Dec. 16, 1958 H. L. COLE ET AL 2,864,327

SEWING MACHINE

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Fig. 1.

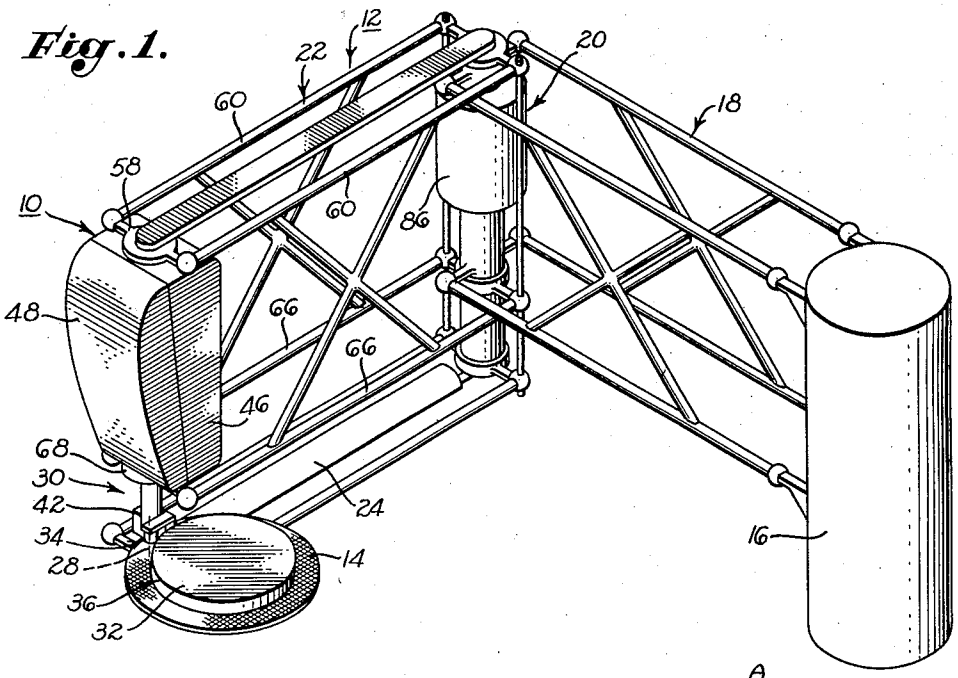



Fig. 4a.

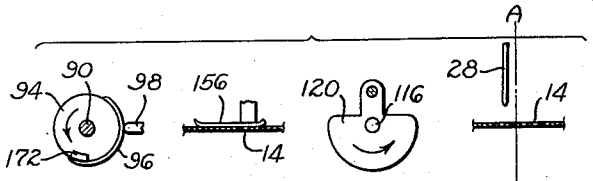



Fig. 4b.

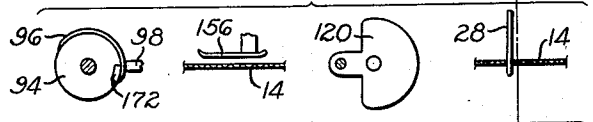



Fig. 4c.

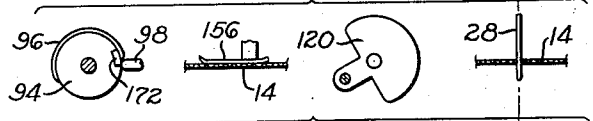



Fig. 4d.

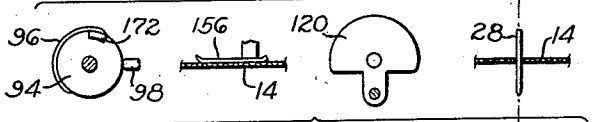
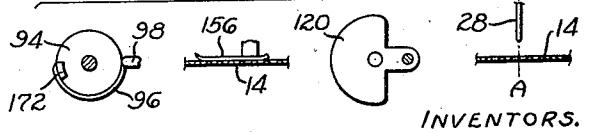



Fig. 4e.





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SEWING MACHINE

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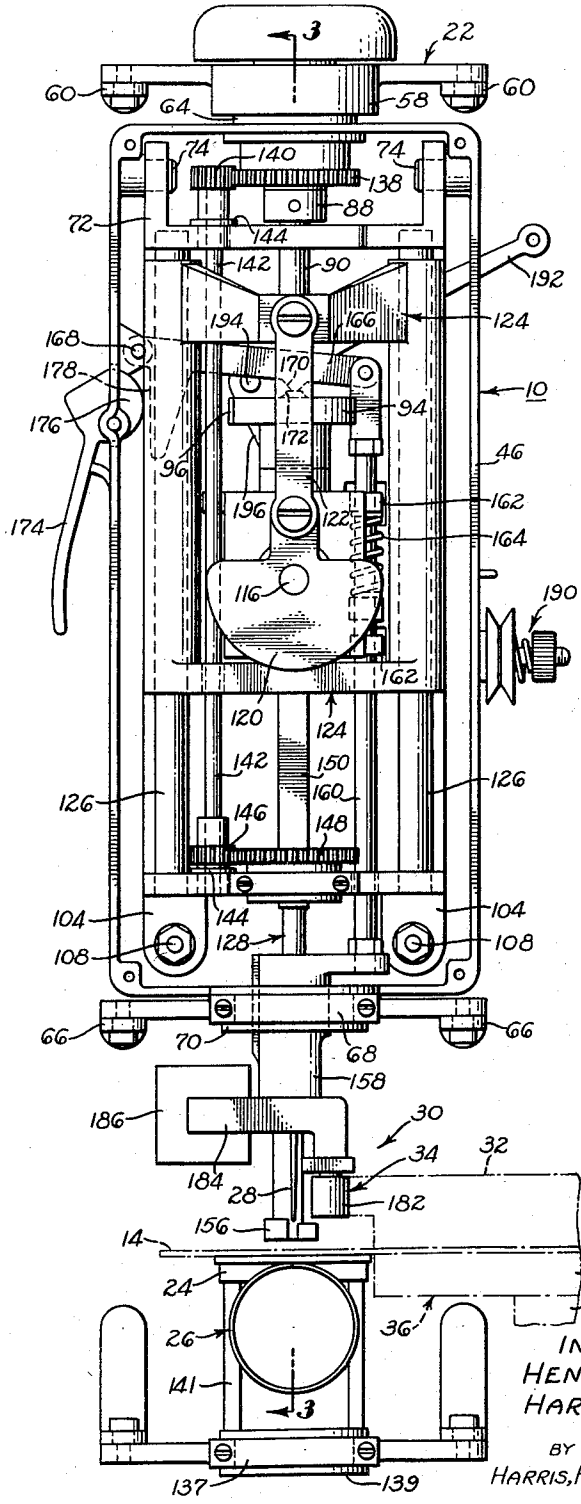



Fig. 2.

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SEWING MACHINE

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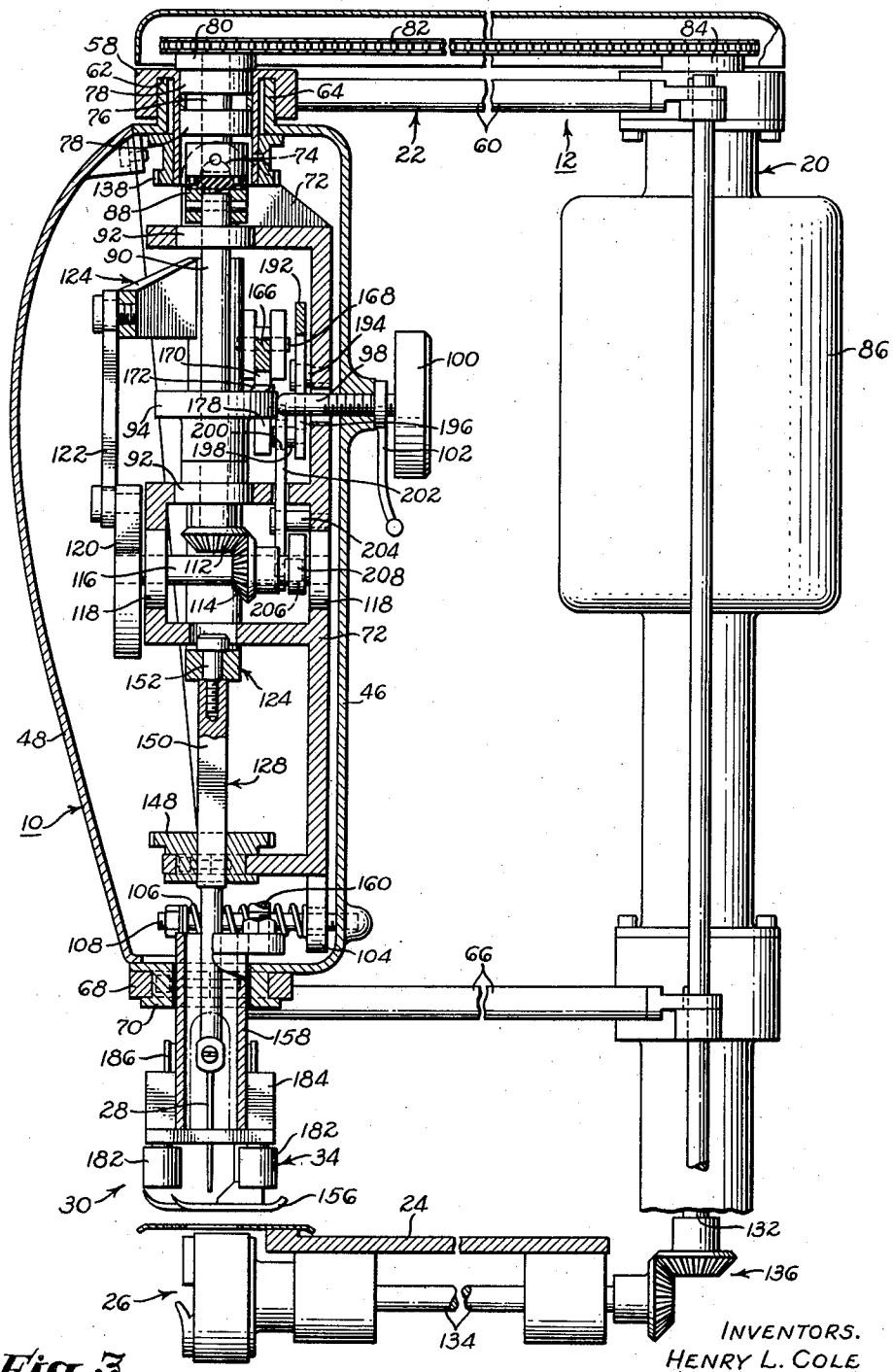



Fig. 3.

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United States Patent Office 2,864,327 Patented Dec. 16, 1958



2,864,327

# SEWING MACHINE

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Application September 2, 1954, Serial No. 453,716

15 Claims. (Cl. 112—2)

The present invention relates in general to a sewing machine wherein a stitch-forming sewing means is moved over a workpiece along a predetermined path to sew the workpiece along such path, instead of moving the workpiece relative to the sewing means.

More particularly, the invention contemplates a sewing machine which includes holding means for the workpiece, stitch-forming sewing means movable relative to the holding means and over the workpiece for sewing the workpiece, means mounting the sewing means for universal movement relative to the holding means in any direction over the workpiece so that the workpiece may be sewed along any of an infinite number of paths, means for guiding the sewing means relative to the holding means along a predetermined path to cause the sewing means to sew the workpiece along such predetermined path, and means for advancing the sewing means along such predetermined path.

An important object of the invention is to provide a stitch-forming sewing means which includes the usual axially reciprocable needle adapted to be alternately inserted into and withdrawn from the workpiece, but wherein means are provided for reciprocating the needle laterally thereof as well in such a manner that the needle is moved forwardly along the sewing path when it is withdrawn from the workpiece and is moved rearwardly along the sewing path relative to the other elements of the sewing means when it penetrates the workpiece so that the needle itself advances the sewing means along the sewing path in a step-by-step manner, the needle itself thus forming the means for advancing the sewing means along the sewing path, which is an extremely important feature of the invention.

Another object is to provide means for varying the extent of reciprocation of the needle laterally thereof to vary the stitch length.

More particularly, an object of the invention is to provide a pivoted needle mount for the needle which is oscillatable through a small angle to produce reciprocation of the needle laterally thereof, the sewing means including cam means for oscillating the needle mount about its pivot, and including adjusting means associated with such cam means for varying the angle of oscillation of the needle mount to vary the lateral reciprocation of the needle, thereby varying the stitch length.

Another object is to provide means for maintaining a predetermined needle azimuth relative to the mounting means for the sewing means at all times as the sewing means is advanced along the sewing path so that the eye of the needle always faces in a predetermined direction relative to the mounting means.

Another object of the invention is to provide means for guiding the sewing means along the sewing path which is preferably magnetic, but which may include grooved templates, and the like.

More particularly, an object of the invention is to provide a guiding means for the sewing means which includes cooperating template means and template following means, one of which is magnetized, either permanently or electromagnetically, the template means being stationary relative to the holding means and the template following means being carried by the sewing means so as to guide the sewing means along a path determined by the template means. Another object in this connection is to provide a magnetic guiding means wherein the template following means is magnetized, either permanently, or electromagnetically.

With the foregoing magnetic guiding means, very simple template means may be utilized, which is an important feature of the invention. Another important feature is that a magnetic attraction may be provided between the template means and the template following means which is sufficiently intense to cause the sewing means to follow the template means around even very sharp corners without reducing the sewing speed, although the speed may be reduced under certain conditions if desired.

Another object is to provide a template means which forms part of the holding means for the workpiece.

Another object is to provide a sewing means which carries cutting means for cutting the workpiece adjacent to the sewing path as the workpiece is sewed.

The foregoing objects, advantages and features of the present invention, together with various other objects, advantages and features thereof which will become apparent, may be attained with the exemplary embodiment of the invention which is illustrated in the accompanying drawings and which is described in detail hereinafter. Referring to the drawings:

Fig. 1 is a semidiagrammatic isometric view of a sewing machine which embodies the invention;

Fig. 2 is an end elevation of a sewing means or head which constitutes a major component of the sewing machine of the invention, a cover plate having been removed from the housing of the sewing head to reveal components within the head;

Fig. 3 is a sectional view taken along the arrowed line 3—3 of Fig. 2; and

Figs. 4*a* to 4*e* are diagrammatic views illustrating the operation of various components of the sewing head of the invention.

Referring first to Fig. 1 of the drawings, the numeral **10** designates a sewing means or head carried by a mounting means **12** which provides for movement of the sewing head in any direction over a workpiece **14** of any suitable material so that the workpiece may be sewn along any of an infinite number of paths. The mounting means **12** may be of any suitable type capable of providing for the desired free movement of the sewing head **10** over the workpiece **14**, the particular mounting means **12** shown being of the type conventionally used in drafting machines, for example. In the particular construction illustrated, the mounting means **12** includes a base **16** to which is pivoted an arm means **18**, the latter being pivotally connected at its outer end to a housing **20** which, in turn, has another arm means **22** pivotally connected thereto in a manner to produce at the junction of the arm means **18** and **22** what might be termed an elbow, as is well known in this particular art. The sewing head **10** is carried by the outer end of the arm means **22** and is rotatable relative to the mounting means **12** about its axis through 360°, the sewing head axis being vertical in the particular construction illustrated. The arm means **22** includes an arm **24** which carries at its outer end a bobbin or looper means **26** (Fig. 3) cooperating with one or more needles **28** carried by the sewing head **10**, the workpiece **14** being received between the sewing head and the bobbin means. The sewing machine of the invention includes magnetic means **30** for guiding the sewing head **10** over the workpiece **14** along a predetermined sewing path to enable the needle **28** and bobbin

means 26 to cooperate in stitching along such sewing path, the magnetic guiding means comprising cooperating template means 32 and template following means 34, one of which, preferably the latter, is magnetized, either electromagnetically, or permanently. The template means 32 is stationary and the template following means 34 is carried by the sewing head 10, the workpiece 14 being held stationary by a work holding means 36 (Fig. 2) shown diagrammatically as including a table means 38, which may be a conventional indexing table, on which the workpiece 14 and the template means 32 rest, the workpiece 14 projecting from the work holding means 36 sufficiently to be operated upon by the needle 28 and the bobbin means 26. In the particular construction illustrated, the template means 32 forms part of the work holding means 36, preferably being formed of a magnetizable material and being held in position magnetically, as by an electromagnet 40 below the table means 38, which is also magnetizable.

Considering the general operation of the sewing machine of the invention as thus far described, it will be apparent that the mounting means 12 will permit movement of the sewing head 10 over the workpiece 14 along any desired path, the path followed by the sewing head being determined by the template means 32, which may be of any desired shape, the shape shown being illustrative only. The magnetic attraction between the template means 32 and the template following means 34 may be made sufficiently intense to cause the sewing head 10 to follow the template means 32 around even very sharp corners without reducing the sewing speed, which is an important feature since it eliminates any necessity for means for varying the sewing speed when sewing around sharp corners, such as the points of a shirt collar, for example. As will be discussed in more detail hereinafter, the needle 28, in addition to being reciprocated axially thereof, i. e., vertically in the particular construction illustrated, is reciprocated laterally thereof in synchronism with the vertical reciprocatory motion in such a manner that the needle is moved forwardly along the sewing path when it is withdrawn from the workpiece 14 and is moved rearwardly along the sewing path relative to the sewing head 10 when it is inserted into the workpiece 14 so that the needle advances the sewing head 10 along the sewing path in a step-by-step manner, the sewing head being advanced one step for each stitch made by the needle 28 in cooperation with the bobbin means 26. Thus, the needle 28 itself constitutes an advancing means for the sewing head, the path of the sewing head being determined by the template means 32, which are important features of the invention. In instances where it is desired to perform a cutting operation on the workpiece 14 in conjunction with the sewing operation, the sewing head 10 carries a cutting means 42, which may be of any suitable type and which is therefore shown diagrammatically.

Referring particularly to Figs. 2 and 3 of the drawings, the sewing head 10 includes a housing 46 having a removable cover or cover plate 48 for access to the components within the housing. At the upper end of the housing 46 is a bearing member 58 carried by upper arms 60 of the arm means 22, the bearing member 58 having therein an annular recess 62 which receives a tubular projection 64 on the upper end of the housing 46. The arm means 22 is provided with lower arms 66 carrying a bearing member 68 disposed in an annular groove in a tubular projection 70 on the lower end of the housing 46. Thus, the housing 46 is free to rotate through 360° relative to the arm means 22, the axis of rotation of the housing 46 being vertical in the particular construction illustrated.

Pivoted within the housing 46 is a needle mount 72 carrying the needle 28 in a manner to be described, the needle mount being suspended from pivots 74 for oscillatory movement about a pivot axis normal to the needle axis, the pivot axis being horizontal in the particular construction illustrated. The needle mount 72 is oscillatable relative to the housing 46 through a small angle to reciprocate the needle 28 laterally thereof to advance the sewing head 10 along the sewing path in the manner hereinbefore suggested and as more fully described hereinafter. Considering the manner in which the needle mount 72 is oscillated, a shaft 76 projects downwardly into the housing 46 through the bearing member 58 and is carried by bearings 78 within the bearing member 58. The shaft 76 is provided at its upper end with a sprocket 80 having trained therearound a chain 82 which is also trained around a sprocket 84 driven by a motor 86 carried by the housing 20 at the elbow of the mounting means 12. It will be understood that the motor 86 is shown located at the elbow of the mounting means 12 for purposes of illustration only, it being possible to locate the motor at the sewing head 10, or at the base 16 of the mounting means 12 if desired.

The lower end of the shaft 76 is connected by a flexible coupling 88 to the upper end of a shaft 90 journalled in bearings 92 in the needle mount 72, the purpose of the flexible coupling 88 being to provide power transmission from the shaft 76 to the shaft 90 while permitting the aforementioned oscillatory movement of the needle mount. The shaft 90 carries a cam 94 having a lobe 96, as best shown in Figs. 4*a* to 4*e*, the periphery of the cam 94 being engageable with an adjustable cam follower 98 threaded into the housing 46 and provided with a handwheel 100 and a lock 102. As will be apparent, as the cam 94 rotates, it cooperates with the cam follower 98 to oscillate the needle mount 72 about its pivot axis, thereby producing lateral reciprocation of the needle 28. The angle of oscillation of the needle mount 72 may be varied by screwing the cam follower 98 in or out, whereby to vary the magnitude of the lateral reciprocatory movement of the needle 28 so as to vary stitch length, as will appear hereinafter. The needle mount 72 is provided at its lower end with arms 104 against which are seated compression springs 106 carried by bolts 108 threaded into the housing 46, the purpose of the springs 106 being to maintain the cam 94 in engagement with the cam follower 98.

Considering now the manner in which the needle 28 is reciprocated axially thereof to cause it to be inserted into and withdrawn from the workpiece 14, the shaft 90 is provided at its lower end with a gear 112 which is meshed with a gear 114 on a cross shaft 116 in bearings 118 carried by the needle mount 72. The cross shaft 116 carries a counterbalanced eccentric 120 having pivotally connected thereto a link 122 which is pivotally connected to a frame 124, the latter being vertically reciprocable relative to the needle mount 72 on guides 126 carried by the needle mount. Rotatably connected to the lower end of the frame 124 is a needle-carrying member 128 which projects out the bottom of the housing 46 and which carries the needle 28 at its lower end, the needle being connected to the needle-carrying member in any conventional manner. As will be apparent, rotation of the eccentric 120 produces reciprocatory movement of the needle 28 axially thereof through the link 122, the frame 124 and the needle-carrying member 128.

Since the housing 46 is freely rotatable about a vertical axis as hereinbefore discussed, it is necessary to maintain the needle azimuth, i. e., the orientation of the needle eye in a horizontal plane, in a constant relationship with the bobbin means 26 for proper cooperation between the needle 28 and the bobbin means. A predetermined orientation of the bobbin means 26, which is driven by the motor 86 through shafts 132 and 134 connected by bevel gearing 136, is maintained by virtue of the fact that the bobbin means is carried by the aforementioned arm 24 of the arm means 22. As is seen in Fig. 2, a bearing member 137 is attached to offset extremities of the arm means 22 so as to support a rotata-

ble ring 139 secured by brackets 141 to the arm 24. In order to maintain the proper relationship between the needle eye and the bobbin means 26, a gear 138 is fixed on the bearing member 58 to which the upper arms 60 of the arm means 22 are connected. Meshed with the gear 138 is a gear 140 on a shaft 142 in bearings 144 carried by the needle mount 72. At the lower end of the shaft 142 is a gear 146 meshed with a gear 148 carried by the needle mount, the needle-carrying member 128 having a square, or otherwise suitably shaped, shank 150 which passes through the gear 148 so that the needle-carrying member 128 may reciprocate vertically relative to the gear 148 to produce axial reciprocation of the needle 28, whereas relative rotation between the needle-carrying member and the gear 148 is prevented. As previously mentioned, the needle-carrying member 128 is rotatably connected to the frame 124, this being accomplished by providing a bearing 152 at the upper end of the square shank 150 which is journalled in the frame 124. As will be apparent, with this construction, the housing 46 may rotate freely through 360° about the needle axis without changing the needle azimuth, i. e., without changing the needle-eye orientation relative to the mounting means 12, the desired needle-eye orientation being maintained by the hereinbefore described connection between the upper arms 60 of the arm means 22 and the needle-carrying member 128. Thus, since the orientation of the bobbin means 26 relative to the mounting means 12 is also fixed in the manner hereinbefore discussed, the bobbin means 26 and the needle 28 are always properly related to each other regardless of the angular position of the housing 46 about the needle axis.

The sewing head 10 includes a presser foot 156 carried by a tubular member 158 which extends upwardly into the housing 46 through the tubular projection 70 at the lower end of the housing, the tubular member 158 being connected at its upper end to a rod 160 which is movable vertically in guides 162 on the housing 46, a compression spring 164 biasing the rod 160 downwardly to bias the presser foot 156 downwardly. Pivotally connected to the upper end of the rod 160 is a link 166 which is pivotally connected, at 168, to the housing 46, the link 166 being provided intermediate its ends with a cam follower 170 engageable by a cam lobe 172 on the cam 94. As will be apparent, the cam 94 thus lifts the presser foot 156 once per revolution, in addition to laterally reciprocating the needle 28 through one reciprocatory cycle for each revolution of the cam. The relation between the needle motion and the presser foot motion will be considered in more detail hereinafter in connection with Figs. 4*a* to 4*e* of the drawings. The presser foot 156 may be locked in its up or retracted position by means of a presser-foot control handle 174 having thereon a cam 176 engageable with an arm 178 on the link 166.

Carried by the sewing head 10 and, more specifically, by the tubular member 158 which carries the presser foot 156, is the template following means 34, the latter being shown as comprising two magnetizable rollers 182 engageable with the template means 32, and carried by a support 184 forming the core of an electromagnet 186, the support 184 being carried by the tubular member 158 which carries the presser foot 156. It will be understood that while the template following means 34 has been shown as electromagnetically magnetized, it may be permanently magnetized in instances where the sewing head is not required to shift from one template to another in an automatic sewing cycle. Also, the template means 32 may be magnetized, either permanently or electromagnetically, instead of the template following means 34.

The sewing head 10 is provided on the exterior of the housing 46 with the usual thread tension control 190 and is provided with an oscillating thread feeder 192, the latter extending outwardly through a slot, not shown, in the housing 46 and being pivoted within the housing at 194, Fig. 2. As shown in Fig. 3, the thread feeder 192 is provided with an arm 196 carrying a pin 198 movable in a slot 200 in a lever 202 which is pivoted to the housing 46 at 204. A cam follower 206 on the lever 202 engages a cam 208 on the cross shaft 116, which drives the thread feeder 192 in a manner which will be apparent.

Considering now the over-all operation of the sewing machine of the invention, Figs. 4*a* to 4*e* diagrammatically show the relative positions of the cam 94, the cam follower 98, the presser foot 156, the eccentric 120 and the needle 28 at different times during the operating cycle, the operating cycle including the events occurring in the formation of one stitch. Referring to Fig. 4*a*, with the cam 94 and the eccentric 120 in the positions shown, the presser foot 156 is down and the needle 28 is withdrawn from the workpiece 14 and has been advanced forwardly along the sewing path, as indicated by the displacement of the needle 28 from the reference line A—A in Fig. 4*a*. With the cam 94 and the eccentric 120 in the positions shown in Fig. 4*b*, the presser foot 156 is retracted and the needle 28 has been inserted into the workpiece 14. With the cam 94 in a position intermediate the positions shown in Figs. 4*b* and 4*c*, and while the presser foot 156 is still retracted, the needle 28 is moved rearwardly along the sewing path into a vertical position. It will be understood that the needle 28 does not actually move rearwardly along the sewing path, being prevented from so doing by virtue of the fact that it is inserted into the workpiece 14, but it does move rearwardly along the sewing path relative to the sewing head 10, with the result that the sewing head is moved forwardly one stitch length along the sewing path. With the cam 94 and the eccentric 120 in the positions shown in Fig. 4*c* of the drawings, the foot 156 again engages the workpiece 14, the needle 28 now being aligned with the bobbin means 26. With the cam 94 and the eccentric 120 in the positions shown in Fig. 4*d*, the presser foot 156 is still in engagement with the workpiece 14 and the needle 28 has penetrated farther through the workpiece 14 so as to cooperate with the bobbin means 26 in the usual manner. In Fig. 4*e* of the drawings, the cam 94 and the eccentric 120 are in positions such that the presser foot 156 is still in engagement with the workpiece 14, but the needle 28 is withdrawn from the workpiece. This completes one cycle, the next event in the cycle being a repetition of Fig. 4*a* of the drawings.

Thus, it will be apparent that the needle 28 itself advances the sewing head 10 over the workpiece 14 in a step-by-step manner as the needle is reciprocated laterally thereof in synchronism with the axial reciprocation thereof in such a manner that the needle moves forwardly along the sewing path when it is withdrawn from the workpiece 14 and is moved rearwardly along the sewing path relative to the sewing head 10 when it penetrates the workpiece so as to advance the sewing head. The sewing path taken by the sewing head when advanced by the needle 28 in this manner is determined by the template means 32, the template following means 34 following the template means 32 due to the magnetic attraction therebetween. As hereinbefore indicated, this magnetic attraction may be sufficiently intense to permit sewing around vary sharp corners without a reduction in the sewing speed, which is a feature of the invention. It will be understood that an infinite number of sewing paths is possible with the present invention because of the fact that the sewing head 10 may move in any direction over the workpiece 14 due to the action of the mounting means 12, it merely being necessary to employ an appropriate template means 32 to attain a particular sewing path. As hereinbefore indicated, a cutting operation may be carried out simultaneously with the sewing operation by mounting any suitable cutting means, such as the cutting means diagrammatically shown at 42, on the sewing head 10.

Although we have disclosed an exemplary embodiment of our invention herein for purposes of illustration, it will be understood that various changes, modifications and substitutions may be incorporated in such embodiment without departing from the spirit of the invention as defined by the claims appended hereto.

We claim as our invention:

1. In a sewing machine, the combination of: holding means for a workpiece; stitch-forming sewing means movable relative to said holding means and over said workpiece for sewing said workpiece, said sewing means including an axially and laterally movable needle adapted to be alternately inserted into and withdrawn from said workpiece; means mounting said sewing means for movement relative to said holding means in any direction over said workpiece; magnetic means for guiding said sewing means relative to said holding means along a predetermined path to cause said sewing means to form stitches in said workpiece along said path; and means for advancing said sewing means along said path, including means for moving said needle forwardly along said path when it is withdrawn from said workpiece and for moving said needle rearwardly along said path relative to said sewing means when it is inserted into said workpiece so that said needle advances said sewing means along said path in a step-by-step manner.

2. A sewing machine as defined in claim 1 wherein said magnetic means includes cooperating template means and template following means one of which is magnetized, said template means being stationary relative to said holding means and said template following means being carried by said sewing means.

3. A sewing machine as defined in claim 2 wherein said sewing means includes a pivoted needle mount carrying said needle and oscillatable through a small angle to move said needle back and forth laterally thereof, said sewing means including cam means for oscillating said needle mount.

4. In a workpiece-processing apparatus, the combination of: relatively movable workpiece-holding and workpiece-processing means, said workpiece-processing means including a support, including a processing head mounted on said support for rotation about an axis intersecting a workpiece held by said workpiece-holding means, and including a processing element carried by said head and cyclically movable into and out of engagement with the workpiece substantially along said axis and cyclically movable transversely of said axis; means interconnecting said support and said processing element for preventing rotation of said processing element relative to said support about said axis in response to rotation of said head relative to said support about said axis so as to maintain constant the angular orientation of said processing element relative to said support; and means for relatively moving said workpiece-holding and workpiece-processing means, including means for moving said processing element transversely of said axis in one direction when it is disengaged from the workpiece and for moving said processing element transversely of said axis in the opposite direction when it is out of engagement with the workpiece, whereby to relatively move said workpiece-holding and workpiece-processing means in a step-by-step manner.

5. A workpiece-processing apparatus as defined in claim 4 wherein said workpiece-processing means is a stitch-forming sewing means, said processing head is a sewing head and said processing element is a needle.

6. In a sewing machine, the combination of: holding means for a workpiece; stitch-forming sewing means movable relative to said holding means and over the workpiece for sewing the workpiece, said sewing means including a sewing head, a support on which said sewing head is mounted for rotation about an axis intersecting said holding means, and a needle carried by said head and reciprocable substantially along said axis into and out of engagement with the workpiece; means mounting said sewing means for movement relative to said holding means in any direction over the workpiece; means for guiding said sewing means relative to said holding means along a predetermined path to cause said sewing means to sew the workpiece along said path; means interconnecting said needle and said support for preventing rotation of said needle relative to said support about said axis in response to rotation of said head relative to said support about said axis so as to maintain substantially constant the angular orientation of said needle relative to said support; and means for advancing said sewing means along said path in a step-by-step manner.

7. A sewing machine according to claim 6, wherein said advancing means includes means for moving said needle transversely of said axis in one direction along said path when it is disengaged from the workpiece and for moving it transversely of said axis in the opposite direction along said path when it is in engagement with the workpiece.

8. In a workpiece-processing apparatus, the combination of: holding means for a workpiece; processing means including a processing head, a support on which said processing head is mounted for rotation about an axis intersecting the workpiece, and a processing element carried by said head and reciprocable substantially along said axis into and out of engagement with the workpiece and movable transversely of said axis; means mounting one of said holding means and said processing means for movement relative to the other to provide for relative movement between said processing element and the workpiece; means for guiding said one of said holding means and said processing means along a predetermined path so as to produce relative movement between the workpiece and said processing element along said path; means for producing relative movement between said holding means and said processing means, including actuating means for moving said processing element transversely of said axis in one direction when it is in engagement with the workpiece and for moving said processing element transversely of said axis in the opposite direction when it is out of engagement with the workpiece; and means producing rotation of said processing head relative to said support about said axis for aligning said actuating means with said path so that said actuating means moves said processing element transversely of said axis in said directions along said path, whereby said processing element produces relative movement between said holding means and said processing means along said path in a step-by-step manner.

9. A workpiece-processing apparatus as defined in claim 8 wherein said holding means is stationary and wherein said processing means is movable relative thereto.

10. A workpiece-processing apparatus according to claim 9 wherein said processing means is a stitch-forming sewing means, said processing head is a sewing head and said processing element is a needle.

11. In a sewing machine, the combination of: holding means for a workpiece; stitch-forming sewing means movable relative to said holding means and over the workpiece for sewing the workpiece, said sewing means including a sewing head, a support on which said sewing head is mounted for rotation about an axis intersecting said holding means, and a needle carried by said head and reciprocable substantially along said axis into and out of engagement with the workpiece and movable back and forth transversely of said axis; means mounting said sewing means for movement relative to said holding means in any direction over the workpiece; means for guiding said sewing means relative to said holding means along a predetermined path to cause said sewing means to sew the workpiece along said path; and means for advancing said sewing means along said path in a step-by-step manner, including actuating means carried by said head for moving said needle transversely of said axis in

one direction when it is in engagement with the workpiece and for moving said needle transversely of said axis in the opposite direction when it is out of engagement with the workpiece, and including aligning means carried by said head and producing rotation thereof about said axis for aligning said actuating means with said path so that said actuating means moves said needle, transversely of said axis, back and forth along said path in said directions.

12. A sewing machine as defined in claim 11 wherein said guiding means includes a template and said aligning means is engageable with said template.

13. In a sewing machine, the combination of: holding means for a workpiece; stitch-forming sewing means movable relative to said holding means and over the workpiece for sewing the workpiece, including a needle movable axially of itself into and out of engagement with the workpiece and movable transversely of its axis; means mounting said sewing means for movement relative to said holding means in any direction over the workpiece; means for guiding said sewing means relative to said holding means along a predetermined path to cause said sewing means to sew the workpiece along said path; and means for advancing said sewing means along said path in a step-by-step manner, including actuating means rotatable about the axis of said needle for moving said needle transversely of its axis in one direction when it is in engagement with the workpiece and for moving said needle transversely of its axis in the opposite direction when it is out of engagement with the workpiece, and including aligning means capable of rotating said actuating means about said needle axis for constantly aligning said actuating means with said path so that said transverse movement of said needle in said directions takes place along said path.

14. In a sewing machine, the combination of: holding means for a workpiece; stitch-forming sewing means movable relative to said holding means and over the workpiece for sewing the workpiece, said sewing means including a sewing head, a support on which said sewing head is mounted for rotation about an axis intersecting said holding means, a needle carried by said head and reciprocable substantially along said axis into and out of engagement with the workpiece, and bobbin means carried by said support; means mounting said sewing means for movement relative to said holding means in any direction relative to the workpiece; means for guiding said sewing means relative to said holding means along a predetermined path to cause said sewing means to sew the workpiece along said path; means for maintaining a constant angular relation between the orientation of said needle and the orientation of said bobbin means about said axis as said head rotates relative to said support about said axis; and means for advancing said sewing means along said path in a step-by-step manner.

15. A sewing machine as set forth in claim 13 wherein said sewing means includes bobbin means cooperable with said needle, said sewing machine including means for maintaining a constant angular relation between the orientation of said needle and the orientation of said bobbin means relative to the axis of said needle.

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