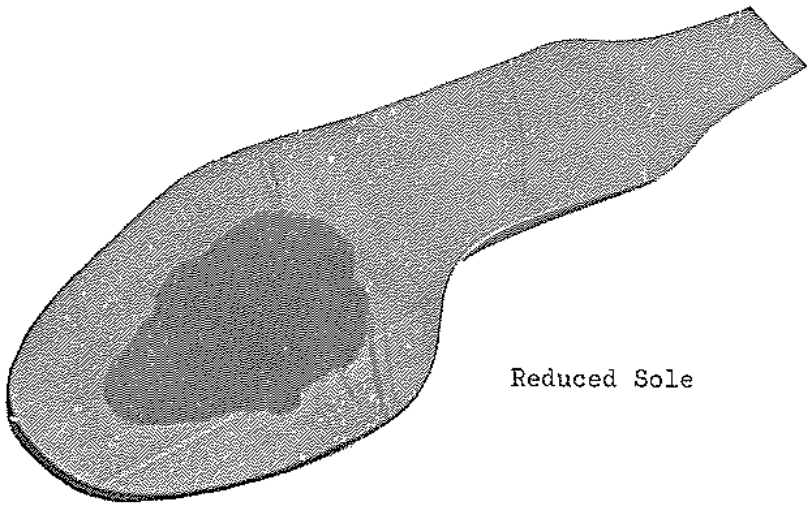
4. Sole Edge Reducing

This operation involves the reduction in substance of the sole edge, a "scarf" approximately $\frac{1}{2}$" wide being removed from the reverse face of the sole around its border. This gives the finished sole edge a neater appearance, helps to promote better shape to the shoe bottom and facilitates adhesion of the sole to the shoe. The wearing qualities are unaffected as the full substance is left in the central area where most wear occurs.

The operation is carried out by passing each sole between a matrix roller and a heavy duty splitting knife which has been honed to a razor-sharp edge. The sole fits into a tapered depression in the roller so that the amount to be removed stands proud. As the roller feeds the sole against the knife edge, the waste material is rapidly and easily removed according to the substance required. Typical sole edge substances for a 3.5mm ($6\frac{1}{2}$ iron) sole would be forepart edge 2.5 - 3.0mm (5 - $5\frac{1}{2}$ irons), waist edge 1.5 - 2.0mm (3 - $3\frac{1}{2}$ irons) and heel breast flap for Louis heels 0.5 - 1.0mm ($1\frac{1}{2}$ - 2 irons).



MATRIX ROLL (As used in Ralphs
Through Reducing Machine)



Reduced Sole

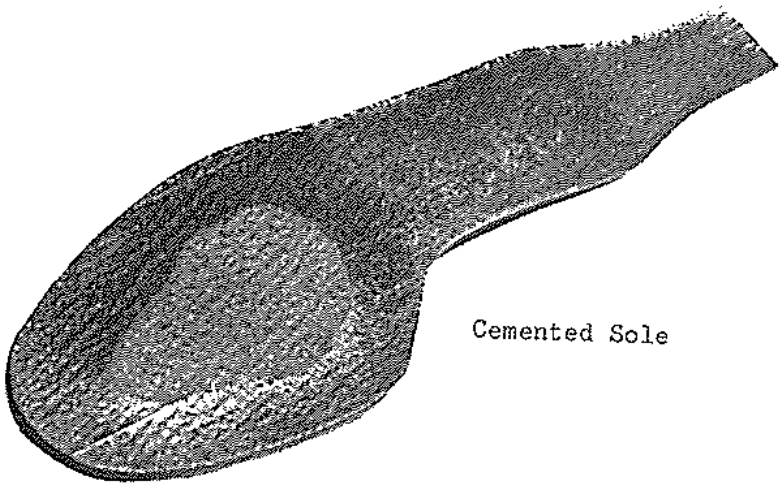
Sole Cementing

Several methods can be used either by means of a hand-brush or more commonly by machine. It is important that a thin even coating of cement is applied to the reverse face of the sole as soon as possible after reducing. If this is not done the surface will 'oxidise' in contact with the air thus causing a weak brittle layer to be formed which will prevent satisfactory adhesion. Care must be taken to ensure that the edges are kept clean and free of cement so that the edge finish will not be impaired.

Where roller type machines are used the cement is normally fed through a top-feed roll so that the cemented surface is face upwards for cleanliness and ease of handling. The bottom roller is usually made of spring-loaded sections so that the various substances created at sole edge reducing can be adequately coated with cement.

Cement Drying

The cement film is dried by atmospheric drying on a rack or, alternatively, is placed in a heated drying cabinet. It is essential that all of the solvents in the cement film are completely evaporated before the sole is stuck to the shoe otherwise bond failure may easily occur.



Cemented Sole

New Balance - EX1016

MULTIPLE SOLE PRE-FINISHING

Probably the best-known method for multiple sole pre-finishing is the "Ralph's Unified Process". This involves only two operators, each working with a bank of four machines. The first operator has, in his care, Stacking, Pre-trimming, Brushing and Spray Edge Inking machines. The second operator completes the process having Through Reducing, Sole Branding and Size-marking, Cementing and Drying machines. The unified process can give up to 24-25,000 pairs of soles per week.

1st Section (Ralphs 209)

Stacking

This machine accurately stacks the bundle of soles (12 pairs) together so that they may be presented to the pre-trimming machine. The soles are clamped together between two templates, air pressure being used to ensure a solid block of soles.

Pre-trimming (Edge Profiling)

The stacked bundle of soles is placed into the trimming machine and clamped onto a turntable. A trimming cutter which was originally tipped with tungsten-carbide but is now coated with particles of diamond is brought into action. The cutter which is rotating at high speed on a vertical shaft traverses from heel to toe on one side of the stacked soles, then stops and withdraws to a safety position. Simultaneously, the stack of soles is reversed through 180° on the turntable, the cutter re-starts, running in the opposite direction, then traverses from heel to toe on the reversed block of soles, stops and withdraws to the start position. All of these machine movements take place automatically simply by pressing the start button. The machine is fitted with a flexible dust extractor tube so that most of the dust is removed. During the machine cycle the operator is free to operate the other machines in his care.

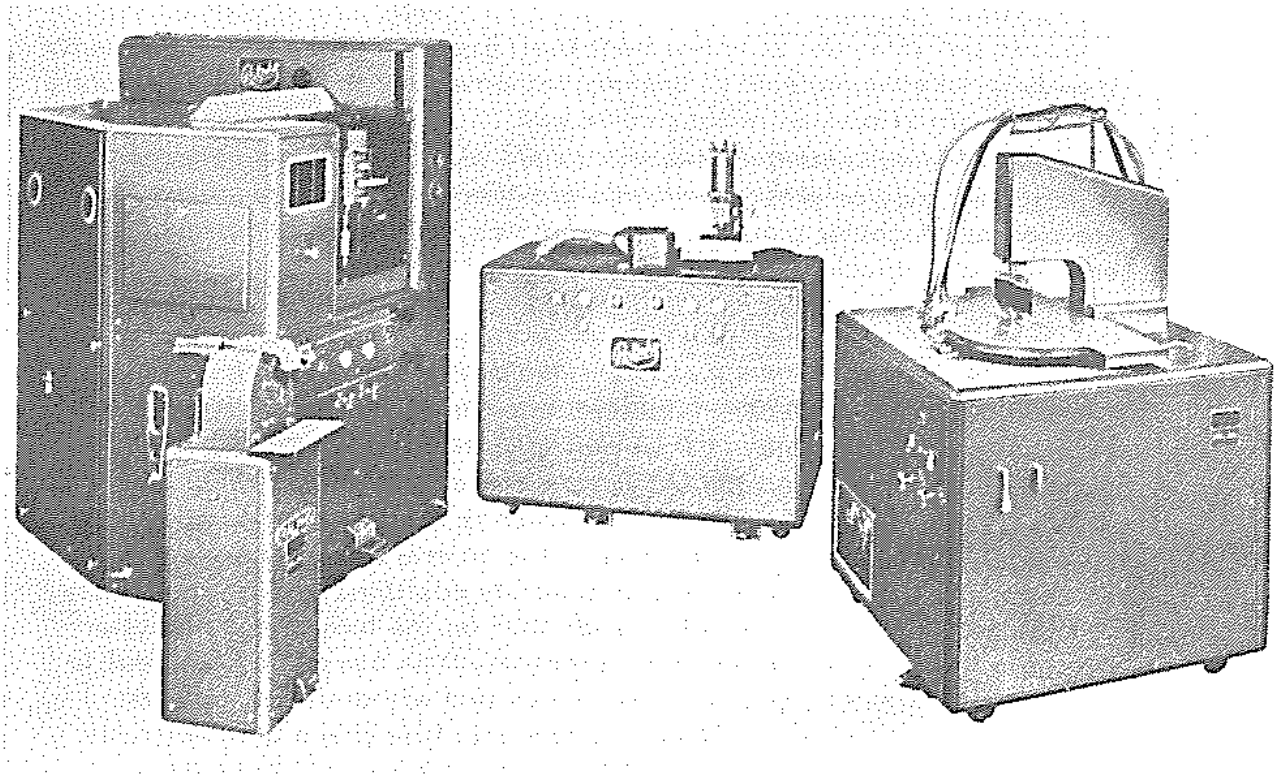
Edge Brushing

The trimmed stack of soles is placed into a clamp on the edge brushing machine. The stack is automatically traversed between a pair of spring-loaded brushes thus ensuring that all residual dust is removed.

Spray Edge Inking

The brushed stack of soles is clamped onto a turntable. A spray gun automatically traverses across the stack, coating the sole edges with a

light application of resin-emulsion finish. As the gun reaches the end of its run, the stack is turned through 180° and the gun then traverses back to the start position, coating the other side of the stack of soles in the same way. This complete sequence is repeated twice more, ensuring that the soles have a uniform coating of edge finish which dries very rapidly (7 - 8 seconds). The operator removes the stack, takes off the templates and passes the bundle of soles to the second operator.



CIC/Ralph... Sole Stacking, Trimming, Brushing and Spray Edge Inking Plant

New Balance - EX1016

2nd Section (Ralphs 264)

Through Reducing

The Unified through reducing machine works on the same principle as other reducing machines. However, it has several advantages:-

(a) The knife and matrix roller can be quickly and simply changed.

(b) Lack of positive machine feed causes irregular reduction of substance. "Take away" rollers fitted to the machine ensure that the sole is passed over the splitting knife at an even speed on the tip of the flap section where there is no feed from the bottom roller.

(c) A stack of soles is fed automatically through the machine at the rate of one per second. Up to 48 soles may be positioned in the machine at once.

(d) The machine employs the Bailey Matrix Roller which can be relied on to give a high degree of precision.

(e) The feed adjustments allow any given matrix to cover a greater range of similarly shaped soles than was previously possible.

(f) The machine has been designed to link up with the next operation by means of a short piece of conveyor belt.

Sole Branding and Size Marking

The soles being ejected from the through reducing machine are fed into the branding and stamping machine. Each sole passes between a pair of spring loaded rollers. By accurate timing and positioning this actuates the trade-mark brand and size-stamping head to meet the sole at precisely the exact moment.

As each sole is ejected from the machine it is automatically fed into a Transfer Unit which turns it over so that the reverse side is facing upwards ready for through cementing. Thus the soles are passed through the transfer unit, going straight into the cementing operation. Alternatively, Branding and Size Stamping may be carried out independently of the Unifed Process.

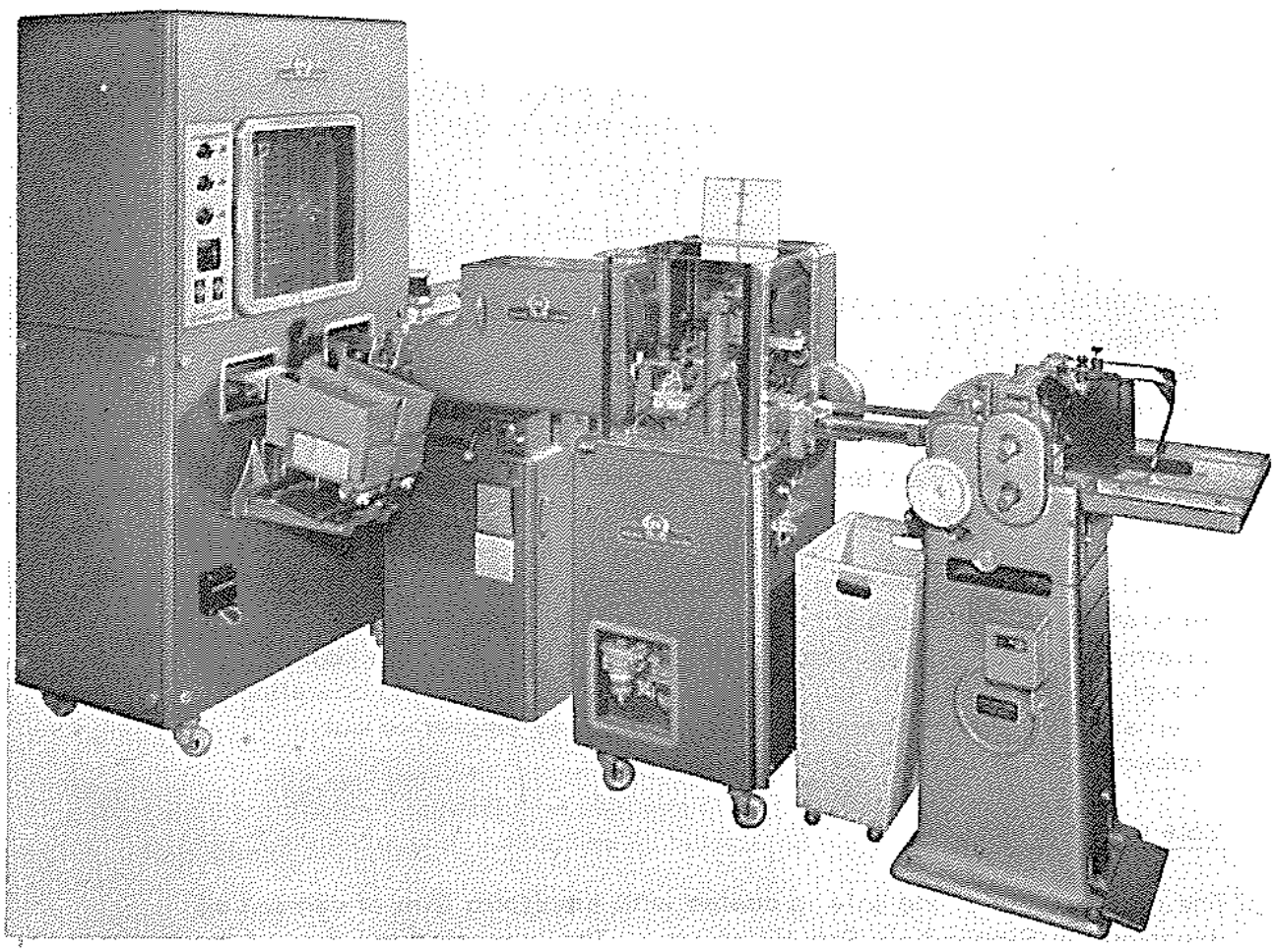
Sole Cementing

The reverse side of the sole is coated with a uniform film of cement as described in Single Sole Pre-finishing. The cemented soles are fed immediately into the Drying Cabinet.

Cement Drying

As each sole is fed into the entrance to the Drying Cabinet it contacts a micro-switch which causes it to be picked up by the rods of an elevator and moved up one position. As the elevator moves the soles up one side of the cabinet and down the other, the cement film is dried by means of infra-red heat. The dried soles are ejected from the drier at one per second into a waiting container.

It can be seen from the foregoing description that the Unified Process provides a rapid service in pre-finishing. Much work has been done in building in labour saving devices into the Unified machinery and equipment, resulting in considerable cost savings in labour and work content. The system has been found to operate best when long runs of the same type and size of sole are being processed. A manufacturer may find it necessary to use some of the single-sole and some multiple pre-finishing machinery in order to have a system which is suited to his particular needs.



Unified Automatic Through Reducing, Cementing, Embossing, Stacking and Drying Plant No. 264

New Balance - EX1016

Insole Preparation for Cemented Construction

Press Cutting

Two pieces of blended strip are stapled together accurately, face to face, to produce a pair of insoles at one cut. On the heavy duty hydraulic press it is usual to cut two thicknesses in this way.

There are machines, however, normally travelling head beam presses, which will cut four or more thicknesses at once. Because of the hard nature of most insole backerboards, it is necessary to use heavy duty press knives to ensure an accurate cut with no distortion of the knife.

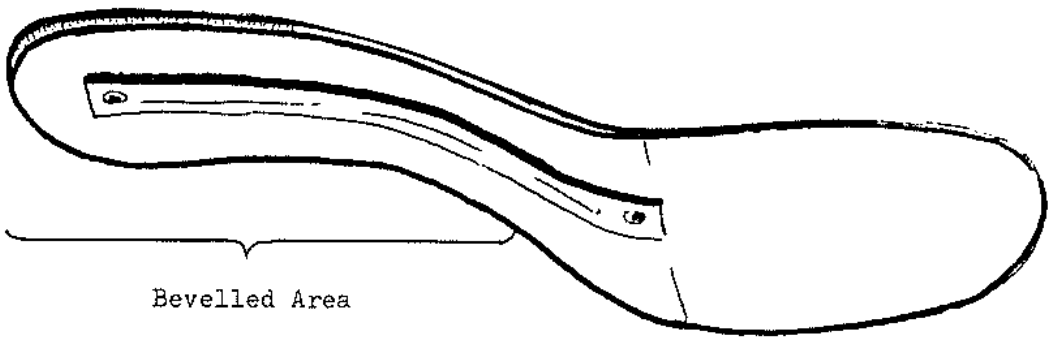
Flexing

Previously it was common practice to place a series of cuts by rotating circular knives across the joint area of the insole forepart after press cutting. These were pre-determined to a depth of one third of the substance and intended to assist flexing of the forepart in wear.

Today, however, these cuts are normally made, if required, in the blended strip. Usually this applies only to insoles for ladies footwear.

Seat Bevelling

The feather edge of the insole backer is bevelled to a pre-determined angle by means of a rotating cutter. The bevel extends the curves of the seat and waist of the last and allows tighter lasting to the insole edge.



Punch 502 Hole

As will be described in a later chapter, the use of a CIC/Ralphs 502 Backmoulding and Seat Lasting machine necessitates a hole being punched in the seat of the insole for location purposes. This is done by using a punching machine set to a pre-determined position.

Shank Recessing

A groove or recess is cut into the backpart of the insole by means of a rotating cutter. This allows the shank to be correctly positioned at the later operation of pre-shanking.

Insole Moulding

This is a critical operation in the cemented construction. The insole must be moulded to the exact shape and contours of the bottom of the last. This is necessary so that -

i) It is possible to produce tight lasting in the waist.

ii) Any curling of the insole edge at forepart lasting is eliminated.

iii) The feather edge of the upper is well defined for purposes of roughing and sole attaching.

iv) Better shape retention in the finished shoe.

There are a number of machines available for this operation. Basically, all of these have male and female moulds into which the insole is positioned. Extremely heavy pressure is exerted on to the insole in order to produce the correct result.

Pre-Cementing

Where cement lasting using liquid cement is to be employed the outer margin of the insole is coated with a film of the required adhesive either by hand brush or by roller type machines. This is then dried, usually in a heated cabinet.

Where hot-melt cement lasting is to be used there is no need for this operation.

Pre-Shanking

Traditionally, metal shanks were attached to the insole, after lasting, by tacks, staples, pitch or hot-melt resin. The main method used

New Balance - EX1016

nowadays is for the shank to be pre-fitted to the insole in a recess as previously described. When located accurately the shank is secured at both ends by means of eyelet-type rivets.

Insole Covering or Binding

It is usual that where the insole is intended for use with sandal-type footwear, i.e. sling-back or peep-toe, then the edge of the insole is bound with a strip of appropriate material to prevent the raw edge of the insole being visible in the finished shoe.

Additionally, insoles for use with sling-back or peep-toe sandals are sometimes gouged at the positions where straps have to be lasted in at a later stage. This affords a reduction in substance and, consequently, an improved appearance in the finished sandal. Alternatively, block marks may be made in these positions to ensure accurate location of the straps during lasting.

CHAPTER 11
BOARD MANUFACTURE

The following is a brief description of the basic processes required for the manufacture of leatherboard, cellulose board, or backer-board.

Stock Preparation

1. Cleaning

   The raw materials are examined and any foreign matter is removed.

2. Pulping

   Cellulose materials, i.e. wood pulp or waste paper, are disintegrated into a wet slurry of fibre in water. This is carried out by breaking down the material in a pulping machine and mixing the resulting fibres with water.

3. Grinding

   A variety of grinding mills are used to break down leather into its individual fibres.

4. Beating

   The fibres are beaten by passing the pulp between stationary and rotating bars to obtain a fraying effect on the fibres. The effect of beating considerably affects the fibre properties so it is varied for different types of fibre and boards. Generally, the longer the beating, the higher the tensile strength and rigidity of the finished board.

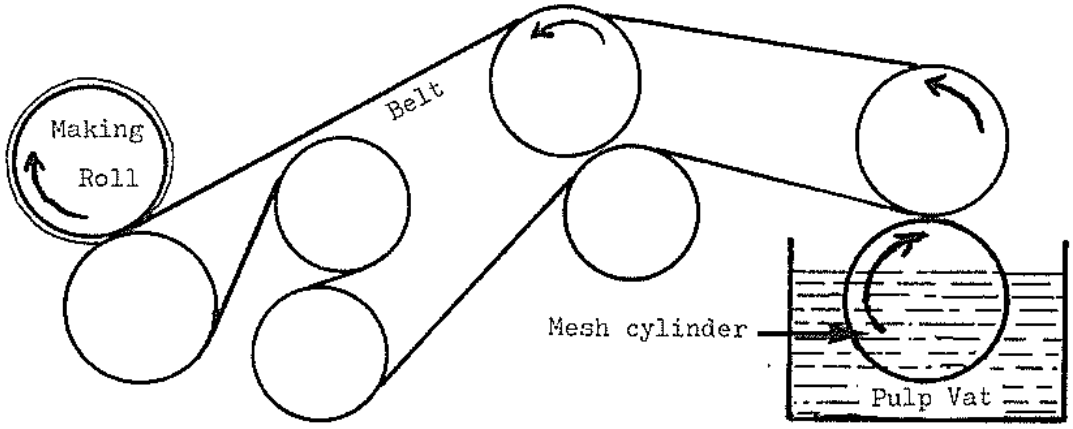
Board Making

There are 3 methods in general use for board making, each depending on the same principle, i.e. the beaten fibre is diluted and drained through wire gauze to form a sheet.

New Balance - EX1016

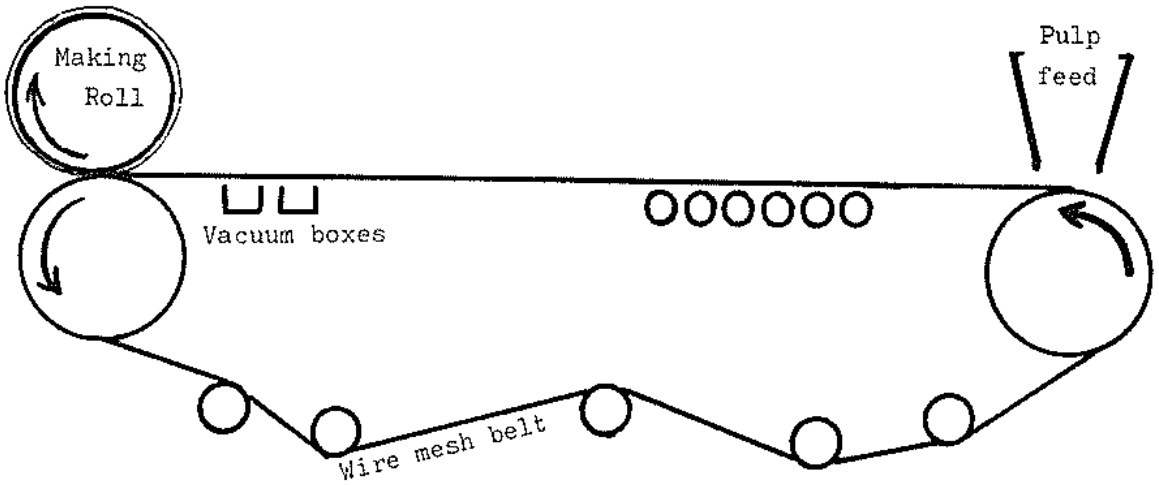
1. Cylinder Vat Machine

Diluted fibre is fed on to a wire mesh-covered hollow drum cylinder. Water drains through the wire and a layer of fibres is picked up on the cylinder. This layer passes on to a continuous felt and is transferred to a making roll which has a groove across its width. As the layer reaches the necessary substance a spike is inserted into the groove so cutting off the board. Boards are stacked between felts for pressing.



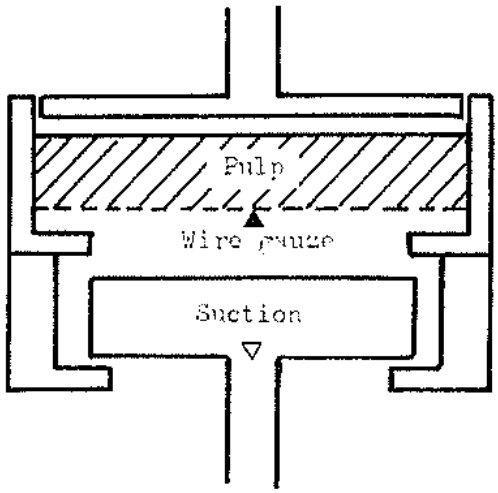
2. Fourdrinier Machine

Diluted fibre is fed on to a continuous wire gauze belt on rollers. As it is carried along the belt drainage takes place through the wire assisted by a vacuum process. The 'mat' of fibres passes on to a making roll as in the vat machine. This process can also be used to make thin board continuously.



3. Direct Drainage

Diluted fibre is run into a tray with a wire gauze bottom. Water runs through the wire, suction being applied to assist its removal. The sheet is removed from the wire and stacked between felts for pressing.



Pressing

The stack of sheets, interleaved with felts to allow water to drain away, is placed in a hydraulic press. Pressing primarily removes water but also compresses the board into a denser, stronger material.

Drying

The pressed boards are hung up or passed on to a slow moving conveyor. Careful control of temperature and relative humidity is essential to prevent the boards being overdried. A certain amount of moisture is necessary in the finished board so they are allowed to reach equilibrium in the air after drying.

Post Drying Treatment

The dried boards are rolled and sorted. Subsequent treatment varies with the intended use and will consist of some or all of the following:-

Grading, splitting, sanding, finishing and packing.

New Balance - EX1016

CHAPTER 12

INTRODUCTION TO MAKING

"Making" is the name given to the department in which all the component parts of the upper and bottom are brought together to construct the shoe.

There are a number of ways in which footwear can be made. Each particular method is known as a "Method of Construction" and in each case will consist of a particular sequence of lasting operations allied to a specific method of sole attachment.

It will be shown that one method of lasting can be often combined with one of several methods of sole attaching to form a variety of "Methods of Construction".

These methods are often dictated by the use which is intended for the finished article.

A miners boot must be durable and waterproof whereas the criterion for slippers is comfort. A high fashion shoe is usually meant to complement a certain mode of dress but the yachting shoe must have high frictional properties in the sole for safety purposes on a wet deck. Hence, each will demand different considerations in their manufacture and the use of a variety of upper and component materials.

In order to clarify the situation for the student of shoemaking, we shall be dealing with each method as a separate entity as far as possible. Initially, however, some explanation of the various sections of the Making Department is necessary.

Assembly

This is the section where all of the upper and component parts of the shoe are brought together. Uppers from the Closing Room, soles and insoles from bottom stock preparation, socks from the Cutting department, plus heels and shanks from suppliers, are all typical items held in the Assembly area. Allied to these is the stock of lasts in current use, known as the "last plant". Sufficient stock must be available so that the "marrying up" of these items can be carried out in advance of the Making operations. Usually 1 - 2 days supply is held.

The uppers and components are put together in boxes or on racks in work ticket order according to the daily work input planned into the Making room.

An up-to-date term for the organization of the Assembly area is "Focal Point Planning". Indeed the planning of work into the making room in a methodical way is of vital importance in a modern shoe factory so that the stock of expensive lasts may be used as often and economically as possible.

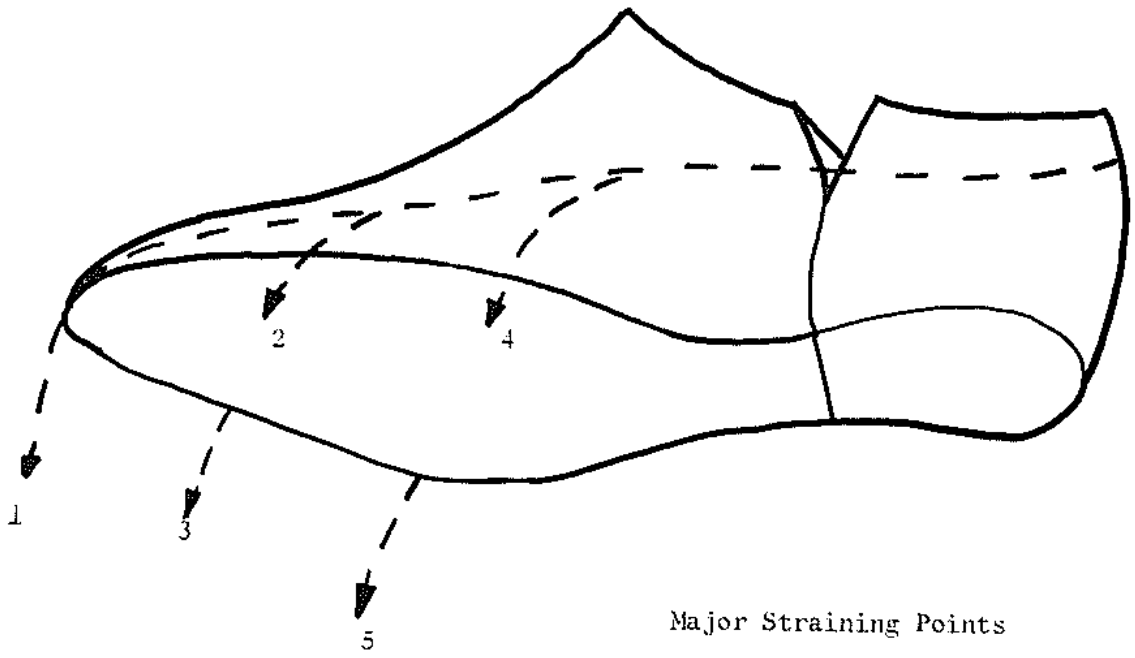
New Balance - EX1016

This rapid, frequent use of lasts is known as "last-turn-round". It is essential that each work ticket has its full quota of uppers and components all of the correct style, size and fitting so that the ticket of work can be completed in the correct sequence. Any shortages may cause serious delays in the making room processes.

Lasting

Lasting is the term applied to the processes involved in stretching the upper material over the last and securing it to the bottom of the insole either with tacks or with adhesive. Providing that the operations are carried out in the correct way, the upper will conform itself to the contours of the last and, when the last is removed, retain this shape.

The areas of the last which present the greatest difficulties in lasting are those in which major shape changes occur. To achieve shape retention it is essential to apply strains at certain major points. The diagram below illustrates these major straining points and the direction of each strain. These directions of strain are known as "drafting lines".



Major Straining Points

The amount of strain applied must be suitable for the material and design to achieve the best shape retention throughout the life of the shoe.

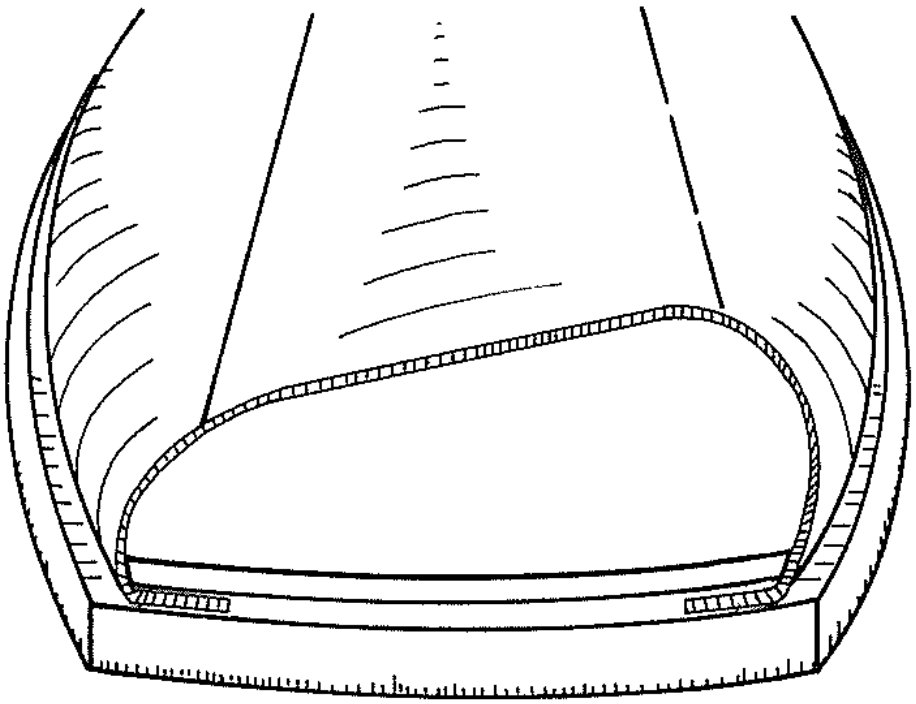
Shoes must be lasted in pairs so that the design of the uppers is correctly matched. The back height (the height of the back seam) must be correct to specification. A high back height will rub the wearer's heel, a low back height will make the shoe too loose.

If the initial stretch is not taken out of the upper, the topline will remain loose, giving a poorly fitting shoe. Thus, it is essential that the topline is pulled taut to maintain a correct fit. As the outside ankle bone is lower than the inside one, it is also critical that correct "topline" balance is achieved. "Topline Balance" means that the outside quarter is 3mm (1/8") lower than the inside quarter where the topline fits under the ankle bones.

Attaching

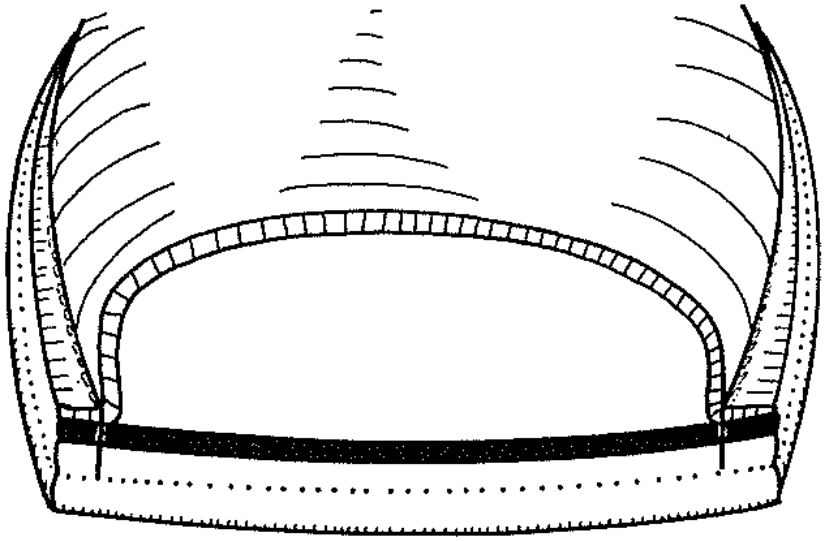
Soles are attached to most footwear today by means of thread and/or adhesive. Some of the methods using adhesive simply attach the sole by applied pressure while others use direct moulding techniques. It will be shown also that one technique of moulding (polyurethane) requires no adhesive in order to attach the sole.

Direct attachment as the term suggests means that the sole is attached directly to the shoe bottom. Alternatively, "indirect attachment" means that there is a layer of material between the shoe bottom and the sole. Indirect methods of attachment are easier to repair than the direct methods.



Direct Attachment

New Balance - EX1016



Indirect Attachment

METHODS OF CONSTRUCTION

As mentioned earlier in this chapter, the way in which the shoe is made is known generally in the trade as the "Method of Construction". In some cases the method of lasting will be the factor controlling the description while in others the sole attachment technique will decide.

An attempt is made below to explain some of these terms, and to state briefly how each type is made.

1. Direct Stuck Construction (Cemented)

This method, evolved in the years preceding the second World War, consisted originally of tack-lasting the upper under the insole ("in-lasting") and attaching the sole with adhesive to the bottom of the shoe.

The tacks used for lasting were left permanently in the shoe, having been clinted over on the metal plate fitted to the bottom of the last. Temporary tacks or staples used to hold the insole in position during lasting were removed before sole attaching. However, the points of lasting tacks and any temporary tacks accidentally left in could cause injury to the customer's foot. Thus, shoemakers and machinery manu-

New Balance - EX1016

facturers worked towards eliminating the use of tacks or staples. The result of many years work is that today many shoes are completely cement-lasted and the sole is attached by cement, so the term "Direct Stuck or Cemented Construction" is now a more realistic term. This construction has also largely replaced the older machine-sewn construction.

2. Moulded Constructions

(a) Direct Vulcanised

The direct vulcanisation of rubber soles on to the bottom of tack-lasted shoes and boots was developed in the late 1940's. The method originated from Spain having been invented by Senor Mediano under the term C.E.M.A. (Construidores Espanoles Maquinas Automaticas - Spanish Automatic Machine Construction). This method was used widely for school, warm-lined and agricultural footwear until the late 1960's - early 1970's, but was largely superseded by the injection moulding of P.V.C. Tack lasting was gradually replaced by cement lasting.

(b) Injection Moulded P.V.C. (Poly Vinyl Chloride)

This method, introduced into the trade around 1963, involves the direct injection of molten P.V.C. on to the bottom of the shoe. As mentioned above, it has largely taken the place of direct vulcanising.

(c) Injection Moulded P.U. (Polyurethane)

The most recent method of direct moulding, developed in the late 1960's, has had a considerable impact on the trade as it is the first method which dispenses with the need for a coat of adhesive on the shoe bottom. Polyurethane is extremely self-adhesive. It is also known to have better wearing qualities than any other soling material of comparable density. It will be shown later that this is an outstanding example of the introduction of a chemical process into the industry.

3. Veldtschoen Construction

The name of this construction stems from the Dutch Veldskoen (field shoe). It is interesting to note that it was much used by the Boer settlers in South Africa but the method has been known for many centuries.

The modern Veldtschoen method is the only one where the upper material is flanged outwards during the lasting process and attached by adhesive and stitching to a layer of material known as the runner or middle. This runner replaces the insole used in other methods. The sole is attached by adhesion. Veldtschoen is also often known as "Stitched-down Construction".

The veldtschoen method is still strongly recommended for shoes which are to be guaranteed waterproof,

New Balance - EX1016

4. Machine Welted Construction

The traditional method of shoemaking, the welted process, has lost some of its popularity in recent years but is still used for the manufacture of high quality expensive footwear. It is expensive because of the high labour content in producing footwear using this method. Further the use of all leather uppers, soles and heels adds to the total cost.

A special insole having a rib or wall is used. The upper is in-lasted to this rib by means of wires and staples or more recently by adhesion. A strip of leather, the welt, is sewn to the upper and rib by means of a chain stitch. The welt, having been beaten flat, then has the sole attached to it by adhesion and lock-stitching.

5. Californian Slip-lasted (Force Lasted) Construction

This is the modern development of a centuries-old system of slipper-making being utilised today for footwear where comfort is the main criterion.

The essential factor to be noted about slip-lasted work is the way in which the upper is constructed in the closing room. This is done in the following manner. A sock, a strip of material (known as the platform cover) and the upper are stitched together around the feather edge. This is commonly known as sock and platform stitching, the result being an upper which is partially shaped before lasting. When the upper reaches the Making Room the last is 'forced' or 'slipped' into the upper. Sock and platform stitching may be carried out around the forepart only or around the complete feather edge. Further operations to complete the process will be described at a later stage.

6. String Lasting

A method which has gained popularity in recent years, string lasting, replaces all lasting operations with a single operation. After normal closing operations have been completed a strong string is attached by means of an overlock stitch to the lasting edge of the upper. The lasting operation consists of fitting the upper to the last and drawing the string taut either by hand or by machine, then tying the ends.

Often this method is used in conjunction with Injection moulding, but it is possible to attach soles by the Direct Stuck method if so desired.

New Balance - EX1016

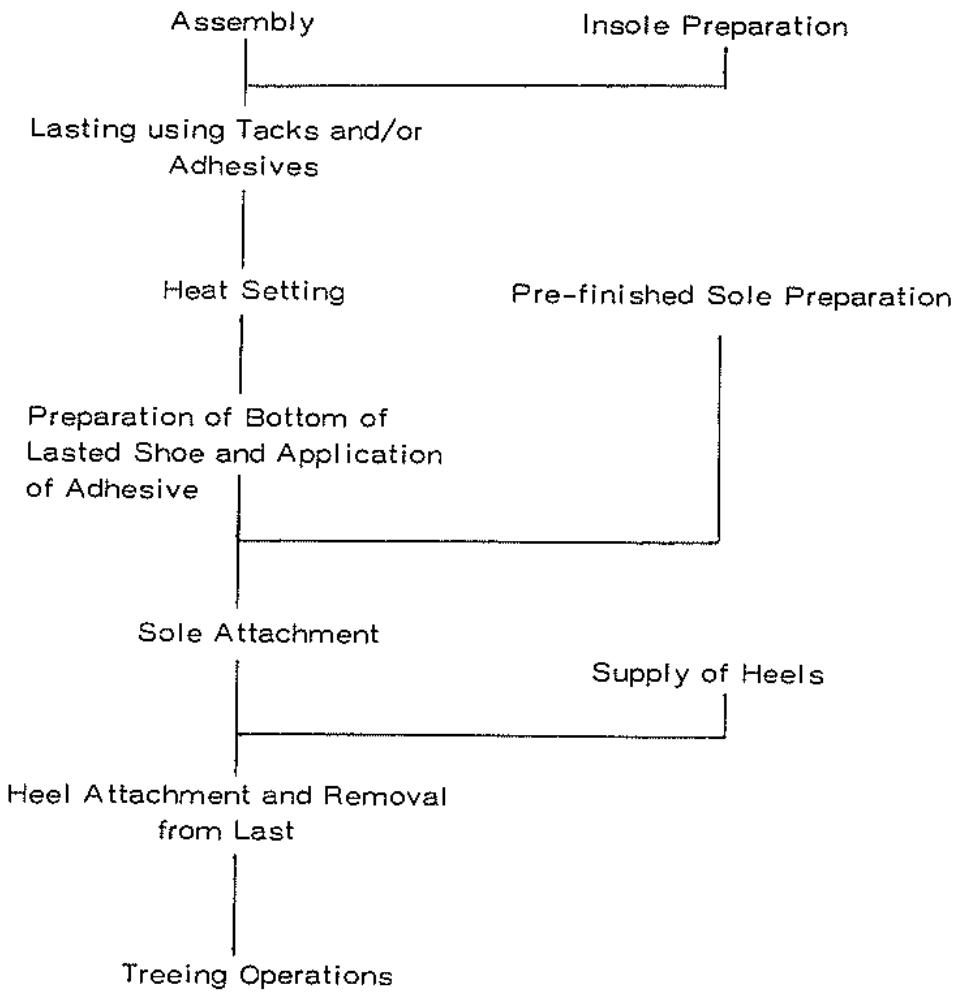
CHAPTER 13

FLOW CHARTS FOR METHODS OF CONSTRUCTION

Introduction

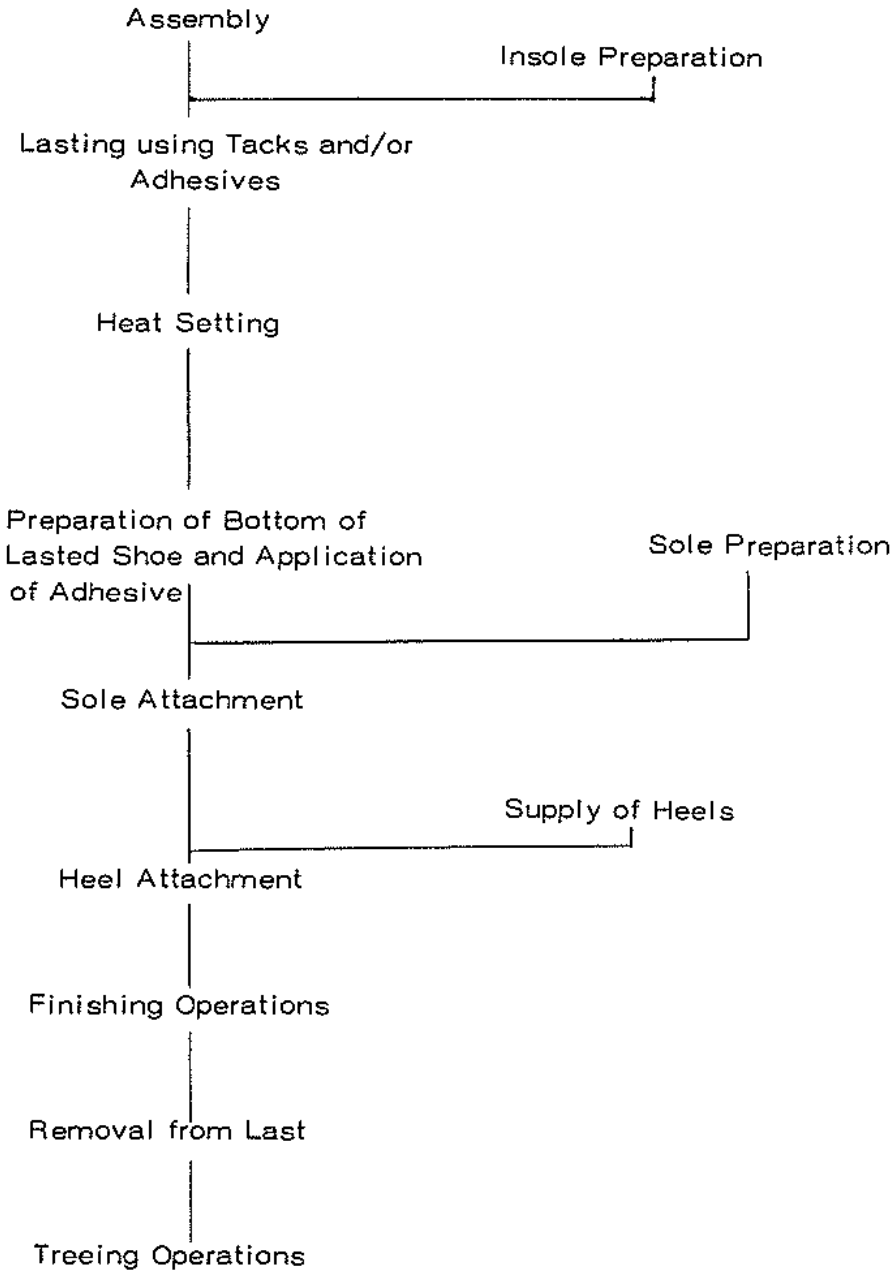
This chapter is intended to provide the student with a quick, easy reference to the basic sequence of operations required for each method of construction. A more detailed explanation of each process is contained in later chapters.

1. Cemented (Direct Stuck) Construction using Pre-finished Soles



New Balance - EX1016

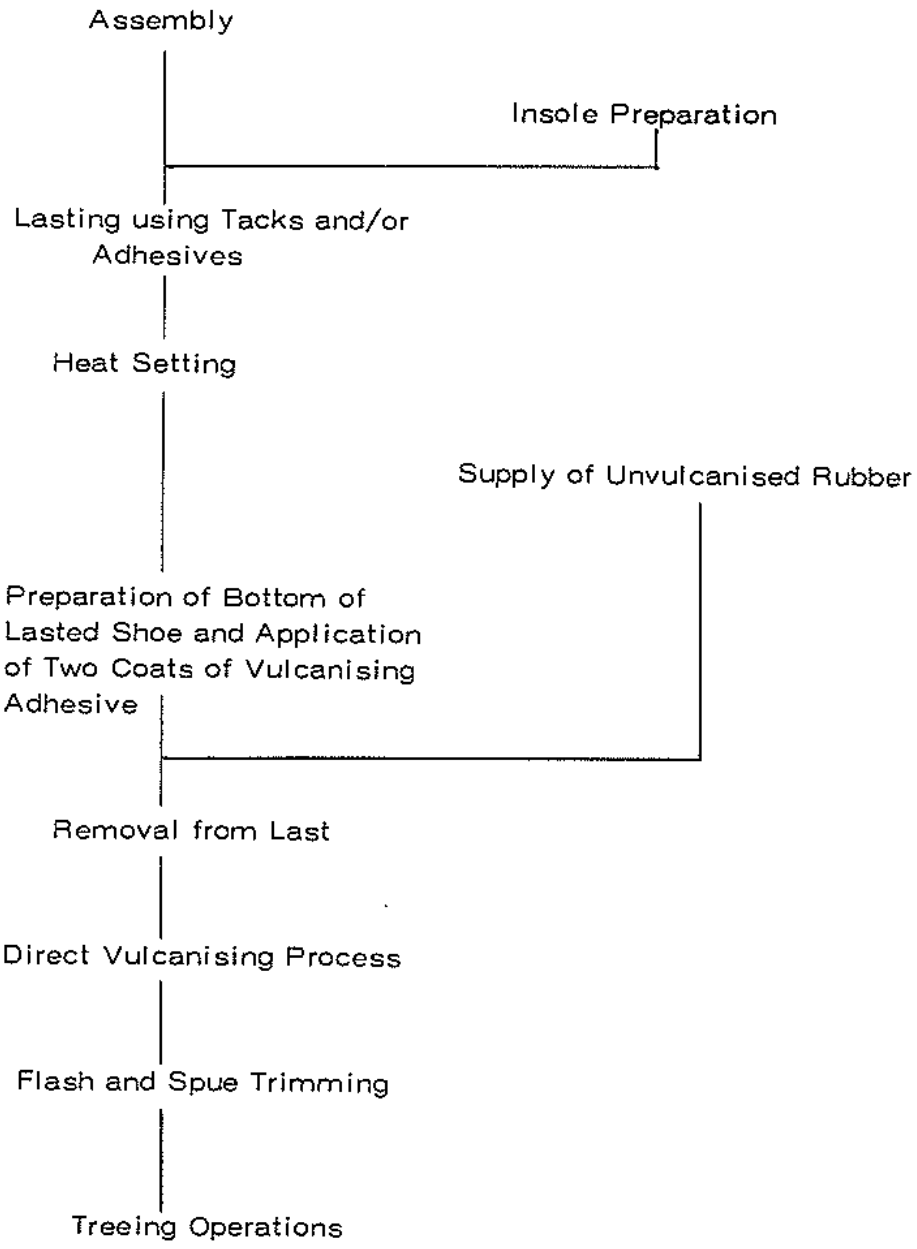
2. Cemented (Direct Stuck) Construction using Soles requiring Finishing on the Shoe



New Balance - EX1016

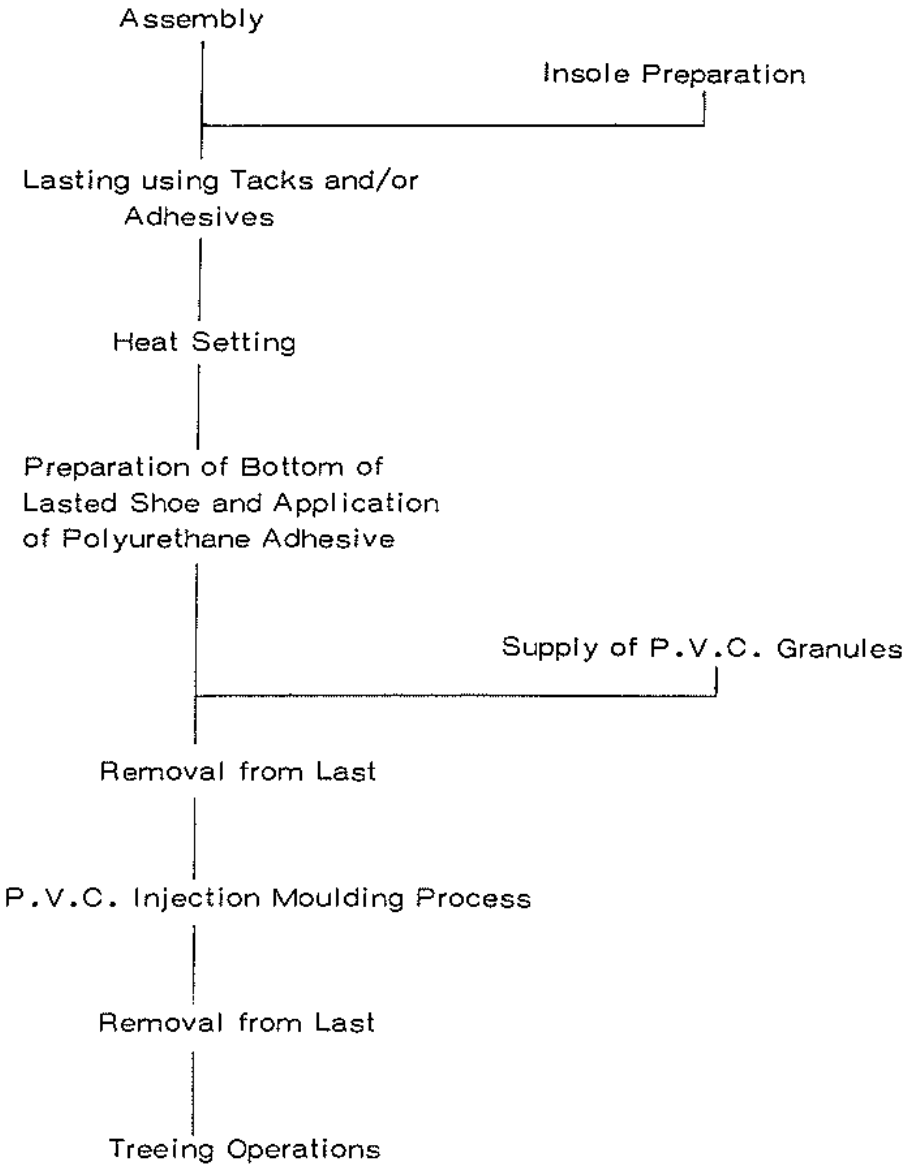
3. Moulded Constructions

(a) Direct Vulcanised



3. Moulded Constructions (Contd.)

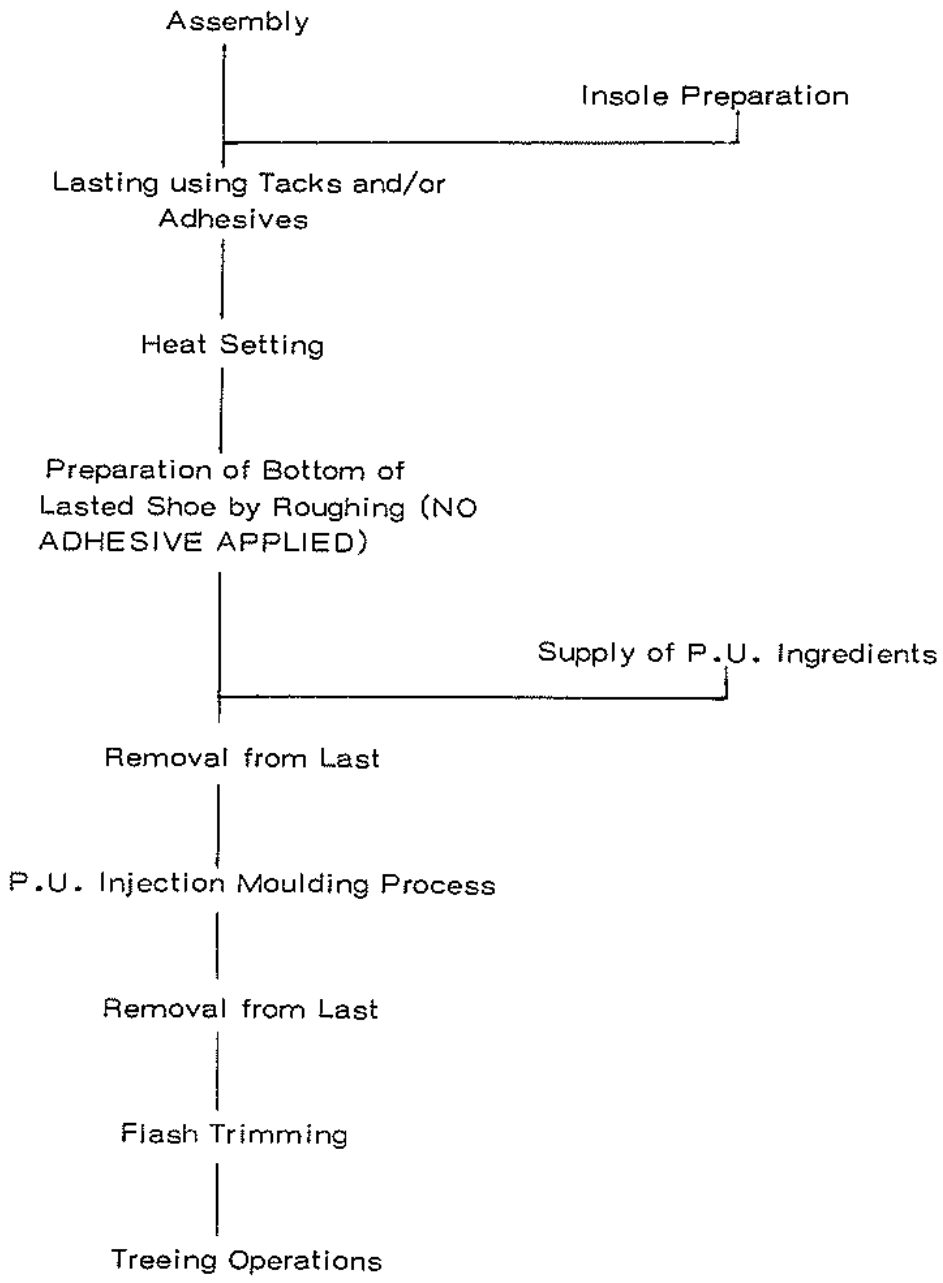
(b) Injection Moulded P.V.C. (Poly Vinyl Chloride)



New Balance - EX1016

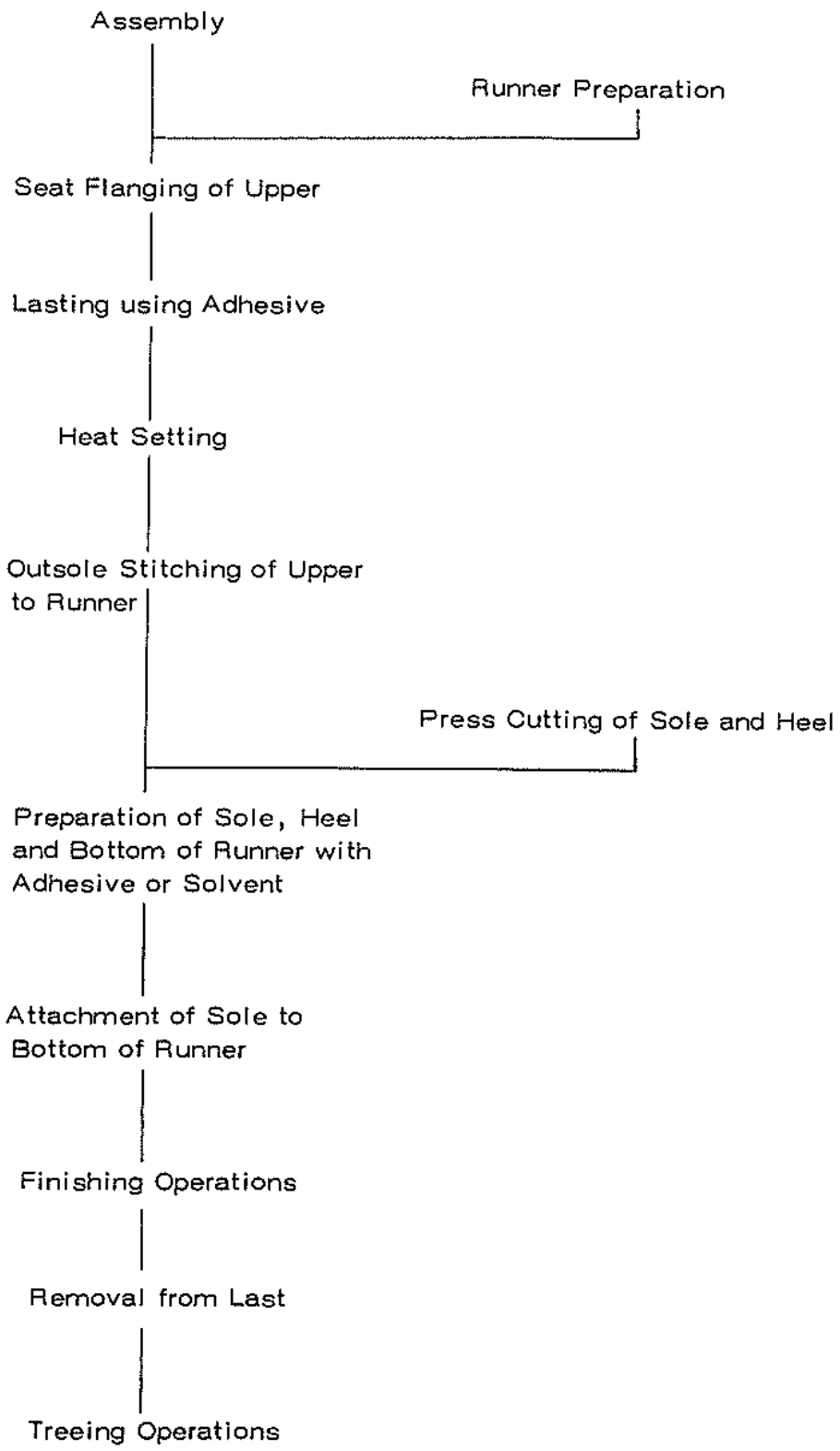
3. Moulded Constructions (Contd.)

(c) Injection Moulded P.U. (Polyurethane)

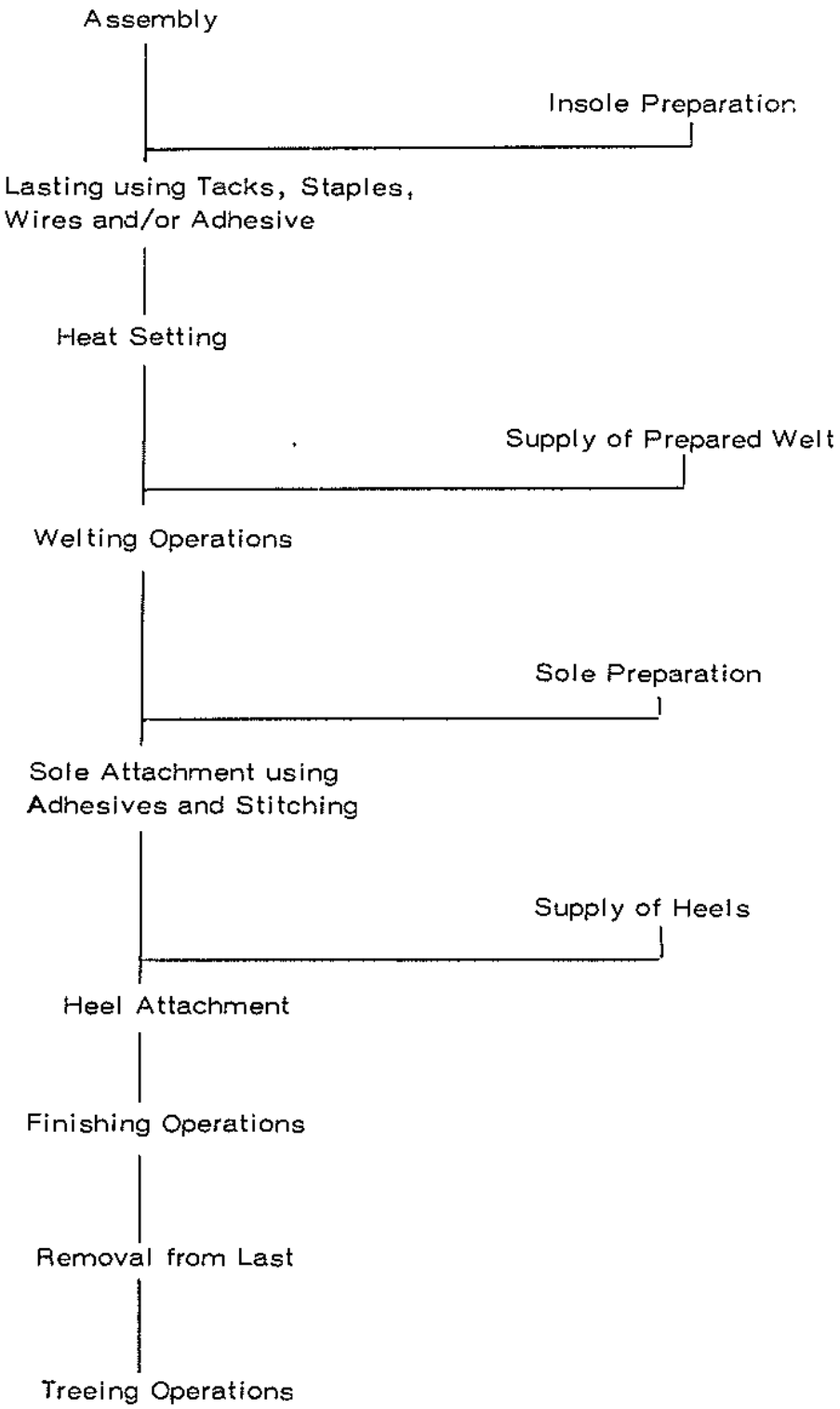


New Balance - EX1016

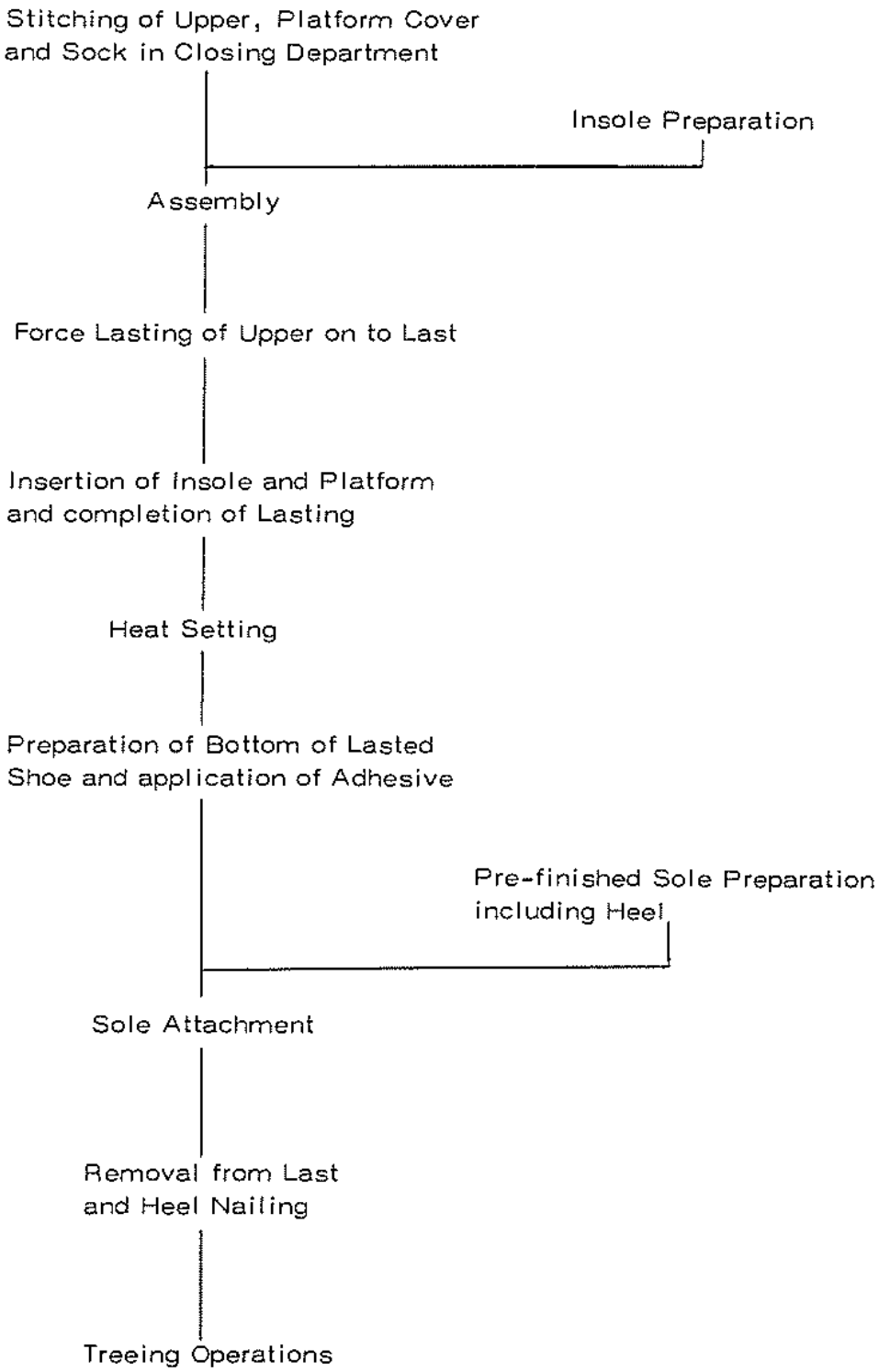
4. Veldtschoen Construction



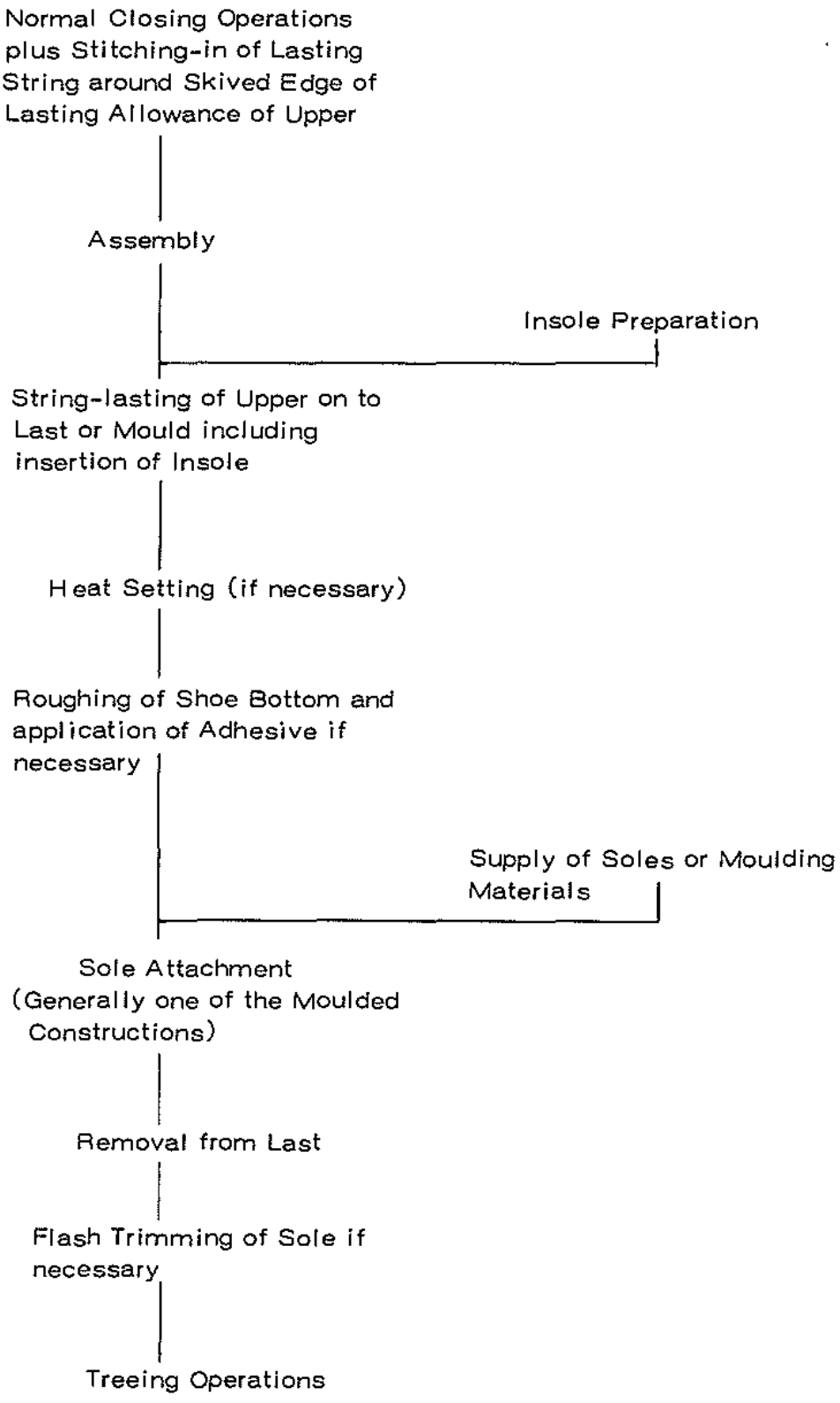
5. Machine Welted Construction



6. Slipiasted Construction



7. String Lasted Construction



CHAPTER 14

CONDITIONING OF UPPERS

(a) Before Lasting

(1) Brief History

(2) Current Methods

(b) Heat Setting

(1) Brief History

(2) Current Methods

(a) Conditioning of Uppers before Lasting

(1) Brief History

It has been known by shoemakers for many years that it is of great advantage to introduce moisture into an upper before attempting to last it.

Detergent and soapy mixtures have been on the market for some decades for this purpose. They are applied by sponge and are known generally as 'Wetting Solutions'.

However, to do this to each upper before lasting is time consuming and other methods have been introduced in order to speed up the process.

Some thirty years ago, a widespread method was the use of a 'mulling chamber' or 'atomising room'. This involved the use of a small closed room where the bundles of uppers were hung on numbered pegs. The relative humidity of the room was raised virtually to saturation level by the use of portable humidifiers or by sprays of water. These sprays broke up the water into extremely fine droplets so that a mist was formed in the room. The uppers received from the closing room were hung until needed for lasting.

Consequently, some uppers received more treatment than others as the work was not always put into or taken from the room in the correct order. Those that were made too wet could easily suffer from iron stains on the lining where contact was made with the plate on the last bottom. Leathers which were prone to water staining sometimes became badly marked in patches, where the uppers were bundled together.

New Balance - EX1016

(2) Current Methods

Rapid Conditioning Cabinet

This method has been used for some years and is still in use today particularly for leathers which are prone to grain cracking. The uppers are spaced out on rods fitted into the cabinet. A rapid stream of hot water vapour at 50°C is blown over the uppers, the cycle time being 15 - 30 minutes. It is essential that the uppers are lasted as soon as possible after being taken from the cabinet. This is because the moisture taken up quickly evaporates off into a warm factory atmosphere. Every upper is subjected to identical treatment and very consistent moisture gains are added. Further, as the whole upper is treated, the backpart of the shoe is in a better condition for backmoulding and seat lasting.

Contact Mulling

There are a number of machines on the market for this method. In using these machines, not only is the upper conditioned but also the thermoplastic toepuff is softened. This obviously gives a better toe shape. Where this type of puff is used with a different leather some manufacturers will use the rapid conditioning as well as contact mulling.

In general terms, synthetic uppers require only a dry heat to condition them for lasting. Where a synthetic has a fabric base there is some advantage in using moist heat. Leathers normally require moist heat so the machines can be pre-set to give either of these conditions.

The uppers are placed normally singly into the machine. Dry heat or moist heat is brought to bear on the vamp. Some machines have room for more than one upper so the operator places them in position in the necessary order. These machines work on a pre-set time dwell.

Toe Steamers

A variety of steamers is available. These consist of a grid rest on which the uppers are placed generally in one or two pairs. Water is heated by an immersion heater type element with the result that a concentrated moist heat envelops the vamp.

(b) Heat Setting

(1) Brief History

Before the use of rapid conveyorised methods, the lasted upper often

New Balance - EX1016

stayed on the last for 2 - 3 days. Indeed in the welted process it was commonplace for this period to extend to a week. These systems involved a great deal of work in process and large last plants to accommodate them.

The development of new techniques meant that shoes had to be treated after lasting to ensure a rapid setting of the upper to the last shape and good shape retention in wear.

It is interesting to note that some of the old techniques of forced drying were, in fact, forms of heat setting even though they were unscientific in the approach to the problem.

Leather uppers when changed from the flat skin into a three-dimensional state by lasting would, if left long enough, naturally assume the new shape and retain it. This was because of the inherent properties of leather.

Modern techniques have all sought to accelerate and improve this setting and shape retention.

Current Methods

The development of heat setting techniques has been in three main stages.

All work on a system of progressing the lasted shoes through a cabinet to achieve the necessary 'set' and shape retention.

Where the systems have differed is in the way in which the heat is used.

(a) Infra Red

The early heat setters used only infra red heated elements. The lasted shoes were passed by a conveyor system through the cabinet. The basic disadvantage was that this form of heat was very directional and certain parts of the shoe did not receive as much heat treatment as others.

(b) Stress Relaxation

SATRA in co-operation with machinery and footwear manufacturers did a great deal of research into heat setting problems. The result of this work was the H.V.A. (high velocity air) type of heat setter.

New Balance - EX1016

The principle on which this works is that the upper has been subjected to a variety of strains and pulls in lasting which set up stress in the material. To get the material to lay down 'tight-to-wood', it would be an advantage to relax these stresses.

So H.V.A. setters were introduced which set out to do this. The shoes pass through hot moist air in the first section, this serving to relax the material down to the last. Secondly, they pass through a hot, dry air section. This removes the moisture and sets the shoe more accurately to its new shape. In both parts of the cabinet all round heating is ensured by high velocity air currents being blown over all parts of the shoe.

Typical heat setters in this category are:-

(1) Cox & Wright Rotary H.V.A. heat setter

(2) B.U. No. 6 H.V.A.



B.U. No. 6 Humid H.V.A. Heat Setter

(c) Dry Heat Setting for Synthetics

It has been found in recent years that dry heat setting is advantageous for synthetic materials.

Two main types have been developed for this purpose.

They are:-

(1) B.U. No. 7 H.V.A. (Dry hot air only)

(2) Cox & Wright)
or) Catalytic (infra red) heat setters
(3) Salient Engineering)

In general, leather uppers are heat set at 120° - 130°C but synthetic materials are set at 140°C or over.

New Balance - EX1016

CHAPTER 15

CEMENTED CONSTRUCTION (DIRECT STUCK)

In recent years there have been many developments in machinery used for lasting in the cemented construction. The result has been that cemented lasting has been considerably simplified. Many firms now completely last the shoe in three stages. There are many systems available, this being of great advantage to the footwear manufacturer as he can select a system which is suitable for his particular product. Factors such as heel height, waist curvature, whether it is lasting for men's, women's or children's work will all have a considerable effect on the manufacturer's choice of system.

This chapter will describe the major operations and how they can be utilised within these various sytems.

Upper and Insole Cementing

Cement is applied to the lasting edge of the upper and to the insole before lasting. The cements used are generally neoprenes applied by roller-type machines. Where hot-melt adhesives are being injected during the lasting operations this cementing operation is unnecessary.

Insert Stiffeners

A flat or semi-moulded stiffener of the type described in the section on stiffeners is usually employed, i.e. fibre-board or fabric-based material coated or impregnated with thermoplastic resins.

The stiffener is inserted between the upper and lining in the heel area. Alternatively, the stiffener may be stitched into position in the upper.

Back Moulding and Seat Lasting

This operation may be carried out either on or off the last. Essentially, the uppers are pre-heated to soften the thermoplastic coating of the stiffener, the quarters are moulded to shape and the seat is lasted to the insole, which has also been pre-heated. Off-the-last back moulding requires the use of expensive, precision-made moulds in sufficient sizes to meet a particular size range. Some of the machines on the market use holt melt injection so the insoles and uppers are not pre-cemented. Also some machines have left and right operating heads whereas some have one head which can be alternated for left and right feet uppers.

The basic steps of the operating cycle for one upper are as follows:-

The upper is placed into the pre-heater for a pre-set time at a pre-determined temperature. If hot melt is not being used the insole is also pre-heated. The upper is taken from the pre-heater and placed on to the mould where the

New Balance - EX1016

vamp is clamped into position. The upper must be correctly balanced for back height and seam positions. Heel to toe tension is imparted into the upper by means of the clamp (known as the drafting unit). The insole is positioned on one or two locating pins on the mould. The complete assembly then moves up into an inflatable seat band. On being inflated the band holds the upper under pressure while a pair of heated wiper plates move inwards so causing the lasting allowance to be stuck down firmly to the seat of the insole. After a pre-set time dwell the plates release and the complete unit moves back to the start position where the upper can be removed.

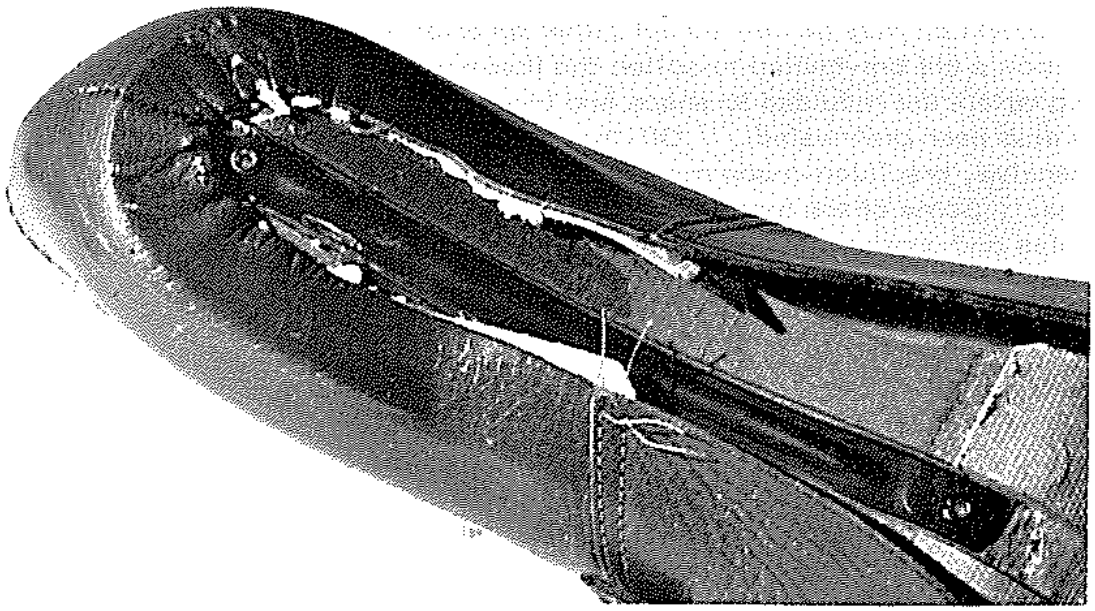
The moulds are chilled to 0°C in order to ensure rapid set-back of the stiffener material.

Alternatively, the operation may be carried out on the making last so dispensing with the expensive moulds previously mentioned. In this case hot melt is also normally used, the insole being tacked on to the last before the operation.

The correct result must be:-

(1) Back height correct
(2) Back seam central, upright and straight
(3) Well moulded seat and quarters
(4) No creases at feather edge
(5) Linings cleared, well stuck down and not marked
(6) Lasting allowance well stuck down
(7) Quarters not marked
(8) Top lines correctly balanced

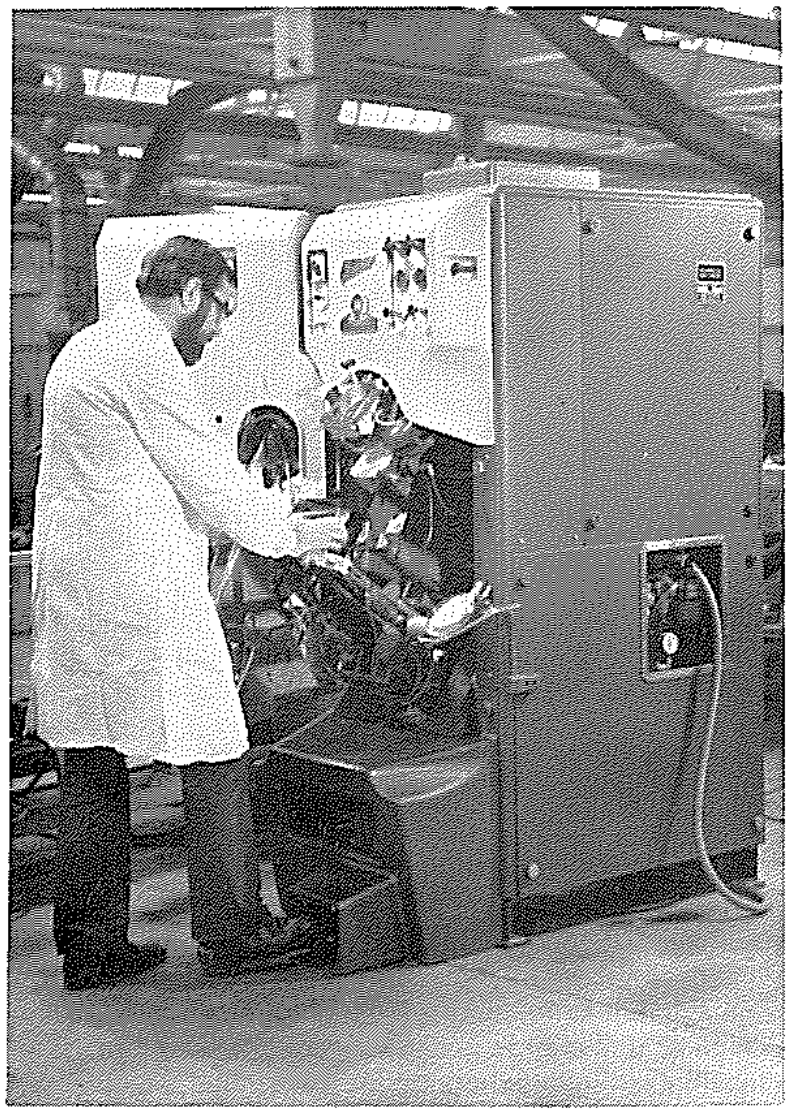
N.B. Some manufacturers prefer to only back mould the upper at this stage without using seat lasting. The seat lasting is then completed at a later point in the lasting system.



Backmoulding/Seat lasting completed

New Balance - EX1016

Typical suppliers of back moulding and seat lasting machinery are B.U.S.M.C. Ltd. and C.I.C/Ralphs Ltd.



C.I.C. Ralphs Ltd. Combination Backmoulding and Seat Lasting Machine No. 522

Insert Last and Tack-On Sole

The last is inserted into the partly lasted upper so that the insole can be accurately positioned to the feather edge and tacked on with one tack in the toe area. Where difficulty has been experienced with inserting the last into a lace-up design the shoes are not laced in the Closing Room but are secured with a plastic lace clip.

Forepart Lasting

Forepart lasting machines were first introduced to the trade in this country during the mid 1950's. This was one of the major instances where a new machine was designed to incorporate more than one operation. Since then this has been one of the areas of greatest development in lasting.

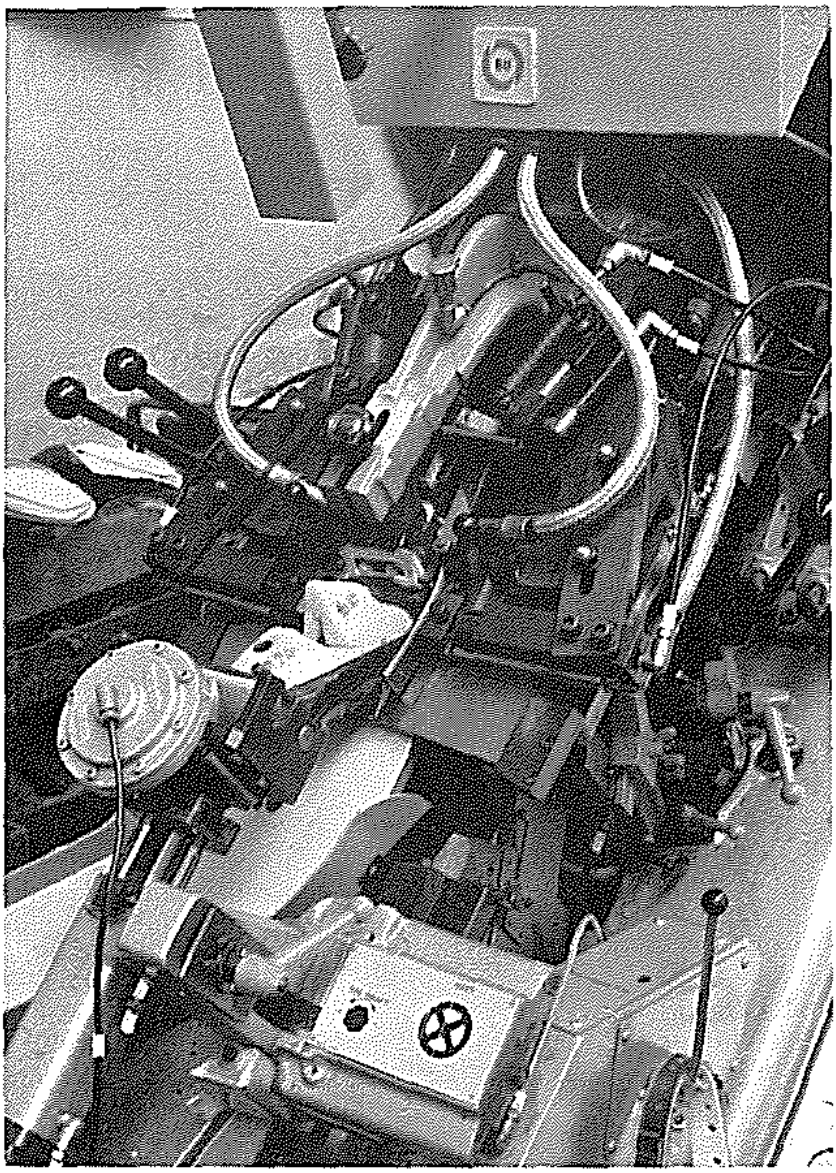
Today, forepart lasting machines have sophisticated systems which allow the operator to carry out adjustments by the turn of a knob, the pull of a lever or by operating a switch. However, the operator still has to use a degree of skill in accurate positioning of the upper into the machine. Providing this is done correctly and the machine is properly adjusted, then the machine carries out the rest of the operation. The upper and insole may be pre-cemented; alternatively, a hot melt system can be built into a number of machines.

The essential steps in the operating cycle are:-

After conditioning, the upper is initially stretched over the toe of the last in a device known as bench pincers. The upper is then placed into the machine so that the lasting allowance can be gripped by a series of machine pincers. The insole and last are supported on a last support and insole stabiliser. As the pincers grip and pull the upper, the last and insole are pushed at a controlled rate into the upper. The result is that the upper is correctly drafted into position over the last. A Teflon-coated toe band then engages around the toe area holding the upper securely against the last just above the feather edge. Following this stage, heated metal wiper plates or blades move inwards in a horizontal plane under the bottom of the forepart so wiping the upper material against the insole and sticking it down securely. Careful timing of the machine causes the pincers to release fractionally before the final wiping action of the plates. A final downwards pressure known as the "bedding pressure" ensures that the lasting allowance is pressed flat to the insole. After a pre-set time dwell the forepart-lasted shoe is automatically released from the machine.

Typical suppliers of forepart lasting machines are B.U.S.M.C. Ltd., ASTRA and International Shoe Machinery Co. Ltd.

New Balance - EX1016

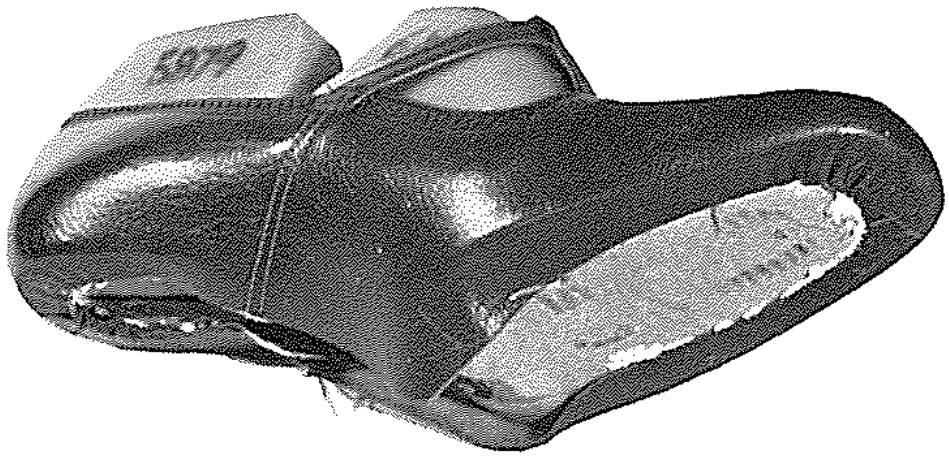


Forepart lasting (B.U. No. 4A)

The correct result of this operation must be:-

(1) Vamps firm and tight to wood
(2) Uppers matching as pairs
(3) Toplines tight and correctly balanced
(4) Toe shape correct to last
(5) No creases at feather edge
(6) Even lasting allowance and flat to insole
(7) Upper securely stuck to insole
(8) Correct vamp depths
(9) Tabs or fronts square

N.B. Some of the early forepart lasting machines had left and right operating heads. Most of the modern machines have a single head which can be used for both left and right feet.



Forepart lasting completed

New Balance - EX1016

Waist Lasting (Side Lasting)

The waist may be lasted by one of a number of methods.

(a) Hand Method

With pre-cemented insoles and uppers the cement can be activated, the upper pulled in by hand pincers and hammered down.

(b) "Kamborian" Cement Side Lasting

Named after one of the early types of cement side lasting machines. The upper is gripped by twin rollers which turn it down to the waist while a further roller, (known as the "sleeking roll"), parallel to the insole, secures the upper to the insole waist. Pre-cemented work may be used; alternatively, a machine having hot melt extrusion is commonly used. A variety of machines employ very similar techniques to that described although they are supplied by different manufacturers.

(c) Automatic Side Lasting

In recent years we have seen the development of "2 machine" lasting systems, comprising usually a forepart lasting machine plus a combination seat-lasting/waist-lasting machine. In this case, the waist or side lasting is carried out automatically by a pair of tapered rollers working simultaneously, while the shoe is held for seat lasting. At the time of going to press, these machines are undergoing constant improvements, modifications, etc. The logical aim of all the research being carried out currently would seem to be the one-machine lasting system or even the one-machine lasting and attaching system.

(d) "Consol" Side Lasting

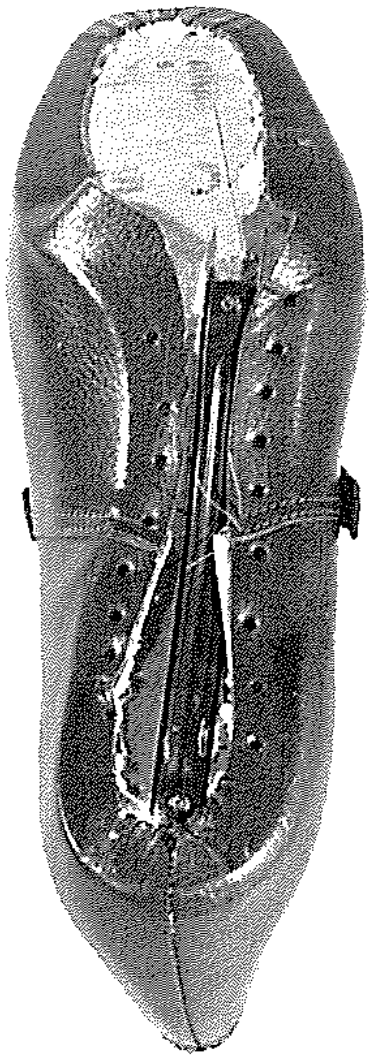
Some manufacturers still prefer to use tacks in the waist, particularly for high-heeled work or for heavy materials. Tacking also prevents insole delamination which is a danger with cement side-lasting techniques. The major machine used for this operation is the B.U.S.M.C. "Consolidated Hand Method Lasting Machine" commonly known as the "Consol".

A pair of angled pincers which can be adjusted for strength and direction of pull, grip the lasting allowance in the waist and pull it inwards over the insole against pressure exerted by the operator. A carrier block, pre-fed with a single tack, wipes forward and holds the upper down firmly on to the insole as the pincers release. An angled driver rod now drives downwards in a hole in the carrier block so striking the tack home through the upper into the insole. The point of the tack as it pierces the insole is clinted over on the metal last plate. A row of tacks is driven in along the waist of the shoe approximately 12mm ($\frac{1}{2}$") apart and 9.5mm (3/8") in from the feather edge.

N.B. When cement side lasting some manufacturers still prefer to add a few tacks by "Consol" or, alternatively, heavy duty staples may be used in one or two spots along the waist.

The correct result must be:-

(1) Upper tight to wood
(2) Upper bonded or tacked securely to insole
(3) Tacks correctly spaced
(4) Tacks correctly driven
(5) Topline correctly balanced



"Consol" waist lasting completed, but joints still not secure

New Balance - EX1016

The lasting should now be complete. However, on some styles of shoe there can be a small pocket not secured at joints. This can be stuck down with cement and using a pair of hand pincers. The shoe is now ready for heat setting (see previous chapter).

Because of the complexity of systems available on the market we have only described the general principles of cement lasting in the foregoing chapter. For details of specific systems reference should be made to the literature published by the machinery houses.

New Balance - EX1016

ATTACHING FOR CEMENTED CONSTRUCTION

The preparation of the shoe bottom and sole is highly critical if a good bond between sole and upper is to be obtained.

Due to the variety of upper and sole materials available today the method of preparation chosen will vary considerably. However, that method must be suitable for the upper, sole and adhesive system involved.

PREPARATION OF THE SHOE BOTTOM

The method chosen is dictated by the upper material involved,

e.g. Grain leather can be roughed using a wire brush or an abrasive roller.
Suede leather will be lightly roughed as above.
P.V.C. coated leather will be roughed.
P.V.C. coated fabric may be solvent-wiped or may be felt-wheeled.
Poromerics may be roughed or solvent-wiped.

Bottom Roughing

This operation involves the removal of the grain and finish from the complete area of lasting allowance by means of a wire brush or abrasive. The wire brush can be of crimped, single steel wires which may be bonded together in vulcanised rubber or unbonded and held together firmly by clamping plates to prevent the brush spreading in wear. Alternatively, the wires may be of twisted brass ("cable brush"). Where an abrasive is used it is usually garnet or aluminium oxide.

It is essential that a good feather line is determined so that the sole can be accurately bonded to the upper with little or no roughing visible. The operator must be able to judge the exact depth of roughing necessary for the type of material being roughed. This is a critical factor as it is essential that the operator should only remove the finish and grain so that short regular fibres are exposed. This presents an ideal surface for a good strong bond. It is usual for any pleats in the lasting allowance at the toe to be sanded flat on an abrasive roller before roughing the shoe bottom.

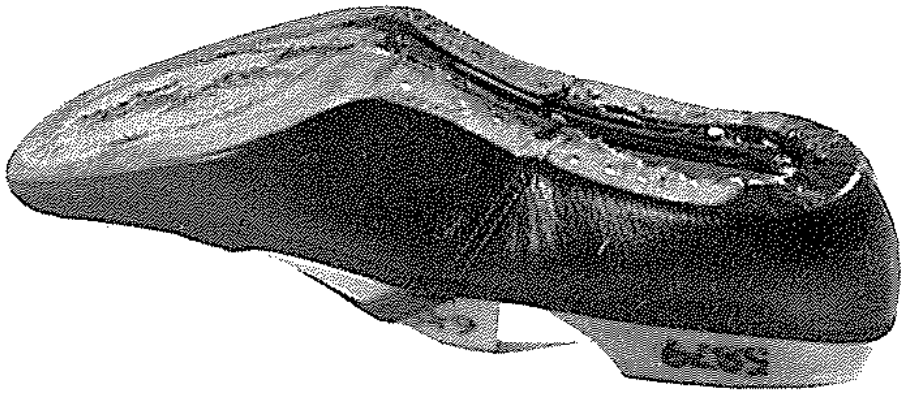
The correct result must be:-

(a) All grain surface removed over entire lasted margin.

(b) Roughing not to extend over feather edge.

(c) No excess roughing or damage to feather edge.

(d) No burnt areas (due to blunt brush or abrasive).



Bottom roughing completed

Solvent Wiping

Where roughing may damage the backing fabric on P.V.C. coated material the bonding area may be solvent wiped with M.E.K. (Methyl Ethyl Ketone). This effectively removes migrated plasticisers from the P.V.C. surface as well as other contaminants so enabling the adhesive to "key" to the surface.

Flat Wheeling

Alternatively, a rotating felt wheel may be used. The frictional effect causes a fine layer to be removed so giving a clean surface to be bonded.

Shank Attaching

As mentioned previously in "Insole Preparation for Cemented Construction" it is more common practice for the shank to be attached by rivets or eyelets at that stage. However, some manufacturers still prefer to attach the shank after bottom roughing. The available methods are the use of tacks, staples or hot-melt adhesive. The shank is attached to the insole backpart through the centre of the waist. Accurate positioning is essential so that the shank does not protrude over the joint line on which the ball of the foot pivots. Also there must be sufficient shank to fit under the heel or undue strain on the heel breast area can result with consequent fracturing of the insole at this point.

The correct result must be:-

(a) Correct shaped shank used.

(b) Shank correctly positioned.

(c) Shank securely attached.

N.B. The use of the Plastak insole, as previously described, is one of the developments which, in future, may remove the need of a shank.

Bottom Cementing

The two main types of adhesive used for bottom cementing today are neoprene rubber or polyurethane with the latter being the more important. A great variety of these two types is marketed by adhesive manufacturers, each variety being suitable for specific or general applications. The footwear manufacturer consequently has to carefully select the particular adhesive for the materials he is using.

The adhesive can be applied by hand brush, a pressure extrusion brush or by a roller type machine.

The preparation procedure must be thorough. Fresh cement of the correct viscosity and scrupulously clean equipment are both vitally important. With some types of material a primer coat of adhesive with a lower viscosity is used to give increased penetration into the fibre structure of the upper. The second coat of the correct viscosity is then applied.

It is essential that the cement be allowed to dry completely to evaporate all of the solvent content. If this is not done the adhesive layer may not reach the full bond strength which is intended for it.

Drying methods vary from drying on open racks to drying in heating cabinets or tunnels built over conveyors.

New Balance - EX1016

The correct result must be:-

(a) Even application of cement over the shoe bottom.

(b) No missed patches.

(c) No pools of cement.

(d) No cement over feather edge. (This may erase the leather finish, spoiling the appearance).

N.B. A development which appeared some years ago was a one-way stick system where thermoplastic resins were applied only to soles. The system is widely used in America; in this country, however, bond strengths were found to be rather unpredictable except on good quality full chrome uppers with leather or resin rubber soles. Consequently, it has not yet been accepted in the U.K. in any great degree.

Attach Filler

On the majority of direct stuck shoes a cavity remains within the perimeter of the lasted upper which needs to be filled to a level surface. This can be done by using pre-shaped fillers of felt, foam or scrap upper leather which are simply stuck to the insole using the bottom cement. In some cases, the filler may be stuck to the sole instead, or occasionally the sole is made with extra substance in its centre, thus obviating the need for a filler. It is important that the filler is of correct substance and size and is positioned correctly.

PREPARATION OF THE SOLE

The method chosen will be dictated by the soling material involved,
e.g. Resin rubber may be split, surface scoured or reduced.
Leather may be split or roughed by wire brush or needle roughing.
Other rubbers may be wire brush roughed specially primed or halogenated.
P.U. (Polyurethane) soles are solvent vapour degreased.
P.U. and P.V.C. soles are solvent wiped.

Splitting

The sole is passed through a splitting machine where a roller forces the material against a very sharp knife. This serves to reduce the sole to a level substance and with leather soles remove any unwanted loose fibre structure so that the cement will have a firm texture to which it can adhere.

Surface Scouring

Used mainly on resin rubber units, this treatment is carried out by passing the sole through a machine. A feed roll in the machine passed the sole under an abrasive roller and then beneath a brushing roll. This serves to scour off a pre-set amount of material so removing any mould skin and mould release agent which may be present.

Sole Edge Reducing

This has been dealt with in the section headed "Sole Preparation for Cemented (Stuck-on) Construction".

Wire Brush Roughing

Usually a brush of crimped single steel wires is used up to about 6 in. wide. The soles are roughed by hand and the result is similar to that achieved by surface scouring.

Needle Roughing

Applicable only to leather soles. Needle roughing consists of a rotating head made up of a series of saw-toothed washers placed side by side. The high speed of the head causes the needle-sharp points of the saw teeth to cut circular furrows in the material at very close intervals.

Priming

Some adhesive systems require special primers to be used. One outstanding recent development is the use of methyl acrylate primers where it is necessary to stick natural crepe soles direct to the bottom of shoes.

Previously, this was always considered to be a difficult bond to make but the use of these primers has made it much easier.

Halogenation

A technique which has been known to footwear chemists for many years but only brought into use in recent years. Halogenation consists of treating the rubber surface with a chlorine-based solution in a volatile solvent. This treatment has two main affects - it materially restores any brittle surface present which has occurred by oxidisation but also a chemical bond is promoted in addition to the normal physical bond.

Halogenation is a hazardous process due to the high risk of dermatitis, consequently the only protection is that afforded by nitrile rubber gloves. Also the fumes given off must be kept away from heat sources or toxic fumes may result.

New Balance - EX1016

However, providing adequate safety standards are observed, halogenation, when properly used, has great benefits in improving bond levels.

Solvent Vapour Degreasing

When P.U. soles are moulded a high level of silicone and greasy agents used as mould release remain on or near the surface. This has a serious effect as it completely in hibits the bond.

Solvent vapour degreasing (S.V.D.) is a technique whereby the soles are suspended in a cloud of vapour in a tank. The vapour is that given off by Genklene solvent (tri-chloroethane 1, 1, 1,) and this has the effect of extracting these greasy substances and evaporating them off from the surfaces of the unit. The solvent is then distilled so that a fresh cloud of vapour is always present.

Solvent Wiping

When P.V.C. materials are left in storage for any length of time, plasticisers, used in the manufacture of the P.V.C., migrate to the surface.

P.U. soles are often treated with dyes or other inks.

The presence of migrated plasticisers on P.V.C. or inks and dyes on P.U. can all seriously affect the bond.

Thus, the bonding surfaces are washed over with solvent (M.E.K. or mixed solvents) to remove these contaminants before cementing.

An important development which has come to light at the time of writing (see S.A.T.R.A. Bulletin January 1975) is that P.V.C. surfaces which are rough have better adhesion characteristics than smooth surfaces.

Sole Cementing

A description of sole cementing by machine has been given in the section headed Sole Preparation for Cemented (Stuck-on) Construction. It should be noted, however, that certain sole units cannot be passed through roller-type machines because of their contours and variations in substance.

These are cemented by use of a hand brush. The rules concerning drying apply in the same way as for shoe bottom cementing.

Heat Setting - may be carried out at this stage, if it was not done before roughing. The process is described in detail elsewhere in the book.

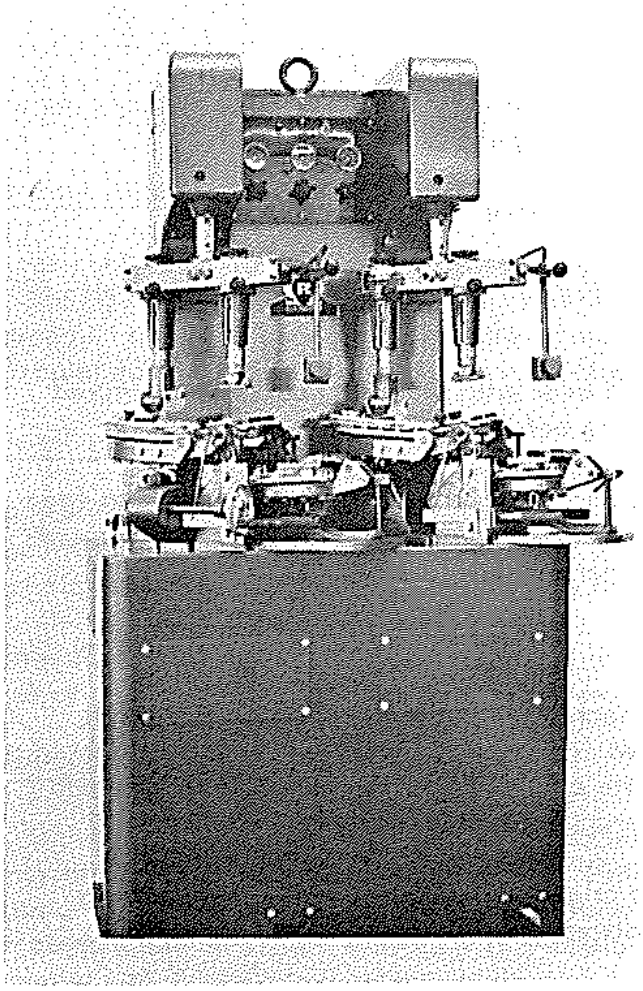
Sole Attaching (Sole Laying)

The dried films of cement on both upper and sole must be heat activated before the sole is pressed on to the shoe. This is often done by infra-red heat or, on

the the more recent models, by quartz-halogen lamps. A small number of heat activators have ceramic-covered elements. A recent development is the use of articulated elements which can be used to follow the contours of sole units with high heels.

The activators vary in their operation, some being controlled by the operator, while others are semi-automatic only requiring loading and unloading by the operator. Soles and shoes are heated at a pre-set temperature for a pre-determined time dwell. As they are taken from the activator the operator has to rapidly locate the sole on the shoe bottom. This calls for considerable skill on the part of the operator.

The shoe is then positioned in the sole laying press, clamped into position and held under pressure for a pre-set time dwell and at a pre-adjusted pressure.



C.I.C. Ralphs Ltd. Universal Sole Attaching Press No. 669A

Sole laying machines are mostly two-stationed, one left and one right foot. Some models, however, have only one station which suffices for both feet. Pneumatic or hydraulic pressure may be employed. With pneumatic the shoe is clamped into position and the air bag is inflated around the shoe bottom at a pressure of 4 - 5.5 bars (60 - 80 lb. per sq. in.) so conforming the sole to the bottom of the shoe.

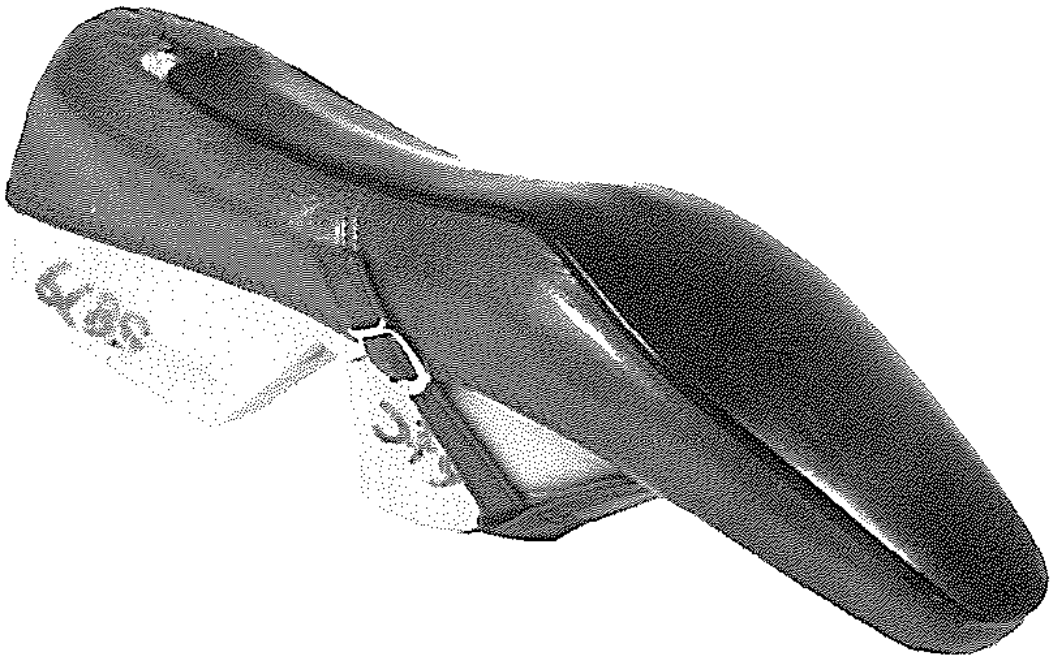
The hydraulic type has a pad made from solid rubber but operates on a similar principle. Pad boxes can be easily changed or adjusted when any major shape changes take place. Correct settings and pressures are important to achieving a good bond. The dwell time varies but is usually 12 - 15 seconds.

Because sole bonding is such a critical process, frequent checks are essential to ensure that good bonds are being obtained. It is advisable that sole bonding be laboratory checked once daily.

The correct result must be:-

(1) Sole correctly positioned on shoe.

(2) Sole securely stuck to specified standard.



Sole attaching completed

Last Slipping

When the shoe has cooled, the last is slipped from the shoe either manually or by machine. Care must be taken that the topline or seams are not damaged or broken.

Heel Attaching

The method normally used with the cemented construction is Inside Heel Attaching. The exception is on men's shoes carrying a built heel.

Heeling nails are automatically fed in a pre-set pattern into a nailing stand. The shoe is placed in an inverted position over the nailing stand and the heel is clamped into the correct position on the shoe seat by the first pressure on the machine treadle. A second pressure causes the nails to be driven through the insole and into the body of the heel. An average of 4 - 6 nails is used.

The correct result must be:-

(a) Heel positioned correctly to give an uninterrupted back curve.

(b) Front of heel square to sole.

(c) Correct toe spring and heel pitch.

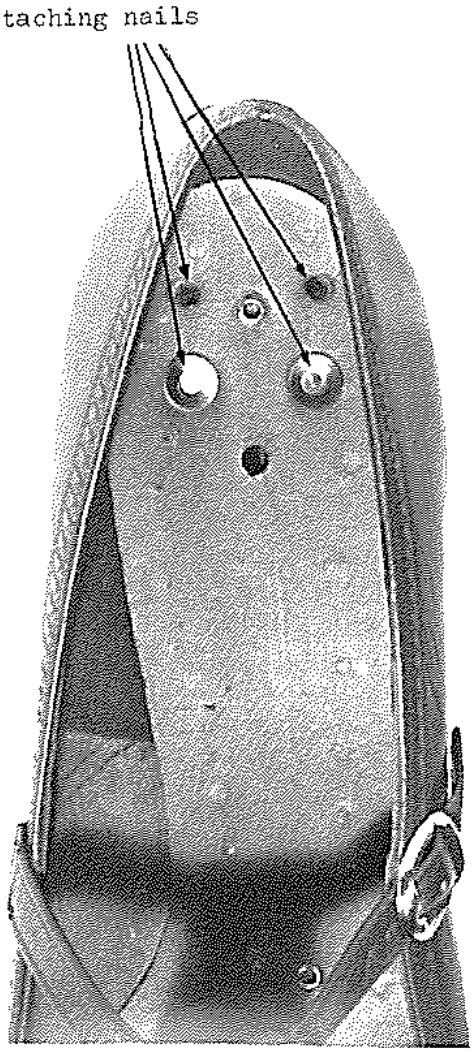
(d) Nails to be driven flush to insole.

(e) Correct number and pattern of nails.



Heel attaching completed (Covered Cuban Heel)

New Balance - EX1016



The shoes are now ready for the series of operations which come under the heading of Treeing or Shoe Room.

Summary

The cemented construction is now very widely used in footwear manufacture.

The outstanding advantages of the construction are:-

(1) Lightness in weight and greater flexibility due mainly to the absence of tacks requiring a heavy insole thus adding to the weight of the shoe.

(2) Economy due to the elimination of highly skilled operations and the machinery involved. This is mainly due to the advent of pre-finishing of soles. (See section headed "Preparation of Soles for the Cemented Construction").

(3) A reduction of operations speeds up the work flow and makes more economical use of the last plant.

The main disadvantages:-

(1) Cemented soles are difficult to repair because the shoe can easily lose shape when the sole is removed, making it difficult to prepare a good surface to attach a new sole. The light substance insole makes it impossible to stitch the sole to the upper.

(2) The light substance insole can cause difficulties in lasting, as it may easily roll back from the feather edge of the last. This causes a poorly-defined feather edge in the finished shoe and may breakdown in wear.

The widespread use of the Cemented Construction has, obviously, depended on the development of adhesives which are suitable for the variety of materials involved. Thus, it is essential that before any adhesive system is adopted, sufficient laboratory testing is carried out to prove that the proposed system is a suitable one.

New Balance - EX1016

CHAPTER 16

MOULDED CONSTRUCTIONS

The use of moulding techniques was known in the 1930's for low pressure vulcanisation of sponge soles on to slippers, but it was not until 1950 that the use of high pressure moulding became sufficiently developed to vulcanise solid rubber soles to footwear.

Since that time other developments in moulding have taken place so that we can see three clear stages in the use of moulding techniques.

1950 - C. & J. Clark introduced high pressure vulcanising into this country from Spain where it had been used by Senor Mediano. (See methods of construction in Introduction to Making).

1963 - Injection moulding of P.V.C. (poly vinyl chloride) was introduced into Clarks St. Peters factory at Radstock.

1966 - After several years of intensive development injection moulding of P.U. (Polyurethane) was officially launched on the market.

By this time direct vulcanisation had seriously declined as it had been superseded by P.V.C. Very few firms were using direct vulcanising by 1970 but it is still used for the production of solid rubber sole units, mainly, of course, by the component manufacturers.

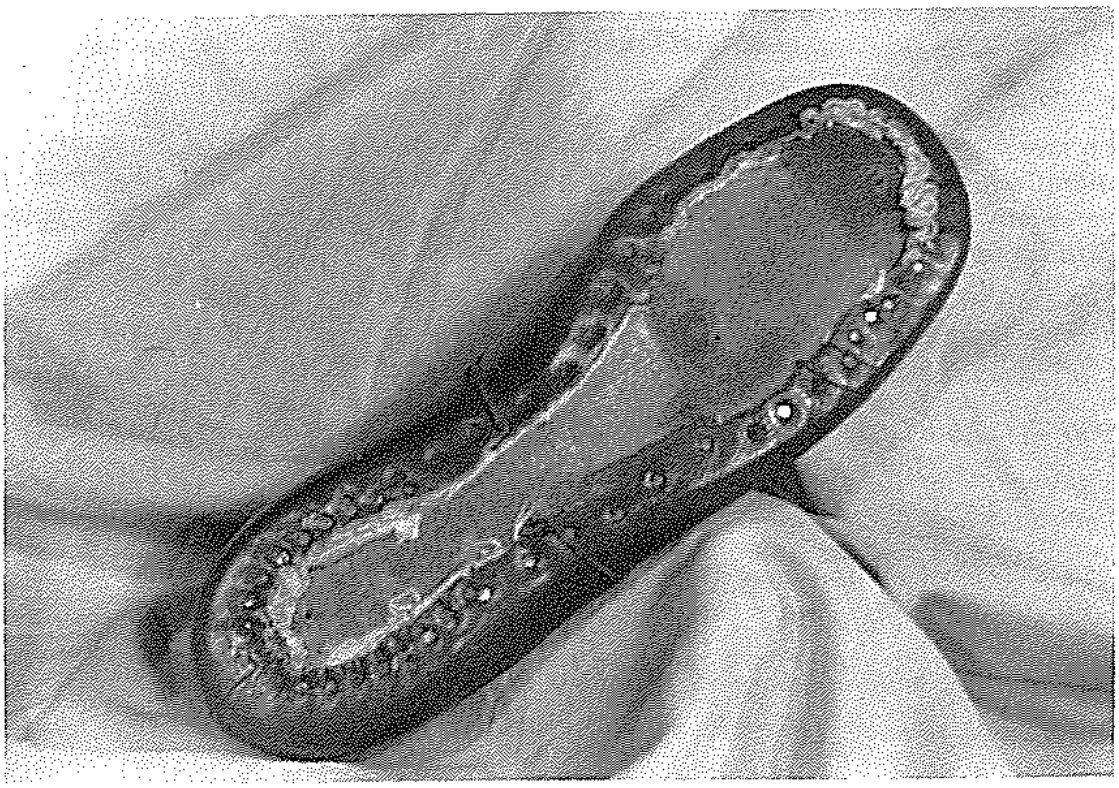
Lasting for Moulded Constructions

When vulcanising was first introduced cement lasting was also in its infancy. Latex was used to last foreparts, the remainder of the shoe being tack-lasted to the insole.

This method was unsuitable for vulcanising as the latex would not withstand the heat of the vulcanising machines. So it was necessary to revert to the older method of completely tack-lasting the shoe. It was several years before sufficiently good synthetic adhesives were developed which would withstand the necessary temperatures. When this occurred, tack-lasting was gradually phased out.

Today, lasting as described in the chapter on "Cemented Construction" is employed for all direct moulded work).

New Balance - EX1016



Fully tack lasted shoe

This is followed by heat setting (see chapter entitled "Conditioning of Uppers").

Direct Vulcanising

The name vulcanising is derived from Vulcan the Roman god of fire and metal working.

Indeed the process employs intense heat to achieve the curing of the rubber.

To produce a rubber which is solid enough to act as a soling material it is necessary to combine it with sulphur, which acts as a hardening agent, and to heat the mixture under pressure. This is the process of vulcanising. It can be used to produce sole or heel units or to weld the sole directly on to the shoe bottom, thus becoming direct vulcanising.

New Balance - EX1016

Fillers and pigments are added to colour the rubber and make the compound cheaper, plus accelerating agents to speed up the process time. This process time is known as the cure time. It will vary with the amount of rubber used and the mould temperature.

The early days of vulcanising brought many problems to light. C.I.C. Engineering Co. Ltd. was formed by C. & J. Clark to develop and manufacture the necessary machinery. Many engineering difficulties had to be solved, then when production of shoes by the new process was started material problems arose. Many upper leathers, insoles and stiffeners would not withstand the high machine temperatures. Moisture contents of these materials had to be strictly controlled because even a fairly low moisture content produced charring of the upper and insole. To overcome this, the upper leathers, insoles and stiffeners had to be wholly chrome tanned or have a high chrome content. Vegetable-tanned uppers and linings could not be used at all.

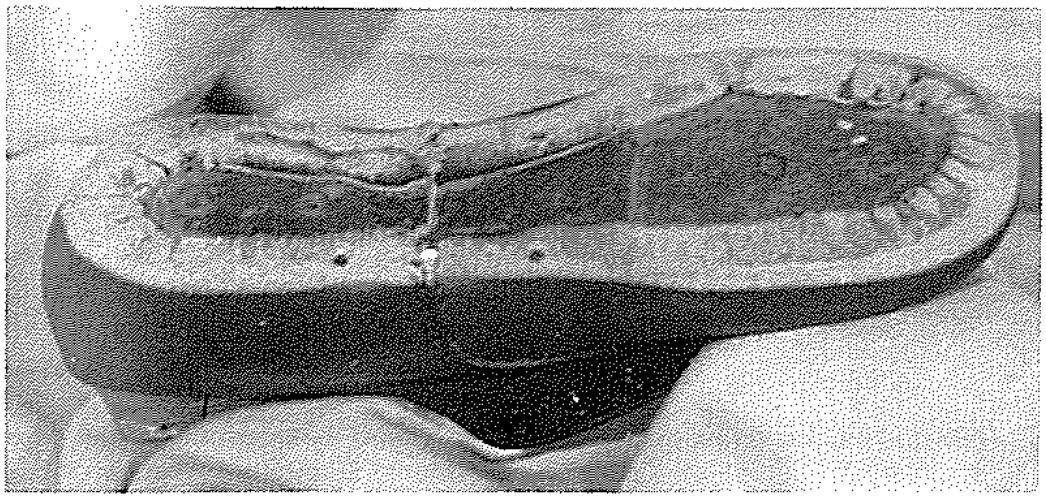
Bottom Preparation for Vulcanising

Upper Trimming and Sanding

On the first types of work it was normal practice to trim and sand away any surplus lasting allowance to produce a flat bottom. Later this was amended to only sanding away toe pleats.

Roughing

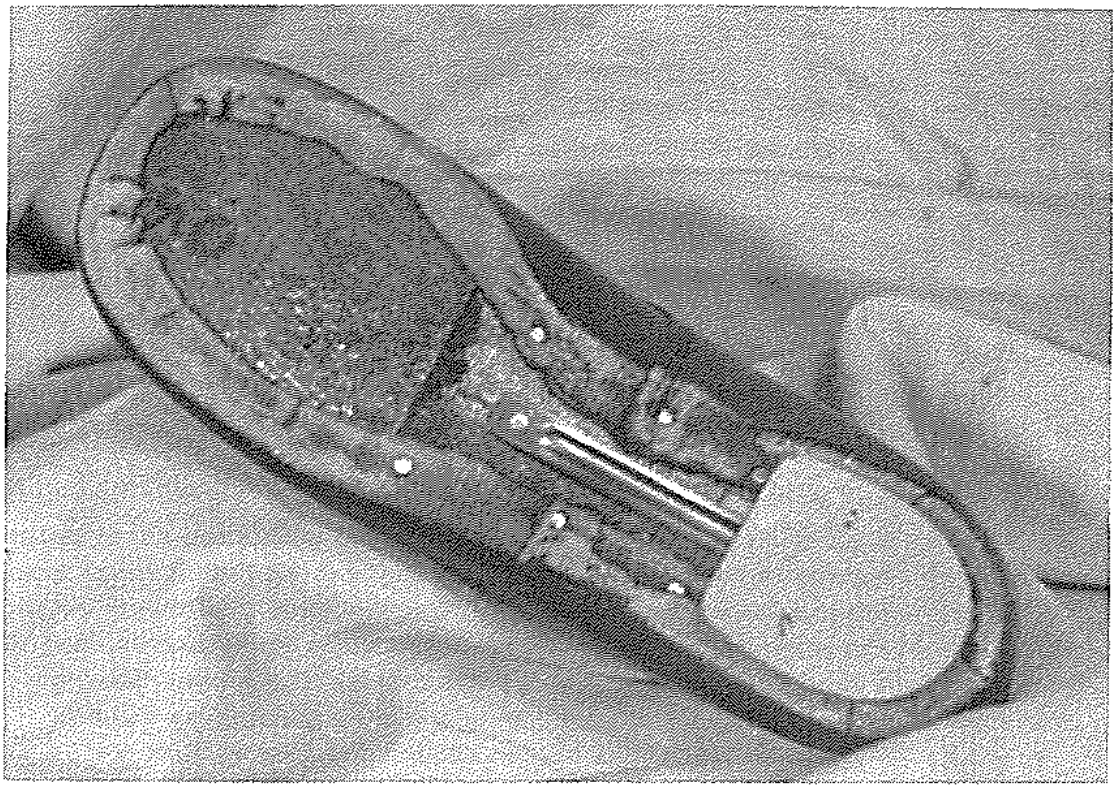
Roughing is as critical for vulcanising as for the cemented construction. The grain surface is removed in the same way except that it must extend over the feather edge of the shoe. This is necessary because the side moulds in the machine must grip around the sides of the shoe to form an absolute seal. If this is not a perfect seal, the rubber flowing inside the mould will be forced out over the side moulds by the high pressure. This spillage will harden around the feather line and is known as "spue".



Roughing for direct vulcanising

Attach Shank and Filler Block

The shank is attached securely in the correct position usually by tacks. A heel filler block made of balsa wood or layerboard is attached in the seat area by staples. The filler block is necessary to give an even substance of rubber over the shoe bottom. This gives an even cure through the sole and heel. It also reduces weight and expense.



Shank and Filler Block attached

New Balance - EX1016

The correct result must be:-

(a) Correct shaped shank used

(b) Shank correctly positioned

(c) Shank securely attached

(d) Correct size filler block

(e) Block correctly positioned

(f) Block securely attached

Cement 1st Way

A cement compounded from the same rubber mix as that used in the sole is applied to the shoe bottom. The first application acts as a primer and is applied liberally.

The correct result must be:-

An even application over the whole roughed area.

Cement Drying

The shoe passes through a drying cabinet where infra-red heaters and blowing fans evaporate the solvent from the adhesive.

Cement 2nd Way

A second coat of the same cement is applied but this is of a higher viscosity than the first coat.

Cement Drying

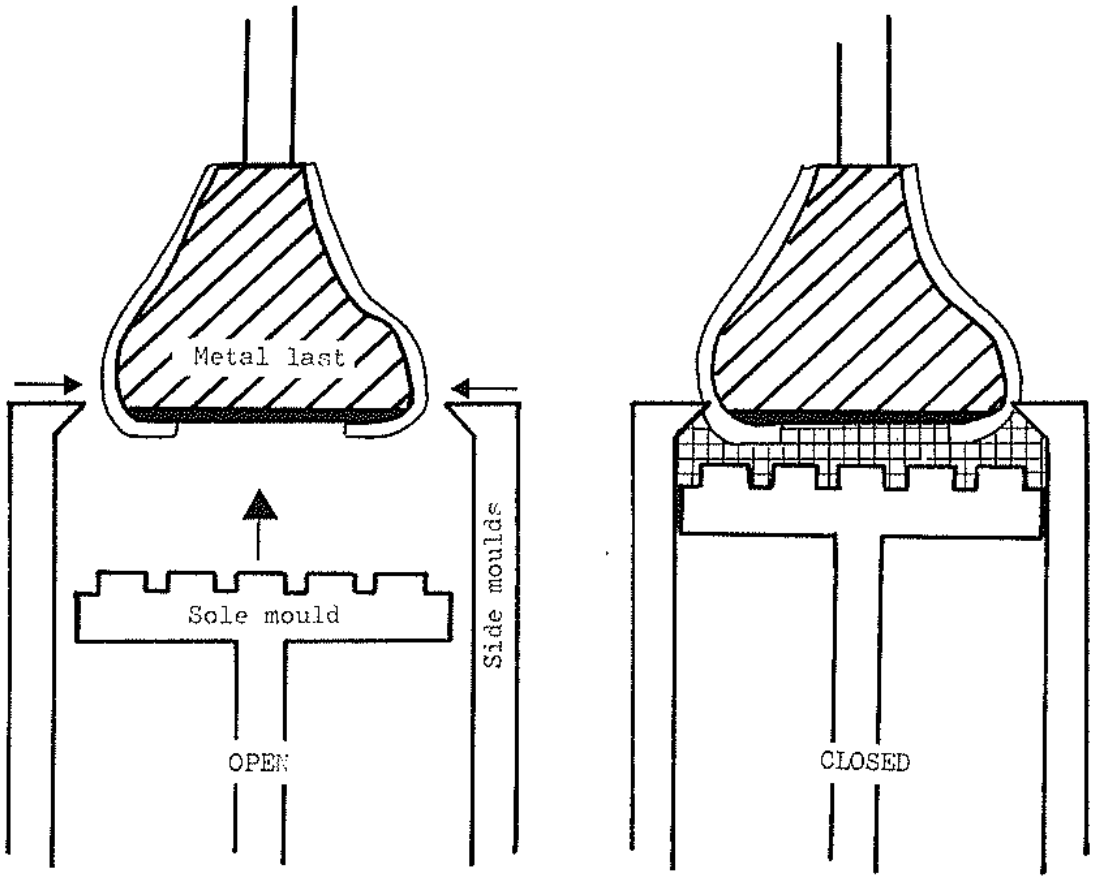
The second coat of cement is also dried.

Vulcanising

The machine is built to process a pair of shoes at a time. The moulds used consist of four parts - the sole mould or piston, two side moulds which join at the toe and heel, and the metal last.

The moulds of the correct size, style and fitting are fitted in the machine and heated electrically to approximately 180°C. The side moulds are slightly cooler than the sole mould.

Because of the high pressures used, the moulds have to be securely fixed in the machine and are difficult to change quickly.



The shoe is slipped from the making last and re-lasted on to the metal last.

A sole "blank" (cut to approximate shape and correct weight required) is pre-heated to 110°C. This reduces the time cycle in the machine.

The blank, of unvulcanised rubber, is placed on the sole mould and the shoe on the alloy last is locked into position over it.

By operating a switch, the side moulds close to grip the sides of the shoe at the insole edge, completely sealing the shoe into the mould. The sole mould moves upwards under hydraulic pressure of 600-800 lb. per sq.in, to a pre-set level. This determines the substance of the finished sole.

New Balance - EX1016

By virtue of the heat and pressure, the rubber blank melts, flows to fill the mould evenly, and vulcanises itself to the bottom of the shoe. The cement film on the shoe bottom is also vulcanised so that the complete sole and heel unit is firmly attached to the shoe.

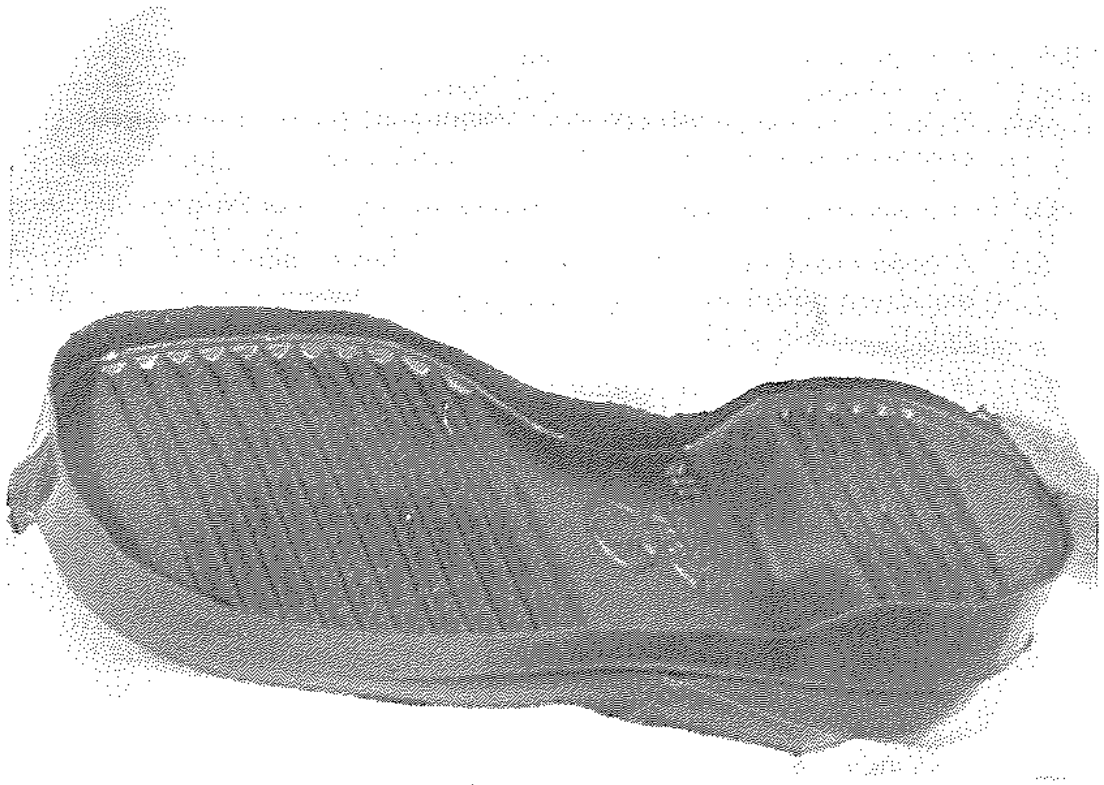
During the process the blank changes from unvulcanised material which is plastic in nature to a vulcanised rubber which is hard-wearing and elastic in nature. The time taken for this curing cycle varies according to the type of rubber mix, the volume of rubber and the heat employed, but is usually about four minutes. At the end of the cycle the machine automatically opens.

The correct result must be:-

(a) Clean and clear mouldings

(b) No damage to upper

(c) Good bond



Direct vulcanising completed

Flash Trimming

Where the moulds meet, a thin film of rubber is formed along the sole edge and at heel and toe. This is known as "flash". The flash has to be trimmed off, also any "spue" which has formed at the feather edge.

The correct result must be:-

(a) All flash removed cleanly from sole and heel

(b) All spue removed cleanly without damage to the upper

(c) No burst seams or toplines

The shoe is now ready to be taken into the Treeing Department.

INJECTION MOULDING OF P.V.C.

When injection moulding of P.V.C. was introduced it was quickly recognised that the process and the product had a number of advantages over direct vulcanising.

The main advantages are:-

(a) P.V.C. was originally much cheaper than other materials of comparable qualities.

(b) The wearing properties are comparable with medium grade rubbers.

(c) A good clean finished sole appearance can be achieved with excellent definition of mould contours, printing and fineness of detail.

(d) It can be made in all colours including pastel shades.

(e) The colours obtained are more constant than those of rubber.

(f) The moulds do not require heating.

(g) The process time is much shorter.

(h) Less flash and spue are produced.

(i) The moulds can be changed in a fraction of the time that it takes to change moulds for vulcanising.

P.V.C. compounds are essentially simple compounds, but for soling purposes, because of the adhesion problem, they must be of a specific formulation. They are readily converted, by an easily controlled process, into soles and heels. In a given formulation, properties are so predictable, that relatively small variations can be readily detected by reliable control tests.

The wear properties of P.V.C. are closely related to the softness of the material. Softness of P.V.C. is measured in terms of SHORE A degrees.

New Balance - EX1016

If the material is too hard the edges will chip and cracking will take place in cold flexing conditions. It will also slip easily. P.V.C. which is too soft is difficult to bond because of the high plasticiser content.

Thus, a softness of 50 - 75 SHORE A degrees is usually employed. For cold weather wear S.A.T.R.A. recommend 78 - 90 SHORE A degrees.

One problem is that with thin substances with soft materials, "print through" of rough walking surfaces, such as sharp stones, takes place.

Bonding to the upper with modern one-part or two-part polyurethane adhesives is reasonably simple, but it must be remembered that the flexibility of the sole will have some bearing on the bond because of the force exerted at the sole-upper interface during walking.

BOTTOM PREPARATION FOR P.V.C. INJECTION MOULDING

Sand Toes and Roughing

Toe pleats are sanded flat on an abrasive roller.

Roughing is, again, a critical operation. For P.V.C. moulding the roughing can go to the feather edge or over as for vulcanising. Because of the low pressures involved it is a matter of preference whether the sole is attached to the feather edge or slightly over.

Attach Shank and Filler Block

This operation is the same as for vulcanising. The filler block simply cuts down the P.V.C. around the heel, shortens the cooling time and prevents distortion of the heel shape.

Cementing

A one-part or two-part polyurethane adhesive is applied by machine or hand brush over the whole shoe bottom. Careful application is necessary to avoid spillage over the feather edge as these adhesives can adversely affect the finish of upper leathers. It is important that the adhesive is dried correctly to evaporate the solvent content.

P.V.C. Injection Moulding

The first machines developed in this country to directly mould P.V.C. to leather uppers were the C.I.C. Solemaster and the B.U.S.M.C. Primatic. Both machines were multi-stationed, the C.I.C. having ten moulds and the B.U. twelve moulds. This was to allow the shoe sufficient cycle time for cooling of the P.V.C.

A variety of machines have been developed since by a number of companies, both in this country and on the continent. Notable among these are the C.I.C. Solemaster 'S', a single station machine, and the B.U.S.M.C. 2 - station T.I.M. (twin injection moulding) machine. Both of these incorporate a refrigeration unit to reduce the cooling time in the mould.

A description of the Solemaster 'S' and its operation follows:-

The single station is designed to carry either the left or right sole mould with the attendant side moulds and last mould. These moulds are not heated and the mould change can be completed very quickly by virtue of the quick-release locating screws used. The machine is completely self-contained carrying its own store of plastic granules in a hopper and having its own injection screw and refrigeration unit.

The shoe is slipped from the making last and put on to the alloy last mould. With the shoe in the inverted position the last is slid into the moulding position along a track. This makes contact with an electric solenoid and locks the shoe in position.

The operator can now start the machine cycle by depressing two switch buttons simultaneously, one with each hand. This is an important safety device.

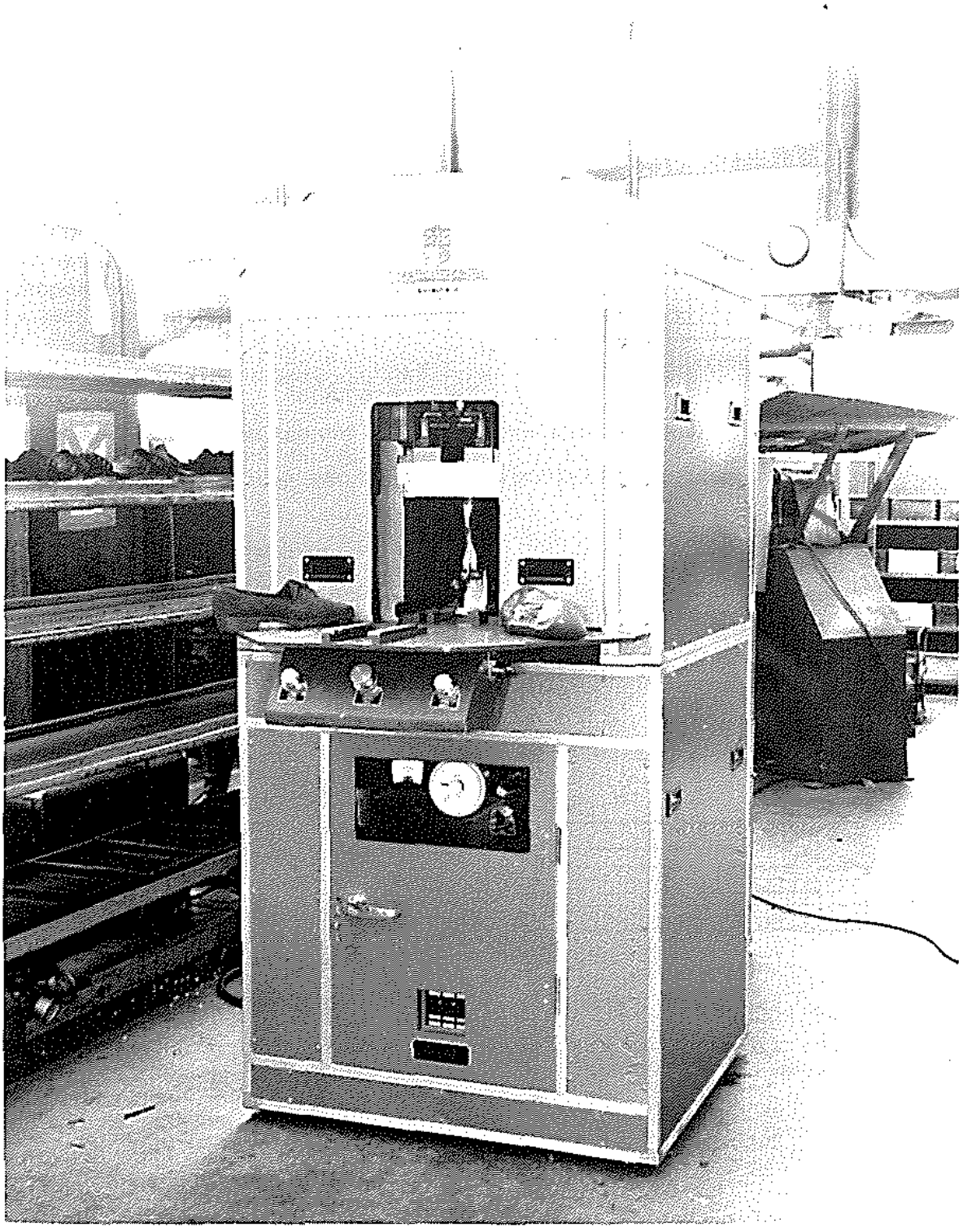
The side and sole moulds close around the shoe and lock into position under low pressure. Automatically, the injection screw which is heated to 165° to 170°C forces molten plastic through an injection nozzle into the mould. When the mould is completely filled a small plunger fitted in the surface of the sole mould, is forced upwards. This makes contact with a micro-switch, automatically cutting off the injection. This plunger is usually located in the heel area of the sole mould. The injection time varies with the size of mould but averages 10 - 20 seconds.

The refrigeration unit causes the molten plastic to cool and harden rapidly to form the solid sole and heel unit. The usual cooling time is 1 - 1½ minutes but again will vary with the mould size. The moulds are automatically unlocked at the end of the cooling time and the shoe is unloaded and removed from the last mould. The shoe is now ready to pass into the Treeing Department.

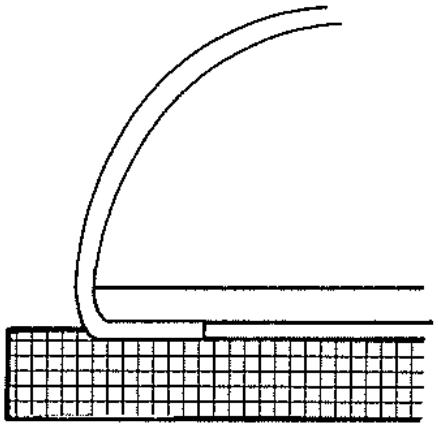
A strip of plastic has been left in the end of the injection nozzle. This solidifies and is know as the sprue; it must be removed before the next shoe can be processed.

Where the machine is set to produce soles to the feather edge, the method is known as top seal and gives a similar appearance to that of a direct-stuck sole; side seal, where the sole extends over the feather edge, produces a heavier appearance.

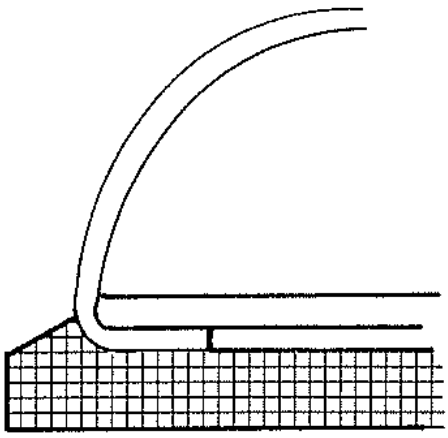
New Balance - EX1016



CIC "Solemaster S" Injection moulding machine



TOP SEAL



SIDE SEAL

The correct result must be:-

(a) Clean and clear mouldings

(b) No flash or spue

(c) Sole securely bonded to upper

New Balance - EX1016

INJECTION MOULDING OF POLYURETHANE

The advent of injection moulding polyurethane in the 1960's brought into shoe-making an outstanding example of the use of a chemical process into a previously traditional industry.

By injecting a stream of resin with a stream of pre-polymer (hardener) into a slightly warmed mould a chemical reaction is initiated which produces "blown" polyurethane (i.e. having a cellular structure). This material is considered by most shoemakers to be the best soling material yet devised being extremely hard-wearing, very lightweight (a specific gravity of 0.5 compared to P.V.C's s.g. of 1.5) and having considerable anti-slip properties. The process can be used to produce sole units or to direct injection mould sole and heel on to the shoe bottom.

The main advantages are:-

(a) No adhesives are required on the shoe bottom.

(b) No roughing required on suede although it is usual to sand toe pleats flat.

(c) High durability.

(d) Good abrasion resistance.

(e) Very light and comfortable. The production of heavy substance sole units produces no weight problems.

(f) Can be liquid at room temperatures.

(g) High temperature and pressures not necessary.

(h) P.U. is chemically resistant to oils, etc.

The main disadvantages are:-

(a) Costly raw materials.

(b) Control of materials critical.

(c) Requires careful chemical and processing control.

(d) Adhesive properties very strong, therefore it sticks to machine and moulds.

(e) Cannot be reprocessed.

(f) Heavy substance soles can lead to flexing problems unless properly designed.

Lasting

It is important to note that while, as previously mentioned, the lasting methods employed are those used in the cemented constructions, string-lasting is also

used as this lends itself to injection moulding, being able to be done on the last mould. Because P.U. is a searching material it is essential that the lasting allowance is flat to the insole.

Bottom Preparation for P.U. Injection Moulding

The shoe bottom is roughed and toe pleats sanded flat. Where footwear with a mudguard is being processed the roughing may well extend 9 - 12mm (3/8 - 1/2 in.) up the side of the lasted upper. As mentioned previously, suede needs no roughing but toe pleats are sanded flat.

Also it must be remembered that no adhesive is required as P.U. is a remarkably self-adhesive material.

Injection Moulding Technique

Again the usual mould set-up consists of a sole mould, two side moulds and a last mould. However, when sole units are being processed it is sometimes possible to have a mould cavity representing the sole and side areas, with a sealing plate to close the moulds.

The moulds are slightly warmed to 50° - 60°C. A pre-determined amount of the mixture is injected into the mould, this amount being measured in "shots". The number of shots required for any particular mould size is marked on the mould, and is carefully metered by the injection head.

Once the material has been injected there is a process time of two minutes, at the end of which the mould automatically opens. During this time the materials have reacted, generating heat and gas to form the cellular construction. The outer surfaces of the sole generally have a solid skin.

A critical point when moulding P.U. is the cleanliness of the mould. Because of the self-adhesive properties any dirt, odd bits of moulding flash etc. will be moulded into the next sole. Thus, each time the mould is used, a mould release agent of silicone in a solvent base must be applied to all the mould surfaces. The release agent must not be allowed to get on to the bottom of the lasted upper or it will completely prevent adhesion.

Because of the searching nature of P.U. it is essential that the side moulds are tight-fitting to prevent spue forming above the feather-line. Top seal moulds have been of great advantage in minimising this problem. The high cost of moulds also makes it important that they are handled carefully when mould changing takes place.

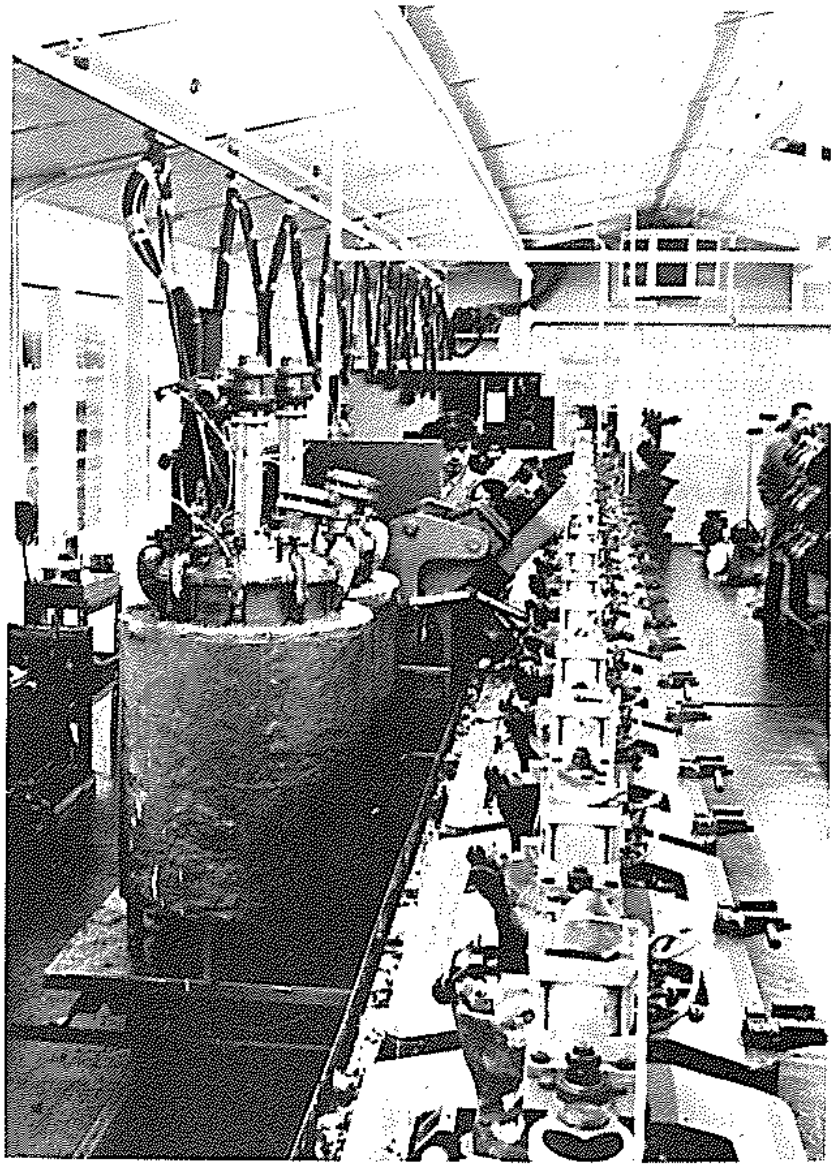
There are two methods by which the process can be carried out:-

(i) Where an injection head mounted on a trolley moves along behind a row of moulding machines each holding one pair of moulds.

New Balance - EX1016

As the trolley reaches each mould an injection nozzle is inserted in to the injection point, injects and retracts before moving to the next mould.

(ii) Where the injection point is in a fixed position and the moulds are held in a machine which rotates to bring each mould to the injection point in turn. Injection is controlled from a console which can be used manually or automatically.



"IN LINE" Polyurethane injection moulding plant

New Balance - EX1016

There are three systems of production:

(a) The Quasi-prepolymer system

(b) The prepolymer system

(c) The one shot system

In the quasi-prepolymer system, some of the resin is reacted with isocyanate to form one stream which is termed the prepolymer. The remaining resin and components make up the other stream. The proportions should be about 1 : 1.

The prepolymer system is where all the resin is mixed with the isocyanate to form one stream and then the other materials form the other stream. Due to the differences in viscosity and the wide mixing ratio of 10 : 1, there may be some difficulty with mixing.

In the one shot system the isocyanate forms one stream. Thus, there is no pre-chemical step. However, this produces both chemical and mechanical control problems.

The correct result must be:-

(a) Sole and heel to be correct to mould pattern.

(b) No spue above feather edge to cause damage to upper.

(c) No blown heels or soles (those having air pockets below the surface).

(d) Sole to be correctly and securely stuck to upper.

Note Where P.U. moulded soles are being made for use with direct stuck work, a coat of cement is necessary. (See sole preparation in cemented construction).

Safety

The injection moulding of P.U. raises some important safety problems.

(a) The raw materials can give off toxic vapours so strict safety precautions are necessary.

(b) In the event of fire, extreme hazards arise and immediate evacuation of the building is vital.

(c) The materials can easily cause dermatitis so barrier-creams/ protective gloves must be worn when handling them.

(d) Cleaning agents used on machine parts can be corrosive. Extreme care in handling is necessary.

New Balance - EX1016

(e) Storage must be carefully controlled. Any water getting into storage drums may easily cause ideal conditions for an explosion.

(f) Regular chest X-rays are necessary for all personnel concerned with the process.

(g) Personnel with a history of chest and respiratory problems should not be employed on the process.

Flash Trimming

When the moulding process is complete the shoe is removed from the last mould and any flash is trimmed off. This is usually done by passing the edge of the sole against a rotating, slotted wheel which, running at high speed, pushes the flash against a razor-sharp knife. The flash is trimmed off close to the edge of the sole.

The correct result must be:-

(a) All flash trimmed off cleanly

(b) No damage to moulded contours of sole or heel

The shoes are now ready to be passed to the Treeing Department.

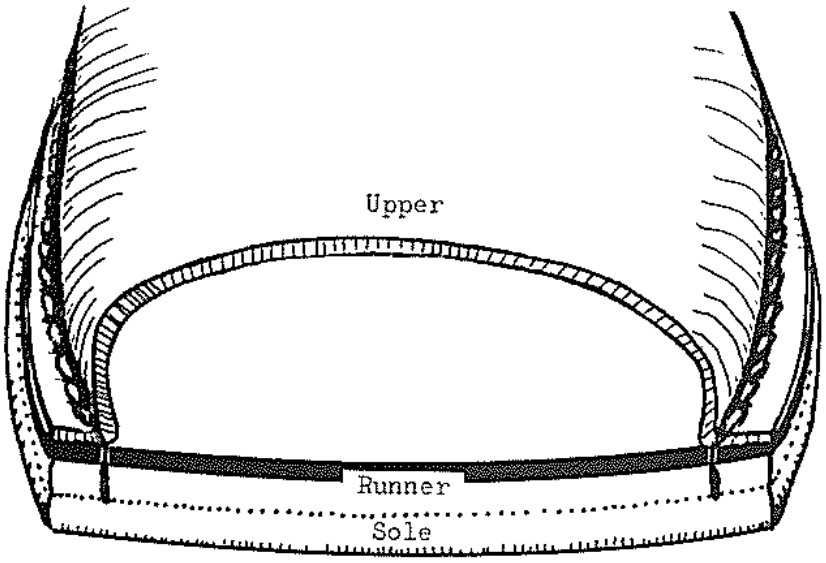
CHAPTER 17

VELDTSCHOEN CONSTRUCTION

Introduction

As mentioned previously in the Introduction to Making, the Veldtschoen construction (also known as the stitched-down construction) is distinctive in the method of lasting employed. It is the only one where the lasting allowance is turned outwards. The allowance is stuck down onto a laminated "runner" which takes the place of the insole. After lasting, the upper and runner are lock-stitched together close to the feather edge, the sole and heel then being stuck to the bottom of the runner.

There are many variations of this construction. The upper may be flanged out only around the forepart, back to the heel breast, or completely around the upper. We shall take the full Veldtschoen with a plantation crepe sole and heel as our standard.



CROSS SECTION OF VELDTSCHOEN SHOE

New Balance - EX1016

The construction is processed as follows:-

Insert Stiffeners

A flat stiffener, skived to a knife edge, is inserted between the upper and counter lining, keeping the edge of the stiffener to the lasting edges of the upper and lining.

Traditionally, the stiffener has been of leather or fibreboard dipped into a liquid latex-based adhesive. The more modern practice, however, is to use a thermoplastic-coated stiffener.

The correct result must be:-

(a) Stiffener flush to lasting edge

(b) Clean work with no stains

(c) No creases in linings

(d) Correct stiffener

Seat Flanging

Heated moulds similar in shape to the backpart of the last are used to mould the upper and lining to the approximate shape of the last. Simultaneously, heated plates flange the lasting allowance outwards approximately 12 - 14mm (1/2 - 9/16"). This not only pre-shapes the seat of the upper and lining for the later operation of seat lasting but also determines the correct backheight of the upper. Because of the heat employed it is inadvisable to use vegetable-tanned linings as they will shrivel or burn quite easily.

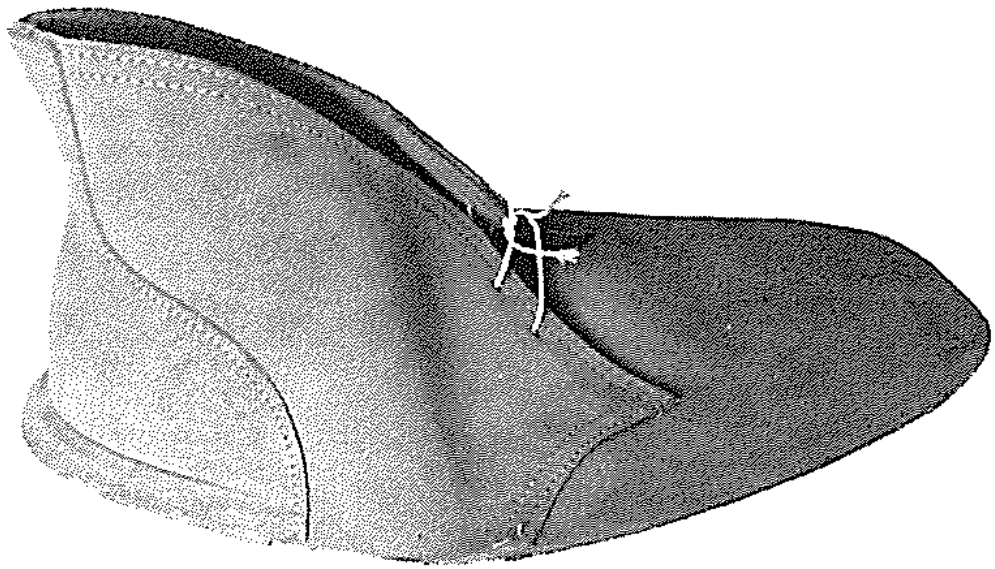
The correct result must be:-

(a) Correct width of flange around seat to produce correct back-height.

(b) No creased linings

(c) No damage to upper or lining from excessive heat

(d) No damage to upper seams



Seat flanged (Chukka boot upper)

Rough Runners

The runner is usually made of leather or leatherboard combined with a layer of rubber. Roughing of the leather or leatherboard is carried out using a rotating wire brush, to a width of 3/8" from the edge. This roughing is for adhesion purposes at lasting.

The correct result must be:-

(a) Runner roughed to specified width

(b) Roughing to be complete and of sufficient depth

(c) No damage to runner

Latex Runners and Uppers

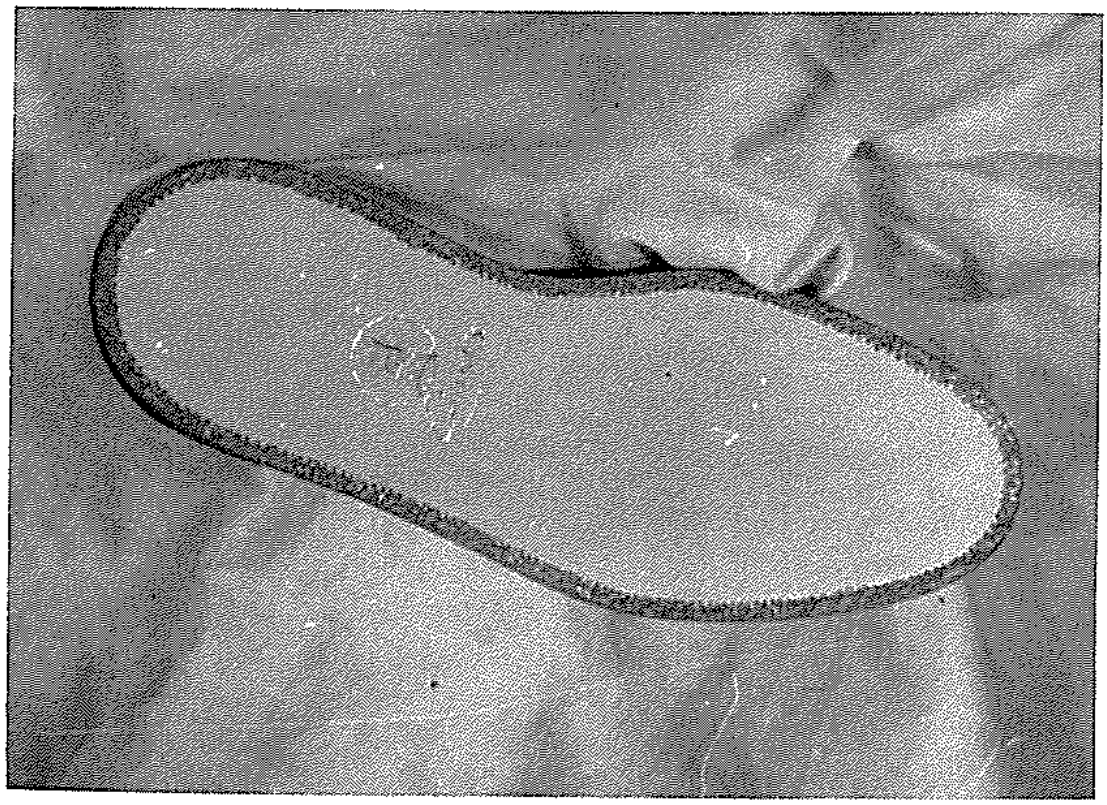
Latex is applied by rotating rollers to the roughed margin of the runner and allowed to dry. The lasting allowance of the upper is coated with latex in a similar manner on the flesh side, also being left to dry.

The correct result must be:-

(a) Even application of latex on uppers and runners

(b) Latex applied to specified width

(c) Clean work



Runner roughed and latexed

Mulling

The uppers are conditioned in a rapid conditioning cabinet for 20 - 30 minutes before lasting.

Toe Lasting (Toe Forming)

The two principal machines for this operation are the B.U.S.M.C. No. 2 Veldt Toe Former and the Walther Toe Lasting machine.

The object of the operation is to tension the upper over the last for good shape retention, flanging the upper outwards and combining it to the margin of the runner. Thus, the upper is formed to the correct shape of the last around the toe.

The Walther machine is twin-headed. It is usual with the B.U.S.M.C. machines to use a pair of single-head machines, side by side.

In each case the left head is fitted with toe plates for left shoes and the right for right shoes. This eliminates changing for lefts and rights.

Originally the runner was attached to the last bottom with staples. This has now been eliminated, the runner being held in the machine to align it correctly to the last. The upper is held by machine pincers, pulled down and stuck firmly to the runner margin by heated toe plates.

The correct result must be:-

(a) Uppers tight to wood

(b) Uppers correctly balanced

(c) Patterns square

(d) Upper well bonded to runner with well defined feather edge

(e) Toe to be exact shape of last

(f) Correct allowance of runner over edge of last

(g) No plate marks



Toe lasting completed

Seat and Waist Lasting

The seat of the upper, previously moulded and flanged, is brought down on to the seat of the runner. Here it is finally shaped and stuck to the runner seat This is carried out on the Standard seat lasting machine. The machine is a simple one having a pair of heated plates, suitable for lefts and rights, which can be adjusted for position and amount of wiping action.



Seat lasting completed

The shoe taken from the seat lasting machine is now waist lasted usually by the same operator. The usual machine is the B.U.S.M.C. Veldtschoen Flange Bedding machine which has two slowly revolving wheels. The lasting edge of the upper and runner are passed between the wheels so compressing and securely sticking the lasting allowance to the runner through the waist.

The correct result must be:-

(a) Seat bedded to runner to produce correct back height

(b) Shape of seat well defined

(c) Well defined feather edge at seat and waist

(d) Lasting allowance stuck securely to runner.

(e) No plate marks on upper

The lasting operations are now complete.

New Balance - EX1016



Waist-lasting completed

Outsole Stitching

To combine the upper permanently to the runner, it is necessary to stitch completely around the shoe tight to the feather edge. The most up-to-date machine is the B.U.S.M.C. No. 10 Outsole Stitcher which produces a lock-stitch at the rate of 1,000 stitches per minute.

The working of the machine is rather complicated, but basically the machine cycle is as follows:-

The shoe is presented to the machine in an inverted position and clamped between a stitching table and a presser foot. A chisel-pointed curved awl pierces the combined upper and runner from underneath and retracts in preparation for the needle. The curved needle descends through the hole made

by the awl. A barb on the needle picks up the thread to start the formation of a stitch. The barb pulls a loop of thread upwards through the material and transfers it to the hook of the shuttle. This shuttle, revolving around a bobbin of waxed thread, takes the loop around the bobbin. The machine causes the loop to be pulled tightly back into the material, pulling the waxed thread with it to form a lock-stitch in the centre of the substance.

The length of stitch can be adjusted on the machine.

It is usual to have a bobbin winding machine close to the Outsole Stitcher to maintain a supply of pre-wound waxed bobbins.

The correct result must be:-

(a) Correct stitch length

(b) Correct tension

(c) Stitching tight to feather edge

(d) Correct start and stop position

(e) No damage to upper



Outsole stitching completed

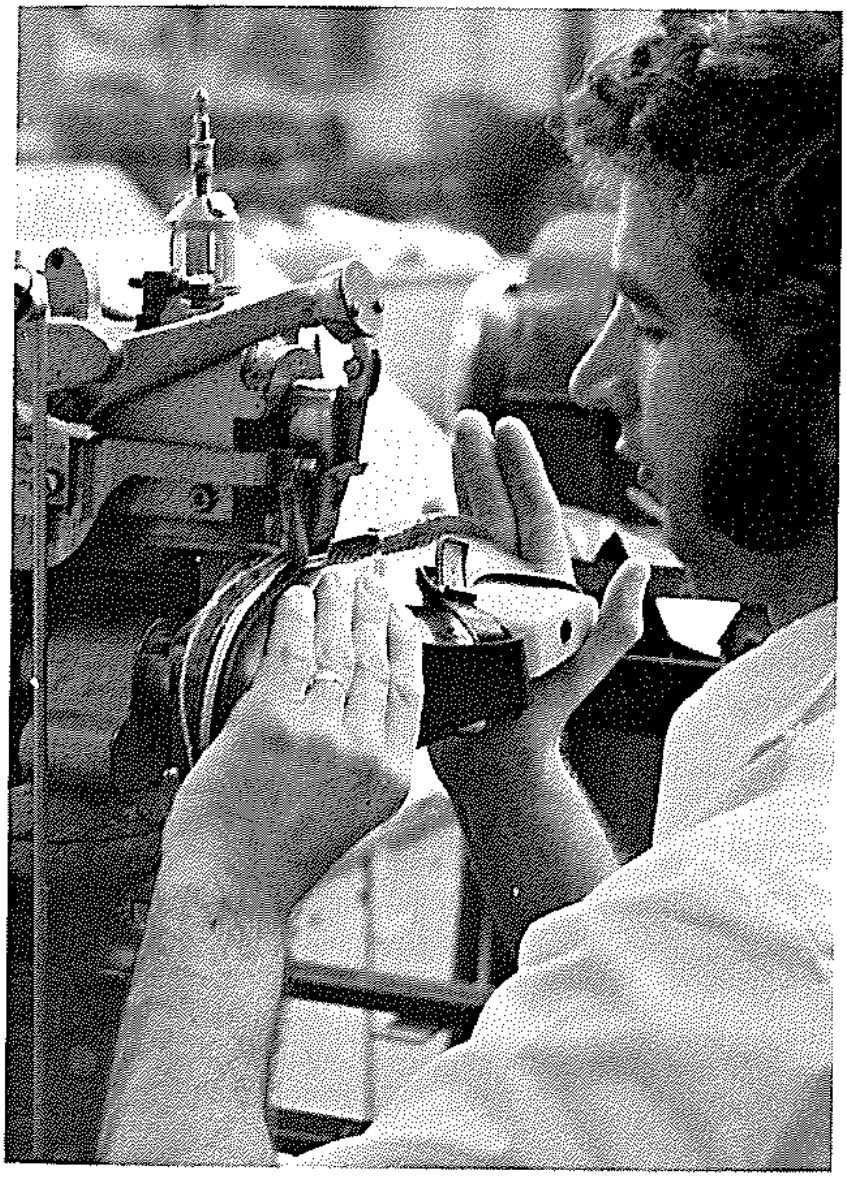
New Balance - EX1016

Bottom Pressing

During lasting and stitching the runner is often pulled out of shape. To form the runner to the bottom contours of the last and ensure that the edge is flat, the shoe bottoms are pressed. The machine consists of a water-filled leather pad box and clamping arms. The shoe is placed under the clamping arms with the bottom resting on the pad box. Hydraulic pressure is applied to the base of the pad so pushing the shoe upwards, thus re-shaping the runner to the bottom of the last.

Rough Rounding

A reciprocating knife, with an oscillating feed, is used to trim excess upper and runner to a uniform shape around the shoe. This is not the finished edge of the



Rough rounding

shoe-only a profile for the final edge finish at a later stage. Sometimes this operation is carried out after sole attachment.

The correct result must be:-

(a) Correct edge distance and edge at right angle to runner

(b) No damage

Heat Setting (see chapter entitled "Conditioning of Uppers").

Naphtha Soles and Heels

Solvent naphthalene is applied to the runner bottom, the inner face of the sole, the heel area of the sole and the heel. This serves to produce a film of rubber solution on these surfaces. The film is allowed to dry to a 'tacky' condition and then the soles and heels are attached. The solvent must be applied over the whole surface area.

Note No oil must be allowed to come into contact with the solvent as a fraction as low as 10 parts of oil to 1 million parts of solvent will cause breakdown of the adhesive bond.

Sole and Heel Attach

The sole and heel are positioned to the bottom of the shoe and the shoe is placed into the sole attaching machine.

This serves to press the sole and heel firmly to the bottom of the runner giving a permanent attachment. The usual machine has inflatable, leather covered pads and clamping arms for pressing the sole and heel to the shoe.

An application of detergent liquid is given to the surface of the crepe sole and heel because at edge paring fine particles of crepe removed by the rotating cutter will permanently attach themselves to the sole and heel. The detergent prevents this and is allowed to dry before edge paring.

The correct result must be:-

(a) Soles and heels correctly positioned

(b) Soles and heels securely stuck

(c) Detergent applied evenly to entire sole and heel

Edge Paring

The edges of the soles and heels have to be trimmed and pared to a uniform, smooth finished appearance. This is done using high-speed rotating cutters. Usually the edge has a square, upright appearance in the finished shoe.

Operator skill does much to determine the smooth finish required. The speed of the cutter shaft is usually 9,000 - 10,000 revolutions per minute, thus considerable care on the part of the operator is necessary to avoid removing too much material. To obtain a good finish the crepe must be kept as cool as possible. Should it be allowed to get overheated crepe will soften and drag against the cutter.

Some manufacturers have the crepe edges 'stoned' or scoured after pairing to ensure a really smooth edge. The abrasive stone is fitted to a second shaft on the paring machine and runs at 8,000 - 9,000 r.p.m.

The operator must be always aware of the safety factor due to the high speed and sharpness of the cutter and stone. A grinding attachment is fitted to the machine so that the operator can sharpen his cutter as necessary.

The correct result must be:-

(a) Correct width of welt (edge distance from upper)

(b) Square smooth edges

(c) Crepe dust removed cleanly from edges

(d) No burnt runner edges. (Due to blunt cutter or stone)

(e) No damage to stitches or upper

(f) Sole and heel shape to be uniform and matching in pairs



Edge trimming

New Balance - EX1016

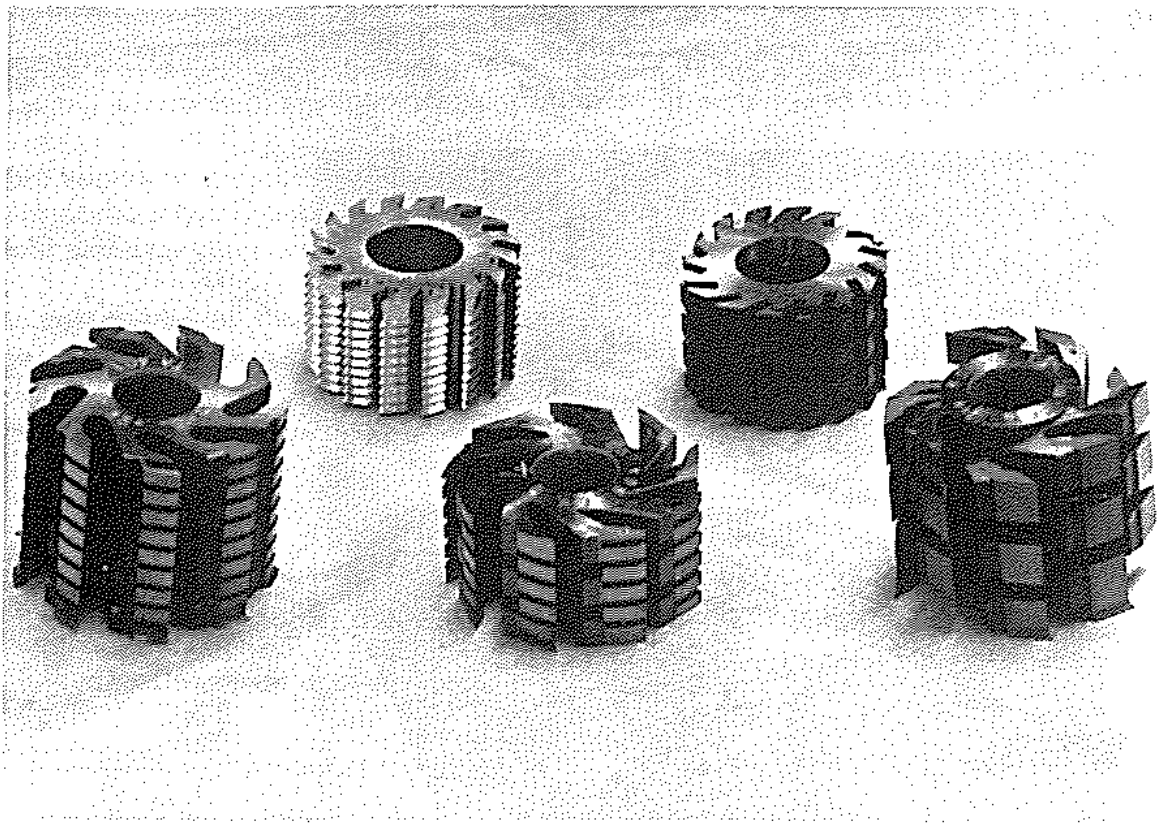
Edge Paring Developments

During recent years a number of machinery manufacturers have attempted to develop machines which would automate or semi-automate this operation.

One of the most notable among these has been the Torielli Auto Edge Trimming machine developed by Torielli, an Italian firm.

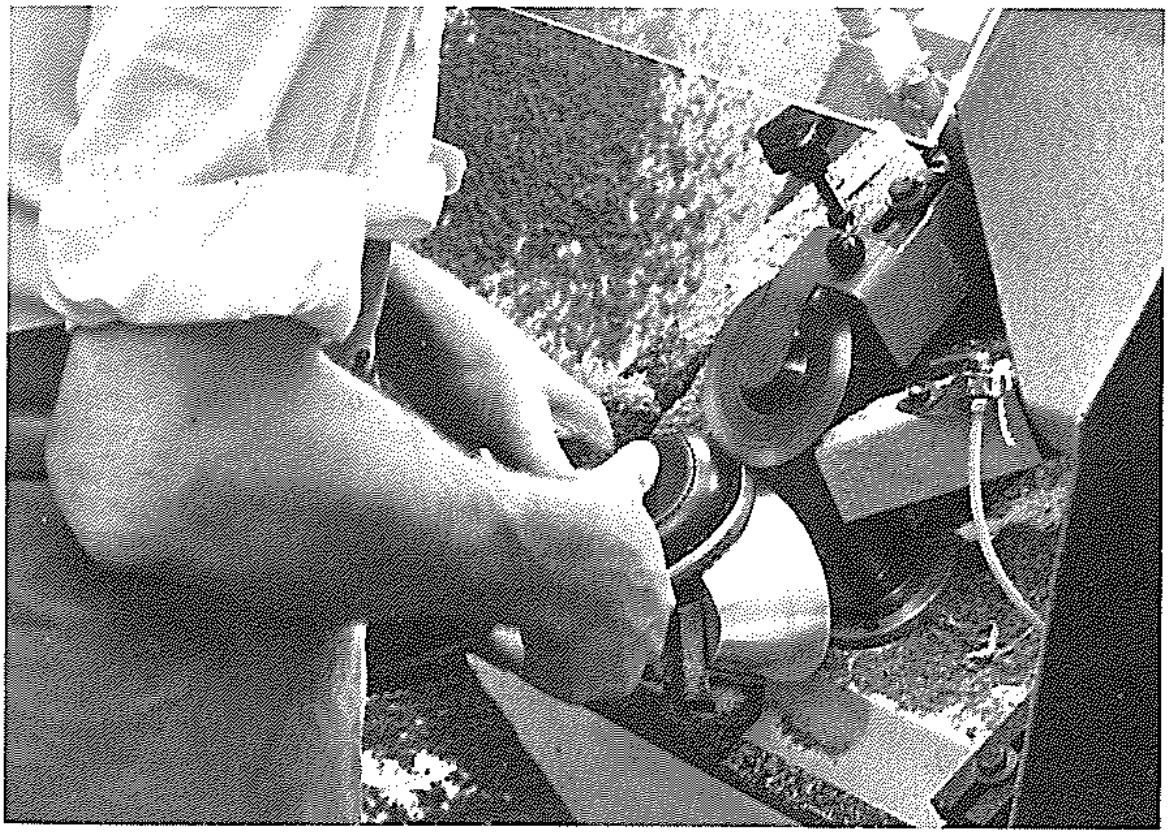
This machine works on the basis of a tungsten-carbide cutter rotating at 9,000 - 10,000 r.p.m. at about operator waist level. The shoe is placed on to a cone-shaped rest and the sole edge being inserted under a circular guard covering the cutter. By adjusting the size of guard different edge distances can be determined. Trimming is carried out by traversing the shoe in a horizontal plane against the cutter. In theory, it is possible to trim the shoe without rough-rounding but this has been found to be only practical on certain size ranges.

An essential part of the technique is precision-grinding of the cutter blades using a diamond abrasive stone. A separate machine is supplied for this purpose. At the time of writing development of guards, cutters and techniques is still taking place.



Edge paring cutters

New Balance - EX1016



Torielli Auto Edge Trimming Machine

Edge Inking

An even coating of dry-bright wax emulsion is applied to the edge of the flanged upper and runner with a fine brush. This imparts a gloss to the edge, improving the appearance and sealing the edge.

Alternatively, the whole of the edge may be coated with a viscous rubber dye to give a contrasting appearance.

Brush Uppers

The complete shoe is brushed on a rotating bristle brush to remove any crepe rubber dust or crumbs which may be left on the upper.

Slip Lasts

The shoes are now complete. The lasts are removed from the shoes and they are ready to move into the Treeing department.

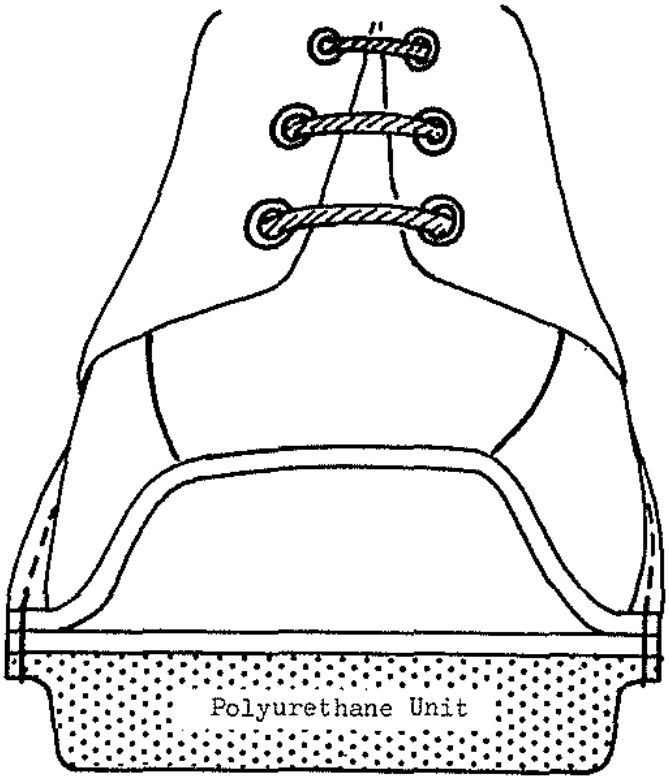
New Balance - EX1016

Footnote

1975 saw the introduction by Clarks Ltd. of a new concept in veldtschoen construction ——— the "Polyveldt". The polyveldt shoe is lasted outwards as a normal veldtschoen style, but instead of a crepe sole, it has a polyurethane sole/heel wedge-type unit. The sole unit has a flanged outer rim to facilitate stitching to the runner and upper. The obvious advantages of this version of the construction are:

(a) Superior wearing qualities of polyurethane.

(b) Outsole stitching is never in any danger of coming into contact with the ground.



CROSS SECTION OF "POLYVELDT" CONSTRUCTION

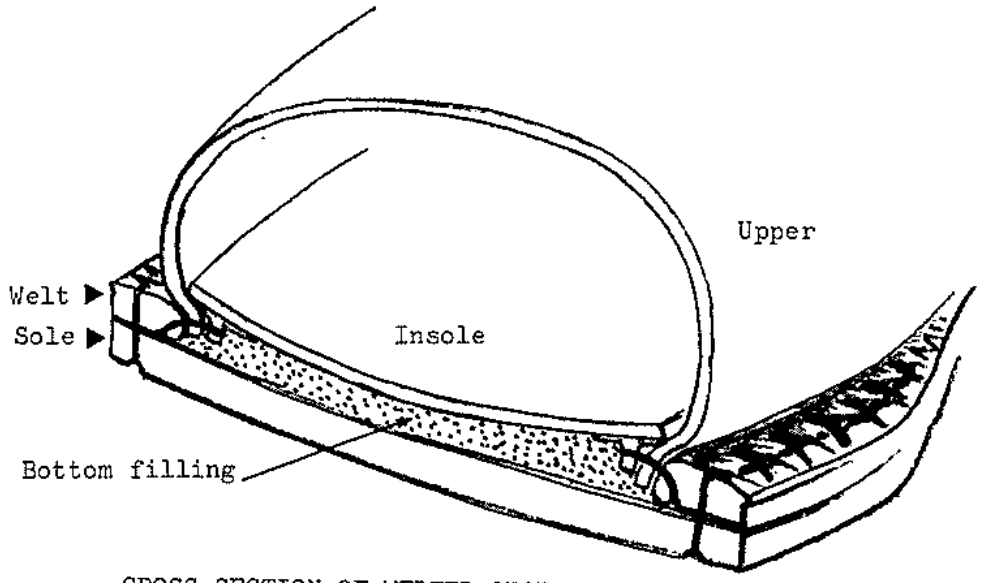
New Balance - EX1016

CHAPTER 18

MACHINE WELTED CONSTRUCTION

The traditional method for well made, waterproof walking shoes has, for many years, been the machine welted process, which is a mechanised version of the old method of handsewn welted. The method varies greatly from any previously described. During the last decade the lasting processes have been modified, utilising machinery which was originally developed for the cemented construction. Some of the more important of these will be described in this chapter.

One of the major differences in the process is the use of an insole with an upstanding wall or rib which is positioned 5mm (7/32") from the edge of the insole. During lasting the upper and lining (if the shoe is full lined) are secured to this wall. A strip of leather known as the welt is then sewn in to combine the welt, upper and lining to the wall of the insole. After the welt has been sewn in the sole is stuck to the shoe bottom and is stitched through the welt by means of a lock-stitch machine. This is an indirect attachment as the sole is not directly attached to the upper.



CROSS SECTION OF WELTED SHOE

New Balance - EX1016

Advantages

(1) Because of the indirect attachment, the sole of the shoe can be repaired a number of times.

(2) Also because of the indirect attachment, the shoe has better shape retention than any other construction, even after repairing.

(3) The welted shoe is comfortable because the cavity between the insole and sole is filled with resin bonded cork which cushions the foot.

(4) A well-made machine welted shoe is very waterproof.

Disadvantages

(1) The work content to produce a welted shoe is extremely high when compared with modern methods.

(2) The operations demand a high degree of skill.

(3) To produce a well-made machine welted shoe, the materials must be of good quality and good quality leathers are expensive.

(4) The construction demands that the sole and heel are finished after attachment to the shoe. This adds considerably to the cost of the shoe as pre-finishing methods cannot be used.

(5) Modern rapid conveyorised shoemaking systems cannot be easily applied to machine welted work because of the long delays necessary to dry out the welt and sole. This leads to more work in progress necessitating larger last plants.

In this chapter we shall describe a man's shoe having welts attached to just behind the heel breast and carrying a leather sole and built heel. The preparation of the insole and sole, lasting and attaching will be included.

INSOLE PREPARATION

There are two types of insole which may be used:-

A channelled leather insole or one of a number of styles of ribbed insole.

Channelled Leather Insoles

These are cut from the belly or shoulder portions of the hide. It is important that the insole is flexible but has a firm fibre structure.

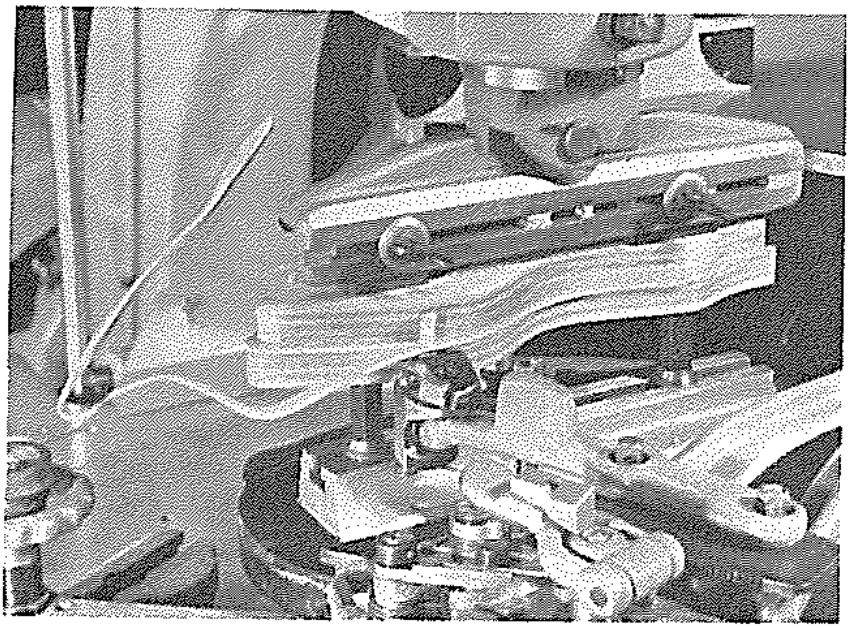
Castor Cut

The insoles are press cut to a castor shape.

New Balance - EX1016

Planet Rounding

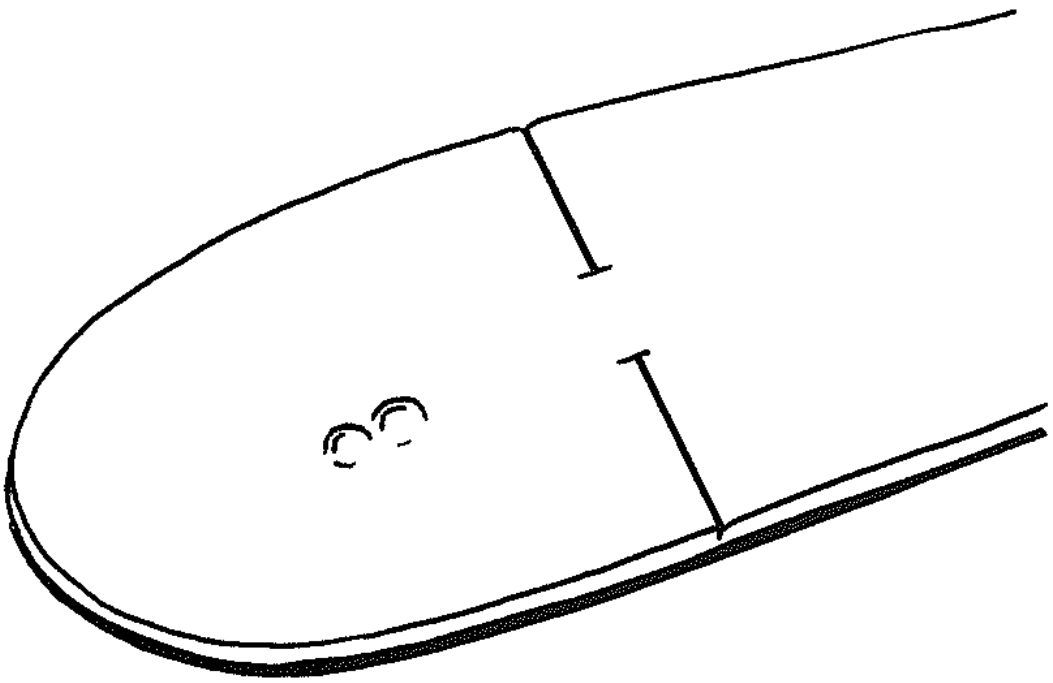
The castor insole is clamped on a wooden pattern block of the correct size and shape required. A knife then traverses around the block cutting off the surplus material.



Planet Rounding

Seat Chopping

This simple operation determines the correct position for the ends of the welt which must come approximately $\frac{1}{2}$" behind the heel breast line. Two cuts are made $\frac{3}{4}$" long and approximately one third of the total substance in depth, across the seat area of the insole. The size may also be stamped on the seat of the insole.



Seat chopping (channelled leather insole)

Channelling

This is the most skilled operation in the preparation of this type of insole because of the experience necessary to determine the substance and texture of each insole and pre-set the channel knives accordingly.

The width of the edge channel is normally determined by the substance of the upper material being used but is normally 7mm (9/32") in the waist and 5mm (7/32") in the forepart. This width varies in the forepart from the toe-cap line to the outside joint being gradually reduced to 4mm (5/32"). Thus, when the welt is attached a "joint swell" is produced.

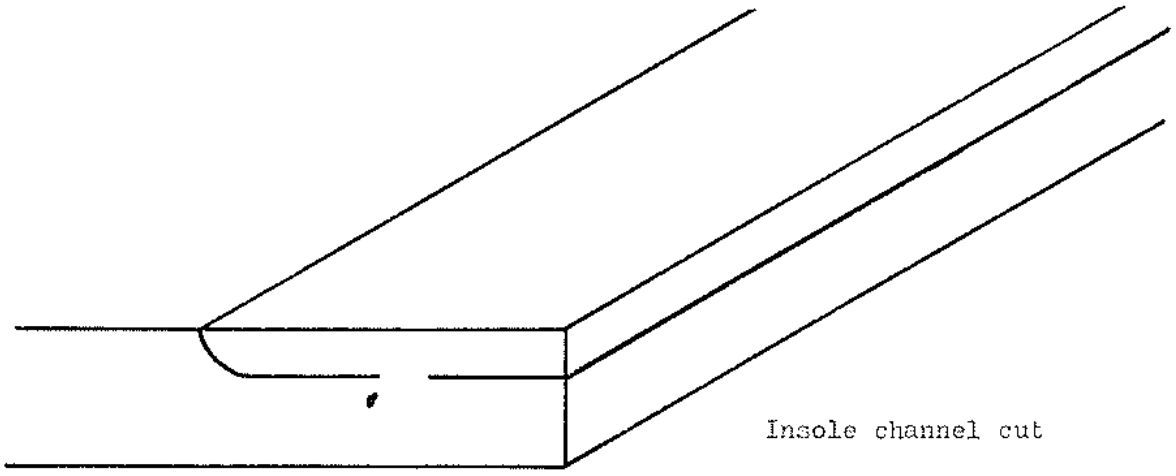
The substance between the inner channel and the edge channel must not be less than 4mm (5/32"). If it is more, the channel will be too weak to stand up to the strain imposed at the welt sewing operation.

Latex Channels

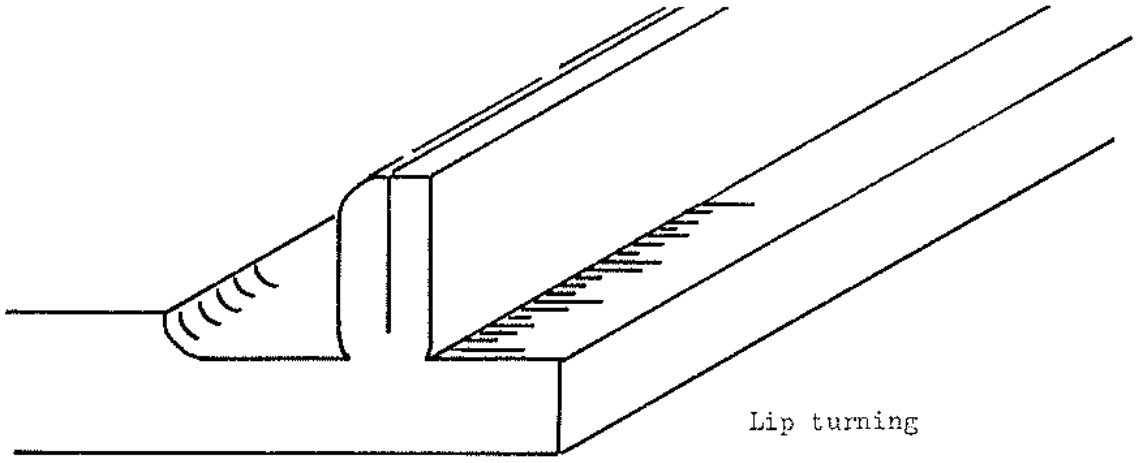
A coat of latex is applied over the top of the cut channels and allowed to dry.

Lip Turning

The two channel lips are turned inwards towards each other, the latex causing them to be stuck together to form a "wall" or "holdfast". To keep the wall upright around the acute curve of the toe a knife automatically makes small cuts in the edge of the inner channel, thus relieving the strain on the material.



Insole channel cut



Lip turning

Gemming

Some manufacturers prefer to strengthen the insole wall with a strip of fabric tape. If this is required the inside area of the wall is coated with latex which is then allowed to dry. A strip of "gemming" tape, usually of linen, is then attached and pushed firmly into the inside angle of the wall. Any excess material can then be trimmed off to the height of the wall.

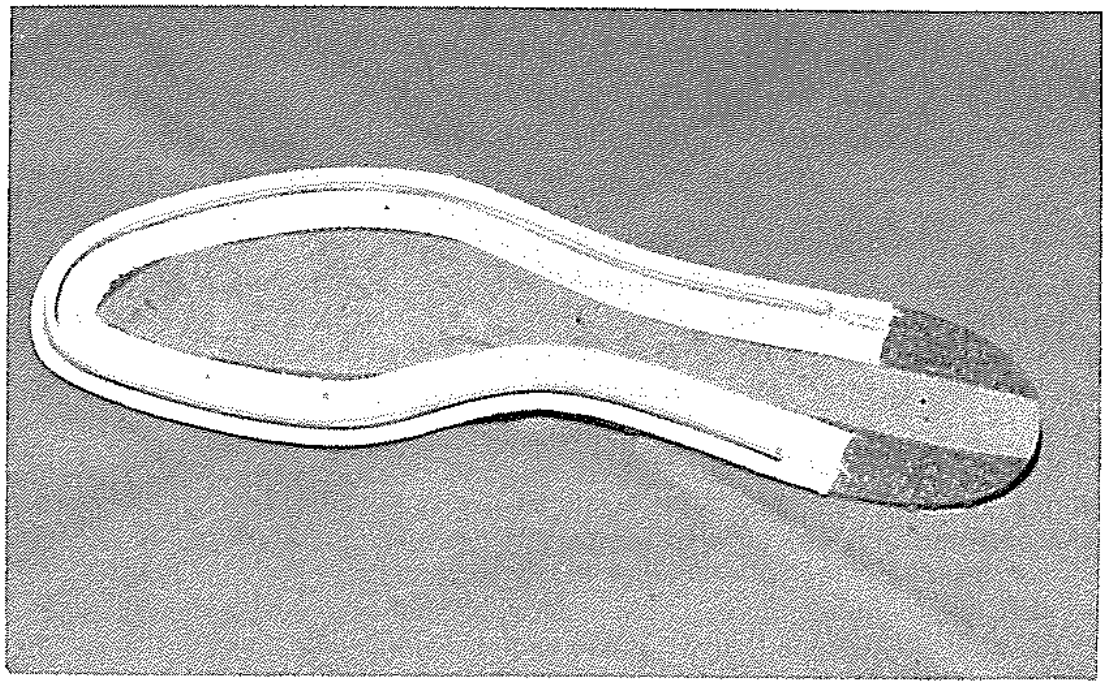
RIBBED INSOLES

A variety of insole "ribs" are available. Basically each of these consists of a fibre core covered with a linen tape flanged out at each side. These ribbed insoles were developed in the 1950's and rapidly replaced the channelled insole previously described. The rib is either upright or lays down at an angle, the attachment of the rib being virtually the same for all types. Originally, the rib was applied to leather insoles but today many leatherboard insoles are used. Lighter substance insoles can also be used because no channels are required. This has added to the flexibility of the shoe.

The insole is castor cut and planet rounded or, alternatively, "direct cut" to the required size and shape.

A margin of sufficient width is coated with adhesive, usually neoprene, and allowed to dry. Some manufacturers will also apply a second coat.

The pre-fabricated, pre-cemented rib, fed from a reel, is attached to the insole by a special rib-laying machine. This uses a jet of hot air to heat activate the cement films immediately prior to the rib being attached by a hammering action. It is essential that the rib be accurately positioned in relation to the insole edge. The distance of the rib from the insole edge is normally the same as that used for channelled leather insoles. So that the start and finish points of the welt sewing will be accurately positioned, the ends of the rib are cut off at an equal distance from the seat.



Ribbed insole

New Balance - EX1016

SOLE PREPARATION

The soles are castor cut and planet rounded or "direct" cut. It is important that the sole leather is firmly fibred, of the correct substance, and has a good appearance with no visible defects.

Waist Reducing

In order that the sole will have a lighter appearance in the waist of the finished shoe, the edge substance is reduced through the waist from the joint positions to the heel breast. The width of material removed, (the scarf), is approximately 19mm ($\frac{3}{4}$") wide. Usually a 6mm (12 iron) sole will be waist reduced to 3 - 4mm (7 - 8 irons).

Sole Roughing

The sole is roughed to remove the flesh fibres, usually with a wire brush or by abrasive.

Sole Cementing

The flesh side of the sole is coated with cement, usually neoprene, and allowed to dry. Originally only a rubber solution was applied as this was regarded as being only a temporary bond to secure the sole until it was outsole stitched. However, the use of neoprene cement nowadays ensures a much more permanent bond, thus adding to the strength of the shoe.

Tempering

It is difficult to work with dry leather soles, so to bring the material into a workable condition it is necessary to soak the soles in water until the fibre structure is saturated. Some tannages will require lengthy soaking to achieve the correct result. To speed up the operation a sole tempering machine can be used, either the vacuum or pressure type:-

(i) Vacuum Tempering

The soles are placed in chromium-plated racks in a chamber which is partially filled with water. The racks are held above water and the chamber is hermetically sealed. A vacuum is then created by means of a pump; this removes the air from the fibre structure of the leather. The soles are then lowered into the water. The vacuum is then reversed and an air pressure of 4 bars (60 lb. per sq.in.) is created. This drives the water into the air spaces in the soles. After 5 - 10 minutes the soles are raised from the water and a partial vacuum is again created. This reduces the surface moisture of the soles. The chamber is opened so that the soles can be removed ready for immediate use.

New Balance - EX1016

(ii) Pressure Tempering

The soles are placed in a cylinder and sealed. Water is forced into the leather structure under air pressure of up to 100 bars (1500 lb. per sq.in.) for 3 - 5 minutes. This tempers the soles very quickly but often removes loose tannins from between the fibres which is detrimental to the sole.

Soles are tempered just prior to attachment to the shoe.

WELTED LASTING

The lasts, used for the welted construction where the welt extends to just behind the heel breast, require only a seat plate.

As mentioned earlier a number of developments have taken place over the past decade regarding welted lasting. Thus, for purposes of simplification two variations will be described – the traditional method of lasting and the cement method of lasting.

Traditional Method

Insole Tacking

The insole is tacked flush to the feather edge with 5 tacks in the forepart, one at the waist and one at the seat. These tacks are necessary to hold the insole tight to the last as it is not pre-moulded.

Seat Bevelling

Where a leather insole is being used it is necessary to bevel the seat of the insole at a pre-determined angle to follow the curve of the last. This is necessary because invariably leather insoles stretch during the preparation operations. So any surplus material is trimmed off around the seat by rotating cutters.

This operation is not normally required if a previously bevelled leatherboard insole is in use.

Mulling

The uppers are mulled in the usual way.

Insert Stiffeners

Pre-moulded leatherboard stiffeners are dipped into a bath of diluted latex and then inserted between the upper and quarter linings.

New Balance - EX1016

Back Tacking

The upper is positioned over the last and tacked to the insole at the seat, determining the correct backheight and ensuring the backseam is central. Two tacks are generally used, one each side of the backseam.

Insert Toe Puffs

Men's fully lined walking shoes require a substantial toe puff. A celastic puff is most commonly used. The puff is activated in acetone and positioned, when partially dry, between upper and lining. This type of puff is self-adhesive when partially dry so holds itself firmly in position.

Pulling Over

Conventional pulling over machines were developed to reproduce the strains originally used in hand lasting, i.e. the initial pull of the machine pincers is over the toe, with the side pincers following to pull the upper down on the last. The pincers operate against springs and the strength of the pull can be adjusted hydraulically for lighter materials.

Before operating the machine, the initial pull on the upper is the heel to toe tensioning. This is done by means of a bench pincer. Using the correct handling, the shoe is transferred to the machine, positioning the lasting allowance into the machine pincers of which there are five. At each pincer position a tack block holds a tack ready for driving.

The action of the machine is in two parts:-

(1) The pincers grip the toe and sides of the forepart lasting allowance, pulling the upper down on to the last. The upper, at this stage, can be adjusted if necessary for any minor balancing alterations.

(2) The pincers release fractionally before the machine drives a tack in at each position through the upper and insole into the last. The tacks are left proud in the upper positioned tight against the wall of the insole.

This is a highly skilled operation requiring a high degree of accuracy on the part of the operator.

The correct result must be:-

(a) Vamps holding firm and tight to wood

(b) Uppers matching as pairs

(c) Patterns square

(d) Toplines tight and correctly balanced

(e) Vamp and toe cap depths correct

(f) Backseams straight

(g) Correct number of tacks

(h) No damage to upper

Side Staple Lasting

This operation is similar to that of consol side lasting, but staples are used instead of tacks. These staples made by the machine from a roll of wire driven sideways through the upper and lining and securing them to the insole wall. This permanently holds the upper in position through the waist. The staples are positioned at 12mm ($\frac{1}{2}$") intervals from the end of the insole wall up to the pulling-over tacks on both sides of the waist.

The correct result must be:-

(a) Uppers tight to wood through waist

(b) Toplines correctly balanced

(c) Backseams central

(d) Back heights correct

(e) Linings cleared and free from creases

(f) Staples positioned half way up insole wall

Bed Lasting (Toe Lasting)

The shoe is inserted in the machine in an inverted position. The toe tack is removed. Hand operated, often power assisted, wiper plates are wiped in to hold the lining, toe puff and upper tight to the wall of the insole. The plates hold in this position while an anchor tack is placed on either side of the forepart just behind the plates. A soft wire is fastened to the first tack, pulled tightly around the toe of the shoe, tight to the base of the wall and fastened to the second tack. The wiper plates are then released. The ends of the wire are turned in over the wall of the insole to minimise damage.

The correct result must be:-

(a) Toe shape correct to last

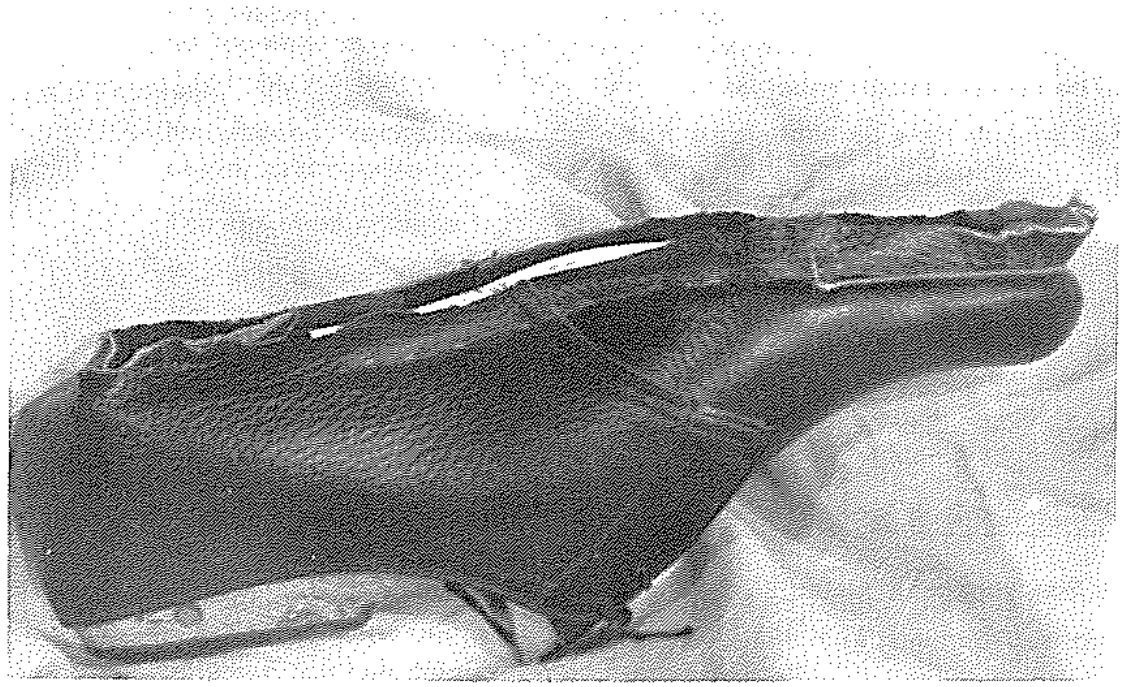
(b) Lining, toepuff and upper held tight to wall of insole by bracing wire

(c) No creases around toe

New Balance - EX1016

(d) No damage by wiper plates or wire ends

(e) Shoes matching in pairs



Waist lasting and toe lasting completed

Seat Lasting

The seats are tack lasted. A machine commonly used for this operation is the B.U. No. 4 Tack Seat Lasting machine.

The shoe is placed in the machine in an inverted position on a jack-post. As the first pressure on the treadle takes place the shoe is moved inwards and upwards so that the back of the shoe is fitted against an adjustable leather seat band. A second pressure on the treadle causes a series of wiper blocks to move in over the seat of the shoe. These wiper blocks flatten the lasting allowance in the seat area. Tacks held in the wiper blocks are driven simultaneously into the seat thus securing

the lasting allowance to the insole. The machine can be fitted with one or two tack boxes, the tacks being fed through tubes into the driving position by the action of the machine on the previous shoe.

Up to twenty tacks are driven into the shoe simultaneously, the points of the tacks being clinted over on the seat plate of the last. The position of the tacks is important. They must be 9.5mm (3/8") in from the feather edge of the seat to avoid fouling the seat rivets and heeling nails which are inserted at later stages in the process.

The correct result must be:-

(a) Back height correct

(b) Seat to be exact shape of last

(c) Feather edge free from creases

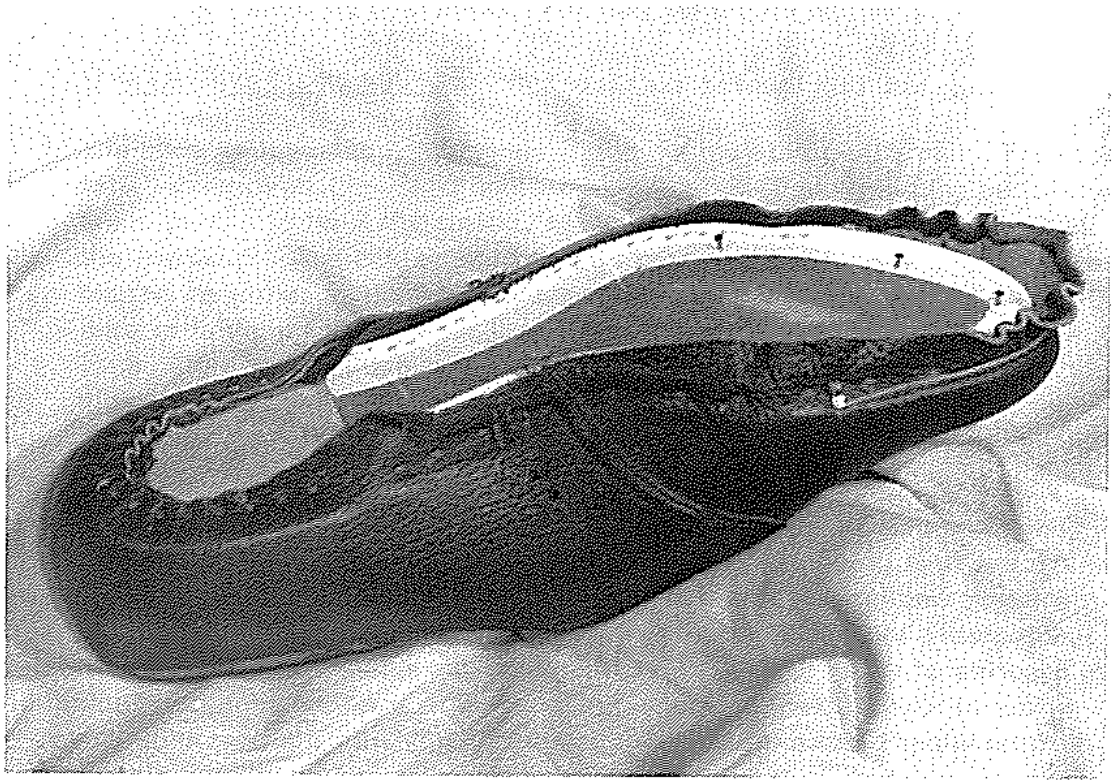
(d) Tacks 9.5mm (3/8") from feather edge

(e) Correct number of tacks

The shoe is now completely lasted.

Heat Setting

(See chapter entitled "Conditioning of Uppers").



Fully lasted shoe (traditional method)

New Balance - EX1016

CEMENT LASTING FOR WELTED WORK

As mentioned previously a number of developments have taken place during the past decade in lasting techniques and systems for welted footwear. These have been concerned mainly with the adaptation of cement lasting machinery.

The use of cement lasting has a number of advantages, e.g.

(1) Cemented and welted footwear can be lasted on the same machinery so increasing machine utilisation and reducing the amount of machinery required.

(2) No staples, tacks or bracing wires are needed so welt sewing is easier and needle breakages are less.

(3) The finished shoe is lighter in appearance and more flexible.

(4) There is a significant saving in upper material.

(5) Less bottom filling is needed.

The two main disadvantages are:-

(1) Where the work is fully lined, the upper and lining must be laminated together. This means additional work in the closing room.

(2) The adhesive used for laminating upper and lining must be compatible with the lasting adhesive. If it is not then contact between the two adhesives must be avoided.

The basic sequence of operations is as follows:-

(1) Backmould and seat last or backmould only

(2) Forepart last

(3) Cement side last

(4) Seat press (for work that has been only backmoulded)

Backmould and Seat Last (or Backmould only)

This operation is carried out on the last as described in the chapter headed "Cemented Construction" using a pre-cemented insole and upper.

Forepart Last

A number of machines can be used for forepart lasting of welted work. The criterion is that the machine must have a suitable hot-melt cement applicator or imprinter to apply adhesive to the insole rib. Alternatively, hot melt must be able to be switched off if using a pre-cemented rib.

New Balance - EX1016

The wiper plates must not wipe in too far or the rib may be damaged. Consequently, a limiting mechanism is needed on the machine so that the wiping action "stops" at a pre-determined position.

Either conventionally ribbed insoles or the more recent types having a laid down rib can be used successfully for cement lasting.

Thus, as described in the chapter on Cemented Construction, the upper is in-lasted to the insole, being bedded firmly against the insole rib.

Typical machines used are the B.U.S.M.C. No. 4A Pulling and Lasting machine or the Astra 378B Pulling and Lasting machine.

Cement Side Last

This can be done on a variety of cement side lasting machines being carried out in a similar manner to that used for the cemented construction. Pre-cemented insoles and uppers can be employed; alternatively, hot-melt may be used.

Seat Press (for work that has only been Backmoulded)

A simple seat press can be used for this operation consisting of a heated seat plate with a pneumatic pressure pad. The shoe seat which, in this case, has been pre-cemented is positioned on the heated plate. Pressure is exerted on the backpart of the last. This serves to bed down the lasting allowance to the seat of the insole. A typical machine of this type is manufactured by the Standard Engineering Co. Ltd.

The shoe is now completely lasted.

Heat Setting

(See chapter entitled "Conditioning of Uppers").

ATTACHING OPERATIONS

Most of the operations which follow apply to both conventional and cement-lasted welted work. An asterisk (*) will denote where the operation is rendered unnecessary by the use of cement lasting techniques.

Upper Trim and Tackdraw

The remaining pulling over tacks and insole forepart tacks are removed. A simple machine, using two disc cutters, trims surplus upper, toepuff and lining material down to the top of the insole wall.

New Balance - EX1016

Pound Seat*

The seat is pounded flat on a pounding machine. Loose rings connected to a high-speed rotating cylinder produce a beating action to pound the lasting allowance flat to the insole.

Lift Anchor Tacks*

It is important that the two anchor tacks holding the bracing wire are slightly lifted to prevent needle breakage at welt sewing.

Welt Sewing

This is a highly skilled operation because all subsequent operations and the wearing qualities of the finished shoe depend on correct welt sewing. The welt is a narrow strip of leather, $\frac{1}{2}$ - $\frac{3}{4}$ inch wide, depending on the type of shoe made, and from $2\frac{1}{2}$ - 6 iron in substance. On the flesh side is a groove in which the stitch is embedded, and on the grain side, the welt is bevelled so that it will lie at right angles to the feather edge when beaten. The welt is tempered before sewing.

The machine is rather complex, producing a chain stitch. The linen thread passes through molten wax and is coated. The object of this wax coating is to lubricate the thread and to seal up the holes made by the needle in the welt and upper, thus improving the waterproofing property of the shoe. The thread passes through heated elements to keep the wax in its molten state right up to the point where the needle makes the stitch.

The welt is threaded into the welt guide, which is set in such a position that the needle pierces the welt through the groove.

The welt is now sewn into the base of the insole wall, permanently combining the upper and welt to the insole. The awl, synchronised with the needle, pierces the welt and upper material but not the wall of the insole. The awl and needle feed mechanism is pre-set to produce the correct stitch length, usually 4 stitches per inch, giving a strong seam.

The correct result must be:-

(a) Stitched seam in groove on welt and to bottom of insole wall.

(b) Correct stitch length.

(c) Correct tension with welt and upper held firmly to insole wall.

Remove Bracing Wire and Insole Tacks*

If the welt sewing is correctly accomplished, the bracing wire will have been forced up to the top of the insole wall and can be easily removed. The two anchor tacks and the three remaining insole tacks are also removed.

Inseam Trimming

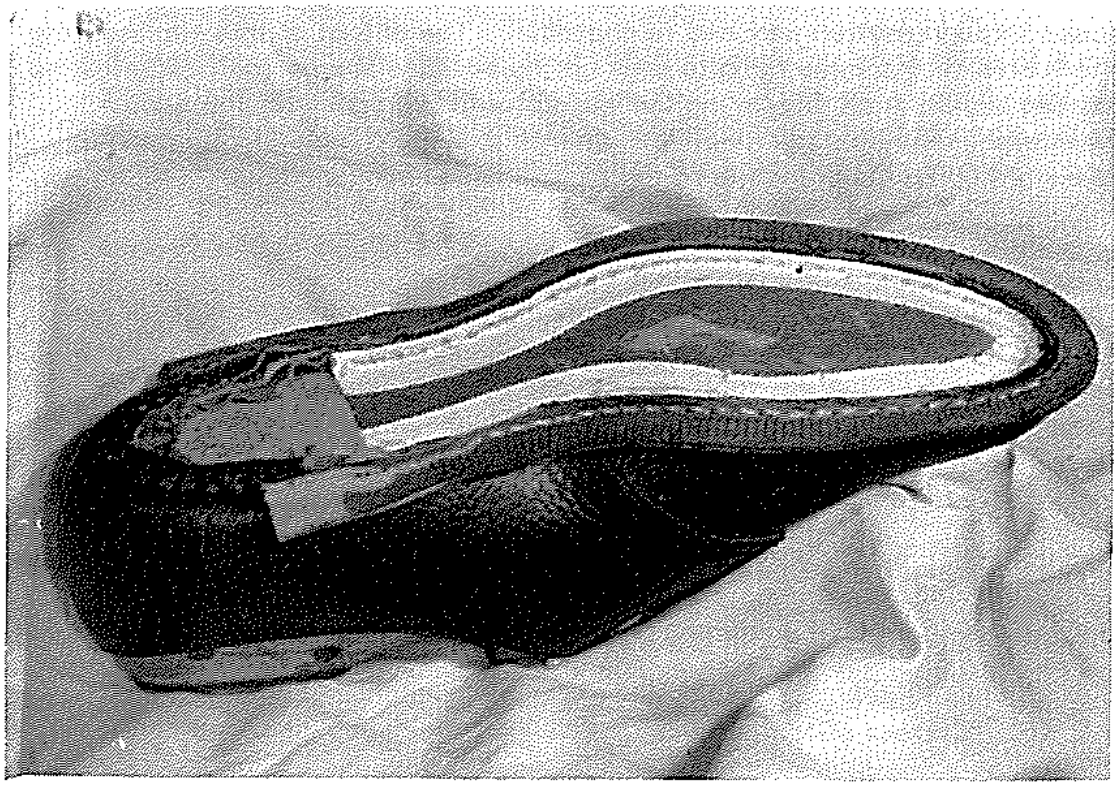
A cylindrical knife trims the welt, upper and insole wall tight to the seam to reduce the eventual cavity between insole and sole, and to improve flexing.

This operation cannot be carried out successfully unless the welt has been sewn in correctly. Any damage to the welt seam will result in failure of that seam.

The correct result must be:-

(a) No damage to stitched seam

(b) All surplus material trimmed tight to seam



Welt sewn in, and inseam trimmed

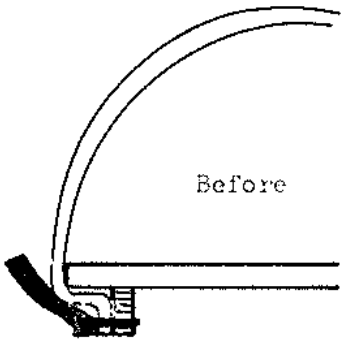
New Balance - EX1016

Welt End Tacking and Butting

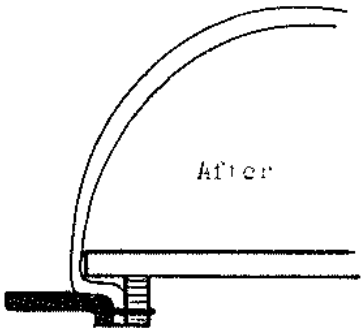
This is a bench operation. The object is to beat the welt ends at the ends of the insole wall back into line with the wall, and to tack them in that position. The ends are then skived to a knife edge to blend with the seat piece at a later stage.

Welt Beating

The welt, still in its mellow state, is beaten for two reasons. Firstly, to bring it out at right angles to the shoe and, secondly, to consolidate the fibre structure which will result in a better edge finish. The welt is fed between the anvil and a vibrating hammer. Care must be taken that the welt is not damaged.



WELT BEATING



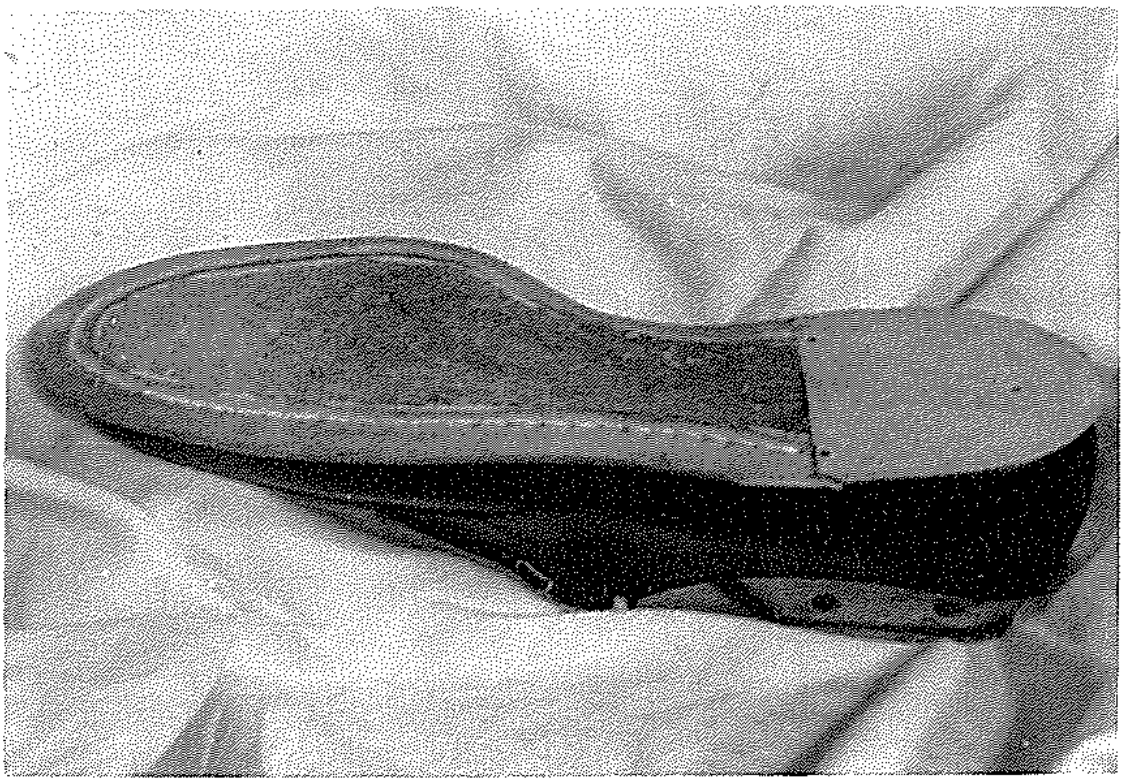
Shank and Bottom Fill

The shank is attached with hot melt or molten pitch. It cannot be secured by tacking because the last only carries a seat plate. Many manufacturers "buy in" a special purpose shank which acts as a filler for the cavity at seat and waist.

The whole cavity on the bottom of the shoe created by the insole wall is filled to produce a flat bottom after the sole is attached. When a special purpose filler is used it also acts as an insulation and cushioning to the bottom of the foot.

It is generally accepted that the best type of filler for machine welted shoes is a resin bonded granulated cork filler. This filler is heated and applied with a hot, special purpose knife. This is known as a hot filler.

The main type of cold filler in use is ground asbestos fibre, mixed with a thin rubber solution. The disadvantage of this is that it shrinks on drying. A mixture of ground leather fibre and rubber solution is also used.



Shank inserted, bottom filled and seat piece attached

New Balance - EX1016

Attach Seat Piece

A leather seat piece of the same substance as the welt and skived to match the welt skive, is attached at the seat. The skived edge is solutioned and the seat piece is tacked over the lasting allowance. Its function is to build up substance around the seat, equal to that of the welt.

Dry

The shoes are passed through a drying cabinet at 25 - 30°C to dry out the welt and bottom filler. The welt cannot be force-dried rapidly, because it is vegetable tanned and chars at fairly low temperatures.

Cement Bottoms

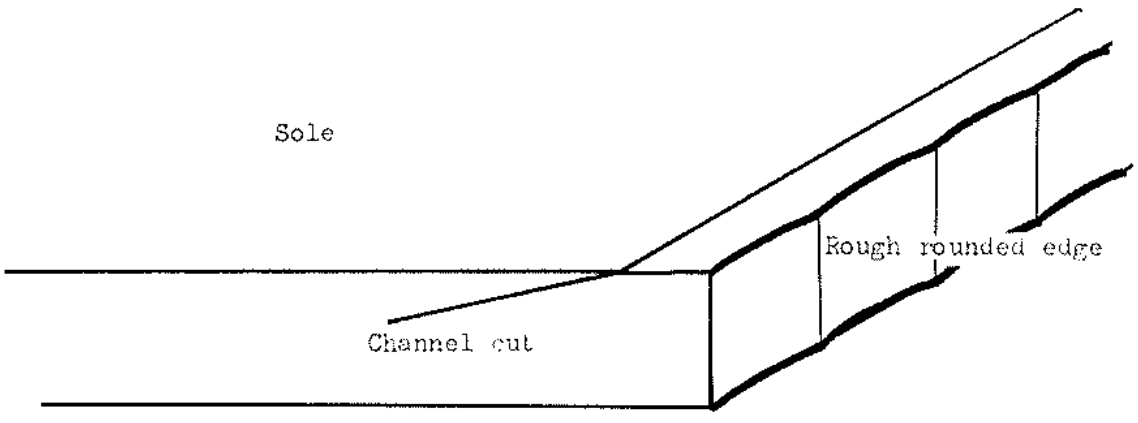
The complete shoe bottom is coated with sole attaching cement, usually neoprene, and allowed to dry.

Sole Attaching

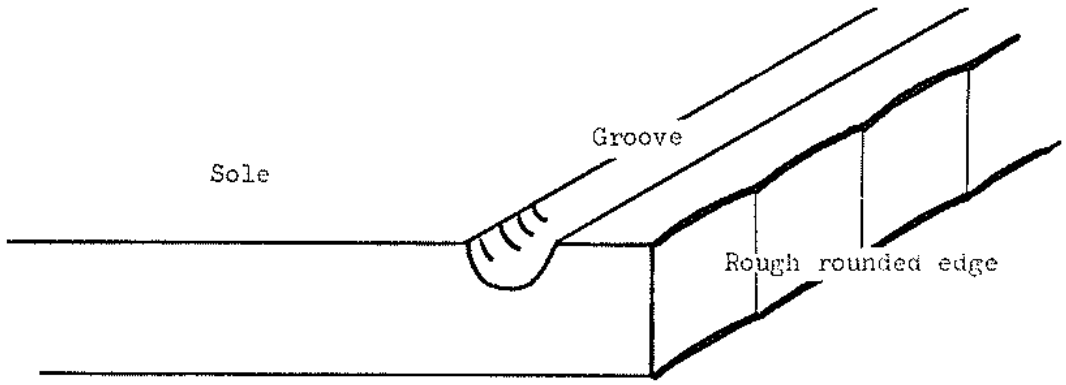
The tempered soles are married up to the ticket of work. Following heat activation the soles are attached to the shoes and pressed in the sole laying press. It is usual to leave an allowance on the sole pattern for rough rounding. Providing there is sufficient width left all round, no great degree of accuracy is required.

Rough Round and Channel

This operation has been described in the Veldtschoen construction but for machine welted it is a more highly skilled operation. Not only is the edge of the sole trimmed but it is necessary to vary the width of welt around the shoe to improve the appearance. Simultaneously, a channel is cut in the bottom of the sole to bury the stitching and improve the appearance of the sole bottom.



New Balance - EX1016



Alternatively, a groove may be cut out on the bottom of the sole to partially bury the sole stitching; this is normal on brogue shoes.

The correct result must be:-

(a) Correct width of welt around shoe

(b) Shoes to match in pairs for welt profile

(c) Clean edge

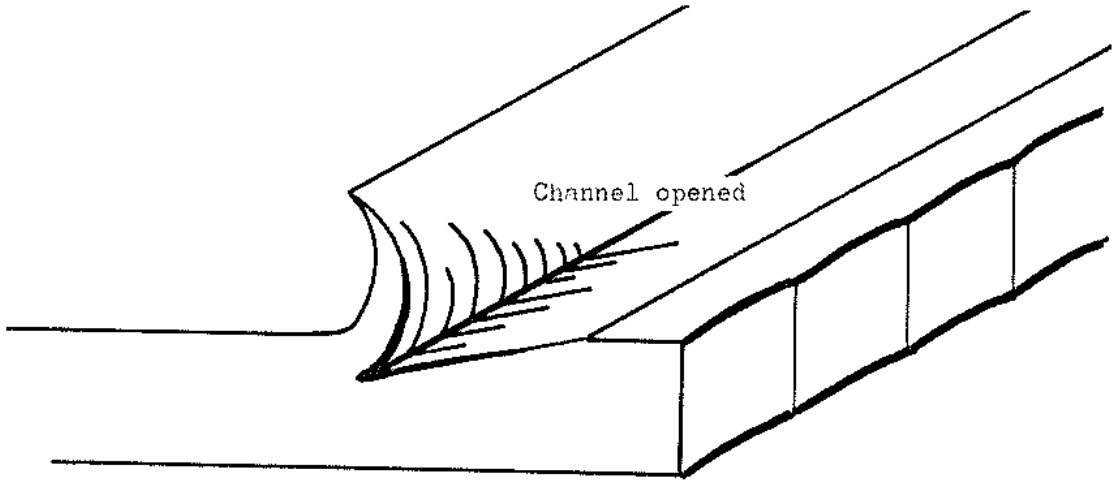
(d) Correct edge of channel

(e) Correct width of channel

(f) No damage to channel

Open Channel

A revolving tool lifts the lip of the channel and turns it back so that the outsole stitching will lie in the base of the channel.



New Balance - EX1016

Outsole Stitching

The soles are still in the mellow state. This operation is the same as outsole stitching on the Veldtschoen construction except that now the stitching cannot be tight to the feather edge because this would damage the welt seam. Instead, an edge guide known as the Scotch Edge is used around the forepart. The stitching must lie in the base of the channel or in the groove. Therefore, it can be seen that there must be a distinct link between Rough Rounding and Outsole Stitching, if the stitching is to be accurately positioned in the channel or groove.

The threads used are generally linen but there are some pure synthetics and some linen and synthetic mixtures on the market. The machine can be set to stitch thin or heavy threads ranging from 4-cord to 12+.



Outsole stitching completed

New Balance - EX1016

The correct result must be:-

(a) Correct stitch length

(b) Correct tension

(c) Stitching correct distance from feather edge

(d) Stitching in correct position in channel or groove

(e) Good stitch appearance on welt

Cement Channel

A resin based latex is applied to the base and lip of the channel and allowed to dry.

Close Channel

The shoe bottom is pressed against a slowly revolving brass wheel with large indentations, to lay the channel flat to the sole, covering the stitching.

Stitch Wheeling

The object of stitch wheeling is purely decorative. An indentation is made in the welt between each stitch to emphasise the stitch.

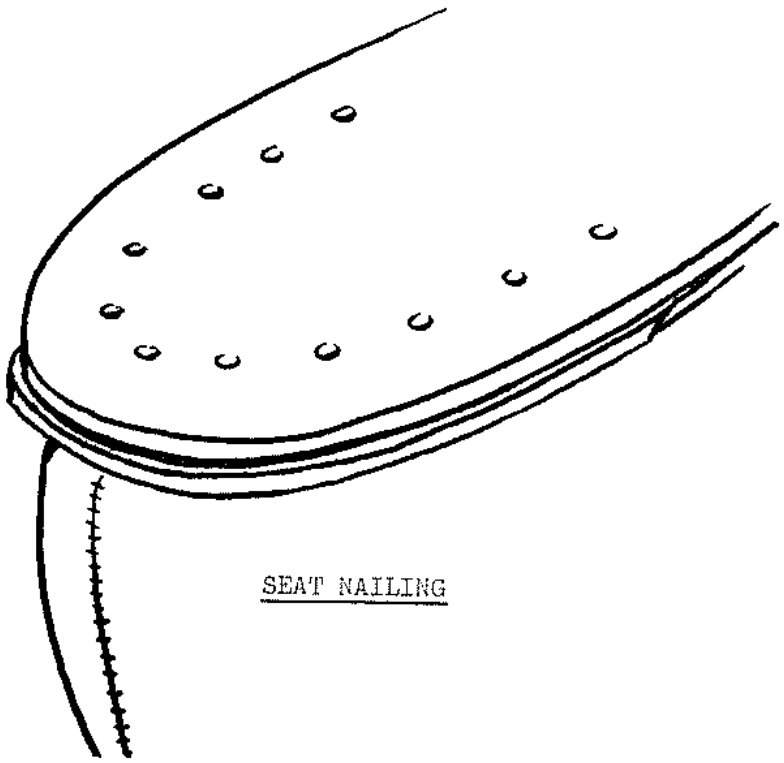
The wheeling machine is fitted with a rotary table which is spring loaded and a heated wheel with exactly the same number of teeth per inch as there are stitches per inch on the shoe. The operator positions the edge of the shoe between the reciprocating wheel and the rotary table and stitch-wheels around the shoe from the heel breast on the outside to the inside joint, but not the inside waist.

Bottom Levelling

The object of this operation is to conform the sole and welt to the contours of the bottom of the last. It is desirable that the soles are still in a mellow state. The machine processes a pair at a time. The shoes are inverted and locked to the machine. Brass rollers, slightly reciprocating, are brought down onto the sole under pressure and roll the sole flat. Brass is used to eliminate any iron stains which might occur if iron came into contact with the damp sole.

Seat Nailing

The seat of the sole is permanently attached to the insole with nails. The shoe is fitted on a swivelling jack and the nails are spaced singly around the seat, $\frac{1}{4}$ inch from the edge of the insole, and are clinted over against the seat plate on the last.



SEAT NAILING

Seat Paring

The surplus sole and seat lift around the seat is trimmed off to 1/8" from the feather edge by machine. This acts as a guide for the operator on heel attaching to position the heel correctly.

Heeling

This method of attaching heels is known as the Outside Method of Attaching. The last is not removed and the shoe is placed into the machine in the upright position. Bifurcated nails are driven into the seat of the sole in the required pattern. The identical pattern of holes is pricked into the heel which is held in a clamp. The heel is now transferred along a runway to be accurately located under the seat of the sole, and the heel is pushed onto the nails. This is a very strong method of attachment and because the last does not have to be removed, there is considerable saving in labour cost and better shape retention results.

The correct result must be:-

(a) Heel to be square to sole and correctly positioned at seat

(b) Heel to be securely attached

(c) Pitch of heel to be correct

The shoes are now ready to be transferred to the Finishing Department where the soles and heels will be completed.

CHAPTER 19

CALIFORNIAN SLIP—LASTED CONSTRUCTION

This is the modern development of a centuries-old system of slipper manufacture. The slip-lasted construction is used where the main criterion is comfort.

The method differs completely from the other methods described in two main ways:-

(a) The closed upper has a partially lasted appearance. This is due to the fact that a fabric sock has been stitched to the vamp around the edge of the forepart.

(b) During lasting the last has to be forced into the partially formed upper to positively form the upper to the shape of the last.

Thus, the system is sometimes called 'force-lasting'.

The partially-lasted appearance of the upper is achieved in the following manner:-

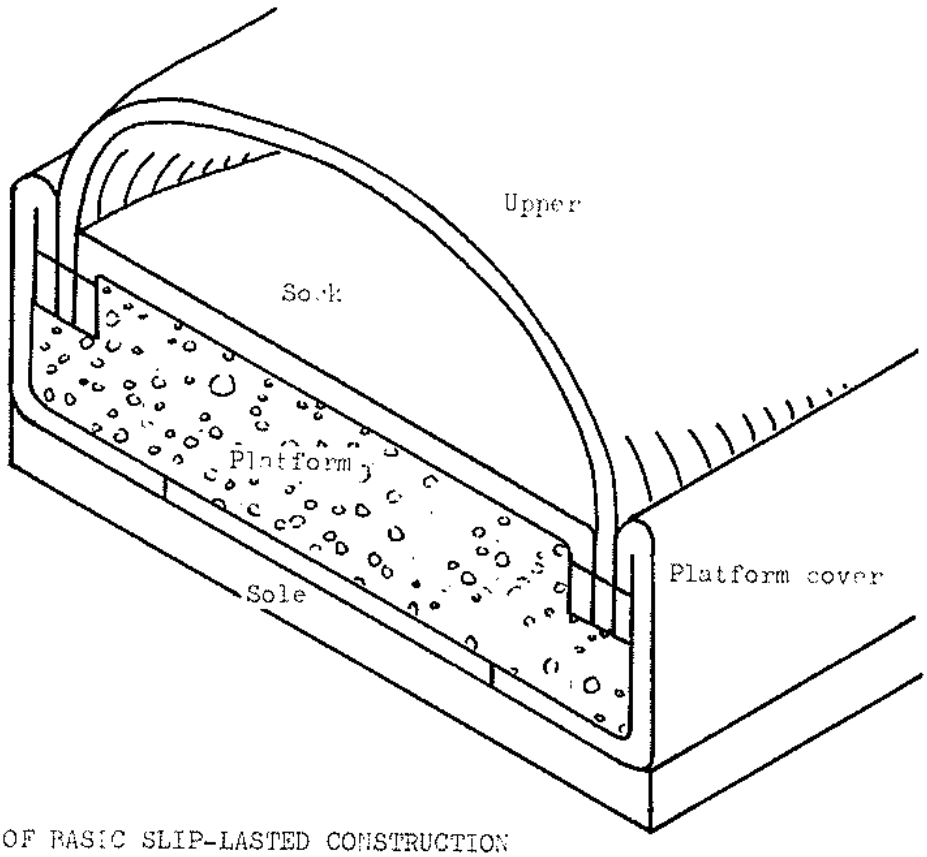
(a) Instead of the normal 12 - 13mm ($\frac{1}{2}$ inch) lasting allowance only 1.5mm (1/16") has been added to the net upper pattern. This may be done around the whole shoe or sandal. Alternatively, this may be in the forepart only with a conventional lasting allowance in the waist and seat.

(b) To this 1/16" allowance a fabric sock is stitched with a closed seam. A strip of leather or P.V.C. coated material is usually stitched face-to-face with the upper on the outside of this seam. This is the platform cover. The seam is an integral part of the upper and must be strong.

Pattern cutting must be of a high standard to achieve a tight fit when the last is forced into the upper. Notches are built in to the cutting knives for socks and vamps. These notches must fit exactly together when stitching takes place. No margin of error can be accepted as any slight discrepancy will result in the upper being out of balance when the last is inserted.

The main feature of this construction is the comfortable 'cushioned' effect obtained by the use of a platform. Originally, a layer of resin-bonded cork was used but this has generally given way to foam rubber. A flat-bottomed last with little toe spring is used; this creates a broad tread area and gives added comfort in wear. The last is either a two-part type joined with a screw or a self-shortening one.

New Balance - EX1016



CROSS SECTION OF BASIC SLIP-LASTED CONSTRUCTION

In this chapter we have selected two types as our standard.

(1) A shoe having a slip-lasted forepart only with consol-lasted waist and stuck seat.

(2) A fully slip-lasted strap sandal.

(1) A SHOE HAVING A SLIP-LASTED FOREPART WITH CONSOL LASTED WAIST AND STUCK SEAT

Insert Stiffeners and Backforming

These two operations are carried out exactly as for normal cement lasting.

New Balance - EX1016

Force Lasting (Insert Lasts)

If a two-part last is used, the screw is slackened. The backpart is positioned in the back of the upper and the forepart of the upper is forced over the forepart of the last. But if a self-shortening last is used it is first "broken" and then inserted into the forepart of the upper. The quarters may now be pushed over the backpart of the last.

It is important at this stage that the stitched seam is positioned accurately around the feather edge of the last forepart as any inaccuracy will have an important effect upon the final appearance.

A two-part last is now screwed together or a self-shortening last is relocked into position. This action, in each case, progressively lengthens the last so achieving a tight fit.

Providing that the sock has been positioned correctly, has not stretched, is the correct size and fitted accurately to the notches, the upper should now be balanced and tight to the last.

An important aspect, also, is that the back height and back seam are correctly adjusted.

The correct result must be:-

(a) Shoes matching in pairs

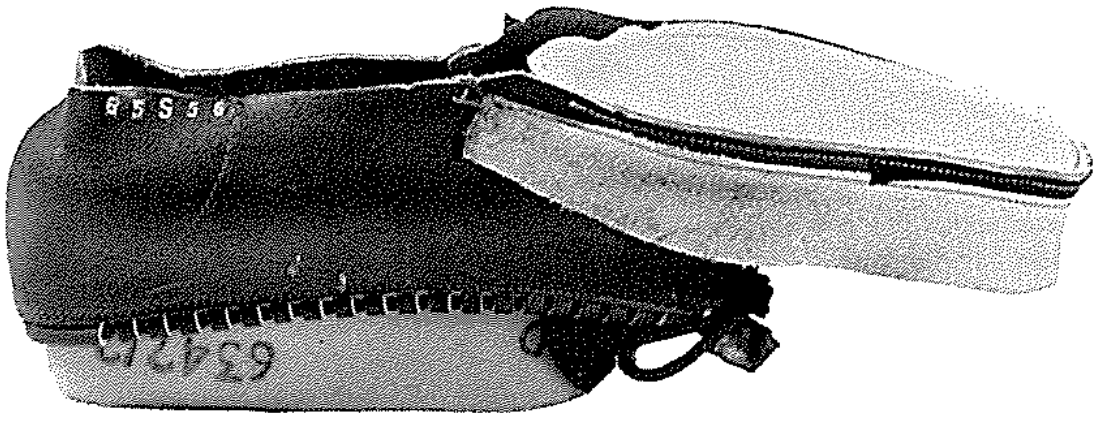
(b) Uppers correctly balanced

(c) Lasted tight to wood

(d) Back heights correct

(e) Back seams straight and central

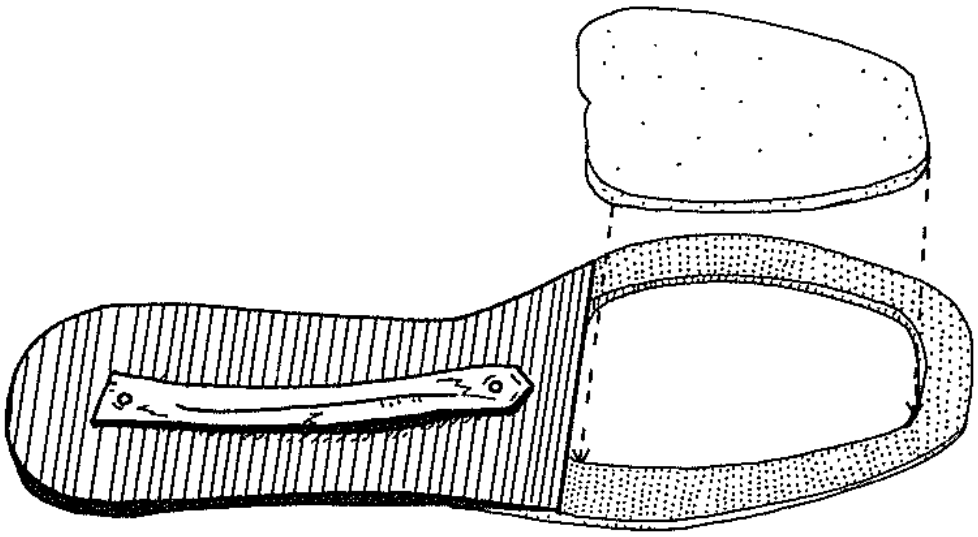
(f) No burst seams



Force-lasting completed

Insert Insoles

The insole may be of the pre-shanked blended type with a flexible leatherboard forepart and a rigid cellulose backpart. Alternatively, the forepart may be of a 'skeleton' type where the centre has been cut out leaving a margin approximately 12mm ($\frac{1}{2}$") wide around the edge of the forepart. This cavity is so designed that the foam platform will fit into it at a later stage.



"Skeleton" Insole

The forepart of the insole and the sock are coated with latex. First, the insole backpart is inserted under the lasting allowance of the waist and seat. Then the forepart is fitted accurately on to the fabric sock so that the insole sits neatly against the inner edge of the seam all the way round. The insole is pressed into position by hand.

New Balance - EX1016

The correct result must be:-

(a) Insole correctly positioned in waist, seat and forepart

(b) Insole forepart securely stuck to sock

Pull Up Platform Covers

The platform cover is now pulled upwards over the feather edge by hand and using lasting pincers. A coat of latex is applied to the inner surface of the cover and to the margin of the insole forepart and allowed to dry to a "tacky" condition, using heat if necessary.

The correct result must be:-

(a) Platform cover pulled up evenly all round forepart

(b) Platform cover and insole correctly latexed

(c) No distortion of platform seam

Wrap Over Platform Cover or Forepart Last

Using a Kamborian machine the platform cover is turned over and stuck down to the insole forepart. The cover must be pulled tight over the feather edge and be free from creases to give a good appearance.

Alternatively, a forepart lasting machine can be used. The B.U. 4A and the Astra 278 have both been used for this operation. The only differences between this and normal forepart lasting is that the hot-melt imprinter is not used and the centre toe-pincer is shut off. This latter adjustment is necessary to avoid pulling the platform cover down too hard at the toe. The use of forepart lasting machines has been quite successful providing that the operator adjusts the wiping action and bedding pressure of the machine carefully. When using this method the platform cover forms the lasting allowance.

The correct result must be:-

(a) Cover pulled tight over feather edge without distortion of the platform seam.

(b) Cover stuck to insole forepart without creases

(c) Platform cover appearance to be even all round forepart.

Consol Lasting

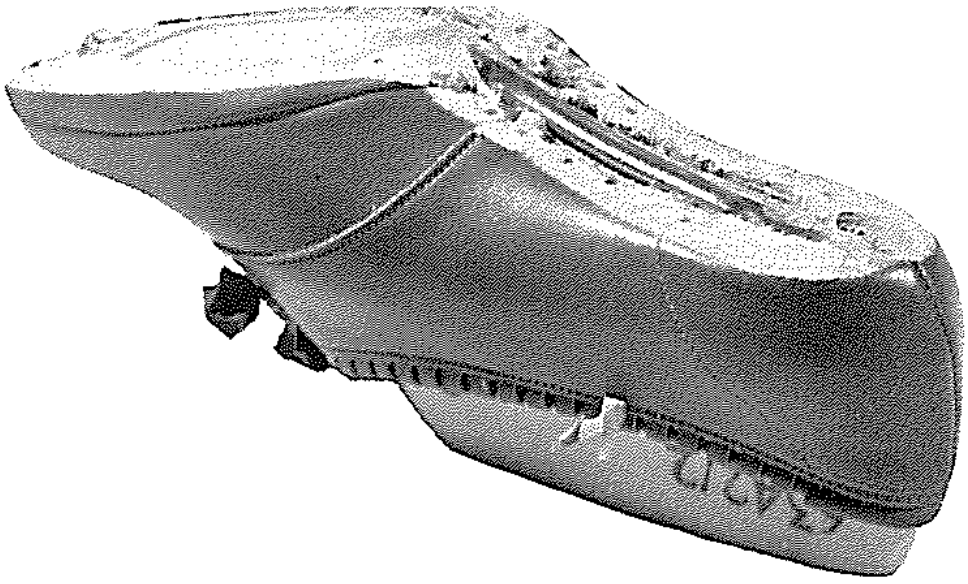
This operation is carried out as described in the chapter on "Cemented Construction". An addition, however, is that the operator has to pull in and tack down the ends of the platform cover neatly behind the joints.

Seat Press

As previously described in "Cement Lasting for Welted Work".

Bottom Roughing

As for Cemented Construction where a leather platform cover is used.



Roughing completed

Solvent Wiping

As for Cemented construction but may be platform cover only.

Cement Bottoms

As for Cemented construction with the operator also fitting the foam pad into the cavity of the insole to form the platform.

New Balance - EX1016

Cement Drying

As for Cemented construction.

Sole Attaching (Sole Laying) and Last Slipping

As for Cemented construction.

The shoes are now ready for the Treeing department.

(2) A FULLY SLIP-LASTED STRAP SANDAL

The insole used for this type of work is a through insole of leatherboard bonded to a layer of foam. The foam forms the platform.

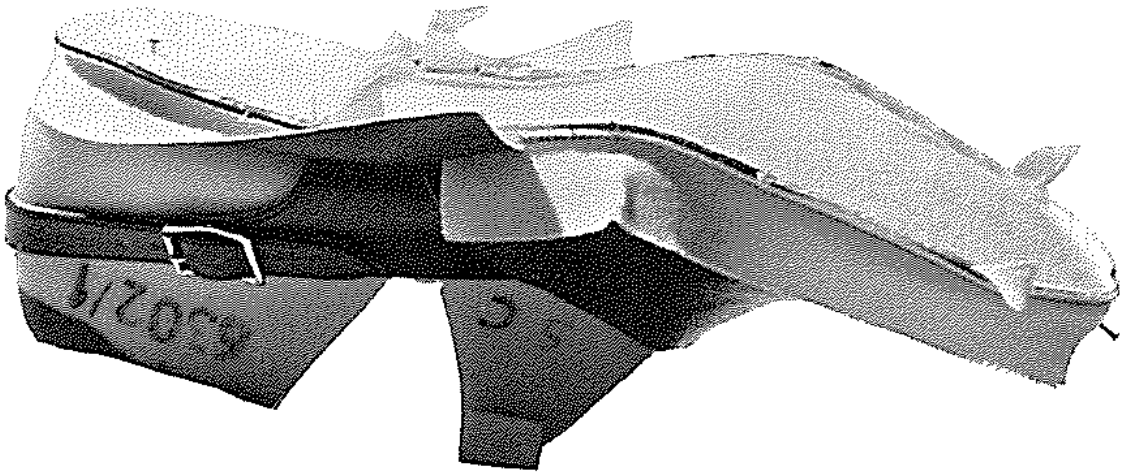
The upper is conventionally sock and platform stitched to a full fabric sock. Lasting tapes are sewn in at the corners of the vamp and at the side strap positions.

A rigid last is used.

Usually a pre-finished resin rubber sole with a pre-fitted wedge heel is used.

Force Last

The upper is forced over the front of the last with the backstrap being pushed into position over the backpart. A tack is inserted into the seat area of the platform cover to hold the seat in position.



Solution Sock and Lay Insole

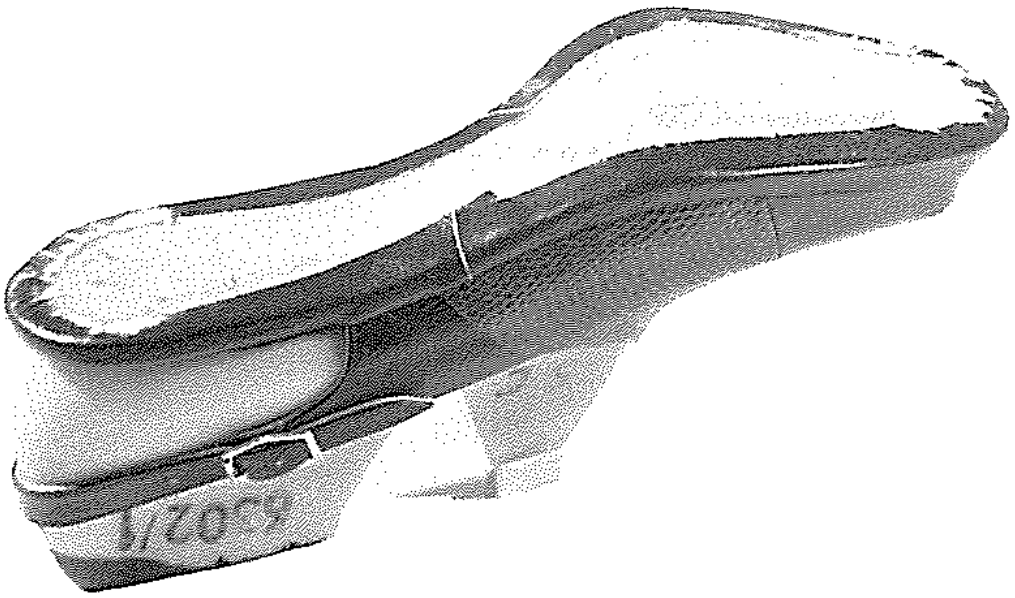
A coat of rubber solution is applied to the bottom of the sock. The lasting tapes are pulled inwards and stuck to the sock. Then the insole is laid, foam downwards, in position correctly on the sock. It is important that it fits neatly to the sock and platform seam.

Pull Up Platform Covers

The seat tack is removed and the covers are pulled up as previously described. Scissors are used to trim the corners of the cover where it is lapped in the inside waist. This cuts down the substance of the lap in the finished shoe. A coat of latex is now applied to the inner surface of the cover and the margin of the insole and allowed to dry.

Wrapping Over

The platform cover is wrapped over by hand in the waist and by using a Kamborian machine at the toe and seat.



Platform cover wrapped over and pleats sanded

Bottom Roughing

Leather platform covers are seat pressed and roughed. Any dust is blown off by an air jet.

Synthetic covers have the toe pleats sanded down, then the covers are solvent wiped.

Bottom Cementing

As for Cemented construction including fitting a filler.

Cement Drying

As for Cemented construction.

Sole Attach and Last Slipping

As for Cemented construction.

Heel Attach

The heel can be attached by the inside heel attaching method described in the Cemented construction. Some manufacturers prefer only to stick the heel to the insole.

The shoes are now ready for the Treeing department.



Completed sandal

New Balance - EX1016

CHAPTER 20
STRING LASTING

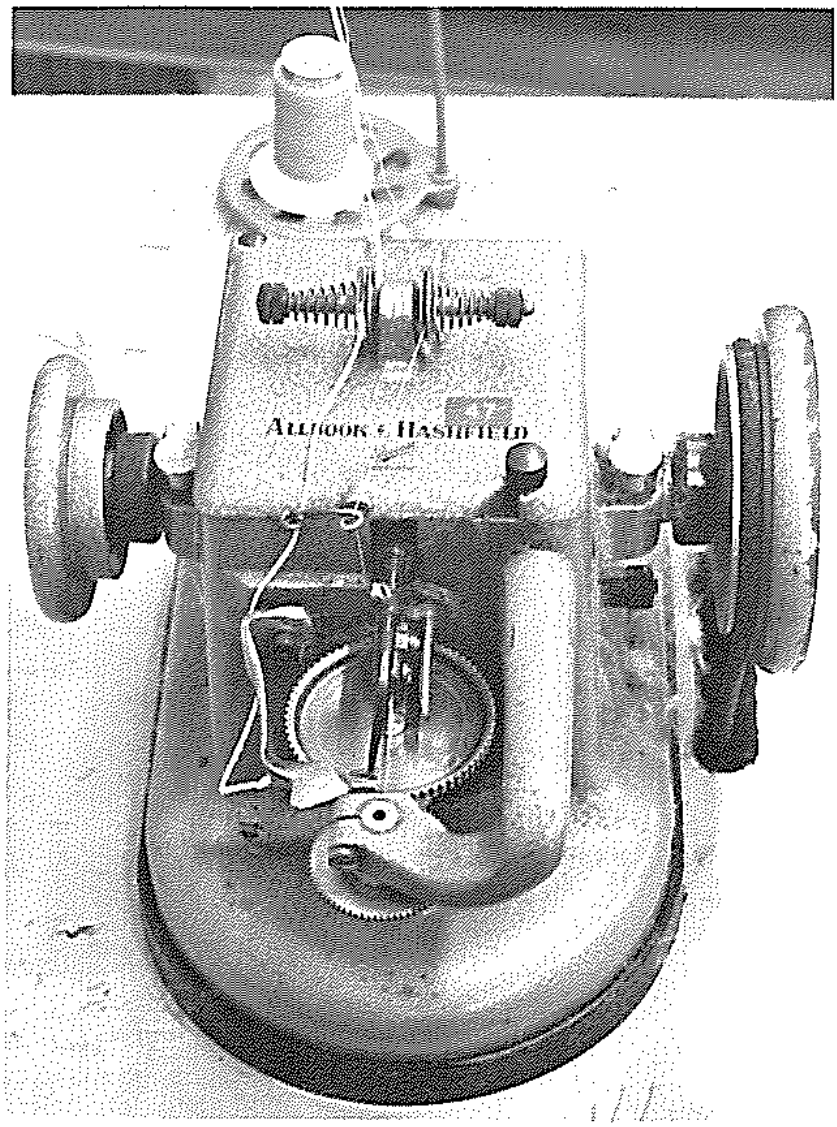
This method of lasting has been gaining popularity in recent years as it replaces all lasting operations with a single operation.

It is particularly suitable for lasting soft flexible upper materials but it has been used on a wide variety of materials.

When the closing operations have been completed, a special string-stitching machine is used to attach a strong string to the edge of the lasting allowance of the upper.

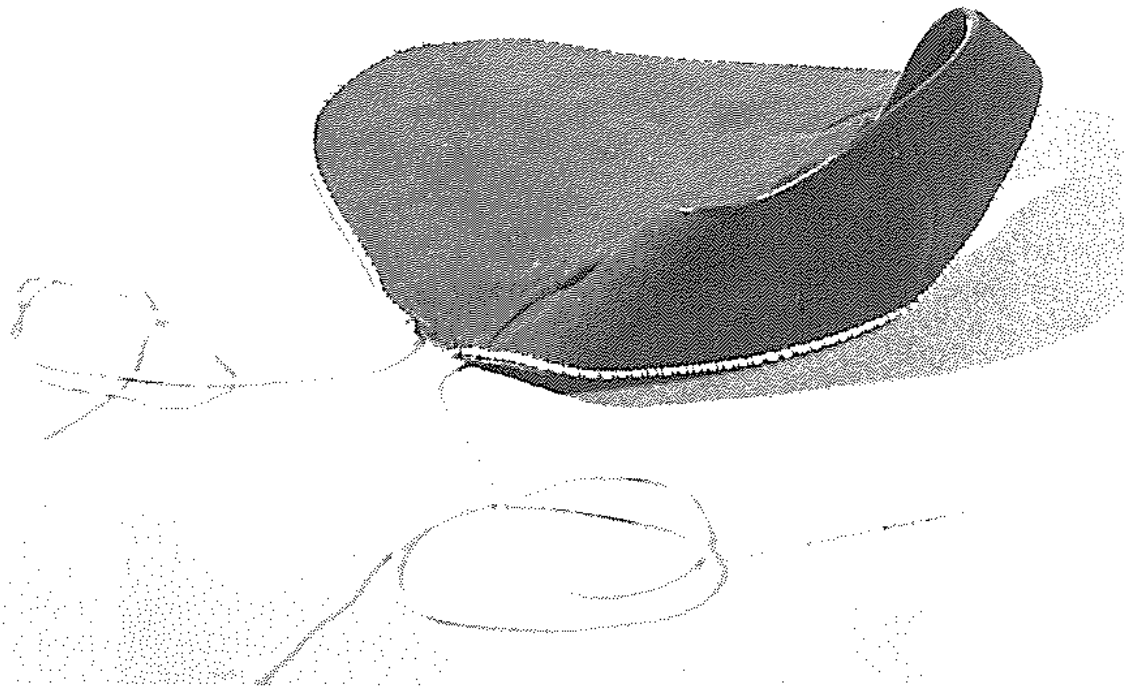
The stitch used is an overlock one which is a type of chain stitch.

Typical machines are the Bonis 'Never Stop' and Allbook & Hashfield 'Success'.

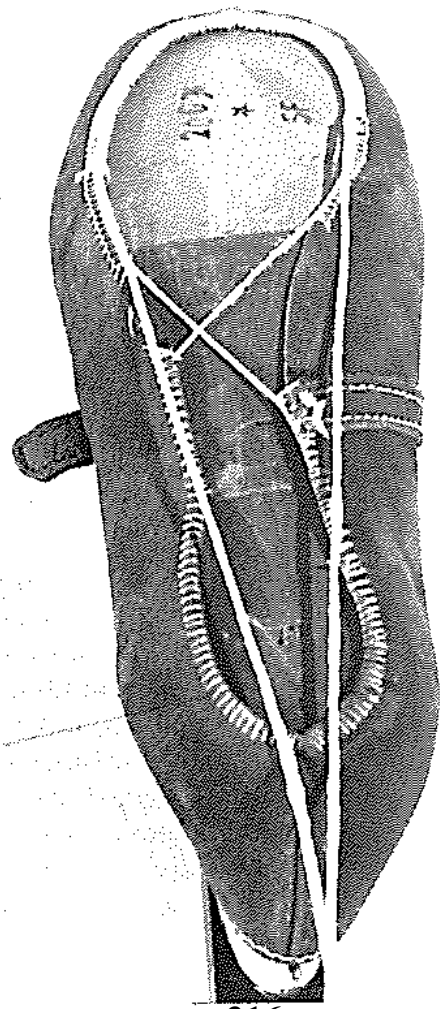


Allbook & Hashfield "Success" Overlock Stitching Machine

New Balance - EX1016



Single string



Double string in forepart

New Balance - EX1016

It is important that the tension of the overlock stitch is correct to allow the string to run freely but not loosely. Also it must not be stitched through the string. The start and stop positions must also be correct.

Ends of about 45 - 60cm (18" - 24") are left on the string for lasting.

Should any of these points be neglected it will be difficult to last the upper accurately. The uppers must be correctly conditioned, generally by steaming, before lasting.

Lasting

When using this method with direct stuck soles a normal making last is used. The method is, however, more popular for moulded constructions, so the metal last mould is more commonly used.

First the upper is placed over the last mould with the backpart of the mould unlocked. A preliminary pull on the string is made to position the upper in as correct a position as possible.

The insole is then positioned, being pushed under the lasting allowance. Usually the insole is a through one of leatherboard or more often a cellulose board without a backerboard.

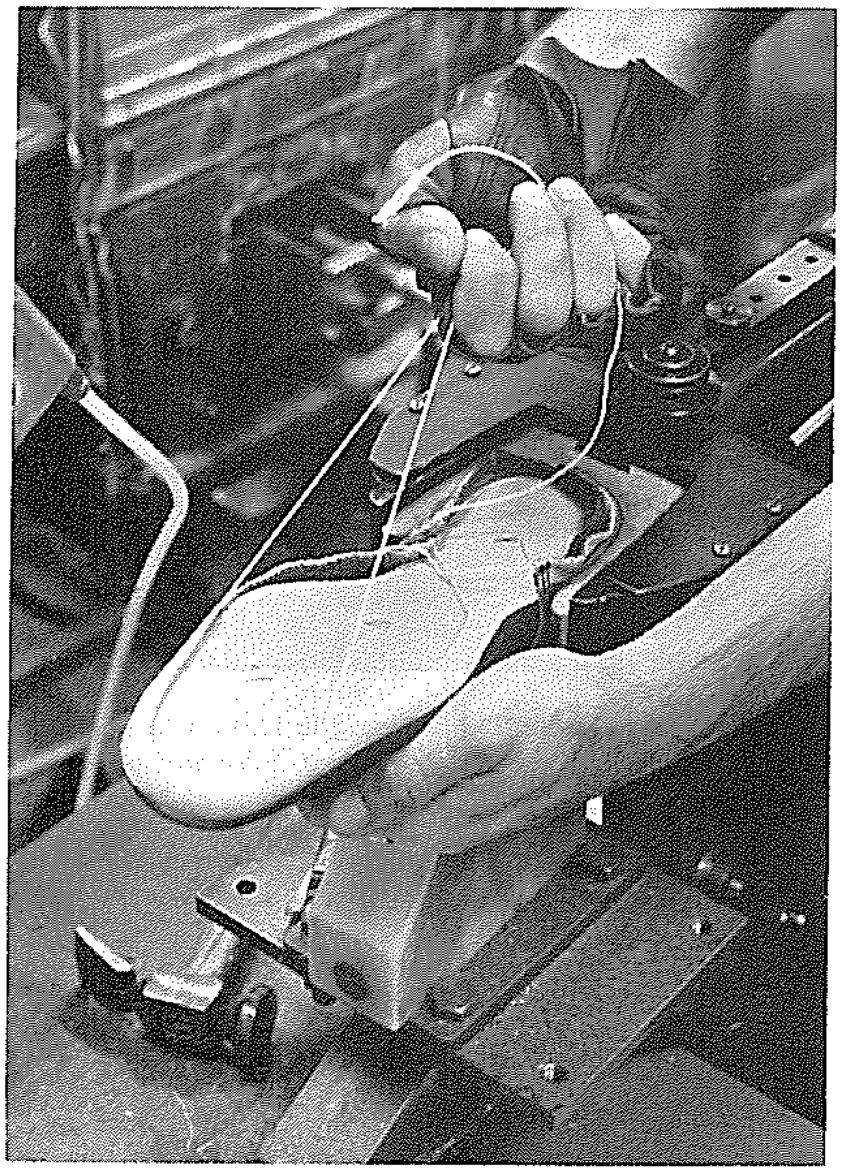
Once the insole is in position the string is pulled tightly to complete the lasting.

The ends of the string are laced across the waist being looped, knotted and cut off tight to the knot. Finally the mould backpart is locked down to ensure a very tight fit.

String lasting can be done by hand, the operative wearing a re-inforced leather glove. The ends of the string are looped around the palm of the hand so that sufficient pull can be exerted.

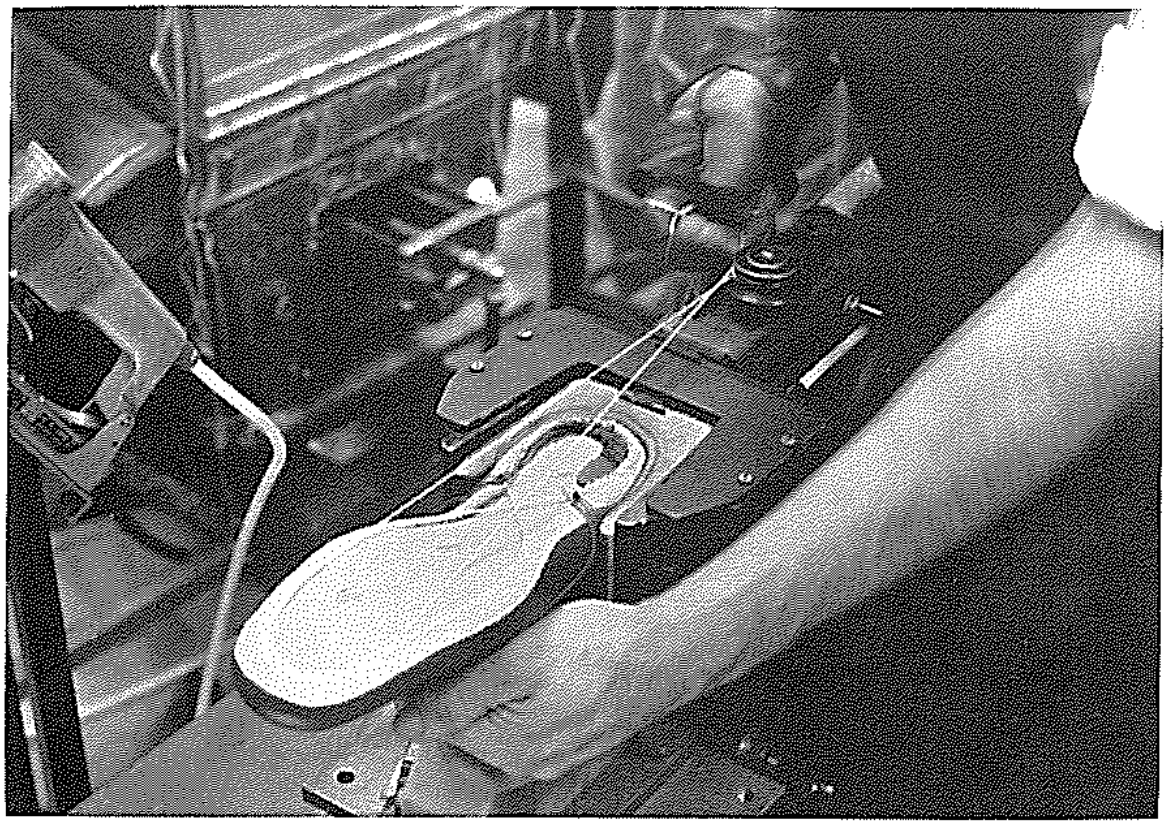
A machine has been developed by the Salient Engineering Co. Ltd. which relieves the strain on the operative.

It is usual when string lasting by hand to use only a single length of string. For machine string lasting, a second length of string is stitched around the vamp edge. This gives a locking action when pressure is exerted and the string ends do not need to be tied off. The string is in one continuous length so as the second row is being stitched a criss-cross formation is made just behind the joint. This serves to pull the lasting allowance inwards in the waist. When machine string lasting the upper is first conditioned generally by steam then placed over the last or last mould which is locked on to the machine table. The back seam and seat are centralised by hand. Pressure on a treadle brings a pneumatically-operated back rest against the back of the shoe so holding it firmly in position.

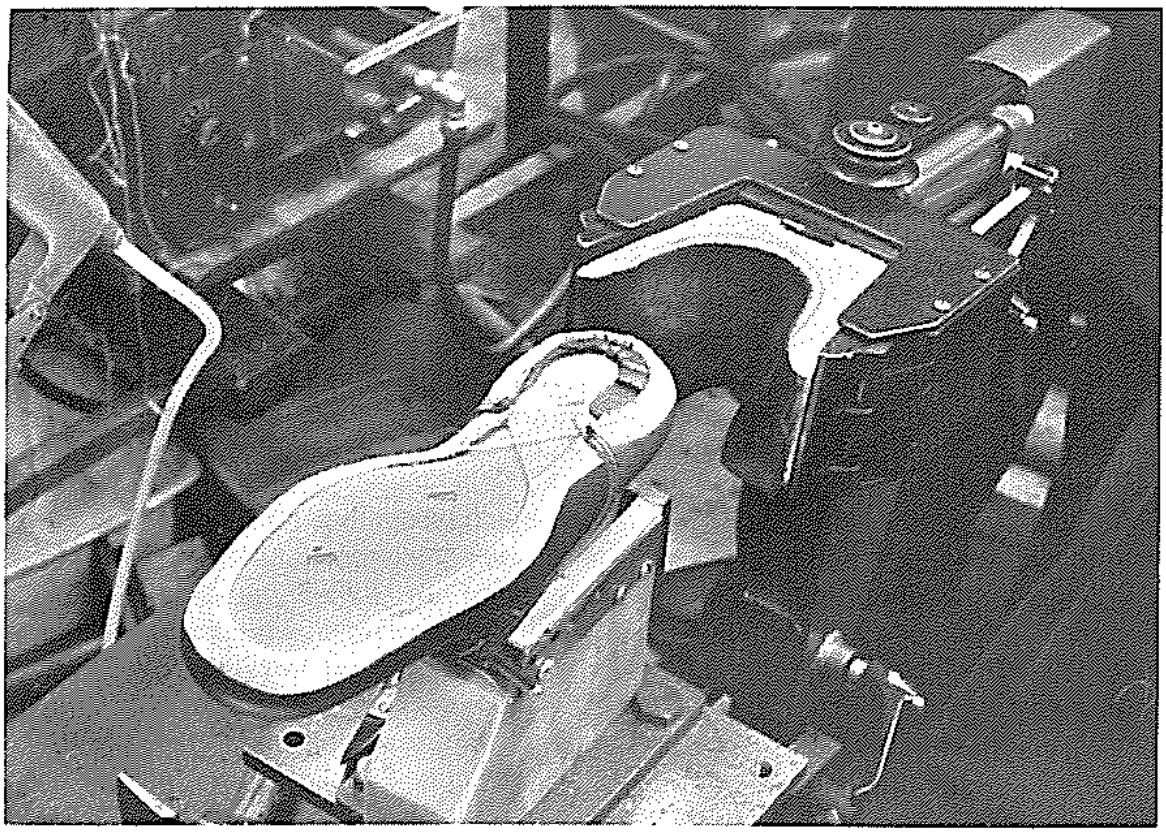


The operator positions the upper at the toe and wraps both string ends around a cam. Another treadle is used which causes the cam to pull firmly against the strings making them taut.

New Balance - EX1016



Successive pulls can be made until the string is locked firmly in position, when the ends are cut off so completing the lasting operation.



New Balance - EX1016

A shank or a combined shank and heel filler block (for moulded work) can now be positioned under the criss-cross of string and laying in the waist of the insole. It may further be held with hot melt cement if necessary.

Synthetic uppers can now be solvent-wiped over the lasted margin for direct-stuck work or moulding. Roughing has to be done carefully to avoid damage to the string. Moulded work can be removed from the machine and placed directly into the moulding machine.

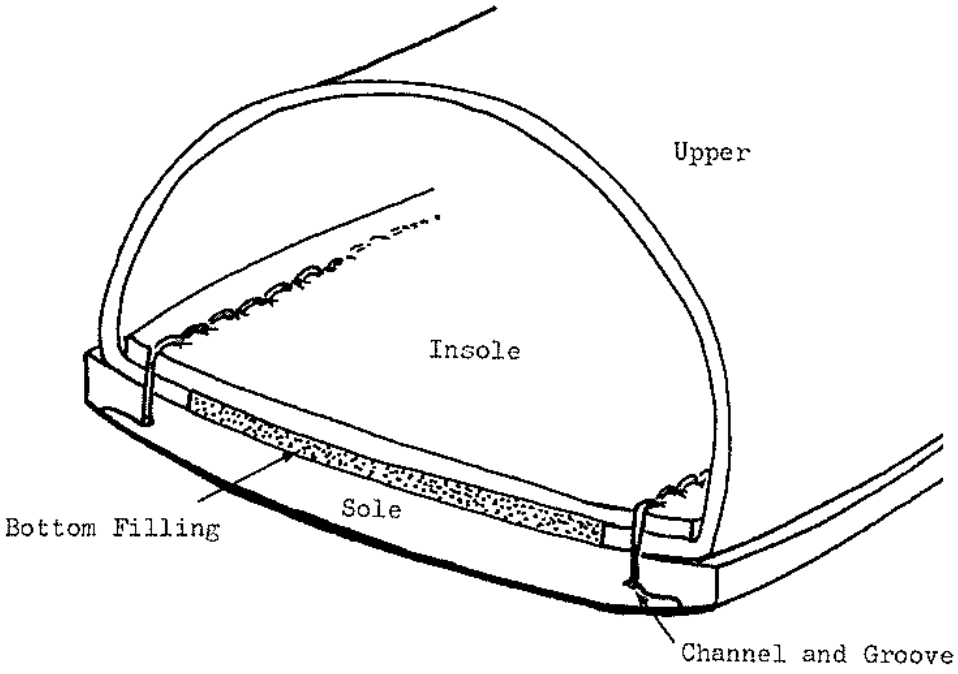
New Balance - EX1016

CHAPTER 21

MACHINE SEWN CONSTRUCTION

This construction was the first method by which a sole was directly attached to an upper with a stitched seam, and was the staple method for the production of medium grade shoes for men's, women's and children's footwear until the mid 1950's.

The shoe is in-lasted on to an insole. After temporary sole attaching the last is slipped and the sole is stitched to the upper and insole.



CROSS SECTION OF MACHINE SEWN SHOE

The shoe remains off the last until the heel has been attached; this is considered detrimental to good shape retention. There are many variations which can be adopted with this method of construction. The soling material can be varied, but we will consider leather as our standard.

New Balance - EX1016

Insoles

For this construction, it is important that the insole material is strong enough to hold both tacks and stitching. A fairly heavy substance is required for this which tends to make the shoes heavy and inflexible. Leather is the usual material, but a good quality fibreboard can be used.

SOLE PREPARATION

Soles are castor cut for the machine sewn construction.

Sequence of Operations

1. Tempering
2. Planet Rounding
3. Channelling and Grooving
4. Edge Reducing
5. Inking
6. Sole Moulding
7. Solution Soles

1. Tempering

As previously described for the machine welted construction, it is important that the leather soles are tempered.

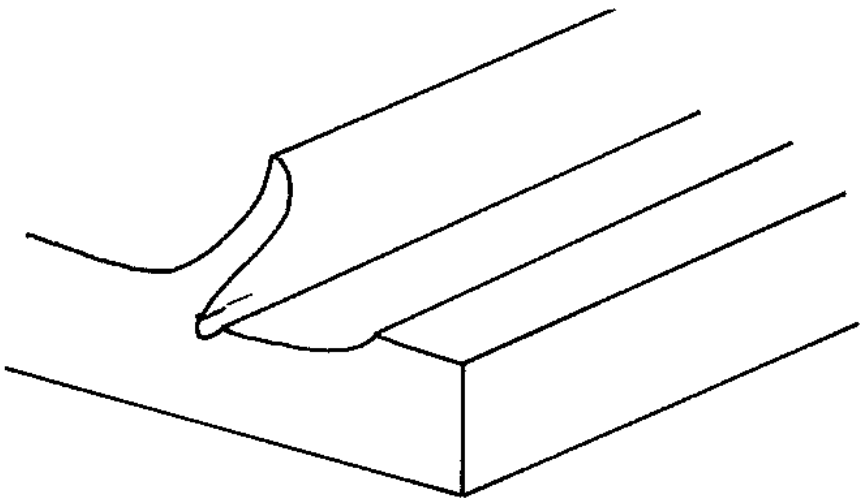
2. Planet Rounding

The castor cut sole is rounded to the correct shape and size.

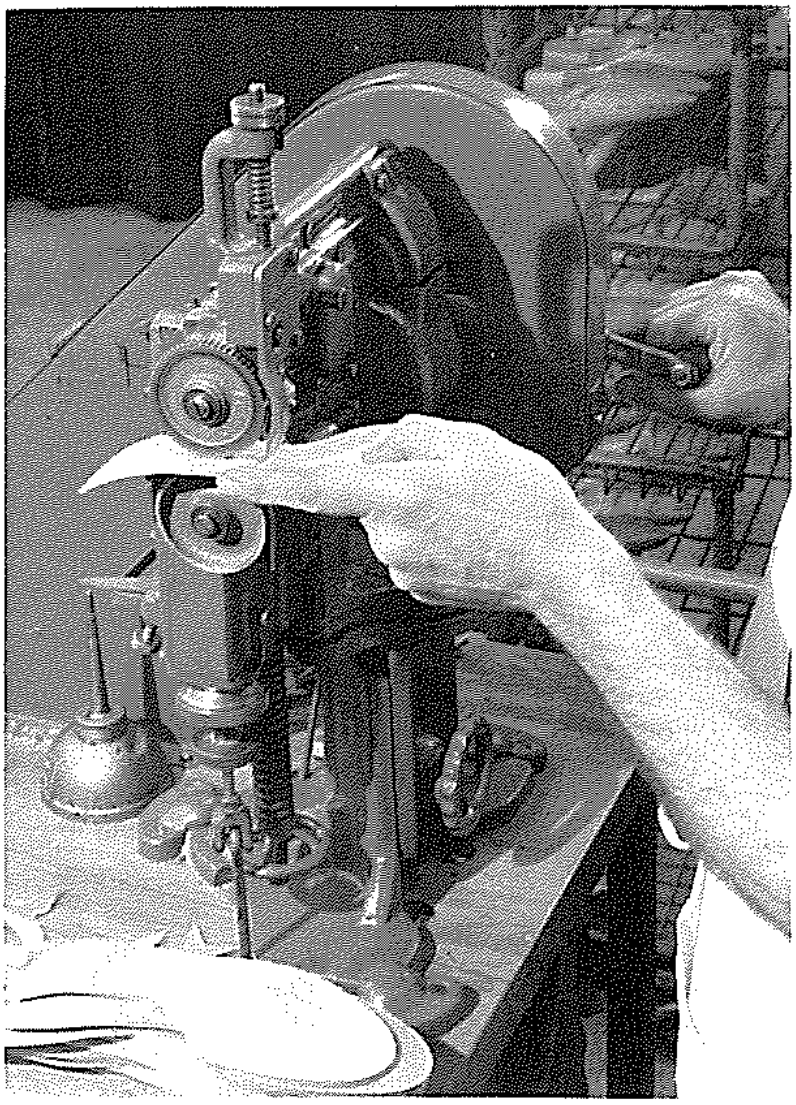
3. Channelling and Grooving

The sole is channelled and grooved simultaneously on the grain side of the leather to just behind the heel breast, at the correct distance from the edge and at the correct angle and depth. The machine is a simple one, but requires good maintenance and skill to set the knives and operate.

New Balance - EX1016



Channel and Groove



Channel and Groove Machine

New Balance - EX1016

4. Edge Reducing

The edge of the sole is reduced through the waist to give the sole edge an improved appearance. The sole must not be reduced too deeply as the remaining substance will be insufficient to give a strong seam.

5. Inking

The flesh side of the sole has a $\frac{1}{4}$" margin of ink applied. This is done to minimise the danger of ink being applied to the upper when the sole is edge inked during finishing.

6. Sole Moulding

The soles are moulded by the same machine which is used for insole moulding. The soles are moulded to the contours of the last bottom.

7. Solution Soles

Rubber solution is applied to the complete flesh side of the sole in readiness for temporary sole attaching. The soles are now ready to marry up with the lasted shoes and must be kept in a mellow state.

Lasting

For many years machine sewn construction shoes were completely tack lasted, but today any of the accepted in-lasted methods can be used.

The uppers are trimmed, the insole tacks are removed and the seats are pounded before moving into the attaching section.

After lasting, the shoes are put through the heat setting machine. It is most important that the uppers are set on the last at this stage because most of the attaching operations are carried out with the shoe off the last.

Attaching

It should be noted that it is not necessary to rough the lasting allowance because good sole attachment is dependent on the stitched seam and not the adhesive.

Sequence of Operations

1. Shank and Bottom Fill
2. Solution Bottoms
3. Temporary Sole Attach
4. Channel Opening
5. Slip Last

6. Littleway Stitching
7. Cement Channel
8. Close Channel
9. Bottom Levelling
10. Seat Nailing
11. Seat Paring
12. Heeling
13. Relasting

1. Shank and Bottom Fill

The shank is tacked in position and the bottom filling applied.

2. Solution Bottom

The complete surface of the bottom of the shoe is coated with a rubber solution and allowed to dry.

3. Temporary Sole Attach

The sole is accurately positioned to the shoe and placed in the sole press to temporarily secure the sole to the shoe.

4. Channel Opening

A revolving tool lifts the lip of the channel and turns it back so that the stitched seam will lie in the groove at the base of the channel.

5. Slip Last

The last is slipped in the usual way and the operator checks to ensure that the channel is open.

6. Littleway Stitching

A chain stitch machine known as a Blake Sewer, was invented in 1862 and used exclusively for almost a century. This has now been replaced by a lock stitch machine of virtually the same design known as the Littleway Stitching machine.

The operator stitches from heel breast to heel breast, manoeuvring the shoe on the rotating horn to keep the stitching in the groove at the base of the channel.

New Balance - EX1016

The correct result must be:-

(a) Correct stitch length

(b) Correct tension

(c) Stitching in groove at base of channel

(d) Stitching tight to insole edge for solidity of seam

7. Cement Channel

A resin based latex is applied to the lip and base of the channel and allowed to dry.

8. Close Channel

The shoe bottom is pressed against a slowly revolving brass wheel with large indentations to lay the channel flat to the sole, covering the stitching.

9. Bottom Levelling

This machine is completely different from the levelling machine described in the welted construction. The machine consists of a pair of steel lasts and brass moulds which are hydraulically operated. The shoe is slipped on to the steel mould and the brass sole mould compresses the sole to the contours of the steel last to produce a flat bottom. Again, brass moulds are used to eliminate any possibility of iron stains. The shoe is removed from the last.

10. Seat Nailing

This operation is similar to that of the machine welted construction in that the seat is permanently nailed. The difference is that the machine has to have a special attachment for clinting the nails because seat nailing is done while the shoe is off the last.

11. Seat Paring

The surplus sole around the seat is trimmed off to 3mm (1/8 inch) from the feather edge by machine.

12. Heeling

As the shoes are already off the last, the heels are attached by the inside method of attachment.

13. Relast

The shoes are relasted on "following" lasts. These lasts are slightly smaller than the making lasts and have no plates on the bottom.

The shoes are now sent to the Finishing and Treeing Departments.

New Balance - EX1016

CHAPTER 22

FINISHING

Traditionally, finishing operations were employed on all types of footwear. It is now generally true that they are only applied to men's footwear of the machine welted, machine sewn and cemented constructions having leather soles and heels.

Sequence of Operations

1. Heel Paring
2. Heel Scour (Rough and Fine)
3. Edge Pare
4. Heel Scour (Superfine)
5. Stain Heels
6. Smooth Heels
7. Gum Heels
8. Ink Edges
9. Edge Set
10. Naumkeag
11. Bottom Polish
12. Heel Burnish and Seat Wheel
13. Clean Uppers and Welts
14. Slip Lasts

1. Heel Paring

The purpose of this operation is to remove any excess material from the heel and to impart to the heel its required shape. This is carried out by a pair of eliptical cutters set into a feed plate, travelling at 6000 - 7000 r.p.m. Guards and guides are fitted to the machine to allow the heel to be fed at a pre-determined position. Because of the variety of materials used it is vitally important that the cutters are regularly sharpened; a special machine is provided for this purpose. A ranging cutter is used to trim the seat portion.

The correct result must be:-

(a) Heel to be correctly shaped.

(b) Cleanly pared from heel corner to heel corner.

(c) No bumps or hollows.

(d) Not to be pared more than 1/32 inch into toppiece.

(e) No damage to upper.

(f) Heel seat to be cleanly randed.

New Balance - EX1016

2. Heel Scour (Rough and Fine)

Abrasive bands are fitted to revolving rollers which scour the heel in progressive stages, first roughly and then finely. The heel is positioned to the roller which is generally fitted with a width guard and fed against the roller. Rough scouring removes any knife marks from heel paring while fine scouring removes any deep scratches from rough scouring. Burning or charring may occur if too great a pressure is exerted. Care must be taken to avoid damage to the upper.

The correct result must be:-

(a) Heel to be scoured from corner to corner

(b) Heel to be correct shape

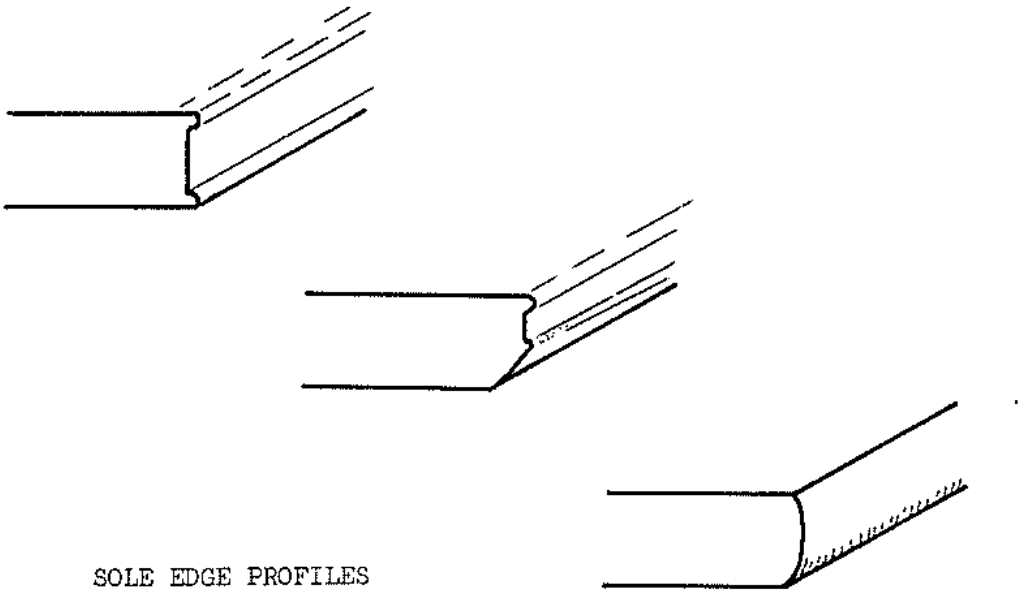
(c) Heel to be smooth - no scouring marks

(d) No damage to upper

(e) No charring on upper

3. Edge Paring

This is an important operation in that it can make or mar the appearance of the finished shoe. The operation consists of removing excess material from the sole edge to produce a uniform sole shape. High speed rotary cutters are used having various profile shapes according to the style of edge required on the sole.



SOLE EDGE PROFILES

New Balance - EX1016

Maintenance of the correct cutting angle and the sharp cutting edge are most important. Most leather sole edges are first pared dry, then wetted with a special fluid and pared again. This serves to lay down the leather fibres and produces a much smoother feather edge.

The correct result must be:-

(a) Sole to be correct shape

(b) Angle of edge to be correct

(c) Joints to be in correct position

(d) Edge pared complete to heel corners

(e) Edges smooth - no burning or charring

(f) Edge distance as specified

(g) No damage to uppers

4. Heel Scour (Superfine)

This operation is the same as the previous heel scouring using a superfine abrasive, usually emery. This ensures that the heel lines up accurately with the waist of the sole.

5. Stain Heels

A coat of waterbased edge finish (as used for sole edges) is applied by bristle brush around the seat area of the heel. This is followed by an application of a spirit based finish by camel hair brush. This serves to swell the fibres of the heel and give an adequate base for later heel finishing operations.

6. Smooth Heels

This is carried out in the same manner as heel scouring but using either a worn superfine abrasive or turning the abrasive over to use the cloth backer. This serves to key the finish into the heel to improve its waterproofing properties and to give it a semi-polished appearance.

7. Gum Heels

A coat of spirit based veneer is now applied to the heel by camel hair brush. This must be applied smoothly and allowed to dry to prepare the heel for the later operation of heel burnishing.

8. Ink Edges

A water based edge finish containing pigment, waxes and gums is applied by hand to the sole edge. A machine may be used. The edge must be

completely and evenly covered with ink, but there must be no ink on the upper, sole or any stitching.

9. Edge Set

This machine has four heads and can be used by two operators. Each head carries a heated oscillating iron which has an identical profile to that produced by the earlier operation of edge paring. The oscillating action of the heated iron melts the previously applied wax and forces it into the fibres of the sole edge. This consolidates the edge increasing its water resistance, and gives the polished appearance.

The correct result must be:-

(a) Edge to be completely and evenly set

(b) No burns

(c) Sole edge profile well defined

(d) No wax on uppers

(e) Joints correctly positioned

(f) Glossy appearance

10. Naumkeag

The machine consists of a rotating inflatable rubber pad, covered with a fine grade abrasive disc. This removes the grain surface either over the whole area of the sole or around the edge, according to requirements.

Care must be taken to prevent excessive removal of the grain otherwise the appearance may be marred.

11. Bottom Polish

A finish may be applied by brush or spray gun, allowed to dry and then wax polished on a revolving linen mop and soft hair brushes.

Alternatively, a friction wax may be used which colours the sole and impregnates the surface. This also requires wax polishing. Black sole bottoms require an additional operation of burnishing with a leather pad before polishing.

12. Heel Burnish and Seat Wheel

There are two alternative methods of heel burnishing.

(a) Cold Wax Burnishing

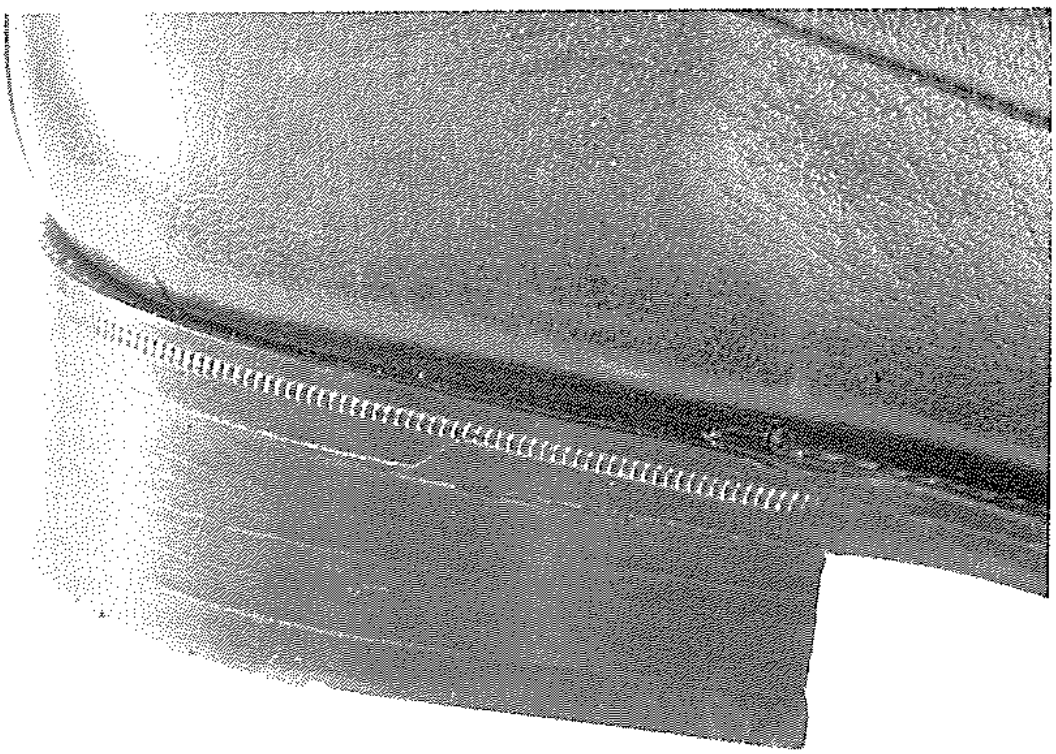
A block of finishing wax is applied to a revolving pad consisting

of closely packed sections of material. The pad provides a friction polish which is then followed up by a final treatment with a camel hair brush.

(b) Hot Wax Burnishing

The machine is fitted with a heated wax pot above a cotton covered pad. Hot wax is dripped onto the pad as required. The heel is held against the pad to apply a coat of the melted wax. An identical pad is then used to give the burnishing treatment followed by brushing to produce a high gloss finish.

The seat wheeling is carried out on a rotating wheel of which the lip is a fixed member, whilst a row of teeth free-wheel. The seat portion of the heel is applied to the wheels to produce indentations around the edge of this area, while the lip serves to iron the top edge to ensure a complete line up with the edge setting of the sole.



Seat-wheeling

13. Clean Uppers and Welts

Surface dust is removed from the upper by brushing on rotating soft brushes. A tapered stiff bristle brush is used to remove dust and wax from the welt and sole edge.

14. Slip Lasts

The last is slipped from the shoe making sure that all lacing strings or gusset stays have been removed and buckles loosened.

There are many variations to this sequence which will be applied to suit the needs of the construction and soling materials.

The shoes are now ready to go into the Treeing department.

New Balance - EX1016

CHAPTER 23

TREEING DEPARTMENT (SHOE ROOM)

The operations carried out in the Treeing Department consist basically of treating the upper, linings and socks in readiness for despatch to the customer. The addition of trimmings, laces, etc. plus box making, packing and labelling are also included.

The treatment given is determined by the upper material involved and the method of construction used.

An operational sequence will be given both for grain and suede leather to show the different treatments.

Grain Leather Uppers	Suede Leather Uppers
1. Remove Tacks	1. Remove Tacks
2. Insert Socks	2. Insert Socks
3. Leather Cleaning	3. Suede Cleaning
4. Hot Air Treeing	4. Lining Clean and Pair Up
5. Dressing	5. Fake Suede
6. Faking (Leather Repairing)	6. Attach Trimmings
7. Attach Trimmings	7. Quarter Mould
8. Quarter Mould	8. Spray Antique
9. Spray Antique	9. Spray Suede
10. Spray Dress	10. Sole Branding
11. Sole Branding	11. Final Inspection
12. Final Inspection	12. Packing
13. Packing	13. Labelling
14. Labelling	14. Despatch
15. Despatch	

It will be seen from the above sequences that some operations apply to both materials while some apply particularly to grain or suede leather.

Sequence for Grain Leather Uppers

1. Remove Tacks

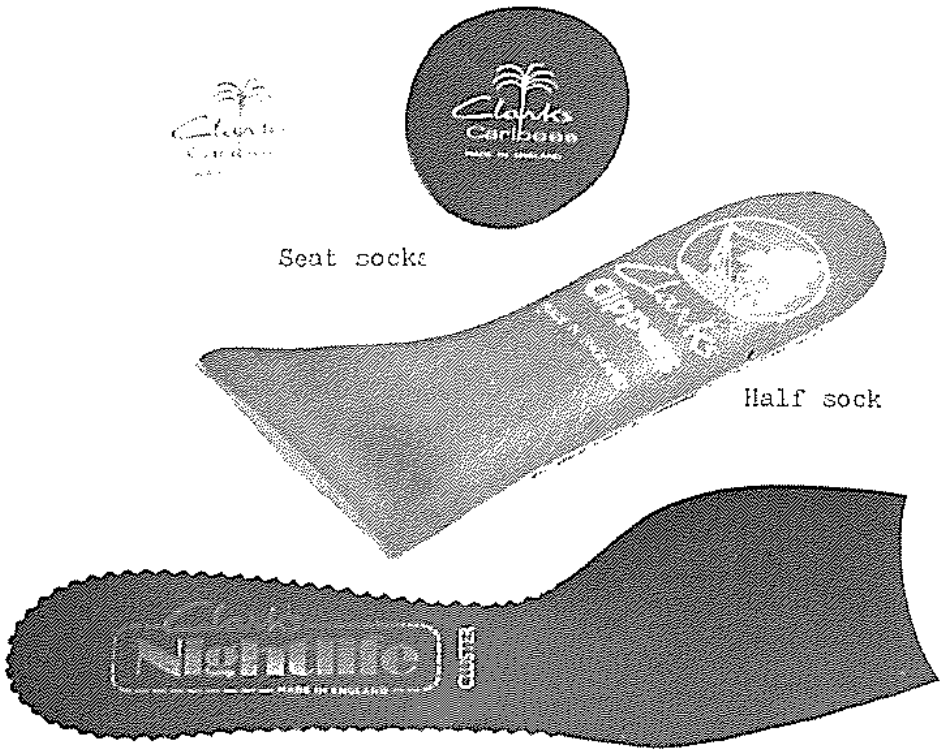
   It is important to ensure that all temporary tacks have been removed from the insole, and that the permanent tacks have been clinted. For this purpose the shoes are checked and any such tacks are removed or ground down.

New Balance - EX1016

2. Insert Socks

The socks may be cut from a variety of materials. Grain leather, suede leather, P.V.C. coated materials or fabric are all used and are normally selected to suit the particular shoe. Sheepskin or fur pile fabric is normally used for warmlined footwear. The style of sock will be determined by the type of footwear.

It may be either a full sock, a three-quarter or a seat sock only.



Full sock for Sling-back, peep-toe evening sandal

The edges of the sock can be gimped, scalloped or perforated to add to the appearance. It is normal practice for the sock to be stamped with some or all of the following details:-

(a) Manufacturers name and trade mark

(b) Range name

(c) Shoe name or number

(d) Country of origin

(e) Size and fitting

A backer pad of foam or fabric can be used to improve the appearance and comfort.

The socks are passed through a roller-type machine to be coated with latex-type adhesive then inserted into the shoe. Socks for warmlined work are coated with a rubber solution type of adhesive.

It is important that the sock is correctly positioned and securely stuck without wrinkles or creases.

3. Leather Cleaning

The upper is completely washed with a cleaning fluid which may be of a detergent or spirit solvent type, or special proprietary cleaners may be used. This is done to remove any block marks, cement, latex or other contaminating materials. Stains may require special treatment with ammonia or carbon tetrachloride. Crepe may also be used to remove stubborn dirt. It is important that the cleaning agent used is compatible with the upper leather finish.

4. Hot Air Treeing

This operation is only necessary on some of the finer grain leathers. The object is to remove any wrinkles or creases in the upper by means of a hot air blast. This also tightens the grain surface and conditions it to receive a later coat of dressing.

Care must be taken not to burn the upper stitches or eyelets.

5. Dressing

A coat of liquid cream dressing is applied by sponge to the upper. The type of dressing must be compatible with the upper leather finish; it may dry glossy or may require a further polishing.

6. Faking (Leather Repairing)

Any small cuts, scratches and digs which may have occurred during manufacture are now repaired.

These small damages, providing they are not going to affect the wear or appearance of the finished shoe are treated as follows:-

(a) Fish glue or hot melt cement is used to stick down the cut.

(b) The damage is sanded down and filled with wax repair crayon of the appropriate colour, then sanded smooth.

(c) A coat of matching pigment is applied as necessary by spray gun or brush.

It is common practice in many factories to restrict this operation to one of applying pigment to the feather edge to cover marks from the roughing operation, and then dressing the shoe as described previously. This is then known as "Pigment and Dress", any further faking necessary being done by a specially selected operator after final inspection.

There is a limit to the amount of faking which can be done. No attempt should be made to fool the customer. Rather all efforts should be made to present the shoe in a saleable condition.

7. Attach Trimmings

When the design of the shoe so requires, trimmings such as bows, false buckles, buttons, etc. are attached, using either an inverted staple or a waxed thread.

8. Quarter Mould

This operation applies only to ladies footwear. The machine used consists of a metal mould similar in shape to the backpart of a last. Padded clamps are fitted, one either side of the mould. The backpart of the topline is placed over the mould and the clamps are brought into position to remould the topline. This is necessary because of distortion which occurs when the last is slipped.

9. Spray Antique

This dressing is only applied to certain colours and types of leather. Its use is mainly dictated by fashion trends. A fine spray gun is used to apply a high staining dye to give a shadow effect on stitching, punching, toplines, feather edges, etc.

10. Spray Dress

Where necessary, a further coat of dressing is applied by spray gun over the whole upper. This imparts the final shop window appearance to the shoe.

11. Sole Branding

The manufacturer's trade mark is branded or embossed on the forepart of the sole. The metal stamp, which is used, is normally heated. It should be remembered that sole branding may be carried out during pre-finishing.

12. Final Inspection

Under normal circumstances this is the last inspection of the shoes before they reach the customer. However, a small percentage may receive further attention by the Quality Control department to check the efficiency of the inspection.

The inspector only has three courses of action:-

(a) Shoes which he finds to be of a satisfactory quality standard are forwarded for packing and despatch.

(b) Shoes which are below standard but can be rectified are returned to the supervisor or the operator concerned.

(c) Shoes which are below standard and cannot be rectified are rejected.

13. Packing

Boxes are bought in blank form and using one of two alternatives are formed immediately prior to the packing of the shoes. The shoes are packed in tissue.

14. Labelling

A label describing the shoe is fixed to each box by glue.

15. Despatch

The labelled boxes are strapped in twelve pairs for despatch to the warehouse. Information is recorded of the style, colour, size and fitting, number of pairs and number of rejects.

Sequence for Suede Leather Uppers

1. Remove Tacks

As for grain leathers.

2. Insert Socks

As for grain leathers.

3. Suede Cleaning

This may be carried out by hand or machine. The operation consists of brushing the upper and loosening any dirt with a small piece of emery cloth.

Solvents may be used to remove stains from oil, latex, cement, etc. but care must be taken to prevent any further staining. Heavy use of the brush or emery may also cause damage by removing the suede pile.

4. Lining Clean and Pair Up

As for grain leather.

5. Fake Suede

Traditionally, this was a separate operation, but now it is often combined with suede cleaning. Any variations in texture or shade can be levelled out by applying a suede stick or powder of the required shade. Serious damage cannot be rectified.

6. Attach Trimmings

As for grain leather.

7. Quarter Mould

As for grain leather.

8. Spray Antique

As for grain leather.

9. Spray Suede

There are three main spray treatments for suede:-

(a) The spraying of a fixative solution to fix the powder used at faking and to improve the "bloom" of the suede.

(b) In the case of black suede, a high staining dye may be used to ensure absolute uniformity of colour.

(c) Suede pigskin may be treated with an expensive coating to improve water repellancy. In this case a special spray gun has to be used and strict safety precautions must be exercised because of the toxic nature of the liquid.

10. Sole Branding

As for grain leather.

11. Final Inspection

As for grain leather.

12. Packing

As for grain leather.

13. Labelling

As for grain leather.

14. Despatch

As for grain leather.



New Balance - EX1016

INDEX

Ankle boot 16
Applique 12
Apron 7
Arch
- anterior metatarsal 35
- inner longitudinal 34
- outer longitudinal 34
- transverse 34
Assembly 203
Astragalus 29
Attaching 205, 232, 293, 317

Back moulding 223
Back strap 14
Back tacking 283
Backers 17
Bagging 132
Bar 13
Barring 146
Base (bones) 27
Belly 94
Bespoke 44
Bevelling 197, 282
Binding
- French 129
- galloon 129
- run-on 130
- hammer-over 130
- English 131
Blake sewing 318
Blister 40
Block marking 115
Blood 33
Board making 200
Bones 27
Bottoms 18
Bottom filling 20, 292
Bottom levelling 296, 319
Boxing 146
Branding 331
Brogue 11
Built heel 22
Burnishing 127
Bursa 41
Butt 94

Calcaneum 27
Californian
(Slip-lasting) 208, 216, 299
Callous 40
Cartilage 35
Cemented construction
206, 209, 223
Cementing
- bottoms 234, 247, 293, 304
- soles 237, 192, 281, 317
Channelling
- insoles 278
- soles 293, 315
Clawed toe 42
Clicking 91
Closing
- edge treatments 127
- finishing off 147
- fitting together 134
- guides 155
- preparation 113
- stitch formations 138
- stitching machines 134
Coated fabrics 93
Collar 133
Components 22
Conditioning 218
Constructions 206
Consumer 25
Conveyors 160
Corn 40
Counter 11
Counter lining 16
Court shoe 15, 82
Cuban 21
Cuboid 29
Cuneiform 29
Cutting
- economy 100
- leather characteristics 94
- machines 105
- materials 92
- qualities required 91
- requirements 98
- systems 102, 108
Cylinder arm 136
Cylinder vat 201

New Balance - EX1016

Degreasing 237
Derby 4
Dermis 32
Direct attachment 205
Direct drainage 202
Direct stuck 206, 209, 223
Dressing 329
Drill forme 75

Edging 128
Edge paring (trimming) 270, 322
Edge setting 324
Elementary shoe 2
Embossing 122
Epidermis 32
Eyelet 24, 147

Facing 10
Faking 329
Fastenings 15
Feather edge 2
Feet 27, 44
Fibula 29
Finishing 321
Fitting 52
Fittings 51
Flash 250, 259
Flat bed 134
Flexing 197
Flow charts 209
Flow moulding 158
Focal point 203
Folding 128
Follicle 32
Footgauge 52
Force lasting 208, 299, 301
Forepart lasting 226, 287
Fourdrinier 201
Foxing 10
French binding 129

Gemming 279
Ghillie 133
Gibson 4
Girth 44

Hallux rigidus 41
Hallux valgus 41
Halogenation 236
Hammer toe 41
Head (bones) 27
Heat setting 219
Heel
- attaching 239, 298, 319
- built 22, 181
- covering 183
- Cuban 21
- lift 22
- Louis 21
- manufacture 181
- paring 321
- scouring 322
- stacked 183
- terminology 179
- wedge 21
High frequency (H.F.) 157

Indirect attachment 206
Injection moulding
- P.V.C. 207, 212, 250
- P.U. 207, 213, 255
Inking 127, 273, 323
Insertion, quarter 10
Insole 3, 18, 171
- blended 18
- ribbed 19, 280
Inseam trimming 290
Inspection 331

Joints
- ankle 30
- ball and socket 29
- gliding 29
- hinge 29
- inter phalangeal 31
- metatarso phalangeal 31
- mid tarsal 30
- sub taler 30
- synovial 30

Lacing 148
Lasts 56
- and feet 69
- co-ordination 67
- hinging 71
- manufacture 70
- model making 67
- terms 57

New Balance - EX1016

Lasting
- allowance 2
- bed 284
- consol 229, 303
- forepart 226, 287
- Kamborian 229
- seat 223, 285
- slip 208, 216, 299
- staple side 284
- string 208, 217, 308, 310
- veldtschoen 261
- waist (side) 229
Lift 22
Ligaments 31
Linings 16
Lip turning 279
Littleway 318
Lockstitch 138
Louis (heel) 21

Machine welted 275
Machine sewn 314
Malleolus 29
Mallet toe 42
Marketing 25
Match marking 99, 114
Metatarsalgia 42
Metatarsals 29
Metatarsus 27
Methods of construction 206
Middle 94
Middle sole 20
Mondopoint 49
Moulded constructions 207, 211, 243
Mudguard 12
Mule 16
Mulling 219
Muscles 31

Naphtha 270
Naumkeag 324
Navicular 29
Neck 94
Needles 149
Nerve endings 33
Notch 117

On-the-round 135
Ornamentations 18
Oscalcis 27
Ossification 35
Outsole stitching 267, 295
Overlock 308
Oxford 4

Paring
- edge 270, 322
- heel 321
- seat 297, 319
Pathfinder 73
Pattern cutting
- bottom patterns 89
- formes 75
- grading 90
- linings 87
- net patterns 84
- standards 80
- working patterns 85
Peep-toe 9
Perforate 121
Pes cavus 43
Pes planus 43
Phalanges 27
- distal 29
- medial 29
- proximal 29
Planet rounding 277
Platform cover 300, 303
Polyveldt 274
Poromerics 93
Post 135
Pounding 289
Pre-finishing 187
Press punch 118
Prick marks 116
Priming 236
Pronation 43
Puff 22
Pulling over 283

Quarter 2, 10
Quarter lining 17
Quarter moulding (reforming) 330

Range developer 73
Raw edge 127
Reducing 190, 317
Rib 280

New Balance - EX1016

Rough round 269, 293
Roughing 232, 245, 262
Runner 20
Russ and Small 108

Saddle 13
Scaphoid 29
Scatter diagram 46
Seam
- bonded 142
- Brooklyn 140
- butted 141
- closed 139
- lapped 140
- moccasin 143
- open 142
- piped 142
- silked 139
- sprung 143
- welded 142
- welted 141
Seat
- chopping 277
- flanging 261
- lasting 223, 285
- nailing 297, 319
- paring 297, 319
Sesamoids 29
Shaft 27
Shank 23, 186
- attaching 234, 292
Shank (hides) 94
Shank (needles) 149
Shell 77
Shoulder 94
Size code 114
Size systems 49
Skeleton 27
Skeleton insole 302
Skin 32
Skiving 123
Sling back 10
Slip beading 133
Slip lasting 208, 216, 299
Slotted fabric forme 75
Sock 3, 24, 328
Sole 21, 169
Sole laying 237, 270, 293
Solvent wiping 233, 237
Splitting 235
Spraying 330
Springing 81
Spue 250
Stick length 45
Stiffeners 23, 176
Stitch wheeling 296
String lasting 208, 217, 308, 310
Surveys, foot 45
Sustentaculum tali 29

Tab 8, 89
Talus 29
Tarsus 27
Tempering 281
Tendon 31
Threads 148
Through sole 20
Tibia 29
Toe cap 6
Toe puff 22, 177
Tongue 8
Topline 2
Toppiece 22
Top-stitching 145
Torielli 272
Treeing 327, 329
Trimmings 18, 148

Unified Process 193
Upper 2, 6

Vacuum forme 78
Valgus ankle 43
Vamp 2, 6
Veeing 146
Vledtschoen 207, 214, 260
Vulcanised 207, 211, 244, 247

Waist 3
Waist lasting 229
Walking shoe 15
Wedge 21
Welt 19
- sewing 289
- beating 291
Welted construction 208, 215, 275
Wing cap 6
Wing, vamp 7

New Balance - EX1016