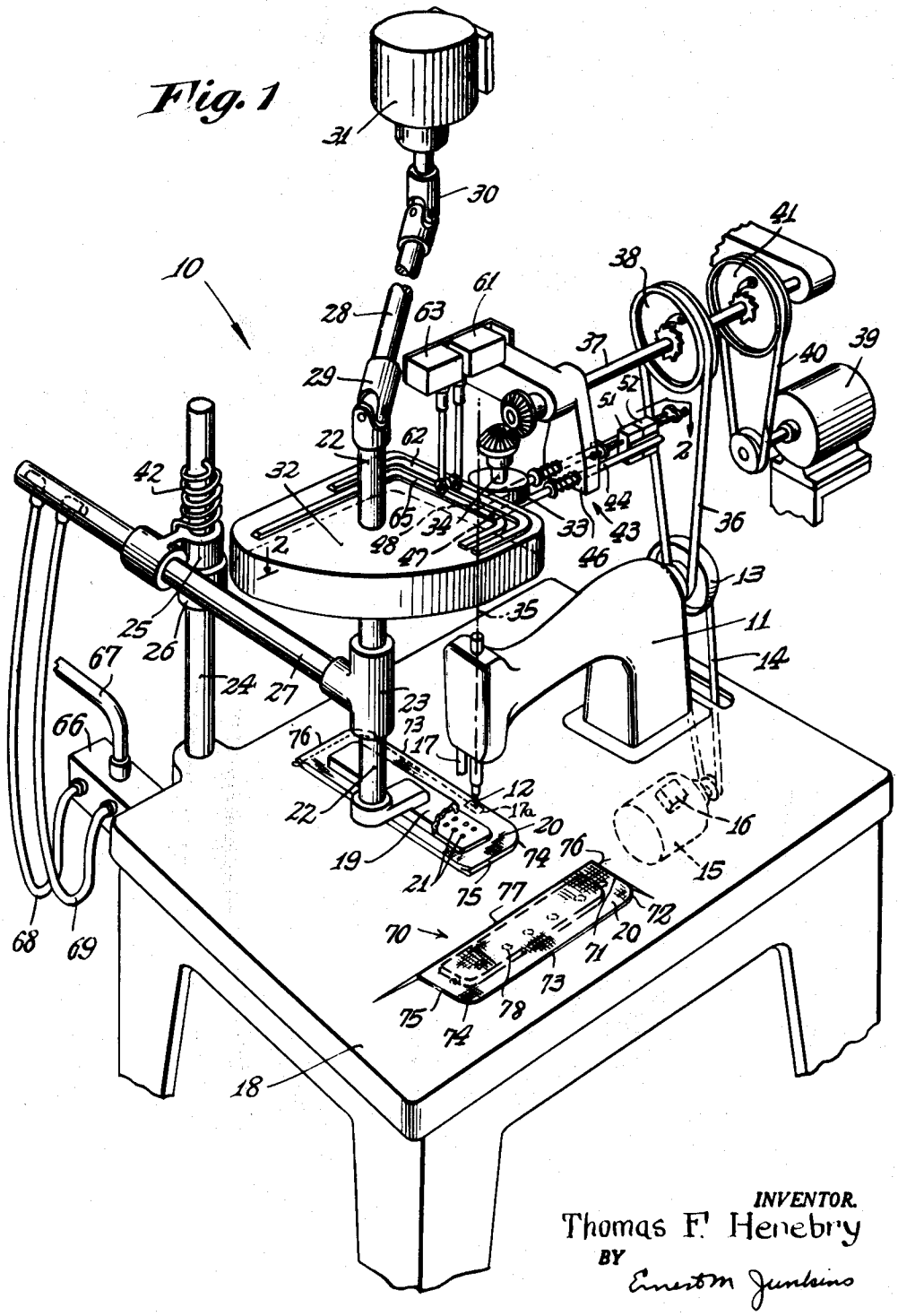
Feb. 23, 1965 T. F. HENEBRY 3,170,423

AUTOMATIC GUIDING APPARATUS

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Fig. 1



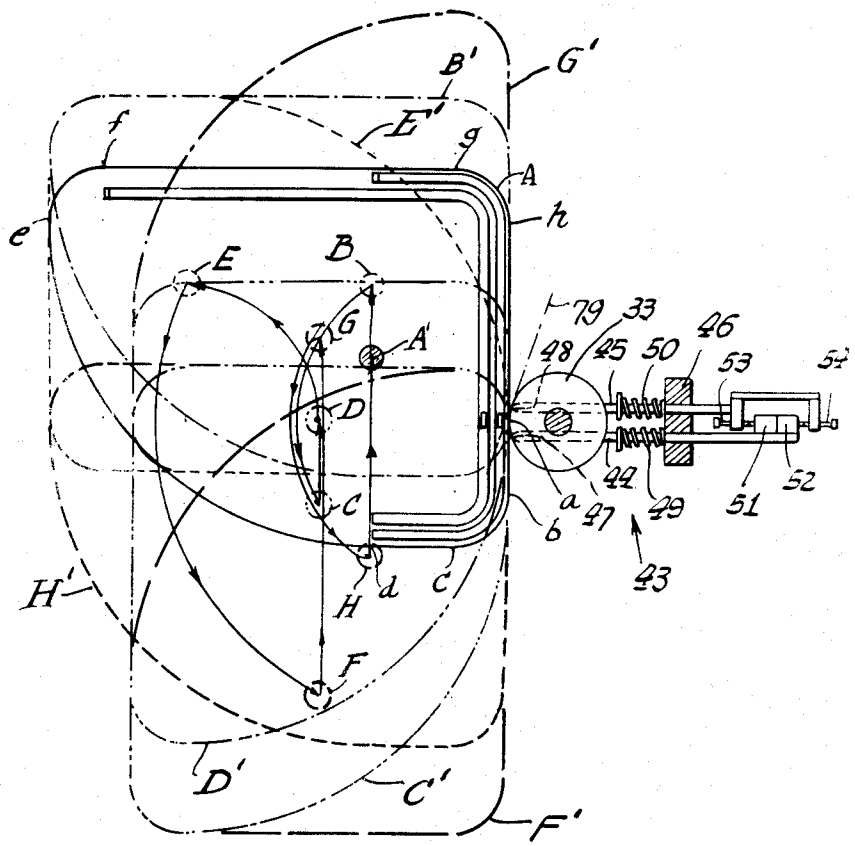

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Fig. 2



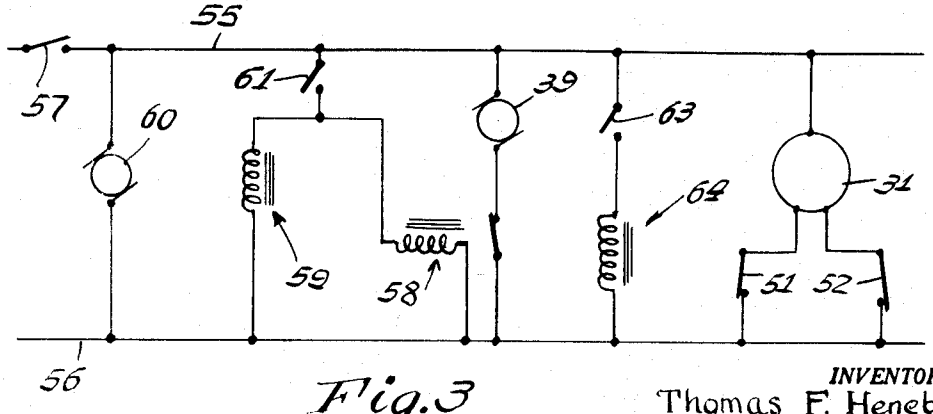




Fig. 3

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3,170,423

# AUTOMATIC GUIDING APPARATUS

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13 Claims. (Cl. 112—2)

The present invention relates to an apparatus for automaticaly guiding work pieces to a work station to have operations performed thereon and more particularly to the use with a sewing machine wherein fabric work pieces are automatically guided to have stitches extend along a selected contour path.

While devices for automatically guiding work pieces, such as two pieces of fabric that are to be stitched together along a selected path, have heretofore been proposed in order to mechanize an essentially hand operation, these devices have not been sufficiently satisfactory to be universally acceptable. Thus the proposed devices have had one or more of the following deficiencies which prevented their acceptance in replacing hand operations. The material was not fed to the needle the same as in a hand operation where the material is pivoted substantially about the needle axis and stitch formation and seam appearance were accordingly adversely affected; the machines were complicated and expensive mechanism generally having complex cam and gear configurations; the positioning and removal of work from the machines was time consuming; and the machines were not sufficiently flexible to enable the stitch path to be changed by simple changes in the guiding apparatus.

It is accordingly an object of the present invention to provide a guiding apparatus for guiding work pieces automatically along a predetermined contour path and which, when employed with a conventional sewing machine, overcomes the above-noted defects in the heretofore known devices.

Another object of the present invention is to provide an automatic guiding apparatus in which work pieces to be stitched are merely placed at a loading station and the guiding apparatus automatically grasps the work pieces to guide them along the selected path and after finishing the path, automatically releases them.

A further object of the present invention is to provide an automatic guiding apparatus that is simple in construction, durable in use, easily changed to guide work pieces along a different path and requires very little skill on the part of the operator.

In carrying out the above objects, the automatic guiding apparatus of the present invention is hereinafter disclosed in its specific embodiment as being used with a sewing machine to guide work pieces to the sewing machine stitching mechanism to have the formed stitches be in a preselected path. The guiding apparatus includes a work holder that is mounted for universal movement in a horizontal plane slightly above a table which supports the sewing machine. Work pieces are positioned on a work piece loading station formed in the table top and the work holder is caused to move over the work pieces at the loading station and grasp and hold them by forming a vacuum in the work holder. With the pieces firmly held by suction, the work holder is moved along a preselected path with respect to the sewing machine needle and any rotational movement of the work holder in following the preselected path is always about the axis of the needle, as in hand sewing. Deviations of the work holder from its selected path are sensed by a sensing means which effects a correction by pivotal movement of the holder about the needle axis. Upon completion of the stitching operation, the vacuum is released, which releases the work pieces from the holder and the above cycle of operations repeated on the subsequent work pieces.



Other features and advantages will hereinafter appear.

In the drawing:

FIG. 1 is a perspective view of the automatic guiding apparatus of the present invention as employed with a sewing machine.

FIG. 2 is a diagrammatic section taken substantially on the line line 2—2 of FIG. 1.

FIG. 3 is an electrical schematic diagram of the interconnection of the electrical components of the guiding apparatus of the present invention.

Referring to the drawing, the automatic guiding apparatus is generally indicated by the reference numeral **10** and while it may be used with other machines, such as a heat seaming machine, it is hereinafter disclosed in conjunction with a sewing machine **11**. The sewing machine is preferably of the chain stitch type and has a needle **12** that is reciprocated by rotation of a hand wheel pully **13** driven by a belt **14** which in turn is actuated by a conventional sewing machine drive mechanism **15** having a transmitter clutch solenoid **16**, that when energized drives the belt **14** and when de-energized brakes the belt **14**, and hence the sewing machine. Adjacent the needle is a presser foot bar **17** and while the presser foot is not shown, it may have the usual configuration. Additionally, the sewing machine may have the usually adjustable length feeding mechanism **172***a*, work plate with stitching forming mechanisms thereunder all not being shown but being of well-known construction. The sewing machine **11** is mounted on a table **18** in the well known manner with the drive mechanism **15** located therebeneath.

The guiding apparatus has a work holder **19**, having the shape shown, in that it approximates the shape of work pieces **20** but is somewhat smaller and is hollow, being provided with apertures **21** in its bottom surface (though a screen may be employed if desired) for reasons which will be hereinafter apparent.

The work holder is eccentrically fastened to the bottom end of a tubular shaft **22** that is supported in a bearing **23** to enable pivoted movement of the shaft and hence the work holder. A vertical cylindrical support **24** is secured to the back edge of the table **18** and rotatably positioned thereon for rotation about the vertical axis of the support **24** is a bearing **25** that is supported by a collar **26**. The bearing **25** supports for only longitudinal axial movement a tubular shaft **27** which by any well-known construction (not shown) prevents rotation of the shaft **27** and which has an end secured to the bearing **23**. Accordingly, the work holder may be pivoted by pivotal movement of the shaft **22**, may move backwards and forwards by the shaft **27** longitudinally moving in the bearing **25** and may move sideways by rotation of the bearing **25** about the vertical axis of the support **24**. While all these movements may occur simultaneously, it will be clear that these movements of the work holder in the specific embodiment shown, are in a horizontal plane that is spaced slightly above the horizontal top of the table **18** and hence the work holder is mounted for universal movement in a plane.

The shaft **22** extends above the bearing **23** and is secured to a telescoping shaft **28**, as by a universal joint **29** while the other end of the shaft **28**, also by a universal joint **30**, is connected to the output shaft of an electric motor **31**, that may be supported in any desired manner. The motor **31** is of the type shown in U.S. Patent 2,105,513 and may, by appropriate energization, as will be hereinafter set forth, be rotated slowly in either direction or maintained stationary. While a specific motor is herein disclosed, it will be appreciated that the invention is not

to be limited thereto since other driving reversible and stationary driving mechanisms may be employed, if desired.

The path followed by the work holder is determined by a shape of a camming surafce which herein is the periphery of a cam **32** that is secured to the shaft **22**. A friction wheel or follower **33** mounted on a stub shaft **34** frictionally engages the periphery of the cam **32** at a point (or a line) according to the present invention, that is vertically aligned with the axis of the needle as indicated by a center line **35**. The shaft **34**, and hence the wheel **33**, is rotated by a belt **36** connected to the swing machine pully **13** and to a shaft **37** through a one-way clutch pully **38** such that the wheel **33** is rotated whenever the swing machine is operating. To drive the wheel **33** whenever the swing machine is not operating, there is an electric motor **39** connected to the shaft **37** by means of a belt **40** and a one-way clutch pully **41**. A coil spring **42** on the support **24** bears against the bearing **25** to urge the cam **32** against the wheel **33** to maintain contact therebetween.

An important part of the present invention lies in the structure wherein the work pieces are caused to pivot about the axis of the needle whenever the shape of the cam dictates such movement or when the path of the stitches in the work pieces deviates from the path determined by the shape of the cam **32**. Whenever no rotational movement is required, then the work pieces are held against rotation. Referring to FIGS. 1 and 2, there is provided a sensing means generally indicated by the reference number **43** that includes a forward sensing element **44** and a rearward sensing element **45**, that are mounted in support member **46** for longitudinal movement. The two elements have ends **47** and **48** respectively that are spring urged as by springs **49** and **50** respectively against the priphery of the cam **32**. The two ends are spaced quite closely together with the end **47** being just slightly in front of the needle axis **35**, while the end **48** is slightly in back of the axis **35**.

It will be clear with the above construction that the cam priphery immediately before and after the needle axis line engagement with the wheel **33** is in engagement with the ends **47** and **48** and if the ends **47** and **48** project the same distance outwardly from the support, then the part of the work pieces just in front of the needle is aligned with the normal direction of machine feed as it should be. Deviation or canting of the work pieces with respect to the normal direction of feed is sensed by the sensing elements by the element ends projecting outwardly different distances, as also occurs when there is a curve in the path of stitching. To correct the deviation and to stitch a curve, the sensing elements provide for rotation of the shaft **22** to move the work pieces to the correct feeding position.

Accordingly the front sensing element **44** has secured thereto two normally closed single pole, single throw microswitches **51** and **52**, that are aligned, with the actuating arm of switch **51** being towards the wheel **33** while the actuating arm of the switch **52** being away from the wheel **33** or in the opposite direction. The rear sensing element has an end formed into a U shape with two actuators **53** and **54** mounted on the legs of the U shape to project inwardly to be engageable with the actuating arm of the switches **51** and **52** respectively that are positioned between the actuators. Thus relative movement of a predetermined amount between the two sensing elements will cause actuation of one or the other of the two switches.

In FIG. 3 is shown the electrical schematic diagram of the present invention with components heretofore referred to being indicated by the same reference numeral. Thus there are normally closed micro-switches **51** and **52** connected to the motor **31** between a pair of input lines **55** and **56** that are connectable to a source of 110 v., 60 cycle alternating current. An on-off switch **57** is located in the line **55**.

The motor **39** is connected to the input lines through a normally closed relay **58**. Reference numeral **59** indicates the selenoid actuated transmitter clutch of a conventional sewing machine drive motor **60** and the solenoid **59**, both generally indicated by the reference numerals **15** and **16** respectively in FIG. 1, when energized, drives the sewing machine by engagement with the continuously driven motor **60** and when de-energized, brakes the sewing machine. The solenoid **59** is connected across the input lines in series with a normally open switch **61**.

As shown in FIG. 1, the switch **61** is mounted to be actuated by a cam ridge **62** formed on the upper surface of the cam **32** such that when the ridge engages the switch arm, the switch is closed, energizing the solenoid **59** to drive the sewing machine. The relay **58**, however, is connected in parallel with the solenoid **59** to the switch **61** so that whenever the switch **61** is closed, the motor **39** is de-energized while on the other hand, when the switch **61** is open the motor **39** is energized to drive the shaft **37** and hence the wheel **33** and cam **32**.

For effecting the grasping, holding and releasing of the work pieces, there is provided a normally open switch **63**, connected in series with a solenoid actuated valve **64** across the input lines. The switch **63** is also mounted to be actuated by a cam ridge **65**, formed on the top surface of the cam **32**. The solenoid valve **64** is contained within a box **66** secured to the table **18** (FIG. 1) to control a valve to connect a source of air pressure to which a tube **67** is connectible with either a flexible suction tube **68** or a flexible pressure tube **69**. The ends of these two tubes terminate in the tubular shaft **27**. The suction tube by directing air under pressure from the source outwardly from the end of the shaft **27** acts as an aspirator to create a vacuum therein which extends through the shaft **27**, the shaft **22** to the apertures **21** formed in the bottom surface of the work holder **19**. The vacuum is sufficient to hold the work pieces. To release the work pieces, the vacuum is destroyed by the switch **63** being opened at the end of the cam ridge **65**, de-energizing the solenoid valve **64** to connect the source tube **67** to the pressure tube **69** for introducing air pressure into the shaft **27** and hence to the apertures **21**.

In the operation of the apparatus, an operator places the two (or more) pieces of work that are to be stitched together along the stitch patch determined by the periphery of the cam **32**, in a work station **70**, formed as a recess in the top of the table **18**. The work pieces shown have the shape of a man's shirt cuff, and are substantially recantuglar, having two curved corners with stitching to extend about a side **71**, a corner **72**, the front edge **73**, a corner **74**, and the other side **75**. The sides **76** and **77** of the work station serve not only to aid in aligning the work pieces, but, also, serve to accurately locate the work pieces in the path of the work holder **19**.

With the work holder in the dotted line position F (FIG. 2) and the work pieces positioned at the work station **70**, energization of the input lines is effected by closing line switch **57**. The suction solenoid **64** is de-energized as is the sewing machine transmitter clutch solenoid **59** by the switch **61** being open but since the relay **58** is of the normally closed type, the motor **39** is energized to rotate the cam and hence the work holder. Moreover, the motor **31** is energized through both switches **51** and **52** and hence remains stationary. As the wheel **33** rotates the cam any deviation of the cam from the path selected by its periphery as sensed by the sensing elements will open either switch **51** or **52** to cause the motor **31** to rotate the shaft **22** to correct for the deviation and which, upon being corrected, the motor **31** stops to hold the shaft non-rotating.

When the work holder is positioned over the work station, the cam ridge **65** closes the switch **63** which causes air to flow out of suction tube **68** to create a vacuum in the work holder which sucks the work pieces off the work station against the holder (holes **78** may be provided in the table to provide for air relief under the work pieces). Carrying the work pieces, the work holder moves around until the point where the work piece is just before the needle at which time the switch **61** is actuated, de-energizing motor **39** and actuating the solenoid clutch **59** to drive the sewing machine, to form a chain stitch and also drive the wheel **33**. The cam is moved by the wheel **33** as stitching progresses on the work pieces in the path determined by the peripheral contour of the cam **32**. If the cam **32** should deviate or cant from the normal sewing machine line of feed to a deviated position, for example indicated by a dotted line **79** in FIG. 2, then the switch **51** is actuated by the end **47** projecting further than the end **48** to cause counterclockwise rotation of the shaft **22** to correct for the deviation. As soon as the deviation has been corrected and sensed by the ends **47** and **48** being equally projecting outward in engagement with the cam **32**, the normal non-actuating position of the elements **44** and **45**, the motor **31** stops rotating.

It will be appreciated that rotation of the shaft **22** causes the cam to rotate and that the center of the rotation is at the needle axis since the rotation is about the line engagement of the cam **32** and the wheel **33** which coincides with the needle axis.

The same occurrence, i.e. rotation of the motor **31**, occurs when a curve appears in the cam periphery, since the position of the ends will be varied by the changing shape of the cam periphery, causing the motor **31** to be energized in a manner that rotates the shaft **22**.

At the completion of the stitching, which, if a chain stitch, may include a short chain string extending from the end of the work pieces, the cam ridge **62** ends, opening the switch **61** which opens the solenoid clutch **59** of the sewing machine, stopping it and simultaneously energizing the motor **39** to drive the wheel **33** and hence the cam **32**.

Further movement of the cam **32** causes the cam ridge **65** to end, opening the switch **63** to cause air pressure to be introduced through the pressure tube **69** to destroy the vacuum and release the work pieces.

During the above cycle, the operator has had time to place the next work pieces at the loading station and, as the work holder is moved to be positioned thereover, the above cycle of operation will be repeated.

Referring to FIG. 2, there is diagrammatically shown the path of the movement of the cam **32**, where small reference characters (*a* through *h*) are used to indicate various points of the cam that are engageable with the wheel **33**, the corresponding position of the shaft **22** for each point when it engages the wheel **33** is indicated by the same letter only capitalized, while a prime capitalized letter indicates the broken line position of the cam. Thus reference characters A and A' are for the full line position of the cam and shaft for the point *a* on the cam where the front edge **73** is being stitched, B and B' are for the next position *b* which is at the start of the rounded corner **74**, C and C' the point *c* which is the end of the corner **74**, D and D' the end of a straight portion constituting the side **75** and where the work piece is released, E and E' the start of a rounded corner, F and F' the end of the corner where the work holder is positioned over the work piece loading station **70**, G and G' the start of the rounded corner **72** of the work piece and H and H' the end of the corner **72**. To show the path of movement between the various positions of the shaft, light lines are employed with arrows showing the direction of the movement along the lines. Throughout this movement of the cam, in addition to effecting the movement of the cam along the selected path, the sensing elements will sence if there is a deviation of the cam from the selected path and operate to rotate the shaft **22** until the deviation is eliminated.

While there has been described a friction drive between the wheel **33** and the cam **32**, it will be appreciated to those skilled in the art that a different driving engagement may be used, as for example, making the wheel **33** a gear and forming the periphery of the cam **32** as a rack, at least for the portion that would engage the wheel **33**.

While the work pieces are being stitched, the speed of the periphery of the cam is the speed of the work pieces passing under the needle. Normally, when both the wheel **33** and the feed dogs are driving the cam and moving the work pieces, then the two speeds have to be the same. In some instances, it may be desirable to eliminate the feed dogs entirely depending on the wheel **33** to do all the moving of the cam and work holder.

In other instances, the wheel **33** may be free running (as by eliminating the belt **36**) and the feed dogs do all the driving. Or again, with both driving some slippage may be permitted between the wheel and the cam (as by decreasing the tension of spring **42**) to let the feed dogs of the sewing machine control the speed of the movement but yet receive assistance in driving from the wheel **33**. In each of the above instances, however, it will be clear that the wheel **33** in a sense functions as a follower for the cam **32**.

The switches **51** and **52** have been disclosed as the normally closed type so that the motor **31**, when both switches are closed, will be energized in its stopped or hold position. However, it is within the scope of the present invention to employ normally open switches and depend on the residual magnetism of the motor to maintain it in the hold or non-rotation position. Moreover, while the motor **31** may be energized by alternating current that has a lower frequency than the 60 cycle source shown if it is desired to decrease its speed and increase its torque.

While the presser foot may be operated at desired times by use of a cam ridge and switch operating the well known solenoid operated presser foot lifting mechanism, the present invention contemplates setting the height of the presser foot so that no lifting thereof is required to introduce the work pieces thereunder.

It accordingly will be appreciated that there has been disclosed an automatic apparatus which enables, when employed in conjunction with a sewing machine, for the stitching of a predetermined path in work pieces which may include both straight and contour portions. The work pieces are simply, yet effectively, grasped in a known relationship to the apparatus by the accurate positioning of the work pieces in a loading station and having the apparatus employ a vacuum as the grasping and holding means. The release of the work pieces is easily effected after the stitching operation by the destroying of the vacuum.

During the stitching operation, the work pieces are moved as if by hand in that rotative movement of the work pieces is always about the axis of the needle and the line of stitches at the needle is maintained in the direction of the normal sewing machine feed, irrespective of the change in contour of the predetermined path. Any deviation from the path is sensed and the work pieces are pivoted about the needle axis until the deviation is eliminated.

Variations and modifications may be made within the scope of the claims and portions of the improvements may be used without others.

I claim:

1. An apparatus for guiding work past a work station along a predetermined path including an arcuate length comprising a work holder adapted to hold work, means supporting the work holder for free lateral and longitudinal and rotational movement in a plane, said work station including a needle, first means for moving the work holder past the needle, means for sensing and pro-

ducing a signal indicative of the approach of the arcuate length of the path to the needle, second means independent of the first work holder moving means adapted to be connected to a source of external energy for moving the work holder to have the work pivot about the needle and means connecting the sensing means to the second work holder moving means for moving the work holder upon receipt of a signal from the sensing means with the work holder supporting means permitting and accommodating any lateral and longitudinal movement of the work holder as it pivots.

2. An apparatus for guiding work past a work station along a predetermined path with the work station having a normal feed path and with said work station including a needle comprising a work holder adapted to hold work, means supporting the work holder for free lateral and longitudinal movement in a plane and rotational movement about the needle, first means for moving the work past the work station, said means supporting the work holder and first means for moving the work causing said work holder to traverse a path which may deviate from the normal feed path, means for sensing and producing a signal indicative of the length of work approaching the work station deviating from the normal feed path, second means independent of the first work moving means adapted to be connected to a source of external energy for moving the work holder to have the work pivot about the needle and means connecting the sensing means to the second work holder moving means for moving the work holder by said second work holder moving means upon receipt of a signal from the sensing means to align the length of work approaching the work station with the normal feed path with the work holder supporting means permitting and accommodating any lateral and longitudinal movement of the work holder as it pivots.

3. An apparatus for guiding work past a stitch forming station including a needle along a predetermined path with said stitch forming station having a normal feed path comprising a work holder adapted to hold work, means mounting the work holder for free lateral and longitudinal and rotational movement, first means for moving the work along the predetermined path, path means moving with the work holder, abutment means positioned to engage the path means at a point in alignment with the needle, means for urging the path means against the abutment means, said means mounting the work holder and said means for moving the work causing said work holder to traverse a path which may deviate from the normal feed path, means for sensing and producing a signal indicative of the deviation of a point of the path means ahead of the point of engagement of the path means and the abutment means with respect to the normal feed path, second means independent of the first work moving means adapted to be connected to a source of external energy for rotating the work holder about the point of engagement and means connecting the sensing means to the work holder rotating means for rotating the work holder upon receipt of a singal from the sensing means with the work holder mounting means permitting and accommodating any lateral and longitudinal movement of the work holder as it rotates.

4. An apparatus for use with a sewing machine for guiding work past the needle along a predetermined path comprising a work holder adapted to hold work, means mounting the work holder for free lateral and longitudinal movement and rotational movement, means for moving the work holder, cam means mounted for movement with the work holder and having a camming surface defining the predetermined path, follower means positioned to engage the camming surface at a point in alignment with the needle, means urging the cam means against the follower means, means for sensing and producing a signal indicative of the deviation of a point of the camming surface on one side of the point of the camming surface engaging the follower means with respect to a point on the other side, means for rotating the work holder and means connecting the sensing means to the work holder rotating means for rotating the work holder upon receipt of a signal from the sensing means with the work holder supporting means permitting and accommodating any lateral and longitudinal movement of the work holder as it rotates.

5. In combination with a sewing machine having a needle and a normal feed path, an apparatus for guiding work past the needle along a predetermined path comprising a work holder adapted to hold work, means mounting the work holder for free lateral and longitudinal movement and rotational movement, means for moving the work holder, path means mounted for movement with the work holder, abutment means engaging the path means at a point in alignment with the needle, means urging the path means against the abutment means, means for sensing and producing a signal indicative of the deviation of a point of the work approaching the needle from the normal machine feed to the needle, means for rotating the work holder to pivot the work about the needle and means connecting the sensing means to the work holder rotating means for rotating the work holder upon receipt of a signal from the sensing means with the work holder supporting means permitting and accommodating any lateral and longitudinal movement of the work holder as it rotates.

6. The invention as defined in claim 5 in which there is provided a source of electrical energy and a means connecting the source to the sensing means, and in which the sensing means produces an electrical signal that is different for when a deviation is sensed than when no deviation is sensed.

7. The invention as defined in claim 5 in which the sensing means signal is an electrical signal having one value for deviation in one direction and a different value for deviation in the opposite direction and in which the means for rotating the work holder rotates in one direction for one value of signal and rotates in the other direction for the different value of signal.

8. The invention as defined in claim 5 in which a support is provided at least at one position beneath the path of movement of the work holder and means defining a work loading station at the position.

9. The invention as defined in claim 5 there is provided means for creating a vacuum connected to the work holder and in which the work holder includes a surface engageable with the work with the surface being formed with apertures therein to enable work to be held by the work holder by suction.

10. The invention as defined in claim 5 in which there is provided a support located at a position beneath the path of movement of the work holder, a work loading station located at said position, said work holder including a surface engageable with the work with the surface being formed with apertures therein and means for applying a vacuum to said apertures when the work holder is positioned over the work loading station.

11. The invention as defined in claim 5 in which the sewing machine includes feed means engageable with the work, said feed means being included in the means for moving the work holder.

12. The invention as defined in claim 5 in which the means for moving the work holder includes means for moving the abutment means and driving means between the path means and the abutment means.

13. An apparatus for guiding work past a work station having a needle along a predetermined path comprising a work holder adapted to hold work, means supporting the work holder for free lateral and longitudinal movement in a plane and rotational movement about the needle, first means for advancing the work holder holding the work past the working station, said means supporting the work holder and first means causing said work holder to traverse a path which may deviate from the predetermined

path, means for sensing and producing a signal indicative of a deviation of the path of the work holder from the predetermined path, second means for moving the work holder independent of the first means and adapted to be connected to a source of external energy and means interconnecting said second means with the work holder and said means for sensing and producing a signal, said second means being actuated upon receipt of a signal to cause a rotational movement of the work holder about the needle to overcome the deviation with the work holder supporting means permitting and accommodating any lateral and longitudinal movement of the work holder necessary to overcome the deviation.



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