March 17, 1959 R. C. POWELL 2,877,635

METHOD AND MACHINE FOR KNITTING SEAMLESS GLOVES

Filed May 26, 1955 3 Sheets-Sheet 1

FIG. 1.

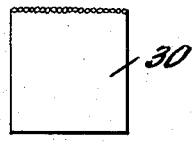


FIG. 2.

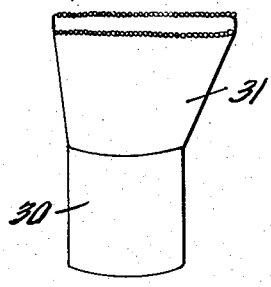


FIG. 3.

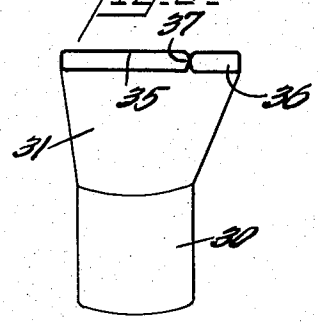


FIG. 3a

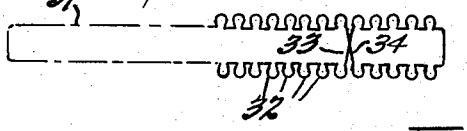


FIG. 3b

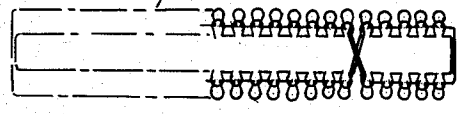


FIG. 3c

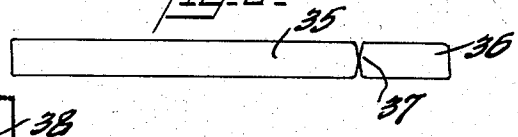


FIG. 4.

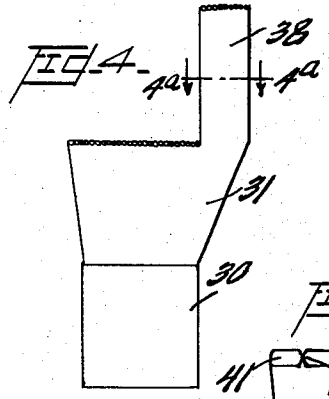


FIG. 4a

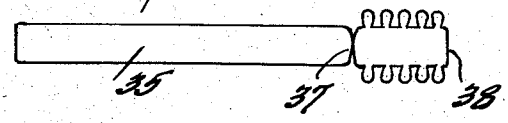


FIG. 6.

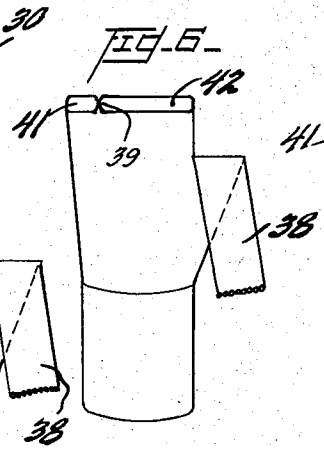


FIG. 6a

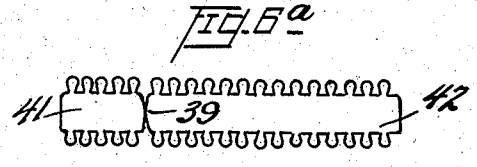


FIG. 5.

INVENTOR

Ralph C. Powell

BY Watson, Cole, Grindle & Watson

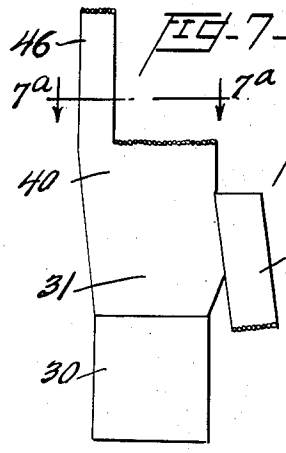
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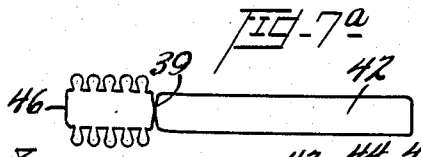
March 17, 1959 R. C. POWELL 2,877,635

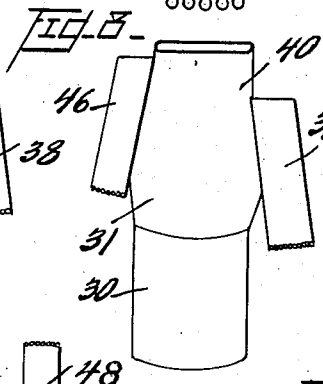
METHOD AND MACHINE FOR KNITTING SEAMLESS GLOVES

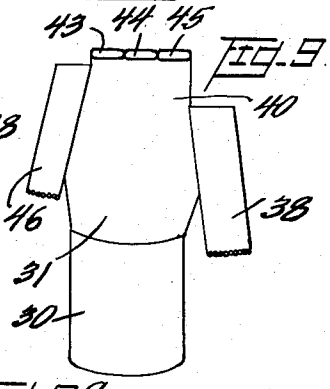
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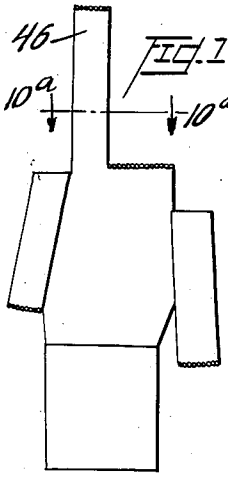
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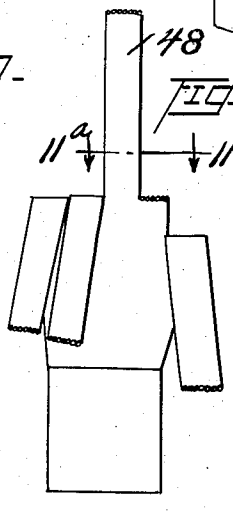


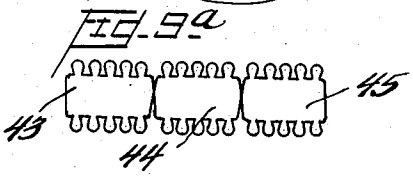


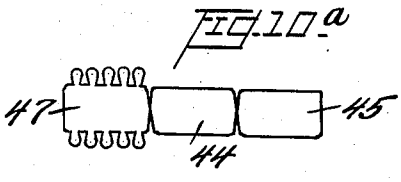


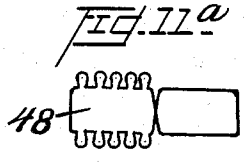


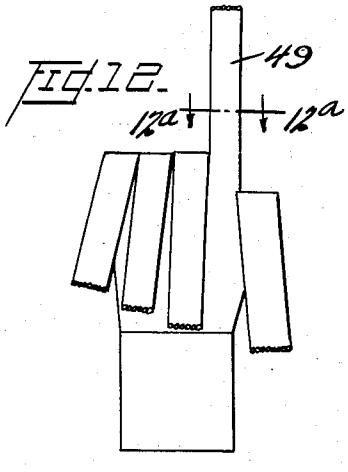


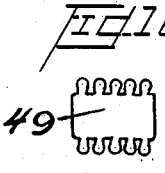












INVENTOR

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March 17, 1959 R. C. POWELL 2,877,635

METHOD AND MACHINE FOR KNITTING SEAMLESS GLOVES

Filed May 26, 1955

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FIG. 13.

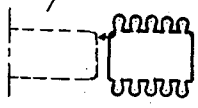


FIG. 14.

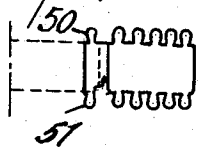


FIG. 17.

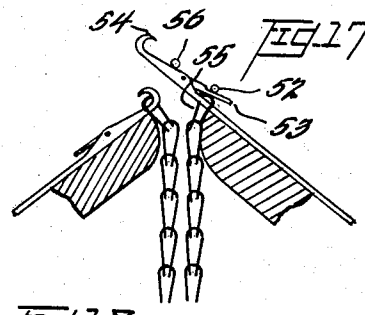


FIG. 15.

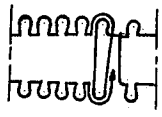


FIG. 16.

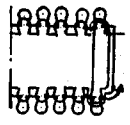


FIG. 18.

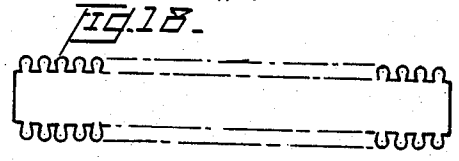


FIG. 19.

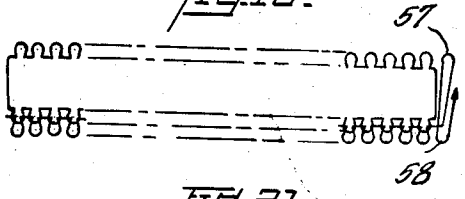


FIG. 20.

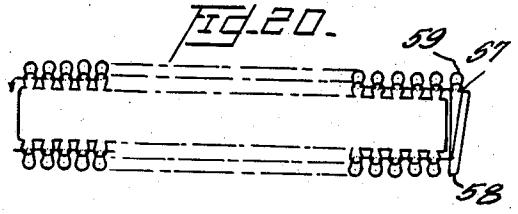


FIG. 21.

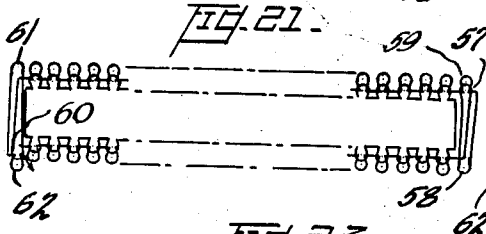


FIG. 22.

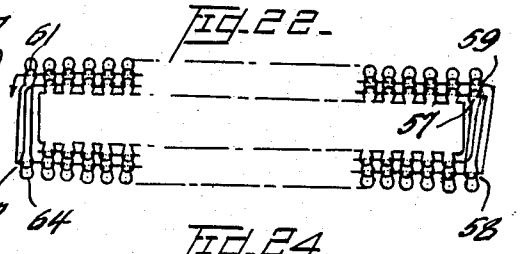


FIG. 23.

Prior Art

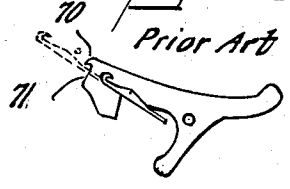


FIG. 24.

Prior Art

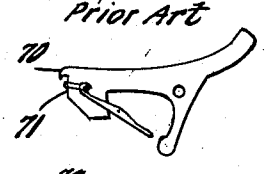


FIG. 25.

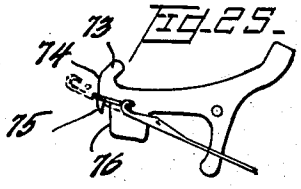
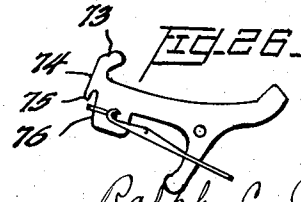


FIG. 26.



INVENTOR

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ATTORNEYS

United States Patent Office 2,877,635 Patented Mar. 17, 1959

2,877,635

METHOD AND MACHINE FOR KNITTING SEAMLESS GLOVES

Ralph C. Powell, Spartanburg, S. C.

Application May 26, 1955, Serial No. 511,367

10 Claims. (Cl. 66—65)

This invention relates to the art of knitted gloves and is principally concerned with the knitting of an improved form of seamless glove by a continuous method in which a machine of the flat bed or "lamb" type is employed.

For many years, it has been the practice in the art to knit gloves by first forming the cuff and hand portion of the glove on a circular knitting machine and then bodily transferring the thus fashioned tube onto a flat bed or circular knitting machine by means of which the fingers are separately knitted. This procedure is obviously expensive as it requires two distinct types of machines and the bodily transferral of the glove from one machine to the other. In the course of such transferral, the terminal loops on the cuff and hand portion of the glove must be cast off from the needles of the circular machine and re-engaged with the needles of the flat bed machine, a tedious and time-consuming operation for even the most skilled of knitters.

In an effort to overcome the disadvantages inherent in the conventional two-step procedure, it was proposed by Simmat in Patent 2,418,957, issued April 15, 1947, now assigned by mesne assignments to me, that the glove be knitted entirely on a flat bed machine, which proposal involved a rather radical departure from the previous thinking in the art. As is well known, a flat bed, or "lamb," machine consists of two opposed, closely spaced, parallel inclined beds of knitting needles in which the needles are successively actuated to knit a narrow or flat tube. Such machines have been available to the art for many years and have been generally superseded, except for certain specialized uses, by more modern equipment capable of a much greater rate of production. They do, however, possess a unique characteristic, not found in any other machine of this general class, of permitting any desired number of adjacent needles, selected either from one or both beds of needles, to be actuated independently of the remaining needles, which are held inactive in the machine, such selective knitting being carried on without unduly disturbing the stitches held on the inactive needles or the ability of the inactive needles to be immediately returned to active use. It is this unique characteristic that causes the flat bed knitting machine to be peculiarly well suited for the practice of the Simmat method and that contemplated by the present invention.

Specifically, it was suggested by Simmat that a glove could be knitted in its entirety on a flat bed machine by the steps of knitting a tubular hand portion to the thumb level, such portion having a fashioned flared side edge, adding to this hand portion a separate thumb tube, continuing the knitting of that part of the hand portion remaining after the completion of the thumb tube to the finger levels, individually knitting in sequential order the four finger tubes and finally closing off the ends of the finger and the thumb tubes in a known manner. Although this method was basically sound and constituted a tremendous advancement over the conventional two-step procedure, both from the standpoint of a reduction in

the capital expenditure required for machinery and a substantial decrease in the time required for the construction of a complete glove, it did possess certain disadvantages which caused the product to be of a lesser commercial value than might have otherwise been the case. For example, when a glove was knitted in accordance with Simmat's directions, it was found that small openings or slits occurred at the crotch between adjacent fingers and the crotch between the thumb tube and the continuing section of the hand tube. While the presence of these slits did not render the gloves wholly unfit for use, it did lessen their commercial value. The slits could, of course, be closed by a separate hand operation but this reduced the over-all saving effected by the practice of the method. In addition, when the usual techniques of fashioning were applied to the Simmat method, it was found that the fashioning holes or islands which are undiscernible in most articles, ladies' hose for example, proved to be objectionably large and apparent, this condition being principally due to the much coarser or heavier yarn employed in the knitting of gloves. Still further, when the short length of yarn connecting the tip of the thumb to the base of the continuing hand portion or the tip of each finger to the base of the next adjacent finger was clipped, the loose ends were not anchored and could unravel or work loose.

It is therefore the principal object of the present invention to provide a method of continuously knitting a glove on a flat bed knitting machine in accordance with the broad principles originally proposed by Simmat in which the disadvantages of the Simmat method are obviated during the actual course of the knitting, without separate operations and without removal of the glove, the article thus produced being complete in the commercial sense and freely saleable after the usual finishing procedures.

A further object of the invention is to provide a method of continuously knitting a glove on a flat bed knitting machine in which the length of yarn connecting the tip of the thumb to the remainder of the glove and the tips of each finger to the base of the next knitted finger are anchored in the glove without interruption of the course of knitting, in which the courses of yarn which constitute the base of the thumb and each finger are cross-knitted in such a way as to constitute a closed juncture between the thumb and the remainder of the glove and between the bases of adjacent fingers, and in which the fashioning of the glove is so effected as to minimize the presence of fashioning holes.

The invention also contemplates the use of an improved sinker of novel configuration, having an elongated hook portion and a vertically extending projection rising above the hook portion, thus providing an edge of substantial vertical dimension above the level of the eye of the hook, on which edge the individual stitches are formed, and, further, varying the pattern of operation of the sinkers with respect to the needles so that the sinkers are not raised until the needles associated therewith are fully retracted into the bed.

These and other objects and advantages of the present invention will be revealed in the following detailed description when read in conjunction with the accompanying drawings. It will be understood that the illustration in two dimensions of knitting processes in the exact manner in which they occur is impossible; consequently, certain liberties in the drawings have necessarily been taken. Thus, for example, plan views of successive courses have been developed in a single horizontal plane although such courses are actually developed in successive spaced horizontal planes. The number of stitches shown is exemplary only, the exact number being dependent upon the size of the glove, the coarse-

ness of yarn and other considerations, all well established in the art. In the drawings:

Figures 1–12*a* illustrate the step-by-step procedure for knitting a glove in accordance with the present invention, some of these figures being shown slightly in perspective;

Figures 13–17 show the preferred way of anchoring the ends of the length of yarn connecting the tip of each finger to the base of the next adjacent finger;

Figures 18–22 show my improved technique of fashioning;

Figures 23 and 24 depict the prior art sinker in association with an adjacent needle and showing the two basic positions of the needle and sinker, the first in which the needle is extended to thread receiving position (dotted lines) and then retracted (solid lines) while the sinker is elevated to permit the movement of the thread underneath the hook of the sinker and the second showing the needle retracted and the sinker in normal rest position with the stitch formed on the edge of the sinker below the hook; and

Figures 25 and 26 illustrate my improved sinker in association with an adjacent needle and show the two operative positions of the sinker and needle, the first in which the sinker remains in its normal rest position while the needle is extended to receive the thread (dotted lines) and then retracted (solid lines) to form the stitch on the edge of the sinker above the hook and the second in which the sinker is elevated while the needle is in retracted position to permit the formed stitch to pass under the hook of the sinker.

As is customary in the knitting of gloves, the first step is to form a cuff or wrist portion **30**, as indicated in Figure 1. Normally narrower than the body of the glove, the cuff portion **30** is knitted in the usual manner and may include ribs, elastic threads, decorative features and the like as may be desired. After the cuff is complete, additional courses of yarn are knitted thereto up to the transverse level of the base of the thumb to form the heel portion **31** of the glove. As the heel portion is being knitted, the transverse dimension thereof is increased by the addition of needles at the ends of the rows, this being preferably carried out in accordance with the specific fashioning technique to be hereinafter described, the result being the flared structure depicted in Figure 2. It is at this point that the upper end of the flared heel portion **31** is prepared for the addition of a thumb tube by means of one of the novel features of the present invention. Looking at Figure 3*a* which is a diagrammatic plan view of the glove, and assuming that the course begins at the left end of the front side of the tubular heel portion, stitches **32** are knitted in the usual manner along the front side on successive needles in the front bed of the machine until there remains on that bed a certain number of needles which has been previously determined as required for the formation of the thumb tube. At this point, instead of continuing along the front side of the tube, a cross-stitch **33** is knitted, which is to say, that the yarn is carried over to the back bed of needles, and the knitting continued on the back bed until the last needle at the right end of that bed has been utilized. The yarn is then returned or brought back to the front bed and knitted on the number of needles necessary for the front of the thumb corresponding to the number selected from the back bed. When the innermost of these needles has been employed, the yarn is crossed over to the back bed once more, as at **34**, and picked up by the needle adjacent the first thumb needle in the back bed and by successive needles toward the left until the course is completed. The knitting of successive courses in this fashion to include cross-stitches subdivides the tubular heel portion **31** into two smaller tubes **35**, **36** interconnected by a web-like lacing **37** of yarns somewhat analogous to the web interconnecting the bases of the fingers of the human hand, thus preventing the formation of a slit or opening at the crotch of the thumb. At least one course of yarn including cross-stitches is necessary for this purpose and additional courses of this character may be added to meet the needs of a particular glove, although I have found from experience that five is generally the maximum if a connecting web of too obvious proportions is to be avoided, while three is approximately the optimum number of such courses, the addition of a second of such courses being depicted in Figure 3*b*. At this stage, the tubular structure appears in slight perspective substantially as in Figure 3 and in plan substantially as in Figure 3*c*.

The next step is to form a thumb tube **38** which is accomplished by knitting successive courses only on those needles previously picked for the formation of the thumb, the remaining needles being held inactive. If the glove were removed from the machine after the last course had been added to the thumb, it would have substantially the appearance of Figure 4. Figure 4*a* is a schematic cross section taken substantially along line *4a—4a* of Figure 4, showing loops or stitches only around the thumb tube in order to illustrate that during this operation knitting is confined to those needles employed for the formation of the thumb. After completion of the thumb tube, the terminal loops are cast off from the thumb needles which are then permanently withdrawn from action and no longer enter the picture.

The next step is to develop a palm portion **40** of the glove by the addition to the tubular structure **35** defined by those needles held inactive during the formation of the thumb tube, of successive courses up to the approximate transverse level of the base of the little finger, as indicated in Figure 5, the thumb tube **38** being shown in this figure as being removed from the zone of active knitting. At the completion of the palm portion **40**, the desired number of cross-stitch courses are knitted to prepare this portion of the addition of a little finger tube, the glove now having the general appearance of Figure 6. Figure 6*a* is a detailed view of a cross-stitch course added to palm portion **40** which course subdivides the palm tube, exclusive of the thumb tube, into a small opening **41** for the little finger and the remaining larger opening **42**, the two being joined by a lacing **39**. After the desired number of cross-stitch courses have been formed, successive courses are knitted in the normal fashion only on those needles which have been previously selected for the little finger tube, the remaining needles being held inactive, until the finger tube **46** is of the desired length. The resultant structure is indicated in Figure 7 with Figure 7*a* being a cross section taken substantially along line 7*a* of Figure 7 and illustrating that knitting is done only on the little finger tube, the remainder of the tube structure **42** being held on its associated needles for use in subsequent steps. The terminal loops of the little finger tube are cast off from their needles, which are then permanently inactivated and the little finger tube withdrawn from the zone of active knitting.

I next add a limited number of successive courses to the basic tube structure remaining after the elimination of the little finger tube to complete the palm portion of the glove to the transverse level at the base of the ring, middle and index fingers, the body of the glove, at this point, having the appearance of Figure 8. Following this, the terminal end of the palm portion is prepared for the addition of the remaining finger tubes by knitting one to five, and preferably three, courses to interconnect the bases of the remaining finger tubes. As can be seen from Figure 9*a*, the cross knit course used here differs somewhat from that previously described in that two cross-stitches spaced apart laterally of the basic tube structure are produced. Thus, beginning at the left end of the remaining needles in the front bed, stitches are knitted on that number of needles corresponding to the number of loops necessary for the front side of the ring finger, after which the yarn is then crossed over to the

back bed and knitted on that number of needles necessary for the back side of the middle finger, and then brought forward again to the front bed of needles and knitted to the right end of the front bed. On the return part of the course, the yarn is picked up and knitted on successive needles of the rear bed, beginning at the right end and working inwardly for that number of needles necessary to form the rear side of the index finger, then crossed over to the front and knitted on the unused needles of that bed, and finally crossed back over to the rear bed and knitted on the needles remaining there. By this means, the tube structure **42** remaining after the subtraction of the thumb and little finger tubes is subdivided simultaneously into openings **43**, **44**, **45** for the remaining three fingers, a structure having the general appearance of Figure 9 being obtained. At this stage, the glove is ready for the addition of the ring, middle, and index finger tubes, preferably in that order, the ring finger **47** being completed by knitting the desired number of successive courses to the opening **43** to the left of Figure 9*a*, the remaining needles being withdrawn from active knitting (Figures 10 and 10*a*), the middle finger **48** completed by knitting successive courses to the opening **44** in the center of Figure 9*a* (Figures 11 and 11*a*) and finally the index finger **49** completed by knitting the desired number of successive courses on the remaining opening **45** to the right of Figure 9*a*. This completes the sequence of knitting operations and there remains only the usual independent operations, such as the closing of the tips of the fingers, washing, brushing, napping and the like, for the glove to be in truly finished condition. Following the usual practice, the tips of the fingers may be closed off by insertion of a draw string in the terminal loops of the fingers, the draw string being tightened and knotted to produce a dome-like closure at the end of the fingers and thumb, or in any other desired manner.

It will be understood that in knitting the glove by the procedure just described, the heel portion **31** may be fashioned along either or both sides, as desired, and along all or just a part of these sides to achieve the particular configuration or effect that may be most advantageous. Furthermore, after the thumb stitches have been cast off from the thumb subdivision of needles, these needles may be employed in widening or fashioning the edge of the palm portion **40** adjacent the thumb. In similar fashion, as the respective finger tubes are completed, the corresponding needles are available for widening an adjacent finger tube above its base, if such widening is desirable. The sequence in which the finger tubes are knitted is, of course, not critical and may be varied to meet the requirements of any given combination of glove, yarn, machinery, etc.

As was referred to in the preliminary section of this specification, the tip of the thumb and the tip of each finger, except the last or index finger, are respectively connected by lengths of yarn to the base of what has been termed the palm portion and the base of the next adjacent finger. The existence of this condition may also be inferred from the preceding discussion of the method of knitting the glove since the thread is not purposely severed or broken from the beginning of the cuff portion to the removal of the completed glove from the knitting machine. Contrary, however, to the impression that may be given by Figures 4, 7, 10 and 11, these lengths of yarn are actually quite short. This is due to the fact that regardless of whether the entire complement of needles or merely a selected number of such needles is engaged in active knitting, the zone or horizontal plane at which stitches are formed remain the same. Thus, when certain needles are actively knitting and other needles are inactive, merely holding previously formed stitches, the new stitches are made by the active needles in the same plane as the stitches being merely held. Accordingly, the distance which separates the last stitch formed by the active needles and the first stitch held by the inactive needles is merely that distance between adjacent needles and the extent of the connecting length of yarn is only substantially equal to such distance. In order to prevent the existence of a loose end of yarn, which might unravel or work loose, at the base of the palm portion or finger tube, as the case may be, which is about to be knitted, it is essential that the first step in knitting a part after the preceding part has been cast off its needles is to anchor the yarn at the base.

The technique I employ in anchoring is, broadly, one of floating the yarn in certain of the needles which will be involved in knitting the particular part and then knitting a stitch on one or more needles, including at least some of the needles holding the floated yarn. The specific needles used for floating or knitting at this point are largely a matter of individual choice and will vary in accordance with the type of yarn being knitted, the pattern desired, etc. By way of explanation, the term "floating" means that the yarn is merely laid in the hook of the needle, the movement of the needle being so controlled as to avoid the formation of a normal stitch.

A specific procedure for anchoring the loose ends which may be used is illustrated in Figures 13–17, showing specifically the last course added to the thumb tube, the "tying in" course at the beginning of the palm portion, and the first two courses of the palm portion. In Figure 13, the fragmentary tubular portion at the left and indicated in dotted lines represents the main tubular portion of the body of the glove defined by those stitches held inactive by the majority of needles of the machine and the smaller solid line tubular portion at the right represents the thumb tube which is actually being knitted on a selected group of needles. The last course of the thumb tube is begun at the left end of the thumb subdivision of needles on the front bed of the machine and is knitted to the extreme right end of this bed, then from the extreme right end of the back bed and toward the left up to the last needle of the thumb subdivision on the back bed, all in the usual way. At this point the action is broken off in Figure 13, to be continued in Figure 14, with the end of yarn and its direction at the imaginary point of interruption being indicated by the arrowhead. Going now to Figure 14, the yarn is brought to the first needle at the right end of the main body tube subdivision of needles on the rear bed and floated in the hook of this needle, as at **50**, after which it is brought forward to the extreme right needle of the main body tube subdivision on the front bed and floated in the hook of this needle, as at **51**. Here, the action is broken off in Figure 14 with the imaginary end of the yarn and its direction indicated by the arrowhead. Referring next to Figure 15, the yarn is passed back to the right end needle of the rear bed subdivision and knitted on this needle together with the previously floated stretch of yarn. Stitches are then successively knitted, from right to left, on the needles remaining in the back bed of the machine and, from left to right, on the needles in the front bed, all in the usual manner, until the last needle in the main body tube subdivision on the front bed is reached. The yarn that was previously floated in the hook of this needle and the yarn from the new course are now knitted into a stitch, the action in Figure 15 being broken off at this point. Continuing in Figure 16, a second course is added to the main body tube portion in the usual manner, the thumb tube portion having been eliminated from Figure 16 since it has been completed and is no longer involved in the procedure, and additional successive courses are formed in whatever number is necessary to complete the palm portion of the glove.

It will be understood that a special anchoring technique is not necessary in connection with the loose ends of yarn at the tips of the thumb and finger as these loose ends become secured coincidental with the closing of the ends of the thumb and finger.

In order to more clearly demonstrate what is meant by floating the yarn in the hook of the needle, there is shown in Figure 17 an enlarged fragmentary vertical cross section of the knitting machine, indicating the relationship of the needles and yarn, at a critical point of the floating in technique. As can be seen from this figure, the yarn **52** (at the right and resting on the open latch **53**), which was placed in the hook of the extended needle **54** during the previous course (not illustrated), was not drawn through the loop of the last complete stitch **55** on this needle, which is to say, that the last complete stitch was not cast off over the closed latch of the needle but was merely retained on the shank of the needle. When the needle **54** is protracted to engage the yarn **56** of the next course, at which position it is shown, the movement of the needle is restricted so that the floated yarn does not pass completely over the open latch. Thus, as the needle **54** is retracted to its normal rest position (not shown), the floated yarn and the yarn from the new course are together brought through the loop of the last complete stitch and together form the new stitch. Although I have described the preferred technique of tying in the loose ends of the yarn specifically only in connection with the thumb and the palm portion of the glove, it will be readily appreciated that the same technique is applicable to the tying in of the tips and bases of the fingers with the action being exactly reversed from that described for the reason that the yarn will be proceeding in the opposite direction on the opposite bed, as can be seen from Figures 9*a*, 10*a*, and 11*a*.

I have already mentioned that the use of coarse or heavy yarn, as is required in glove manufacture, necessitates a modified fashioning technique in order to avoid or minimize the presence of fashioning holes or islands at the point of addition of each needle, and in Figures 18–22 there is depicted the fashioning technique which is preferred for the purposes of the present invention. As is well known, a suitable number of needles at each end of each bed is held in reserve from the very beginning of the knitting to be employed for fashioning. Figure 18 represents the basic tube structure, for example, the cuff portion, to which it is desired that courses of gradually increasing length be added. Assuming, again, that the knitting is begun at the left end of the front bed of the machine, as in Figure 19, stitches are formed successively on the entire complement of needles in the front bed. At this point, new needles are to be added to the extreme right end of the arrays of needles hitherto engaged in active knitting. To accomplish this, a new needle adjacent the last of the original needles at the right end of the back bed is moved from retracted to extended position and the yarn is passed from the last needle at the right of the front bed to the back bed and engaged by the extended new needle, as at **57**. Next, a new needle at the right of the front bed is moved to extended position; a yarn is brought forward from the new needle on the back bed by which it was just engaged to the new needle on the front bed and engaged by the latter, as at **58**. Referring now to Figure 20, the thread is returned to the rear bed of the machine and a stitch **59** is knitted on the new needle through the loop **57** picked up by the new needle first brought into operation, after which successive stitches are knitted from right to left on the originally operative needles in the rear bed, from left to right on the front bed including the new needle, and so on. When it is desired to add new needles to the extreme left of the original group of needles, the yarn at the start of the new course in Figure 21 is first picked up on a new needle in the front bed, as at **60**, thereafter returned to the rear bed of the machine and engaged with a new needle at the left end of this bed, as at **61**, and then brought forward once more to the front bed and knitted through the loop **60** of the newly added needle, as at **62**. A complete normal stitch **62** having been knitted through loop **60**, a course is knitted on successive needles in the front and rear beds, including the needle with which loop **61** was formed, in the usual fashion (Figure 22). The procedure is then repeated as desired to add additional needles to the extreme ends of both beds of needles, although some modification in the path of the yarn may be necessary as a result of the different positions of these additional new needles, such modification being within the skill of a person familiar with the art. From the aforegoing, it will be appreciated that the essence of my new technique by which it differs from previous fashioning techniques resides in the knitting on each of the newly added needles after formation of the initial loops of a normal stitch constituting a part of a regular course before other new needles are added at the same end of the needle beds.

During the course of my experimentation with a continuous method of fabricating gloves, it became apparent that a change was necessary in both the design and actuation of the sinker array if gloves were to be successfully manufactured by such a method on a practical commercial scale. By way of explanation, sinkers are flat sheet metal members of rather peculiar configuration which are arranged vertically in closely spaced parallel relationship with the needles disposed in the intervening spaces. The sinkers function in the nature of a grate into and out of which the needles move and by means of which the needles, when retracted, are able to form U-shaped loops of yarn. An additional role performed by the sinkers is that of retaining previously formed stitches while new stitches are being made and removing from the zone of active knitting stitches as they are formed. For this purpose, each sinker is provided at its inner end with a small downwardly directed hook.

With specific reference now to Figures 23 and 24, there is shown the particular sinker which has been considered standard equipment for use with the flat bed knitting machine for many years and it will be observed that the upper portion of the sinker is extended toward the left in the form of a downwardly opening hook **70** beneath which is a substantially vertical edge **71**. The hook and edge are the only parts of the sinker which have a direct yarn contacting function and, thus, are of importance in the present discussion, the main body of the sinker being provided for purposes of support and control, as is well known.

It will be recalled from previous passages of this specification that the principal advantage of the flat bed machine is its ability to knit on one group or subdivision of needles while another group or subdivision and the stitches held thereon is maintained inactive. While this selective knitting cannot be carried out indefinitely, it can be carried out up to a point where the courses added by the actively knitting needles total six or slightly more inches in length. It will be recalled further that the part of the article which is being held on the inactive needles remains connected to that part which is being actively knitted and that the last course of the temporarily static part is being held in the same plane, or at the same level, as the successive courses being added to the selectively developed part, although, in terms of the fully extended article, they may be as far apart as six or more inches. It will therefore be appreciated that a strain of considerable degree is imposed upon the stitches being held inactive, particularly those closely adjacent the selectively developed part, and the practical extent to which selective knitting may be carried out is determined by the point at which the fixed stitches give way.

I have found that if, instead of forming the stitches along the vertical edge of the sinker beneath the hook, as shown in Figure 24, which is conventional in the art, the stitches be formed on a vertical edge projecting above the point of the hook, and, consequently, spaced inwardly from the vertical edge below the hook, the ability of the

temporarily static stitches to withstand the strain of selective knitting is substantially increased and the tendency of the yarn to rupture under this strain due to localized abnormal conditions of weakness in the yarn is substantially diminished. The improved version of the sinker may be seen in Figures 25 and 26 and it will be noted that the sinker includes an upwardly extending protuberance **73** at its inner end, having a more or less vertical edge **74** terminating in the point of a hook **75** and a vertical edge **76** spaced rearwardly from and extending below hook **75**. Figure 25 also demonstrates that the stitches are actually formed on the vertical edge **74** of the protuberance **73** rather than on the vertical edge **76** beneath the hook. By this means, when the yarn contacting the edge **74** of the protuberance moves to the edge **76** disposed beneath the sinker hook, as occurs during the operation of the machine to be explained shortly, a slight degree of slack or looseness is formed in the stitch, enabling it to better withstand the strain of selective knitting.

As is well known in the art, the action of the needles and sinkers is controlled by cam means, the needles on one bed being successively protracted and retracted as the cam means moves along the stroke of the machine from one end to the other and the needles on the other bed being actuated on the return stroke of the cam means. The movement of the sinkers is similarly governed. In accordance with the practice of the prior art, as can be seen from Figures 23 and 24, the sinkers on either side of a given needle are raised to elevated position (Figure 23) just before the needle is moved to extended or thread-engaging position, shown in dotted lines. The sinkers remain elevated until the needle is returned to its normal stitch-forming position, after which they are permitted to return to their rest position, shown in Figure 24. The sinker being lifted when the stitch is being formed, such formation will take place beneath the hook on the vertical edge **71** there provided. From this, it can be seen that in order for the stitch to be formed on the upper and forward vertical edge **74** of my improved sinker, some adjustment must be made in the control sequence of the machine.

In accordance with the concept of the present invention, the order of operation of the sinker and needle is essentially reversed. Thus, the sinker is retained at normal rest position (Figure 25) entirely throughout the period during which the needle associated therewith is protracted and retracted to form a stitch and only at some later time is it elevated (Figure 26) to permit the terminal ends of the stitch at the sinker edges to pass under the hook to the edge **76**. The exact point of time in the order of operations at which the sinker is elevated is relatively immaterial, provided it occurs subsequently to the formation of a complete stitch and while the needle is motionless. Hence, the timing may be fixed so that sinker elevation takes place substantially 180° out of phase with stitch formation, that is, as the stitches are being formed at one point on one bed of the machine, the sinkers are being lifted at approximately the diametrically opposite point on the other bed of the machine, or the timing can be so set that the sinkers are elevated relatively shortly after the stitches are completely made.

There is a further reason why it is desirable during selective knitting to form the stitch on an extended upper edge of the sinker rather than on the lower edge beneath the hook. In the flat bed knitting machine, the yarn is fed by a traversing mechanism which traverses the entire length of the beds irrespective of whether all or only a part of the needles are in active use and, contrary to the case of the needles, the sinkers are not readily adapted for selective disengagement from their operating mechanism but are elevated irrespective of whether or not the needles with which they are associated are or are not actively engaged in knitting. As a consequence of this, if the sinkers are elevated while the yarn is in its vicinity, there is a tendency for the yarn to be caught or snagged underneath the raised hook of the elevated sinkers, forming long loops extending over the inactive section of the machine, which loops, if not discovered, interfere with the subsequent operation of the machine, and, further, constitute a defect in the glove remediable only with difficulty, if at all, or, if discovered, necessitate the shutting down of the machine for purposes of removal, causing the presence of unanchored loose ends of yarn. By maintaining the needles depressed, as is contemplated herein, the sinkers are less accessible for inadvertent engagement with the yarn being fed and there is virtually no tendency for the yarn to be snagged.

When the stitches are formed on the extended upper edge **74** of the sinker, there is, of course, no hook available which would prevent the terminal reverse bends of yarn formed on such edge from passing over the top of the sinkers, in contrast with conventional procedure, and it may develop during the practice of this invention that some of these loops will tend to slide over the extended top of the sinker as a result of slight misalignment of the sinkers in the bed of the machine. Normally, if the extended edge of the sinker is sufficiently long, this will not be a serious problem. Should it occur, however, it can be easily obviated by adjusting the sinker control mechanism so as to give the sinker a very slight preliminary elevation just prior to stitch formation to thereby center the yarn along the extended vertical edge of the sinker, the sinker being fully elevated only after the stitch is completely formed. The amount of this preliminary elevation will be very small and will, in no case, be great enough to permit the stitch to be formed against the edge **76** under the hook of the sinker.

In order to simplify and facilitate an understanding of the invention, the description has proceeded as though only a single continuous yarn were being knitted throughout. While the use of a single yarn is representative of the practice of the invention in its most elemental form, it is not to be inferred that this is an essential characteristic. As a practical matter, it is frequently preferred to simultaneously knit two or more yarns in part or all of the glove or to alternately knit several different yarns or combinations of yarns in order to obtain a pattern effect, this being made possible by means of a conventional patterning mechanism.

From the foregoing, it will be evident that I have resolved virtually all of the problems in the continuous manufacture of gloves on a flat bed knitting machine and that by following the principles set forth in connection with the various aspects of this invention there can be manufactured at an extremely low cost a glove free from defects and objectionable features which is fully commercially acceptable to the trade. The various specific embodiments which have been shown and described are to be considered as illustrative only and not as restricting the scope of the invention, as various modifications and changes would be suggested thereby to the expert in this field, particularly, though not exclusively, as regards the sequence of steps, except where such sequence is critical.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. In a continuous method of knitting seamless tubular gloves on a flat bed knitting machine which includes the steps of knitting a wrist-band portion, knitting a fashioned partial hand portion to said wrist portion, knitting a thumb tube to a section of said hand portion adjacent one end thereof, completing said hand portion, and adding finger tubes in sequential order, to the completed hand portion, the improvement which comprises knitting in the course of the method at the transverse levels of the base of the thumb and the fingers, respectively, at least one course of stitches including a cross-stitch at at least one point corresponding to at least one of the crotches between the thumb tube and completed hand portion and

between adjacent finger tubes, cross-stitches at all of said crotch points being ultimately provided.

2. The method of claim 1 wherein from one to five of said courses including a cross-stitch is knitted at each of the bases of the thumb and fingers.

3. The method of claim 1 wherein said partial hand portion is fashioned by progressively adding needles to at least one end of the courses of said hand portion to gradually lengthen subsequent courses, at least one normal stitch constituting a part of a regular course being knitted on each new needle after its addition and before the addition of other needles at the same end.

4. The method of claim 1 wherein the stretches of yarn between the extreme termination of the respective digital tubes and the part next in order to be knitted are securely anchored at the base of said next part.

5. The method of claim 4 wherein each of said stretches of yarn is anchored by floating the yarn in the hook of at least one needle and thereafter knitting stitches on at least one needle in which the yarn was floated.

6. In a method of continuously knitting a seamless tubular glove on a flat bed knitting machine having a plurality of needles alternating with a plurality of sinkers, said needles being successively protractable and retractable to form stitches and said sinkers being elevatable from a rest position, the improvement which comprises actuating each of said needles to form a stitch while the sinkers associated with said needles are at rest position and elevating said sinkers only after the formation of said stitch is at least substantially complete.

7. A modified sinker adapted for use in a flat bed knitting machine comprising a body portion, a hook at one end of said body portion, a downwardly projecting hump on said body portion having a generally vertical edge spaced slightly from the point of said hook and extending generally below the point of said hook, and an upwardly directed protuberance on said hook end, having a generally vertical edge extending above and in general vertical alignment with the point of said hook.

8. In a continuous method of knitting seamless tubular gloves on a flat bed knitting machine having two spaced opposed beds of needles, the steps of knitting a wrist band portion; knitting to said wrist band portion a partial hand portion extending up to the general transverse level of the base of the thumb of the glove while fashioning said portion along at least one edge thereof; knitting to the partial hand portion from one to five courses of stitches preparatory to the addition of a thumb tube, said preparatory courses being formed by knitting in one direction along one bed of needles until the point which is to constitute the crotch of the thumb is reached, then crossing over to the other bed of the machine and knitting in the same direction to the end of said other bed, next knitting in the opposite direction on the remaining needles of said first bed until the crotch point is reached, and finally again crossing over to said second bed and knitting in said opposite direction on the remaining needles of said second bed; knitting a thumb tube to the prepared partial hand portion; knitting to the remainder of the partial hand tube a completing hand portion; knitting to the completed hand portion at least one group of one to five preparatory courses, wherein the yarn is crossed over from one bed to the other at at least one point corresponding to the crotch of a finger; to provide cross-overs of yarn at each crotch between adjacent fingers, and adding finger tubes to the prepared completed hand portion.

9. In a method of continuously knitting a seamless tubular article on a flat bed knitting machine having alternating needles and sinkers, the sinkers having a hook at one end thereof, a first edge extending generally upwardly from the point of said hook, and a second edge spaced from the hook in the direction of the other end of the sinker and extending generally downwardly from the hook, the improvement comprising forming each stitch against the upwardly extending edges of an adjacent pair of sinkers and, subsequent to such formation, transferring the sinker-contacting portions of said stitch to the downwardly extending edges of said sinkers, below the hook of the sinker.

10. In a continuous method of knitting a furcated article on a flat bed knitting machine having opposed beds of needles, the improvement comprising knitting at each of the crotch points between the furcations a plurality of cross-stitches, one from each of a plurality of courses, said cross-stitches being formed by crossing the yarn being knitted from one bed to the other at said point in both directions of knitting.

References Cited in the file of this patent

UNITED STATES PATENTS

10,998	Wood	June 6, 1854
13,621	Powell	Oct. 2, 1855
578,153	Lamb	Mar. 2, 1897
583,040	Franck et al.	May 25, 1897
2,270,619	Bowyer	Jan. 20, 1942
2,318,772	Gluck	May 11, 1943
2,418,957	Simmat	Apr. 15, 1947
2,450,067	Wolff	Sept. 28, 1948
2,762,213	Schurich	Sept. 11, 1956

FOREIGN PATENTS

239,959	Germany	Oct. 27, 1911