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Dobner et al.

[11] **3,808,995**

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[54] **SEWING MACHINE WITH DIFFERENTIAL FEED**

[75] Inventors: **Reinhold Dobner**, Kaiserslautern; **Erich Willenbacher**, Karlsruhe; **Wolfgang Baus**, Kaiserslautern, all of Germany

[73] Assignee: **Pfaff Industriemaschinen GmbH**, Kaiserslautern/Pfalz, Germany

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[51] **Int. Cl.** **D05b 27/08**

[58] **Field of Search** 112/2, 79, 121.11, 121.12, 112/121.13, 136, 203, 205, 208, 209, 211, 212

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Primary Examiner—Werner H. Schroeder
Attorney, Agent, or Firm—Robert H. Jacob

[57] **ABSTRACT**

The invention is concerned with a sewing machine with differential feed means for maintaining the surplus width of garment blanks and simultaneously fixing the surplus width maintained by a seam in which the difference of the amount of feed of the feed dogs is controlled by a rotating program carrier, with a measuring wheel as an impulse emitter that scans the actual material feed at the stitch forming location and controls a step motor that drives the program carrier.

3 Claims, 4 Drawing Figures

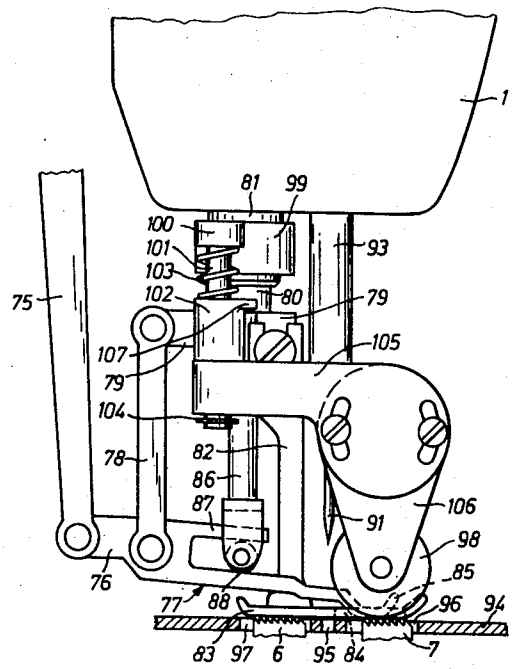

Fig.1

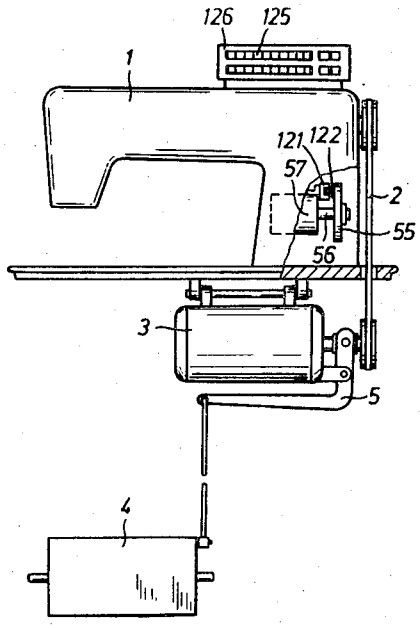
126
125
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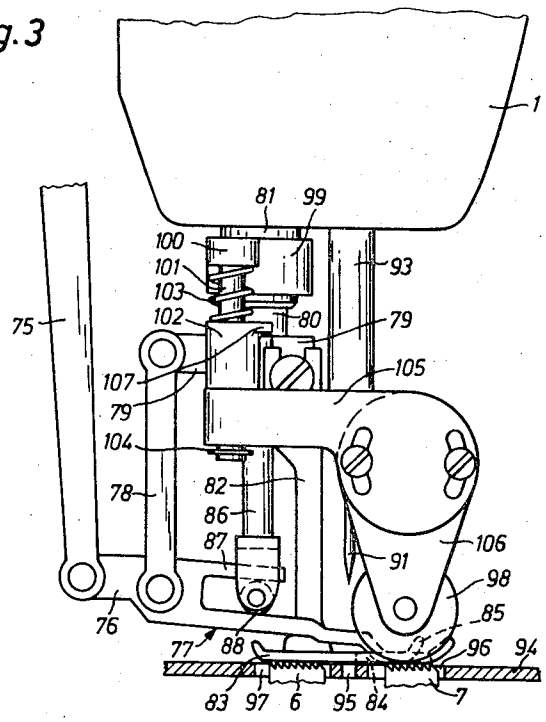
Fig.3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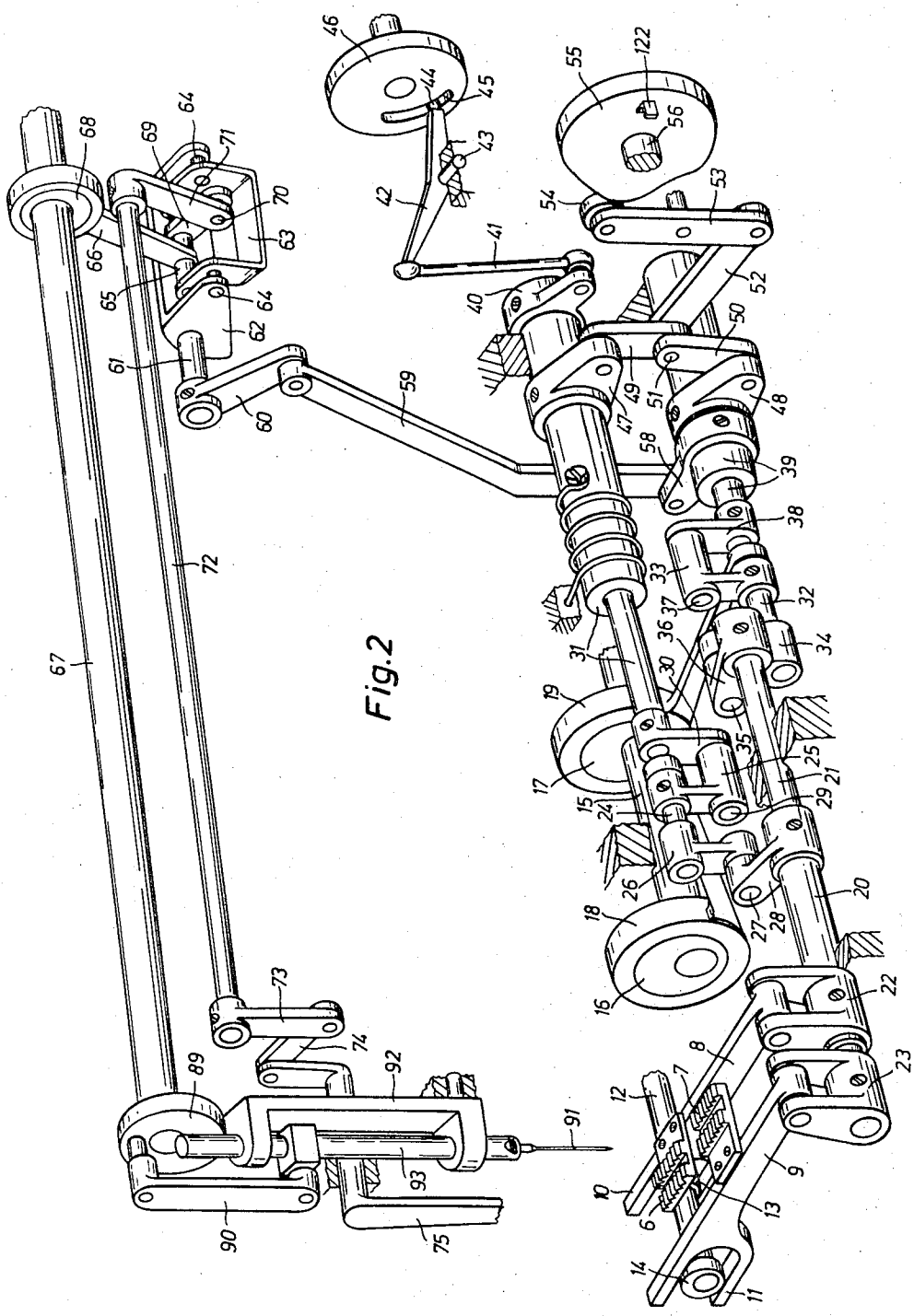
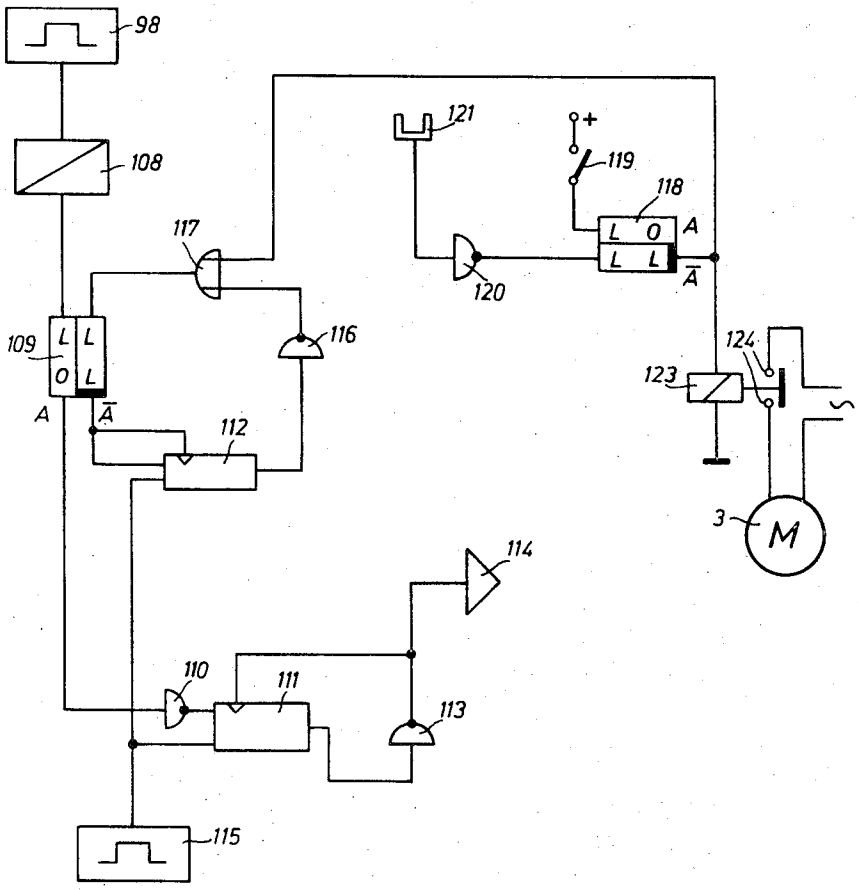


Fig.2

Fig.4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117
121
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118
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115

SEWING MACHINE WITH DIFFERENTIAL FEED

The invention relates to sewing machines of the type equipped with differential feed means for maintaining the surplus width on cut blanks of clothing and for simultaneously fixing of the maintained width by means of a seam, where the difference between the amount of feed of the feed dogs is controlled by a rotating program carrier.

A machine of this type serves, for example, for fitting in the surplus width of sleeve blanks in order to produce automatically the differences required in the gathering of the arm joint in the individual circumferential sections of the sleeve.

In a known machine of this type (German Pat. No. 1,760,182) the program carrier consists of a cam disk which, in order to effect its controlled rotary movement, is coupled to the arm shaft of the machine by way of a reduction gear. Thus, a complete rotation of the program carrier is attained upon termination of a predetermined number of stitches. As a result the seam program stored on the cam disk can only be carried out with a stitch length setting coordinated to this seam length.

The feed elements however, influence the feed of the materials differently for different kinds of materials and depend also on the instant feeding speed as to their reaction to the transporting conditions. Besides, the gathering of the feeding elements is strongly influenced by the characteristics of the material to be sewn and varies especially in cases of deflections between the direction of feed and the direction of the threads of the textile material. The amounts of differences thus developing between the desired value and the actual value of the feed path per stitch add themselves so strongly for a number of stitches required of the gathering program provided on the program carrier that even sewing results are out of the question.

For that reason the automatic control of the gathering effect by the seamstress can be manually influenced with the known machine initially mentioned in order to compensate for deviations from the regular sewing program.

The adjusting of the known machine to different lengths of seams as it is required for executing different model sizes furthermore involves considerable difficulties with the previously known machine. A change of the seam length at which the given program is to be executed requires a corresponding adaptation of the basic stitch length of the machine, a measure therefore which for the reasons mentioned is very time consuming and inaccurate.

These insufficiencies are to be eliminated in accordance with the invention and an arrangement is to be provided which automatically compensates itself from the characteristics of the feeding faults caused by the material to be operated on. For this purpose it was necessary to solve the problem to control the operation of the program carrier for effecting the change of the gathering effect of the feed members by a scanning element influenced by the effective work blank feed. In accordance with the invention this problem is solved in that a measuring wheel scanning the actual material feed at the stitch forming location controls a step motor as impulse emitter which drives the program carrier. Depending on the existing requirements it is possible in this connection to scan the non-gathered material

being sewn which is fed to the stitch forming location or the material already gathered behind the stitch forming location, while the impulse emission of the impulse emitter is adapted to the changed conditions.

Suitably the measuring wheel is arranged in the proximity of the material feed dog in order to scan the material directly. The possibility exists, however, to determine the actual material feed by a measuring wheel arranged remotely from the stitch forming location. In that case the measuring wheel measures, for example, the consumption of a non-stretchable material band that has to be sewn along.

In order to adapt the gathering program of the program carrier automatically to seam lengths selectable at random an adaptable impulse counter is provided between the impulse emitter and the stepping motor, which further switches the stepping motor when it is set back by way of an onward switching impulse.

A particularly fine grading step of the seam length adjustment is obtained in that the machine is provided with switching means where the impulse emitter releases the opening of the counting operation of the impulse counter, as well as that of a second impulse counter by way of a bi-stable storage unit whose received counts are connected to a second impulse emitter which produces impulses of very high constant frequency and the second impulse counter when set back to its initial position upon reaching a predetermined counter position closes by way of the storage unit the counting functions of both impulse counters.

An embodiment of the invention is illustrated in the accompanying drawing in connection with a sewing machine in accordance with the invention and in which:

FIG. 1 is a schematic illustration of one embodiment of a sewing machine with its prime mover,

FIG. 2 is a graphic illustration of the feed mechanism of the sewing machine,

FIG. 3 is a side view of the stitch forming tools of the sewing machine, and

FIG. 4 is a simplified circuit of the electrical controls.

FIG. 1 shows the housing 1 of a sewing machine which is driven by the drive motor 3 by way of a V-belt 2, the number of rotations of which can be controlled by a foot pedal 4 by way of an actuating lever 5 of motor 3.

The sewing machine has, a main feed dog 6 (FIG. 2) and a lower auxiliary feed dog 7, each of which is carried by a support 8 and 9, respectively. These supports present bifurcated ends 10, 11 into which extend eccentrics 13, 14 mounted on a shaft 12. Shaft 12 is driven in a conventional manner, not illustrated, in order to impart lifting movements to feed dogs 6 and 7.

Disposed parallel to and in driving connection with shaft 12 a further shaft 15 is rotatably supported which has eccentrics 16, 17 fastened thereto, each of which is encompassed by an eccentric bar 18, 19, respectively.

Two shafts 20, 21 disposed coaxially one within another are journalled parallel to shaft 15 with a space therebetween. The inner shaft 21 projects from the shaft 20. A bifurcated lever 22 is rigidly connected with the shaft 20 and has linked to it the support 8 which is connected with the main feed dog 6. A bifurcated lever 23 is rigidly connected with shaft 21 and the support 9

to which the auxiliary feed dog 7 is connected is linked to said lever 23.

The free end of the eccentric bar 18 is linked to a bolt 24 which is connected rigidly with a guide member 25 and rotatably with a guide element 26. The guide element 26 is linked by means of a stud 27 to a lever arm 28 which is secured by means of its hub to the shaft 20, while the guide member 25 is rotatably linked by means of a stud 29 to a lever 30 that is secured to a setting shaft 31.

The free end of the eccentric bar 19 is linked to a rod 32, which is rigidly connected with a guide element 33 and is rotatably connected with a guide member 34. Guide member 34 is linked by means of a stud 35 to a lever 36 which has a hub secured to a rod 21, while the guide element 33 is turnably connected by means of a pin 37 with a lever 38 that is secured to a setting shaft 39. As shown in FIG. 2, levers 30 and 38 as well as guide elements or members 25, 26, 33 and 34 are of the same effective length.

A lever arm 40 is mounted on setting shaft 31 which is connected to an arm of a lever 42 by way of a link bar 41. The other arm of the lever 42 mounted on shaft 43 which is journalled in the housing of the sewing machine presents a spherical head which is guided in a slot 45 of a setting disk 46 that is likewise rotatably mounted in housing 1. The slot 45 extends spirally to the axis of rotation of the setting disk 46 in such a manner that the main material feed dog 6 may be set for stitch lengths of 2 to 4 mm. length.

A lever arm 47 is clamped onto the setting shaft 31 and is connected with a lever arm 48 of equal length by way of two link members 49 and 50 of equal length. A transfer bar 52 engages a joint stud 51 between the two link members 49 and 50, which at one end is joined to a double lever 53 journalled in the housing 1, and the other end of which scans by way of a roller 54 the profile of a program support that is in the form of a control disk 55. The control disk 55 is seated on the drive shaft 56 (FIG. 1) of a stepping motor 57 mounted on the housing 1.

A lever 58 is clamped on the setting shaft 39 and connected by a link bar 59 to a lever arm 60 which is secured to a setting shaft 61 journalled in housing 1. A bridge 62 is mounted on setting shaft 61 between the arms of which a further bridge member 63 is rotatably journalled by means of studs 64. The arms of the bridge member 63 are connected by a bolt 65 to which an eccentric bar 66 is linked. An eccentric secured to an arm shaft 67 journalled in housing 1 of the sewing machine, which is encompassed by the eccentric bar 66, imparts rocking movements to bolt 65 about the studs 64.

A link member 69 that engages bolt 65 at one end has its other end linked by means of a stud 70 to a lever arm 71 that is fastened to one end of a rocking shaft 72 journalled in housing 1, parallel to arm shaft 67. A lever arm 73 is connected with the other end of the rocking shaft 72 which is connected by way of a link member 74 to an arm of a double armed lever 75 journalled likewise in housing 1. The other arm of lever 75 engages an arm 76 (FIG. 3) of an upper auxiliary feed dog 77 which is in the form of a double armed lever. The auxiliary feed dog 77 is supported by a guide bar 78 which is linked to support member 79 that is secured to the lower end of a presser foot bar 80 of known form of construction. The presser foot bar is guided in a bearing sleeve 81 journalled in housing 1. In addition a presser foot 82 is secured to the support member 79 which is equipped with a sole 83 that cooperates with the feed dogs 6 and 7 that has recesses 84 for the passage of toes of the auxiliary feed dog 77 that engage the material being sewn.

A bar 86 is disposed in the hollow presser foot bar 80 and is provided at its lower end with a roller 88 that is guided in a bifurcated part 87 of the upper feed dog 77 and which is moved axially up and down in a known manner for effecting the thrust movements of the auxiliary upper feed dog 77.

A crank 89 secured to arm shaft 67 (FIG. 2) is in operative connection by way of a link bar 90 with a needle bar 93 equipped with a needle 91 and journalled in a guide member 92.

The needle 91 (FIG. 3) here works in a known manner with a looper (not illustrated) driven below the stitch plate 94 through a stitch hole 95. One each slot 96 and 97 are provided in the stitch plate 94 ahead of and behind the stitch hole 95 for the passage of the feed dogs 6 and 7.

The feed dogs 6, 7 and 77 are arranged in a manner that the main feed dog 6 can make contact with the sole 83 of the feed dog 82 behind the stitch hole 95 As seen in the direction of sewing and the two feed dogs 7 and 77 ahead of the stitch hole 95.

The control of the step motor 57 is by way of a control circuit with a pulse emitter, known per se, in the form of a pole wheel 98. For this purpose a support 99 is secured to the bearing sleeve 81 for the presser foot bar 80 which carries a downwardly extending stud 101 on a lateral chuck 100. On this stud a sleeve 102 is slidably mounted which is pressed by a spring 103 provided between it and chuck 100 against a safety disk 104 fastened to the lower end of stud 101. Sleeve 102 is provided with an arm 105 which has rotatably secured to it a bearing member 106 in which the pole wheel 98 is rotatably mounted.

With the presser bar 80 in downward position the pole wheel 98 biased by spring 103 rests on the material being sewn laterally of the front part of the sole 83 of the presser foot 82. In order to achieve raising of the pole wheel 98 together with the presser foot 82, an arm 107 extending laterally from the sleeve 102 is provided which reaches beyond the support 79 and is carried along by it as the presser bar 80 is raised.

The pole wheel 98 which is symbolically illustrated in FIG. 4 is provided in a known manner with a pair of Hall generators that have coordinated therewith a number of permanent magnets. As the pole wheel 98 rotates the two Hall generators are penetrated by varying magnetic fields and generate alternating potentials whose frequency is proportional to the speed of rotation of the pole wheel 98. The alternating potential is fed to an impulse dressing stage 108 which is arranged in a manner that an impulse appears at the output of the impulse dressing stage for each millimeter of the length of the path covered by the pole wheel 98. This impulse is conducted to the setting entrance of a bistable storage unit 109 whose output $\overline{A}$ is connected by way of a reversing element 110 with the closing entrance of an impulse counter 111 and whose output $\overline{A}$ is connected with the closing as well as also with the back setting entrance of a second impulse counter 112. The outlet of the counter 111 is connected by way of a reversing element 113 with the resetting entrance of

the counter 111 as well as also with a switching amplifier 114 for the stepping motor 57.

At the counting entrances of the two impulse counters 111 and 112 an impulse emitter 115 is connected which constantly emits impulses of a very high frequency, for example, 33 kc. The output of the impulse counter 112 is connected by way of a reversing element 116 and or-member 117 to the resetting entrance of the storage unit 109. A second entrance of the or-member 117 is connected with the output $\overline{A}$ of a bi-stable storage element 118 whose setting entrance is connected by way of a switch 119 connected with the foot pedal actuating plate 4 for the drive motor 3, to the plus pole of a source of potential. The resetting entrance of the storage element 118 is connected by means of a reversing element 120 with a slot initiator 121 which cooperates with a flag 122 secured to the control disk 55 (FIG. 1) and rotating therewith.

At the output $\overline{A}$ of the storage element 118 (FIG. 4) there is also connected a relay 123 whose rest contacts 124 are located in the circuit of the drive motor 3.

The counter 111 is adjustable by means of a preselecting keyboard 125 (FIG. 1) which is provided in a control box 126 mounted in the operating range of the seamstress on the sewing machine which accommodates the entire switching means. The counter 112 on the other hand is set to a fixed counting value.

The arrangement operates as follows:

The basic setting of the feeding magnitude of the feed dogs 6, 7 and 77 (FIG. 2) takes place in common by turning the setting disk 46 whereby the spiral shaped nut 44 turns the setting shaft 31 by way of the lever 42 connected therewith by means of a joint.

The setting shaft 31 when turning carries along the lever 30 and thus sets the stud 29 serving as the axis of rotation for the link or guide member 25 in relation to the stud 27. During the rocking movement of the bolt 24 through eccentric bar 18 the link member 25 therefore executes a pure rotary movement about the stud 29, whereas the link member 26 executes besides this rotary movement also a relative movement about the shaft 20. This relative movement is transmitted by the lever 28 as a rocking movement onto the lever 22, which imparts thrust movements in the direction of feed to the main feed dog 6 by way of support 8. The magnitude of the feed movement depends on the position of the setting screw 46 and thus on the magnitude of the setting difference between the studs 27 and 29.

The turning of the setting shaft 31 simultaneously effects a rotating of the setting shaft 39 by way of the lever arm 47, links 49 and 50 and lever arm 48. The lever 38 that is fixedly connected with the latter thereby moves the link 33 so that the stud 37 is displaced relative to the stud 35. During the swinging movement of the bolt 32 through the eccentric bar 19 therefore the link 34 effects for reasons stated in connection with the function of parts 24 to 30 besides a rotary movement about the stud 37 a relative movement about the shaft 21. This movement effects a rocking movement of the shaft 21 which imparts feed movements to the auxiliary feed dog 7 by way of lever 23 and support 9.

Furthermore, lever 58 effects during the turning of the setting shaft 39 a rotating of the setting shaft 61 by way of the link 59 and lever arm 60. The strut 62 which is securely fastened thereto turns the strut 63 so that the studs 64 serving as the axis of rotation for the strut 63 are displaced relative to the stud 70. During the swinging movement of the bolt 65 by the eccentric bar 66 the strut 63 carried out a pure rotary movement about the stud 64 in a manner similar to the setting arrangement described above, the link 69 however also effects a relative movement about the rocking shaft 72 and thus causes the same to effect a rocking movement by way of lever arm 71. These rocking movements are transferred by the rocking shaft 72 by way of lever arm 73, link 74 and lever 75 (FIG. 3) to the upper auxiliary material feed dog 77 as feed movements.

The setting disk 46 thus adjusts the stitch length of the main feed dog 6 as well as also that of the two auxiliary feed dogs 7 and 77 that engage the work blank in the manner of tongs. To the amount of feed of the two auxiliary feed dogs 7 and 77 that supply the material to the stitch forming location there is in addition superimposed an amount of feed which depends on the profile of the cam disk 55.

During the sewing operation the material is displaced by the two auxiliary feed dogs 7 and 77 by a larger amount than by the main feed dog 6 from which the required gathering results or the adherence to the surplus width in a manner known per se.

Prior to starting the sewing the step motor 57 and therefore also the control disk 55 are in their starting position in which the flag 122 extends into the slot initiator. The two bi-stable storage units 109 and 118 are set back. The impulse emitter 115 swings steadily and imparts impulses to the counting receipts of the two impulse counters 111 and 112. However these impulses are not counted because a locking signal is present from the storing unit 109 at the locking entrances of the counters 111 and 112. Both counters 111 and 112 are positioned at zero.

By the seamstress's moving the foot pedal plate 4 backwards the switch 119 is closed and the storage unit 118 is set so that the relay 123 drops and the rest contacts 124 in the circuit of the motor remain closed. Simultaneously the storage unit 109 is freed which previously was continuously set back by way of the or-member 117 through the storage unit 118. Now the seamstress can start the sewing operation by stepping on the foot pedal plate 4 in which connection she can control the sewing speed in a known manner by means of the foot pedal 4.

During the sewing operation the pole wheel 98 is turned by the moving material being sewn. The alternating potential produced by the two Hall generators is supplied to the impulse preparation stage 108 and is utilized there in a manner that for each millimeter of material fed an impulse appears in its output. This impulse sets the storage unit 109. As a result the latches at the counters 111 and 112 are released so that the impulses supplied by the impulse emitter 115 are now counted simultaneously in both counters 111 and 112. If now the counter 112 is set to a constant numerical value, for example, 7, then the seventh arriving impulse of the impulse emitter 115 produces at its exit a zero signal which is inverted at the reversing stage 116 and sets back the bi-stable storage unit 109 by way of the or-element 117. As a result, both counters 111 and 112 are closed and counter 112 is simultaneously returned to zero. The counter position "7" is maintained in counter 111.

The next impulse at the impulse maker **108** releases in the same manner by way of storage unit **109** the freeing of both impulse counters **111** and **112**, the counting of seven impulses into both counters and the return of the storage unit **109**, whereupon the counter position of the impulse counter **111** stands at "**14.**"

This manner of operation continues until the counter **111** has reached a counter position which is identical with the selected counter position at the control box **126.** At that moment the counter **111** emits a zero signal which appears at the output of the reversing stage **113** as an L-signal which sets back the counter **111** to zero and simultaneously switches the stepping motor **57** by way of the switching amplifier **114.**

The next impulses of the path are again multiplied by seven count the counter **111** up to preselection and release further steps of the stepping motor **57.** This motor rotates dependent on the number of the arising impulses and the preselected choice set up in the control box **126.**

During its rotary movement by means of the stepping motor **57** in accordance with the material feed, the control disk **55** rocks the double lever **53** which acts on the two links **49** and **50** by way of the transfer bar **52.** With constant turning position of the setting shaft **31** the rotational position of the setting shaft **39** is thereby changed as a result of which also the magnitude of the feed device of the two auxiliary feed dogs **7** and **77** which effect a common feed movement changes with respect to the feed movement of the main feed dog.

The formation of the contour of the control disk **55** is determined by the differential displacement of the auxiliary feed dogs **7** and **77** during a complete course of a seam in relation to the main feed dog **6**, while the angular rotation of the control disk **55** corresponds exactly to the advance of the material being sewn. Thus, while gathering the surplus width on sleeve blanks of garments entirely identical shapes of fit can be obtained. The different seam lengths caused by the different sizes of sleeves can be so set by adjustment of the preselecting keyboard **125** on the control box **126** that the control disk **55** effects a complete turn corresponding to the lengths of seams now changed for performing the entire seam course. In this manner the gathering program stored on the cam disk can be adapted to the most variegated lengths of seams which are smaller than a predetermined maximum seal length to be made. When this maximum adjustable seam length in the preselection "100" at the preselecting keyboard **125** amounts, for example, to 680 millimeters, then a desired seam length "L" can be produced by setting to the preselection $x = L \times 100/680$.

At the end of the seam the control disk **55** has rotated through 360° and the flat rotating with it enters the slot initiator **121.** This initiator sets back the storage unit **118** by way of the reversing element **120.** Thereby the storage element or memory **109** is closed and the further impulses from the pole wheel **98** are faded out; the cam disk **55** remains in this end position. In addition the relay **123** opens the rest contacts **124** which renders the drive motor **3** devoid of current. The sewing machine stops and indicates to the seamstress the end of the operation.

The course of the work can, of course, be changed without changing the basic principles of the invention; thus for example an arrangement may be provided by means of which the direction of rotation of the stepping motor **57** and thereby of the control disk **55** can be reversed in order to enable the sewing of "right" or "left" arm lengths. Besides the starting and the end of the sewing operation can be controlled by means of photo cells in order to insure that the sewing machine runs only so long as there is material under the needle **91.**

We claim:

1. Sewing machine having differential feed means for maintaining surplus width of garment blanks and simultaneously fixing by a seam the surplus width maintained, where the difference of the amount of feed of the feed dogs is controlled by a rotating program carrier comprising a measuring wheel which scans the actual amount of material feed at the stitch forming location of the machine, said measuring wheel having at least one impulse emitter controlling a stepping motor, said program carrier being driven by said stepping motor.

2. Sewing machine in accordance with claim **1,** including an adjustable impulse counter between said impulse emitter and said stepping motor, said impulse counter being adapted to be set back, thereby imparting a forward switching impulse to said stepping motor.

3. Sewing machine in accordance with claim **2,** including a bi-stable storage unit, a second impulse emitter and a second impulse counter, said first impulse emitter being operative to release the counting functions of said first and said second impulse counters by way of said bi-stable storage unit, the counted inputs of said first and said second impulse emitters being connected with said second impulse emitter which is operative to produce impulses of very high constant frequency, and said second impulse counter being operative upon resetting to its starting position after having attained a predetermined position of count to stop the counting functions of both impulse counters by way of said storage unit.

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