United States Patent [19]

Beamish et al.

[11] **3,712,254**

[45] **Jan. 23, 1973**

[54] APPARATUS AND METHOD FOR EDGE STITCHING/BINDING WORKPIECES

[76] Inventors: **Bernard D. Beamish; David G. Taylor,** both of 3289 Lenworth Drive Unit F, Cooksville, Ontario, Canada

[22] Filed: **April 28, 1970**

[21] Appl. No.: **32,631**

[52] **U.S. Cl.** **112/121.29,** 112/47, 271/1, 271/26

[51] **Int. Cl.** **D05b 33/02**

[58] **Field of Search**.....112/121.29, 121.11, 121.12, 112/121.15, 203, 205, 130, 252, 219 R, 219 A, 147, 47; 271/19, 20, 26, 27, 28, 30, 33, 36, 39, 43, 60, 62, 68, 86, 74, 82, 85, 1

[56] **References Cited**

UNITED STATES PATENTS

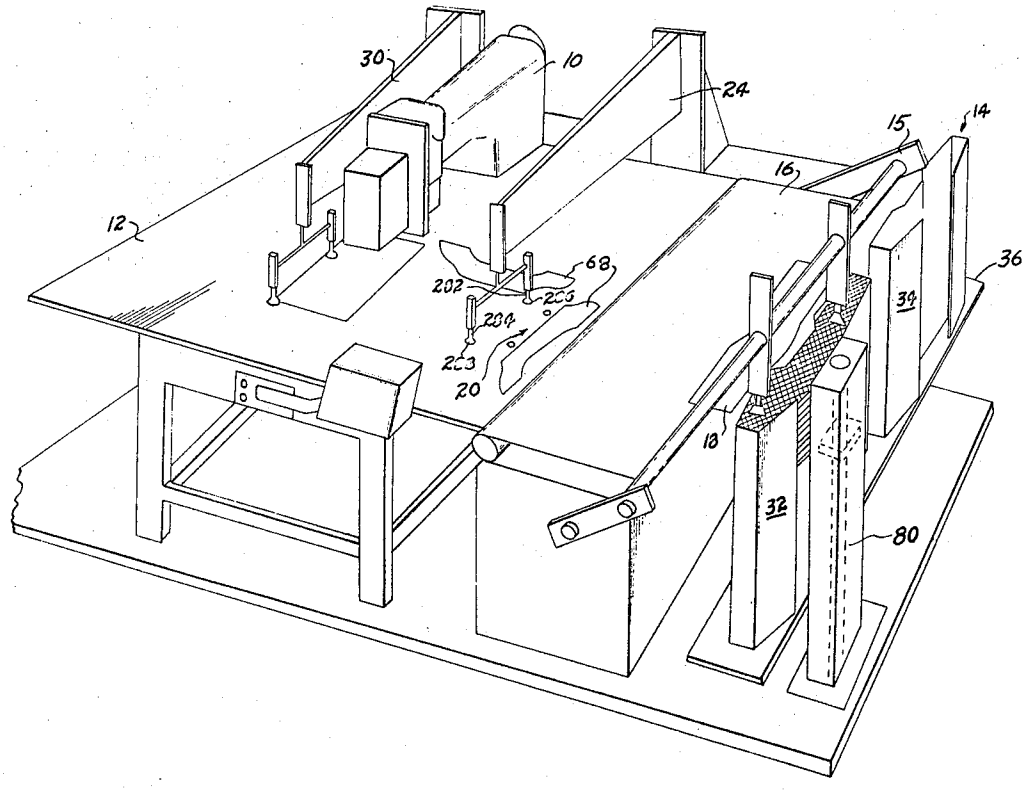
2,971,483	2/1961	Cordier	112/205
3,383,107	5/1968	Hedegaard	112/121.29 X
3,472,187	10/1969	Kaplan et al.	112/203 X
3,204,591	9/1965	Pickett	112/121.11
3,336,025	8/1967	Shichman et al.	271/44 X
2,737,389	3/1956	Evans et al.	271/26 X
3,425,373	2/1969	Miller et al.	112/130
2,526,279	10/1950	Roseman	112/219 R X
3,080,836	3/1963	Clemens et al.	112/203 X
2,251,368	8/1941	Moser	112/219 R
680,665	8/1901	Noble	112/219 R
2,224,261	12/1940	Germain	112/147 X
2,290,123	7/1942	Wilfong	112/203 UX
2,483,138	9/1949	Helmer	112/219 A
3,598,070	8/1971	Rosenberg	112/121.15

Primary Examiner—James R. Boler
Attorney—Holman and Stern

[57] **ABSTRACT**

An apparatus and method for the edge stitching/binding of fabric workpieces in which the workpieces are introduced into a sewing machine at a speed synchronous with that of the sewing machine and in a precise orientation relative to the needle thereof. The workpieces optionally have a tape folded about the edge thereof and are automatically fully stitched at a substantially uniform distance from the edge thereof, whereafter the workpieces are severed into separate entities. During the stitching operation each workpiece is caused to traverse a stitch pattern which consists of a random sequence of straight lines, concave and convex curved portions, by control means which constantly engage the workpiece and which work in conjunction with holding means selectively movable into engagement with the workpiece. The fully stitched workpieces may then be automatically discharged from the apparatus.

29 Claims, 33 Drawing Figures



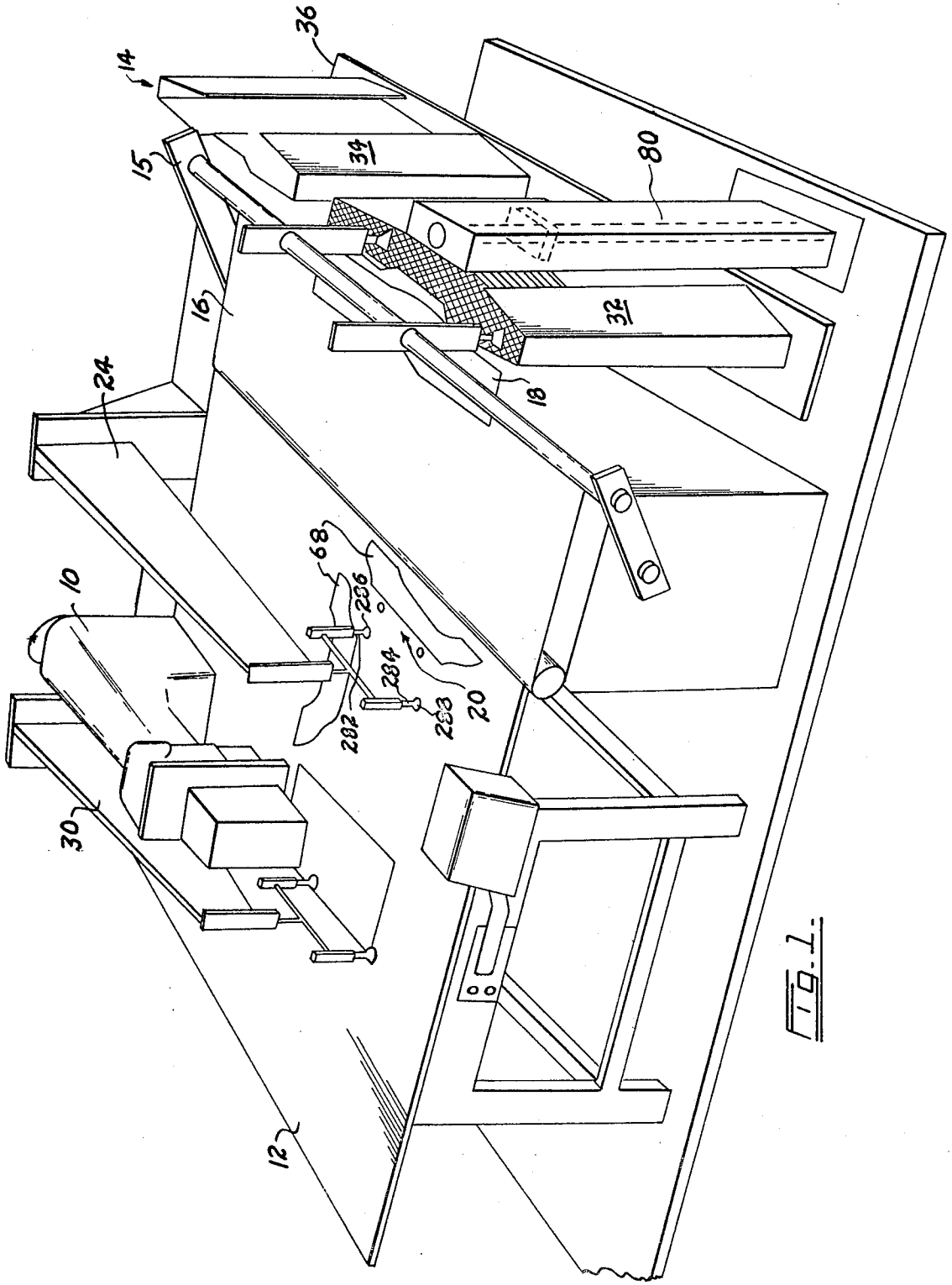


FIG. 1.

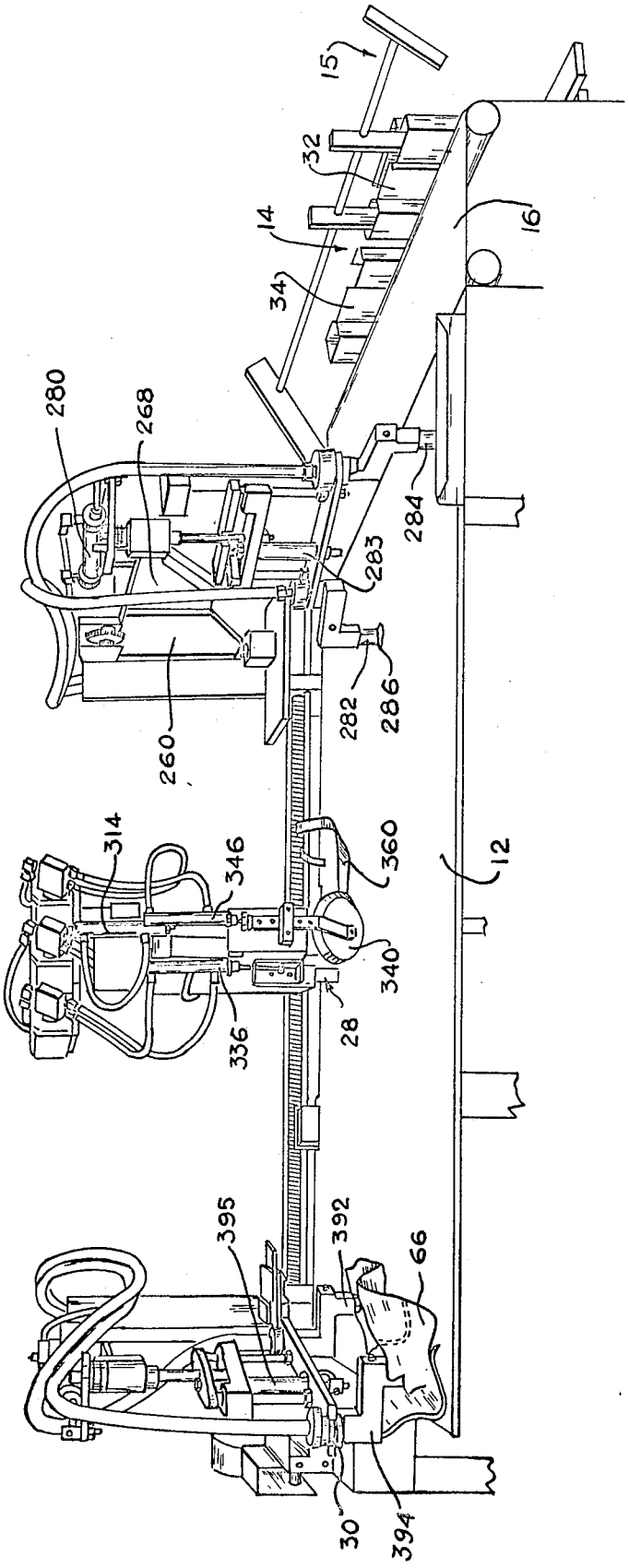

15
32
14
34
16
280
268
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360
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336
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66
30
394

FIG. 2.

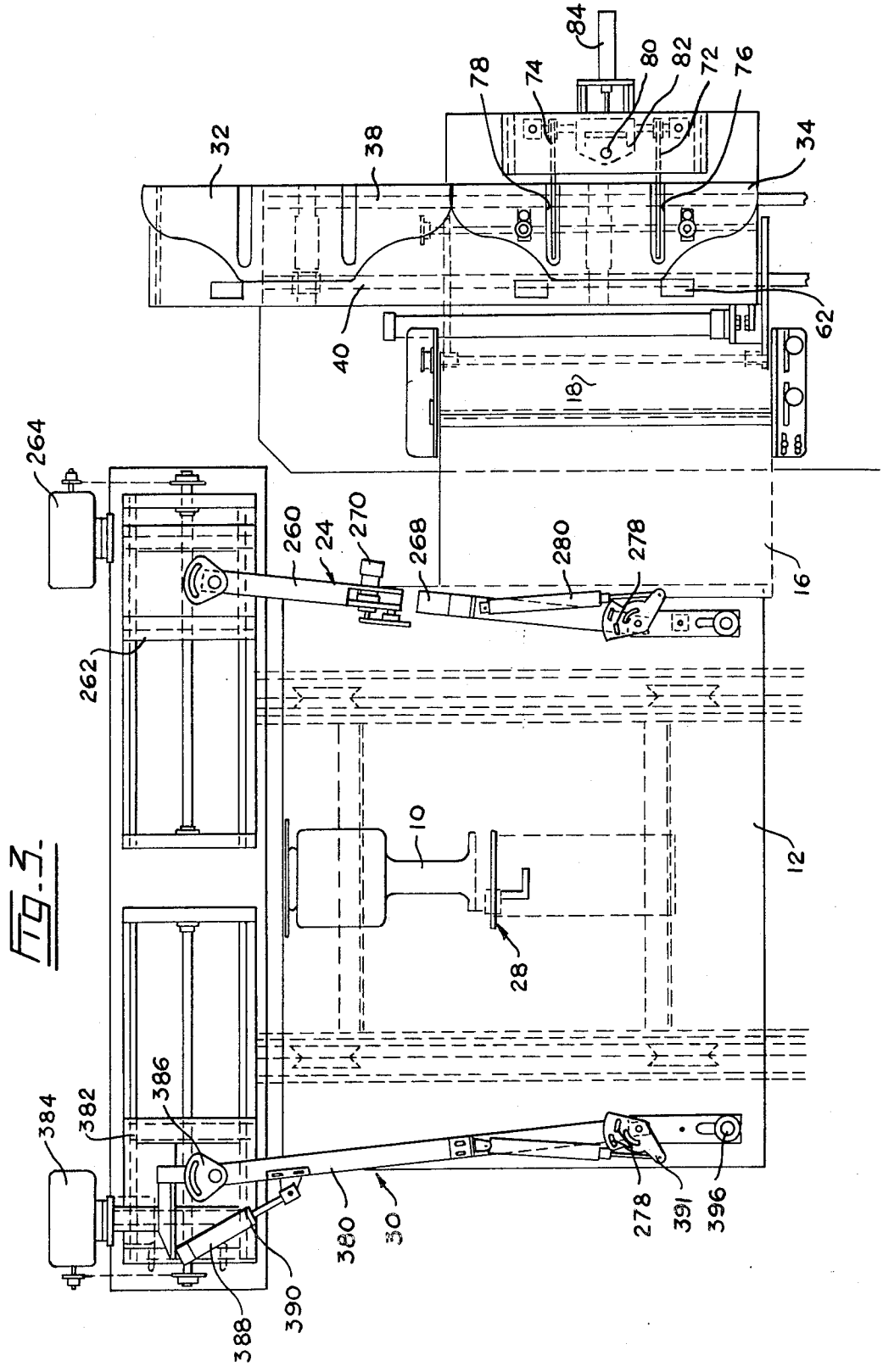

84
80
82
72
76
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74
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278
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FIG. 3.

FIG. 4.

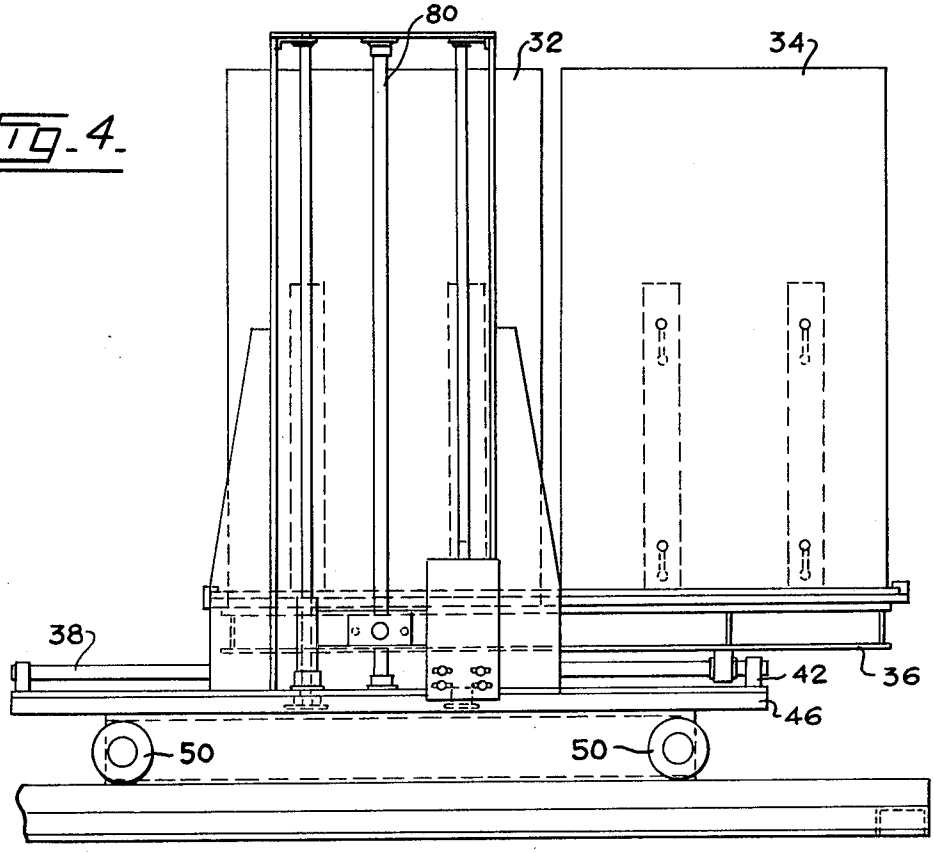
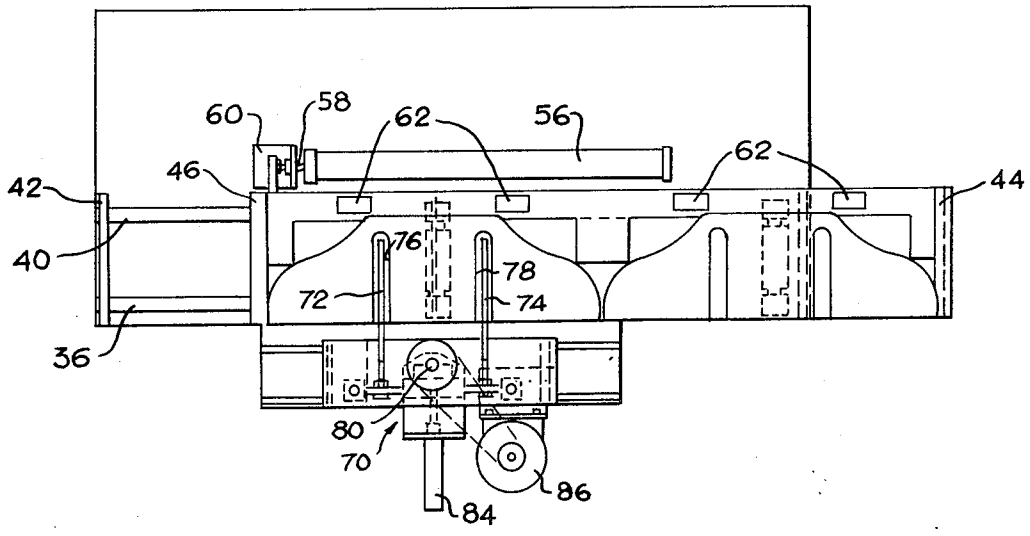

80
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FIG. 5.


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84

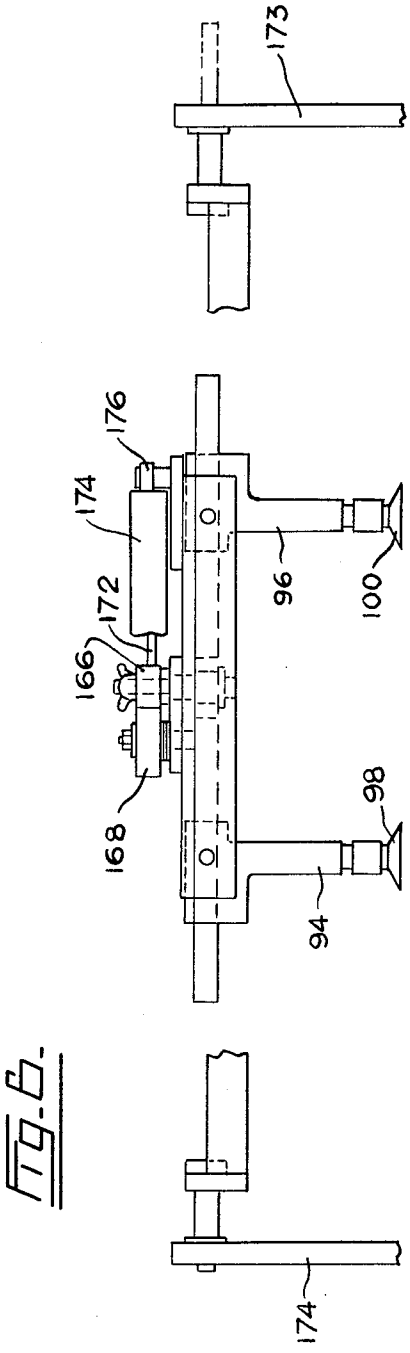

173
176
174
172
166
168
96
100
98
94
174

FIG. 6.

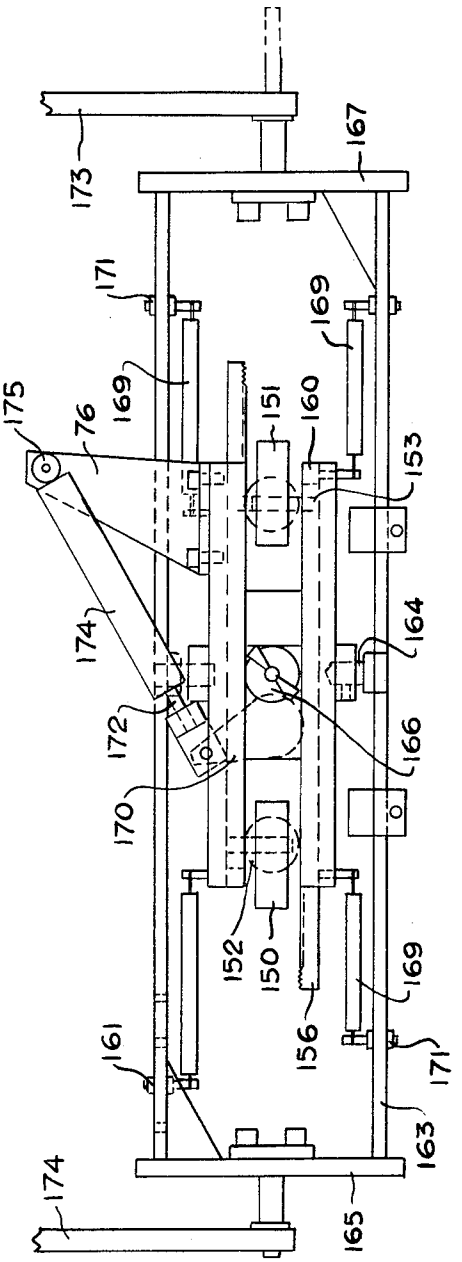

173
167
171
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175
76
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160
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171
163
174
165

FIG. 7.

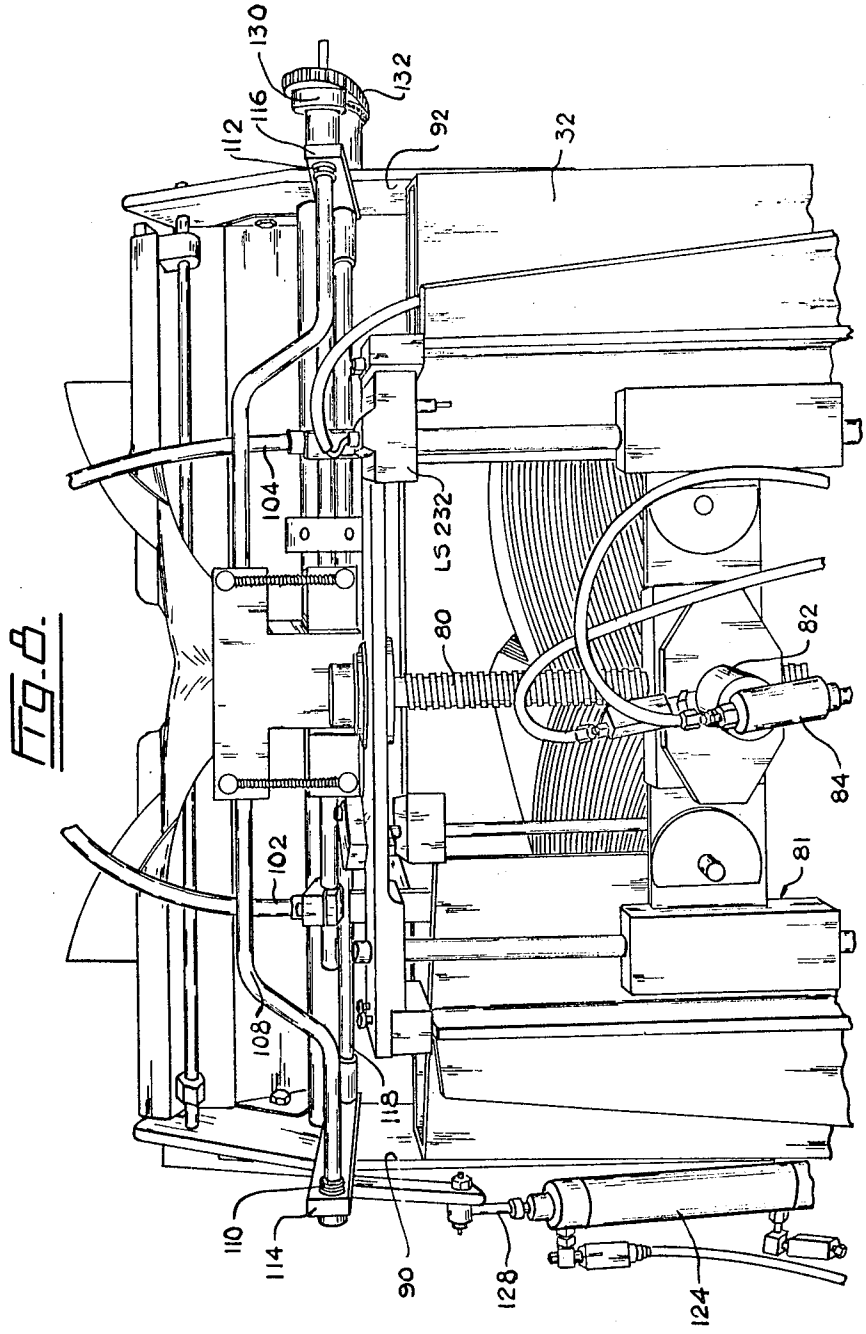

130
132
116
112
92
32
104
LS 232
80
82
84
102
81
108
118
110
114
90
128
124

FIG. 8.

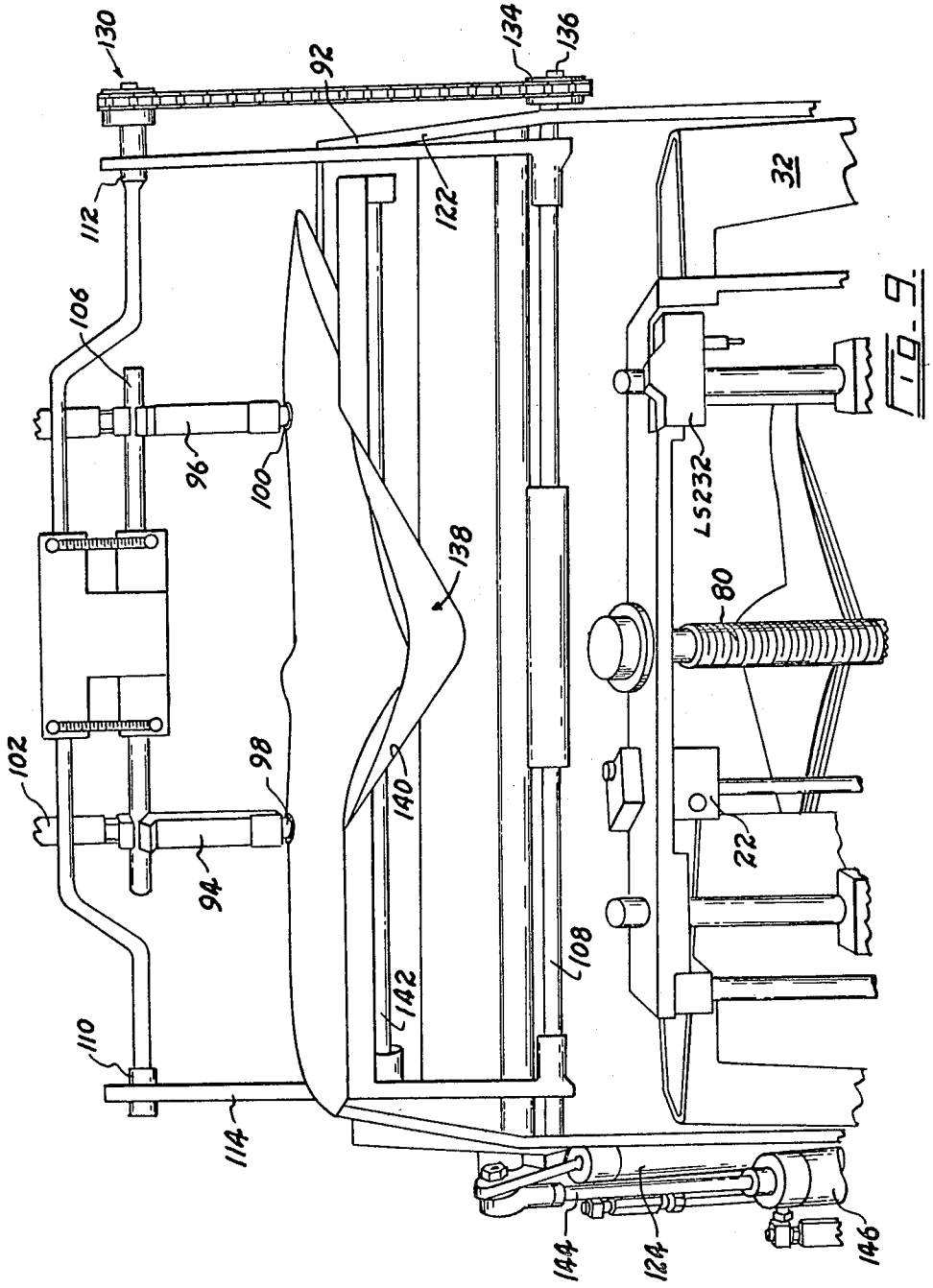

130
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112
122
32
106
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LS232
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FIG. 9.

FIG. 10.

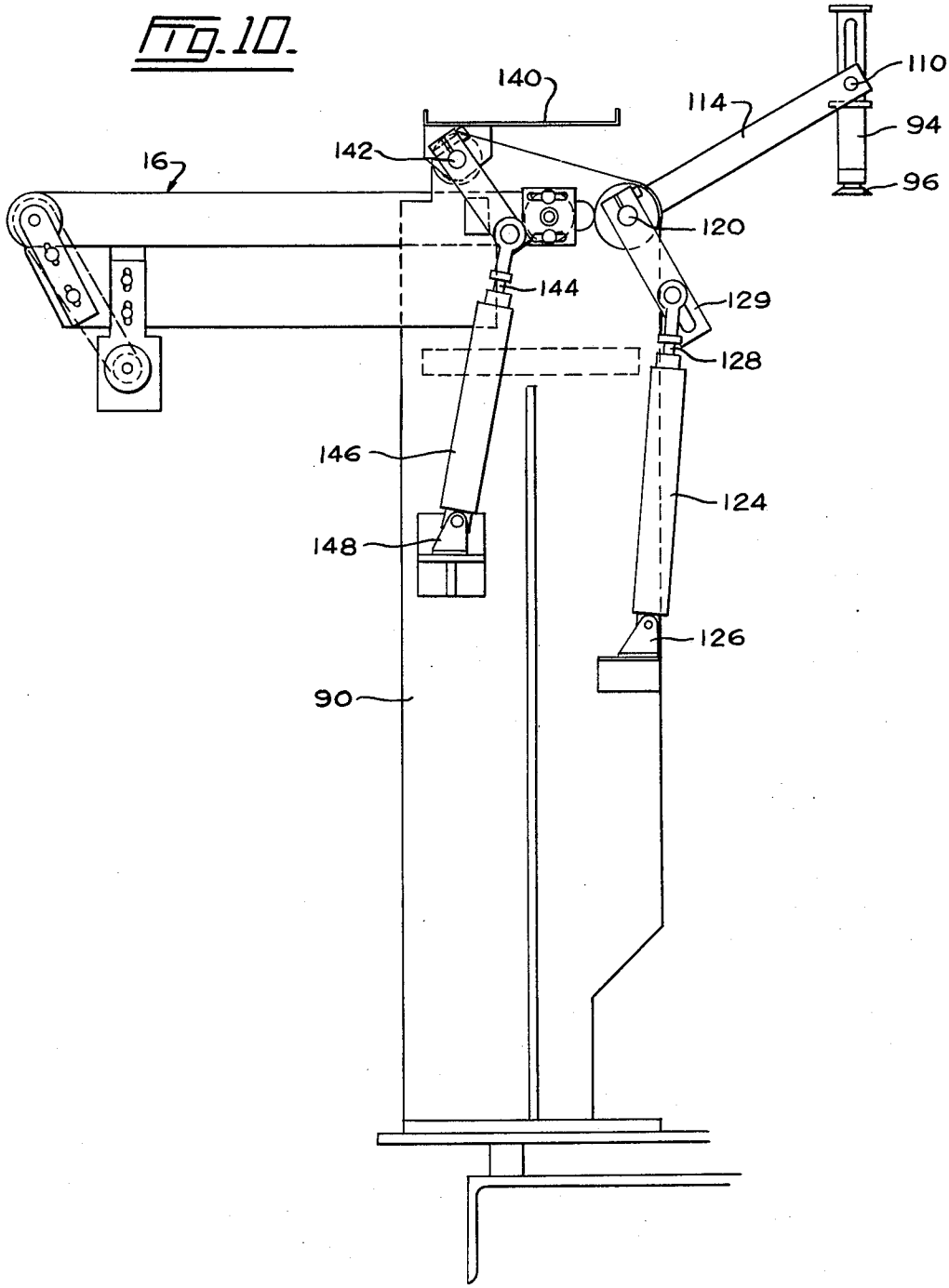
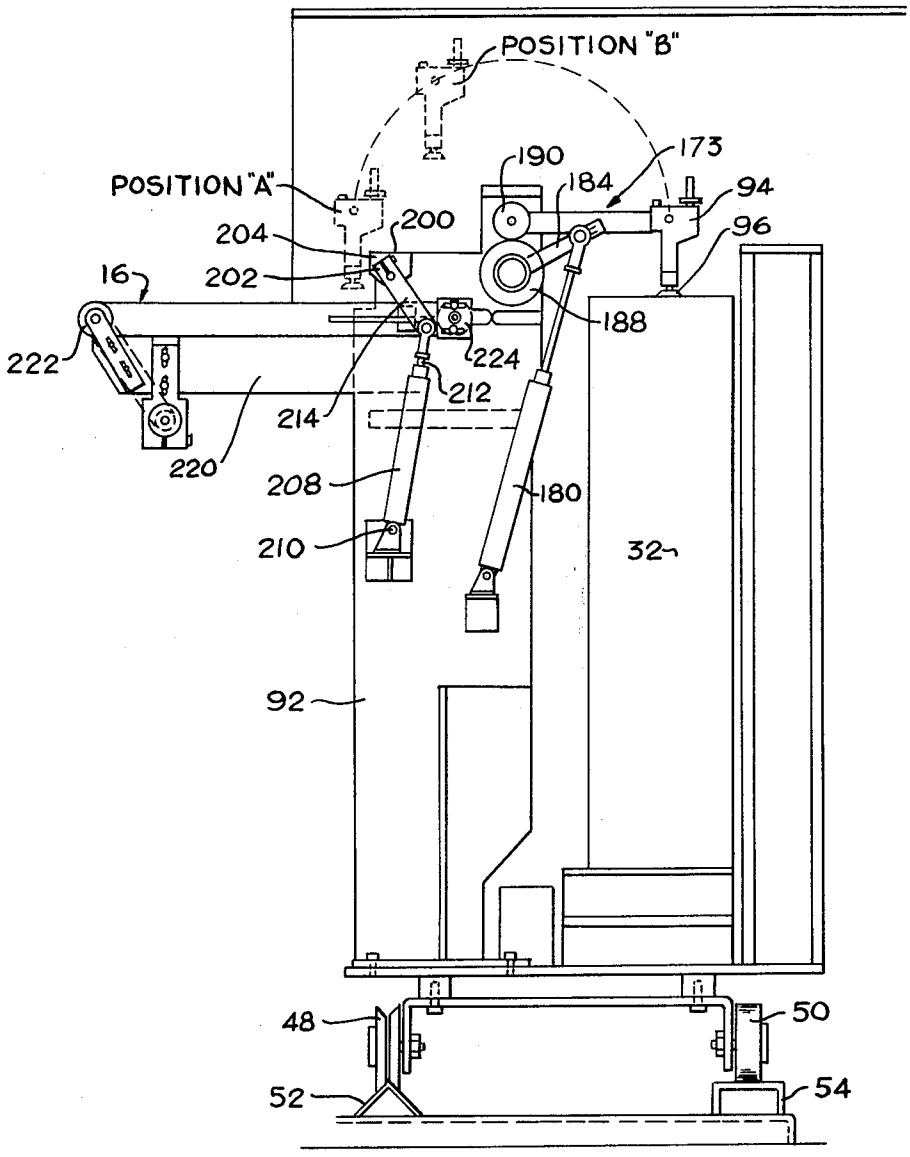


Fig. 11.


POSITION "B"
POSITION "A"
190
173
184
94
96
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204
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222
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212
214
220
208
180
210
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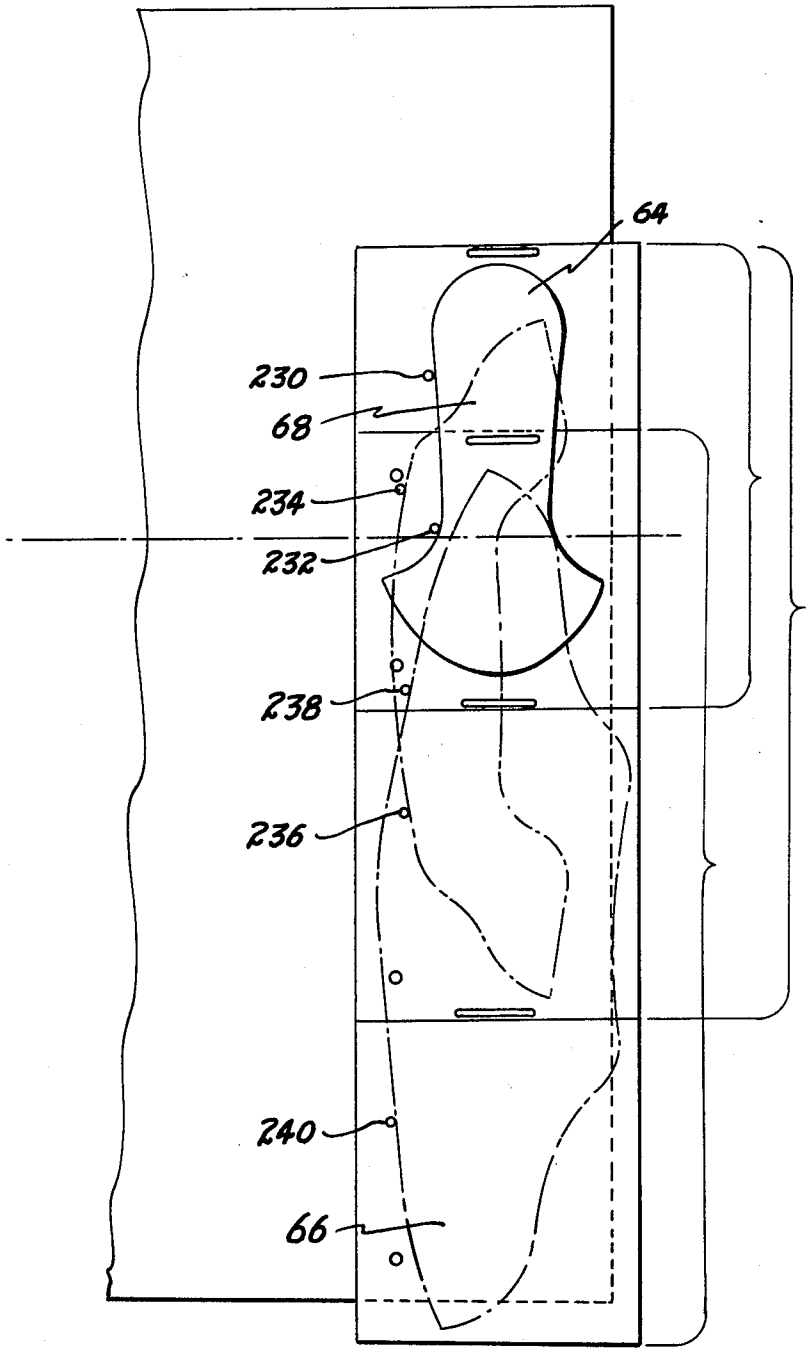


Fig. 12.

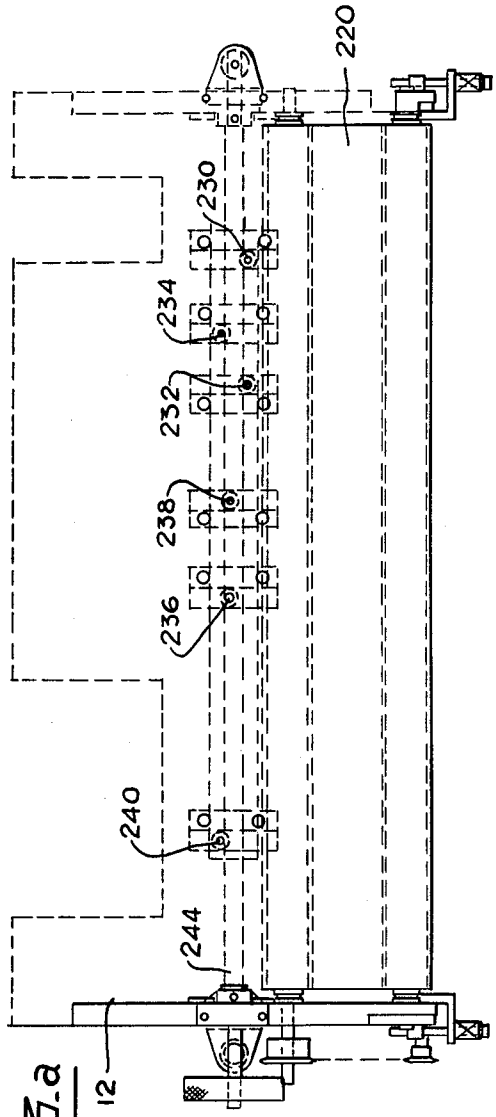


Fig. 13.a

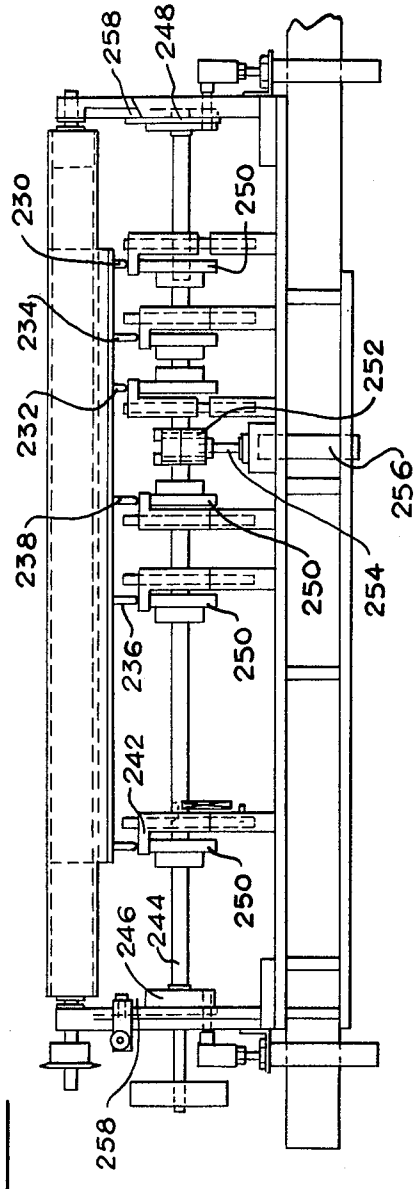


Fig. 13.b

FIG. 14.

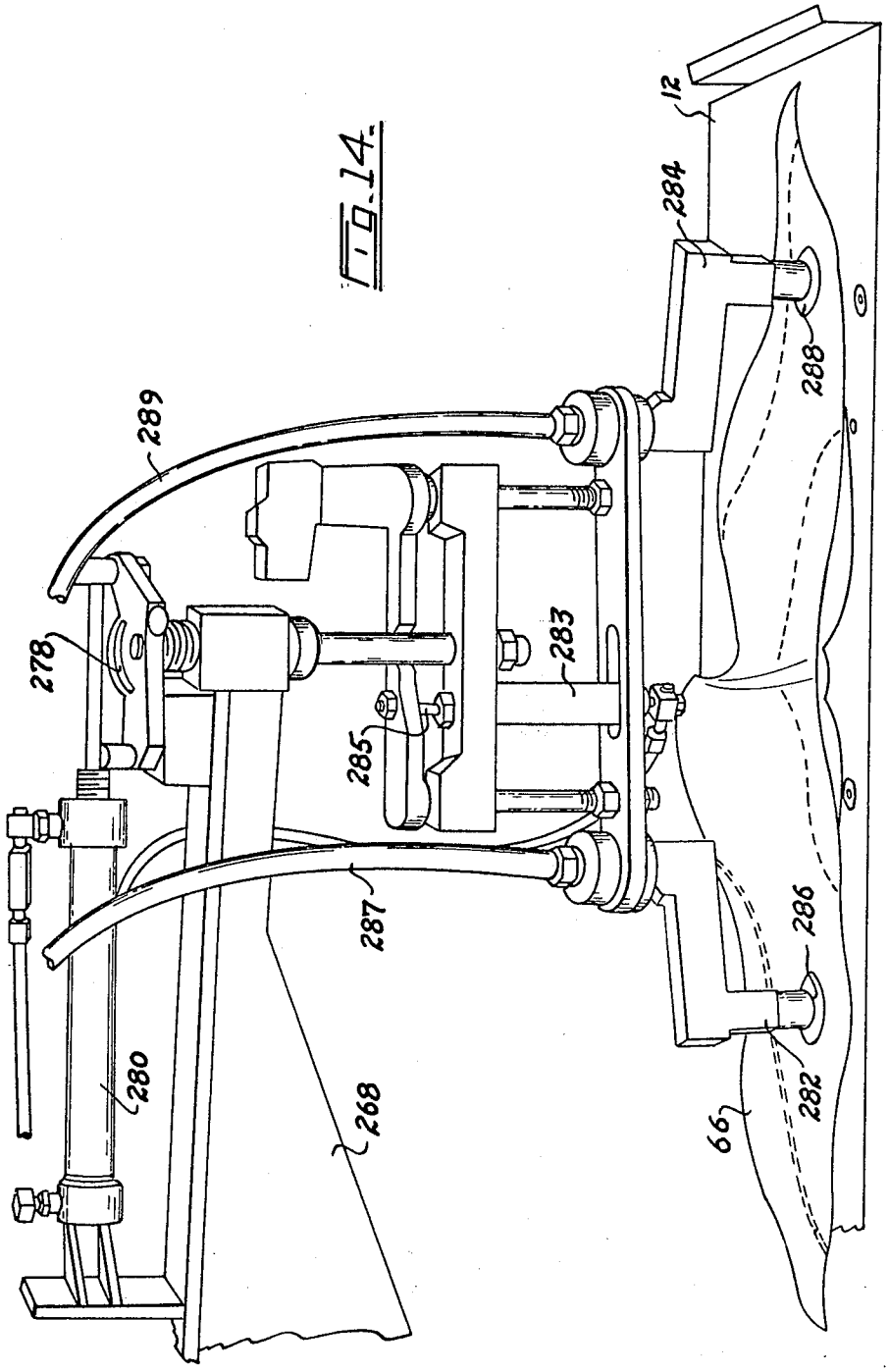


Fig. 15.

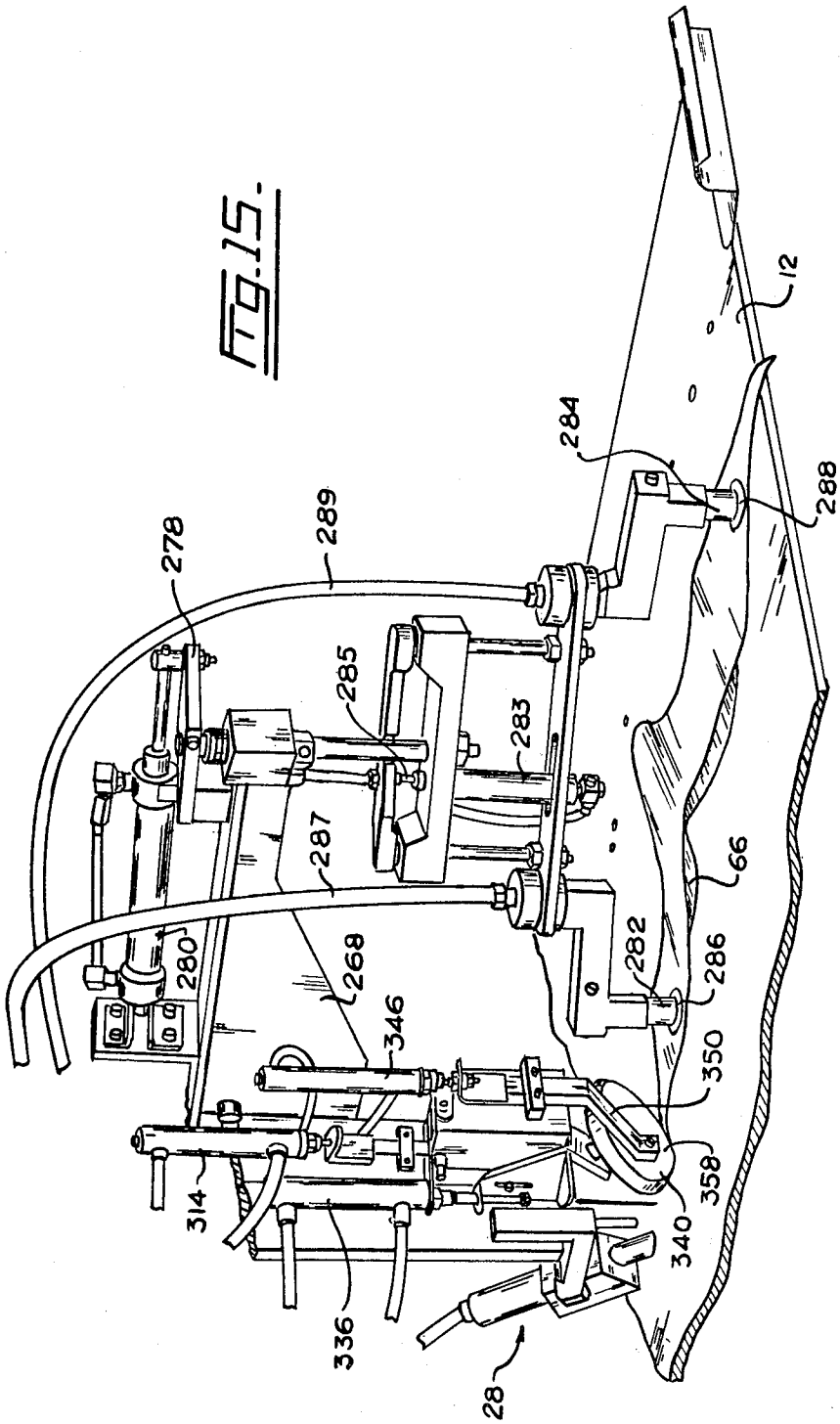

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FIG. 16.

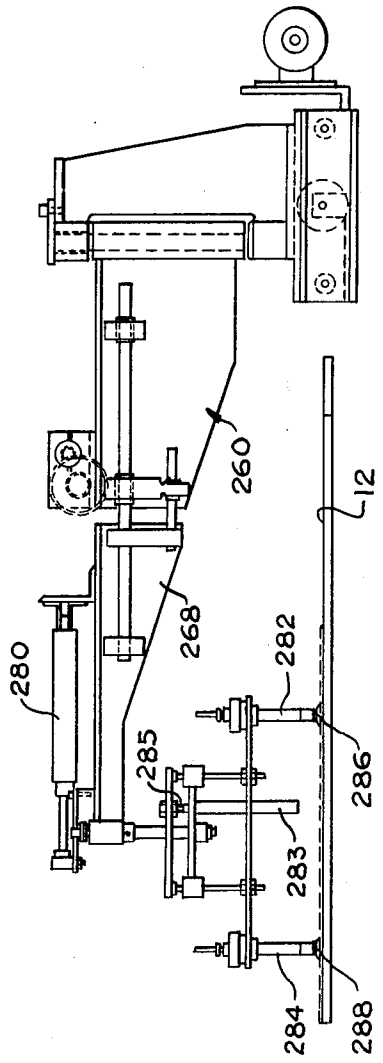
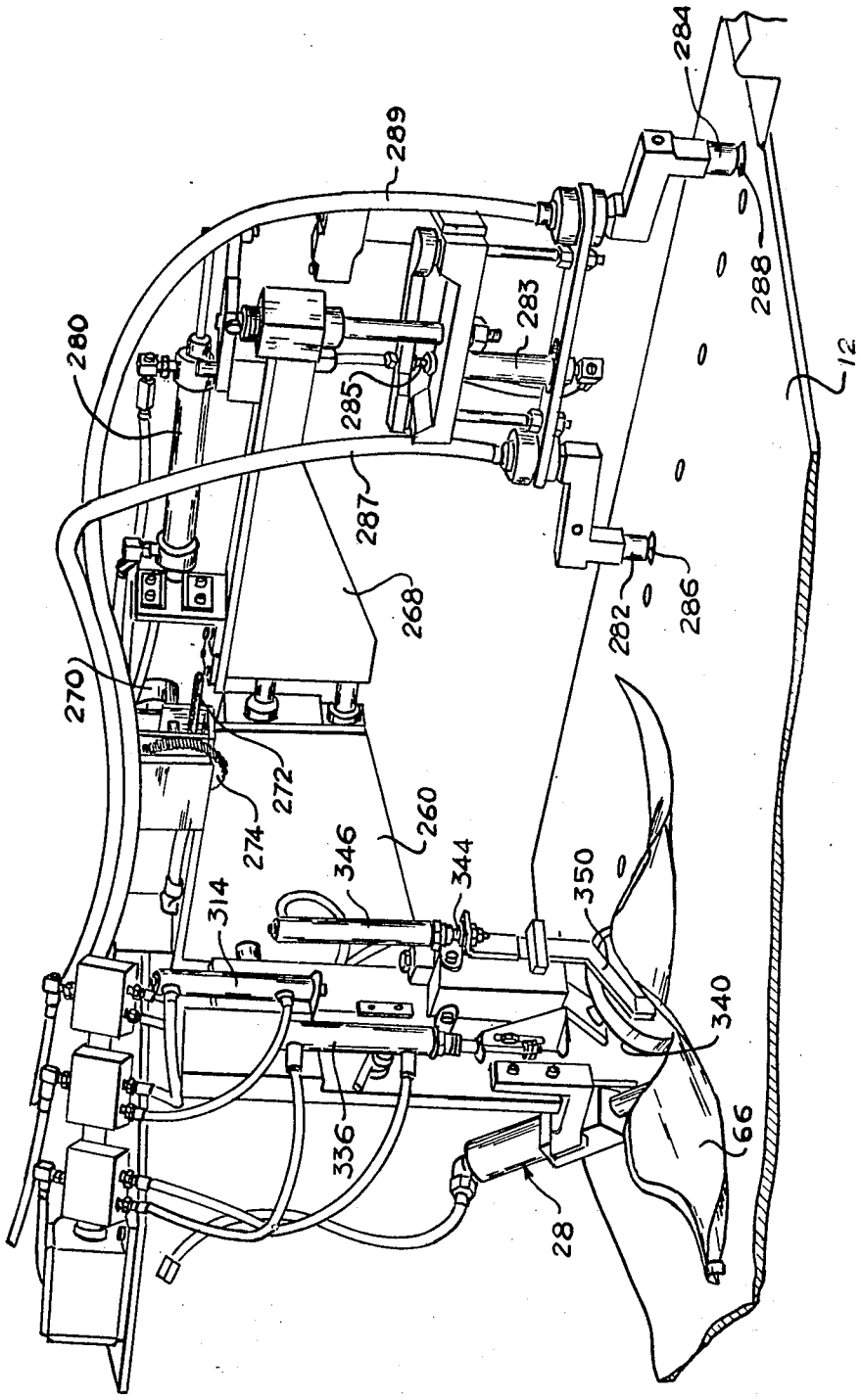


Fig. 17.


284
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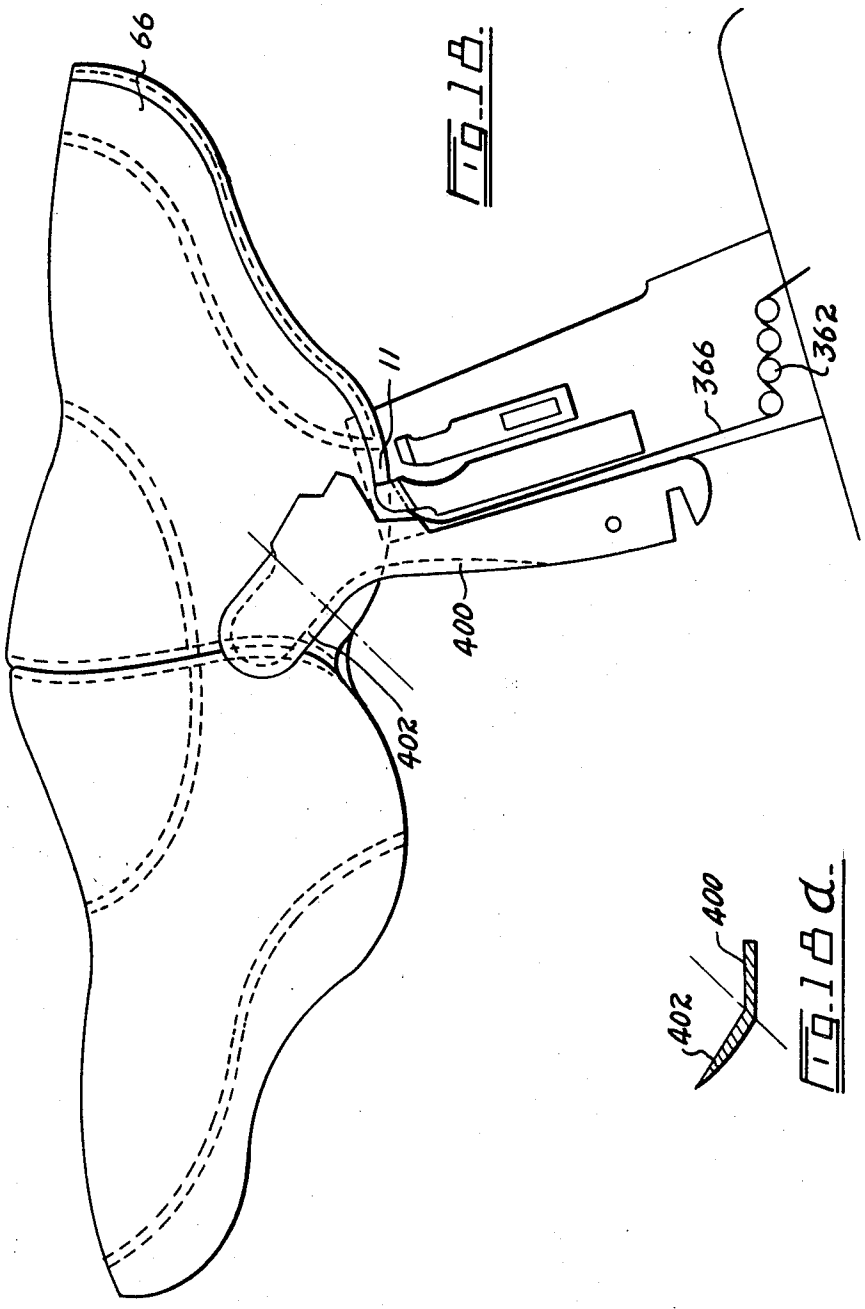


FIG. 18.

FIG. 18a.

Fig. 19.

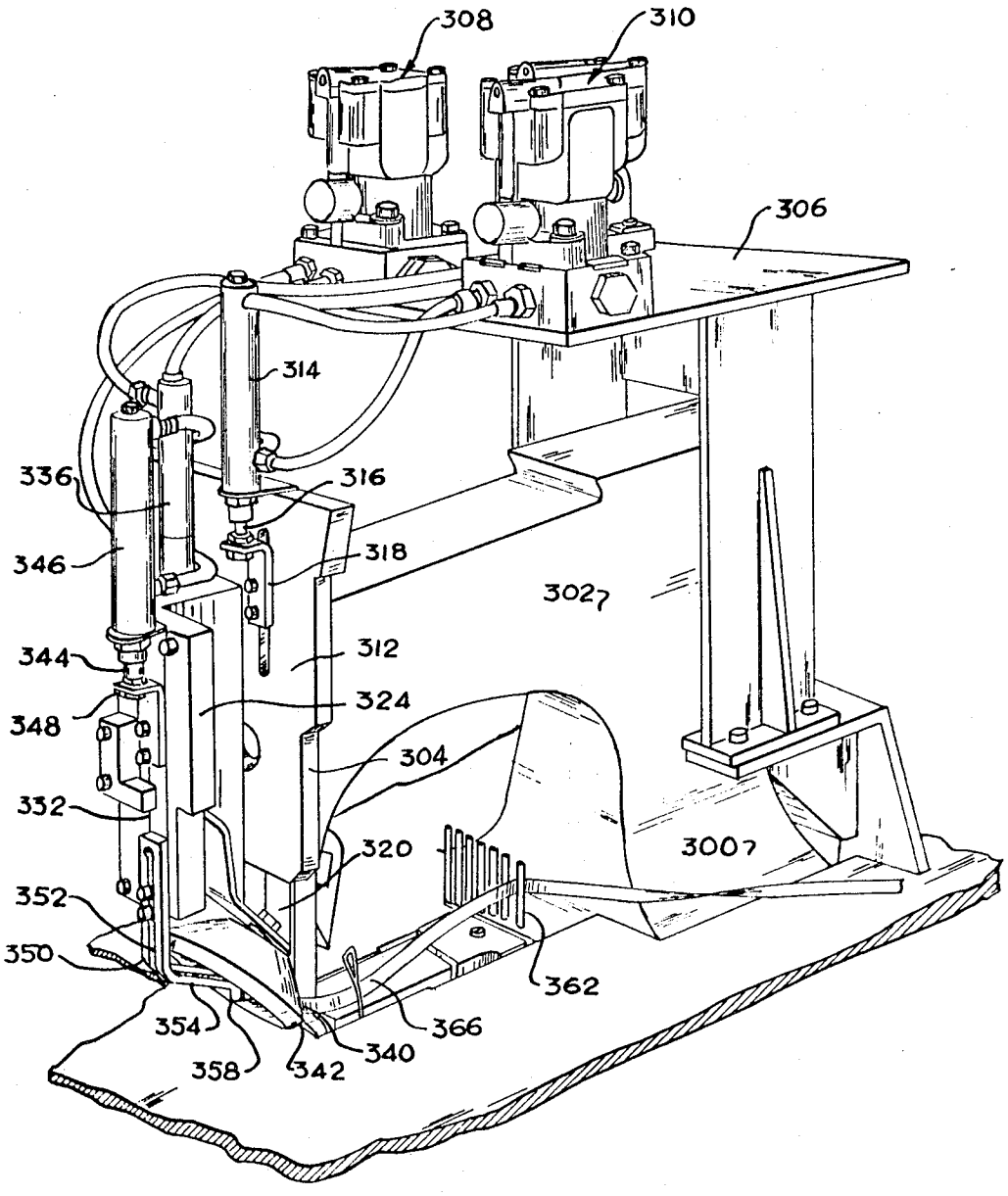

308
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Fig. 20.

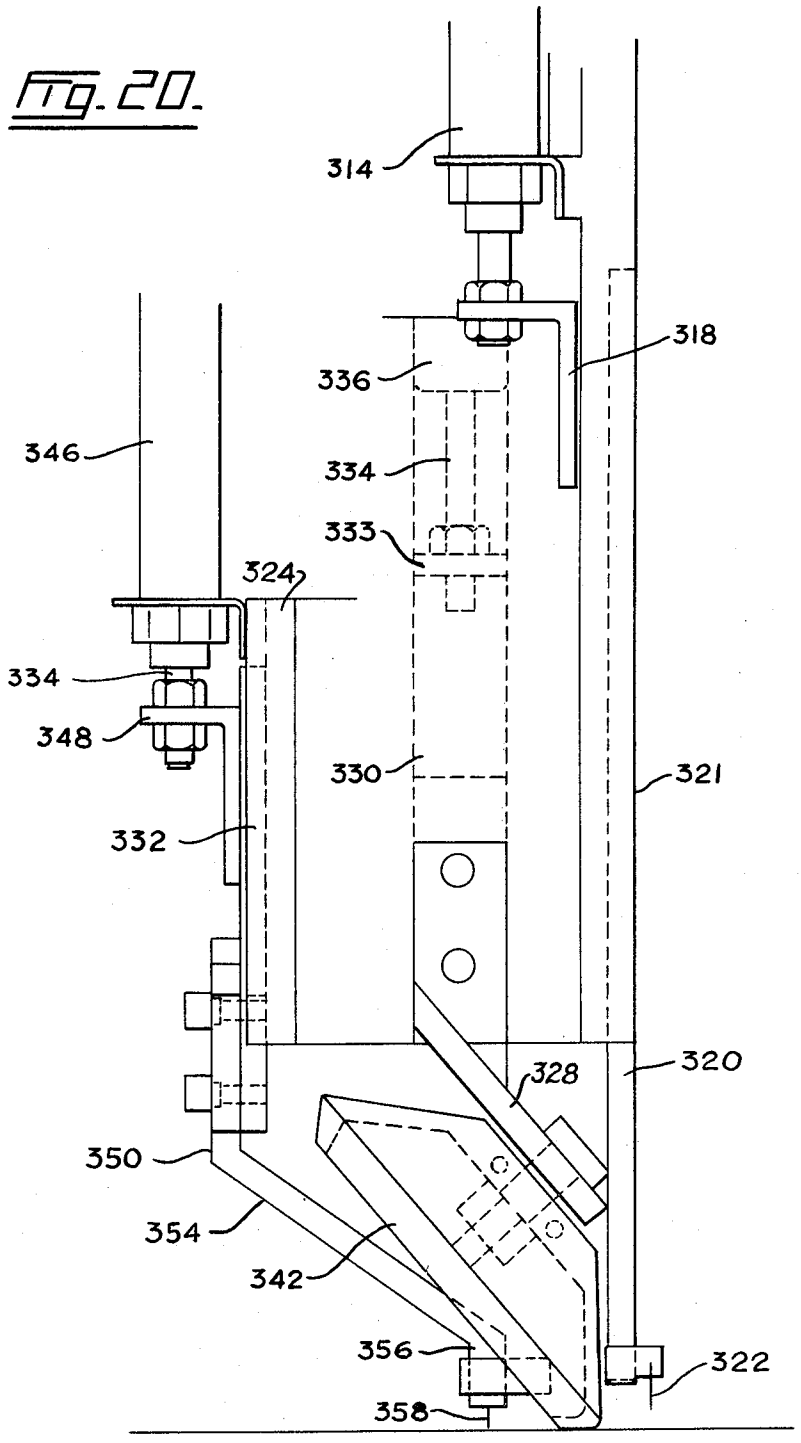
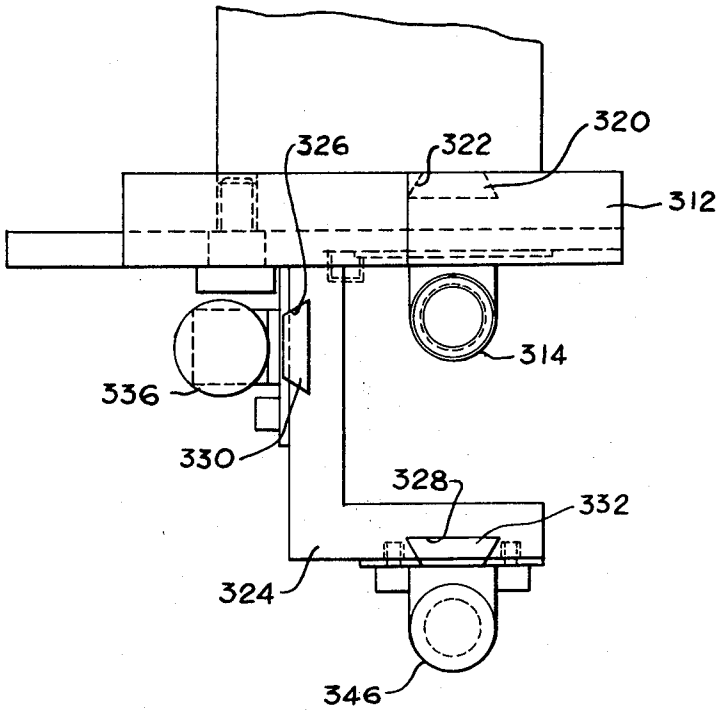

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Fig. 21.



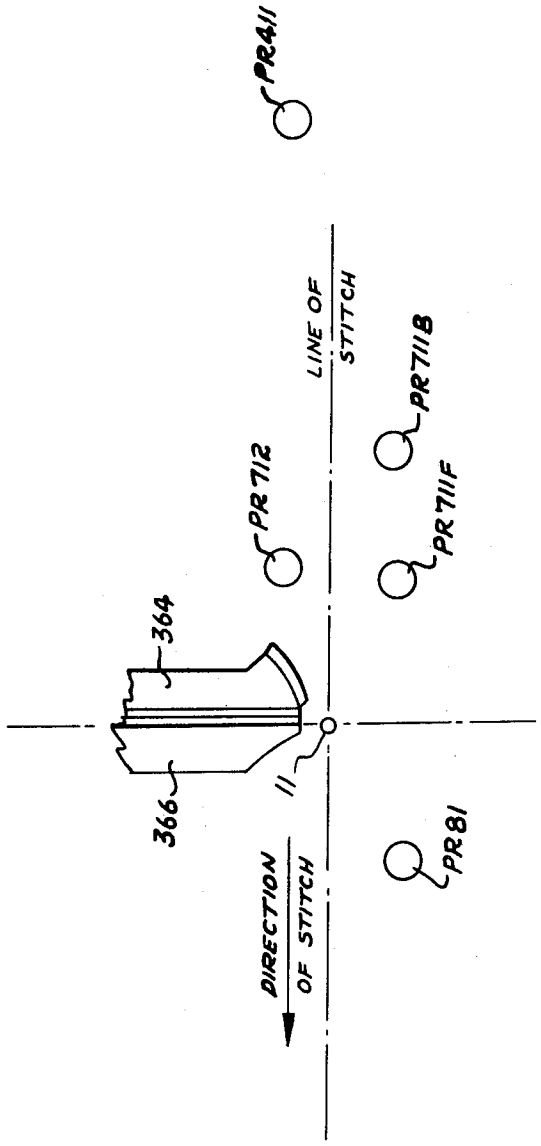

PR411
LINE OF STITCH
PR711B
PR712
PR711F
364
366
11
PR81
DIRECTION OF STITCH

FIG. 22.

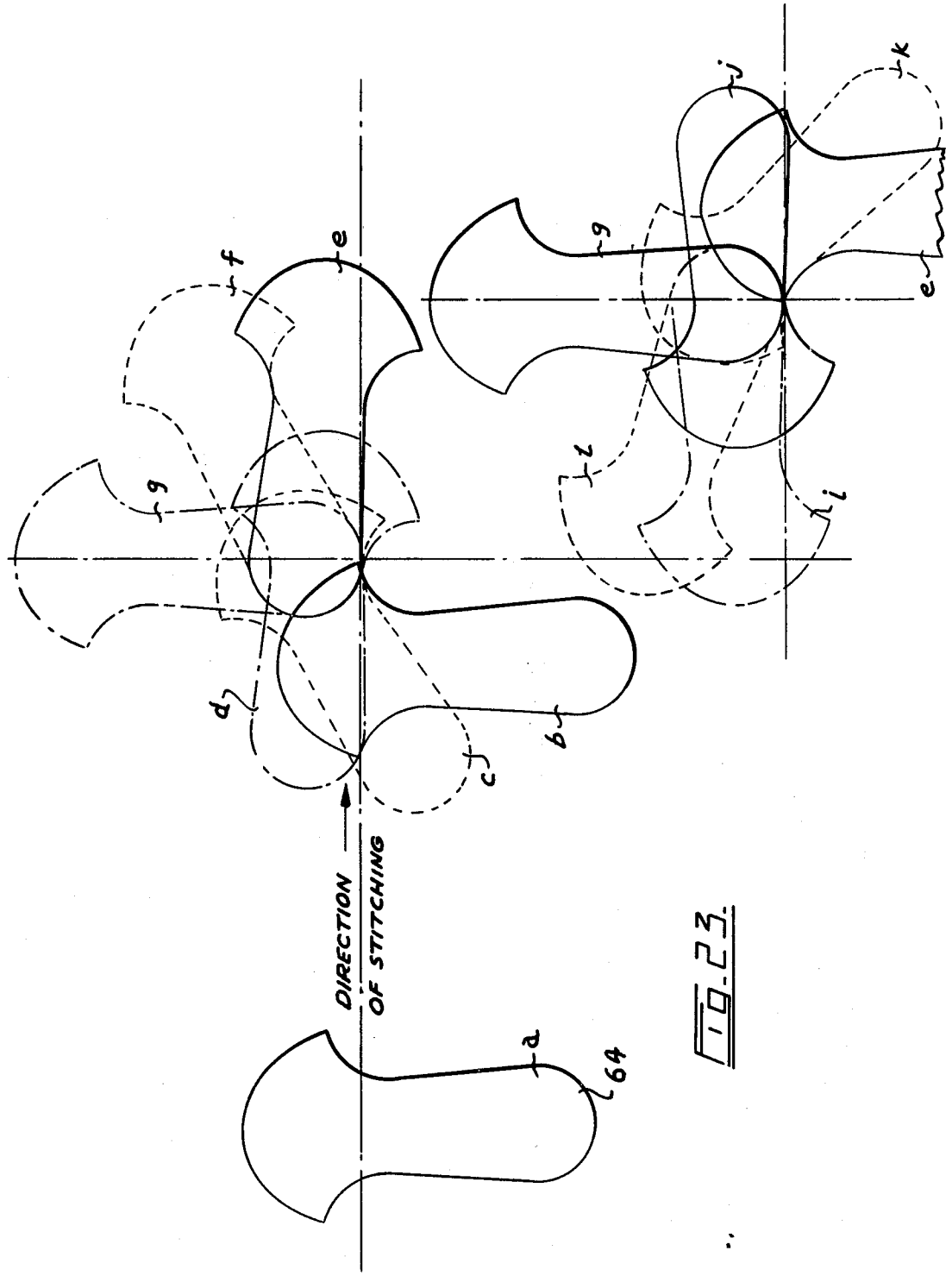
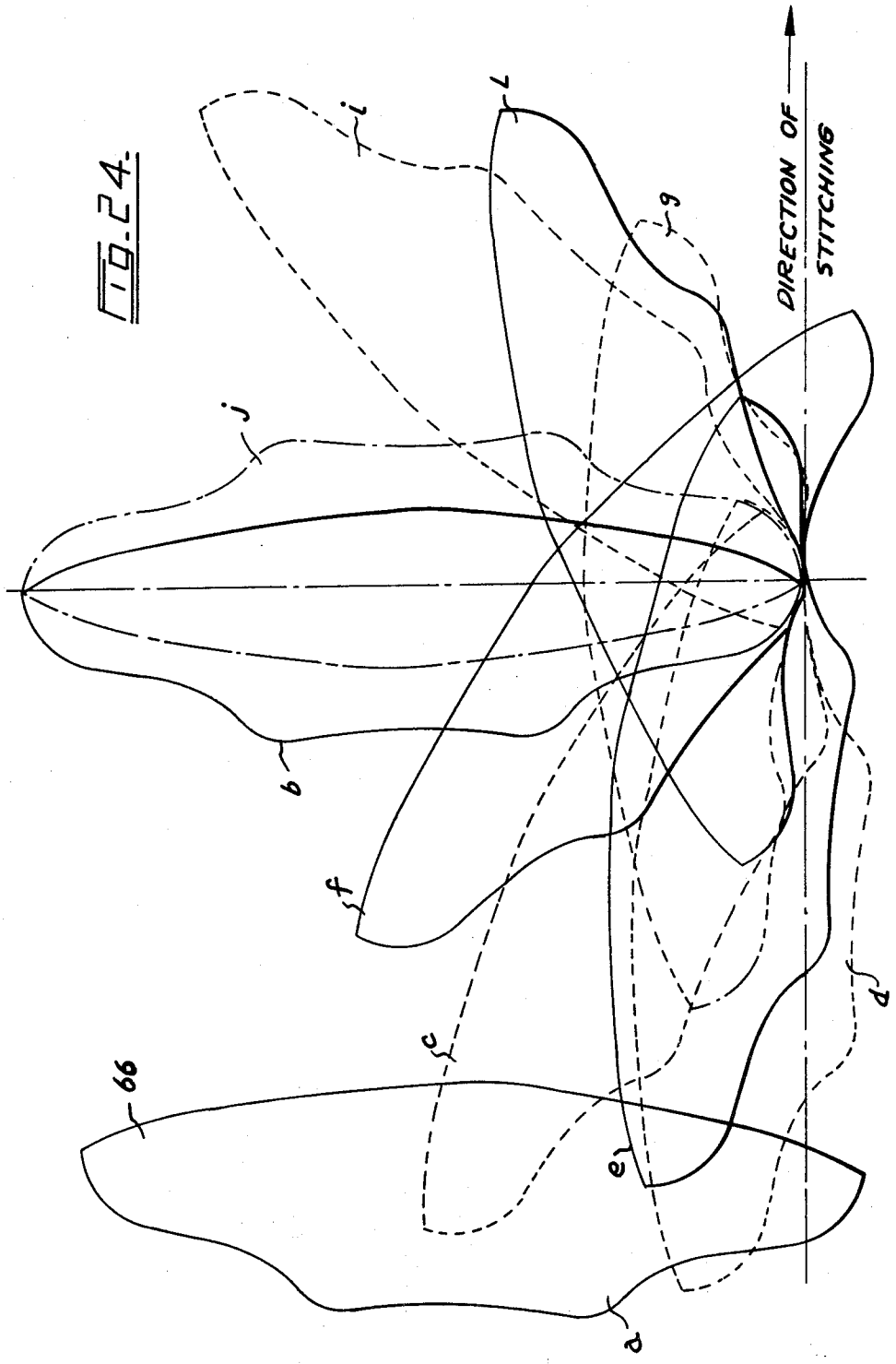


FIG. 23.

FIG. 24.



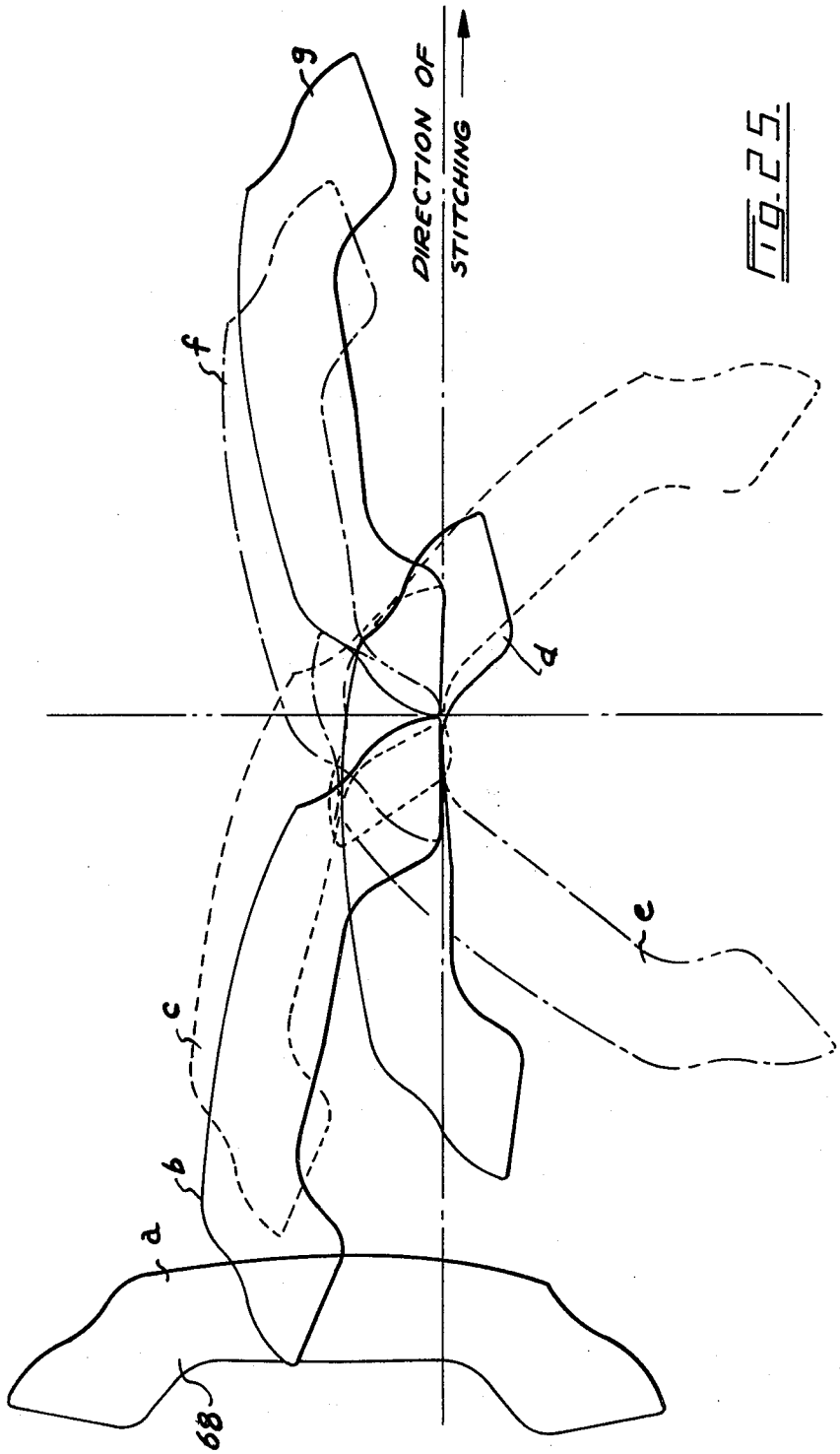


FIG. 25.

Fig. 26.

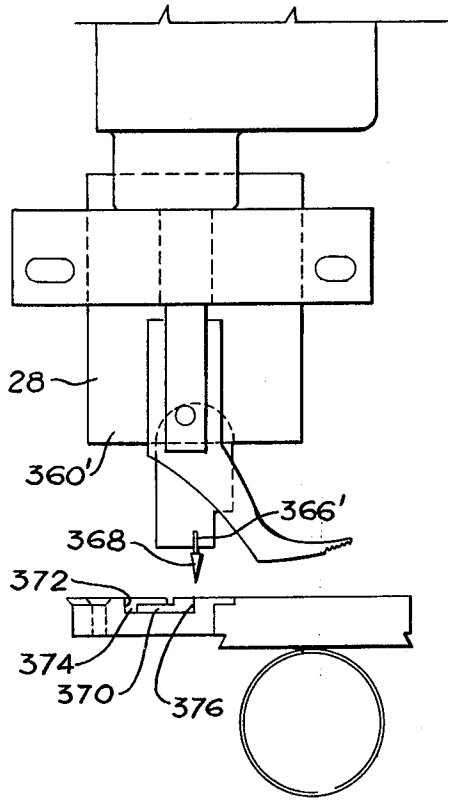
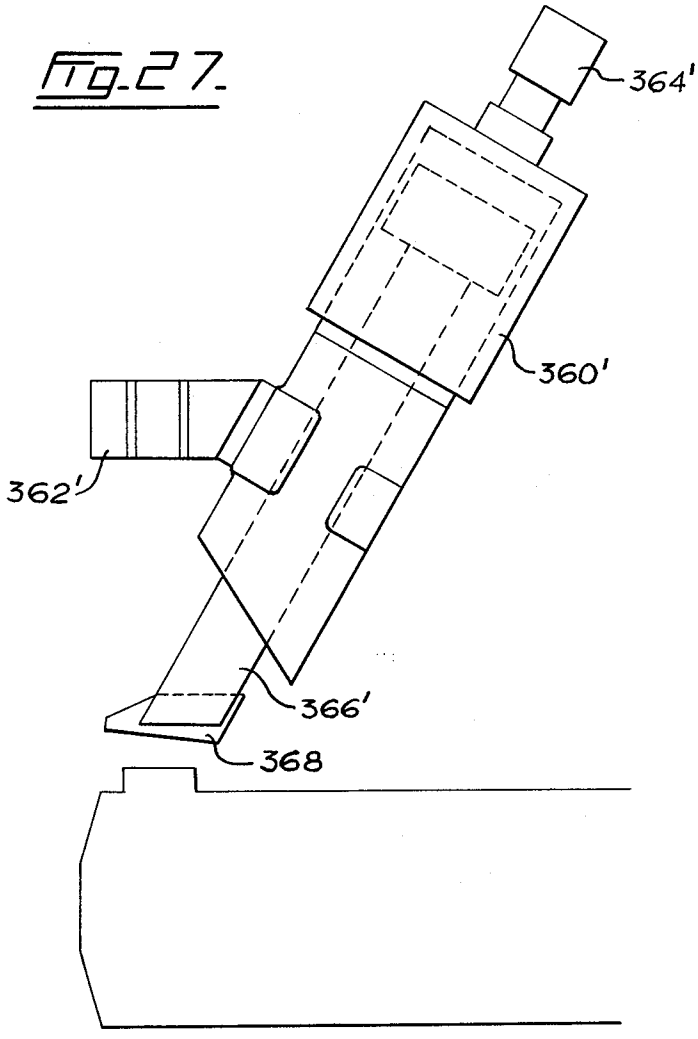


Fig. 27.



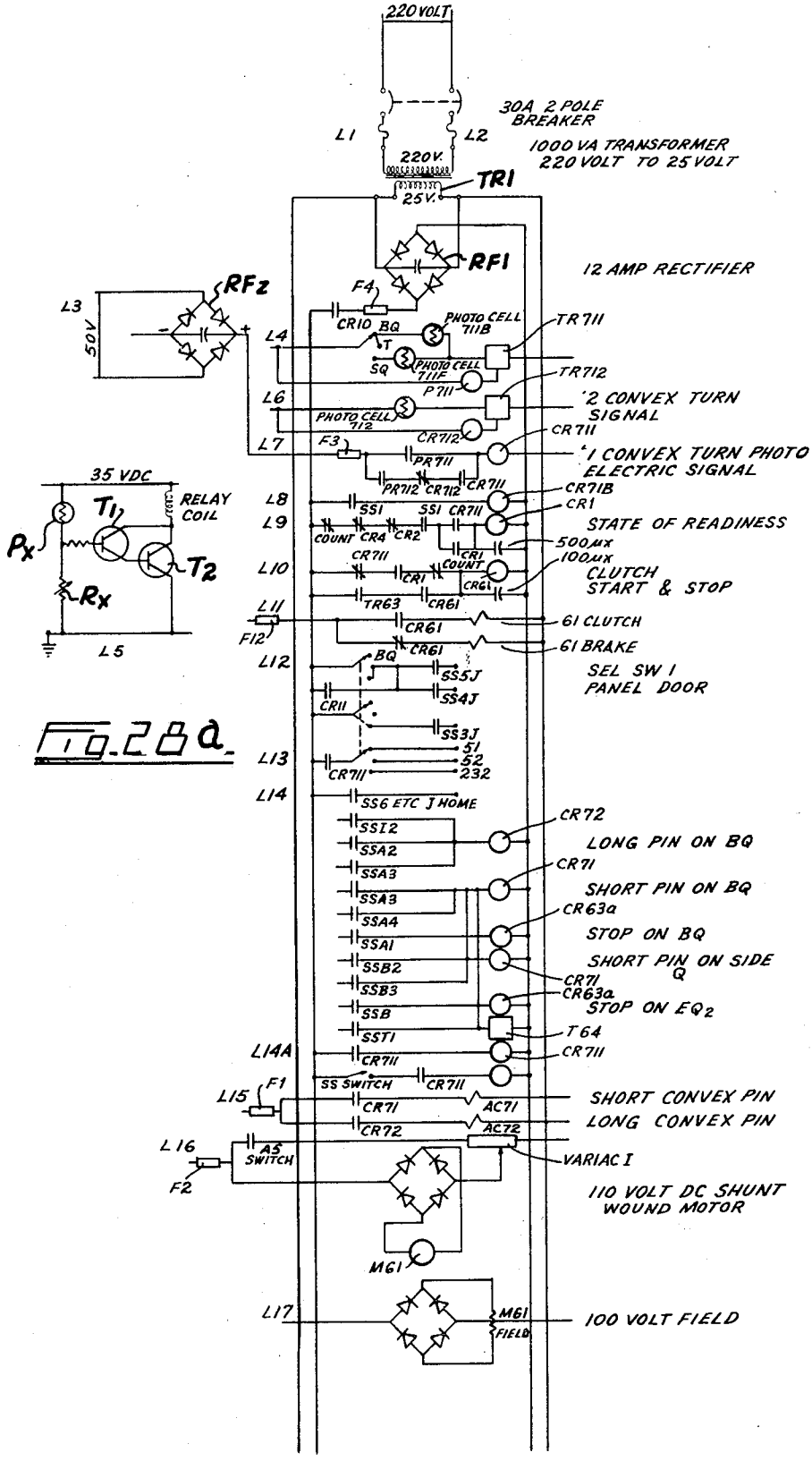

220 VOLT
30A 2 POLE BREAKER
L1
L2
220V.
1000 VA TRANSFORMER 220 VOLT TO 25 VOLT
TR1
25V.
RF1
12 AMP RECTIFIER
RF2
L3
50V
F4
CR10 BQ
PHOTO CELL 711B
TR711
L4
T
SQ
PHOTO CELL 711F
TR712
P711
L6
PHOTO CELL 712
CR712
'2 CONVEX TURN SIGNAL
CR711
L7
F3
PR711
'1 CONVEX TURN PHOTO ELECTRIC SIGNAL
PR712
CR712
CR711
35 VDC
RELAY COIL
T1
Px
T2
Rx
L5
L8
SS1
SSI CR711
CR71B
CR1
L9
COUNT CR4
CR2
STATE OF READINESS
500μx
100μx
CR711
CR1
COUNT
L10
CR1
CR61
CLUTCH START & STOP
TR63
CR61
L11
F12
CR61
61 CLUTCH
CR61
61 BRAKE
L12
BQ
SS5J
SS4J
SEL SW I PANEL DOOR
CR11
SS3J
51
52
232
L13
CR711
L14
SS6 ETC J HOME
SSI2
SSA2
SSA3
CR72
LONG PIN ON BQ
SSA3
SSA4
SSAI
SSB2
SSB3
SSB
SSTI
CR71
SHORT PIN ON BQ
CR63a
STOP ON BQ
SHORT PIN ON SIDE Q
CR71
CR63a
STOP ON EQ2
T64
L14A
CR711
CR711
SS SWITCH
CR711
F1
L15
CR71
AC71
SHORT CONVEX PIN
CR72
AC72
LONG CONVEX PIN
L16
AS SWITCH
F2
VARIAC I
110 VOLT DC SHUNT WOUND MOTOR
MG1
L17
MG1 FIELD
100 VOLT FIELD

Fig. 28a

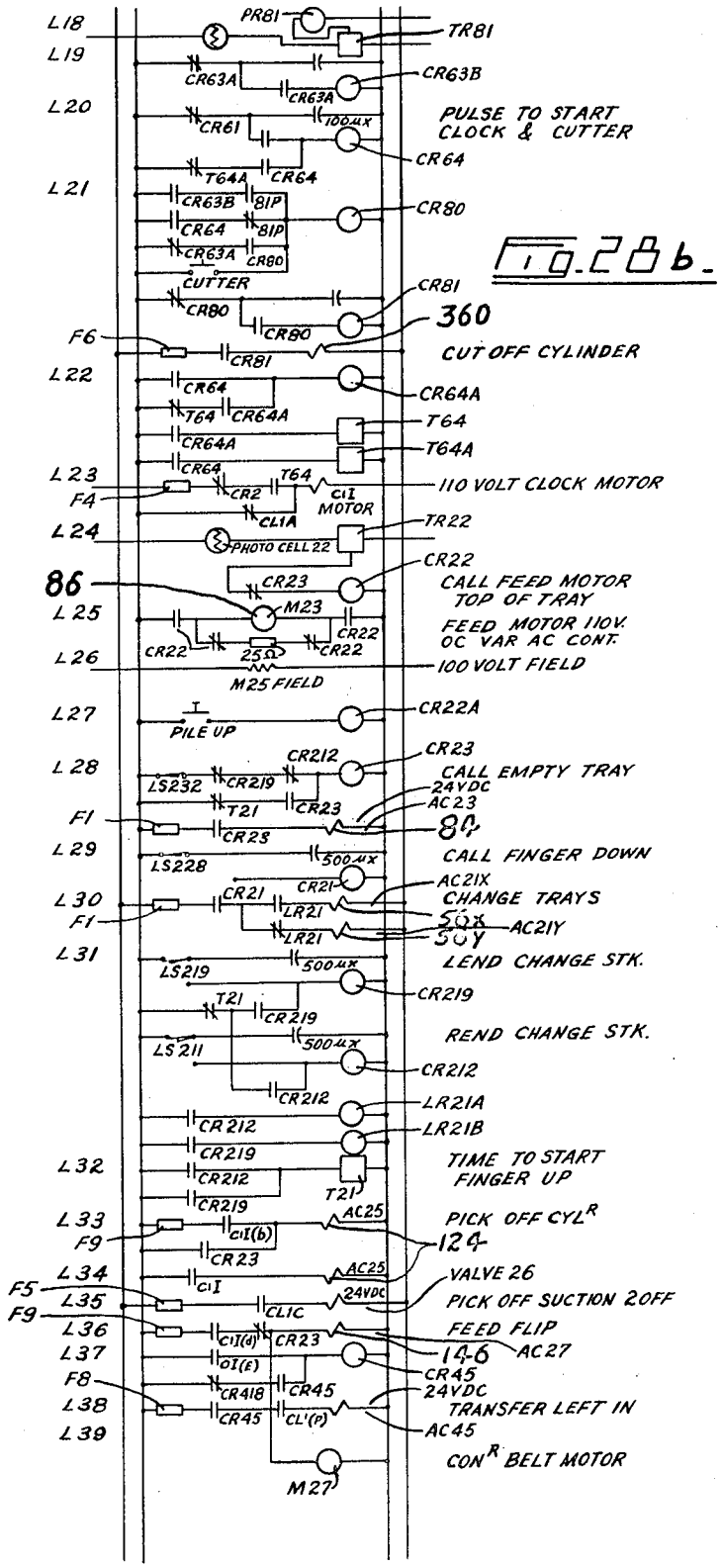

L18
L19
L20
L21
L22
L23
L24
L25
L26
L27
L28
L29
L30
L31
L32
L33
L34
L35
L36
L37
L38
L39
F1
F4
F5
F6
F8
F9
86
PR81
TR81
CR63A
CR63B
CR61
100μx
CR64
T64A
81P
CR80
CUTTER
CR81
360
CUT OFF CYLINDER
CR64A
T64
T64A
110 VOLT CLOCK MOTOR
CL1 MOTOR
CL1A
PHOTO CELL 22
TR22
CR22
CALL FEED MOTOR TOP OF TRAY
M23
FEED MOTOR 110V. OC VAR AC CONT.
25Ω
M25 FIELD
100 VOLT FIELD
CR22A
PILE UP
CR212
CR219
CR23
CALL EMPTY TRAY
24VDC
AC23
80
LS232
T21
LS228
500μx
CALL FINGER DOWN
CR21
AC21X
CHANGE TRAYS
LR21
50X
AC21Y
50Y
LS219
LEND CHANGE STK.
LS211
REND CHANGE STK.
LR21A
LR21B
TIME TO START FINGER UP
AC25
PICK OFF CYL^R
124
CL1(b)
CL1
VALVE 26
24VDC
PICK OFF SUCTION 20FF
CL1C
FEED FLIP
CL1(d)
CL1(E)
146
AC27
CR45
CR418
24VDC
TRANSFER LEFT IN
CL1(P)
AC45
CON^R BELT MOTOR
M27

FIG. 28b.

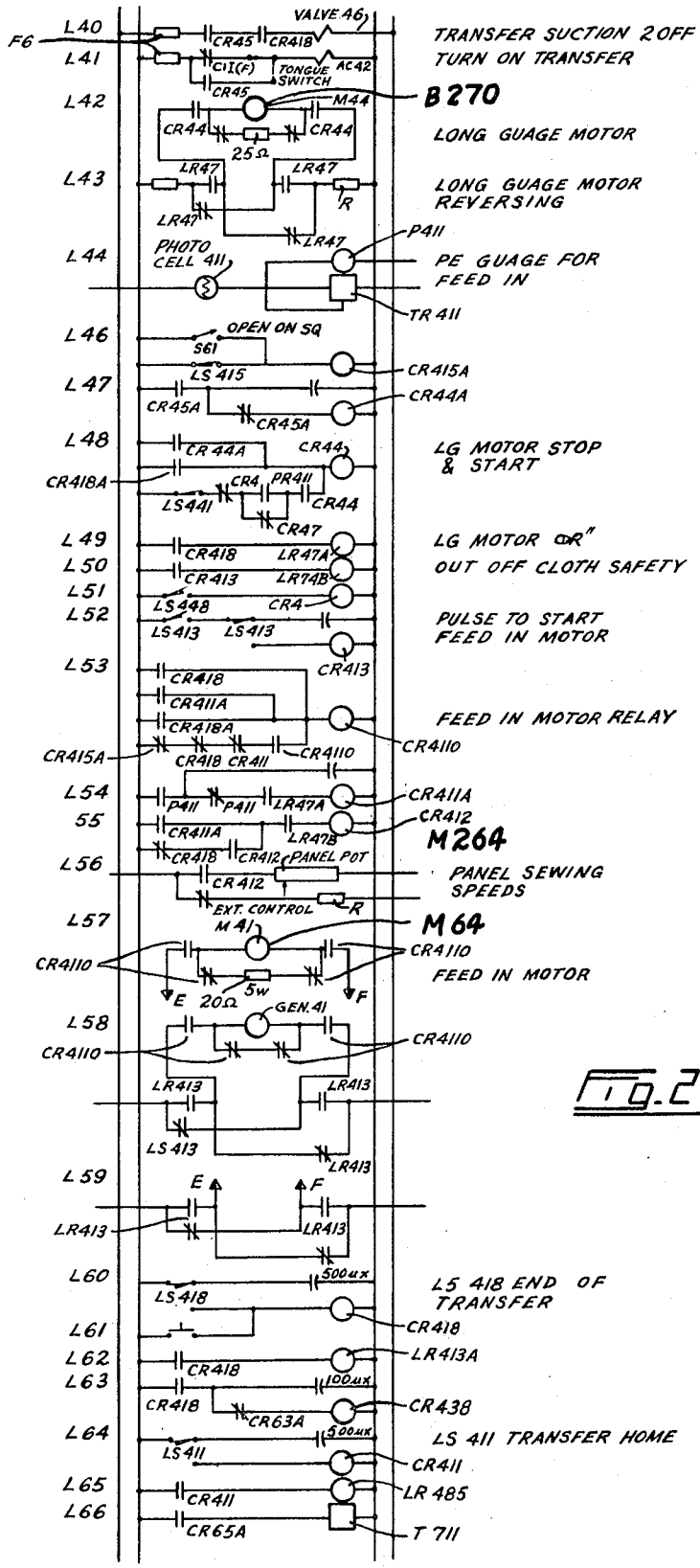

L40
F6
L41
L42
L43
L44
L46
L47
L48
CR418A
L49
L50
L51
L52
L53
CR415A
L54
55
L56
L57
CR4110
L58
CR4110
L59
LR413
L60
L61
L62
L63
L64
L65
L66
VALVE 46
CR45
CR418
C1I(F)
TONGUE SWITCH
AC42
CR45
M44
CR44
CR44
25Ω
LR47
LR47
R
LR47
LR47
PHOTO CELL 411
P411
TR 411
OPEN ON SQ
S61
LS 415
CR415A
CR45A
CR45A
CR44A
CR44A
CR44
CR4
PR411
LS441
CR44
CR47
CR418
LR47A
CR413
LR47B
LS448
CR4
LS413
LS413
CR413
CR418
CR411A
CR418A
CR4110
CR418
CR411
CR4110
P411
P411
LR47A
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LR47B
CR412
CR418
CR412
PANEL POT
CR412
EXT. CONTROL
R
M41
M64
CR4110
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F
GEN. 41
CR4110
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LR413
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E
F
LR413
LR413
500ux
LS418
CR418
LR413A
CR418
100ux
CR418
CR63A
CR438
500ux
LS411
CR411
CR411
LR 485
CR65A
T 711
TRANSFER SUCTION 2OFF
TURN ON TRANSFER
B270
LONG GUAGE MOTOR
LONG GUAGE MOTOR REVERSING
PE GUAGE FOR FEED IN
LG MOTOR STOP & START
LG MOTOR OR"
OUT OFF CLOTH SAFETY
PULSE TO START FEED IN MOTOR
FEED IN MOTOR RELAY
M264
PANEL SEWING SPEEDS
FEED IN MOTOR
LS 418 END OF TRANSFER
LS 411 TRANSFER HOME

FIG. 28C.

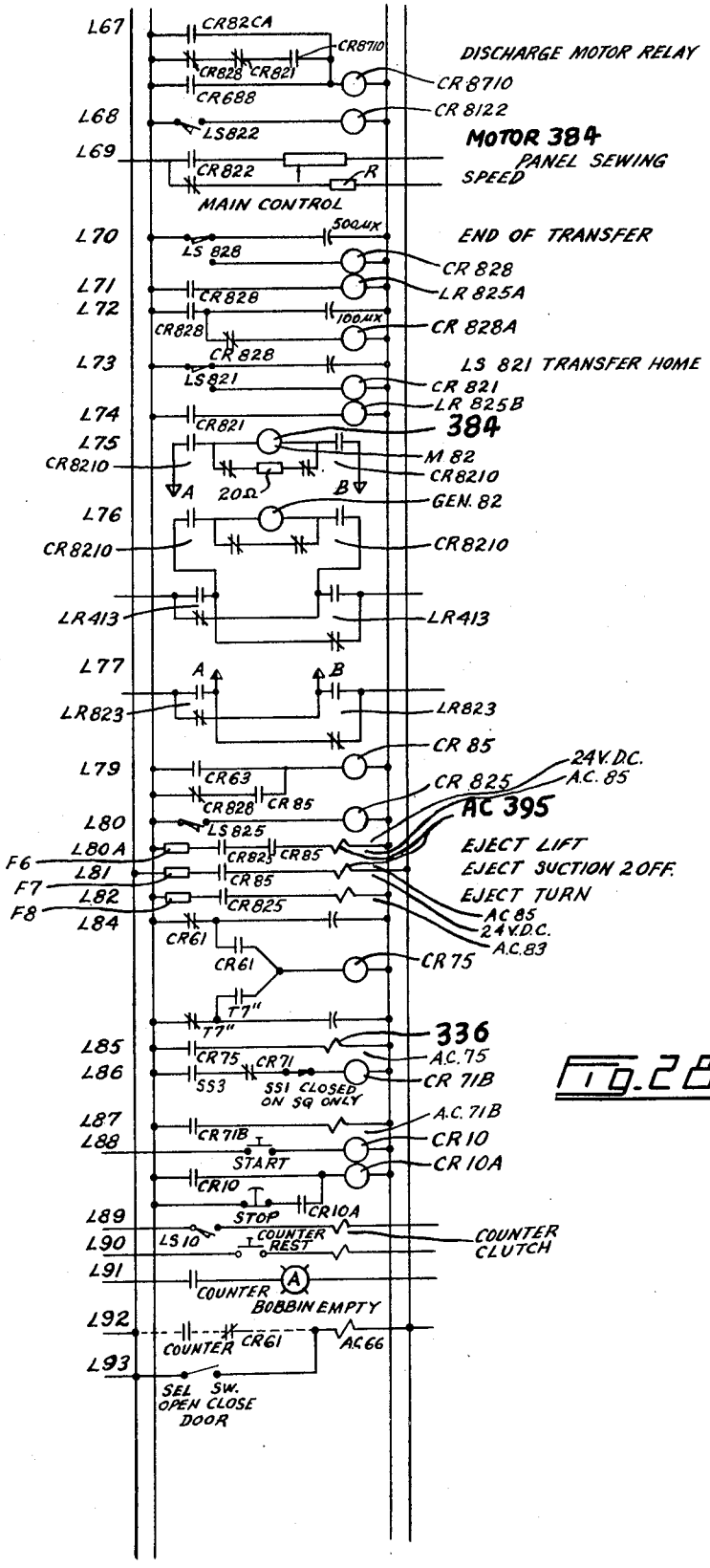

L67
CR82CA
CR8710
CR828
CR821
CR688
DISCHARGE MOTOR RELAY
CR 8710
CR 8122
L68
LS822
MOTOR 384
L69
CR822
R
PANEL SEWING SPEED
MAIN CONTROL
L70
500μx
LS 828
END OF TRANSFER
CR 828
L71
CR828
LR 825A
L72
CR828
100μx
CR 828A
L73
CR 828
LS 821 TRANSFER HOME
LS821
CR 821
L74
CR821
LR 825B
384
L75
M 82
CR8210
CR8210
A
20Ω
B
GEN. 82
L76
CR8210
CR8210
LR413
LR413
L77
A
B
LR823
LR823
CR 85
L79
CR63
CR828
CR 85
CR 825
24V.D.C.
A.C. 85
AC 395
L80
LS 825
L80A
F6
CR823
CR85
EJECT LIFT
L81
F7
CR 85
EJECT SUCTION 2 OFF.
L82
F8
CR825
EJECT TURN
AC 85
24 V.D.C.
L84
A.C. 83
CR61
CR61
CR 75
T7"
T7"
336
L85
CR75
CR71
A.C. 75
L86
SS3
SS1 CLOSED ON SQ ONLY
CR 71B
L87
A.C. 71B
CR71B
L88
CR 10
START
CR 10A
CR10
CR10A
L89
STOP
L90
LS 10
COUNTER REST
COUNTER CLUTCH
L91
A
COUNTER
BOBBIN EMPTY
L92
COUNTER
CR61
AC66
L93
SEL SW. OPEN CLOSE DOOR

Fig. 28d.

APPARATUS AND METHOD FOR EDGE STITCHING/BINDING WORKPIECES

This invention relates to an apparatus and method for the edge stitching/binding of fabric workpieces.

The present invention has particular utility in the edge stitching/binding of the component parts of fabric footwear uppers prior to their assembly and interconnection to form complete articles of footwear, but is also of utility in the edge stitching/binding of other fabric workpieces, particularly where the edges to be stitched/bound have a compound curvature.

Heretofore, edge binding of component parts of footwear uppers, such as the quarters and tongues thereof, has been accomplished by having an operator introduce the parts to the sewing machine and continuously manually control and guide the parts through the stitch pattern. This, as will be appreciated, requires a considerable degree of skill, judgment and dexterity on the part of the operator who must endeavour to ensure that at all times the edge of the part being bound is correctly orientated so that the fabric edge is urged between the edge binding strip and uniformly stitched throughout its length with the stitch line following a path spaced at a substantially continuous distance from the fabric edge.

It is an object of the present invention to provide an apparatus by means of which an operator is required only to introduce a workpiece into the needle of the sewing machine whereafter the edge, with or without a binding strip or tape, is then automatically fully stitched with the line or stitch at a substantially uniform distance from the edge and the workpiece severed as a separate entity upon completion of the stitch pattern.

It is a further object of the present invention to provide a completely automatic apparatus by means of which workpieces to be processed are transferred in seriatim from a container, moved into the sewing machine in a precise orientation relative to the needle thereof, optionally have a tape folded about the edge thereof, and are automatically fully stitched at a substantially uniform distance from the edge thereof, whereafter the workpieces are severed into separate entities, and then automatically discharged from the apparatus.

A still further object of the invention is to provide an apparatus for edge stitching/binding a workpiece which is provided with control means constantly engaging the workpiece and adapted in conjunction with holding means selectively movable into engagement with the workpiece to cause the workpiece to traverse a stitch pattern such that the periphery thereof consists of a random sequence of straight lines, concave and convex curved portions with the stitch line at a substantially constant distance from the edge.

Another object of the invention is to provide automatic control means for an edge stitching/binding apparatus, which automatic control means comprises a logic circuit operable to initiate, sustain and terminate the action of holding means selectively engagable with a workpiece and which are adapted in conjunction with control means continuously engaging the workpiece to control stitching of curved edge portions of the workpiece.

It is also an object of the invention to provide a mechanism for automatically feeding workpieces to be edge stitched into a sewing machine in seriatim from a stack of such workpieces onto suitable conveying means disposed between the stack and the sewing machine and adapted to move workpieces towards the sewing machine with gauging of the workpieces prior to their introduction into the sewing machine.

Another object of the invention is to provide a mechanism for automatically placing an upward fold centrally of the topmost workpiece in a stack of such workpieces prior to removal of said top-most workpiece from the stack thereby to prevent simultaneous removal of more than the top-most workpiece.

A further object of the invention is to provide a mechanism for automatically inverting a workpiece removed from the top of a stack of such workpieces prior to deposition of same onto conveying means adapted to move the workpieces toward the sewing machine.

The invention also has as an object to provide an apparatus for automatically edge stitching/binding fabric workpieces in which the workpieces are introduced into the sewing machine at a speed synchronous with that of the sewing machine.

Another object of the invention is to provide an automatic edge stitching/binding apparatus including a cutting means at the output side of the sewing machine operable to sever fully stitched workpieces accurately at the commencement and termination of curved portions of the workpiece to be stitched as sensed by variations in illumination or radiant energy or in the differential flow from a fluidic orifice caused by variations in interference by the workpiece at one of several discrete sensing points and at the termination point respectively, detectors at the selected commencement point and the termination point being connected in a logic circuit the output of which is used to initiate, sustain and terminate the actual holding means adapted to be selectively engaged with the workpiece which in conjunction with a control means which continuously engages the workpiece controls the stitching of said curved portions of the workpiece.

The invention also has for an object the provision of a method of automatically edge stitching/binding a workpiece in which the workpiece is caused to traverse a stitch pattern such that the periphery thereof consists of a random sequence of straight lines and curved portions corresponding to the edge of the workpiece with the stitch line at a substantially constant distance from said edge, the workpiece being caused to follow said curved portions of the stitch pattern under control of photo-electric, radiant energy or fluidic sensing means which are connected in a logic circuit the output of which is used to initiate, sustain and terminate the action of holding means operable in conjunction with control means continuously engaging the workpiece to direct the movement of the workpiece through the sewing machine.

In accordance with the foregoing and other objects an embodiment of the invention wherein the workpieces are fed in seriatim into a sewing machine comprises automatic means adapted to control the operation of the sewing machine; control means to maintain a workpiece in appropriate position in relation to the needle of said sewing machine to ensure stitching a reasonably uniform distance from the edge of the work-

piece throughout the whole length to be stitched; and severing means adapted at commencement and termination of the stitching operation to cut off from said workpieces any material used in the stitching operation.

Another, fully automated, embodiment of the apparatus according to the invention comprises a sewing machine, means for successively feeding workpieces upwards to the top level of a stack of such workpieces of any pre-selected pattern; means for continuously feeding the workpieces horizontally towards the sewing machine; means for continuously orientating and engaging the workpieces with sufficient accuracy for said workpieces to be fed into the sewing machine with the leading corners thereof orientated and positioned within the tolerance normal to a manual sewing machine operation; means for feeding a tape towards the sewing machine and forming same so as to enclose the edge of the workpiece for subsequent stitching thereto, said edge binding being continuously stitched to said workpieces in said sewing machine in a manner such that the fit of the edge binding to the periphery of each workpiece conforms to at least the acceptable standards of manual stitching; and means for discharging the fully stitched shoe portions successively out of the sewing machine.

Preferably the apparatus includes means for severing the fully stitched workpieces accurately at the commencement and termination of each workpiece whereby each workpiece is completely separated from the immediately preceding and succeeding workpieces.

In accordance with one form of the invention there is provided a control means, which may be in the form of a conical wheel, and which constantly engages the workpiece from above at a closely adjusted pressure. This gently forces the cloth inward to a fence which is attached to an edge folder and guide which extends along back of the needle and which brings in an edge binding tape and folds it over so as to enclose the edge of the workpiece and be stitched to it. The control means which is preferably mounted so as to be free to move vertically on a rocking arm, exerts a substantially constant pressure on the incoming workpiece and urges it towards a stationary stitching fence or guide with a pressure sufficient to cause the stitch to follow a random sequence of straight line and curved edge portions encountered on the workpieces to be processed. In stitching convex curved edge portions a holding means is engaged with the workpiece exactly on the center of a convex curve, that is to say directly opposite the point of inflection at the start of the curve, and the holding means in conjunction with the control means forces the workpiece to take the convex arc notwithstanding the urging of the conical wheel which associates so as to permit the workpiece to skid under it when gripped between the feed needle of the machine and the holding needle inserted into the workpiece. A photoelectric stitch control system is provided to determine the commencement and conclusion of convex curved portions of the workpiece.

In the practical application of the invention to the three particular shoe parts with which we are concerned, it has been found that two convex curve radii cover all requirements, so two separate convex turning pins are provided at different and adjustable distances from the sewing machine needle. The selection of which of a plurality of holding means to move into engagement with the workpiece for each curved portion is determined in accordance with pre-act programmes which are set up on a suitable selector switch or the like.

Other features which may be included in accordance with the invention will be described hereinafter and referred to in the appended claims.

Exemplary embodiments of the invention are shown in the accompanying drawings in which:

FIG. **1** is a schematic view in perspective of a fully automatic edge binding apparatus according to the invention;

FIG. **2** is a perspective view of one practical embodiment of a fully automatic edge binding apparatus;

FIG. **3** is a plan view of the complete apparatus of FIG. **2**;

FIG. **4** is an end elevation view of a feed assembly;

FIG. **5** is a top plan view of the feed assembly of FIG. **4**;

FIG. **6** is a view in side elevation of a workpiece crimping mechanism;

FIG. **7** is a top plan view of the crimping mechanism of FIG. **6**;

FIG. **8** is a perspective view from the input end of the apparatus showing the feed container and the pick-up mechanism with the pick-up mechanism in engagement with the top-most workpiece in the feed container;

FIG. **9** is a view similar to FIG. **8** but with the pick-up fingers and workpiece positioned over the roll-over mechanism;

FIG. **10** is a side elevation view showing one embodiment of the pick-up mechanism and associated roll-over mechanism;

FIG. **11** is a side elevation view of an alternative form of pick-up mechanism and associated roll-over mechanism;

FIG. **12** is a top plan view showing the arrangement of pins at the workpiece preliminary gauging station;

FIGS. **13***a* and *b* show top plan and elevation views respectively, of the gauge station pin-actuation mechanism;

FIG. **14** is a perspective view showing the feed arm assembly in the position whereat it has just engaged a workpiece at the gauging station;

FIG. **15** is a perspective view showing the feed arm assembly with entrained workpiece at the point of introduction of the latter, on the fly, into the stitching head of the sewing machine;

FIG. **16** is a side elevation view showing the feed arm assembly;

FIG. **17** is a view similar to FIG. **15** showing an intermediate stage whereat the workpiece is partially stitched;

FIG. **18** is a top plan view showing the tape feeding and folding device, the stitching fence, the sewing machine and the workpiece feed guide;

FIG. **18***a* is a cross-section view of the workpiece feed guide;

FIG. **19** is a perspective view showing the stitching head and associated controls therefor;

FIG. **20** is a side elevation view showing the control wheel;

FIG. 21 is a plan view showing the disposition of the slides carrying the convex radii pins and the control wheel;

FIG. 22 is a schematic view showing the disposition of the photoelectric cells around the stitching head of the sewing machine;

FIGS. 23, 24 and 25 are diagramatic representations showing the sequence of motions involved in moving each of the three types of workpiece handled by this apparatus from the preliminary gauging position and into and through the complete stitching pattern;

FIG. 26 is a front elevation view showing the cutoff or chopper mechanism and its relationship with the stitching head of the sewing machine;

FIG. 27 is a side elevation view showing the construction of the cut-off or chopper mechanism;

FIG. 28 *a–d* constitutes a complete across-the-line electrical wiring diagram of a relay control circuit for the fully automatic edge-binding apparatus according to the present invention.

GENERAL ARRANGEMENT

Referring to the drawings the edge binding apparatus comprises essentially a sewing machine **10** mounted on a table **12**; a feed assembly **14**; a pick-up mechanism **15** adapted to feed parts to be processed in seriatim from the feed assembly **14** either directly onto a conveyor mechanism **16** or onto a roll-over plate **18** and thereafter onto the conveyor mechanism **16**; a gauging assembly **20** into which the parts are delivered by the conveyor mechanism **16**; a feed arm assembly **24** operable to transfer a gauged part from the gauging assembly **20** into the sewing machine **10** with the part orientated in a pre-determined manner relative to the sewing machine; control means for causing the parts to move through the sewing machine in accordance with a pre-determined pattern whereby an edge tape is sewn to the edge of the part; a cutter mechanism **28** adapted to cut the edging tape and the sewing thread after the part has been completely sewn to sever the fully stitched workpieces as separate entities; and a discharge arm assembly **30** adapted to transfer the processed part from the sewing machine over the table **12** to a discharge position.

In a modified semi-automatic form of the apparatus the parts are adapted to be individually introduced into the sewing machine by hand and to be removed manually after an edge binding tape has been automatically stitched to the part and the part automatically separated after stitching. This modified semi-automatic version which is essentially a simplification of the fully automatic version, comprises the sewing machine with associated stitching head, control tools and motor tools, and the chopper mechanism but has no feed mechanism, no gauging station and no feed or discharge arm assembly.

FEED ASSEMBLY

The feed assembly **14** comprises a pair of parts containers **32, 34** which are mounted in end-to-end relationship on a slide **36**. The slide **36** belt. mounted for movement longitudinally of a pair of parallel shafts **38,40** secured at opposite ends to brackets **42, 44** upstanding from a carriage **46**. The carriage **46** is disposed at the input end of the edge binding apparatus and is movable transversely thereof at right angles to the line of stitching of the sewing machine. The carriage **46** is provided on one longitudinal side thereof with a pair of grooved wheels **48** and on its opposite side with a pair of rollers **50** adapted to run along parallel rails **52, 54** respectively. The slide **36** is movable longitudinally of the carriage **46** along the shafts **38, 40** under control of an air cylinder **56**, the outer end of the piston rod **58** of air cylinder **56** being secured to a bracket **60** mounted on the slide whereby reciprocation of the piston rod **58** is operable to move the slide longitudinally of the carriage between two terminal positions.

The parts to be processed are loaded into containers such as **32, 34** which are of the approximate shape of the parts. Preferably the parts are stacked in these containers as they emerge from the clicker dies which form them. The containers **32, 34** are essentially tubular and may be made of sheet metal or other suitable material. Two of these containers are adapted to be fitted onto brackets **62** in two positions on the slide with the containers disposed for end-to-end and movement of the slide in a direction transverse to the line of stitching of the sewing machine **10** serves to move one or other of the containers into position for feeding parts contained therein into the sewing machine.

The edge binding apparatus is intended to handle three basic parts, namely basketball tongues **64**, basketball quarters **66**, and baseball quarters **68** in a range of sizes from number four to number ten and it is contemplated that three sets of the parts containers will handle the full size range of each item so that in all some nine sets of containers will be required. Obviously the apparatus can be designed to handle other parts and other sizes and where such is the case a larger number of sets of containers would necessarily be required.

The feed assembly arrangement is such that upon exhaustion of parts from one of the containers actuation of the air cylinder **56** serves to move the other container mounted on slide **36** into the feed position with concurrent movement of the exhausted container to one side or other of the apparatus where it may be replaced with a loaded container or alternatively, and if desired, it may be recharged with a fresh supply of parts while the parts in the loaded container are being fed in seriatim through the apparatus.

The parts stacked in the containers stationed at the feed position are adapted to be moved upwardly through the containers by a demand feed arrangement which includes an elevator mechanism generally designated **70** and disposed adjacent the feed position outboard of the container. The elevator mechanism is provided with a pair of cantilever bars **72, 74** which are arranged to project beneath the bottom of the parts containers and adapted to be moved upwardly through parallel slots **76, 78** formed in the bottom wall of the feed container **32** stationed at the feed position. The elevator mechanism **70** is attached to a vertical screw **80** by means of a split nut clutch **82** which is actuated by an air cylinder **84**. When the nut **82** is engaged, rotation of the screw **80** is operable to move the elevator mechanism **70** upwardly and, through engagement of the cantilever bars **72, 74** with the bottom of the stack of parts, to raise the entire stack of parts within the

container. The screw **80** is adapted to be rotated intermittently by a DC electric motor **86** to raise the stack of parts at a regulated speed. When the nut **82** is disengaged the cantilever bars **72**, **74** and the elevator mechanism **70** fall to the bottom of the screw **80** to a position whereat the slide **36** carrying the two feed containers can pass over them in a horizontal direction. The motor **86** has two ranges of armature voltage and actuation of an appropriate switch is effective to change the motor from its low speed to its high speed range.

To describe the operation of the demand feed system let us assume that at the outset the container **32**, which is in the feed position, is empty and the cantilever bars **72**, **74** are down, whereas the container **34** is loaded with parts to be processed. Actuation of a push button serves to operate air cylinder **56** which moves the slide from one end to the other and brings the loaded container **34** into the feed position. The actions of air cylinder **56** are controlled by limit switches LS211 and LS219 (see FIG. **28**) at each end so that on any signal the slide **36** automatically moves to its alternative position at the opposite end from which it started. The arrival of the slide **36** at the opposite end triggers through a capacitor pulse to start the motor **86** and drive the elevator mechanism upward. During the initial part of the upward movement of the elevator mechanism **80** it is found desirable to operate the motor **86** at several, e.g. five, times its normal speed so as to bring the stack of parts in the loaded container rapidly into place for feeding into the apparatus. To this end a push button is provided actuation of which is adapted to apply the high voltage to motor **86**. As will be appreciated the selection of the high speed of motor **86** is a manual override so that an operator at a control console can bring the stack of parts into position for feed more quickly.

Once the stack has reached its approximate place in readiness for parts feeding into the apparatus the motor speed is returned to its operating speed which is relatively slow and the stack of parts now proceeds at the operating speed upwards until the top of the stack intercepts a horizontal light beam which is adjustable to the desired working height of the stack. Interruption of this light beam serves to actuate a photo electric cell PR22 (FIG. **28**) which stops the motor **86** and at the same time puts the apparatus in a state of readiness so that it can commence to feed parts. Thereafter, operation of the push button starts the regular stitching and feed motion of the machine, and it commences to feed parts off the top of the stack. The entire sequence is automatic in the event that the stack of parts is brought up into place as the end manoeuvre of a stack change. The parts are kept continuously at the correct height for feeding by the elevator motor under control of the photo electric cell PR22. As a part is fed from the top of the stack, the photo cell PR22 is illuminated, which starts the motor **86** and causes it to feed the stack upwardly until the light is again occluded by the top-most part in the stack. This continues until all of the parts in the stack have been fed from the container at which time the cantilever bars **72**, **74** on rising engage a limit switch LS232 which is so placed as to indicate an empty stack. This locks up a relay CR23 (see FIG. **28**) which is the stack change relay. Relay CR23 also serves to release the clutch **82** on the screw **80** and this causes the elevator bars **72**, **74** to fall. The elevator bars strike a switch LS228 at the bottom of their stroke and this switch, after a short delay to make sure of clearance, initiates through relay CR21 (FIG. **28**) actuation of an air cylinder **56** which transfers the slide **36** in the appropriate direction to bring a loaded container into the feed position. When the new container arrives in the feed position the elevator clutch **82** is re-engaged, the motor **86** starts to bring the stack of parts up, which, when it occludes the photo cell PR22 at the top of the stack, indicating that the top part is in position, starts the feeding action which again starts the machine stitching cycle.

PICK-UP AND ROLL-OVER MECHANISMS

The parts to be processed are transferred from the feed containers **32**, **34** by a pick-up mechanism generally designated **16**. The pick-up mechanism **16** is mounted between a pair of vertical frame members **90**, **92** upstanding from opposite sides of the carriage **46**, and includes a pair of pick-up fingers **94**, **96** each of which terminates in a rubber suction cup **98**, **100** respectively on which suction can be applied or released through a suitable valving arrangement over the air lines **102**, **104** respectively. The pick-up fingers are mounted on a transverse shaft **106** which is attached to a crank shaft **108**. The crank shaft **108** is mounted at either end in bearings **110**, **112** on a pair of arms **114**, **116** spaced apart by a shaft **118** extending therebetween and secured on opposite ends thereto whereby crank shaft **108**, arms **114**, **116** and shaft **118** form a rectangular sub-frame. The arms **114**, **116** are pivotally mounted at **120**, **122** adjacent their centers to the members **90**, **92** which are secured at their base ends to the carriage **46**. A pneumatic cylinder **124** mounted on a bracket **126** secured to member **90** has its piston rod **128** connected through a crank arm **129** to the pivot **120** whereby actuation of the cylinder **124** is operable to rotate the sub-frame and thus the crank shaft **108** with associated shaft **106** and pick-up fingers **94**, **96**. The end of the crank shaft **108** connected to arm **116** protrudes outwardly therethrough and has a sprocket **130** mounted thereon. A chain **132** runs around sprocket **130** and a further sprocket **134** is fixedly mounted on frame member **92** on the same center as shaft **136**. With this arrangement, as the piston **128** is reciprocated to rotate the sub-frame it imparts a relative rotary motion to the stationary sprocket **134** and, via chain **132** to sprocket **130** on crank shaft **108**. Thus as the sub-frame is rotated the pick-up arms are rotated by a like amount relative to the sub-frame ensuring that the pick-up arms are always orientated in a vertical plane during movement thereof from their initial position whereat they engage the top most part in the feed container to their delivery position.

In the case of tongues the parts are transferred directly from the feed container onto the conveyor mechanism. In the case of the quarters, both large and small, however it has been found that these stack better upside down and they are accordingly stacked in this manner in the feed containers prior to feed thereof into the apparatus. Thus in the case of the large quarters the part is initially transferred from the feed container to a roll-over mechanism generally designated **138**. The

roll-over mechanism comprises a plate **140** secured to a shaft **142** which extends between and is rotatably mounted in the frame members **90, 92** intermediate the feed assembly mechanism **14** and the conveyor mechanism **16**. To accommodate both the large basketball quarters and the smaller baseball quarters two separate changeable plates **140** are provided. One end of the shaft **142** protrudes outwardly through the frame member **90** and is connected with a piston **144** of a pneumatic cylinder **146** mounted on a bracket **148** secured to the frame member **90**. The arrangement is such that reciprocation of piston **144** is operable to rotate shaft **142** and consequently the roll-over plate **140**, through 90° to a position whereat it is directly above the conveyor mechanism **16** whereby a part placed on the roll-over plate **140** is inverted and deposited on the conveyor mechanism.

An alternative and more sophisticated form of feed and roll-over mechanism is shown in FIGS. **6, 7** and **11**. In this embodiment the pick-up **94, 96** are mounted on plates **150, 151** which are secured by pins **152, 153** to racks **154** and **156** respectively. The racks **154, 156** are mounted for reciprocal movement in guides **158, 160**. The guides **158, 160** are supported at their mid points by bearing shafts **162, 164** mounted in bearings secured to parallel transverse shafts **161, 163** which are secured at their ends to plates arms **165, 167** mounted in the swinging arms **173, 174** the plates **161, 163** and the plates **165, 167** together forming a rectangular sub-frame which is pivotally mounted on bearings in the swinging arms **173, 174**. The ends of the guides are resiliently connected to opposite ends of the transverse shafts by means of springs **169** extending between pins **171** mounted on the guides and the shafts respectively. A gear **166** is disposed between and meshes with the toothed racks **154, 156**. The gear **166** also meshes with a further gear **168** mounted on a link **170** secured to the end of a piston rod **172** associated with a further pneumatic cylinder **174** which latter cylinder **174** is mounted to a bracket **176** secured to the guide **175**. With this arrangement reciprocation of the piston **172** serves to rotate the gear **168** which latter is operable to rotate the second gear **166** and through the latter's engagment with the racks **154, 156** to move the racks in mutually opposite directions. In this manner the distance between the pick-up fingers **94, 96** may be varied and by moving the pick-up fingers **94, 96** closer together after the top part in the feed container has been engaged by the suction cups **98, 100** enables a crimp to be made therein ensuring that upon subsequent rotation of the feed transfer mechanism only the top part is removed from the feed container by the pick-up fingers.

In this embodiment also the sub-frame is adapted to be rotated through an angle of up to 180°. The rotary movement of the sub-frame is effected by a pneumatic cylinder **180** the piston **182** of which is connected to one end of a crank arm **184**, the other end crank arm **184** being connected to a gear **188**. Gear **188** meshes with a further gear **190** mounted to the sub-frame **173, 174**. The arrangement is such that reciprocation of the piston **182** rotates the gear **188** via the crank arm **184** and this in turn rotates meshed gear **188**. The latter rotates sub-frame **172** and hence the pick-up arms **94, 96** which latter always remain in the same orientation relative to the apparatus, i.e. in the vertical plane, during rotation of the feed mechanism. The feed mechanism is adapted to be rotated through an angle of up to 180°; the full rotation is employed with tongues and baseball sneakers and disposes the feed mechanism direction over the conveyor mechanism **16** (Position 'A' — FIG. **11**) at the end of the rotational movement whereafter upon releasing the vacuum on the suction cups **98, 100** the part is deposited on the conveyor mechanism **16**. When handling the large basketball quarters however the rotary movement is restricted to approximately 120° at which time the feed mechanism is positioned with the pick-up arms directly above a roll-over plate **200** (Position 'B' — FIG. **11**). In this case the vacuum is then released depositing the part on the roll-over plate **200**. The latter extends transversely of the apparatus and is secured to a shaft **202** pivotally mounted on brackets **204** secured to opposed frame members **92, 94**. A pneumatic cylinder **208** mounted on a bracket **210** secured to the frame member **92** has its piston **212** connected to a crank **214** which is connected to the shaft **202** of the roll-over plate **200**. The roll-over plate **200** may be rotated through 90° by extending the piston **212** which is effective to rotate the crank **214** and the shaft **202** of the roll-over plate **200**. A part deposited on the roll-over plate **200** may thus be rotated through a further arc to invert it and deposit it on the conveyor mechanism **16**.

THE CONVEYOR MECHANISM

The conveyor mechanism **16** consists essentially of a belt **220** extending over spaced apart rollers **222, 224**, which extend transversly of the apparatus and which are driven in conventional manner by a suitable motor (not shown). The belt **220** may be in the form of a continuous sheet or may consist of a plurality of strips continuously extending around the rollers and disposed in parallel relationship.

PRELIMINARY GAUGING MECHANISM

Upon leaving the conveyor belt **220** the parts are urged into a gauging station generally designated **20** wherein they are gauged in two planes to orientate them in a predetermined relationship with the line of stitching of the sewing machine. The gauging is effected by means of sets of pins, one set of pins corresponding to each of the different parts to be handled by the apparatus. In the embodiment shown, see particularly FIGS. **12, 13a, 13b** and by way of example, three sets of two pins are provided. The gauge pins in each set are related to the particular part with which they are associated and have a constant relationship to the sewing machine. Thus pins **230, 232** together constitute a set of pins for the tongues **64**, pins **234, 236** constitute a set of pins for the small baseball quarters **68**, and pins **238, 240** constitute a set of pins for the large basketball quarters **66**. The gauge pins are associated with detents **242** spaced along a shaft **244** which extends transversely of the apparatus beneath the sewing table **12**, the shaft **244** being supported at either end in bearings **246, 248** and bodily movable in a vertical plane. Each detent **242** has a cam **250** associated therewith and rotation of the shaft **244** serves to rotate the cams **250** causing one of the sets of cams to raise its associated sets of detents relative to the

others. In this manner rotation of the shaft **244** enables a particular desired set of gauge pins to be pre-selected. The shaft **244** is supported at its mid-point in a bearing **252** which is connected to the free end of the piston rod **254** associated with a pneumatic cylinder **256**, actuation of the cylinder **256** being operable to raise the whole shaft **244** in a vertical plane whereby to project the pre-selected pins through associated holes formed in the sewing table **12**. The upward travel of the selected pins is limited by means of stops **258** mounted on the associated detents **242**. In their upper extended positions the selected pins project above the top surface of the sewing table **12** and form abutments against which the incoming part from the conveyor **16** is pushed and the part gauged, whereupon the conveyor is stopped.

FEED ARM ASSEMBLY

After gauging, the parts are adapted to be fed into the sewing machine **10** by means of the feed arm assembly **24**. The feed arm assembly includes a cantilever feed arm **260** which is a highly articulated cantilever arm. Its purpose is to transport the parts from the gauging position to the entry position into the sewing machine after having done a fine gauging operation in the longitudinal direction of movement of the parts towards the sewing machine. It is of great importance that this entry into the sewing machine should be made at a widely adjustable but highly controlled speed, so that it will precisely match the stitching speed at the instant the part is introduced into the stitch. This horizontal motion is operated from a slide **262** from behind the sewing machine **10**, but running parallel to the line of stitching. The slide **262** is driven by a DC shunt wound motor **264** which is completely controlled by a transistor circuit operating from a tachometer generator feed-back. The variable speed of the motor **264** is obtained by the setting of a potentiometer; and by having two or more alternative potentiometers, the motor can be given two or more separate speeds on command.

The cantilever feed arm **260** projects forward over the table **12** to the input side of the sewing machine **10** terminating somewhat in front of the sewing machine needle **11**. It is broken in its length to accommodate a horizontal gauging motion **268** in the direction normal to the main motion, or at right angles to the direction of stitching. The motion **268** has a total stroke of two inches, and is operated by very small DC permanent field motor **270** mounted in the arm **260**. The motor **270** has a high gear ratio such that dynamic braking will constitute a solid lock on the motor. The motion **268** is driven through a rack **272** and pinion **274**. Articulated from this gauging motion **268** is a rotary motion **276** turning through a precisely set arc in both directions, controlled by one of three slots **278** in a plate, each of which is machined to a precise length. This rotary motion is operated by a pneumatic cylinder **280** in both directions. The three slots **278** serve to provide three separate radial actions for the three types of parts to be stitched so that when they are fed in along an axis parallel to the sewing machine and to the feed, each will be turned to such an attitude that the leading edge of the part to be sewn will be precisely parallel with the line of stitching. Articulated from this turning motion is an arrangement of two pick-up fingers **282**, **284** with pneumatic vertical motion via pneumatic cylinder **283** and piston **285** to the table. The pick-up fingers **282**, **284** terminate in rubber suction cups **286**, **288** to which suction can be applied or released over suitable air line **287**, **289** under control of a valve. The normal position of the feed arm **260** is at the input end, that is to say over the conveyor belt **16** in an attitude which is square with the feed elevator **70**, with the gauge motion **268** fully extended, the suction cups **286**, **288** up, the suction off.

At the appropriate time under control of a clock signal the suction cups are lowered to pick up a part which has been gauged by the gauge pins which should be accurately gauged with respect to rotational attitude, that is to say, gauged to within ± one sixteenth of an inch in the cross direction, i.e. parallel to the line of stitching, and to within ± one half an inch in the longitudinal direction which is parallel to the feed container, and determined by the accuracy of fit of the stack of parts in the feed container. As this pick-up motion rises with a part, it engages a switch, producing the subsequent motion. By this time, the gauge pins will also have dropped below the table so as to ensure that they will not interfere with subsequent movement of the part which has been gauged. The part is then carried towards the sewing machine **10** for a distance determined by a limit switch on the longitudinal track of the feed arm, then stopped and dropped to the table, but with suction still applied to the suction cups **286**, **288** and the part still engaged by the feed arm **260**. At this point the feed arm **268** commences to move inboard at right angles to the line of stitching, and the motion is so arranged that the leading corner of the part, which is the first section to engage the sewing machine, passes directly over a row of very small holes under which is placed a photoelectric cell PR411 adjusted so that ambient light enters at only one hole. At the same time, a small jet of air from an air line **290** extending out from the sewing machine is directed down on the far corner of the leading edge of the part to ensure that this corner does not curl up. The part is then moved in towards the gauging photocell PR411 at a constant speed by a small D.C. motor **270**, and when it occludes the light, the photo electric cell PR411 is actuated to stop and lock the motor **270** instantly. The part then moves in towards the sewing machine at the precise stitching speed. A faster speed is used on the approach part of the stroke as the part is brought up to a photo electric stitch control arrangement, and on the retract stroke, by an arrangement of potentiometers.

For limiting radial movement of the workpieces pins are provided one of which is permanently fixed to and upstands from the table and the other two of which are adjustably mounted to accommodate workpieces of different sizes and are ejectable through apertures formed at suitable locations in the table. These adjustable pins normally being retracted below the surface of the table and are adapted to rise out of the table to act as banking pins for a workpiece being stitched.

To facilitate correct introduction of the leading edge of the workpiece into the sewing machine needle an elongated guide member **400** (see FIGS. **18** and **18***a*) is provided having a portion **402** bent upwardly out of the main plane thereof and defining with the table a throat

into which the leading edge of the workpiece is fed and thereby guided into correct engagement with the needle 11. The guide member is detachably mounted to the table as by a screw and an appropriately sized and shaped guide member may be selected and secured in position on the table depending on the size and shape of the workpiece to be stitched.

The photo cell stitch control system consists of three photo cells (see FIG. 22) two of which, PR711B and PR711F, which are alternates and form with a third cell, PR712, a working unit. Regarding the two photo cells PR711B and PR711F as a unit which is normally illuminated, it is occluded at the start of the stitch, illuminated at the commencement of the first convex curve, occluded at the end of the first convex curve, illuminated at the commencement of the second convex curve, occluded at the end of the second convex curve, etc. and finally illuminated at the end of the stitch. Each illumination winds up a spring driven stepping switch so that on release, that is occlusion, it will step over one position but it will remain on the first points until the release. Therefore, the stepping switch is always advanced by occlusion. Thus, the stepping switch is wound up at its first position by the original appearance of the light on the photo cell, and the stroke to the first station is completed by the occlusion of this light on the admission of the workpiece to the sewing position. The finished stitch of the workpiece leaves the stepping switch in a wound up position ready to swing over to the next position instantly the light is occluded. The principal shapes which it is required to stitch are basketball uppers, the baseball or "sneaker" quarters, and the basketball tongues. The basketball upper starts with a large convex curve, followed by a concave curve, followed by a small convex curve, followed by a straight line, and followed by a small convex curve, followed by a large convex curve and followed by a large convex curve. The baseball quarter has only two convex curves, both with a small radius. The basketball tongue has only one convex curve which is of a radius to make a semi-circle at the end of the piece. The programme to control the admission of the pin and stop and start of the stitches is set up as mentioned as three different arrangements on the stepping switch which has many levels and the selection switch selects the particular programme on which the machine is to operate. Therefore, changing this switch makes a complete change of programme with every electrical change necessary. Some programmes take up more stations than others. The difference is made up by "homing" the stepper.

Insofar as the actual photo electric cells themselves are concerned there are two principal ones. Photo cells PR711B and PR711F are disposed adjacent each other forwardly of the needle 11 by approximately half an inch and off-set the outboard side by a quarter of an inch, and so PR712 is disposed forwardly of the needle by half of an inch instead of a quarter of an inch to the inboard side of the stitching line.

Coming back to the actual photoelectric cells themselves, there are two principal ones. Photo cells PR 711B and PR 711F are disposed adjacent each other forwardly of the needle by approximately half and inch and offset to the outboard side by a quarter of an inch, and cell PR 712 is disposed forwardly of the needle by one half an inch and set a quarter of an inch to the inboard side of the stitching line. Photo cell PR 711B is used for tongues and the small quarters whilst PR 711F is used for the large quarters.

The transfer from one photo cell PR 711B to the other, is made on the selector switch when the pattern is selected. Therefore, only two photo cells are used at one time. These photo cells are of the photo-resistive type, and in series with a suitable resistor. The point of junction of the photo cell and the resistor lead through a resistor into the base of a two transistor Darlington amplifier which has a gain of approximately 5,000:1. The output of these transistors operate telephone relays. The illumination of PR 711 (B or F) that is the photo cell on the outboard side of the stitching line, or the one furthest away and last opened by the receding edge of the cloth on a convex turn, initiates the relay CR 711 which is locked up on relay CR 712 operated by photo cell PR 712. Obviously PR 712 having been illuminated prior to PR 711, (B or F) is in a position to make an interlock. As the cloth swings around the convex curve, for a time both the photo cells are illuminated but as it approaches the end of the curve and ensuring cloth is in a straight line, tangential to the end of the convex curve, photo cell PR 711 will be first occluded, then, at the very end of the curve photo cell PR 712 will be occluded. In making a convex turn relay CR 711 is the net result of the two photo cells, that is to say it must be actuated by the illumination of cell 711, and held in until the occlusion of PR 712.

Relay CR 711 energizes, one of the two convex radius center pins as determined by the programmes set up on the stepping switch. At the commencement and conclusion of the stitching of the piece, neither pin is actuated, this also being determined by the programme on the stepping switch. Obviously it is of critical importance on any convex turn that the needle penetrate the cloth at exactly the time that the curve in the cloth comes to the sewing machine. The actual transmission of pulse from photo cell PR 711 to relay CR 711 and on to the valve and to actuate a small air cylinder takes a certain time, approximately 55 milliseconds.

The position lead of the photo cells with reference to the stitching needle is adjustable, and is set so that at the speed of motion of the workpiece, the anticipation of the turning signal will be equal to the time taken to effect actuation of the associated holding pin. The speed of the workpiece is a function of the speed of the sewing machine and the length of the stitch. It has been found that setting the system to operate at 2,200 stitches a minute and 12 stitches to the inch is the optimum arrangement for production of the stitches. If this is changed, however, the entire photo cell mount carrying the photo cells PR 711B, PR 711F and PR 712 and which is mounted on a bracket under the sewing table 10 and adjustable by micrometer fore and aft along the line of stitching, may be set very accurately within a few thousandths of an inch. The perfection of setting is judged by the quality of the work turned out, particularly the quality of stitching just at the commencement and conclusion of any convex turn.

It will be appreciated that the photo-electric detection means provided in accordance with this invention consist of individual and adjustable cells of small size which are placed under and protected by a continuous

transparent surface. With this arrangement fast fine adjustment of the sensing means is possible without leaving any orifice or other irregularity on the stitching surface, which must be completely smooth to permit trouble free flow of the irregularly shaped workpiece into the area of the needle.

The particular sensing means are specifically photo cells having a very high degree of amplification so that they can be used with substantially ambient light, without the need for any directed beam, on the cloth having to pass through a sensing slit of a limited vertical dimension. This feature is particularly necessary for that part of the large, basketball upper where the workpiece, due to its fullness, presents a highly irregular three dimensional shape.

As the workpiece enters the stitching area at the photo electric stitch control the sewing machine starts sewing edging tape only. The workpiece advances, being carried by the feed arm **268** until it is drawn into the stitch. At that point the feed arm **268** engages a terminal microswitch on the forward motion of its slide **262** at the back of the machine which causes the vacuum to be shut off from the pick-up cups **286, 288** and the fingers **282, 284** to rise, and then causes the feed arm **268** to reverse and return to its normal position. The gauge motor **270** is also returned to its normal outboard attitude ready for another part.

It will be seen that with this system of fine gauging by electronic means, the edge of the part to be gauged is always presented short of the photo electric cell stitch control, and therefore always moves towards the photo electric cell stitch control which stops the motion precisely on occlusion of the light. As the entire photo electric and motor system is D.C. with a constant speed and constant timing from occlusion to motor lock up, the gauging accuracy is limited only by the quality of the components.

THE SEWING HEAD AND ITS ASSOCIATED CONTROL COMPLEXES

The sewing machine **10** comprises a standard **300** having an arm **302** terminating in the usual sewing head **304** at the free end thereof. A platform **306** mounted over the standard serves as a mount for the pneumatic valves **308, 310** and related controls of the pneumatic work control arrangement associated with the sewing machine as will be described hereinafter.

The sewing machine **10** is a standard commercial sewing machine of the lock-stitch variety, having a single needle **11**. The workpiece is progressed through this machine by what is known as a compound feed, that is to say, the needle in addition to the vertical motion required for stitching also has an integrated horizontal motion of the length of the stitch, so that it enters the workpiece, proceeds through the horizontal motion which advances the workpiece by one stitch length, and on emerging, is retracted in its horizontal motion to the starting point. This horizontal motion is achieved by a crank action set normal to the vertical crank motion. The feed dog, instead of alternating with the action of the needle, engages at the time the needle is engaged and makes its stroke together with the needle. The sewing machine foot is a surrounding open rectangle to hold the workpiece in place between stitches, and does not engage the dogs as with a normal dog feed machine.

A plate **312** is secured to the front face of the sewing head **304**. The plate **312** serves as a mount for a pneumatic cylinder **314**, the piston **316** of which is connected to a bracket **318**. The bracket **318** is secured to a slide **320** mounted in a vertical guideway **321** formed in the rear face of the plate **312**. The slide **320** carries at its lower end a pin **322** which pin under control of the cylinder **314** is adapted to be reciprocated in a vertical plane immediately behind the sewing machine needle **11**. A further bracket **324** is secured to the front face of the plate and the bracket **324** is formed with two vertical guideways **326** and **328** which accommodate slide members **330** and **332**. One of these slides **330** is connected at its upper end to a bracket **333** which in turn is connected to the piston **334** of a pneumatic cylinder **336** mounted to the bracket **324**. An angularly bent plate **338** is secured to the lower end of the slide **330**. The free end of the plate **338** extends inwardly toward the sewing needle **11** and a conical wheel **340** is rotatably mounted thereto. The conical wheel **340** which has a hollow interior and a beveled peripheral edge **342** is movable in a vertical plane by the cylinder **336**. The slide **332** is connected at its upper end to the piston **344** of of a further pneumatic cylinder **346** by an L-shaped bracket **348** and has an arm **350** adjustably mounted on its lower free end. The upper portion of the arm **350** is provided with a slot **352** which permits vertical adjustment of the position of the arm **350** on the slide **332**. An intermediate portion **354** of the arm is bent inwardly and extends within the interior hollow of the wheel **340** terminating in a short vertical portion **356** which carries a pin **358**. In accordance with the invention there is provided a conical wheel which constantly engages the workpiece from above at a closely adjusted pressure. This gently forces the cloth inward to a fence which is attached to a commercial edging folder and guide which extends along back of the needle and which brings in the edge binding tape and folds it over so as to enclose the edge of the workpiece and be stitched to it. This conical wheel which is free to move vertically on a rocking arm, exerts constant pressure on the incoming workpiece and urges it toward the fence with a pressure sufficient to cause the stitch to follow a straight line or all the concave curves encountered on the workpieces to be processed. Convex curves, on the other hand, are made by bringing a holding needle down on the workpiece exactly on the center of the convex curve, that is to say directly opposing the point of inflection at the start of the curve, which forces the workpiece to take the convex arc notwithstanding the urging of the conical wheel which is so shaped as to permit the cloth to slide under it when gripped between the feed needle of the machine and the radius needle inserted into the cloth. A photo electric stitch control system is provided to determine the commencement and conclusion of convex curves. In the practical application of the invention to the three particular shoe parts with which we are concerned, two convex curve radii cover all requirements, so two separate convex turning pins and are provided at different and adjustable distances from the sewing machine needle. The selection of which radius pin to bring down for each curve is determined by one of three programmes which are set up on a suitable selector switch.

The edge tape **360** is led from a suitable supply (not shown) through the upstanding teeth **362** of a comb mounted adjacent the standard **300** and then through a known type of edging folder and guide **364** in which the tape is folded over in readiness to receive and be stitched to the edge of the workpiece being processed. The folder and guide extends behind the needle **11** and has a stitching fence **366** attached thereto which is used to support the workpiece in the horizontal plane and maintain the edge of the workpiece at the correct distance from the line of stitching. The conical wheel **340** which is free to move vertically is adapted to exert a substantially constant pressure on the part being processed and urges it towards the fence **366** with a force sufficient to cause the stitch to follow the straight line portions and all of the concave curved portions encountered on the workpieces to be stitched. Each of the convex curves of the workpiece to be stitched is handled by moving one or other of the pins **322** and **358** down onto the workpiece exactly on the center of the convex curve, that is to say, at a point directly opposite the point of inflection at the start of the convex curve. With one of the pins **322, 358** driven therein, the workpiece is forced to follow the appropriate convex arc notwithstanding the urging of the conical wheel **340** the periphery **342** of which is so shaped as to permit the workpiece to be slid under it when gripped between the needle **11** of the sewing machine and the radius pin **322** or **358** inserted into the workpiece. The radius pins **322, 358** are adapted to be selected and forced into engagement with the workpiece at the commencement, and removed from the workpiece at the conclusion of the convex curves by a photo electric control arrangement as will be described hereinafter.

THE CUT-OFF OR CHOPPER MECHANISM

A chopper mechanism generally designated **28** is mounted to the sewing head **304** and is tucked in as close as possible to the foot of the sewing machine. The chopper mechanism **28** comprises a cylinder **360'** which is mounted to the sewing head **304** by a bracket **362'**. The cylinder **360'** is connected to an air supply by a conduit **364'**. The piston **366'** of the cylinder **360'** has a guillotine knife **368** mounted on its free end and this is adapted to be reciprocated towards a lower retangular blade **370** which is retained in a slot **372** by a key **374**. The lower blade **370** is normally biased against the wall **376** of the slot **372** which is directly in line with the upper blade **368** but is adapted to be moved away from the wall **376** upon entry of the upper blade **368** between it and the wall **376**.

The workpieces being processed are fully stitched out, brought out of the sewing machine and chopped off as a separate entity by the chopper mechanism **28**.

A photo cell PR 81 is placed just in front of the chopper allowing enough space, about three sixteenths of an inch, to compensate for the time taken for the signal to reach the air cylinder **360'** and fire it at the speed at which the workpiece is apt to be going at the time it is chopped. The chopper relay CR 81 is operated both at the start and at the finish of each workpiece. In each case the photoswitch is first cocked by a signal from the programme, and then fired either by the occlusion or the illumination of the chopper photo cell PR 81, depending on whether it is to chop at the beginning of the stitch or at the end of the stitch. This change of condition from actuating the chop on illumination to actuating the chop on occlusion is generated by the stepping switch programme. The cocking action is determined in the case of the end of the stitch by a timer from the last available photo-electric control signal, and in the case of commencement of the stitch from the photo-electric signal indicating that stitching has commenced. In this system according to the present invention the workpiece is not left in the machine almost stitched to the finish as in manual practice. Each piece is fully stitched out, brought out of the sewing machine, and chopped off as a separate entity, so that on a size or style change there is no problem of stitching the last piece. The control circuitry for this set of motions will be described in more detail hereinafter with particular reference to FIGS. **27** *a – d*.

DISCHARGE SYSTEM

The fully stitched and separated parts are then discharged from the apparatus by the discharge arm assembly **30** which is generally the counter part of the feed arm assembly **24** previously described but without the longitudinal adjustment (gauging motion) which is not required. Thus the discharge arm assembly **30** includes an articulated cantilever arm **380** which is mounted on a slide **382** and projects out over the sewing table **12**. The slide **382** is driven by a DC shunt wound motor **384**, transistor controlled and speed adjustable, in a direction parallel to the line of stitching. In place of the longitudinal adjustment provided on the feed arm **260**, the discharge arm **380** has an axial motion at the root of the cantilever extension **386** where it joins the slide bracket **388** which is moved by an air cylinder **390** through approximately 15° and which has the effect of increasing the length of the horizontal stroke so as to bring the finished workpiece clear of the table at the end of its stroke. At the outer extremity of the discharge arm is a turning motion **391** similar to the one on the feed arm **268**, and with counterparts of the same slots **278** to control the radii of the curves so as to take workpieces as they come from the stitching operations and bring them again into a line approximately at right angles to the line of stitching. Dependent from this are two adjustable fingers **392, 394** which can be lifted approximately two inches above the table, by means of an air cylinder **395** and each of these fingers terminates in a suction cup, **396** which can be turned on or off. The normal position of the discharge arm assembly is at the inboard end of the horizontal traverse stroke with the slide and arm inboard and the tools suspended above the position where a finished workpiece is about to emerge. During the course of its inward travel, and controlled by a limited switch on the transverse motion, the rotation is swung to a position corresponding to the arc of the emerging workpiece, the fingers **392, 394** are up and the suction to the suction sups **396** is off.

The apparatus is also provided with an electric stitch counter in order to facilitate the stopping for a bobbin count. The rotation of the sewing machine operates a flexible shaft which in turn operates a gear train having a 100:1 ratio. The gear train has a cam which engages a microswitch LS 10 on each revolution, thereby counting even hundreds of stitches. A bobbin will carry ap-

proximately 7,000 stitches, and the counter can be set at any number from 0 to 100. If the counter is set at 70 then when 7,000 stitches have been counted, it closes the bobbin counting relay, which stops the apparatus, and at the same time opens a trap door just in front of the needle **11** to provide ready access to the bobbin. On seeing the signal that this has happened the operator changes the bobbin, presses a button to reclose the door which may be on an air operated toggle clamp (not shown) and at the same time presses a button to reset the counter. This reactivates the stitching sequence, and the machine will start in the normal fashion.

CONTROL CIRCUIT ARRANGEMENT

A relay control circuit arrangement for the fully automatic form of the edge stitching/binding apparatus will now be described with particular reference to FIG. **28** in which the various circuit lines are designated by the prefix "L".

Referring to FIG. **28**, *Tr*1 is a control transformer which steps down the supply voltage from 220 volts to 25 volts AC. A bridge rectifier *Rf*1 with associated filter **F4** is connected to the secondary winding of the transformer *Tr*1 to produce 24 volts DC for the control circuit. A similar bridge type rectifier *Rf*2 supplied from a 50 volt AC line is employed to provide 35 volts DC filtered by filter **F5** for use with the photo electric cells 711B and 711F alternately which are selected by the switch SS-1. The photocells 711B and 711F serve to indicate the approach of a convex curved edge portion of a workpiece, and are used separately for different patterns. Thus photocell 711B is used during stitching of the large basketball quarters and tongues while photocell 711F is used for the smaller "sneaker" quarters. The output of these cells is shown by the symbol, TR711, which represents a transistor amplifier adapted to operate a relay PR711 which is connected in the output line thereof.

Line L-5 shows an expansion of the symbol TR, such as TR711, which is typical. It will be noted that the photocell Px which is a commercial cadmium selenide photo-conductive cell, is connected in series with an adjustable resistance Rx sufficient to limit the total current across the cell under any conditions to 0.1 watts across the 25 volt supply line. These two units constitute a divider across the line, and the mid point of the divider will vary in voltage by the resistance of the photocell which has a rapid response to light. This variable mid point is connected through a resistor to the base of the first transistor T1 of a Darlington pair of commercial NPN transistors, each having an HFE power gain of fifty to one. In practice, the difference between cut off and the 40 milliamperes of collector current necessary to close the relay is approximately two-tenths of a volt at the base. As this is a very small fraction of the voltage rise as the light shines on the cell, the action is quite rapid.

Line L-6 shows the operation of photocell **712** which is similar to that of photocells 711B and and 711F. photocell **712** signifies the end of a convex curve, and operates relay CR712. Line L-7 is the input signal complex in which relay CR711 is actuated by photocell PR711 which, when illuminated, indicates either the onset of a convex curve or the finish of stitching. This relay, CR711 is locked up on PR712 so that it will remain on until photocell PR712 is occluded, which occurs at the termination of a convex curve, except in the case where the workpiece has been fully stitched out. The termination of the stitch is determined in this circuit by illumination of the photocell PR711B or PR711F when the stepping switch is in position **1**. As shown in line L-8 whenever the stepping switch is in position **1** it is operable to energize CR 713. When CR713 is energized, the interlock is not closed and CR711 only closes for during the time of operation of PR711.

The first automation action of relay CR711 occurs at the start of a new stitching cycle and serves to actuate relay CR1. This is done through a number of conditional or series relays which are shown in the normally closed position. In other words, this action does not take place if any of these conditioning relays are actuated. These conditioning relays are first, the count relay which indicates that the machine does not require to be stopped for a bobbin change; relay No. 4 which is a general trouble signal to be utilized as required to stop the machine for any circumstance which arises later; relay CR2, which is actuated when the machine is stopped for change over of the feed container; and finally a point on stepping switch position **1** which confirms that the program is in the start/stop attitude. The input signal PR711 is shunted by the lockup points of relay CR1, which means that after a new workpiece has entered the stitching complex and occluded PR711, relay CR1 will remain actuated until the stepping switch has moved over to position 2. As this happens very shortly after the occlusion of the release of CR711, CR1 is caused to stay energized for a further period by a small capacitor C.

With relay **CR1** still energized on the capacitor, but relay CR711 released by the occlusion of photocell **711**, relay CR61 is energized. Relay CR61, the sewing machine motor control relay, is locked in by a timer **63**. With CR61 energized the clutch on the sewing machine motor **61** is energized, and the brake is de-energized, and thus starts the stitching operation. The purpose of this is to ensure that several parallel disconnect signals can be in the positive or "make" form, which will be gated in the "or" mode to create a disconnect at CR63, thereby breaking the interlock.

The stepping switch which is the central control of the machine, requires six positions, and a number of levels. Actually, the switch used has twenty radial positions, and it is divided up so that it "homes" to position 1, position 7, and position 14 progressively, and connections are made in parallel between positions 1, 7 and 14; 2, 8 and 15; 3, 9 and 16, etc. That is for position 1, read also position 7 and 14; for position 2, read also position 8 and position 15, etc. The actions of this stepping switch are controlled into three programs by a selector having three positions and a number of circuits in each position. Thus position 1 is used for basketball quarters, which have two large radius convex curves, and two small radius convex curves. Each convex curve requires a separate position on the stepping switch. The second position, position 7, is for the small baseball quarters which have two small radius convex curves. The third position, position 14, is for basketball tongues which have one large radius convex curve, i.e. the

tip of the tongue. The three positions of the selector switch leading to level J of the stepping switch, which is the "homing" level are shown on line L-12. On program 1, which is used for the basketball quarters, the stepping switch homes on position 6; on program 2, which is used for the "sneaker" quarters, it homes on position 4; on program 3, which is used for the tongues, it homes on position 3.

The function of homing is standard procedure in spring operated stepping switches. Starting at any point at which it is desired to have a homing action, line current is fed to such point, which feeds into the wiper as soon as it is reached. All subsequent points are wired directly to the live circuit, so that as the wiper strikes each subsequent point, it will again be energized. The wiper feeds to the coil of the stepping switch through a breaker point which is in series with the coil of the stepping switch, so that when the coil is energized, the switch is opened causing the coil to be de-energized, and the wiper to advance. This action is automatic and very rapid. In this case, in position 1 of the stepping switch it is desired to home from position 6. Position 6 is permanently wired to the live line so that as soon as the wiper reaches this position, it will automatically home. In position 2 it is desired to home from position 4, and a turn of the selector switch makes this point live when the selector switch is in position 2. When the selector switch is in position 3, two poles of the selector switch are used to independently activate points 3 and 4 of the switch, causing the switch to home from position 3.

The next program which is selected by the selector switch is that of the pins 322 and 358 which cause the material to turn on the convex curves. The actuating signal for these pins is CR711 which is a compound action of photo cell PR711 and PR712 on turns, and the single action of photo cell PR711 at the beginning and end of the stroke, as previously described. Signals from this relay are routed by the selector switch into one of three positions onto level A which controls the actions in the first program, level B which controls the actions in the second program, and level I which controls the actions on the third program.

Line L-14 is a switching complex which shows how these three levels are wired into the active elements. Thus, for example, level A connects into relay CR72 at position 2 and position 5, and connects into relay CR71 at position 3 and position 4. Level B does not connect into relay CR72, but connects into relay CR71 at position 2 and position 3. Level I does not connect into relay CR71, but connects into relay CR72 at one position only, position 2. Thus it will be appreciated that with the selector switch in position 1 activating the A level, the stepping switch activates relay CR72 on the second step, CR71 on the third, and fourth, CR72 again on the fifth step, and is brought home on the sixth step. With the selector switch in position 2, activating the B level, the stepping switch actuates relay CR71 on the second and third steps, and comes home on the fourth step. When the selector switch is set in position 3, on the I level, it actuates only relay CR72 on the second step, and returns home on the third step.

As seen in line L-15 actuation of relay CR72 serves to drive down the large radius convex turning pin 358 and actuation of relay CR71 serves to drive down the small radius convex turning pin 322. Relay CR711 is actuated upon the illumination of the photo cell complex, and is released upon occlusion thereof. It will be noted that at position 1 on all levels, again subject to the illumination of photo cell PR711F or PR711B, timer 63 and also the relay CR63A are actuated. As timer 63 times out, at a fraction of a second after its actuation, it opens the holding circuit for the relay CR61, causing the sewing machine motor to stop as will be seen in line L-12. The purpose of the timer is to permit stitching to proceed for a short distance after a workpiece is finished in order to chop that workpiece off as it clears the chopper 28 rather than finish sewing while still in the pattern of the stitch. Relay CR63A relates to the operation of the chopper 28, and the lift of the control wheel 340, as will be described later.

The operating circuit for the armature of the sewing machine motor M61 is shown in line L-16. Motor M61 runs constantly at a speed selected by a variac potentiometer which changes the input voltage on the armature thereof. THis is rectified by a standard bridge and supplied to the armature of a DC shunt wound motor the connections for the field of the motor, which is at a constant voltage being shown in line L-17.

The photoswitch connections for the chopper photo cell PR81 which is just after the needle, approximately in line with the stitch, and ahead of the chopper by a sufficient space to give time for the chopper to descend on the workpiece when supplied with a signal from this switch. The output of the chopper photo cell is amplified through TR81 and fed into photo-relay CR81. This photo-relay, as with CR711, etc., operates at approximately 35 volts. Photo-relay CR81 is in the standard relay voltage circuit and is part of the automation of the chopper which is operated twice in this circuit, namely, once at the commencement of stitching to cut off the forward projecting piece of binding tape left over as the tail of the last workpiece stitched, and once at the conclusion of the stitching at the precise termination of the stitching of the workpiece. It should be understood that while the workpiece runs out beyond the termination of it's stitching cycle over toward the chopper, tape continues to feed into the sewing machine for the distance between the needle and the chopping blade. When the tape is cut off sharply at the end of the piece, then the intermediate joining tape will be left projecting forward from the next item stitched. In the sequence shown in line L-14 it will be noted that for all levels the stepping switch at position 1 brings in a relay, CR63A. Position 1 is the home position to which the stepping switch is brought at the conclusion of the previous program, and it is engaged during the termination of stitching of each workpiece, during the commencement of the next piece, and during any interim period.

Therefore, at the time that the stitch is finished, relay CR73A is made up, and stays made up on the point "1" of the stepping switch until this point is released by a fresh workpiece entering the system, and progressing the stepping switch by occluding the photo-electric in gate CR711. The closing of this switch pulses a second relay, CR63B, which thereby stays in for a period long enough to complete the chopping action, but very little longer, and cannot again be actuated until relay CR63A has been released and reactivated by the

stitching of another workpiece. This relay, CR63B, is used along with another relay which indicates a like condition at the start of stitching, to trigger the chopper.

The condition set up for chopping at the beginning of the stitch is shown in line L-**20**. When relay CR1 is energized it delivers a pulse into relay CR64 which is held in by timer **81** until this timer runs out. This ensures that the trigger condition set up for relay CR64 exists only as long as is necessary, and then is erased. The air cylinder **360** of the chopper is operated by relay CR81 which is supplied with a pulse by the instantaneous closing of relay CR80. This pulse which is based on a capacitor is carefully measured so that relay CR81 stays in exactly long enough for the chopper to reach the bottom of its stroke before it is released and retracts. The motion of the chopper has to be very rapid and instantaneous, and occurs only each time that the relay CR80 is energized, after having been de-energized. At the commencement of stitching, the signal on CR64 is set up, which has a series circuit to operate CR80 through the normally closed contacts of photo-relay CR81. However, as at this point there is no workpiece in the system, photo cell PR81 is illuminated, relay CR81 is energized, and no signal is fed into the chopper. The instant, however, that the travelling workpiece is past the needle **11**, and occludes photo cell PR81, causing photo-relay CR81 to drop out, then a circuit is made into relay CR80 which initiates the chopping stroke. This chopping stroke cannot possibly be repeated as long as relay CR64 remains locked up, since in order to initiate another chopping stroke, relay CR80 first has to drop out and then be re-energized. This condition is further secured by locking CR80 up on the normally closed contacts of CR63A which does not function until the end of the stitch. At the conclusion of stitching, relay CR64 has been released by its timer, and CR63A is energized, breaking the interlock onto relay CR80 which falls back into a de-energized position. At the same time, the energization of CR63A has energized CR63B which, however, can only energize CR80 through the normally open points of relay **CR81**; therefore, the chopper again operates the instant that the end of the workpiece passes, and so illuminates photo cell PR81, marking the termination of the stitched workpiece.

Provision is made to ensure that the chopper does not operate twice. At the commencement of stitching the stepper moves over one point to position 2 and releases relay CR63A which locks up relay CR80 and prevents further action of relay CR81 until it is again energized through the sequence beginning with relay CR64. In this way, it will be observed that at the commencement of the stitch the chopper is cocked so that it will operate instantly on a sudden decrease of light, indicating that the new piece has entered the chopping area; whereas, at the conclusion of the stitch, the chopper is cocked to operate on an instant increase of light which indicates that the workpiece has left the chopping area. In both cases provision is made to prevent double action of the chopper in the event that a flutter in the cloth may possibly induce an extraneous signal.

The feeding operation is shown in line L-**22**. Relay CR64 picks up a subsidiary relay, CR64A, on a pulse. This operates and holds timer T64, and drops out when the timer runs out. The purpose of this timer signal is to start an eight cam multipulse mechanical timer in the system, referred to as Clock 1, to operate the entire feed system. These motions are relatively leisurely, and can be most economically handled by a multicam timer.

Timer T64 provides the timing link between the feed motions and the stitching operations as is seen in line L-**23**. Once the feed system is initiated, it will continue through its cycle to deliver a fresh workpiece into the sewing machine, and T64 must be adjusted to deliver the fresh workpiece just as stitching of the outgoing workpiece of cloth has finished, so that there will be no interference, and on the other hand, no loss of time. Clock 1 uses one of its own points as an interlock to cause it to make one exact cycle when set up. The other seven points actuate the motions of feed and delivery of the workpieces.

Prior to the feeding, in the sequence of the machine, there is the demand feed workpiece system which is a small independent electric-pneumatic system which ties into the overall automation circuit only to stop it when the feed containers are being changed. The stack self-levelling feature is initiated by a photo cell PR22 which operates through a transistor amplifier TR22 to actuate relay CR22. The actuation of relay CR22, however, is subject to relay CR23 being in the normally closed position. When CR23 is energized this indicates that the stack of workpieces in the feed container has come to an end and that changeover of the feed container is in process. Relay CR22 operates a shunt wound DC motor **86**, which is dynamically braked, and which is supplied with a field from the same source as the field feed of motor **61**.

The armature power supply for motor **86** is obtained through a variac and a rectifier from the **110** volt supply line. This motor is so geared that the normal speed of feeding workpieces in response to the photo cell signals is at about 20 percent of the full motor speed, or about 25 volts on the variac. As will be seen, however, there is an override push button which will supply full voltage to the motor armature, thus enabling the motor **86** to run at five times the normal speed, and this can be pressed by the operator if at the start of the cycle it is desired to bring the stack of workpieces up as rapidly as possible into a feeding position. As soon as the push button is released the motor **86** reverts to normal speed which serves to move the top-most workpiece to the feeding position as fast as the preceding workpiece is removed. As one workpiece after another is lifted off the top of the stack, the photo cell **22** is intermittently illuminated to run the motor until the photo cell **22** is again occluded indicating that the next workpiece is in the feeding position.

Initiation of the cycle occurs as shown in line L-**28** at the end of the individual stack as the top workpiece is taken off. At this point, the platen on which the workpiece is supported strikes a limit switch, LS232, and subject to two relays, namely relays CR219 and CR212, not being actuated, operates relay CR23, which locks in on timer **21**. The purpose of the two conditioning limit switches in this circuit is positively to prevent the action started by this line taking place at a time when a change of feed containers is in progress.

The action of relay CR23 is to actuate air cylinder **84** which withdraws the split nut clutch **82** on the elevating screw **80** which hoists the platen intermittently into place through the turning of the screw **80** with its associated stack of workpieces by motor **86**. This clutch is normally engaged. When disengaged, the platen with associated stack of workpieces falls down its slide to the bottom which saves time, and obviates the necessity of reversing the motor. When the platen strikes the bottom, it engages a limit switch LS228 which actuates relay CR21.

Relay CR21 operates either the forward stroke of air cylinder **56**, or the return stroke of air cylinder **56**, depending on the position of latch relay LR21, as to whether it is normally open, or normally closed. This serves to shift the feed transfer carriage **36** either to the right or left, depending on which position it was in previously.

The sequence by which latch relay LR21 is operated will be evident from line L-**31**. At the termination of each end of the stroke of the feed transfer carriage **36** there is a limit switch, LS211 and LS219 respectively. As the carriage **36** strikes the limit switch on arriving at the appropriate end of its travel, it pulses into one of the relays CR212 and CR219, either of which locks up on timer T21 which is the timer indicating the progress of the feed change stroke. These two relays, CR212 and CR219, respectively, operate the two coils of the latch relay, LR21, and cause it to lock in one direction or the other. The purpose of using a mechanical latch relay for this sequence is that when the power is shut off at the end of operations, or by accident, the information regarding the next direction to be taken by the transfer cylinder will not be lost. Either of the relays, CR212 and CR219 serves to operate timer **T21** as is seen in line L-**32**. When timer T21 times out, it drops out either CR212 or CR219, which by this time has, of course, thrown the latch relay LR21 to the other position. It also drops out relay CR23 so that the clutch **82** is re-established between the motor **86** drive and the elevating screw **80**. Reference to line L-**24** will show that the automatic operation of the motor, which is turned on and off by relay CR22 in response to the photo cell PR22, is conditioned by relay CR23; therefore, when relay CR23 is actuated as shown in line L-**28**, the automatic drive operation of motor **86** is shut off. As soon as relay CR 23 drops out, however, indicating that the clutch **82** has again engaged the screw **80**, the automatic operation of motor **86** is reinstated, and of course, as a fresh stack of workpieces is in place, the level is much below the photoswitch, so the motor **86** runs continuously until the top-most workpiece is in place.

If the operator wishes to speed up setting of the stack of workpieces in place, this may be accomplished by the override signal through the push button shown in line L-**27**. During the change of the feed containers the action of the stitching is stopped as will be explained hereinafter in the description of the approach system.

Reference will now be made to the functions of the multi-pulse timer, referred to in this circuit as Clock 1, the initiation of which was described with reference to line L-**23**. The clock is a cam timer with eight fully adjustable cam settings both for time on, and time off, and operated by a synchronous motor. The pulse to start this "clock" is taken out of the stitching cycle. The commencement of each stitching cycle initiates an adjustable solid state timer unit which times up to **10** seconds. When it rings out it starts the clock to operate through one cycle. One of the cams of the clock is used as an interlock to hold on the clock motor for one revolution of the cams. In one rotation the clock performs the following functions:

1. Causes the pickup arm carrying two suction cups to press down on the stack of cloth.
2. Causes the suction to come on, lifting off the top piece of cloth.
3. Causes the pickup arm to swing up up through approximately 180°, depositing a single piece of cloth onto either a flip/flop mechanism in the case of quarters or directly onto the transfer belt in the case of tongues.
4. Turns off the vacuum again.
5. Restores the pickup arm to it's position over the stack.
6. Starts up the belt conveying the deposited piece of cloth from the point of deposit to and into the gauging pin. In the event that the cloth is dropped on a flip/flop, then simultaneously the flip/flop turns over as soon as the pick up arm are clear of it, depositing the quarter which was placed on it upside down in a right side up position on the belt.
7. After a proper time interval, during which time the piece has been pushed by the belt into the gauging pins, stop the belt. Just prior to this, the gauging pins have been elevated from their rest position in which the tips of them are flush with the table, to their operating position projecting one half inch.
8. As soon as the belt has stopped, indicating that the piece is pushed against the gauging pins, causes the outboard vertically acting fingers of the feed arm to drop on the cloth, brings the suction on for the cups which terminate these fingers, then raises the fingers, lifting the gauged cloth over the pins.

As shown in line L-**33** the first station of Clock 1 operates air cylinder **124** which, by its cycling, picks off the top-most workpiece from the stack of workpieces which is in the feeding position. There is also a parallel connection into this air cylinder through relay CR23, the purpose of which is to ensure that when relay CR33 is actuated for a change of feed container, the pick off cylinder **124** will move from its retracted position over the feed container and move into its advance or release position, thus keeping it clear of the feed container carriage and frame which is shifted transversely of the apparatus during changeover of feed containers.

Line L-**34** shows a clock step to actuate the small air cylinder **28** in the pick off mechanism which brings the suction cups together at the instant of pick off so as to crimp the workpiece and avoid feeding more than one workpiece at a time.

Line L-**35** shows another position on the clock which turns on the suction for the pick ups through valve **26**. This suction, of course, is intermittent during pickup, and is released for dropping the piece.

In line L-**36** there is shown another clock position which operates the air cylinder **146** which controls the roll-over mechanism to flip the workpiece over, as described hereinbefore. This is also subject to relay CR23 being in a normal position so that it will not func-

tion during the out of sequence action of air cylinder **124** at the time of feed container change.

Yet another clock position shown in line L-**37** sets relay CR45 which is interlocked to a microswitch at the end of the stroke of the feed arm mechanism which is the delivery stroke for moving a workpiece into the stitching position. This relay, CR**45**, is locked in by relay CR418 which is actuated by limit switch LS418 at the forward end of the stroke of the feed arm mechanism. It controls the transfer lift of the vertical cylinder **283** at the end of the feed arm which actuates the suction cups, subject to another clock signal. The suction is thus retained on the suction cups until the workpiece is released to go into actual stitching, whereas, the vertical pick up motion i.e., cylinder **286** is made to lift the workpiece up from the gauge station into which it has been carried by the conveyor belt **220**, and promptly deposit it on the table.

A further clock signal as shown in line L-**39** turns on the motor to drive the conveyor belt from the position where the new workpiece is dropped, thereby carrying the workpiece horizontally into the gauge station as previously described.

Operation of valve **46**, which controls the transfer suction, is as shown on line L-**40** effected through relay CR**45** but subject to relay CR418 which is activated at the termination of the transfer stroke. This releases the workpiece into the stitching cycle.

Another clock signal, see line L-**41**, actuates the cylinder **280** to turn the workpiece through the required number of degrees to change from the angle from which it was initially gauged, to the angle at which the stitching must commence. As previously pointed out, there are three different precise angles of turn which are set up mechanically, and are altered by changing a pin setting in the slotted plates **278**.

The circuit arrangement for the small gauge motor **270**, which is mounted on the feed arm **260**, is shown on line L-**42**. The armature of motor **270** is shown connected to the line through the normally open contacts of relay CR44, and connected through the normally closed contacts of the same relay across a 25 ohm resistor. This is a standard configuration for shunt wound or permanent field dynamic braking.

The reversing circuit for the motor **270** is shown in line L-**43** and as will be noted the armature polarity is reversed in the two positions of latching relay LR47, the resultant power being fed to the input of the start/stop relay. As previously noted a latching relay is used since it preserves the directional sequence in the event of power interruption.

Line L-**44** shows photo cell PR411 which is used as the sensing signal for electronic gauging in the longitudinal direction applied to its transistor amplifier TR411, and to a relay, P**411**.

Line L-**46** shows the forward operation of this gauge motor **270** from the closing of limit switch LS415, part of the way along the transfer stroke of the feed arm assembly. This switch, LS415, indicates that the workpiece has reached an intermediate position on the transfer ready to be finely gauged prior to entering the stitch.

The closing of the relay CR415 pulses relay CR44A which is one of the starting points of motor **270**. Relay CR44A, as shown in line L-**48**, actuates relay CR44 which starts and stops motor **270** when the workpiece has reached the gauge position. Relay CR44 is actuated also by relay CR418A in its reverse direction after the entire transfer motion is over. Motor **270**, once started, is kept running by the lock-up of relay CR44, which lock is broken by three conditions, namely: firstly, by limit switch LS441 which is in its home position on its retract stroke preparing for a new workpiece to gauge; secondly, by a relay which is put at the forward limit of the stroke so as to signal the system in the event that no workpiece is there to be gauged; and thirdly, the normal operation of the photoswitch, PR411, and the occlusion of the photo cell PR441 by the workpiece indicates that the gauging is complete, and turns off relay CR44 and the motor **44**. However, this is bypassed in the reverse direction by a shunt connection through latching CR47 which is actuated during the reverse stroke of the motor **44**.

As shown in line L-**49**, relay CR47 is a slave to latch relay LR47. The latch relay LR47 is controlled entirely by the motions of the feed arm assembly. The latch relay LR47 is put into reverse by switch SW418 at the forward extremity of the transfer motion, and into a forward direction by relay CR413 which is approximately at the retract end of the transfer motion. This is shown at lines L-**49** and L-**50** respectively.

In the event that there is no workpiece in the transfer system at the time gauging is made, then obviously there will be no occlusion of the photo cell PR411 at the gauge point, and the gauging motor **270** will run to the end of its stroke, which is switch SW448. When this switch closes, therefore, it closes relay CR4 which as shown in line L-**4**, inhibits the makeup of relay CR**1**, and prevents a new stitching cycle from starting. To recover from this situation, the operator actuates a push button described later which actuates relay CR418 (see line L-**60**). This reverses and starts the gauging motor **270**, causing it to back off from switch **448** and stop on its home position ready for another cycle. This sequence is employed to stop the machine at the end of the feed container change because, as soon as workpieces cease to feed into the transfer system from the feed system, the stitching system will automatically shut down, and must be restarted manually by initiating the feed system. When relay CR4 is clear the stitching system will automatically pick up from the transfer system. A signal from limit switch LS451 indicates that the piston **285** of cylinder **283** which controls the lift of the workpieces in the transfer system has been fully retracted, as shown in line L-**38**, presumably with a workpiece.

The main longitudinal motion of the transfer motion, is controlled by relay CR4110 which is the start/stop relay for the motor **264**. Relay CR4110 is first energized by relay CR413 which is actuated by a pulse from limit switch LS451 and conditioned by the limit switch LS413. Limit switch LS413 is a switch at the retract or input end of the transfer motion which has considerable dwell on the cam so that the motor **264** travels an inch or so while still on this switch.

As shown in line L-**54** a pulse on photo cell PR411 which indicates the completion of gauging conditioned by latch relay LR47A so that this pulse can only be delivered when the gauging is in the forward direction. This is to guard against any accidental extraneous

signal. This pulse energizes relay CR411A and a signal also applied over contact CR411A as a starting signal on relay CR4110 to again start the transfer motor **264**. The motor **264** is also started by relay CR418A which starts it in the reverse direction. The holding lock is broken by relay CR411 which stops it on the reverse or home position, by relay CR418 which stops it in the most advanced position of delivery, and by relay CR415A which stops it in the mid position ready for gauging. Relay CR415A as well as stopping the longitudinal motor **264** also starts the gauging motor **270**.

Speed change on motor **264** is effected by relay CR412. It is also initiated by relay CR411A which indicates the completion of gauging, also subject to latch relay LR47B. This signal is held in by relay CR418 until the end of the forward stroke of the transfer.

Motor **264** is a commercial, transistor controlled, direct current shunt wound motor which has certain special features: (a) it starts and stops through the customary dynamic braking, alternating voltage or shunt resistance across its armature; (b) it reverses in the customary fashion by reversing the polarity of the armature; (c) the speed is servo-controlled steplessly and in very minute increments by a ten-turn potentiometer in the control circuit which uses as a reference a built in tachometer winding; (d) this potentiometer can be substituted by switching to an alternate fixed resistance giving another predetermined speed; (e) there is torque control on the motor by manual adjustment; and (f) there is dynamic braking on deceleration to a reduced forward speed.

The object of using such a motor is to introduce the workpieces into the stitching cycle on the fly. It is important that the transfer speed precisely matches the stitching speed at the instant the gauged workpiece enters the photo-electric gate of the stitching system, and proceeds into stitching as previously described. It is also desirable to operate this motor at a faster speed during its preliminary stroke from the stacking position prior to gauging, and during the retraction stroke. In the normally closed position of relay CR412, therefore, motor **264** is operated on external control consisting of a fixed resistor R in place of a panel potentiometer. When relay CR412 is engaged, a panel potentiometer is substituted and this enables the speed to be set with great precision, with the speed checked by a tachometer built into the motor control. The standard stop/start circuit for the motor **264** applied to the armature through two double-throw points of relay CR4110 is shown in line L-**57** and line L-**58** shows the manner in which signal tachometer generator, which is part of motor **264**, may be connected and disconnected into the control circuit by relay CR4110, and reversed through the action of latching relay LR413. Reversal of the armature of the motor **264** is accomplished by the same latching relay, LR413, as is shown in line L-**59**. Provision is made for reversing the transfer stroke at the forward, or sewing machine end, by a pulse action arising from a limit switch LS418 which is located at the precise termination of this end of the stroke. This pulse actuates a relay CR418 which immediately stops the motor **41**, and reverses the motor direction, and subsequently, through a timed relay CR418A, restarts the motor **41** in the reverse direction.

As shown in line L-**61** a push button is provided for relay CR418 in order to reverse the motor **264** and restart it in a reverse direction manually. This is the push button previously referred to and which is used in restarting operations after a stoppage due to the absence of a workpiece. Relay CR418 operates a latching relay LR413A.

A pulsed relay CR63B produces a reverse pulse on reopening into relay CR418A which restarts the motor **264** as shown on line L-**53**. This double pulse arrangement is a conventional capacitor timing circuit.

An identical configuration is employed at the opposite end of the cycle as seen on line L-**63**. When the motion terminates on limit switch LS411, it pulses relay CR411 which throws the latch relay LR413B to restore the motor **264** to a forward motion.

The machine is so physically arranged that the transfer motion picks a workpiece up from the gauge station as shown in line L-**37**, carries through its own sequence as indicated in line L-**39**, which includes electronic gauging to precise length and transfer into the photo-gate of the stitching system as shown in line L-**7**, then follows the workpiece into the stitching system for approximately half an inch by the closely co-ordinated speed control of motor **264**. The feed and transfer systems are synchronized with the stitching system, as previously explained with reference to line L-**21**, by timer T**64** which is initiated out of the stitching cycle.

Discharge of a fully stitched workpiece is initiated by relay contact CR63A closing as a result of the termination of the stitching cycle and thereby actuating timer T711. The output of T711 is used to start the discharge motion outwards by means of motor **384** which is identical with the motor **264**.

Relay CR8210 is the control relay for the motor **384**. It is engaged, that is, the motor **384** is started, by relay CR63B which is in a timing sequence at the finish of stitching, and also by relay CR828A which will be described hereinafter to actuate its return stroke. The relay is interlocked by relay CR828 marking the discharge end of the stroke, and by relay CR821, marking the forward end of the stroke, which marks its home position over the workpiece emerging from the stitching cycle. Relay CR8210 is similar in action to relay CR4110.

The limit switch LS822 which has an extended dwell covering the sewing machine end of the stroke of the motor **384** serves to actuate relay CR822, and thus control the speed of motor **384**. The matched control speed is required only as the motion is leaving the stitching area while the fully stitched workpiece may be still attached to the next workpiece to be stitched. After the chopping motion has been effected; there is no reason to hold to the sewing machine speed, and the entire motion is then speeded up.

As seen in line L-**69** relay CR822 in its normal position, operates on an external resistance giving one speed to the motor **384**, and, in its actuated position, shifts the speed of the motor **384** to a precisely determined speed as set by the control potentiometer.

Relay CR828 is pulsed by limit switch LS828 at the termination of the discharge stroke and this pulse instantly reverses the direction of motor **384** at the same time as it stops it by breaking the interlock on relay CR8210. This change in direction by the reversing coil

of latch relay LR823. When the pulse on relay CR828 is finished, the relay reverse pulses into relay CR828A which restarts the motor **82** in the reverse direction.

A similar configuration occurs at the front end of the stroke as seen in line L-**73**. The terminal limit switch, LS821, pulses relay CR821 which stops the motor **384** by breaking the interlock on relay CR8210, and at the same time puts the motor **384**, into forward drive position by engaging the latch relay LR823B. This is shown in line L-**74**. The start in the forward direction is supplied later through relay CR63B, as previously described.

The actual wiring of the start/stop action on motor **82** through relay CR8210 which incorporated dynamic braking in the conventional fashion is shown in line L-**75**.

Line L-**76** shows the simultaneous engagement and disengagement of the tachometer control generator GEN82 on motor **82**, and also shows the reversal of this generator winding on latch relay LR823 as the motor **384** is reversed. Line L-**77** shows the wiring of latch relay CR823 to reverse the armature current on the motor **384**, such armature current feeding into the sequence on line **75**. Line L-**79** shows the action of relay CR62 which closes precisely at the termination of a stitching cycle to energize relay CR85 which is locked up on relay CR828 marking the termination of the discharge stroke. Line L-**80** shows the action of limit switch LS825 in operating relay CR825. Limit switch LS825 is an extended dwell at the forward, or sewing machine end of the discharge stroke, so that this relay is made up at all times while the discharge stroke is in the sewing area. Line L-80-A shows that relay CR85 operates the discharge pick-up cylinder **395** to effect the downward stroke to engage the finished workpiece at the instant that the stitching cycle is completed. However, the action of relay CR85 is conditioned by relay CR825, so that, as the discharge arm emerges from the stitching area, air cylinder **395** will be released, and the workpiece will be lifted clear of the table **12**.

Line L-**81** shows the use of relay CR85 unconditionally to operate valve **86** thereby applying suction on the suction cups **396**, **398** on the discharge arm assembly throughout the whole of its motion until its termination upon engagement of limit switch LS825 at the end of its travel.

Line L-**82** shows the direct use of relay CR825 to make a turn on the discharge stroke which restores the workpiece to the same angular attitude that it had upon its entry from the feed assembly. A similar motion, **280**, turned the workpiece from an angle parallel to the direction of feed to a suitable angle to enter the stitch. As these pieces are uniform from end to end, they emerge from the stitch at a complementary angle, and this motion restores them to an angle suitable for stacking upon discharge from the apparatus.

Line L-**84** illustrates the motion to raise the stitch control wheel **349** twice during the cycle of the stitch; once at the instant of starting the sewing machine motor upon energization of relay CR61 and the other on timer T711 at a short time delay following the termination of stitching, energization of relay CR61 or timer T711 providing a combination of two parallel pulses which serves to actuate the same relay, CR75.

Energization of relay CR75 serves to actuate the air cylinder **336**. A further peripheral motion is shown in line L-**86** namely the operation of a pin, 71B, which is adapted to be projected up out of the table **12** at a certain point in the cycle only when stitching the small sneaker quarters **68**, pin 71B being required as a banking point to ensure that the stitch follows the very small convex curve occurring at the center of this particular part. The relay CR71B is actuated on a switch SS1 which is "on" for program **11**, during step 3 only, and at a point in that step prior to turning pin 71B being actuated, all by a 3-switch series.

As seen in line L-**87** operation of the relay CR71B serves to operate an air cylinder, AC71B, which actuates the pin 71B.

Line L-**88** shows the panel start and stop through a common disconnect using an interlock relay to maintain the circuit contact in conventional manner.

The operation of the automatic bobbin change counter is shown in line L-89. The counter is a mechanical plus electric counter which counts stitches. A bobin of thread will do various numbers of different parts, but a relatively constant number of stitches. This unit is designed to actuate a signal light A and stop the apparatus before the bobbin runs out. A mechanical link is made into the head of the sewing machine which is connected through a flexible shaft into a 100:1 reduction gear. The output of this reduction gear is equipped with a microswitch LS10 as shown on line L-**89** which operates an electro-mechanical counter counting hundreds of stitches, which is well within its speed range. When this device counts out to the predetermined count set on it, which may be anywhere up to a hundred, that is to say, up to 10,000 stitches, it operates a contact switch to break the circuit on line L-**10**, the actuating circuit for the sewing machine motor clutch/brake system. Inasmuch as it is the actuating circuit which is disconnected rather than the interlock, and as in the course of any cycle the motor is held clutched in by the interlock, the sewing machine continues to run till the conclusion of that particular cycle. However, it cannot be restarted by a workpiece at the photo electric gate.

The signal light A which comes on when a bobbin change is required signals the operator to open a small trap door provided in the table **12** immediately in front of the stitching head and change the bobbin. When this has been done the counter is reset (see line L-**90**) thereby to remove the inhibiting signal and permit resumption of continuous operation.

If desired a powered trap can be provided in which case, an additional signal from the timer is put in series with a normally closed point on relay CR61 which operates the sewing machine motor, to energize an air cylinder AC66 which opens the bobbin change trap door.

This will occur when the counter has rung out, and when, at the same time, the sewing machine is stopped at the end of its cycle, and will further alert the operator to the fact that the bobbin has run empty. After changing the bobbin, the operator is required to manually reclose the trap door.

The push button circuit to close the door is shown in line L-**93** and it will be noted that this action has been kept manual because the trap door must close very

tightly to preserve a perfectly smooth stitching surface. The trap door is therefore powered by a toggle connection (not shown) which could be dangerous if a careless operator triggered it to close inadvertently.

It will be appreciated that in the foregoing only exemplary embodiments of the invention have been described and referred to but that many variations in detail can be envisaged which fall within the scope of the invention as contemplated by the inventor.

Thus, for example, although the control circuitry described is based on relays it has been established that the whole circuit could be constructed utilizing solid state and integrated chip circuits without departing from the basic principles and considerations embodied in the relay circuitry described.

Also while specific detailed reference has been made to the use of photoelectric elements as the commencement and termination point sensing elements it will be appreciated that radiant energy detector systems or fluidic systems adapted to detect variations respectively in radiant energy incident therein or fluid flow therethrough due to variations in interference by the workpieces may be used as the sensing elements.

We claim:

1. Apparatus for stitching the edges of workpieces wherein said workpieces are fed in seriatim into a sewing machine, comprising a sewing machine; a stationary guide disposed adjacent to the feed tools of the sewing machine and behind the sewing machine feed needle; control means adapted constantly to engage a workpiece introduced into the sewing machine and to exert a pressure thereon, said control means disposed adjacent to the stitching head of said sewing machine and adapted to urge a workpiece into engagement with said guide means to cause the stitch to follow a path at a substantially constant distance from the edge of the workpiece; and holding means adapted to be selectively engaged with the workpiece, said holding means being moved into engagement with the workpiece at appropriate positions in relation to selected curved edge portions thereof and working in conjunction with said control means to urge the workpiece to follow a path corresponding to said selected curved edge portions.

2. Apparatus as claimed in claim 1 wherein the workpieces are disposed in a suitably located stack and including means for feeding the workpieces from said stack.

3. Apparatus as claimed in claim 1 including automatic means adapted to remove the completed workpieces from the apparatus.

4. Apparatus for edge binding a workpiece, comprising a sewing machine; means for feeding a tape towards the sewing machine and forming same so as to enclose the edge of the workpiece for subsequent stitching thereto; a stationary stitching guide disposed adjacent to the feed tools of the sewing machine, said guide means associated with said tape feed and forming means, and disposed behind the sewing machine feed needle; control means adapted constantly to engage a workpiece introduced into the sewing machine and to exert a pressure thereon, said control means disposed adjacent to the stitching head of said sewing machine and adapted to urge a workpiece into engagement with said guide means to cause the stitch to follow a path at a substantially constant distance from the edge of the workpiece; and holding means adapted to be selectively engaged with the workpiece, said holding means being moved into engagement with the workpiece at appropriate positions in relation to selected curved edge portions thereof and working in conjunction with said control means to force the workpiece to follow a path corresponding to said selected curved edge portions.

5. Apparatus as claimed in claim 4 including means for separating fully stitched workpieces leaving the sewing machine into separate entities.

6. Apparatus for the continuous edge binding of portions of standard shoe uppers such as quarters, vamps and tongues, comprising a stitching head, means for successively feeding shoe portions upwards to the top level of a stack of such shoe portions of any preselected pattern; means for continuously feeding the shoe portions horizontally towards the stitching head; means for continuously orientating and engaging the shoe portions whereby they are fed to the stitching head with the leading edge at a substantially constant distance from the sewing machine needle; means for feeding a tape towards the sewing machine and forming same so as to enclose the edge of the work piece for subsequent stitching thereto; said edge binding being continuously stitched to said shoe portions in said sewing machine with the line of stitch at a substantially constant distance from the edge of each workpiece; means for discharging the fully stitched shoe portions successively out of the stitching system; means for automatically stopping the stitching operation at the end of each individual stack; and means for automatically reloading the apparatus with a pre-loaded stack of said shoe portions.

7. Apparatus for edge binding a workpiece comprising a sewing machine; means for feeding a tape towards the sewing machine and folding it over so as to enclose the edge of the workpiece for subsequent stitching thereto; a stitching fence associated with said tape feed and folding means, said fence disposed behind the sewing machine needle; control means adapted constantly to engage a workpiece introduced into the sewing machine and to exert a predetermined and adjustable pressure thereon, said control means disposed adjacent the stitching head of said sewing machine and adapted to urge the workpiece into engagement with said fence to cause the stitch to follow a path inwardly of and at a substantially constant distance from the edge of the workpiece; and holding means adapted to be selectively moved into engagement with the workpiece, said holding means being moved into engagement with the workpiece at the centers of selected curved edge portions thereof and adapted in conjunction with said control means to force the workpiece to follow a path corresponding to said selected curved edge portions.

8. Apparatus as claimed in claim 7 wherein said control means comprises a control wheel the peripheral edge of which is inclined inwardly relative to the needle of said sewing machine.

9. Apparatus as claimed in claim 7 including means for severing fully stitched workpieces leaving the sewing machine into separate entities.

10. Apparatus as claimed in claim 7 including a logic circuit operable to initiate, sustain and terminate the

action of said holding means in response to changes in the path of stitching, whereby the holding means is selectively moved into engagement with the work piece to cause the work piece to follow said path corresponding to said selected curved edge portions.

11. Apparatus as claimed in claim **7** including means for feeding a workpiece into the sewing machine; sensing means adapted to be actuated in response to the presence of the edge of a workpiece at a predetermined position relative to the sewing machine needle, said sensing means operable when actuated to cause said workpiece feeding means to feed the workpiece towards the sewing head at a speed synchronous with the speed of the sewing machine.

12. Apparatus as claimed in claim **7** wherein said workpiece is automatically traversed through a pattern consisting of a random sequence of straight lines and convex and concave arcuate portions corresponding to the configuration of the edge of the workpiece, traverse through said concave arcuate portions being effected under control of said control means and through said convex arcuate portions being effected under control of said holding means acting in conjunction with said control means.

13. Apparatus as claimed in claim **12** including means for severing fully stitched workpieces leaving the sewing machine into separate entities.

14. Apparatus as claimed in claim **7** including first detecting means operable when a curved portion of said workpiece is in a predetermined position relative to the sewing machine to initiate movement of a selected one of said holding means into a position engaging said workpiece; and a second detecting means operable when the workpiece has been moved, under control of said selected one of said holding means in conjunction with said control means, through an arc corresponding to that of said curved portion, to retract said selected one of said holding means from engagement with the workpiece whereupon said control means resumes control of the direction of movement of the workpiece.

15. Apparatus as claimed in claim **14** wherein said holding means comprises a plurality of pins.

16. Apparatus as claimed in claim **15** wherein said selected one of said holding means is moved into engagement with the workpiece at a point directly opposite the point of inflection at the start of a curved portion of said workpiece.

17. Apparatus as claimed in claim **7** including means associated with said sewing machine operable to count the stitches made by the sewing machine and to initiate a desired action of the apparatus when the count reaches a predetermined number.

18. Apparatus as claimed in claim **7** including means associated with said sewing machine operable to count the stitches made by the sewing machine and to provide an indication when the count reaches a predetermined number.

19. Apparatus as claimed in claim **7** including a container for holding a stack of workpieces to be stitched; conveyor means disposed between said stack and the sewing machine; pick-up means for removing workpieces in seriatim from said stack and depositing same on said conveyor means; gauge means located adjacent the conveyor means and in the direction of stitching therefrom, said conveyor means operable to urge said workpiece into said gauge means; feed means mounted on and extending over the plane of feed of said workpieces at the input side of the sewing machine, said feed means operable when a workpiece has been gauged to engage said workpiece and move it to a position having a predetermined orientation relative to the sewing machine and to introduce a leading edge portion of the workpiece into the sewing machine, said feed means automatically releasing said workpiece on commencement of stitching of said workpiece and being returned to its normal position in readiness to feed the next workpiece delivered from said sack; cutting means positioned adjacent the sewing machine and operable when said workpiece has been fully stitched to sever the workpiece as a separate entity; and means operable to engage said workpiece after it has been fully stitched and separated to move it away from the sewing machine to a position whereat it is orientated at a predetermined angle to the line of stitching, the successive workpieces being orientated with sufficient uniformity to permit an orderly stacking.

20. Apparatus as claimed in claim **19** wherein said pick-up means comprises a pair of spaced-apart fingers each terminating in a suction cup, the spacing between said fingers being cyclically adjusted in the routine operating program of the apparatus whereby upon engagement of a workpiece by said suction cups said fingers may be moved towards each other thereby causing the center portion of the workpiece to become upwardly folded prior to the removal of said workpiece from said stack.

21. Apparatus as claimed in claim **19** wherein said workpieces are stacked in said container in inverted position and including roll-over means intermediate said container and said conveyor means onto which said workpieces are delivered by said pick-up means, said roll-over means adapted to be rotated about its axis whereby to invert workpieces deposited thereon and to deliver said inverted workpieces onto said conveyor means.

22. Apparatus as claimed in claim **19** wherein said holding means comprise first and second pins mounted on the head of said sewing machine reciprocable in a vertical plane relative thereto.

23. Apparatus as claimed in claim **7** wherein said control means is mounted on the head of said sewing machine and reciprocable in a vertical plane relative thereto.

24. Apparatus as claimed in claim **23** wherein said control means comprises a control wheel.

25. Apparatus as claimed in claim **19** wherein said cutting means comprises an upper blade mounted on the free end of the piston of a pneumatic cylinder and a lower blade fixed in a stationary position adjacent the sewing machine needle in the direction of stitching from said needle, said upper blade reciprocable in an axial direction into and out of engagement with said lower blade.

26. A method of edge binding a fabric workpiece comprising the steps of: feeding the workpiece to a position orientated and located in predetermined manner relative to the needle of a sewing machine; sensing the presence of the edge of said workpiece; adjusting the subsequent speed of feed of said workpiece

into said needle to synchronism with the needle speed; causing said workpiece to traverse a stitch pattern such that the periphery thereof consists of a random sequence of straight lines, concave and convex curved portions corresponding to the configuration of the edge of said workpiece with the stitch line at a substantially constant distance from said edge, traverse through said straight line and concave curved portions being effected under the direction of a control means; selectively engaging holding means with said workpiece at the centers of convex curved portions thereof, said holding means operating in conjunction with said control means to cause said stitch line to follow said convex curved portions; and severing the fully stitched workpieces into separate entities.

27. A method as claimed in claim **26** wherein the fully stitched and separated workpieces are moved away from said sewing machine at a controlled rate to a suitable discharge or storage location.

28. An apparatus for progressively stitching a workpiece along a path consisting of a random sequence of straight lines and concave and convex curved portions at a substantially uniform distance from the periphery of said workpiece comprising: a sewing head; including a sewing needle; a needle counter associated with said needle; a plurality of discrete commencement sensing elements situated outboard of the line of stitching of said sewing head with respect to the sewing needle and in a direction from the needle counter to the direction of stitching, said commencement elements being located at commencement points separated from the needle in the counter direction by several discrete distances, each distance proportional to one of several convex radii of the workpiece, the particular one of said commencement elements to be used for one of said concave and convex curved portion being selected by switching through a predetermined program; means for sensing the commencement of a curved section by detecting a reduction of interference or occlusion by the workpiece at one of said commencement points; holding means adapted to control the stitching of the convex curved portions of said work piece; termination sensing means situated inboard of the line of stitching with respect to the sewing machine and in a direction from the needle counter to the direction of stitching; a logic circuit a selected one of said commencement means and said termination means being connected in said logic circuit, said logic circuit incorporating a holding circuit such that a continuous output signal will be initiated upon occurrence of a difference in the interference at the selected commencement point, will be retained after subsequent change in the interference at such commencement point, but will be terminated by a change in the interference at the termination point, said output signal being used to initiate, sustain and terminate the action of said used to initiate, sustain and terminate the action of said holding means.

29. Apparatus as claimed in claim **7** wherein said selected one of said holding means is moved into engagement with the workpiece at a point directly opposite the point of inflection at the start of a curved portion of said workpiece.

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