United States Patent

[11] 3,613,608

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New York, N.Y.

[54] CONTROL EQUIPMENT FOR MANUFACTURING EQUIPMENT SUCH AS SEWING EQUIPMENT AND THE LIKE

42 Claims, 27 Drawing Figs.

[52] **U.S. Cl.** ..... **112/2,** 318/20.102, 346/33 MC
[51] **Int. Cl.** **D05b 23/00**
[50] **Field of Search** ..... 112/2, 121.11, 121.15, 102, 219 A, 252, 262; 235/151.11; 346/33 MC; 318/162, 20.102; 340/172.5

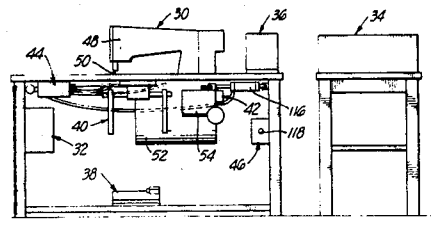
[56] **References Cited**

UNITED STATES PATENTS

2,537,770	1/1951	Livingston et al.	346/33 MC
2,882,847	4/1959	Winz	112/219
2,996,348	8/1961	Rosenberg	346/33 MC
3,178,716	4/1965	Slatin	346/33 MC
3,186,366	6/1965	Haas et al.	112/219
3,324,281	6/1967	Morse	318/18 X
3,386,402	6/1968	Ross	112/252
3,445,639	5/1969	Martens	318/162 X
3,449,540	6/1969	Yanko et al.	318/162 X
3,459,144	8/1969	Ramsey et al.	112/102

Primary Examiner—James R. Boler
Attorney—Mahoney, Hornbaker & Schick

ABSTRACT: The manufacturing equipment is preferably in the form of sewing equipment comprised of a usual sewing head with a reciprocal up and down moving needle electrically driven for sewing a plurality of stitches in an article to be sewn. A presser foot retains the article in place during sewing and downwardly against usual feed dogs which move the article forwardly and rearwardly appropriate for the various stitching operations. A needle positioner is operable with the sewing with the sewing head for positioning the needle in a selected up or down position relative to the article at the termination of any sewing operational step, the needle preferably being positioned down extending through the article between at least certain successive sewing steps so that the article may be manually repositioned by an operator between said steps. A thread cutoff component is operably arranged with the sewing head for cutting off thread used by the needle in stitching at the termination of selected sewing steps, the thread cutoff being operable when the needle is up above the article as positioned by the needle positioner. According to the invention, the needle positioner also includes a counter device automatically counting reciprocations of the needle and capable of transmitting an electrical signal equivalent to such movement count. The sewing equipment may be controlled by the usual manually operable switches such as knee control and foot control switches. The equipment likewise may include usual components such as an automatic pickup for supplying articles to the operator and an automatic stacker for removing sewn articles from the operator, and the sewing head may make use of usual attachments such as pleater and buttonhole attachments. Further, according to the invention, an automatic controller, a power interface and preferably an automatic recorder are electrically connected with the sewing equipment, and a permanent record command switch is preferably arranged with the foot control switch. The power interface serves to electrically integrate the manually operable switches and the automatic controller with the sewing equipment, said power interface being selectively switchable between a manual mode and an automatic mode. In manual mode, the power interface connects the manually operable switches for usual control of the sewing equipment to perform a plurality of operational steps in an overall sewing operation on the article to be sewn, while at the same time, the power interface translates each of the component operational steps into composite instruction signals for transmission to and temporary recording at the automatic controller, any selected of said composite instruction signals being permanently recorded by the automatic controller in sequence by actuation of the permanent record command switch. Each instruction signal includes both function, the component being operated, and duration, either pure time in time elements or needle reciprocations from the needle positioner and counter. The automatic recorder is connected to the automatic controller and is selectively actionable for inserting in proper sequence into temporary and permanent recording of the automatic controller composite instruction signals equivalent to certain of the composite instruction signals resulting from actual operation of the sewing equipment so that selected of the sewing equipment operations either need not be carried out by manual control or may be replaced by the automatic recorder. Also, the automatic controller is arranged for inserting instruction signals for determined time delays between selected component operations, either by permanently recording actual delays between component operations or by inserting numbers of time elements with the automatic recorder. Instructions for indeterminate time delays between component operations and training time delays intermediate selected component operations may likewise be appropriately inserted into the automatic controller. After completion of the permanent recording, when the power interface is in the automatic mode, the automatic controller may be operated to transmit back to the power interface the permanently recorded instruction signals in sequence which are translated by the power interface into commands for operating the various components to repeat the component operational steps to carry out the overall sewing operation including the now inserted determined delays, indeterminate delays and training delays. During the determined delays, a preceding operating component is stopped, the determined delay carried out in time, and a latter component started automatically. During the indeterminate delays, the preceding component operation is stopped, but the latter component operation is not started until manually actuated by a manual control. The training delays are indeterminate and may be intermediate a selected component operation interrupting such operation until manual control actuation or between component operations as an ordinary indeterminate delay, in either case, there being means on the automatic controller for selected elimination of the training delays with the effect of removal from the automatic controller permanent recording.



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FIG. 1.

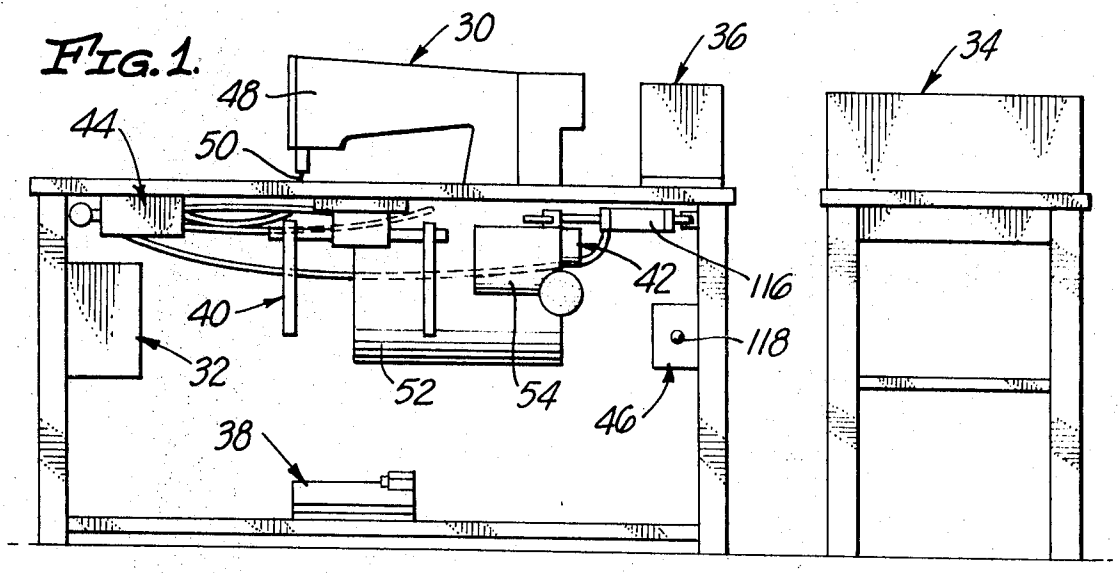


FIG. 2.

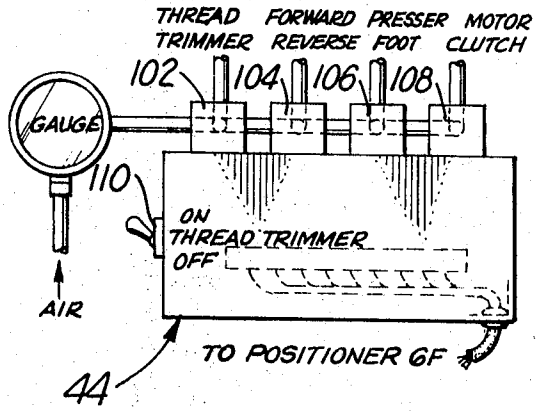


FIG. 3.

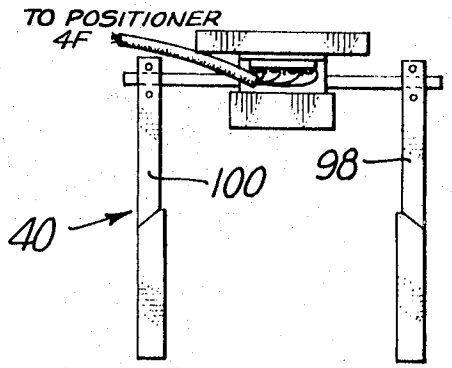
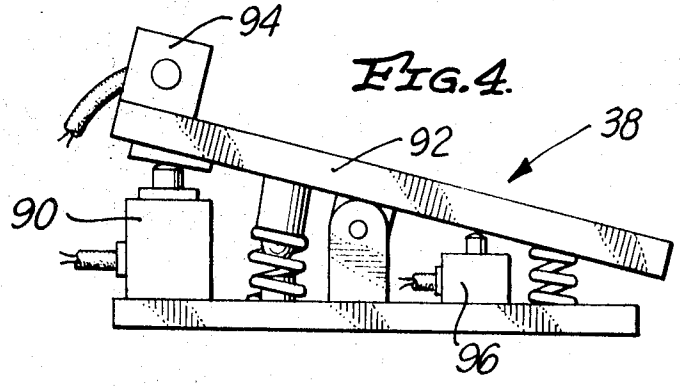


FIG. 4.



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FIG. 5.

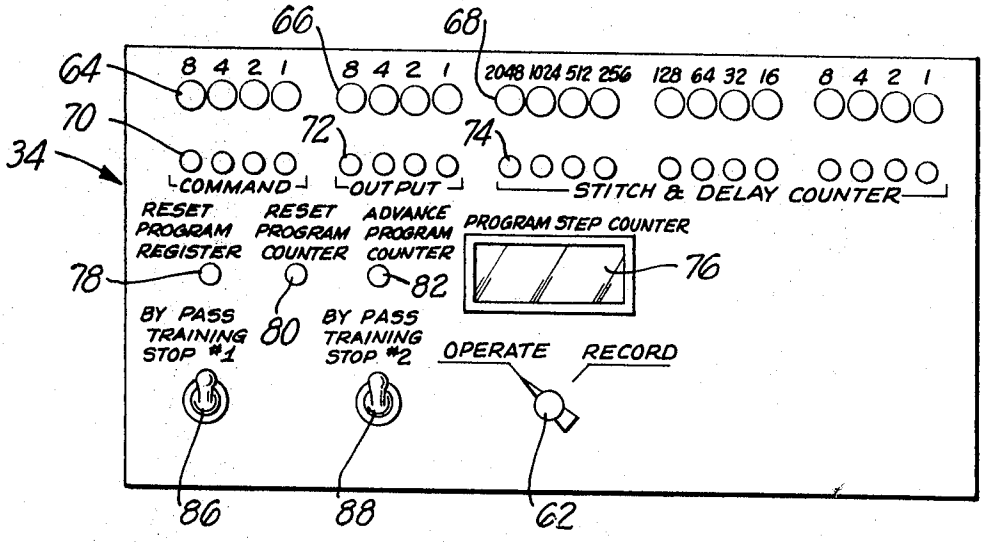


FIG. 6.

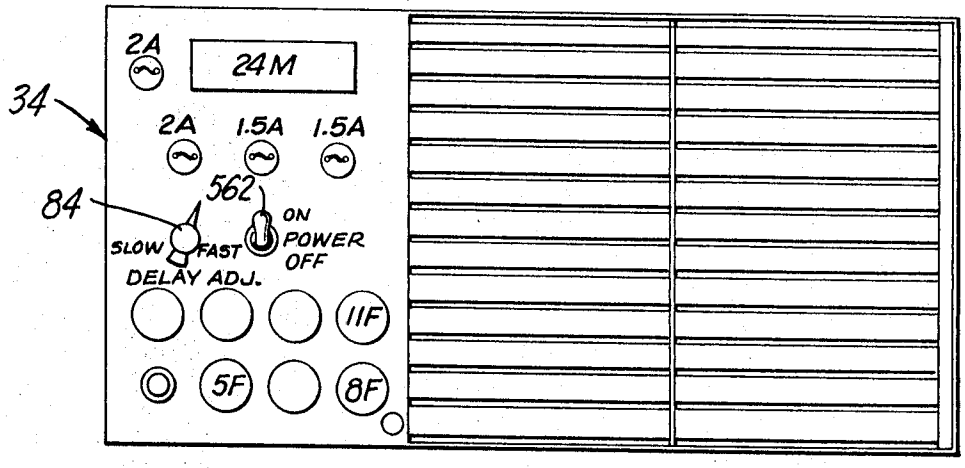
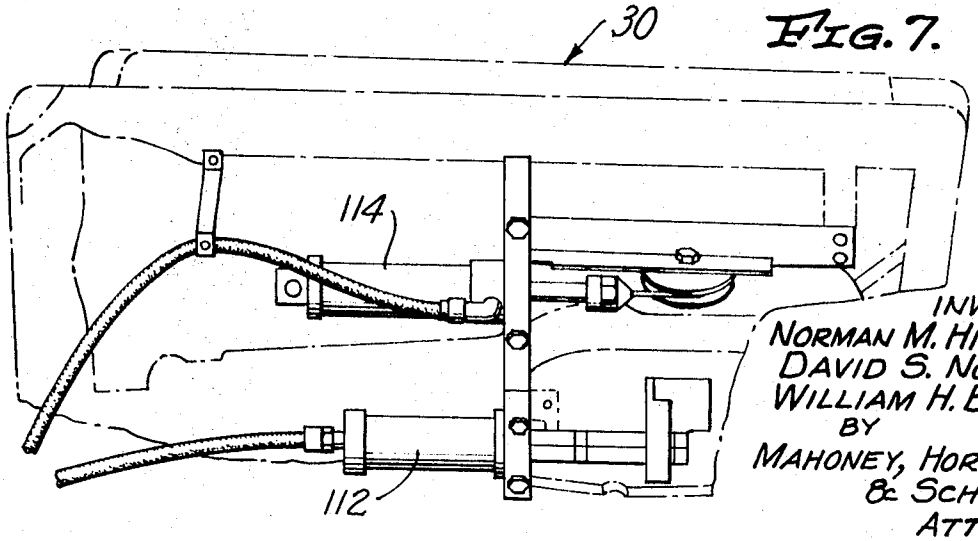


FIG. 7.



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FIG. 8.

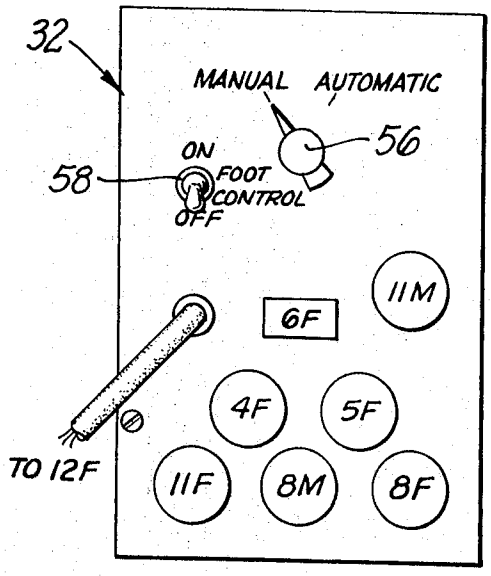


FIG. 9.

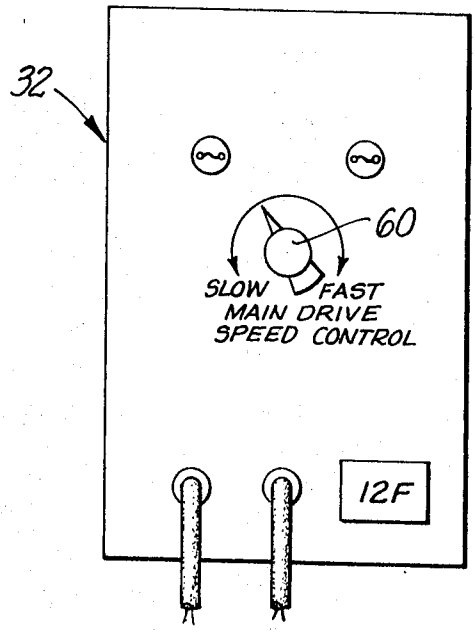
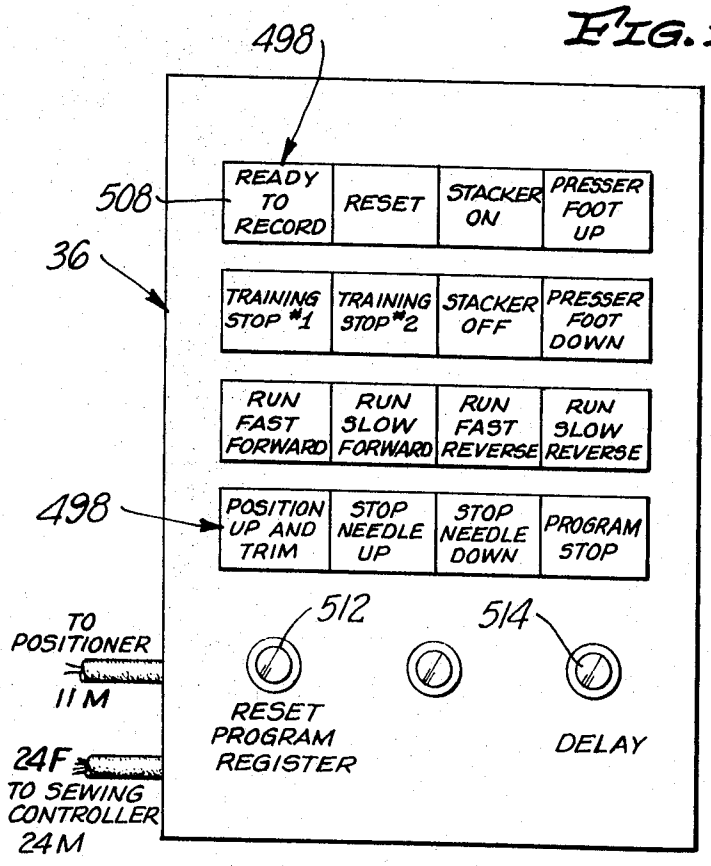
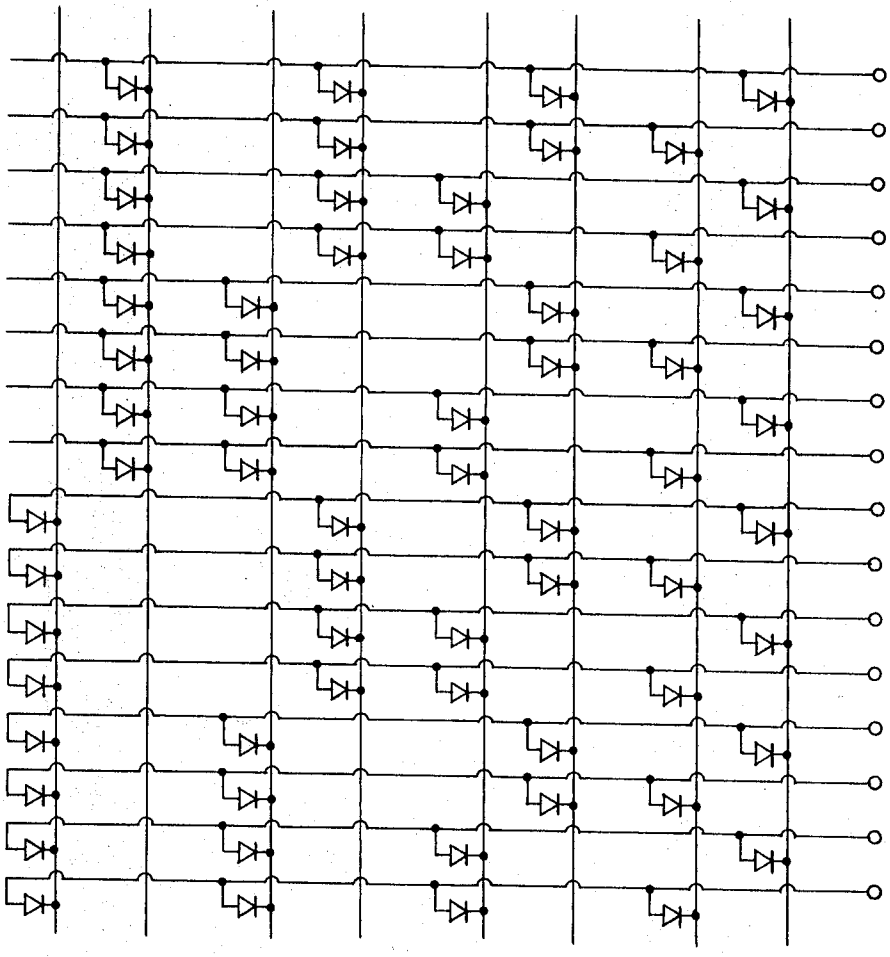


FIG. 10.



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FIG. 18.



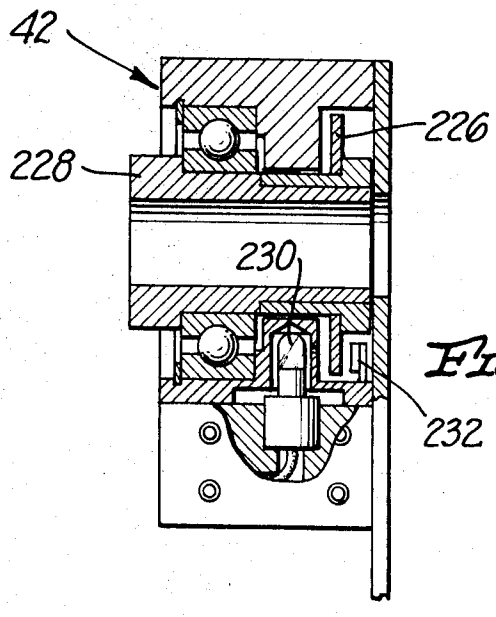
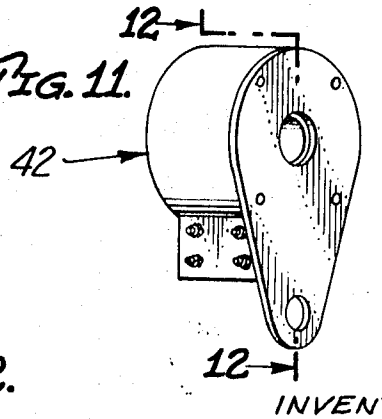


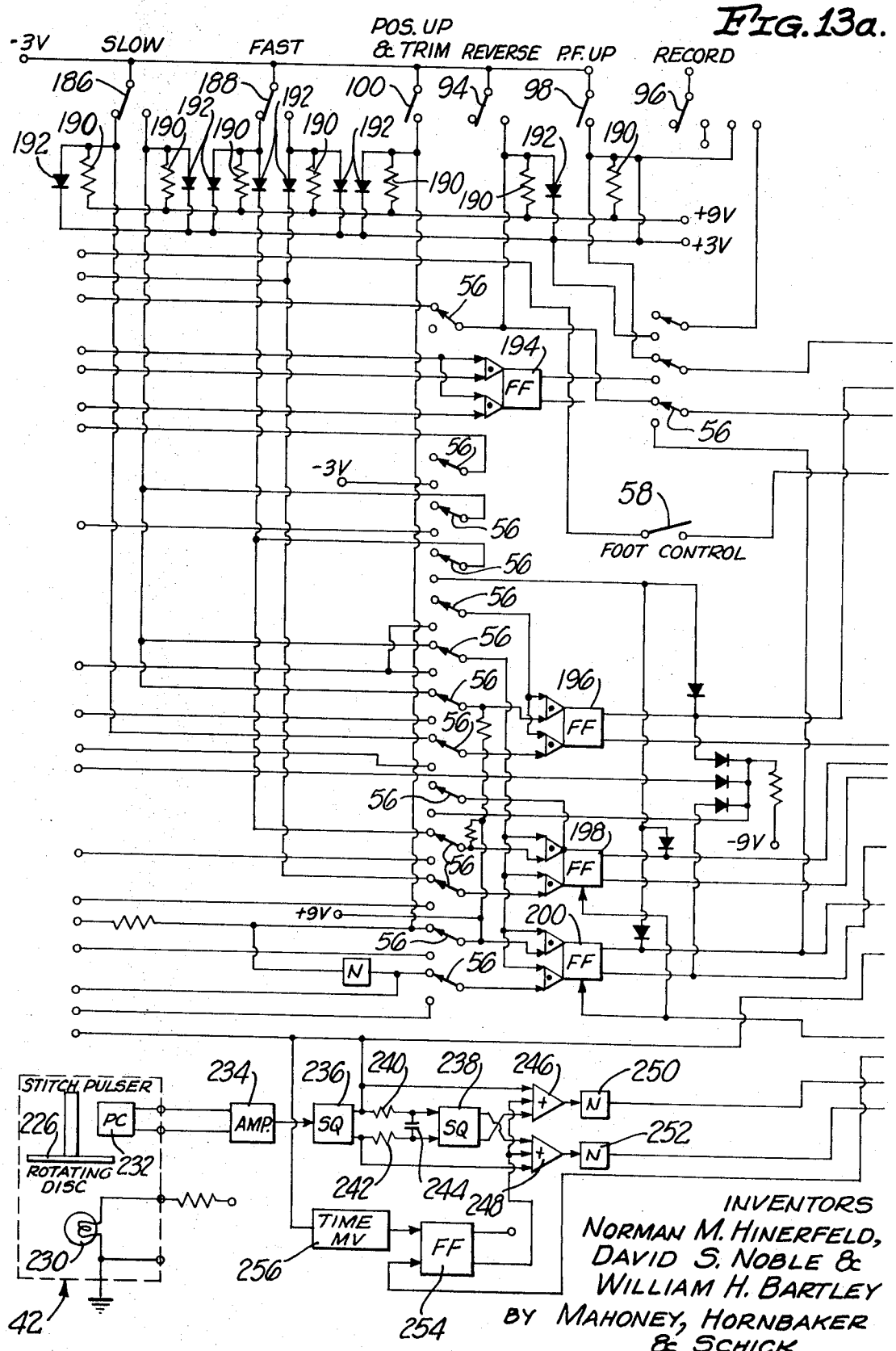
FIG. 12.

FIG. 11.



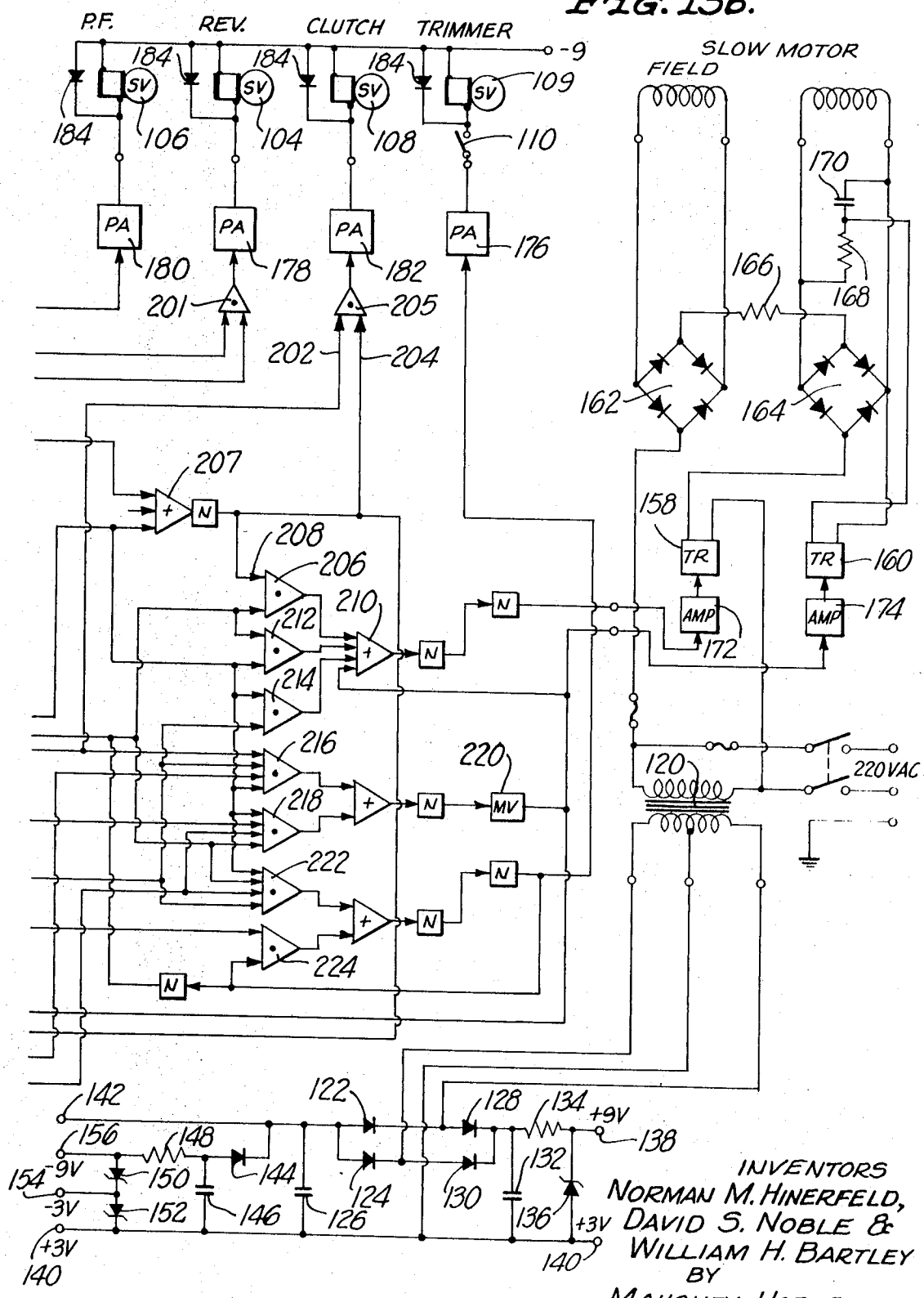
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FIG. 13a.



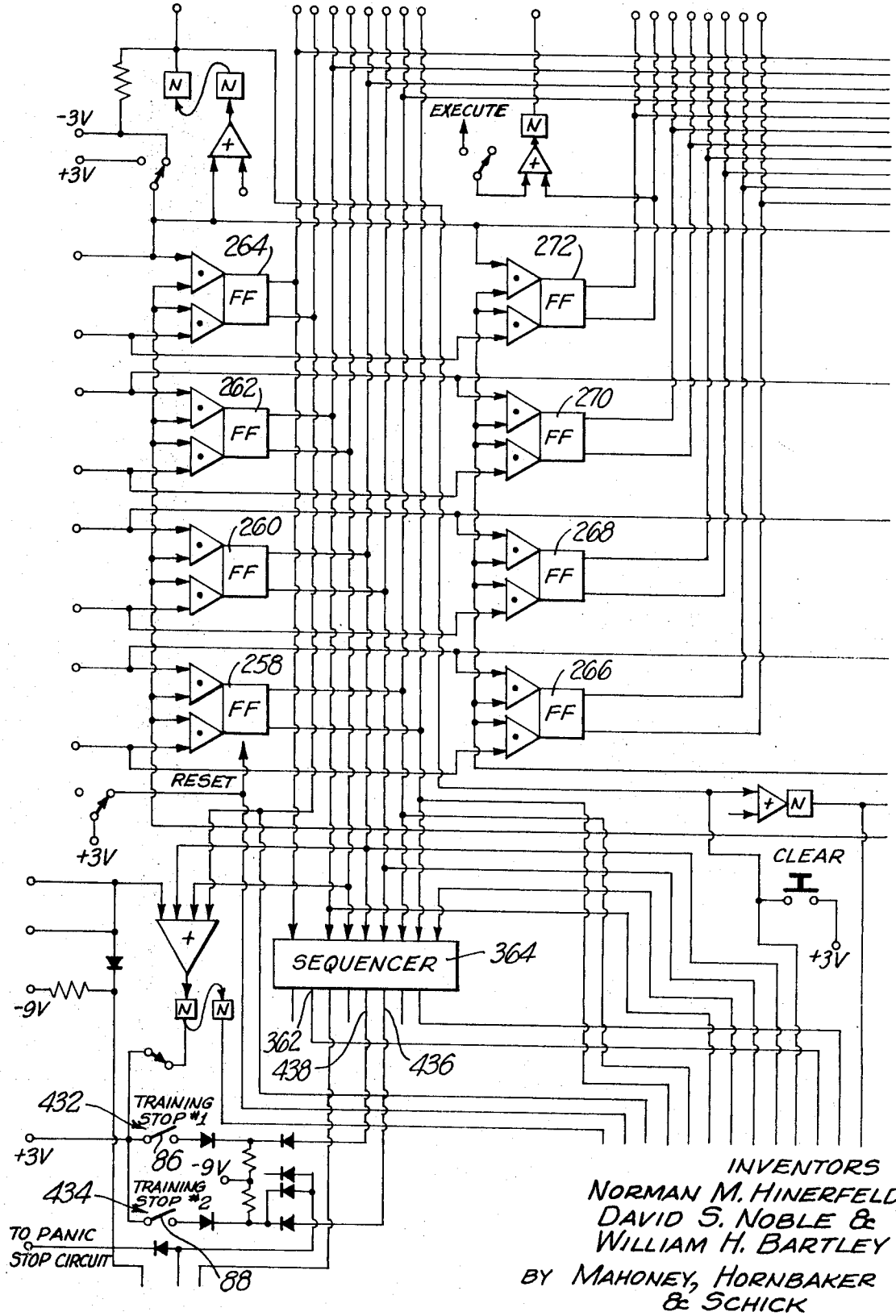
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FIG. 13b.



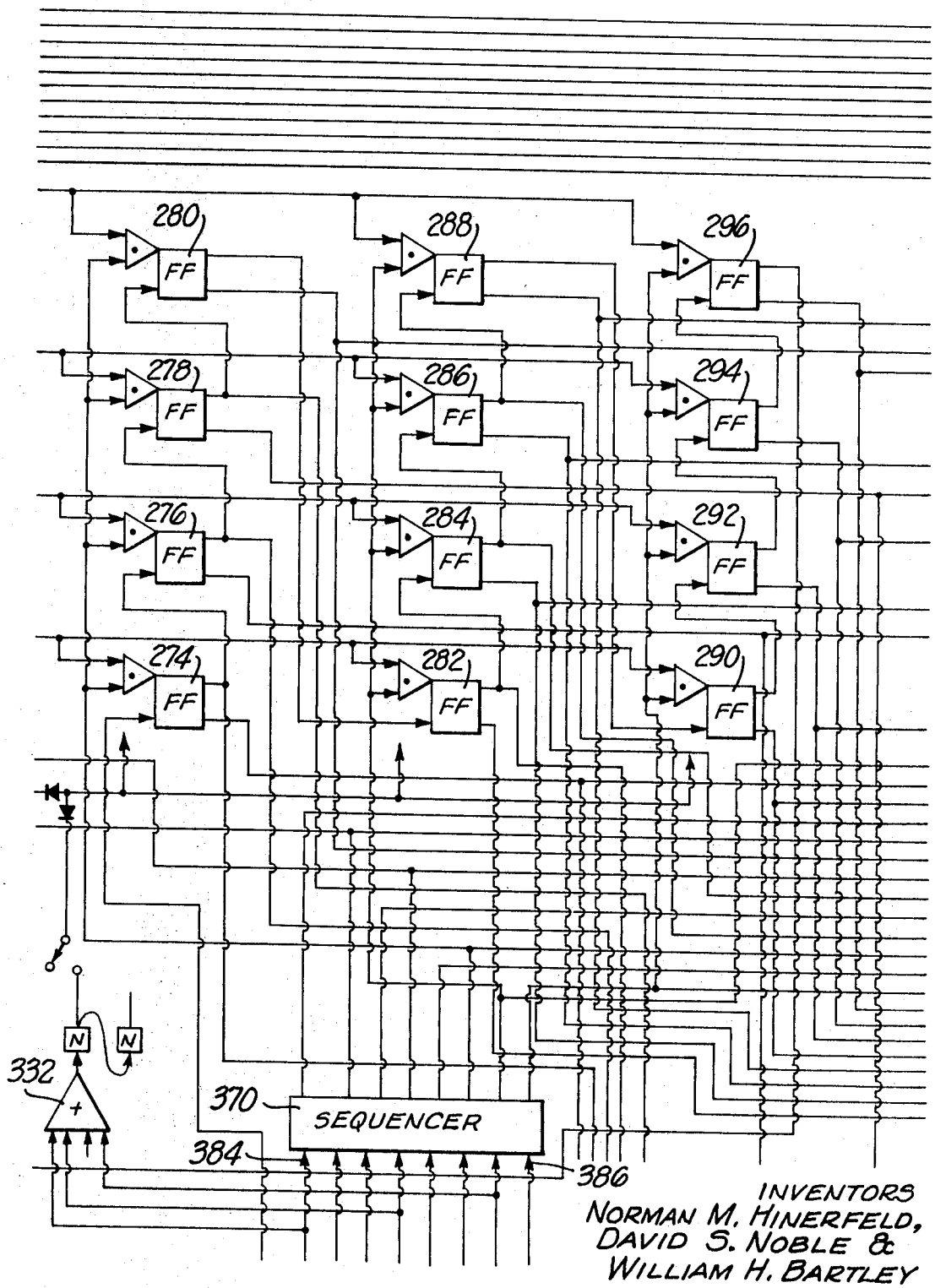
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FIG. 14a.



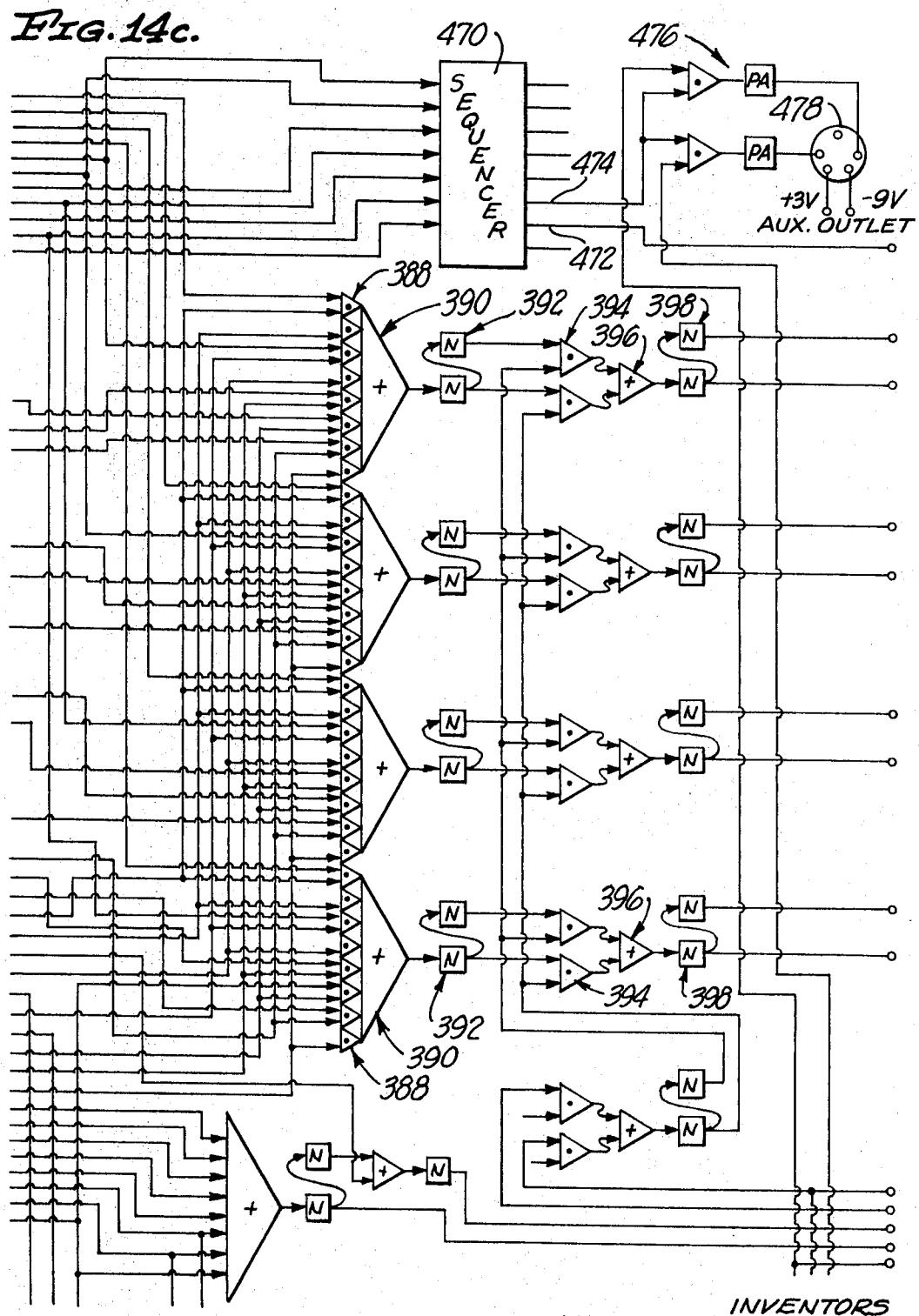
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FIG. 14b.



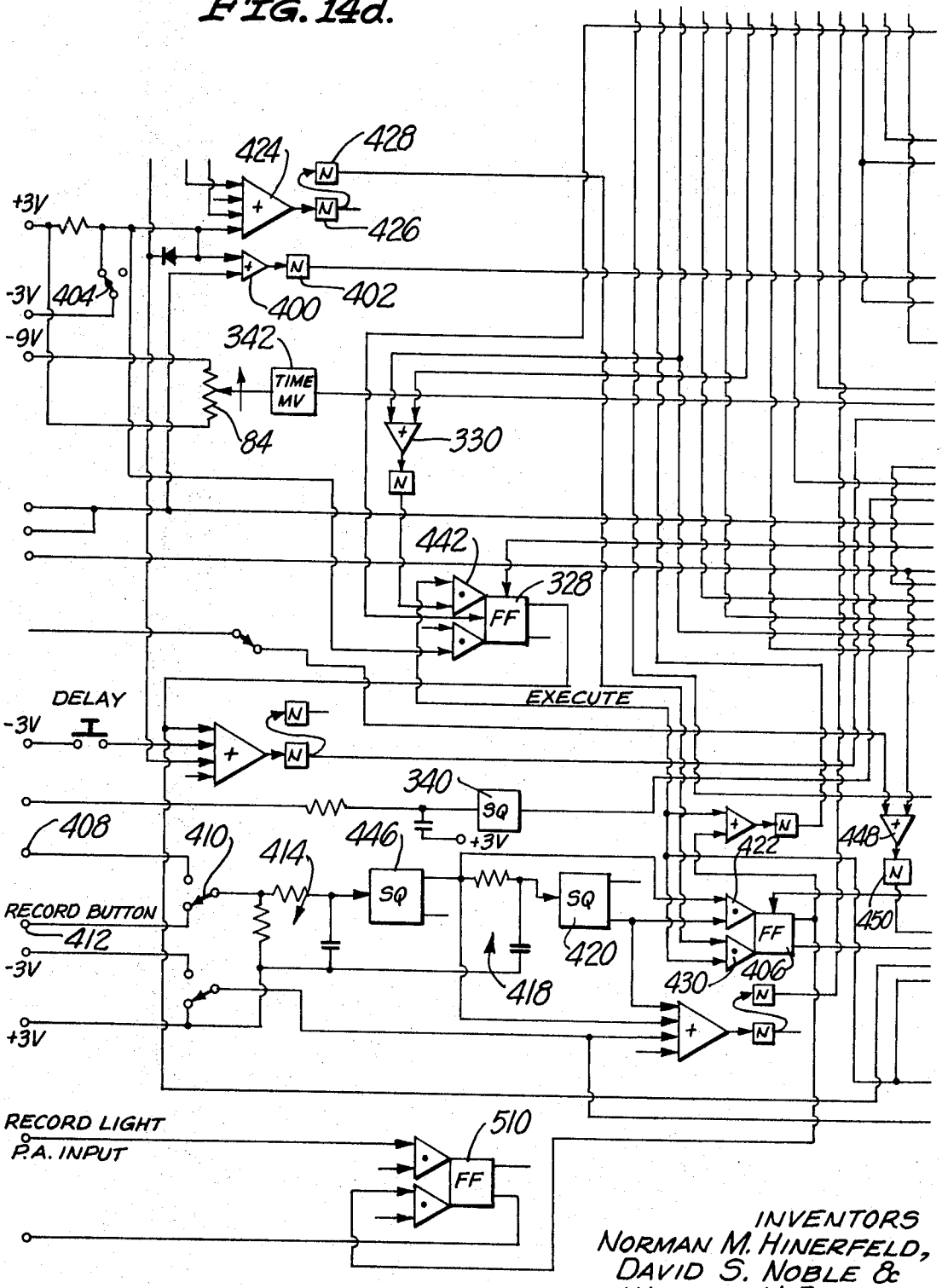
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FIG. 14c.



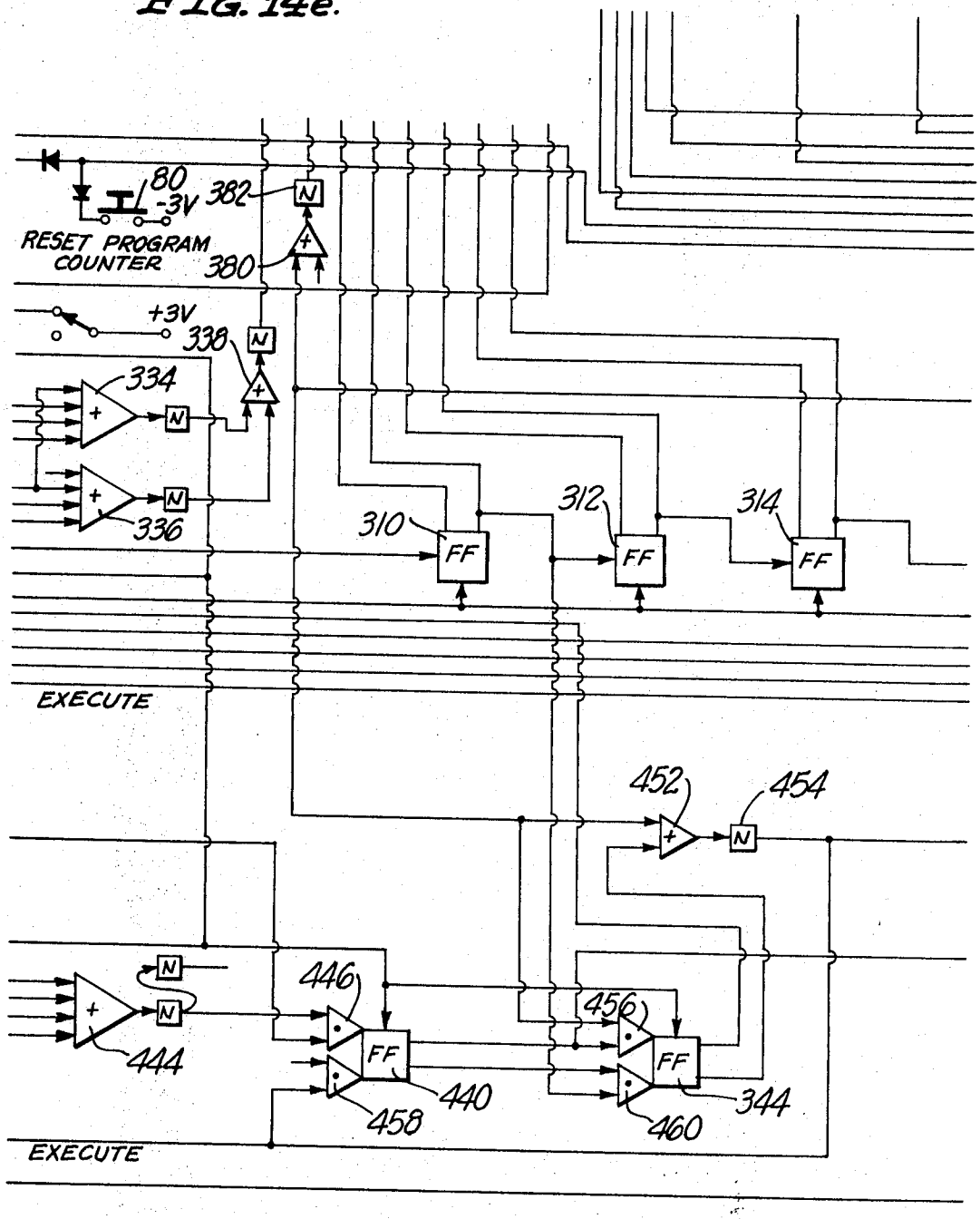
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FIG. 14d.



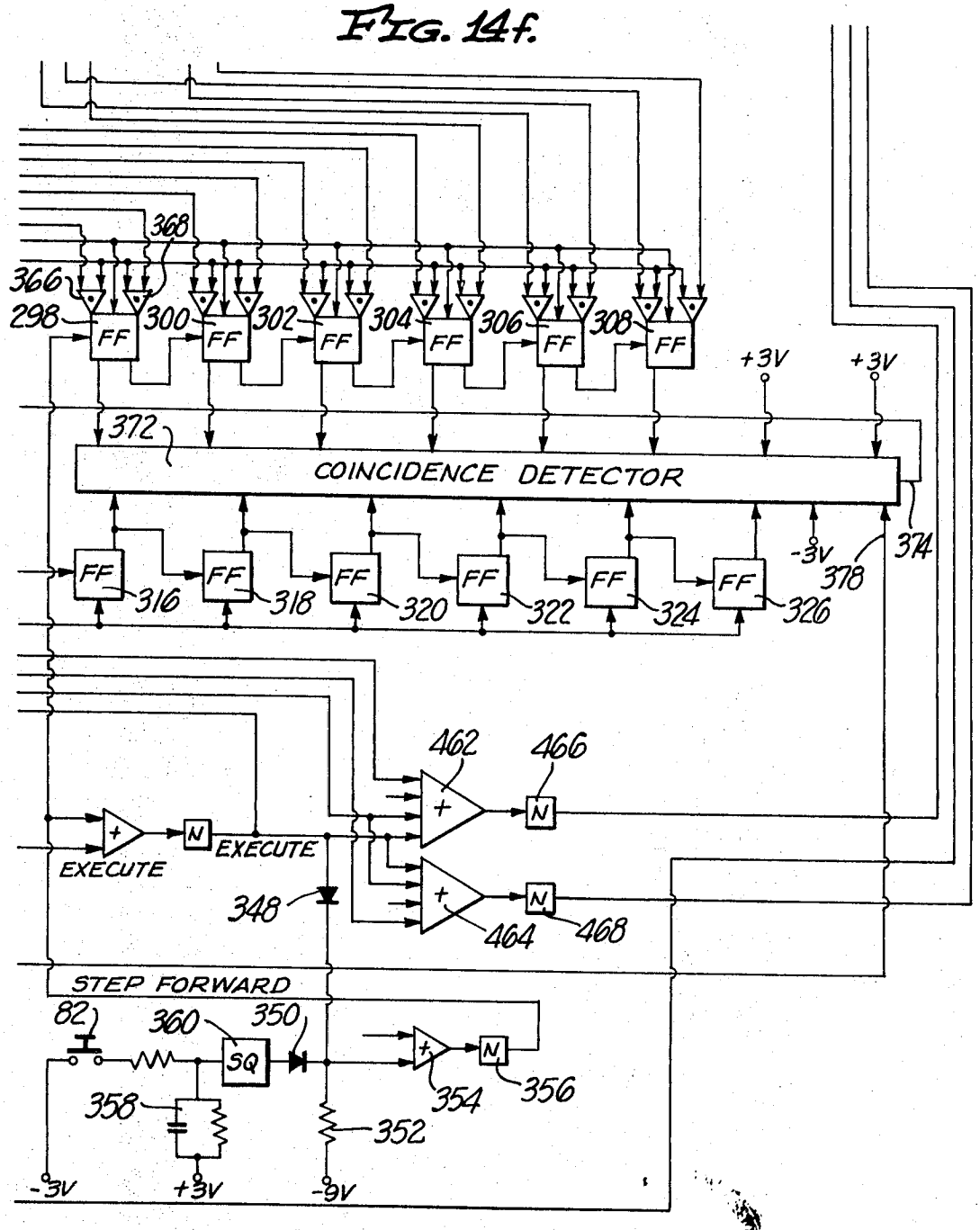
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FIG. 14e.



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FIG. 14f.



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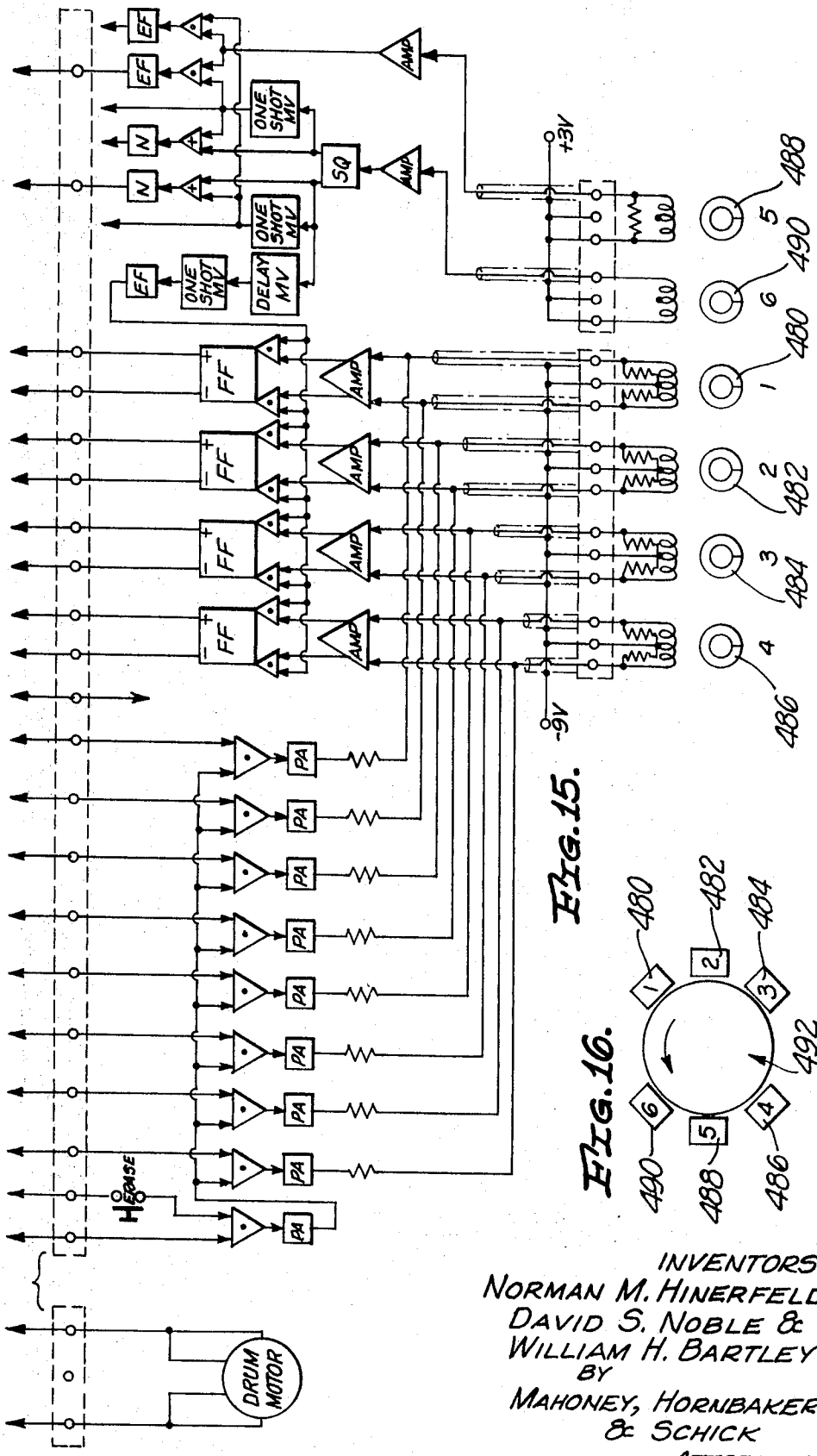
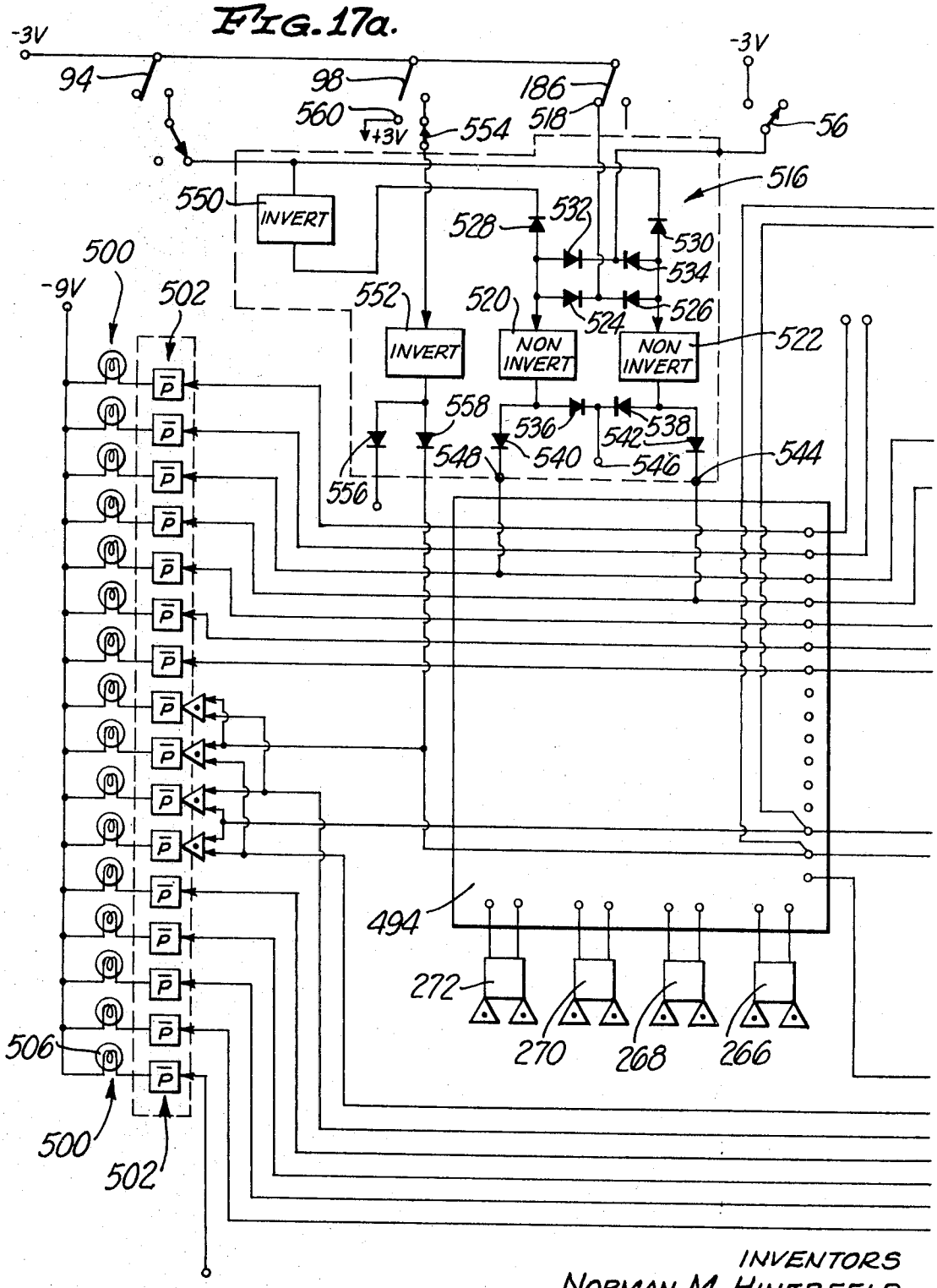


FIG. 15.

FIG. 16.

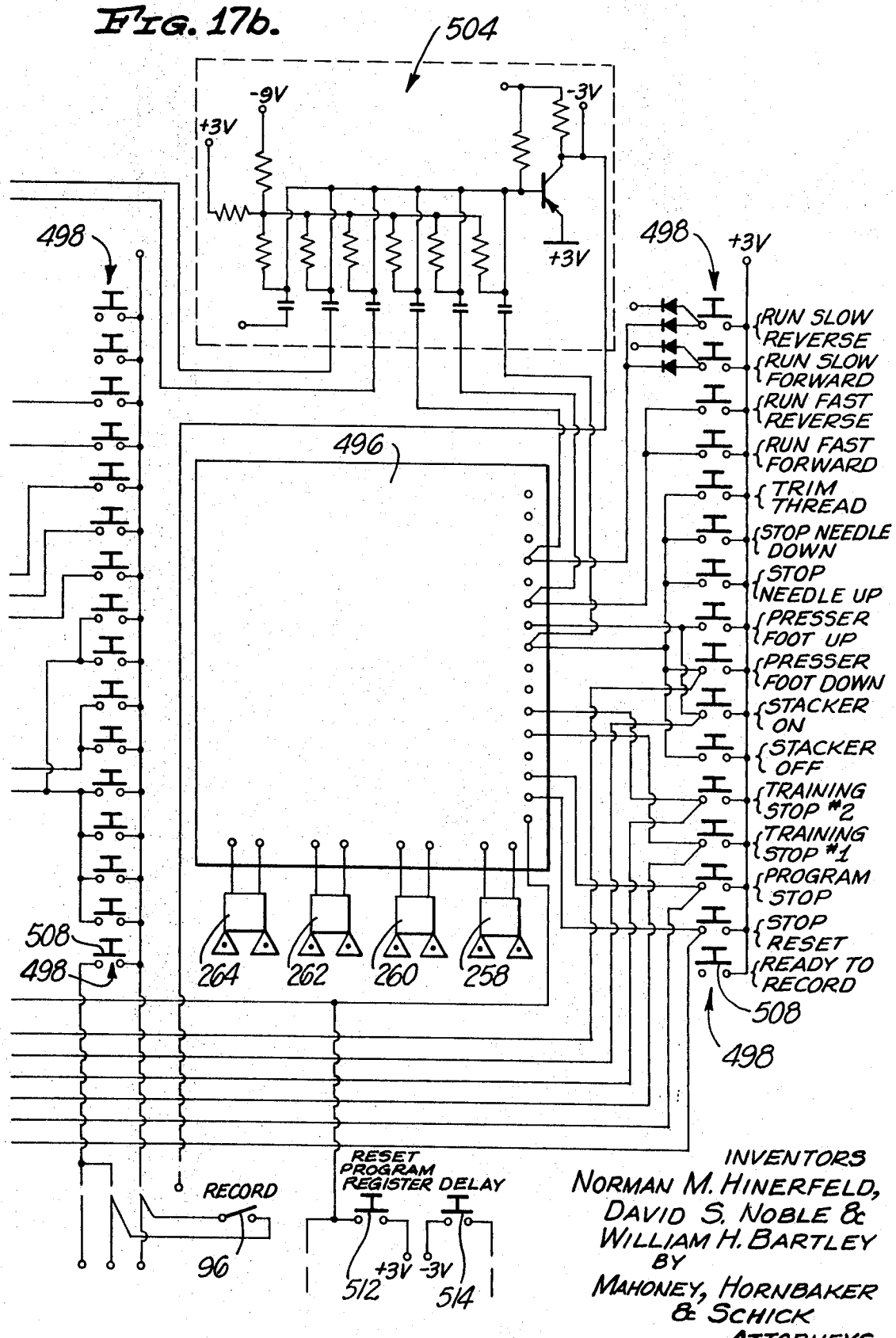
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FIG. 17a.



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FIG. 17b.



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FIG. 19.

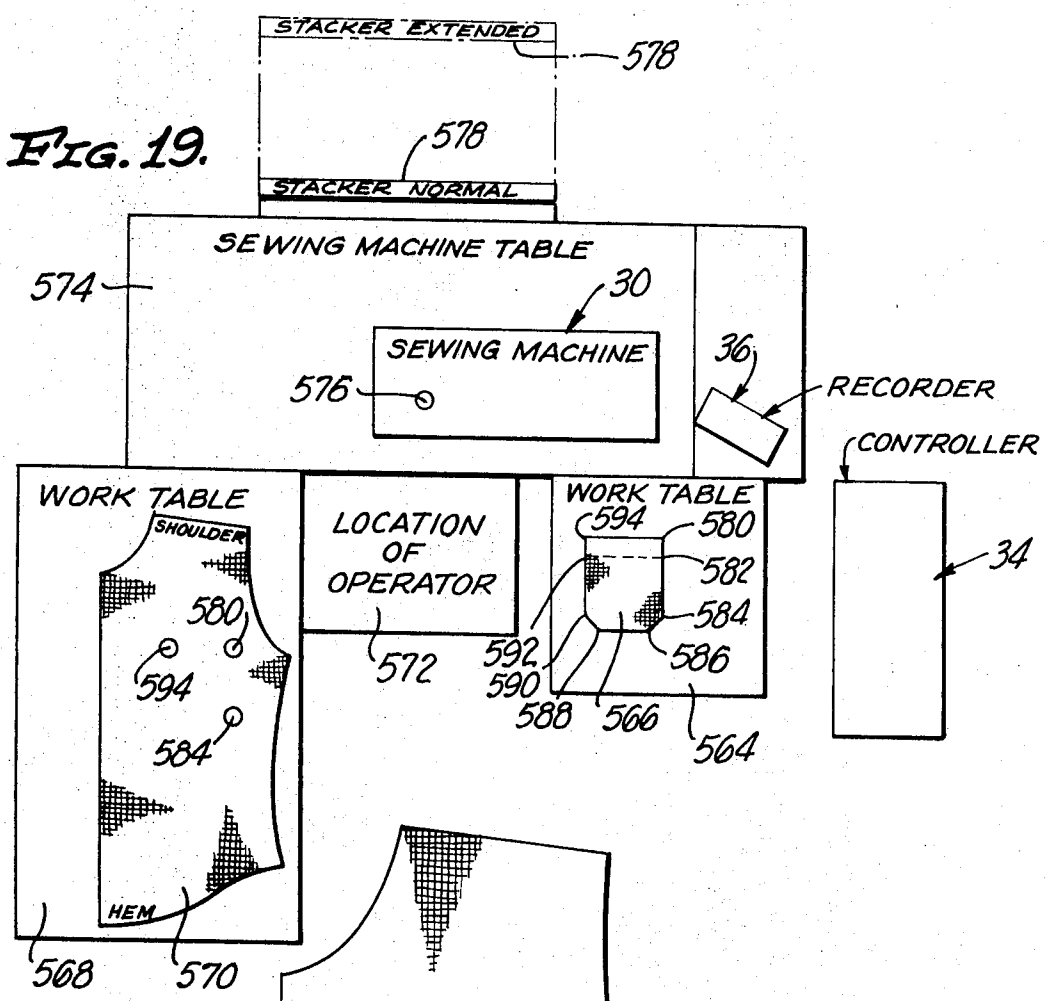
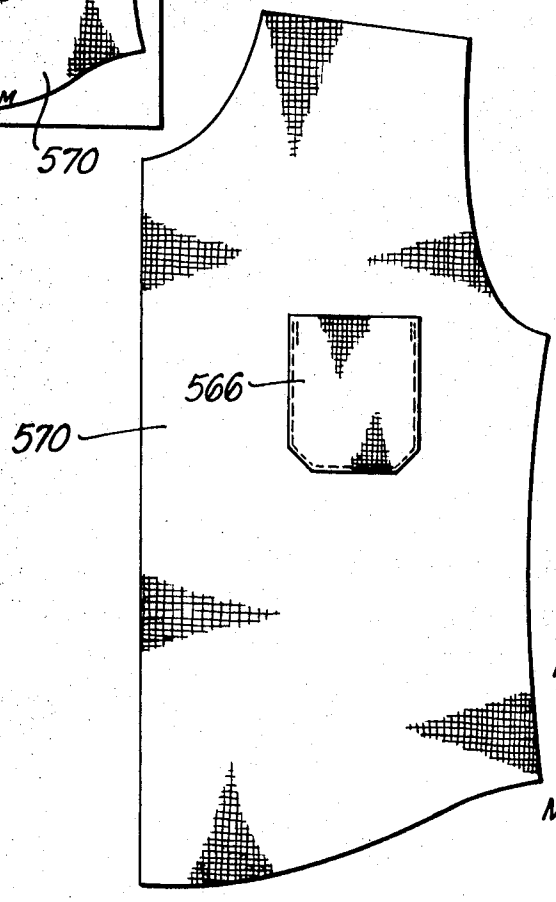


FIG. 20.



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CONTROL EQUIPMENT FOR MANUFACTURING EQUIPMENT SUCH AS SEWING EQUIPMENT AND THE LIKE

BACKGROUND OF THE INVENTION

This invention relates to control devices for manufacturing equipment such as sewing equipment and the like which has the effect of automatically controlling at least the major portion of a series of sequential manufacturing component operational steps having mixed therein certain manual steps required to be performed manually by an operator in carrying out an overall manufacturing operation on an article to be manufactured, so that not only are the manufacturing component operational steps automatically controlled, but also, the manual steps required to be performed by the operator, thereby increasing the efficiency of the overall manufacturing operation. Furthermore, the manufacturing equipment of the present invention is arranged so that instruction signals for carrying out repeated identical overall manufacturing operations may be recorded in an automatic controller permitting the automatic controller to subsequently automatically control the manufacturing components for carrying out the overall manufacturing operation merely by first carrying out the overall manufacturing operation under the manual control of an operator, various means being provided for inserting the instruction signals in the automatic controller creating time delays in the overall manufacturing operation for the manual step performances by the operator. As a result, the minimum of time is required for the programming of the automatic controller in order to permit the same to automatically control an entire overall manufacturing operation, giving maximum versatility and convenience in use so as to be adaptable to a wide variety of mass production manufacturing operations.

There are many manufacturing operations making use of various forms of automatic production machinery wherein a human operator is required to manually control automatic machinery in performing certain steps of the overall manufacturing operation, while at the same time, between certain of the individual automatic machinery steps, such operator is required to manually perform certain manual functions or steps with or on the article being manufactured, such as realigning or repositioning the article being manufactured relative to the automatic machinery in order to carry out a subsequent automatic machinery operational step. Still further, in many such cases, it is necessary to position the automatic machinery relative to the article being manufactured in one determined position at termination of an automatic machinery operational step in order that the required manual operation may be properly carried out by the operator, while in other instances the manufacturing operational step must be terminated with the manufacturing machinery in another position preparatory to the subsequent manual operation. To even further complicate the situation, one manufacturing equipment operational step might require a given number of machinery movements, the next manufacturing machinery operational step a different number of movements, and still the next manufacturing equipment operational step still a different number of equipment movements, in each manufacturing machinery operational step the equipment being required to be manually controlled by the operator.

Even further, the times required for the manual operation by the human operator between the manufacturing equipment operational steps may be of varying length, one manual step requiring a different length of time from a preceding or a subsequent manual step as determined by the manufacturing equipment operational step preceding such operator manual step and the manufacturing equipment operational step succeeding such operator manual step. There are also many instances in the use of automatic production equipment or machinery comprised of a series of components wherein one automatic machinery operational step may require the use of one component and is immediately followed by the use of another component, the first component being required to terminate its particular operational step in a determined position in order that the latter component can properly operate and without damaging the first component. Thus, it may be seen that the types of overall manufacturing operations discussed are not readily adaptable to overall automatic control, but rather would appear to require a great amount of individual human operator control which could only be accomplished by a skilled operator after a long period of intensive training.

One industry in which the overall manufacturing operations include all of the difficulties hereinbefore discussed from the standpoint of attempting to make overall manufacturing operations capable of automatic control is the garment industry wherein the articles to be manufactured are garments basically requiring a series of sewing or stitching operations, as well as various other operations. For instance, in considering the wide variety of sewing operations required in the assembling and manufacture of even very simple forms of garments, it is seen that a wide variety and number of sewing steps can be involved, many requiring forward and reverse sewing and many requiring delays therebetween for manual operator repositioning of the garment for the next sewing step to be carried out. Furthermore, during manual operator repositioning of the garment between sewing steps, it is most convenient for the needle of the sewing head to be positioned projecting downwardly through the garment so that proper alignment is maintained relative to the sewing head needle between the sewing steps.

Also, where the garment being manufactured is of a stable material, that is, a material which is not readily stretchable or deformable, each of the sewing steps will more preferably consist of a determined number of needle reciprocal movements or stitches, absolutely requiring the complete attention of the human operator for proper accomplishment. At the same time, at the termination of particular sewing steps, not only is it necessary for the sewing head needle to be positioned down projecting downwardly through the material for a subsequent manual operator repositioning step, it is also absolutely necessary for the presser foot of the sewing head working in conjunction with the needle during stitching to retain the garment material downwardly against feed dogs progressively moving the material during stitching to be raised in order that the garment material will be free for such manual operator repositioning. When the sewing steps have been completed, that is, at the termination of the last sewing step, it is necessary that the sewing head needle will be positioned up in order that the thread cutoff device of the equipment will be able to operate in the thread the thread being used in the sewing steps without striking the sewing head needle during such thread cutoff.

Certain prior constructions of sewing equipment have included various controls incorporated therein, all requiring manual operation by a human operator, for accomplishing the proper positioning of the sewing head needle in selected up and down positions by means of an automatic needle positioning device. In use thereof, the human operator is required to terminate a particular sewing step and then selectively actuate the needle positioning device to position the needle in the desired up or down position before the subsequent manual repositioning or thread cutoff step can be carried out. Also, as an adjunct to sewing equipment, various supplementary devices have been provided such as pickup devices for supplying garment parts to the operator's sewing station and stacker devices on which a garment may be positioned by the operator after completion of the sewing operations for automatic stacking by the stacker devices.

Although these sewing equipment improvements have added somewhat to the convenience of the human operators, each still requires individual control by that operator at an appropriate time. The operators, therefore, must make a wide variety of mental decisions during an overall garment sewing operation, said decisions being immediately followed by manual actions at proper moments in order to carry out a coordinated overall sewing operation. Thus, it can be seen that a relatively high degree of operator skill has been

required obtained only through long periods of training, and even then, such operations are relatively tedious and tiring even to such skilled operators.

To even more clearly illustrate the complications involved with attempts to fully, or even partially, automate sewing operations in the garment industry, consider the example of the great number of individual automatic and manual operations required for sewing a pocket patch on a shirt front. The finished pocket formed by the pocket patch in the example has an open top and the pocket patch will, therefore, require short lengths of multiple stitching at the top corners thereof for reinforcing in addition to the continuous line of stitching completely around the pocket patch periphery with the exception of the top edge thereof. Furthermore, the pocket patch will have straight sides, angled lower corners and a straight bottom. Finally, assume that a stack of shirt fronts is positioned at the left of the operator and a stack of pocket patches is positioned to the right of the operator, an automatic stacker being positioned directly rearwardly of the sewing machine table for final stacking of the completed pocket assembled shirt fronts.

The requirements of the machine operator would be to first pick up a shirt front from the left side and a pocket patch from the right side, placing the pocket patch at proper location on the shirt front and positioning the temporarily assembled garment at proper location beneath the sewing head needle on the sewing machine table, the needle being at the upper right-hand corner of the pocket patch ready for commencing the sewing or stitching operations. At this time, and in order to accomplish this positioning of the temporarily assembled pocket patch and shirt front beneath the sewing head needle, the needle would have to be in the up position and the presser foot likewise up. The operator is now ready to commence sewing and keep in mind that all component operations must be manually actuated by the operator.

In sequence, the presser foot is lowered, the sewing head actuated to sew four stitches forward and stop, the sewing head is actuated to sew four stitches rearwardly and stop. The sewing head is actuated to sew 36 stitches forwardly to the first corner of the lower right-angle pocket corner and stop, such stop preferably requiring the needle to be positioned down extending downwardly through both the pocket patch and shirt front. The presser foot is raised and the assembled pocket patch and shirt front repositioned to align for sewing along the right-angle pocket corner.

The presser foot is lowered and the sewing head is actuated to sew seven stitches along the angled pocket corner and stop with the needle positioned down. The presser foot is raised and the assembled pocket patch and shirt front manually repositioned aligned for sewing along the straight pocket bottom. The presser foot is lowered and the sewing head is actuated to sew 27 stitches along the pocket straight bottom to the first corner of the left-angle pocket corner and stop, with the needle positioned down.

The presser foot is raised and the assembled pocket patch and shirt front manually repositioned properly aligned for sewing along the left-angled pocket corner. The presser foot is lowered and the sewing head is actuated to sew seven stitches along the left-angled pocket corner and stop with the needle positioned down. The presser foot is raised and the assembled pocket patch and shirt front is manually repositioned to align for sewing along the pocket left-hand straight side.

The presser foot is lowered and the sewing head is actuated to sew 36 stitches along the left-hand pocket straight side to the pocket upper left corner and stop. The sewing head is actuated in reverse to sew four stitches rearwardly and stop, then four stitches again forwardly and stop with the needle up followed by actuation of the thread cutoff and presser foot positioned up completing the sewing or operations or steps. Finally, the completely sewn pocket patch and shirt front are removed from the sewing head and positioned over the stacker with the stacker being actuated to properly stack the same rearwardly of the sewing machine table and permitting the operator to repeat the sequential steps for preparing for and sewing a next pocket patch and shirt front.

Thus, although the sewing of a pocket patch on a shirt front might appear at first consideration as a relatively simple sewing operation, it can readily be appreciated that such a sewing operation requires a great number of closely controlled sewing operations, interspersed with both component positioning operations and operations required to be manually performed by the operator. Furthermore, the operator is required to actuate in various manners the various automatic components, in each case, requiring a mental decision and then a manual movement of proper selected form. Furthermore, the training time for necessary skills in order to accomplish the sewing operations or steps in the proper sequence, as well as the other interspersed steps required, is obviously quite extensive, and even when properly trained, such work is quite tedious and tiring for an operator.

Thus, although small parts of overall sewing operations in the garment industry have been at least partially automatically controlled, no one prior to our present invention has been successful in providing automatic control of virtually an entire overall sewing operation. Obviously, the wide variety and numbers of problems to be overcome if overall automatic control is to be provided are extremely complex and this is particularly true when it is considered that it is clearly impossible to eliminate the human operator from the overall sewing operations. In addition, no one prior to our present invention has been able to reduce training time and to reduce required skills of the ever-present human operator from the sewing operations, all necessary if optimum improvements are to be provided in the garment industry.

OBJECTS AND SUMMARY OF THE INVENTION

It is, therefore, an object of our invention to provide control devices for manufacturing equipment such as sewing equipment and the like, such equipment being of the type normally requiring manual actuation of various components by a human operator in a determined sequence and interspersed with required purely manual operations or steps by said operator in order to carry out an overall manufacturing operation, wherein substantially the entire overall manufacturing operations are automatically controlled including determined time delays between certain manufacturing component operational steps during which the operator must perform manual steps in order to properly complete the overall manufacturing operation. As a result, the requirement for the human operator to manually actuate the automatic-manufacturing equipment and the sundry decisions by the operator normally involved therewith are completely eliminated, the main steps remaining for the operator once the overall manufacturing operation has been commenced being to manually perform certain more minor operations required between various of the automatic component operations. In this manner, the prior tediousness and skill required for such overall manufacturing operations is greatly reduced, thereby likewise reducing operator training time necessary for training an operator to be able to carry out the overall manufacturing operations.

As an example, in the garment industry and the various overall sewing operations thereof, each of the individual sewing steps, including positioning and repeated repositioning of various components, is completely automatically controlled. Where manual repositioning of articles to be sewn is required between any of the sewing steps, a time delay period is supplied during which the operator may accomplish such repositioning and after which, the automatic components immediately resume automatic operation under the automatic control.

It is a further object of our invention to provide control devices for manufacturing equipment such as sewing equipment and the like of the foregoing general character wherein the manufacturing equipment including such control devices may be set up or programmed for carrying out the determined

overall manufacturing operations merely by an operator manually actuating the manufacturing equipment in the usual manner, the various individual of the manufacturing steps being recorded in an automatic controller, after which, the automatic controller is capable of automatically controlling the various components to repeat the overall manufacturing operation, even as to controlling the time of time delays between component automatic operations to provide the operator with sufficient time for manually performing necessary manual operations or steps. In addition, the control devices are arranged with the manufacturing equipment with certain of the same being capable of actuation for directly inserting into the automatic controller program various predetermined instructions of exact form as would be received from the actual operations of the components during a particular manufacturing step. The various components may, therefore, be manually actuated to carry out certain manufacturing operational steps in one manner, yet the automatic controller may be programmed to repeat such component operational steps in a different manner, all as determined by the particular operator controlling the devices and equipment.

Again as applied to sewing equipment for carrying out an overall sewing operation, the overall sewing operation is carried out by the operator manually actuating the various components in proper sequence, for instance, sequential sewing operations or steps. If, directly after the performance of a particular component operational step, say, of actually sewing 75 stitches in an article to be sewn, it is determined that that particular sewing operation should actually include only 55 stitches, instructions for the automatic controller to carry out the stitching step of only 55 stitches may be inserted into the automatic controller program while the instructions for the 75 stitches is not recorded so that upon repeating the overall sewing operation, the automatic controller will carry out that particular sewing step of only the 55 stitches. Also, the time delays between component operations for operator manually repositioning of the article being sewn can be inserted as instructions into the automatic controller merely by permitting that length of time delay between component manual actuations, or, in the alternative, the actual time delay between component operations taken by the operator may be eliminated from the automatic controller recording and a predetermined time delay inserted into the automatic controller recording or program as a substitute for the actual delay time taken operator the operator. Obviously, therefore, although the basic concept of the control devices is that of being able therewith to completely program the control devices for automatically carrying out an overall sewing operation merely by once performing the same under component manual actuation, even increased wide versatility of the control devices permits during such programming, the alteration of various steps to give the exact final programming desired.

It is still a further object of our invention to provide control devices for manufacturing equipment such as sewing equipment and the like as hereinbefore discussed wherein indeterminate time delays may be inserted as instructions into the automatic controller programming either between manufacturing equipment component operational steps or intermediate such component operational steps depending on the desired purpose. For instance, if a manual operation between two component operational steps will vary in time length from one repeated overall manufacturing operation to the next, an indeterminate time delay instruction may be inserted into the automatic controller program having the effect of stopping a preceding component operation at the end of its operational step, but requiring some manual actuation by the operator before the subsequent programmed operational step will commence so as to leave the length of the time delay completely controlled by the operator so that the same can be varied in total length as it is necessary. At the same time, the control devices are arranged so that these indeterminate time delays, functional in the same manner, may be inserted at any point in the automatic controller program, even intermediate a particular manufacturing equipment component operational step, the indeterminate time delays in this case being capable of elimination from the automatic controller program without otherwise altering such program at any time during subsequent automatic control of the manufacturing equipment, thereby constituting training time delays which are permitted to remain in the program during the operator training and can be removed from such program after the operator has become sufficiently trained.

It is an additional object of our invention to provide control devices for manufacturing equipment such as sewing equipment and the like of the foregoing general character wherein each of the manufacturing equipment component operational steps is translated by the control devices into a composite instruction for recording in the automatic controller to program the same, such composite instructions thereafter being sequentially translated back into component operations to carry out the various component operational steps during automatic actuation of the manufacturing equipment by the automatic controller. Each composite instruction as received and recorded by the automatic controller is formed from the combination of function and duration, the function being the particular manufacturing equipment component to be automatically actuated and the duration being either a pure time duration measured in particular time units or a given number of component movements as sensed and counted by the automatic controller with the aid of other parts of the control devices. The determined time delays are measured by the automatic controller merely in time units, since no function is involved.

As applied to sewing equipment for performing a particular overall sewing operation on an article to be sewn, examples of the composite instructions of the different duration types might be a series of sequential sewing operations to carry out a series of sequential sewing steps and a final thread cutoff operation. For the sewing steps, such steps are measured in the number of reciprocal movements of the needle performing the sewing steps, such reciprocal movements being sensed and translated to the automatic controller such that an exact count of needle reciprocations is determined and carried out. The thread cutoff operation is programmed for duration merely in time units, there being a sufficient number of time units to make up an overall total time within which the thread cutoff device can effectively perform the thread cutoff operation.

It is also an object of our invention to provide control devices for manufacturing equipment such as sewing equipment and the like involving the above discussed programmed automatic controller and the composite instructions therefor in order to automatically control the sequential manufacturing operations wherein all of the programmed instructions having the duration thereof measured in manufacturing equipment component movements may be simultaneously altered to alter the time involved in carrying out the same, and all of the programmed instructions having the duration thereof measured in time units may be simultaneously varied in order to vary the total time permitted for a manufacturing equipment component operation or the total length of a determined time delay. As applied to sewing equipment, a variable speed control is provided for the drive motor driving the reciprocal needle in the sequential sewing operations so that by varying the speed of the drive motor, the total time for accomplishing a given number of needle reciprocations is varied, the program in the automatic controller being that solely of needle reciprocation count so as to be unaffected other than the overall duration of a particular sewing step due to the faster or slower needle reciprocations as counted by the automatic controller. At the same time, the automatic controller is provided with a selected adjustment for the time elements which make up the total time period permitted by the automatic controller for the determined time delays so that variable adjustment of the time units will proportionately adjust the total length of the time delays without otherwise affecting the programming thereof in

the automatic controller. The time unit adjustment is limited in the respect that sufficient time must always be supplied for the complete operation of manufacturing components, such as the thread cutoff, to complete full operation thereof during their particular operational step.

It is still another object of our invention to provide control devices for manufacturing equipment such as sewing equipment and the like wherein certain of the manufacturing equipment components may be controlled by the automatic controller to terminate particular component operational steps by stopping in selected positions of that particular component in order that a directly following step may be properly carried out. In the sewing equipment application, a needle counter and positioner is provided operably connected to the automatic controller for not only permitting the automatic controller to count the number of needle reciprocations as hereinbefore discussed, but also to permit the automatic controller to terminate a particular sewing operational step with the reciprocal needle in either a needle down position extending downwardly through the article being sewn or a needle up position spaced above the article being sewn. Thus, the automatic controller may position the needle down between various of the sewing operational steps during the determined time delays separating such steps for manual repositioning of the article being sewn without the article becoming completely misaligned from the needle. Furthermore, at the termination of a last sewing operational step and prior to the actuation of the thread cutoff, the automatic controller may position the needle up so that the immediately following thread cutoff operation may be accomplished without needle interference and damage thereto.

Other objects and advantages of the invention will be apparent from the following specification and the accompanying drawings which are for the purpose of illustration only.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a somewhat schematic front elevational view of the overall sewing equipment assembly incorporation the unique control devices making up a preferred embodiment of the principles of the present invention;

FIG. **2** is an enlarged, fragmentary, front elevational view of an electric solenoid assembly providing power control for certain of the manufacturing components of the sewing equipment assembly of FIG. **1**;

FIG. **3** is an enlarged front elevational view of a knee switch assembly removed from the sewing equipment assembly of FIG. **1**;

FIG. **4** is an enlarged, side elevational view of a foot switch assembly removed from the sewing equipment assembly of FIG. **1**;

FIG. **5** is an enlarged, front elevational view of the automatic controller of the sewing equipment assembly of FIG. **1**;

FIG. **6** is a rear elevational view of the automatic controller of FIG. **5**;

FIG. **7** is an enlarged, fragmentary, bottom perspective view, part in phantom lines, illustrating certain of the power control units for the sewing head unit of FIG. **1**;

FIG. **8** is an enlarged, front elevational view of the power interface or positioner taken from the sewing equipment assembly of FIG. **1**;

FIG. **9** is a rear elevational view of the power interface or positioner of FIG. **8**;

FIG. **10** is an enlarged, front elevational view of the automatic recorder taken from the sewing equipment assembly of FIG. **1**;

FIG. **11** is an enlarged, side perspective view of the needle counter and positioner removed from the sewing equipment assembly of FIG. **1**;

FIG. **12** is an enlarged, vertical sectional view looking in the direction of the arrows **12—12** in FIG. **11**;

FIGS. **13***a* and **13***b* are left-hand and right-hand portions, respectively, of a wiring diagram of the power interface of FIGS. **8** and **9**;

FIGS. **14***a*, **14***b*, **14***c*, **14***d*, **14***e* and **14***f* are upper left-hand, upper center, upper right-hand, lower left-hand, lower center and lower right-hand portions of a wiring diagram of the automatic controller of FIGS. **5** and **6**;

FIG. **15** is a wiring diagram of the controller recording drum and drive means therefor forming a part of the automatic controller of FIGS. **5** and **6**;

FIG. **16** is a schematic view of the controller drum of FIG. **15**;

FIGS. **17***a* and **17***b* are the left-hand and right-hand portions, respectively, of a wiring diagram of the automatic recorder of FIG. **10**;

FIG. **18** is a wiring diagram of the matrixes forming a part of the automatic recorder of FIG. **10**;

FIG. **19** is a schematic layout of the sewing equipment assembly of FIG. **1** including work tables with parts of articles to be sewn positioned thereon ready for use in a sewing operation; and

FIG. **20** is an enlarged, top plan view of a finished sewn article, the sewing operations thereon being carried out in the layout arrangement of FIG. **19**.

DESCRIPTION OF THE BEST EMBODIMENT CONTEMPLATED

Referring to the drawings, an embodiment of the control devices for manufacturing equipment is illustrated and described in the following adapted to sewing equipment of the type normally used, for instance, in the apparel industry for assembling by sewing various articles of apparel. A somewhat schematic view of the sewing equipment is shown in FIG. **1**, the more important parts of which are a sewing unit generally indicated at **30**, a power interface or positioner generally indicated at **32**, an automatic controller generally indicated at **34**, an automatic recorder generally indicated at **36**, a foot switch unit generally indicated at **38**, a knee switch unit generally indicated at **40**, a needle counter and positioner generally indicated at **42**, a solenoid air valve unit generally indicated at **44** and a main power supply switch box generally indicated at **46**. The plan of description to follow will be to first very briefly and generally describe the various parts of the sewing equipment, then describe more in detail various of these parts including electrical and electronic wiring circuits and the interconnection thereof, and finally a step-by-step procedural use of the sewing equipment both in the manual mode and automatic mode.

Basically, the purpose of the control devices of the present invention are to modify and supplement somewhat standard sewing equipment for accomplishing three basic objectives, namely, permit normal human manual control of the sewing equipment including various peripheral equipment for performing overall sewing operations on apparel to be manufactured, permit the automatic programming of an automatic controller, for the main part, directly by and during such operator manual control, and after such programming, permit the overall sewing operations to be directed and carried out by the automatic controller with only very modified and relatively simplified aid of the human operator. As a result, although a relatively highly skilled and trained operator is required for the manual operation and the programming of the automatic controller, once the equipment has been programmed for the automatic control, operators of far lesser skills and training may be utilized while still maintaining and even improving the quality of sewing operations normally obtained through usual manual operator control. Furthermore, under automatic control of the equipment, the human operator is relieved of all but a few of the usually required manual functions so that the operator is under less decision-making stress and can function with greatly improved efficiency and less tiring throughout a working day.

GENERAL

The sewing unit **30** of FIG. **1** is a single-needle sewing unit having a standard sewing head **48** with an up and down

reciprocal needle 50, the needle being reciprocally driven at high speed by a high-speed drive motor 52 and being reciprocally driven at slow speed by a slow-speed drive motor 54. The high-speed drive motor 52 is of usual form, constantly rotating, single direction drive, and clutch actuated for driving connection to the needle 50. The slow-speed drive motor 54 is also of usual construction, single direction drive and only actuated when slow speed drive is desired, this slow-speed drive motor having a usual braking circuit therein for selectively stopping the needle 50 in each of an up position spaced above an article being sewn and down position extending downwardly through the article being sewn.

The sewing head 48 includes also a usual presser foot, not shown, for normally holding the article being sewn downwardly against usual feed dogs, not shown, during the reciprocal sewing movements of the needle 50. The presser foot is selectively vertically movable from normal down position holding the article being sewn against the feed dogs and a raised position spaced upwardly and releasing the article being sewn, the down position of the presser foot being a normal spring urged position and the raised position being a power actuated position as will be hereinafter described. The movement of the feed dog or dogs is coordinated with the reciprocal movements of the needle 50 and the feed dogs move from front to rear in sewing forward and from rear to front when sewing rearwardly or backstitching, all again in the usual manner.

As stated, the high-speed and slow-speed drive motors 52 and 54 are both single direction, operably connected for moving both the reciprocal needle and feed dogs in the coordinated movements, the distance of each movement of the feed dogs determining the length of stitch sewn by the needle. The needle 50 and the feed dogs are normally driven by the drive motors 52 and 54 in the sew-forward direction, but appropriate mechanism is contained in the sewing unit 30 selectively actionable for converting the drive to sew-reverse movement of the needle and feed dogs. Any of the usual attachments may be provided on the sewing head 48, all operable in usual manner, such as top shirring, pleating and many other attachments.

The sewing unit 30 also includes a usual thread trimmer or cutoff actionable for cutting off both the sewing unit lower thread and the thread of the needle 50 at the termination of sewing operations as desired. The thread cutoff operates from beneath and the actuation for movement thereof in the thread cutting operation must be coordinated with the position of the needle 50 so that the needle is in the up position and will not be damaged by the thread cutoff. Furthermore, the thread cutoff in the present sewing unit 30 is arranged pneumatically actuated in a manner to be hereinafter described.

The power interface 32, one of the more important electrical and electronic units of the present construction, is a multipurpose unit serving to generally provide a power drive, with the aid of the solenoid air valve unit 44, for all portions of the sewing unit 30 which require actuation in order to carry out a sewing operation. At the same time, the power interface 32 operably connects all of the automatic controller 34, the foot switch unit 38, the knee switch unit 40 and the needle counter and positioner 42 to the sewing unit for both manually controlled and automatically controlled operation thereof. The power interface 32 is shown in FIG. 1 and in more detailed outside front view in FIG. 8 and rear view in FIG. 9.

Generally, the power interface 32 with selector switch 56 thereof in "manual" placing the power interface in manual mode, operably connects the foot and knee switch units 38 and 40 to the sewing unit 30 for manual control of the sewing unit by an operator through proper actuation of such switch units. Also in manual mode, the power interface 32 serves to translate the various actuations and movements of the components of the sewing unit 30 into low-level electronic signals for recording by the automatic controller 34 when the automatic controller is in a record mode to be hereinafter described. Still further, with the selector switch 56 of the power interface 32 moved to "automatic" placing the power interface in the automatic mode, the power interface serves to translate low-level electronic signals received back from the automatic controller 34 when said controller is in an "automatic" or "operate" mode into commands or directions causing operation of the components of the sewing unit 30 in a determined manner as recorded in the automatic controller.

The low-level electronic signals transmitted to and from the automatic controller 34 by the power interface 32 form for the component operations of the sewing unit 30, as well as sewing unit peripheral equipment, composite instructions recorded by the automatic controller when the sewing unit components are manually actuated and played back by the automatic controller as commands during automatic operation of the automatic controller. These composite instructions for actuation of the components of the sewing unit 30 are made up of function and duration, the function being the particular sewing unit component to be operated or actuated, and the duration being one of pure time measured in time units or the number of movements of a particular sewing unit component, both types being capable of recording by the automatic controller. In the particular embodiment herein involved, the composite instructions for actuation of the presser foot to raise the same and permit it to lower and operation of the thread trimmer for a single operation thereof are measured in time units sufficient to permit such actuation or operation, whereas the composite instructions for the driving of the sewing head needle 50 by the high- and slow-speed drive motors 52 and 54 are measured in needle reciprocations. Instructions for mere time delays are, of course, merely measured in time units.

The power interface 32 also includes a foot control switch 58 providing a choice between requiring sustained actuation of the foot switch unit 38 or merely momentary actuation of the foot switch unit during control of the sewing unit 30 by the automatic controller 34. When the automatic controller 34 is properly programmed and is automatically carrying out an overall sewing operation through its electronic signals to the power interface 32, if the foot control switch 58 is "on," constant pressure is required on the foot switch unit 38 for continued automatic operation of the sewing unit by the automatic controller, but with the foot control switch in "off," the only time depression of the foot switch unit is required is at programmed indeterminate delays whereupon momentary foot switch unit depression will resume the automatic program and the control.

More variable speed control of the components of the sewing unit 30 driven by the high-speed drive motor 52 is desired, which in this case would be the reciprocal movement speed of the sewing head needle 50, the high-speed drive motor 52 is provided as a variable speed drive motor and the speed thereof is controlled by a selectively adjustable speed control switch 60 on the power interface 32. Increasing the speed of the drive motor 52 will increase the reciprocal speed of the sewing head needle 50 and decreasing the speed of the drive motor will have the opposite effect. In view of the fact that the programmed instructions for the movement of the sewing head needle 50 are predicated on the duration measured by the needle movements, such speed adjustment can be made after programming of the automatic controller 34 without otherwise affecting the program thereof.

The automatic controller 34 shown in FIG. 1 and in more detailed front view in FIG. 5 and rear view in FIG. 6 is a versatile stored program controller which has a storage or memory unit within it in which the series of operations of the sewing unit 30, and preferably certain peripheral equipment, are stored in proper sequence and each instruction or step may then be played back as electrical signal commands to the power interface 32 requiring the components of the sewing unit and the peripheral equipment to carry out the overall sewing operation. At this time, only certain broad features thereof are discussed with a more complete detailed discussion of the electrical and electronic arrangement thereof to follow at a later time. As previously stated it is possible to pro-

gram the automatic controller **34** for automatically carrying out an overall sewing operation of the sewing unit through the foot and knee switch units **38** and **40**, while at the same time, the automatic controller is arranged for inserting many composite and pure time instructions corresponding directly to component operational steps and time delays through selective manual actuation of special controls directly on or operably connected to the automatic controller. Referring to FIGS. **5** and **6**, the automatic controller **34** includes a selector switch **62** for setting the automatic controller to record a program for an overall sewing operation or play back such program for automatically controlling the sewing unit **30** to carry out an overall sewing operation. In the "record" position of the automatic controller selector switch **62** with the power interface selector switch **56** in "manual," the automatic controller is set for accepting program instructions. When the automatic controller selector switch **62** is in "operate" position and the power interface selector switch **56** is in "automatic" position, the automatic controller will play back the program thereof to automatically control the sewing unit **30** during an overall sewing operation.

Command lights **64**, output lights **66**, stitch and delay lights **68**, command buttons **70**, output buttons **72** and stitch and delay buttons **74** are contained on the automatic controller **34**, the appropriate lights being located directly above the appropriate buttons. When a particular program instruction is entered into the automatic controller **34**, the appropriate command lights **64** are lit up showing the unique bit pattern contained in that particular program instruction for the command structure of the automatic controller. At the same time, there are a number of program instructions that may, and certain of them must, be entered directly into the automatic controller **34**, and this entry is made by use of the command buttons **70**, output buttons **72** and stitch and delays buttons **74**, all of which will be hereinafter explained in detail.

A program step counter **76** is located on the automatic controller **34** and provides a visual display of the program step numbers. The visual display of the program step counter **76** advances one count at the completion of each step of the program for the overall sewing operation by the sewing unit **30**. Furthermore, this program step counter **76** counts in the "octal" numbering system, all of which will likewise be hereinafter explained.

The automatic controller **34** includes a reset program register button **78** which is used to erase instructions placed in the automatic controller as required when an incorrect instruction has been entered into the program thereof. A reset program counter button **80** is provided for resetting the program step counter **76** to "00" when such button is depressed, the reset program counter button being used each time a new program is to be entered into the automatic controller **34**. An advance counter button **82** may be used to advance the program step counter **76** by one step or count, such action being required for correcting a program instruction, that is to say, the program instructions may be modified or changed by advancing the program counter which in turn advances the program step counter **76** until the program step number that contains the incorrect instruction has been reached.

As previously discussed, the automatic controller **34** records and counts pure time intervals, whether a time interval of a composite instruction for the complete operation of a component of the sewing unit **30** or merely a time delay between component operations, in time units, and the length of such time units may be set and later after programming shortened or lengthened within determined limits by a delay adjustment switch **84**. The midpoint setting of the delay adjustment switch **84** is approximately one-sixtieth of a second for each time unit, the setting at "slow" providing approximately 40 percent more time for each time unit and the setting at "fast" reducing the time allowed for each time unit by approximately 40 percent, so as to provide an overall time adjustment or variation of approximately 20 percent. Thus, assume under automatic or programmed control by the automatic controller **34**, an operator is permitted a time interval between component operations of the sewing unit **30** in order to carry out a manual operation such as repositioning material being sewn, the original time interval can be programmed at approximately a 80 percent greater length and after the operator becomes experienced, the interval length can be shortened approximately 80 percent by selective movement of the delay adjustment switch **84**.

Where training stops or training delays are programmed in the program of the automatic controller **34** either intermediate operations of a particular component of the sewing unit **30** or directly between component operational steps to provide indeterminate delays wherein the component operations stop and will not start under the automatic control of the automatic controller until the operator manually restarts the same, such training stops or delays may be later eliminated from the program and will be bypassed by the automatic controller in an overall sewing operation. One or more training stops or delays may be controlled by each of a training stop No. **1** switch **86** and a training stop No. **2** switch **88** on the automatic controller **34**. With the training stop switches **86** and **88** in one position, the various training stops or delays controlled by each may be inserted into the program of the automatic controller **34** in a manner to be hereinafter described, and later, by moving training stop No. **1** switch to another position, all training stops or delays controlled thereby are eliminated from the program, the movement of the training stop No. **2** switch being similar. Thus, training stops or delays may be included in the original program of the automatic controller **34** for controlling automatically an overall sewing operation and after the operator becomes trained so as to no longer need such training stops, the same can be eliminated from the program, for instance, an original training delay after 6 or 8 inches of stitching in a complete stitching step of 12 inches can be eliminated later to provide the total 12-inch stitching step continuously.

The automatic recorder **36** is an auxiliary record unit operably connected to the automatic controller **34** to provide a method of inserting most or all of an entire instruction into the program of the automatic controller directly corresponding to a component operational step of the sewing unit **30** by means of push buttons, the automatic recorder being shown in FIG. **1** and in more detailed front view in FIG. **10**. In effect, the automatic recorder **36** has certain electrical and electronic circuits permanently set therein capable of actuation by the pushbuttons thereof to transmit to the automatic controller **34** electronic signals corresponding directly to a part of or the total of an electronic signal which would be transmitted from the power interface **32** to the automatic controller during operation of components of the sewing unit **30**, thereby permitting insertion of an instruction into the program without actually carrying the same out with the sewing unit components, or replacing the component instruction with a different desired instruction. The automatic recorder **36** will be described hereinafter more in detail.

The foot switch unit **38** is shown in FIG. **1** and in detailed side view in FIG. **4** and has a two-stage drive motor switch **90** actionable by toe pressure on treadle **92**, a reverse switch **94** mounted directly on the treadle movable therewith and actuated by side toe movement, and an instruction record switch **96** actionable by heel pressure on the treadle. With the selector switch **56** of the power interface **32** in "manual," light toe pressure on the treadle **92** actuates the first stage of the drive switch **90** to actuate the sewing unit slow-speed drive motor **54**, and heavy toe pressure on the treadle, actuates the second stage of the drive switch and actuates the high-speed drive motor **52**, in both cases driving the sewing head reciprocal needle **50**. With the power interface selector switch **56** in "manual" and with the automatic controller **34** "on" and the selector switch **62** thereof in "record," the same actuations result with light and heavy toe pressure on the treadle **92**. With the power interface selector switch **56** in "automatic" and the automatic controller **34** "on" with the selector switch

62 thereof in "operate," light toe pressure on the treadle 92 actuates the first stage of the drive switch 90 to cause the program of the automatic controller to proceed from an indeterminate stop or delay, while heavy toe pressure on the treadle actuates the second stage of the drive switch causing an emergency stop of the automatic controller program and any of the components of the sewing unit 30 by being then actuated thereby.

Side toe pressure on the treadle 92 of the foot switch unit 38 actuates the reverse mechanism of the sewing unit 30 causing the sewing head needle 50 and feed dogs to be driven in reverse. Thus, with side toe pressure and light down toe pressure, the slow-speed drive motor 54 is actuated to drive the sewing head needle 50 and feed dogs in reverse at slow speed with heavy toe pressure actuating the high-speed drive motor 52 for fast speed. This is true whether the power interface 32 is in "manual" without the automatic controller 34 or whether the power interface is in "manual" and the automatic controller is in "record," the reverse switch 94 not being used with the power interface in "automatic" and the automatic controller in "operate."

The instruction record switch 96 of the foot switch unit 38 is used only when the power interface 32 is in "manual" and the automatic controller 34 is "on" and in "record," that is, when the components of the sewing unit 30 are being actuated by an operator and instruction signals are being sent to the automatic controller for the recording of a program therein. As the instruction signals are received by the automatic controller 34 from the power interface 32 or as a result of the use of the automatic recorder 36 and the various described buttons on the automatic controller, such instruction signals for each operational step or delay are only temporarily recorded by the automatic controller 34 and will not be permanently recorded in the automatic controller program until the instruction record switch 96 of the foot switch unit 38 is actuated by heel pressure on the treadle 92. The programming procedure of the automatic controller 34, therefore, requires a command by the instruction record switch 96 for permanent recording or programming of the various program steps from the temporary recording thereof.

The knee switch unit 40 shown in FIG. 1 and in more detailed front view in FIG. 3, includes a right knee switch 98 actionable by right knee pressure and a left knee switch 100 actionable by left knee pressure. Actuating the right knee switch 98 with the power interface 32 in "manual" and the automatic controller "off" or "on" and in "record" causes a raising of the presser foot of the sewing head 48 releasing material being sewn by the sewing head needle 50, the presser foot being raised for the length of time of such actuation.

External control of the automatic controller 34 is provided by the right knee switch 98 when the power interface 32 is in "automatic" and the automatic controller is in "operate" thereby controlling the components of the sewing unit 30 according to a program permanently recorded therein. The effect of this external control is that upon actuation of the right knee switch 98, the automatic controller 34 is caused to advance to its next programmed step which may be a stop or delay or may be an actuation of some sewing unit component, whatever might be in the program of the automatic controller. For instance, assume that material being sewn is of an unstable character so that it is impossible to determine the total number of stitches required in a particular sewing step, the automatic controller 34 might be programmed to drive the sewing head needle 50 through a set number of stitches and then proceed with such stitching with the termination thereof not being determined until terminated by the operator. This external control feature of the right knee switch 98 would be used for stopping or terminating such sewing step at the appropriate time by actuation thereof to advance the automatic controller 34 to its next programmed step which might be, for instance, a delay step with the sewing head presser foot up to permit repositioning of the material or might be a stop with the sewing head needle 50 in up and actuation of the thread trimmer or cutoff.

The left knee switch 100 of the knee switch 40 when actuated with the power interface 32 in "manual" and the automatic controller 34 "off," will cause the sewing head needle 50 to be positioned up and will actuate the thread trimmer or cutoff upon the treadle 92 of the foot switch unit 38 being released. The sewing head needle 50 can only be positioned properly from slow speed but release of the foot switch treadle 92 requires the treadle to pass through the slow-speed phase so as to accomplish such needle positioning and permit actuation of the thread trimmer. Actuation of the left knee switch 100 with the power interface 32 in "manual" and the automatic controller "on" and in "record" causes a pure time delay to be recorded by the automatic controller for the period of time the left knee switch is actuated, the instruction for the needle position up and actuation of the thread trimmer being required to be placed in the automatic controller program through preset instructions in the automatic recorder 36 as previously described. The left knee switch 100 is not used when the power interface 32 is in "automatic" and the automatic controller 34 is in "operate" automatically controlling the components of the sewing unit 30.

The needle counter and positioner 42 will be described later but has the purpose of detecting the position of the sewing head needle 50, whether the needle is up or down, measuring the speed of the needle drive for thread trimming and counting the number of needle movements or stitches for programming the automatic controller 34 and later counting stitches during automatically controlled needle drive by the automatic controller. In other words, the needle counter and positioner 42 serves to first count the needle movements during manual control for programming and then count the needle movements for automatic control from the programming, advancing the program of the automatic controller 34 to the next step upon determination of the programmed number of needle movements or stitches. Also, the needle counter and positioner 42 determines or senses the position of the sewing head needle 50 at slow speed and stops the slow-speed drive motor 54 with the needle positioned "up" or "down" as required.

The solenoid air valve unit 44 is shown in FIG. 1 and in enlarged front view in FIG. 2 with certain of the air cylinders controlled thereby being shown in FIG. 1 and FIG. 7. This solenoid air valve unit 44 includes a series of solenoid air valves actuated through the power interface 32 by the various switches as previously described for manual control and by the automatic controller 34 for programmed automatic control, said valves including a thread-trimmer solenoid valve 102, a forward-reverse solenoid valve 104, a presser foot solenoid valve 106 and a motor clutch solenoid valve 108. The solenoid air valve unit 44 also mounts an On-Off thread trimmer switch 110 which, when moved to "off," eliminates the thread trimmer from any possible actuation despite actuation of the appropriate controls therefor.

Actuation of the thread trimmer solenoid valve 102 directs air to the thread trimmer air cylinder 112 at the underside of the sewing unit 30 as shown in FIG. 7 to actuate the thread trimmer. Actuation of the forward-reverse solenoid valve 104 directs air to the reverse air cylinder 114 at the underside of the sewing unit 30 as shown in FIG. 7 to operate the reverse mechanism of the sewing unit and cause reverse drive of the sewing head needle 50 and the feed dogs. Actuation of the presser foot solenoid valve 106 directs air to and causes raising of the presser foot, the presser foot remaining raised during such valve actuation and automatically lowering upon cessation thereof. Actuation of the motor clutch solenoid valve 108 directs air to the motor clutch air cylinder 116 engaging the clutch of the high-speed drive motor 52, the clutch being disengaged automatically when the motor clutch solenoid valve is not actuated.

The main power supply switch box 46 merely mounts an on-off main power switch 118 which controls the main electrical power to the sewing unit 30.

POWER INTERFACE - POWER SUPPLY

The wiring circuit of the power interface **32**, hereinbefore generally described, is shown in FIGS. **13***a* and **13***b* with the power supply being at the lower right corner and side of the circuit and being generally of conventional type. Incoming power at 220 volts AC is stepped down by transformer 120 to 24 volts AC, and this voltage is full-wave rectified by rectifiers **122** and **124** to yield a negative voltage across capacitor **126**, and is similarly rectified by rectifiers **128** and **130** to yield a positive voltage across capacitor **132**. The positive voltage across capacitor **132** is dropped to a regulated 6 volts by resistor **134** and zener diode **136** in a manner which is well known and widely used, to provide a voltage at terminal **138** which is 6 volts more positive than terminal **140** connected to the other side of diode **136**. The negative voltage across capacitor **126** is provided in an unregulated state at terminal **142** for use where negative voltage which is not regulated will suffice such as the supply for the solenoid valves **102**, **104**, **106** and **108** of the solenoid air valve unit **44**.

In addition, the negative voltage appearing at the junction of rectifiers **122** and **124** is further rectified by means of rectifier **144** in a manner such that heavy loads on the negative voltage at terminal **142** will be partially isolated from the negative voltage across capacitor **146**, such being as well known and accepted manner of isolating power supply voltages. The negative voltage across capacitor **146** is regulated by a series circuit consisting of resistor **148**, zener diode **150** and zener diode **152**, the two diodes being used to obtain two regulated negative voltages, one of which is approximately negative 6 volts at terminal **154** and the other of which is a negative 12 volts at terminal **156**. Thus, 3 voltage supplies are provided, each of approximately 6 volts ad connected in series, these voltage outputs being labeled as if measured from an arbitrary nonexistent point at a potential midway between terminal **154** and terminal **140** so as to be designated plus 9 volts, plus 3 volts, minus 3 volts and minus 9 volts.

POWER INTERFACE - SLOW SPEED MOTOR DRIVE CIRCUIT

The purpose of the slow-speed motor drive circuit is to provide a means for operating the slow-speed drive motor **54** of the sewing unit **30** by means of low-level electronic voltages and currents, said motor being a DC motor. This section of the power interface wiring circuit of FIGS. **13***a* and **13***b* is made up of two amplifier sections and two Triax or bidirectional Thyristor solid state switches **158** and **160**, two full-wave bridge rectifier circuits **162** and **164**, two resistors **166** and **168** and a capacitor **170**. The amplifier portion is, in actuality, a switch, the signal to amplifiers **172** and **174** turn "on" or "off" an AC drive voltage of low magnitude which voltage is used to cause the Triax units of Thyristor switches **158** and **160** to be conductive to high-voltage alternating current. Thyristor switch **158** serves to connect the 220-volt incoming supply to a series circuit consisting of the field supply bridge rectifier circuit **162**, resistor **166** and the armature supply bridge rectifier circuit **164**.

Thus, the incoming AC supply is simultaneously switched and converted to the necessary DC voltage required for the slow-speed drive motor **54** of the sewing unit **30**. Resistor **166** is for the purpose of limiting the maximum current, while a "de coupling" circuit consisting of resistor **168** and capacitor **170** is placed between the motor armature and thyristor switch **160** for the purpose of limiting the maximum rate of change of the voltage across the thyristor switch **160** and thereby prevent undesired "triggering" of this thyristor switch **160**. Thyristor switch **160** is connected across the AC input terminals for the armature supply bridge rectifier circuit **164** through resistor **168** for the purpose of placing a near short circuit across its bridge so as to obtain braking operation when it is desired to stop the slow-speed drive motor **54** of the sewing unit **30** quite suddenly as is normally done.

During operation of the braking cycle, some of the circuit their long-time power dissipation rating. The braking operation should, therefore, be followed by operation which turns off thyristor switch **158**, removing power from the drive circuit of the slow-speed drive motor **54** of the sewing unit **30**.

POWER INTERFACE - SOLENOID AIR VALVES AND DRIVERS

The thread trimmer, forward-reverse, presser foot, and motor clutch solenoid valves **102**, **104**, **106** and **108** of the solenoid air valve unit **44** have previously been briefly described, along with the purposes thereof for actuation of the various air cylinders operably connected to the sewing unit **30**, and electronic power-amplifying circuits **176**, **178**, **180** and **182** connected thereto permit operation of these solenoid valves by means of low-level electronic signals at their input. Rectifier diodes **184** are provided for each of these solenoid valves **102**, **104**, **106** and **108** for the purpose of suppressing the high transient voltages which are generated when inductive loads, such as these solenoid valves are deenergized, as is commonly done. The power-amplifying circuits **178** and **182** have inputs which come from circuits shown symbolically as triangles with a small dot inside the triangle, these circuits being known in the art as AND gates, functioning in a way such that a signal must be applied to both of the inputs to cause actuation of the associated solenoid valve. The on-off thread trimmer switch **110** of the solenoid air valve unit **44** is provided in series with the thread trimmer solenoid valve **102** to permit disabling operation of the thread trimmer if there is any malfunction such that the sewing head needle **50** of the sewing head **30** or the thread trimmer thereof may be damaged.

POWER INTERFACE - CONTROL SWITCHES

The various switches of the power interface **32** and shown in the circuit of FIG. **13***a* as previously briefly described are to permit operation of the sewing unit **30** and peripheral equipment under manual control, and also to permit operation thereof under automatic control by the automatic controller **34** when properly programmed. The power interface selector switch **56** movable between the "manual" and "automatic" positions is shown in FIG. **13***a* as a series of switches **56**, being a multifunction switch provided for the purpose of allowing a choice of manual operation of the sewing unit **30** and peripheral equipment by means of the foot and knee switch units **38** and **40**, or automatic operation by means of the program permanently recorded in the automatic controller **34**. The effect of moving the power interface selector switches **56** is described in more detail under the section headed "Control Flip-Flops and Associated Logic."

The foot control switch **58** of power interface **32** is an "on" and "off" switch for the purpose of providing a choice between requiring sustained operation of the treadle **92** of the foot switch unit **38** or momentary operation of said treadle to effect operation of the sewing unit **30** when under control of the automatic controller **34**, again, all of which has been previously explained.

Slow and fast drive motor switches **186** and **188** are portions of the previously described two-stage drive motor switch **90** of the foot switch unit **38** actionable by light and heavy toe pressure on the treadle **92** of the foot switch unit as previously described. Furthermore, slow and fast drive motor switches **186** and **188** are multiple function switches depending on the settings of the power interface selector switch **56** and the automatic controller selector switch **62** as has been previously described and will be also later alluded to.

In addition to the slow and fast drive motor switches **186** and **188**, there are the right- and left-knee switches **98** and **100** described in the knee switch unit **40**, the reverse switch **94** in the foot switch unit **38** actionable by side toe movement as described, and the instruction record switch **96** of the foot

Various resistors **190** and diodes **192** are associated with switches **186**, **188**, **98**, **100**, **94** and **96** for the purpose of establishing the same voltages and current handling capabilities as the other electronic circuitry involved in the control circuits. That is to say, these resistors and diodes establish compatibility of the switching signals with other electronic control signals existing in the circuitry.

POWER INTERFACE - CONTROL FLIP-FLOPS AND ASSOCIATED LOGIC

This section of the circuitry of the power interface **32** as shown in FIGS. **13***a* and **13***b* consists of several so-called "flip-flops" and associated "gating" circuits, both being well known and widely used in electronic circuitry. Also, used in this section of the circuitry are delay multivibrators, inverting circuits, and squaring circuits, all equally well known and conventionally used.

By way of brief description, a "flip-flop" is an electronic circuit which has two stable states and for descriptive purposes, these two states in the following discussion are called TRUE and FALSE. A flip-flop has two output signals which are opposite in state, one of which is called the ONES output and the other is called the ZEROS output. When a particular flip-flop is in the TRUE state, its ONES output is in the TRUE condition, and its ZEROS output is in the FALSE condition. When the flip-flop is in the FALSE condition, its ONES output is FALSE and its ZEROS output is in the TRUE condition.

There are two types of so-called "gate" circuits used in the control circuit, namely, AND gate and OR gate. The AND gate has the characteristics that when and only when all of its inputs are TRUE, the output is TRUE, and if any inputs are FALSE, the output is FALSE. The OR gate functions in such a way that if any of its inputs are TRUE, its output is TRUE, and only when no inputs are TRUE is the output FALSE. The AND gates are shown in the wiring circuit as "triangles" with "dots" in the centers thereof, and the OR gates are shown as "triangles" with "pulses" in the centers thereof.

The inverter circuit, shown symbolically as a box containing a N, is for the purpose of accomplishing logical inversion of the control signals, converting TRUE to FALSE and FALSE to TRUE. A TRUE input to this circuit results in a FALSE output and a FALSE input results in a TRUE output.

The multivibrator or delay multivibrator circuit is similar to the flip-flop circuit except for having only one stable state. An input signal causes reversal of the state and the multivibrator for a predetermined time after which the circuit returns to its original or rest state even though no additional signals are received by the circuit.

A squaring circuit, shown symbolically as a box containing the letters SQ is similar to the flip-flop circuit in that it has both a ONES and a ZEROS output. It functions as a decision making circuit and changes state suddenly when a slowly changing input reaches a certain magnitude which causes the output to suddenly reverse with the TRUE output becoming FALSE and vice versa. When the slowly changing input drops somewhat below this preset magnitude, the outputs suddenly revert to their original state.

POWER INTERFACE - OPERATION OF CONTROL CIRCUITS

With the foregoing general description of the capabilities of the various so-called logical functions, it becomes possible to describe the operation of the control circuits of the power interface **32** as shown in the circuit of FIGS. **13***a* and **13***b*. For purposes of tracing through this circuit, it should be borne in mind that the description is based on "negative" logic, that is, a minus 3 volt signal level is considered as the TRUE signal level and a plus 3 volt signal level is considered as a FALSE signal level. Flip-flops **194**, **196**, **198** and **200** are the basic controlling units in the circuit for the power interface **32**.

Flip-flop **194** is used only in the automatic mode and when the power interface selector switch **56** is in its "automatic" position, flip-flop **194** is connected to power-amplifying circuit **180** which in turn energizes presser foot solenoid valve **106** causing the presser foot to raise when flip-flop **194** is in the TRUE state and to lower when flip-flop **194** is in the FALSE state. When the power interface selector switch **56** is in the "manual" position, power-amplifying circuit **180** is connected to the right knee switch **98** of the knee switch unit **40** and operation of this switch by knee movement will cause the presser foot to raise. Release of the right knee switch **98** causes the presser foot to lower by deenergizing the presser foot solenoid valve **106**.

The other three flip-flops **196**, **198** and **200** are used in their various combinations to cause the various modes of operation of the sewing unit **30** with these combinations and their resulting modes of operation being tabulated below:

TABLE 1

	Flip-flop			
	196	198	200	Operation
Combination Number:				
7	TRUE	TRUE	TRUE	Run slow reverse.
6	TRUE	TRUE	FALSE	Run slow forward.
5	TRUE	FALSE	TRUE	Run fast reverse.
4	TRUE	FALSE	FALSE	Run fast forward.
3	FALSE	TRUE	TRUE	Position up and trim.
2	FALSE	TRUE	FALSE	Stop needle down.
1	FALSE	FALSE	TRUE	Stop needle up.
0	FALSE	FALSE	FALSE	Stop.

It can be seen from table 1 that the ONES outputs of flip-flop **196** and flip-flop **200** will both be TRUE when the flip-flops are both in the TRUE state, and this occurs for combinations **5** and **7** of table **1**. These combinations are the only ones which call for reverse operation of the sewing head needle **50** and feed dogs of the sewing unit **30**. Thus, the two inputs to AND-gate **201** which controls the power-amplifying circuit **178** to cause reverse operation of the sewing head **48** are connected to the ONES output of these two flip-flops **196** and **200**, the result being that when both flip-flops are in the TRUE state, the sewing head **48** runs in reverse.

Considering the drive to the power-amplifying circuit **182** which controls the motor clutch solenoid valve **108** and through it the main clutch for the high-speed drive motor **52** to drive the sewing head **48** at fast speed, it can be seen that again two TRUE inputs are required at the terminals **202** and **204** of AND-gate **205**. One of these inputs comes from the ZEROS output of flip-flop **198**, so that the main clutch of the high-speed drive motor **52** can only be energized when this signal is TRUE, which occurs only when flip-flop **198** is in the FALSE state. From the tabulation of table 1, it is seen that this is only on combinations **0**, **1**. **4** and **5**. Looking now at the other input to the AND-gate **205** which is terminal **204**, it can be seen that this occurs only when output of an OR-gate **207** is TRUE, this occurring only when no inputs to the OR-gate **207** are TRUE. Since one of these inputs comes from the ZEROS output of flip-flop **196**, this can only happen when flip-flop **196** is in the TRUE state, this condition existing only for table **1** combinations **4**, **5**, **6** and **7**. When combined with the previous condition required, it is apparent that the main clutch of the high-speed drive motor **52** can only be energized for table 1 combinations **4** and **5**, the only combinations calling for "Run Fast."

Another input to the OR-gate **207** is connected to the foot control switch **58** on the power interface **32**, and when this switch is closed, the signal at this input will be FALSE only when the slow drive motor switch **186** of the foot switch unit **38** is actuated by light toe pressure. In this way, control can be

given to the operator by closing the foot control switch 58 on the power interface 32 so as to require that the treadle 92 of the foot switch unit 38 be depressed by toe pressure to permit continued programmed operation of the sewing unit 30 when the same is under automatic control of the automatic controller 34. When the foot control switch 58 of the power interface 32 is open or OFF, the OR-gate 207 input is open which is equivalent to a FALSE input at this point and operation of the automatic controller 34 occurs once the treadle 92 of the foot switch unit 38 is depressed by toe pressure and continues under automatic controller programmed control whether the slow drive motor switch 186 of the foot switch is held actuated or not.

Now considering slow speed operation of the sewing head 48 of the sewing unit 30 by the slow speed drive motor 54, this is controlled by the flip-flops 196 and 198, both being in the TRUE state. Table 1 shows that when flip-flop 196 is TRUE, this calls for Run and when flip-flop 198 is also TRUE, this calls for Run Slow. The operation of flip-flop 200 in these cases will cause the slow run to be either forward or reverse as was previously described, and to run at slow speed, the main clutch for the high-speed drive motor 52 of the sewing unit 30 should be deenergized which is accomplished by the input to the AND gate controlling the motor clutch solenoid valve 108 through the power-amplifying circuit 182. When flip-flop 198 is in the TRUE state, this input is FALSE and the motor clutch solenoid valve 108 is deenergized. To run at slow speed, the input to thyristor switch 158 should be TRUE, so the output of the control gates should be TRUE. Several conditions can cause this, but the one which does it under normal Run Slow operation is the AND-gate 206 of the group. The signal at terminal 208 of the AND-gate 206 is TRUE when flip-flop 196 is in the TRUE state, and if foot control switch 58 of the power interface 32 is closed or "on," the slow drive motor switch 186 of the foot switch unit 38 is actuated, the foot switch unit control having been previously described. This terminal 208 signal is one of the inputs to AND-gate 206 and the other input comes directly from flip-flop 198. Since it is the ONES output, it is TRUE when flip-flop 198 is in the TRUE state which is the case on both of the RUN Slow conditions of table 1, that is, combinations 6 and 7. When both of these inputs to AND-gate 206 are TRUE, the output of OR-gate 210 is TRUE and the thyristor switch 158 is energized resulting in operation of the slow speed drive motor 54 of the sewing unit 30.

The STOP operations, combinations 0, 1, 2, and 3 of table 1, for the main part, are somewhat more complex than the normal Run operations, although combination 0 of table 1 is relatively straightforward. The condition for combination 0 of table 1 exists when flip-flop 196, flip-flop 198 and flip-flop 200 are all in the FALSE state, and under these conditions, no solenoid valves are energized except possibly the presser foot solenoid valve 106 and neither the slow speed drive motor 54 through slow drive motor switch 186 nor braking control through thyristor switch 160 are energized except for certain previously existing conditions where this latter control may be momentarily actuated as described later. When the unconditional stop combination 0 of table 1 occurs, flip-flops 196, 198 and 200 being FALSE, the sewing head 48 and the needle 50 thereof coasts to its normal stop and no positioning or trim action occurs.

Conditions 1 and 2 of table 1 are both stop operations in which the braking circuit of the slow speed drive motor 54 for the sewing unit 30 is used to accurately position the needle 50 in its cycle when sewing action stops. Condition 1 of table 1 stops the sewing head 48 with the needle 50 in the "up" position and Condition 2 of table 1 stops it with the needle 50 in the "down" position, this being accomplished by use of AND-gates 212, 214, 216 and 218. AND-gates 212 and 214 are used to actuate the slow speed drive motor 54 of the sewing unit 30 through the slow drive motor switch 186 until the desired needle position of needle 50 is reached. Flip-flop 196, when in the FALSE condition, is connected to make one input of AND-gate 212 and one input of AND-gate 214 TRUE. The other input of AND-gate 212 is TRUE if flip-flop 198 is in the TRUE state. The other input of AND-gate 214 is TRUE if flip-flop 200 is in the TRUE state. Therefore, if flip-flop 196 is in the FALSE state and either flip-flop 198 or flip-flop 200 is in the TRUE state, the slow-speed drive motor 54 is energized through the slow drive motor switch 186 and the sewing head 48 when the needle 50 thereof runs at slow speed. Under these circumstances, stop action is caused by energizing the braking circuit described in the section SLOW-SPEED MOTOR DRIVE CIRCUITS while maintaining power on the slow-speed drive motor 54, that is, the circuit thereof. This latter requirement is necessary to insure that the field of the slow-speed drive motor 54 stays energized while the motor armature is short circuited by the Thyristor switch 160 since with no field current, proper dynamic braking operation cannot be obtained.

AND-gate 216 and 218 are used to initiate the stop action of the slow-speed drive motor 54 and, therefore, the sewing head needle 50. When a condition such that all inputs of either of these two gates are TRUE, a one-shot multivibrator 220 connected thereto is actuated and its output becomes TRUE. The multivibrator 220 is connected to thyristor switch 160 and energizes it to cause a short circuit across the armature of the slow-speed drive motor 54, in turn, causing the slow-speed drive motor to stop suddenly. The multivibrator 220 is also connected to the OR-gate 210, along with the outputs of the AND-gates 206, 212, and 214 such that thyristor switch 158 remains energized during the braking action even if none of the just-mentioned gates have an output. This is done to insure field current during braking as described in the previous paragraph.

The output of multivibrator 220 also connects to the flip-flops 198 and 200 which resets either or both of these flip-flops to the FALSE state. Since flip-flop 196 is in the FALSE state at the start of either of these stop actions just described, the three control flip-flops 196, 198 and 200 are now all FALSE and condition 0 of table 1 exists except for the braking operation of multivibrator 220 which has not yet terminated. This multivibrator 220 holds the braking circuit energized through both Thyristor switches 158 and 160 for approximately one-half of one second at which time the multivibrator output switches to FALSE and all circuits, except possibly that to the presser foot solenoid valve 106, are deenergized.

The instant of initiation of the braking action is determined by the inputs of AND-gates 216 and 218. Three of these inputs come from the three flip-flops 196, 198 and 200 such that three of the four AND-gate 216 inputs are TRUE under the Stop Needle Up conditions, condition 1 of table 1, and three of the four AND-gate 218 inputs are TRUE under the 37 Stop Needle Down" conditions, condition 2 of table 1. The actual stop action is initiated then by the instant the fourth input becomes TRUE of whichever of AND-gates 216 and 218 has three inputs TRUE. This fourth input in the case of AND gate 216 is a short duration pulse which occurs at the instant the needle 50 is in the desired up position and, in the case of AND-gate 218, it is a pulse which is momentarily TRUE when the needle 50 is in the desired "down" position. The method by which these "up" and "down" pulses are generated is described later under the section describing the needle counter and positioner 42 and its associated circuitry.

The "Position Up and Trim" operation, that is, positioning the sewing head needle 50 "up" and actuation of the thread trimmer or cutoff, is shown as combination 3 in table 1 and occurs when flip-flop 196 is in the FALSE state and flip-flops 198 and 200 are both in the TRUE state. Under these circumstances, AND-gate 222 has three inputs in the TRUE state, the fourth input to this gate being the "down" position pulse just mentioned, which becomes TRUE when the needle 50 reaches the "down" position. At this time, the AND-gate 222 has a TRUE output directed through power-amplifying circuit 176 and on-off thread trimmer switch 110, energizing the thread trimmer solenoid valve 102 to thereby actuate the thread trimmer or cutoff mechanism. As previously stated, on-off thread trimmer switch 110 is provided to permit disabling the action of the thread trimmer in case malfunction has occurred causing improper action or timing of the thread trimmer and the position of the sewing head needle 50, that is

to say, an improper positioning relationship therebetween.

The TRUE input of the AND-gate **222** is also connected to an AND-gate **224** and to an inverter circuit. The AND-gate **224** is for the purpose of sustaining the output to the thread trimmer solenoid valve **102** from the time of the "down" position of the sewing head needle **50** until the "up " position is reached. The output of the inverter circuit which receives its input from the TRUE output of the AND-gate **222** is used to reset the flip-flop **198** and when this occurs, the FALSE-TRUE combination of the control flip flops, combination 3 of table 1, gets changed to a FALSE-FALSE-TRUE combination. Referring to table 1, it can be seen that this is combination **1** which is the combination that causes "Stop Needle Up" operation of the sewing head needle **50**. From this point on, "-Stop Needle Up" operation occurs in the same manner as described previously except that the thread trimmer solenoid valve **102** has been energized to energize the thread trimmer mechanism. The slow-speed drive motor **54** and later the braking circuits thereof are all actuated in the same manner as was described relative to "Stop Needle Down" and/or "Stop Needle Up" operation.

In the preceding, the manner in which the control flip-flops **194, 196, 198** and **200** control the operation of the sewing head **48** and the needle **50** thereof has been described, and the power interface selector switch **56**, previously described under the section, POWER INTERFACE - CONTROL SWITCHES, controls the means whereby these control flip-flops are set to the various combinations required. When the power interface selector switch **56** is in the "automatic" position, these flip-flops receive their inputs from the automatic controller **34**, to be later described, and when the power interface selector switch **56** is in the "manual" position, flip-flop **194** is not used. With the power interface selector switch **56** in "manual," the presser foot solenoid valve **106** is connected directly to the right knee switch **98** of the knee switch unit **40** and this switch controls the presser foot solenoid valve directly. Also, when the power interface selector switch **56** is in "manual," flip-flop **196** is controlled directly from the slow drive motor switch **186** of the foot switch unit **38** so that when the treadle **92** thereof is depressed with light toe pressure, flip-flop **196** is set to the TRUE state and when the treadle is released this flip-flop reverts to the "FALSE" state.

Still further, when the power interface selector switch **56** is in "manual," the inputs of the flip-flops **198** and **200** are, by means of AND gates, isolated from the other control switches unless the slow drive motor switch **186** of the foot switch unit **38** is actuated. When the slow drive motor switch **186** of the foot switch unit **38** is actuated, the flip-flop **198** is immediately set to the TRUE state and this is done by connecting the fast drive motor switch **188** of the foot switch unit **38** to the input AND gates of flip-flop **198**. When the treadle **92** of the foot switch **38** is depressed sufficiently to operate the fast drive motor switch **188**, flip-flop **198** is set to the FALSE state, and when the treadle is released sufficiently to deactivate fast drive motor switch **188**, flip-flop **198** again reverts to the TRUE state. If we assume the flip-flop **200** to be in the FALSE input state, it can be seen from table 1 that light depression of the treadle **92** of the foot switch unit **38** gives combination **6** of table 1 or "Run Slow Forward" operation. Depressing the treadle **92** further, so as to actuate the fast drive motor switch **188**, causes the flip-flops to change to combination **4**, which is the "Run Fast Forward" condition. Releasing the treadle **92** sufficiently to deactivate the fast drive motor switch **188** causes the flip-flops to revert to combination **6** of table 1, or the "Run Slow Forward" condition.

Since the input to the flip-flop **198** is closed when the fast drive motor switch **188** of the foot switch unit **38** is deactivated, complete release of the foot pedal causes the flip-flop **196** to change to the FALSE state, but leaves the flip-flop **198** in the TRUE state. This is combination **2** of table 1 and calls for the operation of the sewing head **48** to stop with the needle **50** in the "down" position. By closing the inputs to flip-flops **198** and **200**, they are free to be reset by the stop action which was described above.

Examination of the connections to the flip-flop **200** sows two things. One of these is that the part of the power interface selector switch disconnects one of the inputs to the power-amplifying circuit **178** of the forward-reverse solenoid valve **104** from the flip-flop **200** and connects it to the reverse switch **94** of the foot switch unit **38** actuated by the side toe pressure. This has the result that the flip-flop **200** will have no effect on reverse operation of the sewing head **48** and the needle **50** thereof, and the combinations **5** and **7** of table 1 are not valid. The other feature of the flip-flop **200** concerns its input, which comes from the left knee switch **100** of the knee switch unit **40**, and it can be seen that if this latter switch is actuated, the flip-flop **200** will be set to the TRUE state, but if this left knee switch **100** is not actuated, the flip-flop **200** is set to the FALSE state. As just mentioned, this will not affect the run operation, combinations **5** and **7** of table 1 not being valid, but it does affect the stop operation, and it can be seen that if the left knee switch **100** is held actuated, when the treadle **92** of the foot switch unit **38** is released and the slow drive motor switch **186** deactuates, the flip-flop **200** will, like the flip-flop **198**, be left in the TRUE state when its inputs are closed. From table 1, it can be seen that combination **3** will exist which calls for the sewing unit **30** to go through the "Position Up and Trim" cycle of operation in the manner previously described.

The left knee switch **100** of the knee switch unit **40** is actuated by knee movement to the left and if this knee switch is held to the left when the treadle **92** of the foot switch unit **38** is released, "Position Up and Trim" operation is initiated. If the left knee switch **100** is held to the left and the treadle **92** of the foot switch unit **38** is momentarily actuated by a light tap of the toe, the operation occurs from the stop position of the sewing head **48**. As was previously mentioned, the control of reverse operation of the sewing head **48** and the needle **50** thereof is disconnected from the flip-flop **200** when the power interface selector switch **56** is in "manual." This forward-reverse solenoid valve **104** is now connected to the reverse switch **94** of the foot switch unit **38** and if this switch is actuated, the sewing head **40** and needle **50** thereof runs in reverse at either slow or fast speed depending on how far the treadle **92** of the foot switch unit **38** is depressed.

NEEDLE COUNTER AND POSITIONER - ASSOCIATED CIRCUITRY WITH POWER INTERFACE

The needle counter and positioner **42** is included diagrammatically in the wiring circuit of the power interface **32** as shown in FIGS. **13***a* and **13***b*, and is also shown in FIGS. **11** and **12** in perspective and vertical section, the same being a vital part of the overall control of the sewing head **48** and the needle **50** thereof as well as being a vital adjunct to the automatic controller **34**. The needle counter and positioner **42** includes a small, partly translucent, partly opaque disc **226**, connected to a sleeve **228** which is rotated by a shaft of the sewing unit **30**, that is, a shaft exactly movable rotatably with the reciprocal "up" and "down" movements of the sewing head needle **50**. The disc **226** is positioned between a light source **230** and a light-detecting cell **232**, the disc being properly circumferentially positioned relative to the reciprocal positions of the sewing head needle **50** such that the disc opaque segment comes between the light source **230** and the light detecting cell **232** when the sewing head needle reaches the needle "down" position as previously described, and clears the path between the light source and light-detecting cell when the sewing head needle reaches the desired needle "up" position.

Thus, the needle counter and positioner **42** is arranged to provide an electronic signal which can be used to provide a signal for stopping the sewing head needle **50** at a desired needle "down" position, can be used to provide a signal for stopping the sewing head needle at a desired needle "up" position, can be used to provide a signal which lasts from the needle "down" position to the needle "up" position for sustaining actuation of the thread trimmer solenoid valve **102** and the thread trimmer mechanism operable thereby, and can be used to provide a signal at each revolution of the sewing head **48**, that is, a signal for each reciprocal movement of the sewing

head needle **50**, which can be counted electronically to maintain an exact count of the number of sewing stitches the sewing head needle carries out.

The light-detecting cell **232**, a photocell, has the output thereof connected to amplifier **234** of the power interface **32** as shown in the wiring circuit of FIGS. **13***a* and **13***b*, and the output of the amplifier **234** is connected to a squaring-circuit **236** which has a ONES and ZEROS output. As has been described, these outputs change suddenly at a point where the opaque sector of the disc **226** is becoming interposed between the light source **230** and the light-detecting cell **232** of the counter and positioner **42**, and revert again suddenly to their original state when the disc opaque sector is passing out from between the light source and the light-detecting cell. This sudden change is desirable for proper operations of the electronic circuits no matter what the speed of the sewing head **48** and the needle **50** thereof at the time the conditions occur, and also to effect a "decision" as to the exact time of causing the various control electronic elements operations.

The squaring circuit **236** is connected to another squaring circuit **238** of the same type through resistors **240** and **242** having a capacitor **244** across the same, and these resistors and capacitor serve to delay the action of the second squaring circuit **238** to a slightly later time than the first squaring circuit **236**. This time delay is used to generate a short duration pulse at the time of change in state of the squaring circuits and this can be done in any of several ways, but this method permits the use of "direct current coupling" which tends to be more reliable and easier to test, as well as lends itself to use in conventional AND and OR circuits which allow for use of additional control signals.

The output of the first squaring circuit **236** is TRUE during the time from the "down" position of the sewing head needle **50** to the "up" position thereof and, of course, the other output of this first squaring circuit **236** is TRUE during the remainder of the time from the "up" position to the "down" position. The outputs of the first and second squaring circuits **236** and **238** are connected OR-gates **246** and **248**, respectively, so that when the "down" position is reached, the output of the OR-gate **248** becomes FALSE until the second squaring circuit **238** changes, and when the "up" position is reached, the output of the OR-gate **246** becomes FALSE until the second squaring circuit **238** changes. The OR-gates **246** and **248** are connected to inverter circuits **250** and **252**, respectively, which provide a TRUE output during this short period of time. The OR-gates **246** and **248** also have a third input which, when held in the TRUE state, prevents an output and thereby can be used to inhibit a TRUE output signal from appearing at the outputs of the inverter circuits **250** and **252**. Thus, a "down" position output pulse for the sewing head needle **50** is received from the OR-gate **248** and the inverter circuit **252**, and an "up" position output pulse is received from the OR-gate **246** and the inverter circuit **250**, each at the appropriate times as indicated.

The third input, previously mentioned, to the OR-gates **246** and **248**, that is, the "inhibit" inputs, is connected to a flip-flop **254** and this flip-flop is set to inhibit the "up" position and "down" position pulses whenever the sewing head **48** is operated for moving the needle **50** thereof. This inhibit operation remains present until the flip-flop **254** is set to the TRUE state by an input from a type of multivibrator **256** which provides an output when its input is removed for a sufficiently long period of time. This period of time is set to be such that only when the movement of the sewing head needle **50** has slowed to a speed low enough to be able to cause proper thread trimming action by the thread trimmer or thread cutoff actuated by the thread trimmer solenoid valve **102**, and only after such slowing to the low speed will output pulses occur. This electronic action is provided as a safety feature to reduce the likelihood of actuation of the thread trimmer solenoid valve **102**, and therefore the thread trimmer, at high speed, even though most sewing units now have mechanical devices to reduce this possibility since actuation of the thread trimmer at high speed will almost certainly cause mechanical damage to the sewing head needle **50** or the blades of the thread trimmer.

AUTOMATIC CONTROLLER - GENERAL

The wiring circuit for the automatic controller **34** is shown in FIGS. **14***a*, **14***b*, **14***c*, **14***d*, **14***e* and **14***f*, with the circuit of the storage drum thereof being shown more in detail in FIGS. **15** and **16**. As previously stated, the automatic controller **34** has a storage or memory unit within which the series of operational steps for the sewing unit **30** and peripheral equipment may be stored, each step then being played back from such memory as required. Each instruction step consists of 20 binary digits, although the basic design of the control and memory unit allows for as many as 32 binary digits. Eight of these binary digits are used for command purposes and the additional 12 are for numerical data associated with the command, such as delay time or stitch count as determined by the previously described needle counter and positioner. A total of **64** steps can be carried out in a single program of the automatic controller **34** and these steps are carried out sequentially except for a certain type of instruction which causes the sequence of steps to be altered or broken.

The instruction step about to be recorded in the program of the automatic controller **34** if the selector switch **62** thereof is in "record", or performed if the automatic controller is in automatic mode by the selector switch being in "operate," is indicated at the program step counter **76** at the front of the automatic controller **34** as is shown in FIG. **5**. This display is in "octal" code for the base 8 numbering system in which there are no eight or nine digits, and this has been done for reasons of circuit simplicity, not necessarily being a requirement. The octal numbers corresponding to the decimal number of a given program are shown in the following table 2. The eight command digits mentioned have been assigned various functions for control of either the sewing unit **30** or the program of the automatic controller **34**, these eight binary digits or "bits" being divided into two groups of four binary digits, each group of four making up a one-out-of 16, or hexadecimal, character. One of these is referred to as the "command" character and the other as the "output" character, since one primarily influences the nature of the action and the other influences the output to which the action applies, thus, composite instructions. In the case of the output commands to the sewing unit **30**, the output character can also contain certain "command" information, and the way in which these combinations are used is shown in the following tables 3 and 4.

TABLE 2

DECIMAL TO OCTAL CONVERSION

Decimal Step	Octal No.	Decimal Step	Octal No.	Decimal Step	Octal No.
0	0	22	26	44	54
1	1	23	27	45	55
2	2	24	30	46	56
3	3	25	31	47	57
4	4	26	32	48	60
5	5	27	33	49	61
6	6	28	34	50	62
7	7	29	35	51	63
8	10	30	36	52	64
9	11	31	37	53	65
10	12	32	40	54	66
11	13	33	41	55	67
12	14	34	42	56	70
13	15	35	43	57	71
14	16	36	44	58	72
15	17	37	45	59	73
16	20	38	46	60	74
17	21	39	47	61	75
18	22	40	50	62	76
19	23	41	51	63	77
20	24	42	52		
21	25	43	53		

TABLE 3

ASSIGNMENT OF COMMAND CHARACTER BITS

Decimal Number	Binary Digits				Command Effect
	8	4	2	1	
15	1	1	1	1	Reserved for future
14	1	1	1	0	Reserved for future
13	1	1	0	1	Activate Output
12	1	1	0	0	Deactivate Output - Terminate by knee switch
11	1	0	1	1	Activate Output
10	1	0	1	0	Deactivate Output - Terminate by stitch count
9	1	0	0	1	Activate Output
8	1	0	0	0	Deactivate Output - Terminate after time delay
7	0	1	1	1	Transfer to Specified Instruction
6	0	1	1	0	Reserved for future
5	0	1	0	1	Training Stop 02
4	0	1	0	0	Training Stop 01
3	0	0	1	1	Reserved for future
2	0	0	1	0	Program Stop
1	0	0	0	1	Program Stop and Reset
0	0	0	0	0	Skip - Do Nothing

TABLE 4

ASSIGNMENT OF OUTPUT CONTROL CHARACTER BITS

Decimal No.	Binary Digits				Sewing Machine	Other Outputs	Command Effect
	8	4	2	1			
15	1	1	1	1	x		Run Slow Reverse
14	1	1	1	0	x		Run Slow Forward
13	1	1	0	1	x		Run Fast Reverse
12	1	1	0	0	x		Run Fast Forward
11	1	0	1	1	x		Position Up and Trim
10	1	0	1	0	x		Stop Needle Down
9	1	0	0	1	x		Stop Needle Up
8	1	0	0	0	x		Stop
7	0	1	1	1		x	
6	0	1	1	0		x	
5	0	1	0	1		x	Reserved for future
4	0	1	0	0		x	
3	0	0	1	1		x	
2	0	0	1	0		x	Operate Stacker
1	0	0	0	1		x	Operate Presser Foot
0	0	0	0	0		x	Not Used

Associated with the command and output characters are the 12 binary digits of numerical information which were previously discussed and these are used, in the control of the sewing unit **30**, as either stitch count or time delay information. That is to say, when a command such as No. **11** of table 3 is called for, which calls for an action to be terminated after its specified stitch count, it is necessary to specify the stitch count, and when a command such as No. **9** of table 3 is called for, the desired time delay must be specified. The stitch counts and time delays are specified by the additional twelve binary digits of the particular instruction.

The foregoing discussion explains the general aspects of the manner in which the automatic controller **34** accomplishes the desired control of the sewing unit **30** and any peripheral equipment therefor. In the following, a detailed explanation and description is contained of the manner in which the various combinations of binary digits are entered, stored, recalled, and accomplish the desired results for use of the automatic controller **34**.

AUTOMATIC CONTROLLER - MAJOR REGISTERS OR COUNTERS

The circuit diagram of FIGS. **14***a*, **14***b*, **14***c*, **14***d*, **14***e* and **14***f* shows the detailed logic design of the main control unit of the automatic controller **34**. FIG. **14***a* is the upper left portion of the wiring circuit, FIG. **14***b* is the upper center portion, FIG. **14***c* is the upper right portion, FIG. **14***d* is the lower left portion, FIG. **14***e* is the lower center portion and FIG. **14***f* is the lower right portion.

The automatic controller **34** includes three major registers or counters which provide the basic control of the entire unit. One of these is the main control register, made up of 20 flip-flops **258** through **296**. Another is the program step counter made up of six flip-flops **298** through **308**, and the third is the drum position counter made up of nine flip-flops **310** through **326**.

AUTOMATIC CONTROLLER - MAIN CONTROL REGISTER

The entire command is normally placed in the main control register, the four command bits being placed in the flip-flops **258**, **260**, **262** and **264**. The output control bits are placed in the flip-flops **266**, **268**, **270** and **272**, while the numerical information is placed in the flip-flops **274** through **280**, **282** through **288** and **290** through **296**. When a particular command is placed in this main control register, the automatic controller **34** executes the called for action when an "execute" signal is generated, or records the instruction when a "record" signal is generated.

When the command to be executed calls for termination after either a specified time or specified stitch count, a pulse source is supplied to the input of the flip-flop **274** which causes the flip-flops **274** through **280**, the flip-flops **282** through **288** and the flip-flops **290** through **296** to run as a binary counter. The output of the last flip-flop **296** in this counter chain is connected to a flip-flop **328** and when the counter reaches a count of ZERO, it causes the flip-flop **328** to switch to the FALSE state which terminates the instruction. The flip-flop **328** has been set to the TRUE state, which causes the application of pulses to the counter input by a combination of the "execute" signal on the flip-flop **328** and a signal from an OR-gate **330** which is TRUE when the flip-flop **264** is TRUE and the flip-flop **262** is in the FALSE state. This condition exists when the command character is in the combination of bits occurring when the table 3 combinations of **8**, **9**, **10** or **11** are in the flip-flops. These combinations can be seen as the commands wherein action is called for which terminates on either stitch count or time delay.

There are several ways in which the counter section of the main control register is made to count, one is by the flip-flop **328** being set to the TRUE state as mentioned which provides a TRUE input to OR-gate **332** and causes a FALSE output therefrom. This, in turn, causes a FALSE input to a combination of OR-gates **334** and **336**. This combination of the OR-gates **334** and **336** is made up of two four-input OR gates which are, through logical operations, connected in such a way that their outputs are combined and appear as an output of a two-input OR-gate **338** and associated inverter (N) which runs the counter section of the main control register.

Inspection of the manner in which these cascaded OR gates are connected shows that the flip-flop **260** will function to cause either of the outputs of the OR gates **334** or **336** to reach the counter input. Any TRUE input to the OR-gates **334** and **336** will prevent any output therefrom from causing the

counter to run. One of the terminals to the OR-gate **334** is a timing signal which results in this signal driving the counter if all other inputs to this OR-gate **334** are FALSE. The other OR-gate **336** has an input which comes from a squaring circuit **340** whose input, via a noise pulse filter, comes from the needle counter and positioner **42**.

The timing signal to the OR-gate **334** mentioned above comes from a timing multivibrator **342** and this circuit is adjustable by means of an adjustable potentiometer which is the delay adjustment switch **84** of the automatic controller **34** previously discussed and shown in FIG. **6**. Such adjustment of the delay adjustment switch **84** changes the length of the time unit used by the automatic controller **34** to measure and regulate all program steps measured by pure time, whether composite instruction steps or merely solely time steps such as time delays between component operational steps of the sewing unit **30**.

The conditions just described result in either a timing signal or the stitch counter signal causing the counter section of the main control register to run depending on whether the flip-flop **260** is TRUE or FALSE and upon certain other conditions. If the flip-flop **260** is TRUE, input to the OR-gate **334** will be TRUE and the timing multivibrator **342** cannot pass through to the counter. Input to the OR-gate **336** will be FALSE, however, and the stitch counter signal will pass through this gate if another input is also FALSE, this being the case if a flip-flop **344** is FALSE, such condition existing if a command is being executed.

When the counter section is caused to run by the flip-flop **328** being set to the TRUE state, the command terminates by the flip-flop **328** being set to the FALSE state by an input which is the carry from the last counter stage flip-flop **296**. Another way in which the counter can be caused to run is by pressing a "delay" button **346** on the automatic recorder **36** which will be hereinafter described more in detail. For present purposes, this is a TRUE input to the OR-gate **332** which causes the counter to run from the timing signal multivibrator **342**. Another input to the OR-gate **332** will also cause the counter to run and this input comes from the presser foot switch on the sewing unit **30** which is the right knee switch **98** of the knee switch unit **40**, via a buffer diode. This input is used to measure the delay time when recording a "Presser Foot Up" command by operating the sewing unit **30** through the manually actuated controls thereof including the knee switch unit **40**.

The way in which the delay times are recorded and played back from the counter section without using a bidirectional counter should be understood. The counter, when recording a delay by counting, runs forward from a count of zero, and when this is recorded in the memory. it is inverted as it is recorded. When the inverted signal comes back from the memory, it is the complement of the original number. When the timing or stitch count command is being executed, then, the counter still runs forward until it reaches a full count, and when it then "turns over" to zero again, a "carry" is generated which reverses the state of the flip-flop **328** which terminates that program step.

AUTOMATIC CONTROLLER - PROGRAM STEP COUNTER

The program step counter keeps track of the program step being executed and as was described, it consists of the flip-flops **298** through **308**, each of which is connected to the next for normal binary counter operation. When an "execute" signals is generated, a "not-execute" signal by virtue of two diodes **348** and **350** and a resistor **352** is applied to the input of an OR-gate **354**. The output of the OR-gate **354** through an inverter **356** is applied to the input counter flip-flop **298**. One other input is possible to the flip-flop **298** and this is from the advance program counter button or the "step forward" button **82** earlier described relative to the outside appearance of the automatic controller **34**. This other input from the "step forward" button **82** is through a resistor-capacitor filter circuit **358** and a squaring circuit **360**, the squaring circuit output normally being TRUE which permits the "not-execute" signal to pass through to the counter input. When the "step forward" button **82** is depressed, the output through the squaring circuit **360** becomes FALSE causing the output of the inverter **356** to become TRUE, and when the button **82** is released, the output of inverter **356** becomes FALSE again and the counter indexes. The type of counter used changes state on a transition from TRUE to FALSE.

The program step counter has two other inputs, one of which is a reset signal which sets the counter to zero and this signal is applied directly to each of the flip-flops **298** through **308**, the counter being set to zero when the signal goes TRUE. This happens when the command being executed calls for a reset to zero action, causing terminal **362** of a sequencer **364**, used here as a decoder, to become TRUE, and this can only happen on "operate" of the automatic controller **34** since a contact of the automatic controller selector switch **62**, previously described, holds this lead at +3 volts or in the FALSE state when in the "record" position. This prevents the reset to zero command from causing any action when it is put in the main control register prior to being recorded. The other way in which the counter can be set to zero is by the reset program counter button **80** previously described relative to the outside appearance of the automatic controller **34**. These two described reset actions are connected to the program step counter through two buffering diodes which prevent interaction.

The other input to the program step counter comes from the counter section of the main storage register and is connected to one input of each of the two input set and reset AND gates on the counter flip-flops, an example thereof being AND-gates **366** and **368** of the flip-flop **298**. Part of the inputs to these AND-gates **366** and **368** to the flip-flop **298** come from the TRUE and FALSE outputs of the flip-flop **274** in the counter section of the main storage register. The other inputs of these AND gates of the program step counter flip-flops are all connected together and serve to gauge the contents of the flip-flops **274**, **276**, **278**, **282**, **284**, and **286** into the program step counter flip-flops **298** through **308**, which occurs when command No. **7** of table 3 is in the main storage register. This particular command causes the program to jump to a new instruction step instead of indexing to the next number in sequence and when this Number **7** command is used, the location of the instruction to be next in sequence should be specified as one less than the desired instruction, since completion of the "execute" signal will index the counter one step. For this reason, location zero of the program step counter should not be used for a desired program step.

It should be noted that the new program step information which is located in the main storage register will be "upside down" because of the way in which the counter information is "turned over" or complemented. To correct for this, the information is "turned over" again when it is transferred to the step counter and this can be seen, for example, by noting that the TRUE output of the flip-flop **274** goes to the FALSE or "reset" input of the flip-flop **298**.

AUTOMATIC CONTROLLER - DRUM POSITION COUNTER

The third major section of the automatic controller **34** is the drum position counter and this counter, while being connected as a single nine-stage binary counter, is actually used as a three-stage and a six-stage counter due to he way in which the commands are recorded, one entire command being recorded in the memory as eight sequential sets of four binary digits. As the memory drum rotates, a "clock" track on which are recorded **512** pulses, provides a timing signal which is connected to the input of the nine-stage drum position counter, and since a nine-stage counter will make a complete counting cycle in **512** counts, it is apparent that the counter and the

memory drum will be synchronized. By recording a single reference pulse on a separate "track" of the drum, and using this pulse to set the counter to a zero count, the counter will always reach a zero count at the same place on the drum periphery. This counter, therefore, can be used to uniquely identify each point on the drum periphery.

The first three stages of the counter, the flip-flops **310**, **312** and **314**, will cycle in a count of **8**. The outputs of these three flip-flops are connected to a sequencer circuit **370** which provides a TRUE output at one of eight different output terminals for each of the eight different counts in the counter. These TRUE output signals are used to independently manipulate the eight different four-bit characters of a command.

AUTOMATIC CONTROLLER - CONTROL OF INFORMATION FLOW

The last six stages of the drum position counter, the flip-flops **316** through **326**, are used to provide the position information or "address" of the **64** program step locations and these flip-flops are connected to a coincidence detector **372**. The coincidence detector **372** provides an output at output terminal **374** thereof when the flip-flops **316** through **326** contain the same number as the flip-flops **298** through **308** of the program step counter. An input at an input terminal **378** of the coincidence detector **372** is used to suppress the output at all times except when it is desired, and this is only when a new instruction or command is gated out of the memory or recorded in the memory.

When a TRUE output occurs at the coincidence output terminal **374**, this is inverted by a negator circuit or inverter circuit, a connected OR-gate **380** and inverter **382**, which causes an input terminal **384** of the sequencer **370** to become FALSE. If input terminal **386** of the sequencer **370** is also FALSE, a time sequence of outputs occurs at the output terminals of the sequencer **370**. These outputs of the sequencer **370** are used to set a new command into the main control register, or to switch the outputs of the main control register flip-flops into the "record" circuitry of the memory. This latter action is accomplished by sets of AND gates generally indicated at **388** in FIG. **14***c*.

The information coming out of the AND-gates **388** via connected OR gates generally indicated at **390** and inverters generally indicated at **392**, is then passed through another set of AND gates generally indicated at **394**, OR gates generally indicated at **396** and inverters generally indicated at **398** and is used to create signals known as "Williams" type of recording signals, well recognized in the art. These signals are of a nature such that they are TRUE for one-half of the recording interval for one bit and FALSE for the second half of the interval if the bit to be recorded is a "ZERO" and FALSE and then TRUE if the bit is a "ONE." This type of recording signal is well suited for application which bits are recorded one at a time, or in this case, eight at a time.

The input terminal **386** of the sequencer **370** is used to feed in a "strobe" pulse which reduces the width of the output pulses to a relatively small time duration, and this is only done on playback or "operate" of the automatic controller **34** so that transients which occur between bits of information cannot get into the main control register. The output of a negator or inverter circuit, OR-gate **400** and inverter **402** shown in FIG. **14***d*, is used to turn the "strobe" pulses ON and OFF on "record" and playback or "operate" of the automatic controller **34**, and when in the "record" mode, a switch contact **404** forming a part of the automatic controller selector switch **62** connects the input of this inverter circuit to −3volts, making it TRUE, which causes the output thereof to be FALSE at the connected input terminal **386** of the sequencer **370**, allowing full-width pulses to be generated by the sequencer **370**.

A flip-flop **406** (FIG. **14***d*) is used as the main run-stop control flip-flop. A terminal **408** is connected to the slow drive motor switch **186** of the two-stage drive switch **90** on the sewing unit foot switch unit **38** and is used to start a cycle of operations when the automatic controller is in the playback or "operate" mode. By means of a switch contact **410** forming a part of the automatic controller "operate" and "record" selector switch **62**, the input to the flip-flop **406** may be switched between a terminal **412** connected to the instruction record switch **96** of the sewing unit foot switch unit **38** and the terminal **408** connected to the slow drive motor switch **186** of the foot switch unit, depending on the automatic controller selector switch **62** being in the "record" and "operate" mode. The selected input from either the terminal **408** or the terminal **412** through the switch contact **410** is filtered by a resistor-capacitor combination generally indicated at **414**, passed through a squaring circuit **416**, passed through a resistor-capacitor delay circuit generally indicated at **418** and is directed as the input through a second squaring circuit **420**.

When the input signal selected by the switch contact **410**, from either the terminal **408** or the terminal **412**, goes TRUE, the output of the first squaring circuit **416** goes TRUE, an since the output of the second squaring circuit **420** is normally TRUE, this output becomes FALSE, but after a short delay time from the output of the first squaring circuit **416** going TRUE. During this short delay time, the inputs to an AND-gate **422** of the flip-flop **406** are both TRUE and flip-flop **406** is set to the TRUE state which starts a step of the sewing unit **30**. If the automatic controller selector switch **62** is in the "record" setting placing the automatic controller **34** in the "record" mode, a −3 volt signal is directed by the switch contact **404** through an inverter circuit, and OR-gate **424** and inverters **426** and **428**, causing the output of the inverter **428** to be TRUE, and this causes a connected input to an AND-gate **430** of the flip-flop **406** to be TRUE. Therefore, when an execute signal occurs, the other input to the AND-gate **430** of the flip-flop **406** becomes TRUE and the flip-flop **406** is set to the FALSE state so that action stops. Since the "execute" signal occurs immediately during "record" operation of the automatic controller **34**, the contents of the main control register will have been recorded and the program step counter will index to the next position.

When the automatic controller selector switch **62**, determining "operate" or "record," is switched to the "operate" position, the changing of the switch contact **404** switches the +3 volt input into the OR-gate **424** or FALSE and this results in the input of the flip-flop **406**, that is, at the AND-gate **430**, will be FALSE, and the automatic controller **34**, once started by setting the flip-flop **406** to the TRUE state, will continue to operate until either of two inputs into the OR-gate **424** becomes TRUE. One of these inputs of the OR-gate **424** is made TRUE by either the actuation of the "panic stop" or "emergency stop" switch which is the fast drive motor switch **188** forming a part of the two-stage drive switch **90** on the foot switch unit **38**, or through the "training stop" circuits to be hereinafter described. The other input to the OR-gate **424** is made TRUE by decoding a normal stop command in the main control register.

The "training stop" circuits referred to in the foregoing are formed by a training stop No. **1** circuit generally indicated at **432** and a training stop No. **2** circuit generally indicated at **434**, these circuits including the training stop No. **1** switch **86** and the training stop No. **2** switch **88** previously described relative to the outside appearance of the automatic controller **34**. When a training stop No. **1** or No. **2** command is in the main control register, a No. **4** or No. **5** command of table 3 is in the flip-flops **258** through **264** and these cause a TRUE output at either of output terminals **436** or **438** of the sequencer **364**. If the respective training stop No. **1** switch and training stop No. **2** switch **86** and **88** are open, these TRUE outputs are permitted to bypass such switches and be directed as an input to the OR-gate **424**. If, however, either the training stop No. **1** switch **86** or the training stop No. **2** switch **88** is closed, that particular stop signal cannot pass through the OR-gate **424** and consequently does not effect a stop action on the flip-flop **406**.

The other primary control flip-flops are a flip-flop **440** (FIG. 14*e*), the flip-flop **344** (FIG. 14*e*), and the flip-flop **328** (FIG. 14*d*), and the latter of these has been mentioned in connection with the counter section of the main control register. If a command calls for stitch count or delay time, an input of an AND-gate **442** of the flip-flop **328** is TRUE and when the command is executed, flip-flop **328** becomes TRUE causing an input of an OR-gate **444** (FIG. 14*e*) to become TRUE and an input to an AND-gate **446** of the flip-flop **440** to become FALSE. This prevents any further action of the flip-flop **440** until the flip-flop **328** is reset by termination of the counter operation.

If the flip-flop **328** is not set to the TRUE state, and, since an "execute" signal is not normally present, three of the inputs of the OR-gate **444** will all be FALSE once the flip-flop **406** has been set to the TRUE state by the start action described earlier. One other of the inputs to the OR-gate **444** from an OR-gate **448** and an inverter **45** is normally TRUE, and, because an input of the OR-gate **488**, this input to the OR-gate **444** becomes FALSE only once per revolution of the memory drum and then only at the ZERO or reference position of the drum. The signal which does this is the same one which insures that the drum position counter is set to ZERO at this time and was described in the secton on the drum position counter. Under these circumstances, it can be seen that once flip-flop **406** is set in the TRUE state, flip-flop **440** will also be set to the TRUE state at the zero position of the memory drum, so that this prevents the generation of a partial coincidence signal at the output terminal **374** of the coincidence detector **372** caused by the flip-flop **440** becoming TRUE during the coincidence period.

When the flip-flop **440** becomes TRUE, the input at the input terminal **378** of the coincidence detector **372** is TRUE and an output will occur at the time of the next program step. This either gates a new command into the main control register or records the one there in the memory. The output of the coincidence detector **372** at the output terminal **374** causes an input to an OR-gate **452** to be TRUE and the output of an inverter **454** to be FALSE. It also causes the flip-flop **344** to become TRUE since an input to an AND-gate **456** of flip-flop **344** is TRUE and, since the flip-flop **440** is in the TRUE state, the other input to the AND-gate **456** of the flip-flop **344** is also TRUE.

When the flip-flop **344** is TRUE, one of its outputs connected to the OR-gate **452** is also FALSE so that this input to the OR-gate **452** is FALSE. It can be seen, then, that at the completion of the signal from the output terminal **374** of the coincidence detector **372**, the input to the OR-gate **452** therefrom will again become FALSE and, since both of the inputs to the OR-gate **452** are FALSE, a TRUE signal will appear from the connected inverter **454**. This signal is called the "execute" signal and activates whatever action the particular command calls for. It also, via an AND-gate **458** to the flip-flop **440** causes this flip-flop **440** to reset.

Once the flip-flop **440** resets, an input therefrom to an AND-gate **460** of the flip-flop **344** becomes TRUE, and a brief time later, an input of the flip-flop **310** will become TRUE and the flip-flop **344** will reset. This input of the flip-flop **344** from the flip-flop **310** is used to prevent immediate reset of the flip-flop **344** by the action of the "execute" signal, since resetting flip-flop **344** causes the "execute" signal, to become false again, and it would thereby "extinguish" itself resulting in a substandard "execute" pulse.

The cycle of events just described occurs each time a new command is executed and, since the "execute" pulse also indexes the program step counter, each command carried out is the next one in the sequence. If delay time is called for, or a stitch count is called for, the flip-flop **328** prevents the action of the flip-flops **440** and **344** until the required delay count or stitch count is achieved.

AUTOMATIC CONTROLLER - AUXILIARY OUTPUT CONTROL

Two four-input OR-gates **462** and **464** with connected inverters **466** and **468** are used to turn auxiliary outputs for the peripheral equipment of the sewing unit **30** "on" or "off," the OR gates and the inverters being shown in FIG. 14*f*. Furthermore, these OR-gates **462** and **464** and the inverters **466** and **468** pass the "execute" pulse through to the outputs of the respective inverters **466** or **468** depending or whether the command calls for activating or deactivating the particular auxiliary output. Also, the particular output to be controlled depends on the combination of binary digits in the output control character of the command and this is decoded by a sequencer **470** shown in FIG. 14*c*. Output terminal **472** of the sequencer **470** is connected through the power interface **32** and thereby to the presser foot solenoid valve **106** of the solenoid air valve unit **44** for the control of the presser foot raising and lowering, said presser foot being a vital part of the sewing unit **30** and the sewing head **48** thereof. The output terminal **474** of the sequencer **470** is connected through an "on" and "off" power amplifier generally indicated at **476**, and thence to a receptacle **478** for use in operating a stacker forming a part of the peripheral equipment for the sewing unit **30**. The remaining output terminals of the sequencer **470** have been reserved for future use as required.

AUTOMATIC CONTROLLER - MEMORY DRUM SECTION

The circuit diagram of the memory drum or storage drum section including the recording and readout circuits thereof are shown in FIG. **15**. With the previous detailed discussion of the wiring circuit for the automatic controller **34** as shown in FIGS. 14*a* through 14*f*, the integration of this memory drum section into the automatic controller **34**, as well as the operation thereof, is clearly apparent to those skilled in the art so that a detailed description is not required.

Briefly, as previously mentioned, the recording signals are of the "Williams" type, well known to those skilled in the art, and in addition to the four channels of readout circuitry, there is a clock pulse amplifier and a major cycle pulse or zero position pulse amplifier. The clock pulse amplifier also provides a "strobe" pulse which can be adjusted slightly in time, and this pulse is used to "strobe" or "sample" the information channel amplifiers at the best instant of each bit time to discriminate against spurious noise and switching transients. The zero position pulse is also "clocked" by one of the clock pulses to accurately establish its time of occurrence with the clock pulses.

The six record and readout heads are indicated at **480**, **482**, **484**, **486**, **488** and **490** in FIGS. **15** and **16**. FIG. **16** shows a diagrammatic and view of the recording drum indicated at **492** and the locations of the various record and readout heads **480** through **490**.

AUTOMATIC RECORDER

The automatic controller **34** is built in such a way that it could be programmed directly by means of pushbuttons but this method is generally known as "microprogramming" where each individual binary digit of each instruction must be inserted individually. In order to simplify this direct programming of the automatic controller **34**, an automatic recorder **36** is provided, the purpose thereof being to provide a method for inserting most or all of an entire instruction with a single pushbutton. An additional function of this automatic recorder **36** is to permit the use of remote pushbuttons or switches to insert partial or entire instructions so as to allow programming of the automatic controller **34** by use of the manual control operation of the sewing unit **30**, giving a unique, exceedingly fast means of accomplishing complete programming of the automatic controller **34** for accurately carrying out an overall sewing operation including actuation of any peripheral equipment therefor.

The circuit diagram for this automatic recorder **36** is shown in FIGS. **17***a* and **17***b*, FIG. **17***a* being the left-hand part and FIG. **17***b* being the right-hand part. Furthermore, the fundamental part of this automatic recorder **36** is a diode matrix having the opposite sides thereof with identical circuitry, such matrix sides being separately indicated at **494** and **496** in FIGS. **17***a* and **17***b*, the common circuitry thereof being shown in detail in FIG. **18**.

The matrix sides **494** and **496** are arranged such that any one of sixteen inputs can be momentarily connected to the +3 volt supply, or momentarily set to the FALSE state, which results in setting a combination of four external flip-flops to any one of the 16 TRUE-FALSE combinations which are possible with four flip-flops. When one of the terminals of the right-hand side of the matrix sides **494** and **496** is grounded, the four flip-flops shown at the bottom of that respective matrix side are set to the binary combination representing that terminal location. The two combinations of four flip-flops shown in FIGS.**17***a* and **17***b* are the master instruction control flip-flops **258** through **272** of the automatic controller **34** and shown in the FIG. **14***a* wiring circuit portion thereof. These flip-flops **258** through **272** are not actually a part of this automatic recorder **36**, but can be set to any of their possible **256** combinations by the matrix sides **494** and **496** making up the diode matrix this automatic recorder **36**.

The inputs to the automatic recorder **36** are of two types, one is a plurality of push buttons at the front panels thereof as shown in FIG. **10** and previously discussed, the same being generally indicated at **498** in this FIG. **17***b* wiring circuit. These pushbuttons **498** each operate two switch contacts, one contact being used as an input to one of the matrix sides **494** or **496** and the other contact being used as the input to the other matrix side **494** or **496**.

The other inputs to the automatic recorder **36** are from power-amplifying circuits of one of two types which, in turn, receive their inputs from external switches. These external switches are not actually a part of this automatic recorder **36**, but are shown in FIG. **17***a* as a part of the "Manual" and "Automatic" selector switch **56** of the power interface **32**, the reverse switch **94** of the foot switch unit **38**, the right knee switch **98** of the knee switch unit **40**, and the slow drive motor switch **186** forming a part of the two-stage drive switch **90** on the foot switch unit **38**, all of which have been previously discussed and are located remote from the automatic recorder **36**.

A visual output from the automatic recorder **36** is provided by the use of illuminated pushbuttons and the lamps which illuminate these pushbuttons are generally indicated at **500** in FIG. **17***a*. Furthermore, the lamps **500** are caused to light by power amplifier circuits generally indicated at **502** in FIG. **17***a*, these power amplifier circuits being constructed such that when their input is grounded or FALSE, the particular lamp **500** lights and the particular push button **498** is illuminated.

The power amplifier circuits **502** have their inputs grounded in a rather indirect manner, this being done by means of "-feedback" effect in that, when an input is momentarily "-grounded" or rendered FALSE by the action of one of the push buttons **498**, the output flip-flops are set to a particular combination, and when this particular combination is present, only the input which caused it will be at the "grounded" or FALSE state. This FALSE state at the inputs to the power amplifier circuits **502** can be used, by the suitable power amplification, to illuminate a specific of the pushbuttons **498** without altering the state of the flip-flops which caused it. If power amplification were not used, the state of the output flip-flops would be altered or their ability to be easily set to a new combination would be effected.

At the upper part of FIG. **17***b*, a pulse-generating circuit is generally indicated at **504** having several inputs and this circuit does not contribute to the function of the automatic recorder **36** in any way except to cause action of a "ready to record" lamp **506** for a "ready to record" pushbutton **508** when any of the other pushbuttons **498** is depressed. This is accomplished by utilizing a pulse generated within the pulse-generating circuit **504** to set a flip-flop **510** of the automatic controller **34** and shown in the automatic controller wiring circuit at the bottom of FIG. **14***d*. This flip-flop **510** of the automatic controller **34** is reset to the FALSE state by a signal generated when the instruction record switch **96** of the foot switch unit **38** is actuated to record an instruction, and this flip-flop resetting to the FALSE state causes the "ready to record" lamp **506** on the automatic recorder **36** to extinguish.

When the "ready to record" pushbutton **508** on the automatic recorder **36** is actuated, the flip-flop **510** of the automatic controller **34** is set to the TRUE state causing the input to the "ready to record" lamp **506** of the automatic recorder **36** to go FALSE. This FALSE signal to the "ready to record" lamp **506**, acting through its power amplifier circuit **502**, causes the lamp to light which illuminates the "ready to record" pushbutton **508**. This provides an assist, when recording a program, for keeping track of whether or not a command has been recorded.

Two pushbuttons are shown at the bottom of FIG. **17***b*, namely, a "reset program register" pushbutton **512** and a "delay" pushbutton **514**. The "reset program register" pushbutton **512** is used to "clear" the main control register of the automatic controller **34**, and the "delay" pushbutton **514** is used as a pushbutton method of entering delay time in an instruction for recording if it is desired to do so by timing the depression of a button. This "delay" pushbutton **514** causes the same action as the left knee switch **100** of the knee switch unit **40** when the automatic controller **34** has the selector switch **62** thereof in "record." The manner in which these switches accomplish the described action has been discussed relative to the automatic controller **34**.

The instruction record switch **96** of the foot switch unit **38** is also shown at the bottom of FIG. **17***b*. This instruction record switch **96** is merely shown here for clarity of the overall circuit connection and, of course, does not actually form a part of the automatic recorder **36**. Furthermore, the manner of operation of this instruction record switch **96** by heel pressure on the treadle **92** of the foot switch **38** has been previously described, as has the integration thereof into and the effect on the automatic controller **34**.

The previously mentioned reverse switch **94** of the foot switch unit **38**, the right knee switch **98** of the knee switch **40**, the selector switch **56** of the power interface **32**, and the slow drive motor switch **186** forming a part of the two-stage drive switch **90** of the foot switch unit **38** shown herein at the top of FIG. **17***a* but likewise not actually forming a part of the automatic recorder **36**, are connected into this automatic recorder circuit by four power amplifier circuits and a plurality of miscellaneous diodes, all at the moment generally indicated at **516**, but to be specifically pointed out hereinafter. Generally, two of the power amplifiers of these circuits are of the inverting type and two are of the noninverting type, the diodes being used to perform certain combinational logic operations in permitting operation of the automatic recorder **36** by means of the four switches referred to exterior of the automatic recorder.

As was previously described, the inputs to the matrix sides **494** and **496** in this automatic recorder **36** are activated when they are momentarily made FALSE. This means that the inputs to the noninverting power amplifiers must also be made momentarily FALSE to effect actuation, and this further means that the inputs to the inverting power amplifiers must be made momentarily TRUE to effect actuation.

Referring to the slow drive motor switch **186** of the foot switch unit **38**, a contact **518** thereof is normally TRUE and becomes FALSE when this slow drive motor switch is actuated, and when this contact **518** goes FALSE, it also permits the inputs of power amplifiers **520** and **522** to go FALSE through action of buffer diodes **524** and **526**, unless prevented by the action of buffer diodes **528**, **530**, **532** or **534** as will be described later. When the inputs of the power amplifiers **520**

and 522 go FALSE, this causes the outputs thereof to both go FALSE, and, through buffer diodes 536, 538, 540 and 542, causes terminals 544, 546 and 548 to go FALSE. These terminals 544, 546 and 548 are connected to specific terminals of the matrix sides 494 and 496 so as to result in setting a combination into the flip-flops of the automatic recorder 36 calling for either "run fast forward" or "run fast reverse."

Referring back to the action of the buffer diodes 528 and 530, it can be seen that the buffer diode 530 is connected to the input of a power amplifier 550 and the buffer diode 528 is connected to the output of this same power amplifier 550. As indicated, the power amplifier 550 is an inverting type so that when the input thereof is TRUE, the output must be FALSE, and when the input thereof is FALSE, the output must be TRUE. This means that only one of the inputs of the power amplifiers 520 and 522 can go TRUE when the slow drive motor switch 186 is actuated. As shown, the input to the power amplifier 550 is determined by the position of the reverse switch 94 on the foot switch unit 38, and when this reverse switch 94 is actuated, the "run fast reverse" instruction is placed in the automatic controller 34, and when this reverse switch 94 is not actuated, the "run fast forward" instruction is placed in the automatic controller.

The buffer diodes 532 and 534 are connected to the selector switch 56 of the power interface 32 and when this selector switch is in the "manual" position, that shown in FIG. 17*a*, there is no effect on the power amplifiers 520 and 522. When, however, this power interface selector switch 56 is in the "automatic" position, opposite that shown in FIG. 17*a*, the buffer diodes 532 and 534 function to prevent the inputs of either of the power amplifiers 520 and 522 from becoming FALSE, so that there is no input to either of the matrix sides 494 and 496 of the automatic recorder 36.

A fourth of the power amplifiers is a power amplifier 552 of the inverting type and when another section, indicated herein at 554 for clarity, of the selector switch 56 on the power interface 32 is in the "manual" position, that shown in FIG. 17*a*, the input to the power amplifier 552 is received from the right knee switch 98 of the knee switch unit 40. As previously described, when the right knee switch 98 is actuated with the power interface selector switch 56, here the switch section 554 thereof, in "manual," such actuation results in the presser foot solenoid valve 106 of the solenoid air valve unit 44 to be actuated raising the presser foot of the sewing unit 30 or the sewing head 48 thereof.

Thus, when the presser foot is raised by actuating the right knee switch 98, the input to the power amplifier 552 is TRUE, and since this power amplifier is of the inverting type, its output is then FALSE, such output passing through buffer diodes 556 and 558 resulting in appropriate terminals of the matrix sides 494 and 496 being FALSE. The overall result is that the instruction calling for "Presser Foot Up" is placed in the automatic controller 34.

When the power interface selector switch 56 is switched to the "automatic" position so that the switch secton 554 thereof is in the position different from that shown in FIG. 17*a*, the input to the power amplifier 552 is connected to a +3 volt contact 560 so as to be set in the FALSE state. The output of the power amplifier 552, through the inversion, therefore, becomes TRUE and no input is entered into the matrix sides 494 and 496 of the automatic recorder 36.

USE OF SEWING UNIT - NORMAL MANUAL CONTROL

The sewing unit 30 can be operated under normal manual control without the programming of the automatic controller 34 being involved or the use of the automatic recorder 36 being involved. In such case, a power switch 562 of the automatic controller 34 would be placed in the "off" position eliminating the automatic controller and the automatic recorder 36 from involvement, and the selector switch 56 of the power interface 32 would be placed in "manual." The sewing unit 30 would then be operated merely by use of the foot switch unit 38 and the knee switch unit 40, in the manner previously described to carry out an overall sewing operation.

As an example of a relatively simple overall sewing operation, the operation previously generally described in the early portion of this specification may be used, that is, the sewing of a pocket patch on a shirt front. Generally, the various steps are as previously outlined in carrying out the manually controlled operation.

For purposes in more clearly illustrating the programming of the automatic controller for carrying out the same overall sewing operation, and then the automatic control of the sewing unit 30 and certain peripheral equipment for carrying out the same overall sewing operation, a schematic layout of the sewing equipment assembly of FIG. 1 including various worktables with parts of the articles to be sewn positioned thereon ready for use in the overall sewing operation are shown in FIG. 19, and the finished sewn article is shown in FIG. 20. As shown in FIG. 19, the layout includes a right worktable 564 having a stack of pocket patches 556 to be sewn thereon, a left worktable 568 having a stack of shirt fronts 570 positioned thereon ready for placement and sewing of the pocket patches 556, and an operator location 572 between the right and left worktables 564 and 568.

Furthermore, the layout of FIG. 19 includes the block showing of the unit 30 on a sewing machine table 574. The exact path of vertical reciprocal movement of the sewing head needle 50 being indicated as a needle location dot 576 circled for clarity. The peripheral equipment for the sewing unit 30 is a stacker 578 which is automatically operable between a normal "at rest" position shown in full lines in FIG. 19 and an "extended" or "stacking" position shown in phantom lines in FIG. 19.

In FIG. 20 an assembled shirt front 570 and pocket patch 566 is shown. Multiple stitching at the top corners of the pocket patch 566 are shown adjacent the open pocket top, such multiple stitching being for reinforcement purposes. Furthermore, continuous stitching around the periphery of the pocket patch 566 is shown with the exception of the open pocket top.

Again for purposes of clarity in illustrating the sewing operation, various locations on the pocket patch 556 have been indicated at 580 through 594, and certain of these locations have also been indicated on the shirt front 570.

USE OF SEWING UNIT - PROGRAMMING UNDER MANUAL CONTROL

In programming the automatic controller 34 under manual control of the sewing unit 30 for later automatic control of said sewing unit by the automatic controller, the selector switch 56 of the power interface 32 is rechecked to be sure it is in "manual" position and the thread trimmer switch 110 on the solenoid air valve unit 44 is rechecked to be sure that it is in the "on" position, as it would have been required to be during the normal manually controlled sewing operation above. Furthermore, the power switch 562 of the automatic controller 34 would be placed in "on" position, the automatic controller selector switch 62 placed in "record" position, the automatic controller delay adjustment switch 84 preferably placed at a midway position for average time unit use, and the training stop No. 1 and training stop No. 2 switches 86 and 88 placed down into "on" position to permit insertion of training stops or delays. Finally, prior to the commencement of programming of an overall sewing operation, the program step counter 76 will be reset to "00" by depressing the reset program register button 78 of the automatic controller 34.

The sewing unit 30 is now ready to commence the programming of the overall sewing operation and the programming method is performed as tabulated in the following:

Program Step "00"—This is a blank instruction that is entered into the automatic controller 34 by depressing the instruction record switch 96 of the foot switch unit 38 and an instruction is recorded that requires no action. After such

recording, the program step counter 76 of the automatic controller 34 will index to program step "01," **visually indicating the same at the front of the automatic controller.**

Program Step "01"—The instruction for a training stop or delay No. 1 is entered into the automatic controller 34 by depressing the training stop No. 1 button of the automatic recorder 36 and when this button is depressed, the "ready to record" button 508 thereof will be illuminated. The instruction record switch 96 of the foot switch unit 38 is then depressed to record this training stop or delay. This training stop No. 1 instruction will cause the program of the automatic controller 34 to stop the sewing unit 30 at this program step "01" each time the overall sewing operation is automatically carried out by the automatic controller 34 as long as the training stop No. 1 switch 86 of the automatic controller 34 is in the "on" position. This particular instruction provides the programmer with the necessary control to check the program and when this instruction has been recorded, the program step counter 76 of the automatic controller 34 will index to program step "02."

Program step "02"—The operator will raise the presser foot by using the right knee switch 98 of the knee switch unit 40 and continue to hold the presser foot up by continuing actuation of the right knee switch while picking up one of the shirt fronts 570 and positioning location 580 at the needle location 576, then picking up one of the pocket patches 566 and positioning the same with the location 580 thereof directly over the location 580 of the shirt front 570, and then finally exactly aligning the location 580 of the temporarily assembled pocket patch 566 and shirt front 570 exactly over the needle location 576 of the sewing unit 30. The operator will then lower the presser foot by releasing the right knee switch 98 which will hold the temporarily assembled pocket patch 566 and shirt front 570 exactly positioned as placed. This total step will take about 800 time units of the automatic controller 34 meaning that, when the automatic controller is in the "automatic" mode, the presser foot will remain raised for a count of 800 time units or approximately 13 seconds and this 800 time element period has been automatically counted by the automatic controller and temporarily recorded therein during the manually controlled performance, that is, the time from the raising of the presser foot to the lowering thereof. The recording of the overall instruction, that is, the time period, is permanently recorded in the program of the automatic controller 34 by actuating the instruction record switch 96 of the foot switch unit 38, causing the program step counter 76 of the automatic controller 34 to advance to program step "03."

Program Step "03"—The sewing head needle 50 of the sewing unit 30, which has obviously been previously in its "up" position, is now positioned "down" by depressing the "stop needle down" button on the automatic recorder 36 and a delay time of 96 time units is entered directly into the program of the automatic controller 34 by depressing the stitch and delay buttons 76 thereof directly under "32" and "64," a total of "96," illuminating these stitch and delay lights 68. This program instruction provides the time required for the sewing head needle 50 to be positioned down, while at the same time for the operator to regrasp the temporarily assembled pocket patch 56 and shirt front 570 for proper control thereof to commence the sewing operation. The instruction is permanently recorded in the automatic controller 34 by actuating the instruction record switch 96 of the foot switch unit 38, although this recording could be accomplished by depressing the "ready to record" pushbutton 508 on the automatic recorder 36 which has been lighted, this choice of recording always being available. The recording action advances the program step counter 76 of the automatic controller 34 to program step "04."

Program Step "04"—A training stop No. 2 instruction is entered the automatic controller 34 by depressing the "training stop No. 2" button on the automatic recorder 36, the same being permanently recorded in the automatic controller program by depressing the instruction record switch 96 of the foot switch unit 38. The program step counter 76 of the automatic controller 34 will automatically index to program step "05."a By way of further explanation of the training stops being programmed herein, these training stops provide indeterminate delays in the program of the automatic controller 34, which, when the automatic controller training stop switches 86 and 88 are down in the "on" position, will stop the automatic controller program when being carried out in the'-'operate" mode of the automatic controller each time that particular program step is reached and the delay will remain until the slow drive motor switch 186 of the foot switch unit 38 is actuated for proceeding with the program. Later, if either of the training stops switches 86 or 88 are moved up to "off," the program steps or the program delays controlled by that switch, that is, any training stop No. 1 or any training stop No. 2 will automatically be bypassed in the "automatic" mode of the automatic controller 34, the same automatically indexing directly over that or those program steps directly to the next program step in order. Thus, this training stop No. 2 as programmed herein can be used for the purposes of permitting a delay or delays for training operators to use the sewing unit 30 under the automatic control of the automatic controller 34. Keep in mind, also, that any number of separated training delay program steps can be programmed into the automatic controller 34 for control by the training stop switches 86 and 88, each switch eliminating all of its control delays when moved to "off."

Program Step "05"—This program instruction is entered by depressing the toe of the treadle 92 on the foot switch unit 38 fully or with heavy toe pressure so as to actuate the fast drive motor switch 188 thereof until four stitches forward are sewn, at which time the treadle 92 is released. This causes the sewing head needle 50 of the sewing unit 30 to sew from location 580 to location 582 of the pocket patch 566, the four stitches being counted by the needle counter and positioner 42, and temporarily recorded in the program of the automatic controller 34. The instruction is permanently recorded in the automatic controller 34 by actuating the instruction record switch 96 of the foot switch unit 38, and the program step counter 76 of the automatic controller 34 indexes to program step "06."

Program step "06"—This instruction is entered by depressing the "run fast reverse" button on the automatic recorder 36, and then activating the reverse switch 94 of the foot switch unit 38 while fully depressing the toe of the treadle 92 to simultaneously actuate the fast drive motor switch 188. The operation or step as manually controlled by the operator is to sew in reverse for a total of four stitches, which stitch count is recorded by virtue of the needle counter and positioner 42, the same being temporarily recorded by the program of the automatic controller 34, the same being at the high speed and terminated by release of the foot switch unit 38. Reverse stitching is, therefore, accomplished from the location 582 to the location 580 of the pocket patch 566. This instruction is recorded permanently in the automatic controller 34 by the actuation of the instruction record switch 96 of the foot switch unit 38 and such recording causes the program step counter 76 of the automatic controller 34 to index to program step "07."

Program Step "07"—This instruction is to sew fast forward a total of 33 stitches and is temporarily recorded in the automatic controller 34 by fully depressing the toe of the treadle 92 of the foot switch unit 38 to actuate the fast drive motor switch 188 until the 33 stitches are completed and the count thereof is transmitted to the automatic controller by the needle counter and positioner 42 as before. At the end of the sewing of the 33 stitches, the foot switch unit 38 is released, and this step will accomplish the sewing the 33 stitches from the location 580 to within approximately one-quarter inch away from the location 584 of the pocket patch 566, and note that this does not carry completely to the location 584 on the pocket patch. The instruction is permanently recorded in the automatic controller 34 by actuation of the instruction record

switch 96 of the foot switch unit 38 and the automatic controller indexes to program step "01."

Program Step "10"—The sew slow forward instruction is temporarily entered into the program of the automatic controller 34 by lightly depressing the treadle 92 of the foot switch unit 38 to actuate the slow drive motor switch 186, and is terminated by releasing the foot switch unit when the sewing head needle 50 has exactly reached the location 584 on the pocket patch 566, which, with the pocket patch 566 and the shirt front 570 of stable material, will be three stitches. This instruction is permanently recorded in the program of the automatic controller 34 by actuation of the instruction record switch 96 of the foot switch unit 38, causing the program step counter 76 of the automatic controller to index to program step "11." Note that if the material of the pocket patch 566 and the shirt front 570 is of unstable material so that the location 584 of the pocket patch might vary, a stitching step of indeterminate number of stitches can be permanently recorded in the program by depressing the "run slow forward" button of the automatic recorder 36 without a time limitation and permanently recording the same, which, under automatic control of the automatic controller 34 when in the "operate" mode or setting of the selector switch 62 would require termination of such stitching step by the operator actuating the right knee switch 98 of the knee switch unit 40 to terminate, and then the slow drive motor switch 186 thereof to proceed with the program. This same indeterminate termination of any stitching step can be used if required and gives the necessary versatility for sewing unstable materials.

Program Step "11"—This instruction is to stop the sewing head needle 50 down for subsequent repositioning of the pocket patch 566 and the shirt front 570 and is entered by depressing the "stop needle down" button of the automatic recorder 36 followed by entering a 32 time unit delay by the stitch and delay button 74 of the automatic controller 34. This instruction will cause the sewing head needle 50 to be positioned down by the needle counter and positioner 42 controlling the same to such position, and the time delay will provide the necessary time for accomplishing such positioning. Thus, the sewing head needle 50 provides the pivot point for the repositioning of the material, and this instruction is recorded permanently in the program of the automatic controller 34 by actuating the instruction record switch 96 of the foot switch unit 38, the program step counter 76 of the automatic controller indexing to program step "12."

Program Step "12"—This instruction is to activate the presser foot solenoid valve 106 raising the presser foot and is accomplished by actuating the right knee switch 98 of the knee switch unit 40 causing the presser foot to raise and the raise delay time to be counted while so raised. During the raised position of the presser foot, the operator manually repositions the pocket patch 566 and the shirt front 570, realigning the same for the subsequent sewing to the location 586 on the pocket patch. The instruction is terminated by releasing the right knee switch 98 causing the presser foot to again lower and the total up and down presser foot movement with the necessary delay time in time units is permanently recorded in the program of the automatic controller 34 by actuating the instruction record switch 96 of the foot switch unit 38, with the program step counter 76 of the automatic controller indexing to program step "13."

Program Step "13"—This instruction is for the purpose of providing the operator with a determined time delay during which the operator will check the position of the pocket patch 56 on the shirt font 570 to be sure that the pocket patch is properly aligned for the proper alignment of the remaining of the locations through the location 594. The determined time delay instruction is entered for temporary recording in the program of the automatic controller 34 by depressing the button under "8" and the button under "64" of the stitch and delay button 74 on the automatic controller 34 giving a total time delay of 72 time units for the required function of the operator. This instruction is permanently recorded in the program of the automatic controller 34 by actuating the instruction record switch 96 of the foot switch unit 38, and the program step counter 76 of the automatic controller indexes to program step "14."

Program Step "14"—This step is another "training stop No. 2," that is, an indeterminate stop used for training purposes and controlled by the training stop No. 2 switch 88 of the automatic controller 34, as previously discussed relative to program step "04." Furthermore, this program step is entered in the same manner and has the same consequence as the program step "04," the program step counter 76 of the automatic controller 34 then indexing to program step "15."

The remaining program steps are either the same or similar, with a few exceptions, to those previously programmed. The remaining programming explanation, therefore, will only refer to the particular instruction recorded, unless further explanation is required.

Program step "15"—This instruction is to sew fast forward four stitches to within approximately one-quarter inch of the location 586 on the pocket patch 566. Again, note that this is not completely to the location 586 on the pocket patch 566 in view of the sewing head needle 50 being required to be positioned down at the location 586 which can only be accomplished at slow speed and this step is at fast speed.

Program Step "16"—This instruction is to sew three stitches at slow speed to the location 586 of the pocket patch 566.

Program Step "17"—This instruction is to position the sewing head needle 50 down for the subsequent material repositioning.

Program Step "20"—This instruction is for the operator to raise the presser foot, pivot the pocket patch 566 and the shirt front 570 around the sewing head needle 50 to align for sewing to the location 588, recheck to verify that the pocket patch is still properly aligned with the shirt front, and lower the presser foot.

Program Step "21"—This instruction is a further determined time delay of sufficient number of time units to permit the operator to regrasp the pocket patch 566 and the shirt front 570 in order to maintain control during the subsequent sewing step.

Program Step "22"—This instruction is to sew fast forward 24 stitches to approximately one-quarter inch from the location 588 on the pocket patch 566.

Program Step "23"—This instruction is to sew slow forward three stitches to the location 588 on the pocket patch 566.

Program Step "24"—This instruction is to position the sewing head needle 50 down preparatory to repositioning of the pocket patch 566 and the shirt front 570 for the next sewing operation or step.

Program Step "25"—This instruction is for the operator to raise the presser foot, reposition the pocket patch 566 and the shirt front 570 aligned for sewing to location 590 on the pocket patch, recheck for proper alignment of the pocket patch 566 over the shirt front 570, and lower the presser foot.

Program Step "26"—This instruction is a determined time delay required for the operator to regrasp the pocket patch 566 and the shirt front 570 for maintaining control during the subsequent sewing operation or step.

Program Step "27"—This instruction is to sew fast forward four stitches approximately one-quarter inch from the location 590 on the pocket patch 566.

Program Step "30"—This instruction is to sew slow forward three stitches to the location 590 on the pocket patch 566.

Program Step "31"—This instruction is to position the sewing head needle 50 down, again to provide the pivot point for the subsequent repositioning of the pocket patch 566 and the shirt front 570.

Program Step "32"—This instruction is for the operator to raise the presser foot, reposition the pocket patch 566 and the shirt front 570 to realign the same for subsequent sewing to the location 594 of the pocket patch, recheck the alignment of the pocket patch with the shirt front, and lower the presser foot.

Program Step "33"—This instruction is again a determined time delay of a determined number of time units to permit the operator to regrasp the pocket patch **566** and the shirt front **570** for maintaining proper control during the subsequent sewing step.

Program Step "34"—This instruction is to sew fast forward 33 stitches to within approximately one-quarter inch of the location **594** on the pocket patch **566**.

Program Step "35"—This instruction is to sew slow forward three stitches to the location **594** of the pocket patch **566**.

Program Step "36"—This instruction is to sew slow in reverse four stitches back to the location **592** of the pocket patch **566**.

Program Step "37"—This instruction is to sew slow forward four stitches to the location **594** on the pocket patch **566**.

Program Step "40"—This instruction is to position the sewing head needle **50** up to trim or cutoff the threads, that is, both the top and bottom threads, by actuation of the thread trimmer solenoid valve **102** to operate the thread trimmer or thread cutoff. The instruction is entered by depressing the "-position up and trim" button on the automatic recorder **36**, and setting a time delay of **64** time units by use of the stitch and delay button **74** of the automatic controller **34**, the time delay being sufficient for accomplishing the total step. The instruction is permanently recorded in the program of the automatic controller **34** by actuating the instruction record switch **96** of the foot switch unit **38**. After such permanent recording of the instruction, the actual operation on the pocket patch **566** and the shirt front **570** can be performed manually by the operator by manually actuating the left knee switch **100** of the knee switch unit **40** with the automatic controller **34** eliminated from the circuit.

Program Step "41"—This instruction is for the operator to raise the presser foot for a sufficient period of time to slide the now permanently assembled or sewn pocket patch **566** and shirt front **570** from beneath the presser foot and place it over the automatic stacker **578**.

Program Step "42"—This instruction is for operation of the automatic stacker **578**, and is entered by depressing the "-stacker on" button on the automatic recorder **36**, and also setting a 256 time unit delay through the stitch and delay buttons **74** of the automatic controller **34**. This gives sufficient time for operation of the automatic stacker **578**, and assuming the stacker is totally automatic, no instruction is required for the "stacker off."

Program Step "43"—This instruction is for the program step counter **76** of the automatic controller **34** to reset to program step "00," and is entered into the program of the automatic controller by depressing the "reset program register" pushbutton **512** of the automatic recorder **36** and then actuating the instruction record switch **96** of the foot switch unit **38**. This will cause the permanent recording of this instruction and will also reset the program step counter **76** of the automatic controller **34** to program step "00." This, therefore, completes the programming of the automatic controller **34** and with this last program step "43," the automatic controller will, under "operate" mode thereof keep proceeding to repeat the entire program permanently recorded every time it reaches this program step "43."

From the foregoing, it can be seen that the automatic controller **34** may be completely programmed, primarily merely by carrying out under operator manual control, the particular sewing operation desired, and an extensive period of programming the automatic controller is not required as has been true with similar-type operations which are to be automatically controlled by conventional computers and the like. It is true that the present assembly makes use of the automatic recorder **36** and appropriate auxiliary automatic-recording equipment directly on the automatic controller **34** for programming the overall sewing operation just performed, but use of these auxiliary elements or devices in many cases is merely for convenience since most of the programming could be accomplished merely by carrying out the overall sewing operation under the operator manual control and actuation. In any event, it can be easily appreciated that a great variety of overall sewing operations can be programmed into the automatic controller **34** totally by the operator carrying out the overall sewing operation under the manual actuation.

A further important advantage to the method of programming the automatic controller **34** by carrying out the overall sewing operation under manual actuation of the sewing unit **30** by the operator is that the chances of programming error are reduced to virtually none. This is true, whether or not the auxiliary automatic recording equipment, such as the automatic recorder **36** and elements thereof on the automatic controller **34**, are required to be used, since the simplicity thereof results in the necessary training of an experienced operator being reduced to one week or less.

USE OF SEWING UNIT - AUTOMATIC CONTROL

In use of the automatic controller **34** for automatically controlling the sewing unit **30** to carry out the overall sewing operation previously programmed in the automatic controller, the selector switch **56** of the power interface **32** is switched to "automatic" and the selector switch **62** of the automatic controller **34** is switched to "operate." Prior to the selector switch **62** of the automatic controller **34** being set in "operate," the program step counter **76** of the automatic controller will have been set or indexed to program step "00," so that upon moving the selector switch **62** to "operate," the program will immediately start. The first program step "00" is blank so that the program step counter **76** of the automatic controller **34** will automatically index to program step "01."

In automatically controlling the sewing unit **30** in carrying out the overall sewing operation, the automatic controller **34** will automatically index to the next subsequent program step unless the particular step being carried out is an indeterminate time delay. In the present program of the automatic controller **34**, the only indeterminate time delays are the training stops and the automatic controller will remain at that particular program step until the toe of the treadle **92** on the foot switch unit **38** is lightly depressed to actuate the slow drive motor switch **186**, at which time the automatic controller will automatically index to the next program step. Thus, in the following only the actuation to end the training stops or delays will be pointed out with the other program steps being carried out consecutively automatically by the automatic controller **34**.

Program Step "01"—The operator actuates the foot switch unit **38** to end the training stop No. **1** and index the program step counter **76** of the automatic controller **34** to the program step "02."

Program Step "02"—The operator will pick up a pocket patch **566** and a shirt front **570** properly temporarily assembling the same and properly positioning them under the sewing head needle **50**, the needle being aligned with the location **580** on the pocket patch. At the same time, the presser foot of the sewing head **48** will raise and remain raised for 800 time units, after which it will lower.

Program Step "03"—The operator will regrasp the temporarily assembled pocket patch **566** and shirt front **570**, while the sewing head needle **50** will position down extending downwardly through the pocket patch and shirt front.

Program Step "04"—This is a first training stop No. **2** and the sewing unit will remain idle until the operator actuates the slow drive motor switch **186** of the foot switch unit **38**, at which time, the program step counter **76** of the automatic controller **34** will index to program step "05."

Program Steps "05," "06," "07," "10," and "11"—The operator will guide the pocket patch **566** and shirt front **570**, while the sewing head **48** and the needle **50** thereof sews four stitches forward, to the location **582**, four stitches rearwardly to the location **580**, 33 stitches forwardly fast and then three stitches forwardly slow to the location **584**, and the needle will position down.

Program Steps 12" and "13"—**The presser foot of the sewing head** 48 **will raise and remain raised for** 128 time units

while the operator repositions the pocket patch **566** and shirt front **570**, the presser foot will lower and the sewing unit **30** will remain idle for a time delay of **64** time units for the operator to check proper alignment of the pocket patch and shirt front.

Program Step "14"—This is another training stop No. **2** and the sewing unit **30** will continue to remain idle until the slow drive motor switch **186** of the foot switch unit **38** is actuated which will cause the program step counter **76** of the automatic controller to index to the program step "15."

Program Steps "15," "16" and "17"—The operator will guide the pocket patch **566** and shirt front **570**, while the sewing head needle **50** sews fast forward four stitches, then sews slow forward three stitches, and then positions with the needle down at location **586** of the pocket patch.

Program Steps "20" and "21"—The presser foot of the sewing head **48** will raise, the operator will reposition the pocket patch **566** and the shirt front **570**, the presser foot will lower, and the sewing unit **30** will remain idle while the operator verifies the alignment of the pocket patch and shirt front.

Program Steps "22," "23" and "24"—The sewing head needle **50** will sew fast forward 24 stitches, then sew slow forward three stitches to the location **588** of the pocket patch **566**, and the needle will be positioned down.

Program Steps "25" and "26"—The presser foot of the sewing head **48** will raise, the operator will reposition the pocket patch **566** and shirt front **570**, the presser foot will lower, and the sewing unit **30** will remain idle while the operator verifies the alignment of the pocket patch and shirt front and regrasp the same for guiding in the further sewing.

Program Steps "27," "30" and "31"—The sewing head needle **50** will sew fast forward four stitches, then sew slow forward three stitches to location **590** of the pocket patch **566** and then position the needle down.

Program Steps "32" and "33"—The presser foot of the sewing head **48** will raise, the operator will reposition the pocket patch **566** and the shirt front **570**, the presser foot will lower, and the sewing unit **30** will remain idle while the operator regrasps the pocket patch and shirt front for guiding during the subsequent sewing operation or step.

Program Steps "34," "35," "36," "37" and "40"—The sewing head needle **50** will sew fast forward 33 stitches, then slow forward three stitches to the location **594** on the pocket patch **566**, then sew slow rearwardly four stitches to the location **592**, then sew slow forward four stitches back to the location **594**, the needle will position up and the thread trimmer will operate.

Program Steps "41," "42" and "43"—The presser foot of the sewing head **48** will raise, the operator will slide the now permanently assembled pocket patch **566** and shirt front **570** from beneath the sewing head needle **50** and place it on the automatic stacker **578**, the automatic stacker will operate, the presser foot will lower, and the program step counter **76** of the automatic controller **34** will automatically index back to program step "00" and immediately proceed with the start of a repeat of the entire program.

It can be seen with the use of the automatic controller **34** for automatically carrying out an overall sewing operation performed by the sewing unit **30** that the operator is relieved of the bulk of the decision making and the normally required manual actuation which has heretofore been required for manually actuating sewing units in carrying out such overall sewing operations. The operator does not have to decide the number of stitches to be sewn, decide when the various sewing unit components such as the presser foot of the sewing head **48** are to be raised and lowered or otherwise actuated, nor when to sew slow or when to sew fast. When the material being sewn is of a stable character, the only decisions and manual operations required of the operator are to maintain alignment and perform repositioning of the material parts being sewn, and even the time periods allowed for such operator manual operations are regulated as to length so that the operator will be aided in maintaining a rhythmical overall sewing operation for producing a greater number of sewn articles with greater accuracy and less fatiguing.

When the operator is of relatively lower skills, the program of the automatic controller **34** can be provided with the training stops or delays permitting the operator to stop for an indeterminate period of time. After a period of time, these training stops can be eliminated, either part or all, merely by switching either or both of the training stop No. **1** and training stop No. **2** switches **86** and **88** on the automatic controller **34** to the "off" position. Thus, despite the complete automatic control of the overall sewing operation by the sewing unit **30**, this program control may be used with relatively unskilled operators for convenient training of the same, and after such training, the overall programming of the automatic controller **34** need not be altered, but only the various training stops or delays conveniently removed without affecting the overall program.

As previously mentioned, where the sewing of relatively unstable materials is involved, any and probably all of the individual sewing steps will be programmed into the automatic controller **34** so that the automatic controller would automatically control a stitching step for carrying out a predetermined number of stitches, and then the automatic controller would merely maintain the sewing head needle **50** continuing to stitch for an indeterminate number of additional stitches. During this indeterminate stitching, the operator would be required to maintain a visual observation of the progress and stop the stitching at the exact location desired by manually actuating the appropriate manual control or switch. Thus, with these stopping locations varying from one overall sewing operation to the next with the use of the relatively unstable material, the overall sewing operation can still be carried out under the control of the automatic controller **34**, but with the operator manual assistance.

It is also possible with the sewing equipment controls of the present invention to insert in a program of the automatic controller **34**, indeterminate stops or delays which are not training stops, but rather permanently remain in the program of the automatic controller **34**. These indeterminate stops or delays would be used with the sewing equipment, or with other manufacturing equipment, where either manual operations or various equipment operations necessary to take place between other program steps are of an indeterminate nature, that is, varying from one overall sewing or manufacturing operation to the next. Such indeterminate delays were not used in the illustrated overall sewing operation, but the possibility of including the same in a program for an overall sewing or manufacturing operation illustrates the wide versatility of the control devices of the present invention and their ready applicability to a wide variety of manufacturing equipment.

In the foregoing illustrative programming of the automatic controller **34** with the overall sewing operation, the delay adjustment switch **84** of the automatic controller **34** was maintained at a midpoint adjustment and this adjustment switch provides added versatility for the equipment by permitting adjustments of the time units measured by the automatic controller to either slower time units or faster time units. In other words, by being able to alter the individual length of a time unit, it is possible to alter all program steps having the duration thereof measured in such time units, whether such program steps are composite steps of both component operation and duration measured in time units or merely delays measured in time units, and this can be done after the programming of the automatic controller **34** without affecting such program other than this stated alteration.

As applied to the sewing unit **30**, alteration of the time units by the delay adjustment switch **84** of the automatic controller **34** can be used to alter, within limits the determined delays between sewing steps during which the operator is permitted to perform manual repositioning of the material being sewn. Thus, when the skills of the operator reach an appropriate level, such delay time adjustment can be used to even further improve the efficiency of the operator, all without affecting the original programming of the automatic controller **34**.

Although previously not mentioned relative to the programming of the automatic controller **34**, the power interface **32** does include a speed control switch **60** adjustable for regulating the speed, preferably only, of the high-speed drive motor **52**, and this adjustment may be used to alter after programming those program steps containing a composite instruction or instructions having the duration thereof measured in component operations or movements. As applied to the sewing unit **30**, the movements of the sewing head needle **50** are counted by the needle counter and positioner **42** with such information being transmitted to the automatic controller **34** so that the instructions for the sewing steps are predicated on sewing head needle reciprocal movements and determined thereby. Thus, if the speed control switch **60** is altered, say to faster, each of the sewing head needle reciprocal movements will be faster and the sewing or stitching steps will be of less required duration to perform or accomplish the same number of stitches. This, again, provides even greater versatility for the control devices of the present invention and any sewing or other manufacturing equipment automatically controlled thereby.

We claim:

1. In manufacturing equipment normally manually controlled by an operator for carrying out the series of manufacturing operations on an article to be manufactured, the combination of: a manufacturing device including manufacturing components having means selectively operable for performing a series of manufacturing operational steps on an article to be manufactured, each of said operational steps being comprised of the combination of function and duration, said function being determined by the particular manufacturing operation performed by said component upon said article, said duration being determined by one of the time measured in a given number of preset time elements to perform the particular of said manufacturing operation and an exact count of the exact number of movements of said component to perform said particular of said manufacturing operation, at least one of said manufacturing components having means for performing its manufacturing steps by performing a plurality of consecutively, repeated substantially identical movements during every operation thereof directly performing an equal number of consecutively repeated substantially identical operations on said article, the duration of every operation of said one component being determined by said exact count of said plurality of said consecutively repeated substantially identical movements, part of said manufacturing component operational steps having said duration thereof determined by said time measured in time elements and part of said manufacturing component operational steps having said duration thereof determined by said number of movements of said components; manual controls selectively manually movable between manufacturing component operating and nonoperating positions; an automatic controller including instruction signal recording and transmitting means for receiving and recording sequential composite instruction signals directly relating to both operational step function and duration of said manufacturing components including said one component and for transmitting back said sequential composite instruction signals after once having received and recorded the same; and a power interface switchable between a manual mode and an automatic mode including electrical component means constructed and arranged operably connecting said manual controls and said manufacturing components and said automatic controller when said power interface is in said manual mode for operating said manufacturing components through manual movement of said manual controls to perform said series of manufacturing operational steps on said article to be manufactured while simultaneously with said manufacturing operational step performance translating at least certain of said steps into said composite instruction signals including said one component duration exact count for sequential transmission to and recording by said instruction signal recording and transmitting means of said automatic controller, said electrical component means being constructed and arranged operably connecting at least said automatic controller and said manufacturing components when said power interface is in said automatic mode for receiving said previously recorded certain composite instruction signals including said one component exact count back from said instruction signal recording and transmitting means of said automatic controller and translating said signals sequentially into commands requiring said manufacturing operational step performances by said manufacturing components to automatically sequentially repeat said at least certain of said steps.

2. Manufacturing equipment as defined in claim **1** in which an automatic recorder is operably connected to said automatic controller and has a plurality of selectively actionable signal transmitter means therein each being constructed and arranged for transmitting a predetermined different instruction signal exactly corresponding to a predetermined one of said instruction signals received by said automatic controller from said power interface when said power interface is in said manual mode upon operation of one of said manufacturing components through said manual controls to perform a particular of said series of manufacturing operational steps, a transmitter actuator operably connected to each of said signal transmitter means for selectively actuating that particular signal transmitter means to transmit its particular composite instruction signal for recording said particular composite instruction signal by said instruction signal recording and transmitting means for said automatic controller.

3. Manufacturing equipment as defined in claim **1** in which said automatic controller includes means for recording by said instruction signal recording and transmitting means artificially generated determined time delay signals for delays of determined length between particular of said recorded composite instruction signals for said component manufacturing operational steps, there being means associated with said automatic controller for selectively artificially generating said determined time delay signals of said selected lengths free of association with said manufacturing component operation and nonoperation, said determined delay signals when transmitted back to said power interface with said power interface in said automatic mode resulting in exact determined time delays between said particular component manufacturing operational steps corresponding exactly to said artificially generated determined time delay signals, said instruction signal recording and transmitting means of said automatic controller automatically starting each of said determined time delays at termination of a former of said particular component operational steps and automatically commencing a latter of said particular component operational steps at an end of said determined time delay.

4. Manufacturing equipment as defined in claim **1** in which said automatic controller includes means for recording by said instruction signal recording and transmitting means artificially generated determined time delay signals for delays of selected length between particular of said recorded composite instruction signals for said component manufacturing operational steps and artificially generated indeterminate time delay signals for delays of indeterminate length between others of said recorded composite instruction signals for said component manufacturing operational steps, there being means associated with said automatic controller for selectively artificially generating said determined and indeterminate time delay signals for delays of said selected and indeterminate lengths free of association with said manufacturing component operation and nonoperation, said determined delay signals when transmitted back to said power interface with said power interface in said automatic mode resulting in exact determined time delays between said particular component manufacturing operational steps corresponding exactly to said artificially generated determined time delay signals, said instruction signal recording and transmitting means of said automatic controller automatically starting each of said determined time delays at termination of a former of said particular component operational steps and automatically commencing

a latter of said particular component operational steps at an end of said determined time delay, said indeterminate delay signals when transmitted back to said power interface with said power interface in said automatic mode resulting in indeterminate time delays between said other component manufacturing operational steps, said instruction signal recording and transmitting means of said automatic controller automatically starting each of said indeterminate time delays at termination of a former of said other component operational steps and automatically maintaining said indeterminate time delay until actuated by a manual actuation of one of said manual controls to start operation of a manufacturing component starting a latter of said other component operational steps.

5. Manufacturing equipment as defined in claim 1 in which said automatic controller includes means for recording by said instruction signal recording and transmitting means artificially generated determined time delay signals for delays of selected length between particular of said recorded composite instruction signals for said component manufacturing operational steps and artificially generated training time delay signals for delays of indeterminate length intermediate selected of said recorded composite instruction signals for said component manufacturing operational steps the being means associated with said automatic controller for selectively artificially generating said determined and training time delay signals for delays of said selected and indeterminate lengths free of association with said manufacturing component operation and nonoperation, said determined delay signals when transmitted back to said power interface with said power interface in said automatic mode resulting in exact determined time delays between said particular component manufacturing operational steps corresponding exactly to said artificially generated determined time delay signals, said instruction signal recording and transmitting means of said automatic controller automatically starting each of said determined time delays at termination of a former of said particular component operational steps and automatically commencing a latter of said particular component operational steps at an end of said determined time delay, said training delay signals when transmitted back to said power interface with said power interface in said automatic mode resulting in training time delays intermediate said selected component manufacturing operational steps temporarily interrupting said selected steps, said instruction signal recording and transmitting means of said automatic controller automatically starting each of said training time delays intermediate said certain component operational steps and automatically maintaining said training time delays of said selected steps until actuated by a manual actuation of one of said manual controls to restart operation of that particular manufacturing component to complete said selected steps; and in which training delay elimination means is operably connected to said instruction signal recording and transmitting means selectively actionable between a nonbypass and bypass position for selectively maintaining and eliminating effect of said training time delays intermediate said selected component manufacturing operational steps with said elimination by movement to said bypass position resulting in said selected component manufacturing operational steps being carried out by said manufacturing components without said training time delays, movement of said training delay elimination means from said bypass to said nonbypass position again maintaining previously eliminated of said training time delays.

6. Manufacturing equipment as defined in claim 1 in which said at least one of said manufacturing components of said manufacturing device performing said plurality of said consecutively repeated substantially identical movements is a component positionable in either of at least two selected positions at termination of said operational steps involving operation of that one component; and in which component positioner means is operably connected to said instruction signal recording and transmitting means of said automatic controller for artificially generating either of at least two instruction signals corresponding to said at least two selected positions of said one positionable component determining the position of said one positionable component at termination of said one positionable component manufacturing operational steps to record an appropriate composite instruction signal in said automatic controller and cause said automatic controller to position said one positionable component in said selected position at said termination of said one positionable component manufacturing operational steps when said power interface is in said automatic mode.

7. Manufacturing equipment as defined in claim 1 in which said automatic controller includes means for recording by said instruction signal recording and transmitting means artificially generated determined time delay signals for delays of determined length between particular of said recorded composite instruction signals for said component manufacturing operational steps, there being means associated with said automatic controller for selectively artificially generating said determined time delay signals of said selected lengths free of association with said manufacturing component operation and nonoperation, said determined delay signals when transmitted back to said power interface with said power interface in said automatic mode resulting in exact determined time delays between said particular component manufacturing operational steps corresponding exactly to said artificially generated determined time delay signals, said instruction signal recording and transmitting means of said automatic controller automatically starting each of said determined time delays at termination of a former of said particular component operational steps and automatically commencing a latter of said particular component operational steps at an end of said determined time delay; and in which time delay regulating means is operably connected to said instruction signal recording and transmitting means of said automatic controller selectively operable for changing said determined delay signals for said determined time delays to selectively change the times of said determined time delays as to future transmission thereof at any time after recording thereof and until rechanged by said time delay regulating means, said selective operation of said time delay regulating means being free of affect on said composite instruction signals recorded and transmitted by said instruction signal recording and transmitting means.

8. Manufacturing equipment as defined in claim 1 in which drive motor means is operably connected to said at least one of said manufacturing components of said manufacturing device for operating said at least one manufacturing component during said manufacturing operational steps of said at least one manufacturing component and said repeated substantially identical movements thereof; and in which speed adjustment means is operably connected to said drive motor means for selectably adjusting the speed of said drive motor means to adjust the speed of said substantially identical movements of said at least one and thereby automatically adjust said duration of said at least one manufacturing component and thereby automatically adjust said duration of said at least one manufacturing component manufacturing operational steps without affecting others of said composite instruction signals recorded and transmitted by said instruction signal recording and transmitting means.

9. Manufacturing equipment as defined in claim 1 in which said article to be manufactured is an article to be sewn with said manufacturing components including a sewing head having a reciprocal needle, a thread cutoff; in which said at least one manufacturing component is said sewing head with said reciprocal needle the duration of the operational steps thereof determined by the number of reciprocations of said reciprocal needle, said manufacturing operational steps involving said thread cutoff having the duration thereof determined by time measured in said preset time elements; in which needle counter means is operably connected to said instruction signal recording and transmitting means of said automatic thru controller for determining the number of reciprocations of said reciprocal needle during a manufacturing operational step to

permit reception, recording and transmitting of composite instruction signals by said automatic controller relating to said manufacturing operational steps; and in which automatic recorder means is operably connected to said automatic controller selectively operable for causing recording of predetermined numbers of time elements by said instruction signal recording and transmitting mean to form artificially generated time element duration instruction signals in said instruction signal recording and transmitting means relating to manufacturing operational steps involving said thread cutoff permitting operation of said thread cutoff by said automatic controller during said time element duration when said power interface is in said automatic mode.

10. Manufacturing equipment as defined in claim 1 in which said article to be manufactured is an article to be sewn and said manufacturing components include a sewing head having a reciprocal needle, a thread cutoff; in which said at least one manufacturing component is said sewing head with said reciprocal needle having the duration of the operational steps thereof determined by the number of reciprocal movements of said reciprocal needle, said durations of said manufacturing operational steps involving said thread cutoff being determined by the time measured in said preset time elements; and in which automatic recorder means is operably connected to said automatic controller and includes a selectively operable time element signal transmitter means and a selectively operable component movement transmitter means, said time element transmitter means being selectively adjustable to a predetermined number of said preset time elements for transmission of an artificially generated predetermined time element duration of a composite instruction to said instruction signal recording and transmitting means to form composite instruction signals involving said thread cutoff for transmission to operate said thread cutoff, said component movement signal transmitter means being selectively adjustable to a predetermined number of component movements for transmission of an artificially generated predetermined component movement duration of a composite instruction to said instruction signal recording and transmitting means to form composite instruction signals involving said reciprocal needle for transmission to operate said reciprocal needle through a determined number of said reciprocations as selected for each said signal.

11. Manufacturing equipment as defined in claim 1 in which said article to be manufactured is an article to be sewn and said at least one manufacturing component is a sewing head having a reciprocal needle; in which said automatic controller has means associated therewith for artificially generating time delay instruction signals between composite instruction signals for providing time delays between operations of said manufacturing components of selectively determined lengths; and in which said instruction signal recording and transmitting means of said automatic controller includes means for receiving from said means artificially generating, recording and transmitting time delay instruction signals between composite instruction signals of certain of said manufacturing operational steps for providing time delays between operations of said manufacturing components during which said article to be sewn may be manually repositioned relative to said sewing head when said power interface is in said automatic mode.

12. Manufacturing equipment as defined in claim 1 in which said article to be manufactured is an article to be sewn and said at least one manufacturing component is sewing head having a reciprocal needle in which said automatic controller has means associated therewith for artificially generating time delay instruction signals between composite instruction signals for providing time delays between operations of said manufacturing components of selectively determined lengths; in which said instruction signal recording and transmitting means of said automatic controller includes means for receiving from said means artificially generating, recording and transmitting time delay instruction signals between composite instruction signals of certain of said manufacturing operational steps for providing time delays between operations of said manufacturing components during which said article to be sewn may be manually repositioned relative to said sewing head when said power interface is in said automatic mode; in which at least part of said time delays are artificially generated instruction signals resulting in transmitted determined time delays automatically starting at the termination of a manufacturing operational step with the following manufacturing operational step being automatically started by said instruction signal recording and transmitting means upon the ending of said determined time delay when said power interface is in said automatic mode; and in which determined time delay regulating means is operably connected to said instruction signal recording and transmitting means for selectively regulating means is operably connected to said instruction signal recording and transmitting means for selectively regulating said instruction signals relating to said determined time delays to automatically increase and decrease said determined time delays after recording of said determined time delay instruction signals by said instruction signal recording and transmitting means without affecting said composite instruction signal recording and transmission, said determined time delay instruction signals remaining as selectively regulated until regulated despite repeated operations of said manufacturing equipment by said power interface being in said automatic mode.

13. Manufacturing equipment as defined in claim 1 in which said article to be manufactured is an article to be sewn and said at least one manufacturing component is a sewing head having a reciprocal needle; in which said automatic controller has means associated therewith for artificially generating time delay instruction signals between composite instruction signals for providing time delays between operations of said manufacturing components of selectively determined lengths and of indeterminate lengths; in which said instruction signal recording and transmitting means of said automatic controller includes means for receiving from said means artificially generating recording and transmitting time delay instruction signals between composite instruction signals of certain of said manufacturing operational steps for providing time delays between operations of said manufacturing components during which said article to be sewn may be manually repositioned relative to said sewing head when said power interface is in said automatic mode; in which a part of said time delays are determined time delays and a part of said time delays are indeterminate time delays, said determined time delays being of determined length beginning with termination of a preceding manufacturing operational step and with said instruction signal recording and transmitting means automatically starting a next manufacturing operational step at the end of said determined time when said power interface is in said automatic mode, said indeterminate time delays starting at the end of a preceding manufacturing operational step and not ending until said instruction signal recording and transmitting means is manually actuated to transmit a next composite instruction signal starting a next manufacturing operational step when said power interface is in said automatic mode, certain of said indeterminate time delays being indeterminate training time delays; and in which time delay eliminating means is operably connected to said instruction signal recording and transmitting means selectively actionable for automatically eliminating instruction signals relating to at least certain of said indeterminate training time delays from said instruction recording and transmitting means to thereafter eliminate transmission of instruction signals relating to said at least certain indeterminate training time delays by said instruction signal recording and transmitting means when said power interface is in said automatic mode, said elimination of said instruction signals relating to said at least certain of said indeterminate training time delays being free of otherwise affecting said recording and transmission of said instruction signal recording and transmitting means.

14. In manufacturing equipment normally manually controlled by an operator for carrying out a series of sequential manufacturing operations on an article to be manufactured, the combination of: a manufacturing device including manufacturing components having means selectively operable for performing a series of sequential manufacturing operational steps on an article to be manufactured; manual controls selectively manually movable between manufacturing component operating and nonoperating positions; an automatic controller including instruction signal-recording means for receiving and first temporarily recording sequential instruction signals directly relating to said sequential operational steps of said manufacturing components, said instruction signal-recording means after said temporary recording permanently sequentially recording any of said instruction signals temporarily recorded upon electronic command and automatically permanently eliminating from recording in said sequence any of said instruction signals not permanently recorded, instruction signal-transmitting means for transmitting back said sequential permanently recorded instruction signals; permanent record command means operably associated with said automatic controller actionable for electronically commanding said instruction signal recording means to permanently record any of said instruction signals temporarily recorded; and a power interface switchable between a manual mode and an automatic mode including electrical component means constructed and arranged operably connecting said manual controls and said manufacturing components and said automatic controller when said power interface is in said manual mode for operating said manufacturing components through manual movement of said manual controls to perform said series of sequential manufacturing operational steps on said article to be manufactured while simultaneously with said manufacturing operational step performance translating said steps into said instruction signals for sequential transmission to and temporary recording by said instruction signal-recording means of said automatic controller, said electrical component means being constructed and arranged operably connecting at least said automatic controller and said manufacturing components when said power interface is in said automatic mode for receiving said permanently recorded instruction signals back from said instruction signal recording means through said instruction signal transmitting means of said automatic recorder and translating said signals sequentially into commands requiring said manufacturing operational step performances by said manufacturing components to automatically sequentially exactly repeat said steps corresponding to said permanently recorded instruction signals.

15. Manufacturing equipment as defined in claim 14 in which each of said component manufacturing operational steps is a composite operational step comprised of the combination of function and duration, said function being determined by the particular manufacturing operation performed by said component upon said article, said duration being determined by one of the time measured in a given number of preset time elements to perform the particular of said manufacturing operation and an exact count of the exact number of movements of said component to perform said particular of said manufacturing operation, at least one of said manufacturing components having means for performing its manufacturing steps by performing a plurality of consecutively repeated substantially identical movements during every operation thereof directly performing an equal number of consecutively repeated substantially identical operations on said article, the duration of every operation of said one component being determined by said exact count of said plurality of said consecutively repeated substantially identical movements, part of said manufacturing component operational steps having said duration thereof determined by said time measured in time elements and part of said manufacturing component operational steps having said duration thereof determined by said number of movements of said components; in which said instruction signal-recording of said automatic controller is constructed and arranged for receiving and recording composite instruction signals directly relating to said composite manufacturing operational steps including said one component duration exact count; in which said instruction signal-transmitting means of said automatic controller is constructed and arranged for transmitting back said composite instruction signals directly relating to said manufacturing operational steps of said manufacturing components including said one component duration exact count; and in which said power interface is constructed and arranged for translating said composite manufacturing operational steps into said composite instruction signals and said composite instruction signals into said commands requiring said manufacturing operational step performance by said manufacturing components.

16. Manufacturing equipment as defined in claim 14 in which each of said component manufacturing operational steps is a composite operational step comprised of the combination of function and duration, said function being determined by the particular manufacturing operation performed by said component upon said article, said duration being determined by one of the time measured in a given number of preset time elements to perform the particular of said manufacturing operation and an exact count of the exact number of movements of said component to perform said particular of said manufacturing operation, at least one of said manufacturing components having means for performing its manufacturing steps by performing a plurality of consecutively repeated substantially identical movements during every operation thereof directly performing an equal number of consecutively repeated substantially identical operations on said article, the duration of every operation of said one component being determined by said exact count of said plurality of said consecutively repeated substantially identical movements; in which said instruction signal recording means of said automatic controller is constructed and arranged for receiving and recording composite instruction signals directly relating to said composite manufacturing operational steps including said one component duration exact count; in which said instruction signal-transmitting means of said automatic controller is constructed and arranged for transmitting back said composite instruction signals directly relating to said manufacturing operational steps of said manufacturing components including said one component duration exact count; in which said power interface is constructed and arranged for translating said composite manufacturing operational steps into said composite instruction signals and said composite instruction signals into said commands requiring said manufacturing operational step performances by said manufacturing components; in which a part of said composite manufacturing operational steps have the duration thereof determined by time elements and a part of said composite manufacturing operational steps have the duration thereof determined by said number of movements of said components; and in which an automatic recorder is operably connected to said automatic controller and has a plurality of selectively actionable signal transmitter means therein each being constructed and arranged for transmitting a predetermined different instruction signal exactly corresponding to a predetermined one of said instruction signals received by said automatic controller from said power interface when said power interface is in said manual mode upon operation of one of said manufacturing components through said manual controls to perform a particular of said series of composite manufacturing operational steps, a transmitter actuator operably connected to each of said signal transmitter means for selectively actuating that particular signal transmitter means to transmit its particular composite instruction signal for recording said particular composite instruction signal by said instruction signal recording means of said automatic controller.

17. Manufacturing equipment as defined in claim 14 in which each of said component manufacturing operational steps is a composite operational step comprised of the combination of function and duration, said function being deter-

mined by the particular manufacturing operation performed by said component upon said article, said duration being determined by one of the time measured in a given number of preset time elements to perform the particular of said manufacturing operation and an exact count of the exact number of movements of said component to perform said particular of said manufacturing operation, at least one of said manufacturing components having means for performing its manufacturing steps by performing a plurality of consecutively repeated substantially identical movements during every operation thereof directly performing an equal number of consecutively repeated substantially identical operations on said article, the duration of every operation of said one component being determined by said exact count of said plurality of said consecutively repeated substantially identical movements; in which said instruction signal-recording means of said automatic controller is constructed and arranged for receiving and recording composite instruction signals directly relating to said composite manufacturing operational steps including said one component duration exact count; in which said instruction signal transmitting means of said automatic controller is constructed and arranged for transmitting back said composite instruction signals directly relating to said manufacturing operational steps of said manufacturing components including said one component duration exact count; in which said power interface is constructed and arranged for translating said composite manufacturing operational steps into said composite instruction signals and said composite instruction signals into said commands requiring said manufacturing operational step performances by said manufacturing components; in which a part of said composite manufacturing operational steps have the duration thereof determined by time elements and a part of said composite manufacturing operational steps have the duration thereof determined by said number of movements of said components; in which an automatic recorder is operably connected to said automatic controller and has a plurality of selectively actionable signal transmitter means therein each being constructed and arranged for transmitting a predetermined different instruction signal exactly corresponding to a predetermined one of said instruction signals received by said automatic controller from said power interface when said power interface is in said manual mode upon operation of one of said manufacturing components through said manual controls to perform a particular of said series of composite manufacturing operational steps, a transmitter actuator operably connected to each of said signal transmitter means for selectively actuating that particular signal transmitter means to transmit its particular composite instruction signal for recording said particular composite instruction signal by said instruction signal-recording means of said automatic controller; and in which said automatic controller includes means for recording by said instruction signal recording means artificially generated determined time delay signals for delays of determined length between particular of said recorded composite instruction signals for said component-manufacturing operational steps, there being means associated with said automatic controller for selectively artificially generating said determined time delay signals of said selected lengths free of association with said manufacturing component operation and nonoperation, said determined delay signals when transmitted back to said power interface by said transmitting means with said power interface in said automatic mode resulting in exact determined time delays between said particular component manufacturing operational steps corresponding exactly to said artificially generated determined time delay signals, said transmitting means of said automatic controller automatically starting each of said determined time delays at termination of a former of said particular component operational steps and automatically commencing a latter of said particular component operational steps at an end of said determined time delay.

18. Manufacturing equipment as defined in claim 14 in which each of said component-manufacturing operational steps is a composite operational step comprised of the combination of function and duration, said function being determined by the particular manufacturing operation performed by said component upon said article, said duration being determined by one of the time measured in a given number of preset time elements to perform the particular of said manufacturing operation and an exact count of the exact number of movements of said component to perform said particular of said manufacturing operation, at least one of said manufacturing components having means for performing its manufacturing steps by performing a plurality of consecutively repeated substantially identical movements during every operation thereof directly performing an equal number of consecutively repeated substantially identical operations on said article, the duration of every operation of said one component being determined by said exact count of said plurality of said consecutively repeated substantially identical movements; in which said instruction signal recording means of said automatic controller is constructed and arranged for receiving and recording composite instruction signals to said composite manufacturing operational steps including said one component duration exact count; in which said instruction signal-transmitting means of said automatic controller is constructed and arranged for transmitting back said composite instruction signals directly relating to said manufacturing operation steps of said manufacturing components including said one component duration exact count; in which said power interface is constructed and arranged for translating said composite manufacturing operational steps into said composite instruction signals and said composite instruction signals into said commands requiring said manufacturing operational step performances by said manufacturing components; in which a part of said composite manufacturing operational steps have the duration thereof determined by time elements and a part of said composite manufacturing operational steps have the duration thereof determined by said number of movements of said components; in which an automatic recorder is operably connected to said automatic controller and has a plurality of selectively actionable signal transmitter means therein each being constructed and arranged for transmitting a predetermined different instruction signal exactly corresponding to a predetermined one of said instruction signals received by said automatic controller from said power interface when said power interface is in said manual mode upon operation of one of said manufacturing components through said manual controls to perform a particular of said series of composite manufacturing operational steps, a transmitter actuator operably connected to each of said signal transmitter means for selectively actuating that particular signal transmitter means to transmit its particular composite instruction signal for recording said particular composite instruction signal by said instruction signal-recording means of said automatic controller; in which said automatic controller includes means for recording by said instruction signal-recording means artificially generated determined time delay signals for delays of determined length between particular of said recorded composite instruction signals for said component-manufacturing operational steps, there being means associated with said automatic controller for selectively artificially generating said determined time delay signals of said selected lengths free of association with said manufacturing component operation and nonoperation, said determined delay signals when transmitted back to said power interface by said transmitting means with said power interface in said automatic mode resulting in exact determined time delays between said particular component manufacturing operational steps corresponding exactly to said artificially generated determined time delay signals, said transmitting means of said automatic controller automatically starting each of said determined time delays at termination of a former of said particular component operational steps and automatically commencing a latter of said particular component operational steps at an end of said determined time delay; in which said automatic controller includes means for recording

by said instruction signal-recording means artificially generated training delay signals at any selected point intermediate particular of said recorded composite instruction signals for said component manufacturing operational steps, there being means associated with said automatic controller for selectively artificially generating said training time delay signals of said indeterminate lengths free of association with said manufacturing component operation and nonoperation, said training delay signals when transmitted back to said power interface by said transmitting means with said power interface in said automatic mode resulting in training time delays of indeterminate length intermediate said particular component manufacturing operational steps interrupting operation of said manufacturing component carrying out said particular component manufacturing operational step until determined actuation of that particular manufacturing components manual control deliberately restarting operation of that particular manufacturing component; and in which training delay eliminating means is operably connected to said automatic controller selectively operable between nonbypass and bypass positions for selectively maintaining and eliminating said training delay signals from effect in said interrupting of said particular composite operational step and permitting the carrying out of said particular composite operational step by said automatic controller upon movement to said bypass position without said training time delay interruption, movement of said training delay eliminating means from said bypass to said nonbypass positions again maintaining previously eliminated of said training delay signals.

19. Manufacturing equipment as defined in claim 14 in which said article to be manufactured is an article to be sewn with said manufacturing components including a sewing head having a reciprocal needle; in which at least part of said manufacturing operational steps involving said reciprocal needle have the duration thereof determined by the number of repeated reciprocations of said reciprocal needle; in which needle counter means is operably connected to said instruction signal recording and transmitting means of said automatic controller for determining the exact number of repeated reciprocations of said reciprocal needle during a manufacturing operational step to permit reception, recording and transmitting of an instruction signal by said automatic controller relating to said exact needle reciprocations of said manufacturing operational steps; and in which said automatic controller has means associated therewith for selectively artificially generating and said instruction signal recording and transmitting means of said automatic controller is constructed and arranged permitting insertion in said recording thereof of permanently recorded instruction signals for exact length determined time delays of any determined lengths between determined of said composite instruction signals for said manufacturing operational steps of said manufacturing components, the length of any determined time delay being possible of determination without regard to others of said determined time delays said determined time delays regardless of length starting at termination of a former manufacturing operational step and said instruction signal recording and transmitting means automatically starting a next manufacturing operational step upon completion of that particular length determined time delay.

20. Manufacturing equipment as defined in claim 14 in which said article to be manufactured is an article to be sewn and said manufacturing components of said manufacturing device include a sewing head having a reciprocal needle movable between needle up and down positions; in which needle counter and positioner means is operably associated with said reciprocal needle and is operably connected to said automatic controller for counting the exact number of said reciprocations of said reciprocal needle during said manufacturing operational steps involving said reciprocal needle and aiding in forming said instruction signals in said instruction signal recording and transmitting means to terminate said manufacturing operational steps involving said reciprocal needle at the termination of a predetermined exact number of said needle reciprocations, said needle counter and positioner means also being operably associated with said reciprocal needle and operably connected to said automatic controller for determining positioning of said reciprocal needle and aiding in forming said instruction signals in said instruction signal recording and transmitting means to terminate certain of said manufacturing operational steps involving said reciprocal needle after said exact number of reciprocations with said reciprocal needle in said down position extending through said article to be sewn; in which said automatic controller has means associated therewith for selectively artificially generating and said signal recording and transmitting means of said automatic controller is constructed and arranged permitting insertion in said recording thereof of permanent instruction signals for exact length determined time delays of any determined lengths between determined of said instruction signals for said manufacturing operational steps of said manufacturing components, the length of any determined time delay being possible of determination without regard to others of said determined time delays, said determined time delays regardless of length starting at termination of a former manufacturing operational step and said instruction signal recording and transmitting means automatically starting a next manufacturing operational step upon completion of that particular length determined time delay; and in which said reciprocal needle is positioned down by said needle counter and positioner means and said instruction signal recording and transmitting means during at least certain of said determined time delays providing time during said delays for manual repositioning of said article to be sewn with said reciprocal needle extending therethrough prior to a next manufacturing operational step being started by said instruction signal recording and transmitting means of said automatic controller at termination of said delays.

21. Manufacturing equipment as defined in claim 14 in which said article to be manufactured is an article to be sewn and said manufacturing components of said manufacturing device include a sewing head having a reciprocal needle movable between needle up and down positions; in which needle counter and positioner means is operably associated with said reciprocal needle and is operably connected to said automatic controller for counting the exact number of said reciprocations of said reciprocal needle during said manufacturing operational steps involving said reciprocal needle and aiding in forming said instruction signals in said instruction signal recording and transmitting means to terminate said manufacturing operational steps involving said reciprocal needle at the termination of a predetermined exact number of said needle reciprocations, said needle counter and positioner means also being operably associated with said reciprocal needle and operably connected to said automatic controller for determining position of said reciprocal needle and aiding in forming said instruction signals in said instruction signal recording and transmitting means to terminate certain of said operational steps involving said reciprocal needle after said exact number of reciprocations with said reciprocal needle in said down position extending through said article to be sewn, said needle counter and positioner means also being operably associated with said reciprocal needle and operably connected to said automatic controller for determining positioning of said reciprocal needle and aiding in forming said instruction signals in said instruction signal recording and transmitting means to terminate at least one of said manufacturing operational steps involving said reciprocal needle after said exact number or reciprocations with said reciprocal needle in said up position spaced above said article to be sewn; in which said automatic controller has means associated therewith for selectively artificially generating and said signal recording and transmitting means of said automatic controller is constructed and arranged permitting insertion in said recording thereof of permanent instruction signals for exact length determined time delays of any determined lengths between determined of

said instruction signals of said manufacturing operational steps of said manufacturing components, the length of any determined time delay being possible of determination without regard to others of said determined time delays, said determined time delays regardless of length starting at termination of a former manufacturing operational step and said instruction signal recording and transmitting means automatically starting a next manufacturing operational step upon completion of that particular length determined time delay; in which said reciprocal needle is positioned down by said needle counter and positioner means and said instruction signal recording and transmitting means during at least certain of said determined time delays providing time during said delays for manual repositioning of said article to be sewn with said reciprocal needle extending therethrough prior to a next manufacturing operational step being started by said instruction signal recording and transmitting means of said automatic controller at termination of said delays; in which said manufacturing components of said manufacturing device include a thread cutoff having means thereon properly operable only when said reciprocal needle is in said up position for performing a thread cutoff operation of thread involved in sewing by said reciprocal needle; and in which said reciprocal needle is positioned up by said said needle counter and positioner means and said instruction signal recording and transmitting means during termination of said one manufacturing operational step and said instruction signal recording and transmitting means operates said thread cutoff at said one manufacturing operational step termination while said needle is positioned up.

22. Manufacturing equipment as defined in claim 14 in which said article to be manufactured is an article to be sewn and said manufacturing components of said manufacturing device include a sewing head having a reciprocal needle movable between needle up and down positions; in which a drive motor is operably connected to said sewing head actionable reciprocally moving said needle, said drive motor when actuated being controllable between fast and slow speeds driving said reciprocal needle at said fast and slow speeds; in which needle counter and positioner means is operably associated with said reciprocal needle and is operably connected to said automatic controller for counting the exact number of said reciprocations of said reciprocal needle during said manufacturing operational steps involving said reciprocal needle and aiding in forming said instruction signals in said instruction signal recording and transmitting means to terminate said manufacturing operational steps involving said reciprocal needle at the termination of a predetermined exact number of said needle reciprocations, said needle counter and positioner means also being operably associated with said reciprocal needle and operably connected to said automatic controller for determining position of said reciprocal needle and aiding in forming said instruction signals in said instruction signal recording and transmitting means to terminate certain of said operational steps involving said reciprocal needle after said exact number of reciprocations with said reciprocal needle in said down position extending through said article to be sewn, said needle counter and positioner means also being operably associated with said reciprocal needle and operably connected to said automatic controller for determining positioning of said reciprocal needle and aiding in forming said instruction signals in said instruction signal recording and transmitting means to terminate at least one of said manufacturing operational steps involving said reciprocal needle after said exact number of reciprocations with said reciprocal needle in said up position spaced above said article to be sewn; in which said automatic controller has means associated therewith for selectively artificially generating and said signal recording and transmitting means of said automatic controller is constructed and arranged permitting insertion in said recording thereof of permanent instruction signals for exact length determined time delays of any determined lengths between determined of said instruction signals for said manufacturing operational steps of said manufacturing components, the length of any determined time delay being possible of determination without regard to others of said determined time delays, said determined time delays regardless of length starting at termination of a former manufacturing operational step and said instruction signal recording and transmitting means automatically starting a next manufacturing operational step upon completion of that particular length determined time delay; in which said reciprocal needle is positioned down by said needle counter and positioner means and said instruction signal recording and transmitting means during at least certain of said determined time delays providing time during said delays for manual repositioning of said article to be sewn with said reciprocal needle extending therethrough prior to a next manufacturing operational step being started by said instruction signal recording and transmitting means of said automatic controller at termination of said delays; in which said manufacturing components of said manufacturing device include a thread cutoff having means thereon properly operable only when said reciprocal needle is in said up position for performing a thread cutoff operation of thread involved in sewing by said reciprocal needle; in which said reciprocal needle is positioned up by said needle counter and positioner means and said instruction signal instruction recording and transmitting means during termination of said one manufacturing operational step and said instruction signal recording and transmitting means operates said thread cutoff at said one manufacturing operational step termination while said needle is positioned up; in which said drive motor is controlled by said instruction signal and transmitting means to move said reciprocal needle at fast speed during initial portions of said manufacturing operational steps involving said reciprocal needle preceding said certain of said determined time delays nd to move said reciprocal needle at slow speed during latter portions of said manufacturing operational steps involving said reciprocal needle preceding said certain of said determined time delays, said drive motor being controlled by said instruction signal recording and transmitting means to move said reciprocal needle at fast speeds during an initial portion of said one manufacturing operational step involving said reciprocal needle preceding said thread cutoff operation and to move said reciprocal needle at slow speed during a latter portion of said one manufacturing operational step involving said reciprocal needle; and in which automatic recorder means is operably connected to said instruction signal recording and transmitting means of said automatic controller constructed and arranged selectively actionable for selectively generating and placing artificially generated instruction signals into said instruction signal recording and transmitting means equivalent to any selected determined count of needle reciprocation as a substitute for actual counting by said needle counter and positioner means and later use by said instruction signal recording and transmitting means in controlling said reciprocal needle reciprocations during a manufacturing operational step involving said reciprocal needle.

23. In manufacturing equipment for carrying out a series of manufacturing operations on an article to be manufactured, the combination of: a manufacturing device including manufacturing components having means selectively operable for performing a series of manufacturing operational steps on an article to be manufactured, at least one of said manufacturing operational steps requiring continuous operation of a certain manufacturing component throughout said step performing a plurality of consecutively repeated substantially identical movements with a first part of said step being determined duration of an exact number of said movements for each of said manufactured articles so as to be adaptable to automatic control and with a second part of said step being of indeterminate duration of an additional indeterminate number of said movements for each said article to commencement of said step so as to require manual control for terminating said step and placing said manufacturing device in a condition for a commencement of a subsequent step; manual control means operably

connected to at least said certain manufacturing component manually actionable for stopping said component and stop said component movements to terminate said one manufacturing operational step and place said manufacturing device in condition for commencement of a subsequent step; and an automatic controller including instruction signal-transmitting means operably connected to said manufacturing components for automatically operating said certain manufacturing component to automatically start and continuously operate to carry out said manufacturing operational step first part by counting said component movements after said automatic start and operate said component exactly for said component movement exact count, said instruction signal-transmitting means after said step first part determined duration and completion by said component movement exact count being constructed and arranged for continuously proceeding to automatically operate said certain manufacturing component during said step second part indeterminate duration and continue said component movements until manual actuation of said control means to stop said component to terminate said step and place said manufacturing device in said condition for said commencement of said subsequent step.

24. Manufacturing equipment as defined in claim 23 in which said instruction signal transmitting means of said automatic controller is constructed and arranged automatically controlling said manufacturing components for creating a time delay of determined length immediately after manual termination of said one manufacturing operational step second part by action of said manual control means and automatically starting predetermined of said manufacturing components to carry out another of said manufacturing operational steps immediately at expiration of said determined time delay.

25. Manufacturing equipment as defined in claim 23 in which said series of manufacturing operational steps performed by said manufacturing components on said article to be manufactured includes a plurality of consecutive of said one manufacturing operational step with each of said one operational steps being formed by said first parts of said determined duration of various exact numbers of said component movements and said second parts of said indeterminate duration of additional indeterminate numbers of said movements; and in which said instruction signal-transmitting means of said automatic controller is constructed and arranged for automatically delaying operation of said certain manufacturing component immediately between each of said one manufacturing operational consecutive steps for determined time delays and automatically operating said certain manufacturing component to immediately start the next of said one manufacturing operational consecutive steps upon expiration of that particular determined time delay, the exact number of said component movements in any step first part being free of dependence on other steps, the exact length of any determined time delay being free of dependence on the exact length of any other determined time delay.

26. Manufacturing equipment as defined in claim 23 in which said article to be manufactured is an article to be sewn and said manufacturing components include a sewing head having a movable stitching needle thereon operable to sew stitches in said article to be sewn; in which said certain manufacturing component is said sewing head with said movable needle; in which said one manufacturing operational step is the step of sewing a plurality of stitches by said sewing head needle between generally predetermined locations on said article to be sewn; and in which stitch counter means is operably associated with said sewing head needle and is operably connected to said instruction signal-transmitting means of said automatic controller for automatically counting a determined number of stitches making up said exact number of movements for said one manufacturing operational step first part duration and cause said instruction signal-transmitting means to terminate said determined duration of said one manufacturing operational step first part and immediately start said one operational step second part continuously proceeding to automatically operate said sewing head.

27. Manufacturing equipment as defined in claim 23 in which said article to be manufactured is an article to be sewn and said manufacturing components include a sewing head having a movable stitching needle thereon operable to sew stitches in said article to be sewn; in which said certain manufacturing component is said sewing head with said movable needle; in which said one manufacturing operational step is the step of sewing a plurality of stitches by said sewing head needle between generally predetermined locations on said article to be sewn; in which stitch counter means is operably associated with said sewing head needle and is operably connected to said instruction signal-transmitting means of said automatic controller for automatically counting a determined number of stitches making up said exact number of movements for said one manufacturing operational step first part duration and cause said instruction signal-transmitting means to terminate said determined duration of said one manufacturing operational step first part and immediately start said one operational step second part continuously proceeding to automatically operate said sewing head; and in which said instruction signal-transmitting means of said automatic controller is constructed and arranged automatically controlling said manufacturing components for creating a time delay of determined length immediately after manual termination of said one manufacturing operational step second part by action of said manual control means and automatically starting predetermined certain of said manufacturing components to carry out another of said manufacturing operational steps immediately at expiration of said determined time delay.

28. Manufacturing equipment as defined in claim 23 in which said article to be manufactured is an article to be sewn and said manufacturing components include a sewing head having a movable stitching needle thereon operable to sew stitches in said article to be sewn; in which said certain manufacturing component is said sewing head with said movable needle; in which said one manufacturing operational step is the step of sewing a plurality of stitches by said sewing head needle between generally predetermined locations on said article to be sewn; in which stitch counter means is operably associated with said sewing head needle and is operably connected to said instruction signal-transmitting means of said automatic controller for automatically counting a determined number of stitches making up said exact number of movements for said one manufacturing operational step first part duration and cause said instruction signal-transmitting means to terminate said determined duration of said one manufacturing operational step first part and immediately start said one operational step second part continuously proceeding to automatically operate said sewing head; in which said series of manufacturing operational steps performed by said manufacturing components on said article to be sewn includes a plurality of consecutive of said one manufacturing operational steps of said sewing of various plurality of stitches by said sewing head needle between various generally predetermined locations on said article to be sewn with each of said sewing operational steps being formed by said first parts of said determined duration of various exact numbers of said stitches and said second parts of said indeterminate duration of additional indeterminate numbers of said stitches; and in which said instruction signal-transmitting means of said automatic controller is constructed and arranged for automatically delaying operation of said sewing head needle immediately between each of said sewing operational consecutive steps for determined time delays and automatically operating said sewing head needle to immediately start the next of said sewing operational steps upon expiration of that particular determined time delay, the exact number of said stitches in any step first part being free of dependence on other steps, the exact length of any determined time delay being free of dependence on the exact length of any other determined time delay.

29. In manufacturing equipment for carrying out a series of manufacturing operations on an article to be manufactured the combination of: a manufacturing device including manufacturing components having means selectively operable for

performing a series of manufacturing operational steps on an article to be manufactured, said component manufacturing operational steps being sequential operational steps and having between certain of said operational steps required time delay steps during which an operator is required to manually perform an operation on said article before proceeding with a subsequent of said certain operational steps in an overall plan of manufacture of said article, at said article, one of said manufacturing components when operated performing a plurality of repeated substantially identical movements during each of said one manufacturing component operational steps and said article manufacture requiring at least two consecutive of said one manufacturing component operational steps; and an automatic controller including instruction signal-transmitting means operably connected to said manufacturing components for automatically sequentially operating said manufacturing components to perform said series of said manufacturing operational steps and immediately automatically stopping said manufacturing components for predetermined exact times sequentially between said certain operational steps to form said time delay steps and immediately automatically sequentially operating appropriate of said manufacturing components at termination of said predetermined times of said time delay steps to automatically proceed with said subsequent of said certain operational steps, said one manufacturing component operational steps being controlled by said instruction signal transmitting means counting said repeated identical movements in each of said steps and terminating said each step when a predetermined number of said movements have been made according to original independent predetermination for that step, said instruction signal-transmitting means being constructed and arranged for providing said time delay steps of sufficient predetermined time normally permitting said operator to manually perform said required operation on said article according to said overall plan of manufacture, one of said time delay steps being between said one manufacturing component operational steps and being of sufficient predetermined time normally permitting said operator to manually reposition said article in a predetermined manner.

30. Manufacturing equipment as defined in claim 29 in which training time delay means is operably connected to said instruction signal-transmitting means of said automatic controller actionable for inserting training time delays intermediate certain of said components manufacturing operational steps during which said certain manufacturing operational steps are interrupted, said interrupted certain manufacturing operational steps being automatically interrupted upon reaching said training time delays and automatically continued by said instruction signal transmitting means at termination of said training time delays, said training timed delay means including mean actionable alternately in a nonbypass position for maintaining said training time delays intermediate said component certain manufacturing operation steps and in a bypass position for selectively permanently removing throughout said means bypass positioning said training time delays from intermediate said component certain manufacturing operational steps after which said instruction signal-transmitting means automatically operates that particular of said manufacturing components to carry out that particular of said certain manufacturing operational steps without said training time delay interruption and without otherwise disturbing said manufacturing operational steps.

31. Manufacturing equipment as defined in claim 29 in which adjustment means is operably connected to said instruction signal-transmitting means of said automatic controller selectively operable between various settings for permanently increasing and decreasing the time lengths of said time delay steps as long as maintained at a given setting while still maintaining said time delay steps in proper sequence between said certain operational steps and without otherwise effecting said certain operational steps.

32. Manufacturing equipment as defined in claim 29 in which said article to be manufactured is an article to be sewn and said one manufacturing component is a sewing head having a movable needle thereon capable of sewing stitches in said article to be sewn by a plurality of repeated identical movements thereof; in which said one manufacturing component operational steps are sewing steps during which said sewing head needle sews a plurality of stitches in said article to be sewn; and in which said time delay step between said one manufacturing component operational steps provided by said instruction signal-transmitting means is of said sufficient predetermined time normally permitting said operator to manually reposition said article to be sewn between said sewing steps by said sewing head needle.

33. Manufacturing equipment as defined in claim 29 in which said article to be manufactured is an article to be sewn and said one manufacturing components is a sewing head having a movable needle thereon capable of sewing stitches in said article to be sewn by a plurality of identical movements thereof; in which said one manufacturing component operational steps are sewing steps during which said sewing head needle sews a plurality of stitches in said article to be sewn; in which said time delay step between said one manufacturing component operational steps provided by said instruction signal transmitting means is of said sufficient predetermined time normally permitting said operator to manually reposition said article to be sewn between said sewing steps by said sewing head needle; and in which needle stitch counter means is operably associated with said sewing head needle and is operably connected to said instruction signal-transmitting means of said automatic controller for automatically detecting said needle identical movements of said sewing head needle during said stitching steps and permit said instruction signal-transmitting means to count and maintain a needle stitch count through said needle stitch counter means during each of said stitching steps.

34. Manufacturing equipment as defined in claim 29 in which said article to be manufactured is an article to be sewn and said one manufacturing component is a sewing head having a movable needle thereon capable of sewing stitches in said article to be sewn by a plurality of repeated identical movements thereof; in which said one manufacturing component operational steps are sewing steps during which said sewing head needle sews a plurality of stitches in said article to be sewn; in which said time delay step between said one manufacturing component operational steps provided by said instruction signal-transmitting means is of said sufficient predetermined time normally permitting said operator to manually reposition said article to be sewn between said sewing steps by said sewing head needle; and in which adjustment means is operably connected to said instruction signal-transmitting means of said automatic controller selectively operable between various settings for permanently increasing and decreasing the time lengths of said time delay steps as long as maintained at a given setting while still maintaining said time delay steps in proper sequence between said certain operational steps and without otherwise effecting said certain operational steps.

35. Manufacturing equipment as defined in claim 29 in which said article to be manufactured is an article to be sewn and said one manufacturing component is a sewing head having a reciprocally movable needle thereon capable of sewing stitches in said article to be sewn by a plurality of up and down movements spaced above said article and passing downwardly through said article; in which said one manufacturing component operational steps are sewing steps during which said sewing head needle sews a plurality of stitches in said article to be sewn; in which said time delay step between said one manufacturing component operational steps provided by said instruction signal-transmitting means is of said sufficient predetermined time normally permitting said operator to manually reposition said article to be sewn between said sewing steps by said sewing head needle; and in which needle

stitch counter and positioner means is operably associated with said sewing head needle and is operably associated with said sewing head needle and is operably connected to said instruction signal-transmitting means of said automatic controller for automatically detecting said needle identical movements of said sewing head needle during said stitching steps and permit said instruction signal-transmitting means to count and maintain a needle stitch count through said needle stitch counter and positioner means during each of said stitching steps, said instruction signal-transmitting means automatically stopping said needle movements of said sewing head needle with said needle in said down position extending downwardly through said article to be sewn between said stitching steps permitting said operator to manually reposition said article to be sewn with said needle extending downwardly through said article to maintain said article positioned relative to said needle between said stitching steps.

36. Manufacturing equipment as defined in claim 29 in which said article to be manufactured is an article to be sewn and said one manufacturing component is a sewing head having a reciprocally movable needle thereon capable of sewing stitches in said article to be sewn by a plurality of up and down movements spaced above said article to be sewn and passing downwardly through said article; in which said one manufacturing component operational steps are sewing steps during which said sewing head needle sews a plurality of stitches in said article to be sewn; in which said time delay step between said one manufacturing component operational steps provided by said instruction signal-transmitting means is of said sufficient predetermined time normally permitting said operator to manually reposition said article to be sewn between said sewing steps by said sewing head needle; in which needle stitch counter and positioner means is operably associated with said sewing head needle and is operably connected to said instruction signal-transmitting means of said automatic controller for automatically detecting said needle identical movements of said sewing head needle during said stitching steps and permit said instruction signal-transmitting means to count and maintain a needle stitch count through said needle stitch counter and positioner means during each of said stitching steps, said instruction signal-transmitting means automatically stopping said needle movements of said sewing head needle with said needle in said down position extending downwardly through said article to be sewn between said stitching steps permitting said operator to manually reposition said article to be sewn with said needle extending downwardly through said article to maintain said article positioned relative to said needle between said stitching steps; in which said manufacturing components of said manufacturing device includes a thread cutoff having means thereon properly operable when said sewing head needle is in an up position spaced above said article to be sewn and clear of a path of movement of said thread cutoff means; and in which said instruction signal-transmitting means automatically detects through said needle stitch counter and positioner means and stops said needle movements of said sewing head needle with said needle in said up position at termination of a last of said stitching steps and sequentially automatically operates said thread cutoff for performing said thread cutoff operation of said thread involved in said stitching steps during said needle up positioning.

37. Manufacturing equipment as defined in claim 29 in which said article to be manufactured is an article to be sewn and said one manufacturing component is a sewing head having a movable needle thereon capable of sewing stitches in said article to be sewn by a plurality of identical movements thereof; in which said one manufacturing component operational steps are sewing steps during which said sewing head needle sews a plurality of stitches in said article to be sewn; in which said time delay step between said one manufacturing component operational steps provided by said instruction signal-transmitting means is of said sufficient predetermined time normally permitting said operator to manually reposition said article to be sewn between said sewing steps by said sewing head needle; and in which training time delay means is operably connected to said instruction signal-transmitting means of said automatic controller actionable for inserting training time delays intermediate selected of said sewing steps during which said selected sewing steps are interrupted, said interrupted selected sewing steps being automatically continued by said instruction signal transmitting means at termination of said training time delays, said training time delay means including means actionable alternately in a nonbypass position for maintaining said training time delays intermediate said selected sewing steps and in a bypass position for selectively permanently removing throughout said means bypass positioning said training time delays from intermediate said selected sewing steps after which said instruction signal-transmitting means automatically operates said sewing head to carry out that particular of said selected sewing steps without training time delay interruption and without otherwise disturbing said manufacturing operational steps.

38. Manufacturing equipment as defined in claim 29 in which said article to be manufactured is an article to be sewn and said one manufacturing component is a sewing head having a reciprocally movable needle thereon capable of sewing stitches in said article to be sewn by a plurality of up and down movements spaced above said article and passing downwardly through said article; in which said one manufacturing component operational steps are sewing steps during which said sewing head needle sews a plurality of stitches in said article to be sewn; in which said time delay step between said one manufacturing component operational steps provided by said instruction signal-transmitting means is of said sufficient predetermined time normally permitting said operator to manually reposition said article to be sewn between said sewing steps by said sewing head needle; in which needle stitch counter and positioner means is operably associated with said sewing head needle and is operably connected to said instruction signal-transmitting means of said automatic controller for automatically detecting said identical movements of said sewing head needle during said stitching steps and permit said instruction signal-transmitting means to count and maintain a needle stitch count through said needle stitch counter and positioner means during each of said stitching steps, said instruction signal-transmitting means automatically stopping said needle movements of said sewing head needle with said needle in said down position extending downwardly through said article to be sewn between said stitching steps permitting said operator to manually reposition said article to be sewn with said needle extending downwardly through said article to maintain said article positioned relative to said needle between said stitching steps; and in which training time delay means is operably connected to said instruction signal-transmitting means of said automatic controller actionable for inserting training time delays intermediate selected of said sewing steps during which said selected sewing steps are interrupted, said interrupted selected sewing steps being automatically continued by said instruction signal-transmitting means at termination of said training time delays, said training time delay means including means actionable alternately in a nonbypass position for maintaining said training time delays intermediate said selected sewing steps and in a bypass position for selectively permanently removing throughout said means bypass positioning said training time delays from intermediate said selected sewing steps after which said instruction signal-transmitting means automatically operates said sewing head to carry out that particular of said selected sewing steps without training time delay interruption and without otherwise disturbing said manufacturing operational steps.

39. In manufacturing equipment for carrying out a series of manufacturing operations on an article to be manufactured, a combination of: a manufacturing device including manufacturing components having means selectively operable for performing a series of manufacturing operational steps on an article to be manufactured, each of said operational steps being comprised of the combination of function and duration, said

function being determined by the particular manufacturing operation being performed by said component upon said article, said duration being determined by one of the time measured in a given number of preset time elements to perform the particular of said manufacturing operation and an exact count of the exact number of movements of said component to perform said particular of said manufacturing operation, at least one of said manufacturing components having means for performing its manufacturing steps by performing a plurality of consecutively repeated substantially identical movements during every operation thereof directly performing an equal number of consecutively repeated substantially identical operations on said article, the duration of every operation of said one component being determined by said exact count of said plurality of said consecutively repeated substantially identical movements; drive motor means operably connected to at least said one of said manufacturing components for operating said one component to perform each of said one component-manufacturing operational steps, there being a plurality of said one component-manufacturing operational steps in said series of manufacturing operational steps for each of said articles to be manufactured, each of said one component-manufacturing operational steps requiring a predetermined plural number of said one component repeated identical movements; speed adjustment means operably connected to said drive motor means selectively adjustable for selectively increasing and decreasing operational speed of said drive motor, said operational speed increases automatically decreasing said duration and said operational speed decreases automatically increasing said duration of all of said one component-manufacturing operational steps by changing the speed of said one component movements to change the time required for said one component to complete its exact count of said repeated identical movements in each of said one component-manufacturing operational steps but without affecting manufacturing operational steps not involving said drive motor means; and an automatic controller including instruction signal-transmitting means operably connected to said manufacturing components for automatically operating said components in a predetermined sequence to perform said series of said manufacturing operational steps, automatic counter means operably associated with said instruction signal-transmitting means for automatically counting said number of movements of said one manufacturing component during said one component manufacturing operational steps and causing termination of said one component operational steps through said instruction signal transmitting means after said predetermined number of said one component exact movements have been counted for each of said one component operational steps regardless of said adjusted speed of said drive motor.

40. Manufacturing equipment as defined in claim 39 in which said instruction signal-transmitting means of said automatic controller is constructed and arranged for automatically causing determined time delays made up of a determined number of preset time elements according to a predetermined plan between certain of said manufacturing operational steps of said manufacturing components, said determined time delays automatically commencing upon termination of a preceding manufacturing operational step and a succeeding manufacturing operational step commencing at the end of that particular determined time delay, said instruction signal transmitting means including time delay adjustment means operably connected thereto for selectively adjusting the preset time element length and thereby change the time length of each of said determined time delays permanently to a new time length as long as a particular new adjustment is maintained and without otherwise affecting the planned order of sequence of said series of manufacturing operational steps.

41. Manufacturing equipment as defined in claim 39 in which said article to be manufactured is an article to be sewn and said one manufacturing component is a sewing head having a movable needle sewing through repeated needle movements a plurality of stitches in said article to be sewn during said one component manufacturing operational steps; in which said automatic counter means of said automatic controller is constructed and arranged for automatically exactly counting said number of stitches sewn by said sewing head needle during said one component manufacturing operational steps; and in which said speed adjustment means operably connected to said drive motor means automatically changes operational speed of said sewing head needle repeated movements through changing operational speed of said drive motor means upon selective adjustment of said speed adjustment means.

42. Manufacturing equipment as defined in claim 39 in which said article to be manufactured is an article to be sewn and said one manufacturing component is a sewing head having a movable needle sewing through repeated needle movements a plurality of stitches in said article to be sewn during said one component manufacturing operational steps; in which said automatic counter means of said automatic controller is constructed and arranged for automatically exactly counting said number of stitches sewn by said sewing head needle during said one component-manufacturing operational steps; in which said speed adjustment means operably connected to said drive motor means automatically changes operational speed of said sewing head needle repeated movements through changing operational speed of said drive motor means upon selective adjustment of said speed adjustment means; and in which said instruction signal transmitting means of said automatic controller is constructed and arranged for automatically causing determined time delays made up of a determined number of preset time elements according to a predetermined plan between certain of said manufacturing operational steps of said manufacturing components, said determined time delays automatically commencing upon termination of a preceding manufacturing operational step and a succeeding manufacturing operational step commencing at the end of that particular determined time delay, said instruction signal-transmitting means including time delay adjustment means operably connected thereto for selectively adjusting the preset time element length and thereby change the time length of each of said determined time delays permanently to a new time length as long as a particular new adjustment is maintained and without otherwise affecting the planned order of sequence of said series of manufacturing operational steps.