May 14, 1968 WOLF-RUDIGER VON HAGEN 3,382,827

DIFFERENTIAL MATERIAL FEED REVERSIBLE IN THE FEED DIRECTION, WITH ONE ADJUSTING AGENT EACH FOR THE FEED LENGTH OF THE TWO MATERIAL FEEDERS

Filed Sept. 22, 1965 4 Sheets-Sheet 1

FIG. 1

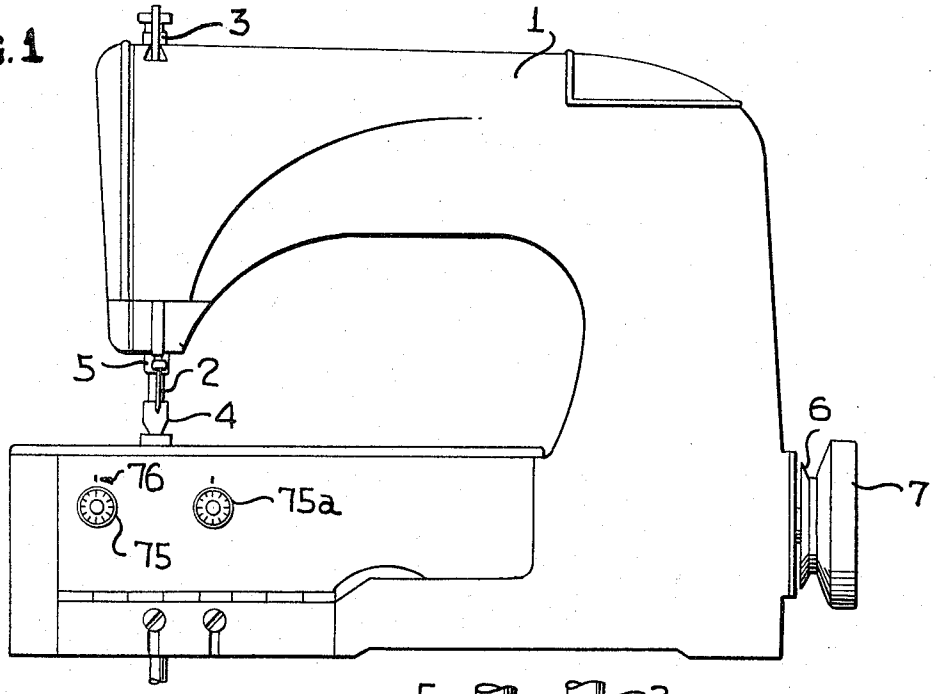
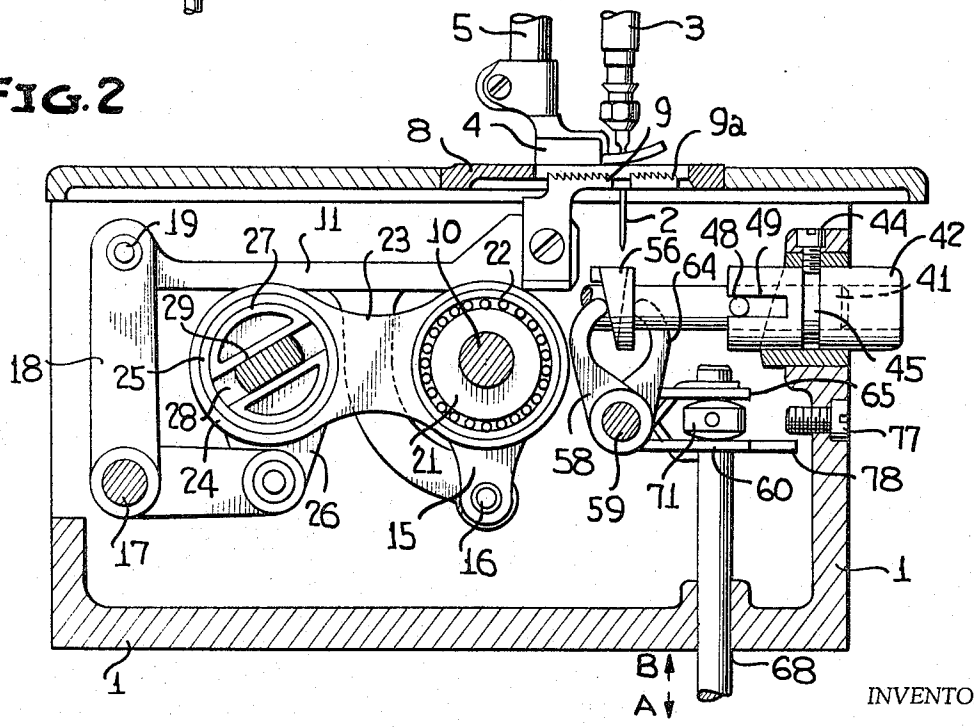


FIG. 2



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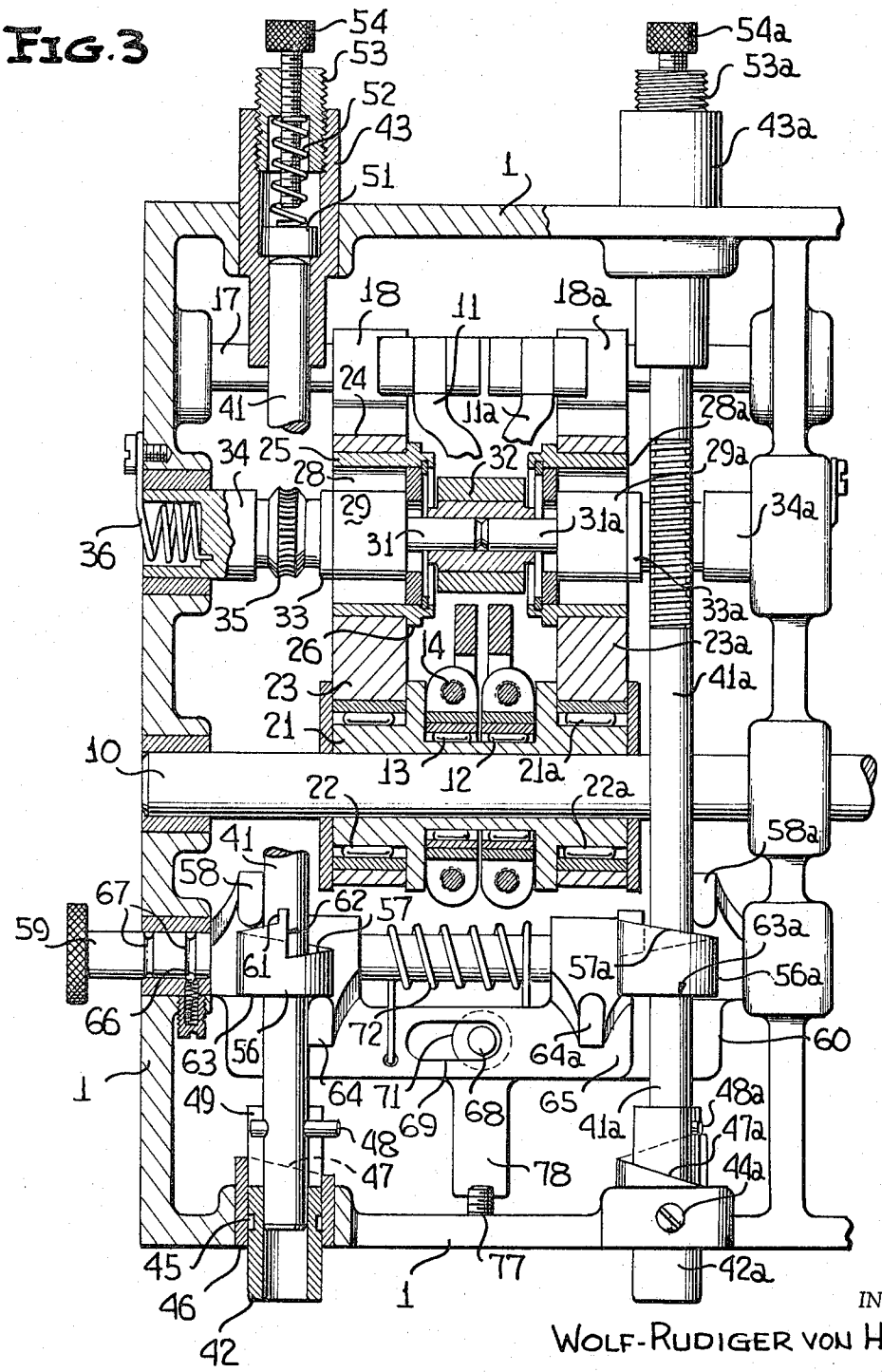
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FIG. 3



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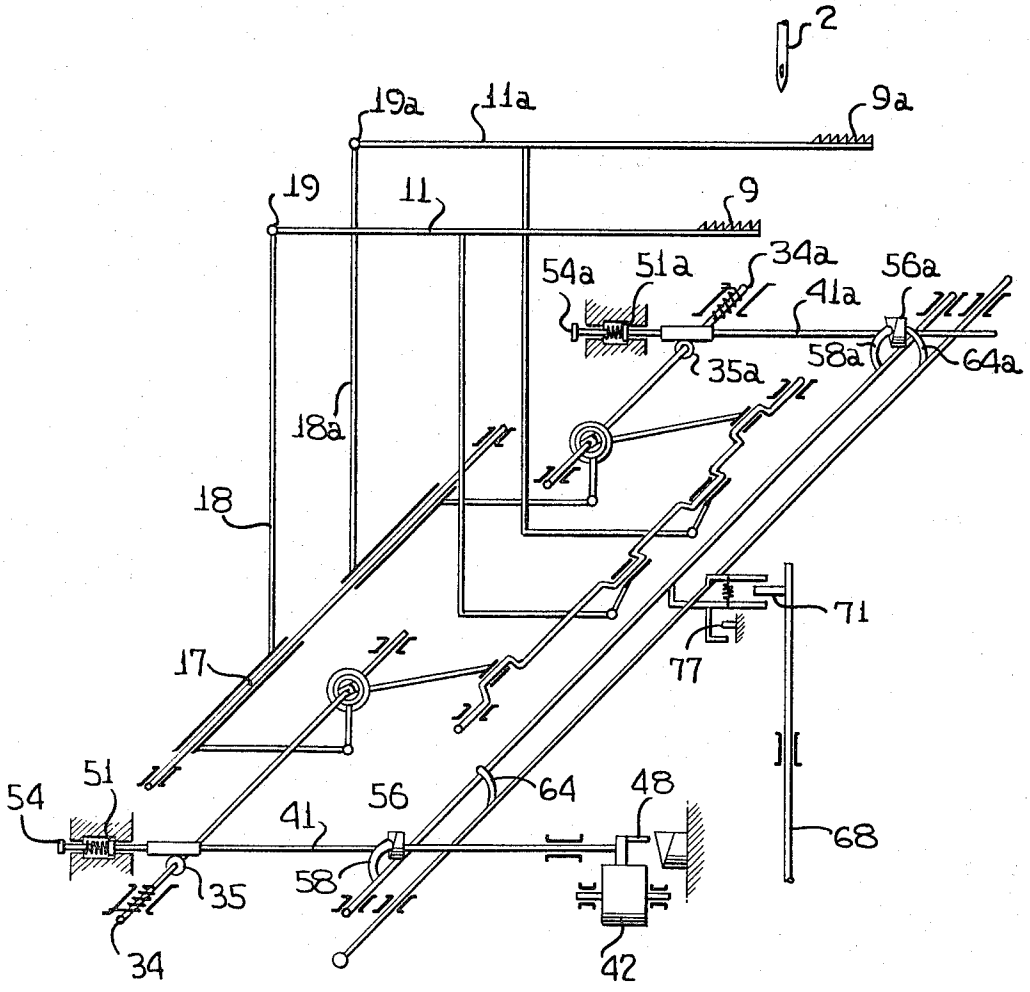
BY Mason, Porter, Miller & Brown
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DIFFERENTIAL MATERIAL FEED REVERSIBLE IN THE FEED DIRECTION, WITH ONE ADJUSTING AGENT EACH FOR THE FEED LENGTH OF THE TWO MATERIAL FEEDERS

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FIG. 4



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DIFFERENTIAL MATERIAL FEED REVERSIBLE IN THE FEED DIRECTION, WITH ONE ADJUSTING AGENT EACH FOR THE FEED LENGTH OF THE TWO MATERIAL FEEDERS

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FIG. 5

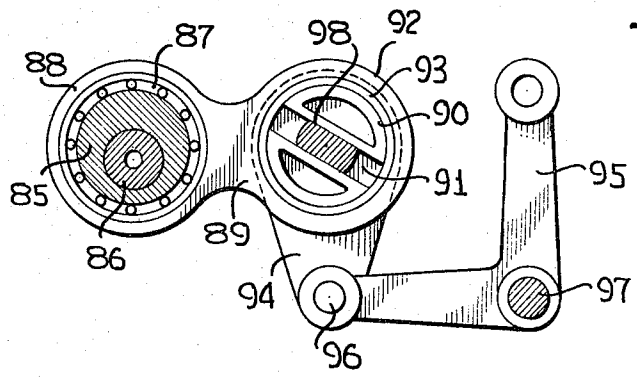


FIG. 6

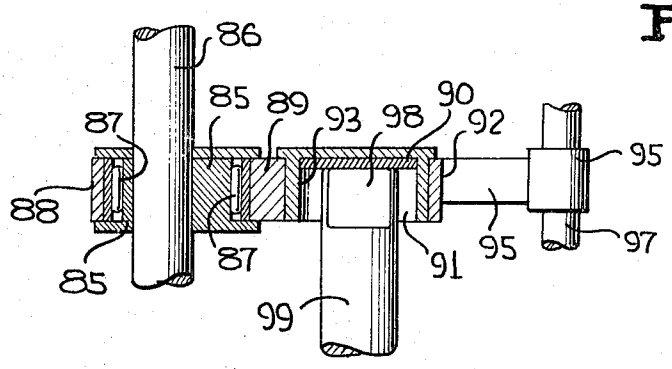
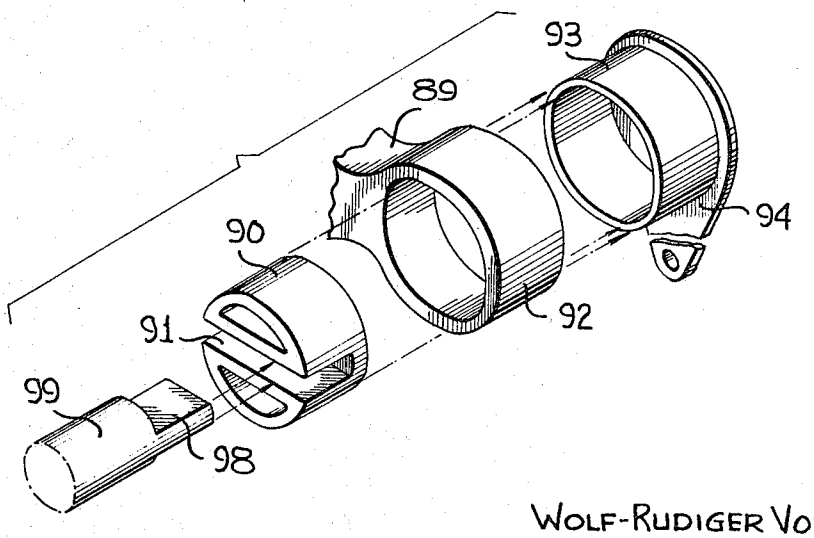


FIG. 7



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United States Patent Office 3,382,827 Patented May 14, 1968

3,382,827

DIFFERENTIAL MATERIAL FEED REVERSIBLE IN THE FEED DIRECTION, WITH ONE ADJUSTING AGENT EACH FOR THE FEED LENGTH OF THE TWO MATERIAL FEEDERS

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Filed Sept. 22, 1965, Ser. No. 489,136
Claims priority, application Germany, Sept. 24, 1964, U 11,052; Nov. 20, 1964, U 11,215
52 Claims. (Cl. 112—209)

ABSTRACT OF THE DISCLOSURE

This disclosure relates to differential feed provisions utilizable in a sewing machine employing feed dogs for feeding material past the stitching station of such sewing machine. Movement of the feed dogs is supplied from an eccentric driven pitman which is connected to the feed dogs via a phase variable and length of throw variable connection. Adjustment of the phase variable and length of throw variable connection is provided through rotatable and axially movable shafts having affixed thereto worm gears in engagement with worm wheels connected to the aforementioned connection. The shafts may be rotated to effect rotation of the worm wheel or axially moved to cause the worm gears to serve as racks in engagement with the worm wheels to reverse the phase or increase the length of feed.

The invention is concerned with a differential material feed reversible in the feed direction, said feed involving the use of two material feeders, with one adjusting agent for adjusting the feed length with respect to each of the two material feeders.

In feed arrangements of the character here under consideration, it is desirable that the feed length of the two material feeders be adjusted at different lengths in order to either stretch the material or to crimp it. Moreover, in such arrangements it is essential that the feeding length of the material feed that traverses the longer path can be increased from time to time, during sewing, and that the feed direction be reversible for the purpose of locking the seam, and whereby both material feeders may traverse an equally great feed path after reversal of the feed direction.

According to one proposal for such a material feed, the adjusting shafts for the two material feeders are coupled by spring means and can be changed in their positioning relative to one another through adjustable stops. The adjusting shafts are coupled one with the other in such a manner that in the case of adjustment of the feed length of one of the material feeders, the adjusting shaft for the other material feeder is carried along. In this proposal the reversal of the feed direction is accomplished through a reversing member which engages on one of the adjusting shafts and carries along the other adjusting shaft via the stops. Since in the case of this installation the coupling spring induces the stops always to join, the material feeders are not set to equally great feed lengths whenever the reversal of the movement takes place.

According to another proposal, one of the two adjusting shafts is equipped with a driver and the other with a stop. Here too, the two adjusting shafts are coupled in such a manner that the driver of one adjusting shaft carries along the other and the latter can then be set to a greater feed length through continued rotation and through lifting off of the stop. In this proposal the purpose of reversal of the feed direction, the adjusting shaft that can be set to the greater feed value is coupled with a reversing member which, upon being operated, will first set both adjusting shafts equally, will make the driver and the stop join, and then adjust both together.

In the last mentioned proposal the arrangement has the disadvantage that it cannot be reset, through regulation of the adjusting means alone, from a crimping effect to a stretching effect, because the reversal of the material feed can take place only via the adjusting shaft which has been set for the greatest material feed length. Since, however, in the case of crimping it is the front material feeder which must execute the greatest material feed length in the sewing direction and in the case of stretching it is in the rear feeder, there will in each case be a necessity for a different set of material feeders since only one of the material feeder bearers can be adjusted for the longer feed. The changing of the material feeders requires some assembly and adjusting work, and therefore, it is not possible to reset the machine quickly from "crimping" to "stretching."

The present invention has for a purpose to provide a differential feed arrangement which is reversible in the feed direction, and in which both a crimping as well as a stretching effect can be achieved, and this purpose can be achieved without rebuilding the machine.

In its more detailed nature the invention, in part, resides in providing an arrangement wherein each adjusting member is adjustable independently of the adjustment of the other adjusting member from zero to the greatest desired feed advance, and wherein there is provided a separate reversing means which can be coupled with both adjusting members for reversing the feed direction, said reversing means including drivers engageable against stops of the adjusting members in such a manner that in the case of operation of the reversing means a driver will carry along first the adjusting member which each time is set for the greatest length of advance until the second driver, upon synchronization of the adjusting agents, abuts against the stop of the other adjusting member.

By reason of the fact that according to the present invention each adjusting member is adjustable from zero to the greatest advance value independently of the adjustment of the other, and that for the reversal of the feed directions there has been provided a separate reversing member which can be coupled with both adjusting members, the amount of advance of one material feeder can be increased or decreased, as compared to the amount of advance of the other feeder, merely through an adjustment of the adjusting members, and at the same time upon reversing of the feed direction, both material feeders are synchronized, in order to then be placed together in the position in which the feed direction has been reversed.

As a particularly advantageous feature of this invention worm gear and screw shaft drives are employed as adjusting devices, and these become effective as screw shaft drives for the purpose of adjusting the feed length while, for the purpose of reversing the feed movement, the screw shafts act as toothed racks upon the associated worm gears.

The worm shafts carry curved cam areas which are opposed to the drivers, and the drivers are connected one with the other so as to be pointed in the same direction and in such a manner that they will both engage at like position on the curved cam areas. However, when the curved cam areas are placed at different positions, then, each time, a particular driver will engage against the associated curved area which has been set for the greatest feed length.

Each worm shaft also is equipped with a stop bolt which is engageable with a fixed stop surface. These stop surfaces have the increased or double pitch of the curved areas and the stop bolts abut in the zero position against the stop surfaces. In the case of an adjustment of a certain feed length, the stop surface associated each time moves back by double the amount relative to the stop bolt as compared to the travel of the driver which is carried along by the curved area associated with it. As a result, the feed length is set to the same length in the case of a reversed material advance while the worm shaft is shifted in an axial direction.

Further drivers, which can be brought to engage with one each of the worm shafts according to one's choice, permit a shifting of these drivers in an opposite axial direction. Through this shifting it is possible to enlarge from time to time, and during sewing, the path of the material feeder set for the longest advance. Adjustable stops will limit the shifting of the worm shaft.

The invention also comprehends a broad sub-combination concept in the form of a novel drive forming a part of the above mentioned combinations incorprated in sewing machines, or in other uses, said drive having for its purpose to produce a longitudinal movement variable in its magnitude and displaceable in phase by 180 degrees, said movement being produced by a crank mechanism with constant eccentricity using a connecting link guide which is adjustable in its angular position in relation to a couple, said connecting link guide consisting of a crank having thereon a slide guide block.

There are known drives which produce longitudinal movements displaceable in phase by 180 degrees and which are variable in their magnitude and can be produced by a rotating eccentric. However, all such drives hitherto known require relatively large spaces in installation.

One such known drive has employed a connecting link guide, but in it the connecting rod surrounding a driving eccentric was articulated with its driven end between the ends of a couple, one end of which is articulated to a sliding block and the other to a control handle or toggle lever, and the sliding block is guided in the crank of an adjusting shaft. This known drive also is not entirely satisfactory in that it requires a relatively large space in which it may be installed and it is also disadvantageous in that it is exceedingly difficult to produce the crank within the adjusting shaft.

To drive according to the present invention serves a main purpose of being so compact as to be subject to arrangement in the smallest possible space and yet be adaptable for the production of the desired longitudinal movement displaceable in phase in the direction by 180 degrees and variable in magnitude, there being included a crank drive with constant eccentricity, and a connecting link guide adjustable in the angular position in relation to a couple including a crank and slide guide block.

According to the present invention the problem of providing the desired compact part arrangement is solved by reason of the fact that the connecting link guide has been arranged in the bearing center or eye of the driven end of the connecting rod. Through this arrangement of the connecting link guide, the drive will require an exceedingly small space in installation. This space saving purpose is further achieved through the fact that the bearing center of the couple surrounds the connecting link guide and is mounted together with it in the bearing center of the driven end of the connecting rod.

An important feature of the invention resides in the fact that the connecting link guide consists of a cylindrical part having a crank extension, and in the provision of a sliding block extension on an adjustig shaft, and in the fact that the bearing center or eye of the couple surrounds the connecting link guide in cup-like form or in the shape of a pot.

With the above and other objects in view that will

hereinafter appear, the nature of the invention will be more clearly understood by reference to the following detailed description, the appended claims and the several views illustrated in the accompanying drawings.

In the drawings:

FIGURE 1 shows a sewing machine embodying the invention, the same being viewed from the front.

FIGURE 2 shows a vertical cross section taken through the bench of the machine shown in FIGURE 1.

FIGURE 3 shows a part plan and part horizontal sectional view taken generally on the line 3—3 on FIGURE 2.

FIGURE 4 is a somewhat schematic illustration of the driving mechanism viewed obliquely and from above.

FIGURE 5 is a side elevational view, parts being in cross section, showing the simplified subcombination form of drive.

FIGURE 6 is a horizontal sectional view of the parts shown in FIGURE 5.

FIGURE 7 is an exploded perspective view illustrating the driving end portion of the pitman, the bearing center with its couple or crank link extension, the slotted cylindrical element and the slide block equipped adjuster shaft.

The sewing machine structure herein disclosed as a preferred example embodiment of the invention has the usual housing generally designated **1** and in which is mounted the usual needle bar **3** carrying the needle **2** and a presser foot rod **5** carrying the usual presser foot **4**. Conventional stitch forming devices (not shown) are contemplated and are to be assumed as disposed to cooperate with the needle in the usual manner. The drive of the machine is to be understood as accomplished in the usual manner via a drive pulley **6** which is combined with a hand wheel **7**. The presser foot **4** operates in a conventional manner over a needle plate **8** and cooperates with the feed dogs or material feeders. There are two feed dogs or material feeders and they have been designated **9** and **9***a* respectively in the drawings. The associated driving elements and adjusting members operating and controlling operation of these elements have been correspondingly designated in part by reference numeral and exponent letter *a*, since these elements are the same essentially for the one or the other of the material feeders **9** and **9***a*. Therefore, for the sake of simplicity, in the subsequent description we shall refer consistently to the reference number only, without reference to the exponent letter. Since the elements in the operating and control devices for both material feeders in the present drive are essentially the same, the keeping of stocks is simplified in an advantageous manner and the cost of part production is materially cheapened.

The feed dogs or material feeders **9** are mounted as shown in FIGURE 2 on carriers **11** which receive an up-and-down movement imparted in the usual manner by a lifting eccentric means **21**, the same being arranged on the main shaft **10** of the machine. See FIGURES 2 and 3. Bearing eyes **14** of depending connecting arms **15** surround the lifting eccentric **21** and have therein needle bearing means **13** as shown in FIGURE 3, said connecting arms being pivotally connected at **16** with the feed dog carriers **11**.

Bell crank levers **18** are rockably mounted at **17** and are pivotally connected at **19** to the feed dog carriers **11**. The levers **18** serve in the usual manner for imparting the desired longitudinal movement to the feed dogs or material feeders **9**.

Motion is imparted to the levers **18** through the eccentrics **21** carried on the shaft **10** and each of which operates within needle bearing means **22** surrounded by one end of a pitman or connecting rod **23** whose other end carries in a bearing eye **24** the generally cup-shaped bushing **25** from which a driving control arm or crank link **26** depends. A bearing rotor **27** equipped with a centrally traversing slot **28** is rotatably supported in each of these

bushings and it will be apparent by reference to FIGURES 2 and 3 that a generally rectangular slide guide or block 29 projects into each of the slots 28. This compact back-to-back arrangement of the cup-like bushings 25, the encased bearing rotors 27 and the depending arms 26, will permit the housing of the driving mechanism in a very compact manner in the very limited space available in the usual sewing machine benches. See FIGURE 3. Each sliding guide extension or block 29 carries at its inner end a peg or trunnion 31 which is mounted in a fixed bearing 32 provided on the frame. On the outer sides the members from which the slide guide blocks 29 extend take the form of a collar 33, and a shaft portion 34 carrying a worm wheel portion 35, the outer end of the shaft portion being supported in the housing 1 as shown in FIGURE 3. The free outer end of each shaft 34 is hollow and accommodates a torsional return spring 36, as clearly illustrated at the left in FIGURE 3.

Each worm shaft 41 serves for the adjustment of the oblique positioning of the generally rectangular guide blocks or extensions 29, that is the angular relation thereof to a plane leading from the axis of the main shaft 10 through the axes of the shafts 34, as viewed in FIGURE 2. These worm shafts are mounted with one end slidable in and rotatable with a casing 42 serving as a handle or manual adjuster device, and with the other end slidable in a frame supported bushing 43. The shafts 41 are thus shiftable in an axial direction. The casings or adjusters 42 are held against axial shifting by means of a fixed screw 44 engaging in a casing groove 45. The screws 44 reach through frame supported bearing bushings 46 enclosing the casings 42, and each said bushing has a curved area or cam edge 47 presented inwardly of the housing and having twice the pitch of the worm portion of the associated worm shaft. A stop bolt or pin 48 is projected through each worm shaft 41 and corresponds to a certain point on its associated curved area or stop surface 47. Each said bolt protrudes on one side through a longitudinal slot 49 in the respective casing or adjuster handle. These stop bolts or pins 48 serve simultaneously as driving connections for imparting rotation to the worm shafts 41 upon turning the casings 42 and, in conjunction with said slot 49, as guide means allowing the shafts 41 to be shifted longitudinally and inhibiting rotation of the shafts relative to said casings 42.

The other end of each worm shaft 41 lies against an abutment 51. See FIGURE 3. The abutments 51 are longitudinally movable in frame supported bushings 43 wherein they are limited in movement by shoulder means provided in the bushings 43, as illustrated in FIGURE 3. The abutments 51 are held against the worm shafts 41 by spring means 52 supported in a cup-like part 53 threaded into the respective bushing 43. Each spring means 52 acts against the associated torsion spring 36 in the hollow end of the respective shaft 34 and has about twice the strength, thus to be dominant over said torsion spring means. A screw 54 is threaded into each part 53 and serves as an adjustable stop engageable by the respective abutment during the shifting of the same against the action of the associated spring 52.

Each worm shaft 41 has a cam collar 56 fixed thereon and which is equipped on its frontal or inner end with a curved area or cam surface 57 of the same pitch as the shaft worm portion. The drivers 58, which are mounted for swinging movement about the shaft 59, oppose the curved areas or cam surfaces 57 on the collars 56. The drivers 58 have the same angular position and are connected one with the other through a bridge 60 as shown in FIGURES 2 and 3. The ends of the curved camming surfaces 57 provide stops at 61, 62, against which the drivers 58 will engage in their end positions during the rotation of the worm shafts 41.

The outer ends or frontal surfaces 63 of the collars 56 facing away from the curved areas or cam surfaces 57 are opposed to the drivers 64. The drivers 64 are spaced apart a lesser distance than are the opposing surfaces 63 of the collars 56 associated with them, and they are attached to the shaft 59 and are connected one with the other through the bridge 65. The shaft 59 is shiftable in an axial direction, in order to place one or the other of the drivers 64 or 64*a* for engagement with a selected one of the end surfaces 63 or 63*a* of the collars 56. See FIGURE 3. A spring pressed detent ball 66 opposes the grooves 67 in the shaft 59 and holds the driver 64 firmly each time it is shifted to a selected, adjusted position. An actuator or connecting rod 68 is passed through a longitudinal slot provided in the bridges 60, 65, said rod being guided for longitudinal shifting movement in the machine housing 1 as clearly illustrated in FIGURE 2. The rod 68 is movable in opposite directions, as indicated at A–B, and is to be understood as connected with an operating element (not shown) of any suitable form, such as a foot pedal acting in two directions, as in the case of a rocker. The elongated slot 69 through which the rod 68 passes permits a shifting of the drivers 64 together with the shaft 59. An adjusting or actuator ring 71 is secured on the rod 68 between the two bridges 60, 65. In the starting position, the ring 71 on the rod 68 will abut against the bridge 65 as shown in FIGURE 2. A torsion spring 72 engages at each of its ends with one of the bridges 60, 65 and thus presses the drivers 58, 64 against their associated or opposing surfaces of the collars 56.

Operation—differential feed

For the adjusting of a certain feed path of the material feeders 9, the casings or adjusters 42 are twisted, or turned manually. In order to be able to read or visually determine the amount of adjustment, the ends of the casings 42 which protrude from the machine housing 1, and which serve as actuator handles, have been equipped with scales 75, 75*a* which move past indicator marks 76, as shown in FIGURE 1. The casings 42 can be turned the same amount, or in differing amounts. Through this turning of the casings 42, the connected or associated worm shafts 41 are turned and the associated slide guide or block extensions 29 are brought into the desired oblique positions by reason of the resulting rotation of the particular worm wheels 35. At the same time, it will be possible to give to the casing 42 or 42*a* a larger turn (twist) and thus to impart differing oblique positions to the slide guide or block extensions 29. When turning the main shaft 10, the eccentric 21 will shift the connecting rods 23 or pitmans back and forth in a plane traversing the axis of the shaft 34 bearing the worm wheel 35 and its slide guide extension or block 29. Thus, the bearing rotors 27 will be caused to move up and down a greater or lesser amount, depending on the degree of oblique or angular positioning of the slide guide blocks or generally rectangular extensions 29, and this up-and-down movement imparts a rocking movement to the associated bell crank lever 18 through the control arms 26. From this rocking movement, each material feeder 9 will be given a longitudinal movement by its particular carrier 11, and each carrier 11 will be moved up and down simultaneously by operation of the eccentric 12.

Through adjustment turning of the casings or sleeves 42, and thus of the worm shafts 41, for bringing about adjustment of the feed path, the collars 56 also are turned and the drivers 58 will be caused to ascend along the curved areas or cam surfaces 57. Simultaneously, the curved areas or cam surfaces 47 of the bearing bushings 46 will become spaced from the stop bolts or pins 48 by twice the amount by which the drivers 58 are moved by the curved areas 57. Since the drivers 58, 58*a* have the same angular position in relation to one another, in the case of a differing adjustment of the bushings or adjuster sleeves 42, only that driver 58, as shown in FIGURE 3, abuts against the associated curved area or cam surface 57, whose associated casing 42 had been adjusted to the greater feed value.

For reversal of the material feed arrangement, the rod 68 is moved in the direction of the arrow A in FIGURE 2 and it will carry along both drivers 58 and 58*a* by reason of the adjusting ring 71 engaging at the bridge 60. As a result of this, as viewed in FIGURE 3, the worm shaft 41 is shifted axially by movement of the driver 58 until the connected driver 58*a* comes to rest against the curved area or cam surface 57*a*. In this axial shift, the worm shaft 41 first acts as a toothed rack upon the associated worm wheel 35 engaged by the shaft worm, as a result of which the sliding block 29 is turned back from its oblique position shown in FIGURE 2, in direction of the zero position in which it remains in angular position identical to that of the sliding block 29*a*, within said slide guide connection 28. In this position of the parts the driver 58*a*, now will rest against the curved area or cam surface 57*a*, as a result of which both worm shafts 41 and 41*a* are shifted together axially and act as toothed racks in moving the worm wheels 35 and 35*a* and through them both sliding blocks 29 beyond their zero position into inverted or reversed oblique positions. The stop bolts or pins 48 and 48*a* will follow this axial shift until they abut the corresponding curves 47 and 47*a* on the bushings 46 and 46*a*. In the case of the adjusted and differing feed length of the material feeders, corresponding to FIGURE 3, however, only the stop bolt 48*a* comes to rest against the curved area 47*a*, since the stop bolt 48*a* in the previous adjustment of the feed length had been turned by the lesser amount, therefore having the lesser spacing from that point of the curved area 47*a* which is at this time directly opposed to it. Since the material feeder which in each case is adjusted to the smallest feed length will determine the length of the stitch, one will thus, upon reversal of the feed arrangement as aforesaid, achieve the same length of stitch, since, in the manner stated, both material feeders are switched over to the smallest adjusted feed value. After a releasing of the actuater 68, the springs 36 and 36*a* will put the worm shafts 41 and 41*a* again back into their starting positions in which they are pressed against the counterbearings or abutments 51 and 51*a*.

In order to additionally enlarge the path of the material feeder adjusted to the greater feed value, for any selected period or periods of time during sewing, the associated stop 54 is adjusted to the desired greater value. Also, through shifting of the shaft 59, the associated driver 64 is brought into position against the surface 63. The switching in of the intermittently larger length of the feed takes place again via the rod 68, which however is now shifted in the direction of the arrow B in FIGURE 2. As a result, the driver 64 is swung horizontally by movement of the adjusting ring 71 via the bridge 65 and shifts the worm shaft 41, together with the counterbearing or abutment 51, and against the force of the spring 52, until said counterbearing comes to abut against the stop screw 54. At the same time, the worm shaft 41 again acts as a toothed rack upon the meshing worm wheel 35 and the slide block or shaft extension 29 is brought into a more oblique position. This axial shifting of the worm shaft 41 is supported by the spring 36, and thus in the shifting of the worm shaft 41 in the direction stated, only half the force of the spring 52 must be overcome. After a releasing of the rod 68, the spring 52 and abutment 51 again will push the worm shaft 41 back into the adjusted starting position, whereby it naturally follows that the slide block 29 is again brought back into the position set through turning of the casing 42, by reason of the racklike action of the shaft worm on the meshing worm wheel 35.

If instead of the material feeder 9, the material feeder 9*a* executes the greater feed path, that is if the material during sewing instead of being stretched is to be crimped and from time to time an even greater additional width is to be gathered, then the greater feed length has been set along the casing or adjuster sleeve 42*a* and the driver 64*a* is brought into position against the surface 63*a* through shifting of the shaft 59. The intermittent switching on of the larger feed path takes place in the same manner through operation of the rod 68 in the direction of the arrow B.

Since the worm shafts 41 and 41*a* may be shifted independently of the advance values set along the casings 42 against the stops 54, the advance values are added. If one sets along the casings 42 a relatively large feed path and inadvertently the stops have been adjusted in such a manner that there is also possible a relatively large axial shifting of the shafts 41 and 41*a*, the sliding blocks 29 could be rotated unduly far through shifting of the shafts 41 and 41*a*. In order to prevent this, a stop screw 77 has been provided, and the arm 78 of the bridge 60 will engage the stop screw 77 and prevent the undesired additional shifting movement of said shafts. If one of the curved areas 57, 57*a* cooperating with the drivers 58, 58*a* is in that position in which the largest advance value has been set, then that particular driver 58 will be swung so far around the shaft 59 that the arm 78 of the bridge 60 will come to rest against the stop screw 77. Insofar as the adjusted feed value is smaller than the greatest possible value, the arm 78 will be at the corresponding distance from the stop 77. Since, however, the drivers 58, 58*a* and 64, 64*a* via the collars 56, 56*a* of the shafts 41, 41*a* and the spring 72 are all braced against one another, in the case of operation of the rod 68 in the direction of the arrow B, all these will be swung together. As a result, the arm 78 will again rest against the stop 77 and will permit a shifting of the shaft 41 or 41*a* against the force of the spring 52 or 52*a* only by an amount corresponding to the value between the advance length set and the greatest possible advance length.

In the simplified or subcombination drive showing in FIGURES 5 and 6 an ecentric 85 is shown as secured in any approved manner on a driving shaft 86, which eccentric is enclosed within an antifriction bearing 87 in turn mounted in the bearing center or bearing 88 of a connecting rod or link 89.

In this simplest and compact embodiment of the invention, a cylindrical element 90 having a slide guide or crank slot therein is mounted in the bearing eye 92 of the driven end of the connecting rod 89. The cup-like bearing center 93 of a couple or crank link 94, developed somewhat in the shape of a pot, is located between the cylindrical element 90 and the bearing center 92 of the connecting rod 89, said bearing center 93 forming a hinge joint, with the cylindrical element 90 as well as with the bearing eye 92. A bell crank lever 95 for transmitting motion to a part to be driven is pivotally connected at 96 to the couple 94 and is swingable about a fixed point of support at 97. A slide block 98 projects into the guide or crank 91 and protrudes at the front side from a shaft 99.

Through turning of the adjusting shaft 99, the crank slot 91 can be brought into varying angular positions on both sides of the connecting line between the axis of the shaft 86 and the axis of the shaft 99. If the crank slot is aligned with said connecting line, then the cylindrical part 90 will move only in the direction of said line and the couple 94 will pivot at the same time essentially about the articulating point or pivotal connection 96 between the couple 94 and the bell crank lever 95. The cylindrical part 90, therefore, will not execute a movement in the direction of the articulating point 96. In the position as shown in FIGURE 5, the elements 92, 90 and 93 will execute a reciprocating movement with movement of the crank slot 91 along the slide block 98 in the direction of the articulating point 96, and will impart a swinging movement to the bell crank 95 about its center 97. This movement will change in magnitude in response to changes in the angular position of the crank slot 91, or of the slide block 98 with relation to a line struck between the axis of the shaft 86 and the axis of the shaft 99. Through turning of the shaft 99 and changing the position of the slide block 98 in the

angular position to the other side of said line, the reciprocating movement imparted through the couple **94** to the bell crank lever **95** will be displaced in phase by 180 degrees.

The bell crank lever **95** as shown, is to be considered merely one design by way of example for passing on of the reciprocal movement produced by the couple **94**. Naturally, the couple **94** could also be connected with some other gear train, for example, a connecting rod which can be articulated to the articulating point **96**. Also, it is within the ambit of the present invention, to provide in a kinematic reversal, the adjusting shaft **99** with a crank, and the cylindrical part **90** with a sliding block.

It will be readily apparent by reference to FIGURE 6 how compact the drive connections are and how they lend themselves to incorporation in very restricted spaces such as the sewing machine base incorporation illustrated in FIGURE 2 wherein two of the drives are disposed in close side-by-side or back-to-back relation. In this very compact sewing machine embodiment of FIGURE 2 the rotor or block in which the guide slot is formed must be perforated to provide for extension of the shaft end portions **31–31***a* and central bearing therefor, but in the last described simplified subcombination drive of FIGURES 5 and 6 the cup-like member **93** and the guide slotted element **90** need not be centrally perforated.

While preferred part structures and arrangements have been disclosed herein they are to be considered exemplary and variations may be made without departing from the spirit and scope of the invention as defined in the appended claims.

I claim:

1. In a sewing machine the combination of two material feed dogs carried on closely paralleling and generally horizontally and longitudinally disposed feed dog carriers, and two independently controllable sets of drive and control devices effective to impart motion to the feed dogs differentially and in direction changeable by a phase displacement of 180°, each said set of devices comprising drive shaft means (**10**), a movement imparting pitman (**23**) having at one end a bearing eye connection about an eccentric (**21**) and a bearing center (**24**) at its other end, a first cylindrical member (**25**) rotatably mounted in said bearing center (**24**) and having a crank link (**26**) extending therefrom, a second cylindrical member (**27**) rotatably mounted in the first cylindrical member (**25**) and having a guide slot (**28**) traversing said second cylindrical member centrally, pivotally mounted bell crank means (**17, 18**) connected with said crank link (**26**), and guide slot engaging means operable to adjust the position of the second cylindrical member (**27, 28**) to selectively place its slot (**28**) along a line struck through the centers of said bearing eye and the bearing center (**24**) of the pitman (**23**) and in a selected angular relation to said line thereby to selectively bring about selected degrees of said 180° phase displacement.

2. The sewing machine structure combination as defined in claim **1** wherein in each set of the drive and control devices the particular eccentric, pitman, cylindrical members, crank link extension and bell crank lie substantially in coplanar relation and at one side of and in close proximity to a plane occupied at least in part by the feed dog carriers and generally paralleling the direction of movement of said feed dog carriers.

3. The sewing machine structure combination defined in claim **1** wherein the eccentrics (**21**) are carried on a common support rotor fixed on the drive shaft (**10**).

4. The sewing machine structure combination as defined in claim **1** wherein the guide slot engaging means in each set of said devices comprises a generally rectangular sectioned slide guide block extension from an adjustment shaft, and further including means for independently adjusting the adjustment shafts about their axes.

5. The sewing machine structure combination as defined in claim **1** wherein the guide slot engaging means in each set of said devices comprises a generally rectangular sectioned slide guide block extension from an adjustment shaft, and further including means for independently adjusting the adjustment shafts about their axes, said last named means comprising a worm wheel secured on each adjustment shaft and two independently operable worm shafts each having a worm portion meshed with one of the worm wheels and rotatable to adjust the particular adjustment shaft in worm couple fashion and axially movable in one direction and the other to adjust the particular adjustment shaft through rack-like cooperation of its worm portion with the worm wheel with which it is enmeshed.

6. In a sewing machine the combination of two material feed dogs carried on closely paralleling and generally horizontally and longitudinally disposed feed dog carriers, and two independently controllable sets of drive and control devices effective to impart motion to the feed dogs differentially and in direction changeable by a phase displacement of 180°, each said set of devices comprising drive shaft means (**10**), a movement imparting pitman (**23**) having at one end a bearing eye connection about an eccentric (**21**) and a bearing center (**24**) at its other end, a first cylindrical member (**25**) rotatably mounted in said bearing center (**24**) and having a crank link (**26**) extending therefrom, a second cylindrical member (**27**) rotatably mounted in the first cylindrical member (**25**) and having a guide slot (**28**) traversing said second cylindrical member centrally, pivotally mounted bell crank means (**17, 18**) connected with said crank link (**26**), and guide slot engaging means operable to adjust the position of the second cylindrical member (**27, 28**) to selectively place its slot (**28**) along a line struck through the centers of said bearing eye and the bearing center (**24**) of the pitman (**23**) and in a selected angular relation to said line thereby to selectively bring about selected degrees of said 180° phase displacement, and wherein the guide slot engaging means in each set of said devices comprises an adjustment shaft and a generally rectangular sectioned slide guide block extension of said adjustment shaft, and further including means for independently adjusting the adjustment shafts about their axes.

7. Sewing machine structure as defined in claim **6** wherein each guide slotted cylindrical member includes a central aperture, each adjustment shaft having a trunnion extension passing through one of said central apertures and journalled in a common centrally disposed bearing.

8. In a sewing machine the combination of two material feed dogs carried on closely paralleling and generally horizontally and longitudinally disposed feed dog carriers, and two independently controllable sets of drive and control devices effective to impart motion to the feed dogs differentially and in direction changeable by a phase displacement of 180°, each said set of devices comprising drive shaft means (**10**), a movement imparting pitman (**23**) having at one end a bearing eye connection about an eccentric (**21**) and a bearing center (**24**) at its other end, a first cylindrical member (**25**) rotatably mounted in said bearing center (**24**) and having a crank link (**26**) extending therefrom, a second cylindrical member (**27**) rotatably mounted in the first cylindrical member (**25**) and having a guide slot (**28**) traversing said second cylindrical member centrally, pivotally mounted bell crank means (**17, 18**) connected with said crank link (**26**), and guide slot engaging means operable to adjust the position of the second cylindrical member (**27, 28**) to selectively place its slot (**28**) along a line struck through the centers of said bearing eye and the bearing center (**24**) of the pitman (**23**) and in a selected angular relation to said line thereby to selectively bring about selected degrees of said 180° phase displacement, and wherein the guide slot engaging means in each set of

said devices comprises an adjustment shaft and a generally rectangular sectioned slide guide block extension of said adjustment shaft, and further including means for independently adjusting the adjustment shafts about their axes, said last named means comprising a worm wheel secured on each adjustment shaft and two independently operable worm shafts each having a worm portion meshed with one of the worm wheels and rotatable to adjust the particular adjustment shaft in worm couple fashion or axially movable in one direction or the other to adjust the particular adjustment shaft through rack-like cooperation of its worm portion with the worm wheel with which it is enmeshed.

9. Sewing machine structure combination as defined in claim 8 wherein there is fixed on each said worm shaft an adjuster sleeve disposed for convenient manual actuation and having indicating indicia thereon cooperable with indicating indicia on a frame portion for visually indicating the adjusted positions of the worm shafts.

10. Sewing machine structure as defined in claim 8 wherein each worm shaft has affixed thereon a cam collar (56) presenting two endwise directed faces (57, 63) the one (57) of which is interrupted heliform in shape presenting stop surfaces (61, 62), and further including a cross shaft (59) whereon two bridges (60, 65) are rockably mounted for rocking movement independently and together, spring means constantly tending to hold the bridges together, actuator rod and ring means with the ring means disposed between the bridges, driver members carried by one bridge for engaging the collars at one end, and driver members carried by the other bridge for engaging the collars at the opposite end, said driven members (58) being in constantly spaced relation and being disposed for engagement with said stops (61, 62) at rotational limits of the shafts (41), whereby swinging movement of the bridges about the center of the cross shaft (59) serves to impart longitudinal movement to the worm shafts (41) when the carried driver members are caused actively to engage one or both collars (56).

11. Sewing machine structure as defined in claim 10 wherein the drivers on one of the bridges (65) are spaced apart a distance less than the spacing between the collars (56) and said one of the bridges (65) being shiftable with the cross shaft (59) to present one or the other of the drivers (64) for engagement with an end surface (63) of a collar (56).

12. Sewing machine structure as defined in claim 10 wherein the heliform faces on the collars (56) have the pitch of the worms on the worm shafts (41).

13. Sewing machine structure as defined in claim 10 wherein the heliform faces on the collars (56) have the pitch of the worms on the worm shafts (41), and wherein machine frame portions fixedly support sleeves having heliform stop surfaces (47) of twice the pitch of said heliform faces (57) for engagement by stop pins (48) projecting as drive couples through the worm shafts (41) and longitudinal slots (49) provided in casings manually rotatable and held captive in the bearing bushings (46), said pins (48) projecting over said heliform stop surfaces (47) in position for engagement therewith.

14. In a sewing machine the combination of two material feed dogs carried on closely paralleling and generally horizontally and longitudinally disposed feed dog carriers, and two independently controllable sets of drive and control devices effective to impart motion to the feed dogs differentially and in direction changeable by a phase displacement of 180°, each said set of devices comprising drive shaft means (10), a movement imparting pitman (23) having at one end a bearing eye connection about an eccentric (21) and a bearing center (24) at its other end, a first cylindrical member (25) rotatably mounted in said bearing center (24) and having a crank link (26) extending therefrom, a second cylindrical member (27) rotatably mounted in the first cylindrical member (25) and having a guide slot (28) traversing said second cylindrical member centrally, pivotally mounted bell crank means (17, 18) connected with said crank link (26), and guide slot engaging means operable to adjust the position of the slotted cylindrical member (27, 28) to selectively place its slot (28) along a line struck through the centers of said bearing eye and the bearing center (24) of the pitman (23) and in a selected angular relation to said line thereby to selectively bring about selected degrees of said 180° phase displacement, and wherein the guide slot engaging means in each set of said devices comprises an adjustment shaft and a generally rectangular sectioned slide guide block extension of said adjustment shaft, and further including means for independently adjusting the adjustment shafts about their axes, said last named means comprising a worm wheel secured on each adjustment shaft and two independently operable worm shafts each having a worm portion meshed with one of the worm wheels and rotatable to adjust the particular adjustment shaft in worm couple fashion and axially movable in one direction and the other to adjust the particular adjustment shaft through rack-like cooperation of its worm portion with the worm wheel with which it is enmeshed, and spring biased abutment devices engageable by the worm shafts in movement in one direction and spring means active through the worm wheels to constantly tend to move said worm shaft in an opposite return direction, said spring biased abutment means having dominance over said last mentioned spring means.

15. The sewing machine structure combination of claim 14 wherein further including adjustable fixed stops for limiting movement of said abutment devices.

16. Sewing machine structure combination as defined in claim 14 wherein the spring means acting through the worm wheels comprise torsion springs housed in hollowed end portions of the adjustment shafts.

17. In a sewing machine, drive means for imparting longitudinal movement of variable magnitude and phase to a feed device, said drive means comprising crank means for imparting said longitudinal movement to said feed device, pitman drive means eccentrically connected with a drive shaft, guide slot connection means including a guide slot member having a slot disposed therein and guide slot engaging means disposed within said slot, said pitman drive means including a pitman having a bearing eye at one end thereof opposite the eccentric connection thereof with said drive shaft, said guide slot connection means being positioned within said bearing eye and connecting said crank means and said pitman drive means.

18. Drive means as defined in claim 17 wherein said crank means comprises a crank link, said crank link having a cylindrical bearing center encompassing said guide slot connection means, said cylindrical bearing center being journaled in said bearing eye.

19. Drive means as defined in claim 18 wherein said guide slot connection means further comprises an adjustable shaft, said guide slot member comprising a cylindrical member, and said guide slot engaging means comprising a generally rectangularly sectioned extension of said adjustment shaft.

20. Drive means as defined in claim 18 wherein said bearing center of said crank link includes a cup-like portion encompassing said guide slot connection means.

21. Drive means as defined in claim 18 wherein said bearing center of said crank link includes a cup-like portion encompassing said guide slot connection means, said guide slot connection means further comprising an adjustment shaft, said guide slot member comprising a cylindrical member, and said guide slot engaging means comprising a generally rectangularly sectioned extension of said adjustment shaft.

22. Drive means as defined in claim 21 wherein said cylindrical member is of unapertured cup-like configuration.

23. Drive means as defined in claim 21 including means

for adjusting said adjustment shaft about the axis thereof, said cylindrical member having an aperture formed therein, said adjustment shaft including a trunnion extension extending through said aperture and bearing means engaging said trunnion extension.

24. Drive means as defined in claim 17 wherein said guide slot means further comprises an adjustment shaft, said guide slot member comprising a cylindrical member and said guide slot engaging means comprising a generally rectangularly sectioned extension of said adjustment shaft.

25. Drive means as defined in claim 24 including means for adjusting said adjustment shaft about the axis thereof.

26. In a sewing machine, drive means for imparting longitudinal movement variable in magnitude and variable through 180° of phase displacement to a feed device, said drive means comprising a drive shaft, an eccentric on said shaft, movement imparting pitman means having at one end a bearing connection about said eccentric, and said pitman means having a bearing center at the other end thereof, a first cylindrical member rotatably mounted in said bearing center and having a crank link extending outwardly therefrom, a second cylindrical member rotatably mounted in said first cylindrical member and having a guide slot formed therein and traversing said second cylindrical member centrally, pivotally mounted bell crank means connected with said crank link for driving said feed device, and guide slot engaging means within said guide slot for adjusting the position of said second cylindrical member to selectively place the slot therein along a line struck through the centers of said bearing eye and said bearing center of said pitman and in a selected angular relation to said line, whereby adjustment of the position of the slotted member effects selected degrees of phase displacement of the movement imparted to the feed device.

27. Drive means according to claim 26 wherein said eccentric, pitman means, first and second cylindrical members, crank link extension and bell crank means lie in generally coplanar relation.

28. Drive means according to claim 26 wherein all of said eccentric, pitman means, first and second cylindrical members, crank link extension and bell crank means lie in generally coplanar relation, and further comprising an adjustment shaft, said guide slot engaging means comprising a generally rectangularly sectioned extension of said adjustment shaft, and means for adjusting said adjustment shaft about its axis.

29. Drive means according to claim 26 wherein said eccentric, pitman means, first and second cylindrical members, crank link extension and bell crank means lie in generally coplanar relation, and further comprising an adjustment shaft, said guide slot engaging means comprising a generally rectangularly sectioned extension of said adjustment shaft, and means for adjusting said adjustment shaft about the axis thereof, said means for adjusting comprising a worm wheel secured on said adjustment shaft and a worm shaft having a worm portion affixed thereto and meshed with said worm wheel and rotatably to adjust said adjustment shaft through said worm wheel, said adjustment shaft being axially movably mounted for axial movement in one direction or the other to adjust said adjustment shaft through rack-like cooperation of said worm portion with said worm wheel.

30. Drive means according to claim 26 wherein said eccentric, pitman means, first and second cylindrical members, crank link extension and bell crank means lie in generally coplanar relation, and further comprising an adjustment shaft, said guide slot engaging means comprising a generally rectangularly sectioned extension of said adjustment shaft, a feed dog carrier disposed in generally horizontal position and pivotally connected with said bell crank and said crank link extension for movement therewith and means for adjusting said adjustment shaft about the axis thereof.

31. A reversible differential material feed comprising first and second material feeder means, first and second adjusting means for adjusting the length of advance of said first and second material feeder means respectively, and reversing means for reversing the feed direction of said first and second feeder means, said reversing means including driver means in driving relation with at least one of said first and second adjustment means for substantially equalizing the length of advance of said first and second feeder means and for driving said adjustment means to a feed reversing position.

32. A material feed according to claim 31 wherein said driver means include first and second drivers, said first and second adjustment means comprising first and second driver engaging means engageable by said first and second drivers for aligning and moving said adjustment means.

33. A material feed according to claim 32 wherein said driver means comprises further drivers movable into driving relation with one of said first and second adjusting means for driving one of said first and second adjusting means to a feed increase position.

34. A material feed according to claim 31 wherein said adjustment means each comprises an axially shiftable and rotatable worm shaft having a worm gear disposed thereon, a worm wheel engaging said worm gear, and means coupling said worm wheel to said feeder means for varying the length of advance in response to rotation thereof, said driver means being movable into driving relation with said worm shafts for axial movement of said worm shafts and worm gears, whereby said worm gears move in rack-like cooperation with said worm wheels to effect limited rotation thereof.

35. A material feed according to claim 34 wherein said worm shafts include collars thereon having helical faces corresponding to the pitch of said worm gears for contacting said driver means.

36. A material feed according to claim 35 wherein said driver means include first and second drivers fixed in their position in relation to one another, and contactable substantially simultaneously with said helical faces when said shafts are equally angularly adjusted.

37. A material feed according to claim 36 wherein said helical faces have stops thereon at the beginning and end thereof for contacting said drivers and limiting angular movement of said shafts.

38. A material feed according to claim 37 wherein each of said worm shafts has affixed thereto a stop bolt, said feed further comprising helical stop surfaces aligned with said stop bolts and lying in the path of movement thereof for limiting axial movement of said worm shaft, said helical stop surfaces having twice the pitch of said helical faces on said collars.

39. A material feed according to claim 38 wherein said adjustment means include rotatable adjusting casings having a slot formed therein, said stop bolts being situated in said slots for imparting rotational movement of said casings to said worm shafts, and said worm shafts extending axially movably into said casings for movement relative thereto.

40. A material feed according to claim 34 further comprising biasing springs and counter-bearing means between said biasing springs and said worm shafts for biasing said shafts in the direction of movement of said shafts by said driver means corresponding to feed reversal and return spring means for biasing said shafts in opposition to said biasing springs.

41. A material feed according to claim 40 wherein said return spring means biases said worm shafts through the engagement of said worm gears with said worm wheels.

42. A material feed according to claim 40 further in-

cluding a pair of fixed stops, said counter-bearings being biased against said fixed stops by said biasing springs and wherein said return springs bias said worm shafts against said counter-bearings in opposition to the biasing of said biasing springs.

43. A material feed according to claim 40 further comprising adjustable stops aligned with said counter-bearings, said counter-bearings being movable into engagement with said adjustable stops in response to movement of said worm shafts in opposition to said biasing springs.

44. A material feed according to claim 34 including a driver mounting shaft, said driver means comprising further drivers, all of said drivers being rotatably mounted upon said shaft for rotation into and out of driving relation with shafts for driving one of said first and second adjusting means to a feed increase position.

45. A material feed according to claim 44 wherein said mounting shaft is shiftably mounted and said further drivers are mounted upon said shaft for shifting movement therewith, said further drivers being movable into and out of driving relation with said first and second worm shafts in response to axial movement of said mounting shaft.

46. A material feed according to claim 44 wherein each of said worm shafts has mounted thereon a collar having endwise directed surfaces for abutment by said drivers.

47. A material feed according to claim 46 wherein said first and second drivers are engageable with corresponding surfaces of said collars, said first and second drivers being interconnected by a bridge member, said further drivers being engageable with the remaining surfaces of said collars and being interconnected through a further bridge member, whereby said first and second drivers are rotatable in unison and said further drivers are similarly rotatable.

48. A material feed according to claim 47 further comprising an operating rod in operative engagement with said bridges for rotatably moving said drivers, said operating rod including an adjusting ring located between said bridges.

49. A material feed according to claim 48 wherein said adjusting ring is in abutting relationship with at least one of said bridges for movement thereof to effect shifting of at least one of said worm shafts.

50. A material feed according to claim 48 wherein a stop member is provided in the path of movement of at least one of said bridges for limiting the rotational movement thereof.

51. A material feed according to claim 34 wherein each of said worm wheels is mounted upon an adjusting shaft, said adjusting shaft having thereon a slide guide block, said material feeder means including adjustable connection means for connecting said material feeder means to a movement imparting means, said adjustable connecting means being in engagement with said slide guide block for altering the length and phase of movement of said feed means in response to variations in the position of said slide guide block.

52. A material feed arrangement according to claim 51 wherein said adjustable connecting means includes a connecting rod having one end adapted for connection to the movement imparting means and having a bearing eye disposed at the other end thereof and a slotted guide member disposed within said bearing eye, said slide guide block being positioned within said slotted guide member for altering the angular position thereof in response to rotation of said worm wheel.

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