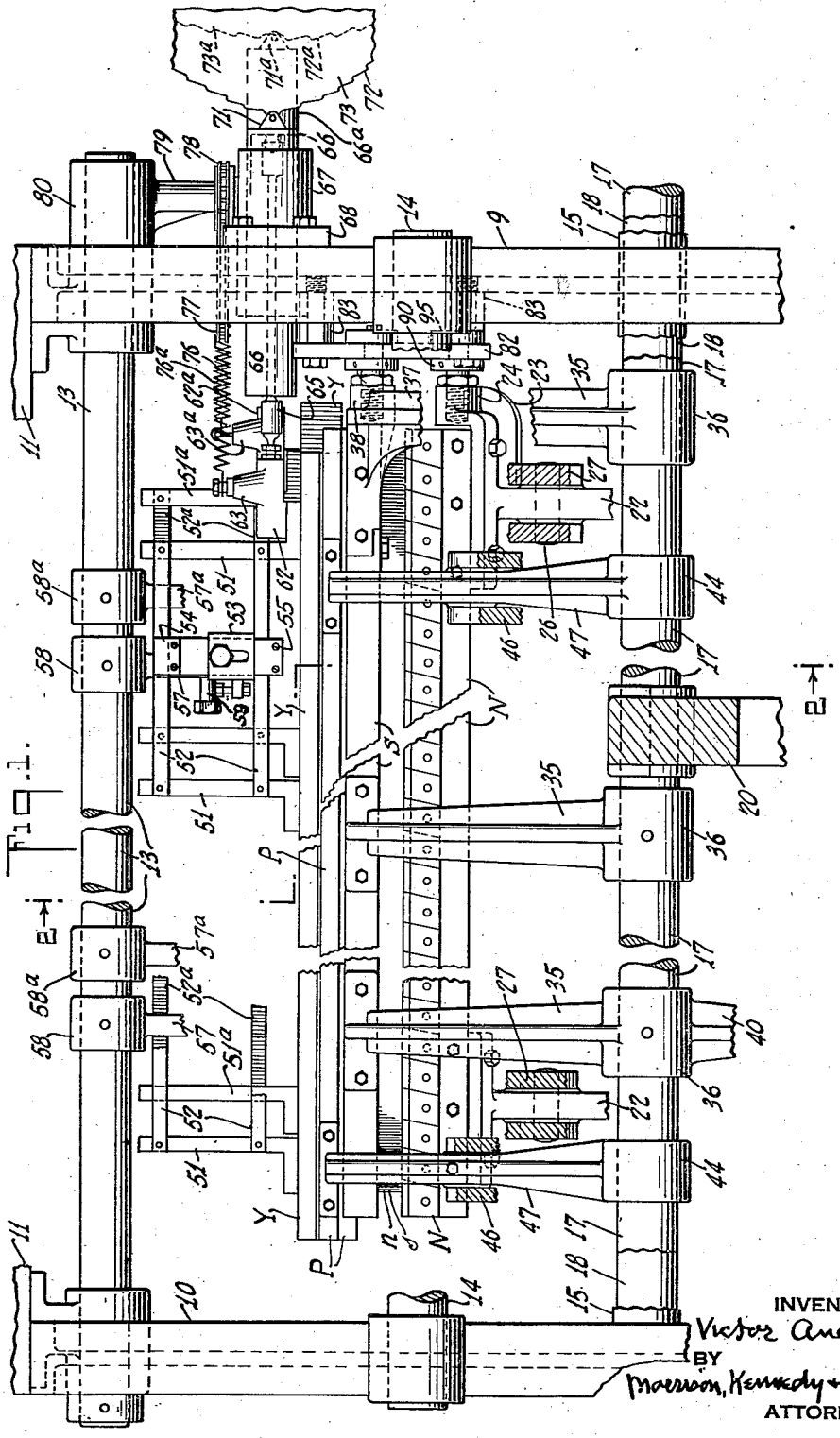
Feb. 17, 1942. V. ANDERSON 2,273,246

STRAIGHT-TYPE WARP-KNITTING MACHINE

Filed Jan. 9, 1941 3 Sheets-Sheet 1



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STRAIGHT-TYPE WARP-KNITTING MACHINE

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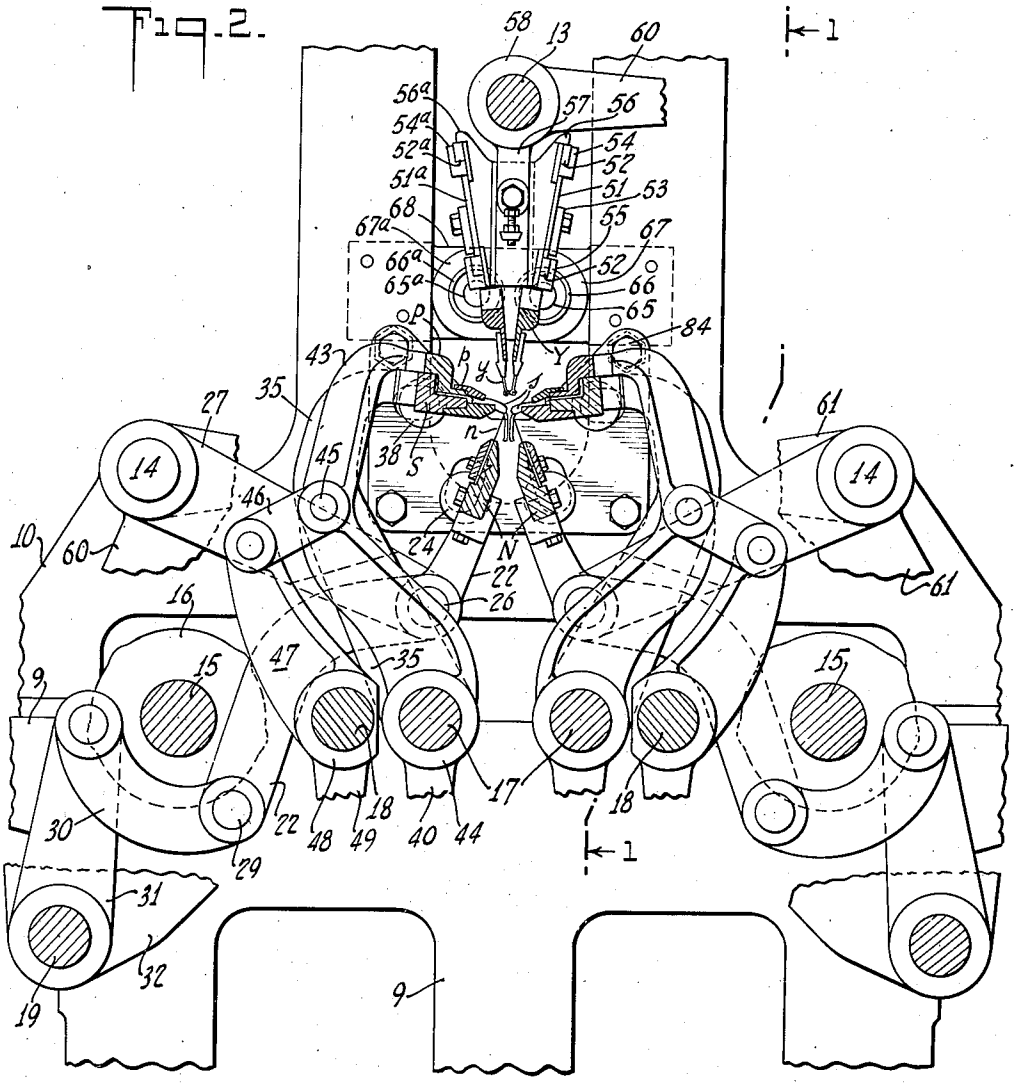
Fig. 2.



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STRAIGHT-TYPE WARP-KNITTING MACHINE

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Fig. 3.

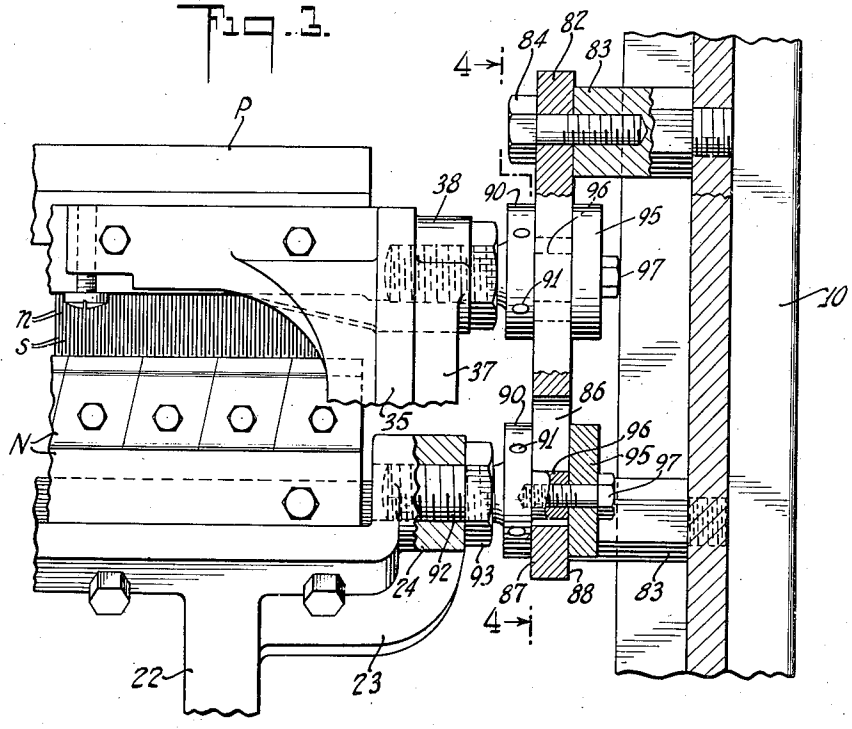
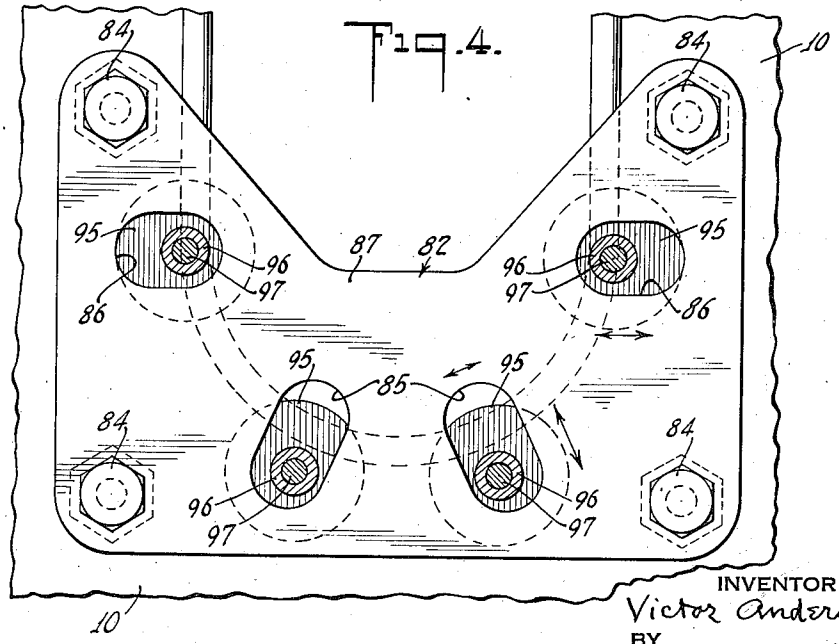


Fig. 4.



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Patented Feb. 17, 1942 2,273,246

UNITED STATES PATENT OFFICE

2,273,246

STRAIGHT-TYPE WARP-KNITTING MACHINE

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Application January 9, 1941, Serial No. 373,717

20 Claims. (Cl. 66—87)

This invention relates to straight-type warp-knitting machines. Warp knitting machines form a well known class wherein numerous warp yarns, fed in through a bank of yarn eyes or guides are manipulated into a warp-knitted fabric by cooperation of the series of yarn guides with other conventional knitting instruments, including usually a bank of united needles, a corresponding bank of sinkers, and a press bar or presser.

A typical instance of a knitting machine of this class and of the straight or flat type is the well known tricot knitting machine, adapted for the production of tricot or ribbed fabrics such as are used for the manufacture of gloves and various other products. Such tricot machines are sometimes of double construction so that two series of warp yarns adjacently advancing in the direction of the knitting progress are combined with each other in the fabric; and for purposes of illustration the present invention is shown as embodied in a double tricot knitting machine, adapted to produce a close knitted fabric with similar ribbed appearance on both faces; and in which are often incorporated additional yarns or other unknit materials. As a practical illustration of such a machine, the series of knitting instruments may have a longitudinal extent of 84 inches, with for example 40 instruments to the inch, so that the machine is adapted to handle as many as several thousand warp threads in the knitting of a wide fabric, which may proceed at the rate of 275 cycles or loops per minute, and at considerably greater speed on single tricot machines.

Prior instances showing the general class of knitting machine herein involved include Patent No. 2,254,201 issued September 2, 1941, in the name of Victor Anderson upon an application filed March 1, 1940, Serial No. 321,644,, directed to a united needle mounting adapted to use on tricot machines, and the construction of which mounting is illustrated herein. An earlier example of a double warp-knitting machine of flat type is shown in the expired patent of Saupe No. 1,218.212 of March 6, 1917. The general class of the machine being known, the entire construction thereof is not disclosed in this application, which however comprises illustrative disclosure of certain general and known features with sufficient fullness for clear explanation of the principles of the present invention.

A troublesome condition with the class of knitting machine referred to. which does not pertain appreciably in weft knitting, is the injurious and delaying effect of thermal expansion and contraction of the longitudinal members or bars that support the banks of instruments, yarn guides, needles and sinkers. The yarn guide carrier bar is given short longitudinal movements cooperating in laying the many warp yarns about the needles. The term "longitudinal" will herein be used to denote lineal motions or directions parallel to the bars or lengthwise of the machine, while "transverse" will denote movements or dispositions in planes at right angles to the longitudinal; such longitudinal lines being usually horizontal and the transverse planes vertical, and at right angles to the longitudinal direction. In this sense each of the other bars, the needle bar and the sinker bar, extend longitudinally but have relative operating movements that are transverse, that is, in any direction at right angles to the longitudinal, with components in up-and-down, or back-and-front or a combination of both directions. The same is usually true of the press bar.

The banks of guides, needles and sinkers are very numerous and are closely spaced, and high accuracy is therefore essential in shifting, for example, the yarn guide eyes, relatively between the needles, to avoid contact, clash, injury and breakage, which would be costly. Yet the parts are unavoidably subject to substantal changes of temperature, causing expansions and contractions that have in prior practice been unequal in effect, even when the bars are of similar metals or have the same coefficient of thermal expansion. The needle and sinker bars have usually been mounted on rockarms symmetrically disposed, these bars tending therefor to expand both leftward and rightward from a central point or base; while the carrier bar has been mounted for longitudinal shift, caused by an actuating device acting at a given point, as near the right end of the bar, which therefore has been the base of its expansion; with the consequence that any substantial temperature variation has thrown the instruments materially out of register at some parts or even throughout the length of the machine. So frequent and serious has been this drawback that the troublesome practice has been followed of testing and correcting registry repeatedly, even several times a day, the correction being effected by manual adjustment for example of the operating connections between the yarn guide carrier bar and its actuating cam. Such connection, in effect, consisted in shifting the

base of expansion of the carrier bar, at or near its end; but this was in itself a delaying operation, troublesome, and only temporary, until another temperature change occurred.

The difficulties thus pictured are the more troublesome with mountings of light or aluminum alloys for the needles and other instruments; whereas it has long been known that the shifting and oscillating parts must be of light metal to obtain the best rate of production, with machines of high speed, as here, involving several cycles per second. But the excessive coefficient of thermal expansion of the light alloys merely accentuates the trouble of lack of register; and so much was this the case that many tricot knitting machines are made with ferrous-metal mountings, to minimize thermal drawbacks, but at the expense of considerably retarded output rate.

The broad object of the present invention is to improve generally the efficiency and accuracy of operation of machines of the class and type concerned; while a particular object is to obviate the described drawbacks and so to construct the combined elements of the machine as to afford a self-acting correction for the described tendencies of thermal expansion and contraction; especially with the use of the light alloy mountings, thus materially improving the rate of knitting. To the attainment of such objects, and other advantages that will appear, the present invention consists in the novel warp-knitting machine, and the novel features of operation, combination and mechanism, herein illustrated and described; and as well the novel method involved for maintaining accurate register between the banks of yarn guides, needles and sinkers despite the effects of thermal expansions and contraction thereof.

In the accompanying drawings,

Fig. 1 is a side elevation view of a warp-knitting machine of the straight type embodying the present invention and showing the general and more important parts necessary for the convenient description of the invention; the figure being broken away transversely at certain points for the purpose of indicating that the machine may be relatively substantially longer than actually indicated; and this figure may be considered as a righthand or front elevation of Fig. 2, but with certain parts omitted to the right of the crooked section line 1—1 of Fig. 1.

Fig. 2 is a transverse or vertical section taken in fore-and-aft or transverse planes as indicated by the crooked section line 2—2 of Fig. 1.

Fig. 3 is an enlarged elevation view corresponding with a portion of Fig. 1 near its right hand end showing certain important parts in front elevation.

Fig. 4 is a transverse sectional view looking endwise toward the right on the vertical planes indicated by the crooked section line 4—4 of Fig. 3.

As will be seen from Figs. 2 and 4 especially, the machine is of double construction, known as a double tricot knitting machine, wherein as seen in end view the major portion of the construction is symmetrically duplicated about a central vertical longitudinal plane; for which reason it is only necessary to describe the parts at one symmetrical side, especially of Fig. 2. In a sense the machine has two fronts, the center being the back of each, wherefore the terms outer and inner better express the relations or directions of parts or motions.

While various auxiliary knitting instruments may be employed, as well known in the art, for affording special manipulation of the yarns or for the introduction of fleece or other materials into the fabric or for other purposes, for simplicity of description the instruments illustrated include only the bank or series of united needles *n*, the bank of united sinkers *s*, the presser or press plate *p* and the bank or united series of yarn guides or eyes *y*. These four instruments and any others employed are to be operated by automatic mechanism to manipulate the series of warp yarns to produce therefrom the desired fabric. The exact movements and manipulations of the cooperating instruments do not concern the principles of the present invention and therefore will not be described in their entirety. The general character of the respective movements enters into the purposes of the invention and may be described as follows. Thus the yarn guides *y* are to have longitudinal operative movements, while each of the other instruments, the needles, sinkers and presser are to have only transverse movements, whether up-and-down, fore-and-aft or a resultant thereof, so that, by the combined operative movements the yarns may be manipulated as necessary, for example by being carried around the needles in each cycle, performed by a combination of longitudinal yarn guide and transverse needle movements; and the yarn guides may also have certain transverse movements cooperative therewith.

For these purposes the several instruments are mounted on longitudinal carrying members which are herein designated by the usual term bars, which may next be enumerated as follows, referring to one side only of the machine. The extended bank or series of needles *n* stands upwardly from a needle bar N in which the needles are clamped in the manner disclosed in said Patent No. 2,254,201. The bank or series of sinkers *s* extends rearwardly or inwardly from a sinker bar S on which the sinkers are rigidly mounted. The presser may be in the form of a plate *p* mounted on a press bar P. The presser plate may be plain or may be formed with underneath ribs and grooves to permit cooperating engagement with the sinkers beneath, so that these two instruments may move transversely relatively to each other while under continuous engagement. The bank or series of yarn guides *y* is mounted dependingly on a yarn guide carrier or bar Y which for convenience will be termed a carrier bar to distinguish it from the other or needle, sinker and presser bars.

To describe first some of the known and other general parts of a tricot knitting machine, the drawings indicate a general frame comprising main or lower cross frame pieces 9 and above them upper cross frames 10. These may be composed of I-beams, and extending lengthwise across the top of them are longitudinal frame members 11. As best shown in Fig. 2 there are several longitudinal rods, axles or shafts of fixed position and extending substantially the length of the machine, including a top frame rod 13, which may also be a rockshaft, centrally positioned and from which depends the carrying mechanism of the yarn guide bars and eyes. At a lower level at each side is an axle or rockshaft 14 on which oscillate certain parts including needle bar connections. At a still lower level are several further fixed-position longitudinal members including a rotary shaft 15 which may be one of the regular cam shafts of the machine, and is shown carrying a cam 16. At about the

same level is a rockshaft 17 with or about which oscillate arms carrying respectively the sinker bar and press bar; and nearby is a second rockshaft 18 from which are derived movements of the press bar. At a still lower level is shown another axle or rockshaft 19 carrying rockarms taking part in the needle bar movements. Fig 1 shows further a low transverse frame member 20 which may constitute or carry bearings for the longitudinal axles or shafts 15, 17, 18 and 19.

With these general parts thus described and located reference will now be made to the connections for operating the several bars carrying the knitting instruments. Each of the two needle bars N is shown mounted at the upper ends of arms 22, at least two in number, each of which arms is of crooked shape and is floating in the sense that it has no fixed fulcrum. The right hand one of the floating arms 22 in Figs. 1 and 3 is shown as formed with an endwise extension 23 which curves upwardly to where it carries a threaded head, in the nature of a nut, positioned substantially in longitudinal line with and being in effect a rigid part of the needle bar N itself. This special extension and threaded member take part in the operation of the present invention as will be later described.

The movements of each needle bar may be effected and controlled through its floating arms 22 by a plurality of actuating connections, for example as follows: Somewhat below the needle bar, each floating arm 22 is formed with a pivot 26, by which the arm has pivotal connection with a rockarm 27 swingable about the axle or rockshaft 14. The arm 27 may be fast on the rockshaft 14, which may carry a second rockarm, not shown, which may extend to suitable connections, not shown, for effecting the timed rocking of these parts, as from the cam shaft 15. As will be clear from Fig. 2, the rocking of arm 27 affords rising and lowering movements of the needle bar, necessary in carrying out the cycle of knitting movements.

The needle bar also must have fore-and-aft or in-and-out swinging movements, and for this purpose the lower end of the floating arm 22 is provided with a pivot 29 affording connection with a curved link 30 extending between the arm 22 and a rockarm 31 oscillating about or with the axle or rockshaft 19. Rigid with the rockarm 31 or rockshaft 19 is a second rockarm 32, these constituting a lever, and the second arm may extend to a suitable actuating cam or means, not shown, adapted to effect the rocking of these parts and thereby the swinging of the needle bar in coordination with the other movements described. An advantageous arrangement is that the rockarm 32 is forked or has two branches, each carrying a roller, and these rollers bearing on the peripheries of two separate cams on shaft 15, shaped to give positively the exact needle movements required; and the same as to sinkers and press bar.

By these mechanisms the set of floating arms 22 which carries each of the needle bars N may be caused, in each knitting cycle, to produce the components of the needle movements necessary to afford the actual movements of the needles in coordination with the movements of the sinkers, yarn guides etc.; and these actuations may be derived from cams mounted on the cam shaft 15, or from other cams or equivalent sources of actuation unnecessary to describe. It will be observed that the movements of the needles on each needle bar comprise movements only in up-and-down and fore-and-aft directions, each needle therefore moving only in a vertical transverse plane, defined as a fore-and-aft plane extending at right angles to the longitudinal.

Referring next to the sinker operating connections, each sinker bar S is shown mounted near the upper ends of a series of rockarms 35, three being seen in Fig. 1, each having a lower hub 36, and all of these hubs being mounted fast upon the axle or rockshaft 17. The right hand one of the rockarms 35 is shown in Figs. 1 and 3 as having at its upper end an extension 37 carrying a threaded head or nut 38, which is longitudinally adjacent to and substantially in line with the sinker bar S, and constitutes an effective part or extension thereof, as with the head 24 at the right end of the needle bar. These parts may be rocked in any suitable manner, for example through an arm 40 fast on the shaft 17, and this may receive its actuation from a cam on the cam shaft 15 or otherwise to afford the fore-and-aft swinging movements of the rockarms 35 and the in-and-out motions of the sinkers in cooperation with the needle and thread guide movements.

Coming to the press bars P, each thereof is arranged to move in a usual manner directly above the sinkers to perform in the knitting the usual pressing function of this instrument. For this purpose the press bar is mounted at the upper ends of a set of rockarms 43, two being shown in Fig. 1, each suitably curved to clear other parts, and at its lower end formed with a hub 44 mounted loosely on the axle 17, thus determining its path of swinging movement. To perform this actuation the rockarm 43 is provided with a midway pivot 45 shown as connected by a link 46 with the upper end of a shorter rockarm 47, which may be generally parallel to the rockarm 43 and the lower end of which is formed with a hub 48 mounted fast upon the rockshaft 18. By means of another rockarm 49 on the shaft 18 these parts may be put through their operative movements by any suitable connections, not shown, from a cam on the cam shaft 15 or other source of actuation.

When the press bar has no underneath grooves or ribs or similar engagement upon the sinkers there is no thermal difficulty because expansion changes do not affect the sinker or press bar actions. When the press bar does have groove or rib engagement with the sinkers this is a continuous engagement, and therefore no thermal problem exists since the bank of sinkers engages the press bar grooves and thus ensures proper longitudinal positioning of the press bar. For this reason the principles of the invention pertain especially to the needle, sinker and carrier bars and will be so described.

The yarn guide carrier bar mounting may be of the following or any conventional character. There are two such bars, the one at the right side of Fig. 2 being the near one in Fig. 1, where the nearer bar Y conceals the other bar, except where the latter projects rightwardly beyond the end of the former. The two bars are independently shiftable longitudinally so that the two banks of yarn eyes may take different operative positions during the knitting. Under this conventional practice a great variety of longitudinal movements is possible, according to the fabric and pattern desired; and in general the motions are symmetrically opposite, one bar progressing gradually leftward while the other shifts rightward, followed by reverse movements. Except

for these differences of longitudinal movement and position the two carrier bars are similarly arranged symmetrically as seen in Fig. 2, and both of them are carried by certain mountings which derive their common support from the overhead axle or rockshaft 13.

The mounting of each carrier bar Y may be described as follows, referring especially to the right-hand side of Fig. 2. Upstanding from the carrier bar are a number of light, open structures which may be called lattices, serving as sliding carriages, parts of two of them being shown in Fig. 1. Each lattice may comprise thin but stiff upright members or strips 51, two being shown spaced longitudinally apart, and these are interconnected by similar longitudinal strips 52, thus completing each quadrilateral lattice or carriage, the strips being rigidly interconnected, and the uprights having feet based upon the bar Y itself. The two longitudinal strips of each lattice may constitute slidebars and by these slidebars the several lattices, and the carrier bar which is supported by them are mounted for their longitudinal movements.

Thus on Figs. 1 and 2 are shown upper and lower carriage guides 54 and 55, which are mounted on the outer side of an extension or wing 56 projecting outwardly from a depending member or drop bracket 57, the upper end or hub 58 of which is mounted fast upon the overhead axle or rockshaft 13. The two wings may be a single piece adjustably attached by screw device 59 to the drop bracket 57.

By such fittings the symmetrically opposite carrier bars are separately mounted on the bracket 57 to receive independent but cooperating longitudinal movements, and the entire system is thus carried dependingly from the overhead axle, so arranged that the yarn eyes *y* are at the proper level to cooperate with the banks of needles and sinkers in the performance of warp knitting. It is usually desirable to cause not only longitudinal, but transverse movements of the yarn guides, so that symmetrical series of guides may cooperate with symmetrical series of needles in the production of a fabric wherein the warp threads introduced at each side may be carried through to appear at the other side of the knitted fabric. By combined longitudinal and transverse movements the eyes can lay the yarns in loops around one or more needles. Such transverse movements of the yarn guides may be caused by bodily rocking the carrier bar mounting system, preferably by oscillating the overhead shaft 13, thereby rocking the drop brackets 57 and the described parts carried thereby. For this purpose the shaft 13 at a suitable point may be provided with a rockarm 60, partly shown, and this rockarm may be connected by suitable linkage, not shown, with a further connection, such as the upper arm of a rock lever 61 mounted loosely on the axle 14, its lower arm deriving its rocking movements from a suitable actuating source such as a cam on the cam shaft 15. These various connections are deemed unnecessary to describe in detail since their specific forms do not affect the principles of the present invention.

To avoid confusion on Fig. 1 as to certain duplicated parts that appear also on Fig. 2, such parts are numbered as already stated in regard to the parts appearing at the right hand side of Fig. 2, while those at the left hand side carry the exponent *a*. This refers particularly to the already mentioned reference numbers 51ª, 52ª, 54ª, 56ª, 57ª and 58ª, whose application to Fig. 1 therefore permits distinction between the two sets of parts; and in the continued description the same system is applied to certain further parts, as will appear by the reference numbers 62ª, 63ª, 66ª, 67ª, 71ª, 72ª, 73ª and 76ª.

Bearing in mind the requirement that the two carrier bars Y be separately movable longitudinally the following connections from the sets of lattices upon the respective carrier bars are adapted to impart the desired endwise motions. Attached to the lattice 51, 52 is what may be termed a block 62, having an upstanding post 63 for attachment of a spring. The block 62 is shown mounted for example on top of the base flange or foot of the most right hand lattice upright 51 in Fig. 1. At the right end of the block 62 appears part of a connection 65, which may be in the nature of a long universal link, extending between the block and the far interior end of a sliding hollow plunger 66. The plunger extends and slides through a guiding sleeve 67 fixedly mounted on or formed with a cross bracket or plate 68 attached to the frame uprights 10. At its extreme right end the plunger 66 carries a suitable follower 71, with stud or roller, which therefore may be actuated methodically to cause the endwise movements of the lattices and carrier bar.

For the purpose of causing longitudinal shiftings of the described system the follower 71 is shown bearing upon the peripheral portion, formed with small indentations or serrations 72, of a cam 73. This may be an interchangeable cam mounted on a driven cross shaft, not shown. These parts are to be understood as duplicated for the respective carrier bars, the parts not described bearing the exponent *a*. The cams 73 and 73ª being open cams springs 76 and 76ª are employed to hold the followers thereto. The springs are attached to the tops of the posts 63 and 63ª and extend toward the right. The two springs have their right hand ends attached to the two ends respectively of a short free length of sprocket chain 77, which is indicated as passing around a sprocket wheel 78 which is mounted to turn freely within a drop bracket 79, the hub 80 of which is fast to the overhead rockshaft 13. This arrangement of springs and sprocket afford an equalizing action in the resilient pull holding the two carrier bars toward the right and holding the cam followers 66 against the peripheries 72 of the cams. At the same time the spring pull remains substantially constant throughout substantially symmetrical longitudinal shiftings of the respective carrier bars Y.

The difficulty which has been already outlined may be further explained as follows, referring particularly to the yarn guide carrier bar and to the needle bar which latter may be considered as representative of the other bars. By inspection of the mountings of the shiftable needle bar N this will be seen to have a natural base of thermal expansion which is approximately at the middle of the bar, due to the symmetry of the mountings, a rise in temperature causing a slight straining apart of the carrying arms. On the other hand the natural and usual mode of actuation of the carrier bar is at or near one end of it. Each of the carrier bars being operatively movable longitudinally it is clear that its point of actuation determines and substantially constitutes its base of thermal expansion. Therefore the bases of expansion of the carrier bar and needle bar respectively have heretofore been ex-

tensively removed from each other approximately by half of the full length of these bars. The result is that after the bars have at any time been initially adjusted to bring the yarn eyes and the needles into thorough registry, a substantial thermal expansion or contraction, especially with aluminum or similar alloys, may bring about a serious lack of registry in which, as can readily be shown, there will not be exact registry at any one point in the entire length of these parts.

This difficulty is solved by the present invention acting on the following principles, it being understood that the carrier bar and needle bar are composed of a metal or metals which correspond as to their thermal expansion coefficient. The carrier bar has its actuating device to effect longitudinal shiftings during knitting, and this device may be considered as the cam 73 acting through the follower 71 and link 65 extending to the block 63 mounted upon the bar Y. On the other hand the needle bar, whose operative movements are in directions transverse to the longitudinal, is held against longitudinal shifting during knitting. In one way or another the base of longitudinal thermal expansion of the needle bar is maintained at a substantially predetermined point in its length; and according to the present invention the carrier bar actuating device is arranged to act at an effective point in the length of said bar which corresponds longitudinally in position with the aforesaid predetermined base point of the needle bar. In this way cooperative registration of the banks of yarn guides and needles is self-maintained notwithstanding substantial thermal expansions or contractions of the bars.

The invention has method aspects in that it involves a method of maintaining accurate register between the two bars and between the instruments they carry, the yarn-eyes and needles, throughout temperature variations, comprising actuating the carrier bar at a given point, as one end of it, to establish there an expansion base, and causing the needle bar to be held against longitudinal movement at the corresponding point or end.

Broadly this principle may be applied by utilizing the naturally central base of expansion of the needle bar and coordinating therewith the base of expansion of the carrier bar by causing the actuating device of the latter to operate at the middle part of the carrier bar rather than at one end. This arrangement is not preferred because having certain objections, including the fact that to arrange the actuating device at the center of the machine would be complicated and inconvenient; and due to the further fact that the natural or central base of expansion of the needle bar would not be reliably predetermined at a definite point, and for obvious reasons might vary substantially in several machines which are otherwise identical. This last mentioned drawback could be overcome by providing at the center of the needle bar an added positioning means which would insure a constant base point of thermal expansion and contraction.

In its preferred form the present invention retains the end device to actuate the carrier bar, and adds to the machine, at the same end, a positioning means or member, preferably maintained fixed, to which the needle bar end is connected in a manner to hold the bar against longitudinal movement while permitting it freely to receive its transverse movements during knitting. Such an embodiment of the invention is illustrated in the drawings and is specifically described as follows.

To maintain the right hand end of the needle bar N in Fig. 1 at a predetermined longitudinal point there is shown a positioning means such as to permit its transverse operating movements, illustrated in the form of a plate 82 preferably fixed in a transverse plane, but which might be longitudinally adjustable. The positioner or plate 82 is shown mounted on two frame columns 10 by means of four posts 83, outstanding longitudinally from the columns, the positioner being secured to the posts by four bolts 84. The plate is preferably formed with a system of apertures 85 and 86 for the play of certain parts as will be described, and the positioner is shown as a flat plate with a true surface 87 facing the knitting mechanism and preferably with a true opposite surface 88.

The needle bar N has connecting means causing it to take its longitudinal position from the positioner 82. As an illustrative construction for this purpose it is shown provided with a sliding piece in the nature of a shoe or disk 90 mounted beyond the extreme end of the needle bar and having a true flat surface bearing against the face 87 of the positioner. The shoe or slider 90 is formed with pin or wrench holes 91 to receive pins for adjustably turning it, and each slider has a threaded stem 92 which is engaged in the threaded nut 24 rigid with the end of the needle bar, a lock nut 93 holding in rigid relation these elements. The sliding disk 90 thereby may move freely over the surface of the positioner while the needle bar undergoes operative shiftings, and the bearing of the slider against the plate determines the position of the right end of the needle bar and thereby predetermines its base of thermal expansion. Initial fine adjustment may be necessary and this is readily performed by loosening the lock nut 93, turning the disk 90 and its threaded stem 92 and again tightening the lock nut.

As a means to keep the sliding disk 90 flat against the positioner plate 82 various expedients may be added or the swinging mountings of the bar N, may be forced under a definite strain for this purpose of resilience otherwise applied. A positive engagement is preferred, such as confining the slider between the plate and an opposite piece or holddown, but a simpler contrivance is the following. A second slider disk 95 is added, playing over the surface 88 of the fixed plate. This is spaced from the first disk by a spacer ring 96 of length to give a close sliding fit between each disk and the plate, while a bolt 97 is passed through 95 and 96 and threaded into 90 to secure these three parts rigidly together to constitute a slidable carriage for the needle bar. The necessary play is afforded for free up and down and in and out bar movements by the slot 85 in the plate, cut substantially larger than the parts traversing it.

For the sinker bar S are shown corresponding parts, slider disk 90, pin holes 91, screw stem, lock nut, second slider disk 95 to hold 90 to the plate, spacing piece 96 and securing bolt 97. In any connection of a bar to the positioning plate there may be interposed rollers or balls to ease the motion and reduce wear; or the bar disk 90 may be shaped to slide up and down in an undercut way on an intermediate carriage plate which in turn can slide in and out in an undercut way on the fixed plate 82.

In the case of the rockshafts comprised in the mountings of the needle bars, sinker bars and press bars, it is preferred that these be free for slight longitudinal play in their bearings, thus not to obstruct the positioning action of the invention; but in the case of the overhead rockshaft for the carrier bars, this may be held by collars against such movement, the carrier bars having spring-resisted longitudinal motion.

The described and equivalent self-acting constructions and arrangements, therefore, accomplish the desired objects, by keeping the yarn guides, needles and sinkers always in practically exact register, and, by their engagement with the sinkers, the ribs or grooves of the press-bar. It is true that there are certain factors present which tend to cause slight discrepancies in complete precise register between the yarn guides and the other instruments, but these are negligible. One such factor is the occasional slight disalinement of each carrier bar Y with the other bars due to the endwise shiftings of the carrier bars, as seen in the Fig. 1 position of the parts; but this is only minor, and on the average the register is exact. Another possible factor is in relation to the iron or steel parts to the right of the bars Y, N and S in Fig. 1 which naturally modify minutely the actual thermal displacement of the bars. But this is negligible, first, because the expansion coefficient of the ferrous metal is only about half of that of the light alloy of the bars. Moreover, any possible effects practically offset each other because the longitudinal extent of the ferrous parts between the respective bars and the stationary frame 10 (which is the eventual base of the longitudinal positionings) is practically equal in the several cases; wherefore any relative thermal effect is insignificant or non-existant. For all practical purposes, even in a long machine, the parts keep true register in a self-controlled way; perfect coordination being maintained reliably and without personal attention; and so effectively is this done that it renders it practical to use the lightweight, highly-expansible alloys, and thus permits greatly improved speeds of production of wide warp-knitted fabric.

There has thus been described a novel warp-knitting machine of the straight type constructed in accordance with the present invention and adapted to attain the objects thereof, and also the novel method of operation which is therein involved; but since many matters of method, operation, combination and mechanism may be variously modified without departing from the novel principles, it is not intended to limit the invention to such matters except to the extent set forth in the appended claims.

What is claimed is:

1. In a warp-knitting machine having the carrier bar carrying a bank of yarn guides and receiving knitting motions including longitudinal motions, and the needle bar carrying a bank of needles and receiving only transverse knitting motions; the method of maintaining accurate register between the two bars throughout variations of temperature, comprising applying the longitudinal actuation to the carrier bar at a given longitudinal point thereof to establish a base of longitudinal thermal expansion thereof, and causing the needle bar to be held against longitudinal thermal movement at a point in its length corresponding to said given longitudinal point of the carrier bar.

2. In a warp-knitting machine having the carrier bar carrying a bank of yarn guides and receiving longitudinal knitting motions with actuation applied near one end, and the needle bar carrying a bank of needles and receiving only transverse knitting motions; the method of maintaining acurate register between the yarn guides and the needles carried by the two bars respectively, throughout substantial variations of temperature, comprising maintaining a base of longitudinal thermal expansion of the carrier bar near its end by its aforesaid actuation, and causing the needle bar to be held against longitudinal thermal movement near that end of its length corresponding to said actuation end of the carrier bar.

3. In an automatic warp-knitting machine having the carrier bar carrying a bank of yarn guides and receiving longitudinal knitting motions, and the needle bar carrying a bank of needles and receiving only transverse knitting motions; means for maintaining accurate register between the two bars and the instruments they carry throughout variations of temperature, comprising a device for applying the longitudinal actuation to the carrier bar at a given effective longitudinal point thereof to establish a base of longitudinal thermal expansion thereof, and means for causing the needle bar to be held against longitudinal thermal movement at a point in its length corresponding substantially to said given longitudinal point of the carrier bar.

4. In a straight warp-knitting machine, the yarn guide carrier bar and the needle bar, both extending longitudinally and both composed of metal corresponding as to thermal expansion; an actuating device to effect longitudinal shiftings of the carrier bar during knitting, and means mounting the needle bar to shift transversely while held against longitudinal shiftings during knitting, with its base of longitudinal thermal expansion at a substantially predetermined point in its length; said actuating device being arranged to act upon the carrier bar at an effective point in the length thereof corresponding longitudinally in position with such predetermined point of the needle bar, whereby cooperative registration of the banks of yarn guides and needles is self maintained notwithstanding substantial thermal expansions or contractions of said bars.

5. A machine as in claim 4 and wherein the means mounting the needle bar comprises a transversely arranged fixed positioner or plate located substantially at the base point of thermal expansion of the needle bar, and said bar has a connection thereto comprising an extending shoe sliding against one side of said plate; and wherein is adjusting means between the needle bar and said positioner for initially setting the needles for non-conflict with the yarn guides.

6. An automatic warp-knitting machine of the straight type comprising movable parallel longitudinal bars holding the bank of yarn guides and the bank of needles respectively and composed of a metal or metals having substantially the same coefficient of thermal expansion, and mechanism for operating said bars in coordination to work the warp yarns into a fabric including an actuating device to cause relative longitudinal movements of the yarn guide bar and actuating means to cause relative transverse movements of the needle bar; said actuating device being arranged to act upon said yarn guide bar at a given longitudinal point thereof, as near one end, and said needle bar having a positioning means

to which it is connected at a longitudinal point thereof corresponding substanitally to said given point of the yarn guide bar, and said positioning means being adapted to operate to hold said needle bar against longitudinal movement while permitting its transverse operating movements; whereby with any longitudinal thermal expansion or contraction of said bars the entire bank of needles is maintained in correct relation to the bank of yarn guides to ensure operation without conflict.

7. A machine as in claim 6 and wherein the positioning means comprises a fixed member set transversely and upon which an extension of the needle bar may slide, thereby to maintain the bar in a predetermined longitudinal position.

8. A machine as in claim 6 and wherein the positioner is a fixed transverse plate, and the needle bar has an extension comprising shoes slidably engaging both sides of such plate.

9. A machine as in claim 6 and wherein the connections between the needle bar and positioning means comprise longitudinal adjusting means.

10. A machine as in claim 6 and wherein the positioning means comprises a fixed member set transversely and upon which an extension of the needle bar may slide, thereby to maintain the bar in a predetermined longitudinal position; and the connections between the needle bar and positioning means comprising longitudinal adjusting means.

11. A machine as in claim 6 and wherein the positioner is a fixed transverse plate, and the needle bar has an extension comprising shoes slidably engaging both sides of such plate; and the connections between the needle bar and positioning means comprising longitudinal adjusting means.

12. An automatic straight warp-knitting machine comprising a system of knitting instruments including longitudinal series of yarn guides, needles and sinkers cooperable to manipulate a series of warp yarns for the production of a fabric, a longitudinal yarn guide carrier bar having near one end a timed actuating device or cam to impart methodical longitudinal movements to the carrier bar and yarn guides, and needle and sinker bars parallel to said carrier bar, each having a timed operating means to impart methodical transverse movements to it and thereby to the needles and sinkers respectively in each cycle in coordination with the yarn guide movements; in combination with a fixed positioning member or plate transversely arranged near the same end of said bars as is said actuating device, a connection near said end of each of asid needle and sinker bars connecting it to said positioning member and adapted to prevent longitudinal movements of said bars while permitting the operative transverse movements thereof, and means for initially adjusting said bars in relation to said positioning member to coordinate their normal longitudinal positions to each other and to said carrier bar for non-conflicting cooperation between the yarn guides, needles and sinkers; whereby such operative coordination is preserved notwithstanding any thermal expansion or contraction longitudinally of said several bars.

13. A machine as in claim 12 and wherein the positioning member is a flat plate in fixed position, each of said needle and sinker bars having an extension with a shoe slidable on said plate.

14. A machine as in claim 12 and wherein the positioning member is a flat plate in fixed position, each of said needle and sinker bars having an extension with a shoe slidable on said plate to hold the shoes to the plate.

15. A machine as in claim 12 and wherein the positioning member is a flat plate in fixed position, each of said needle and sinker bars having an extension with a shoe slidable on said plate, and a second shoe sliding on the other side of the plate to hold the shoes to the plate; the plate having an aperture and the two shoes being connected through said aperture, which is large enough to permit the operative transverse bar movements.

16. A machine as in claim 12 and wherein the adjusting means comprises a screw device in the connections between each bar and the positioning member.

17. A warp-knitting machine as in claim 3 and wherein the yarn guide carrier bar is given during knitting methodical motions in both longitudinal and transverse means.

18. A warp-knitting machine as in claim 4 and wherein the yarn guide carrier bar is given during knitting methodical motions in both longitudinal and transverse directions.

19. A warp-knitting machine as in claim 6 and wherein the yarn guide carrier bar is given during knitting methodical motions in both longitudinal and transverse directions.

20. In a straight knitting machine comprising longitudinal banks of cooperating knitting elements, and separate elongated metallic parallel bars supporting the respective banks of elements, the longitudinal dimensions of which bars are affected by temperature changes; means for maintaining the banks of knitting elements in mutually registered relation to each other notwithstanding thermal changes in the lengths of the respective supporting bars, said means consisting in a device for determining the position of one of said bars as to a given longitudinal point thereof thereby to establish a base of longitudinal thermal expansion of said bar, in combination with a means for causing another of said bars to be held against longitudinal thermal movement at a point in its length corresponding substantially to such given longitudinal point of the first mentioned bar; whereby cooperative registration of the respective banks of elements is self-maintained under substantially different thermal conditions.

VICTOR ANDERSON.

CERTIFICATE OF CORRECTION.

Patent No. 2,273,246. February 17, 1942.

VICTOR ANDERSON.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 7, first column, line 58, claim 12, for "asid" read --said--; page 7, second column, line 14, claim 14, after "said" insert --plate, and a second shoe sliding on the other side of the--; and line 33, claim 17, for "means" read --directions--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 21st day of April, A. D. 1942.

Henry Van Arsdale,
Acting Commissioner of Patents.

(Seal)