ABSTRACT

An embroidery sticher including an embroidery frame that holds a workpiece cloth and that is provided with a sewable area for sewing the held workpiece cloth; a transparent display device that has a display area that provides visibility behind thereof and that is capable of displaying embroidery pattern information of at least an embroidery pattern to be sewn; and an attachment mechanism that allows detachable attachment of the display device at a position that renders the display area and the sewable area to at least partially overlap.
FIG. 5
FIG. 13
CONTROL PROGRAM

PREINSTALLED EMBROIDERY PATTERN DATA

ID
SHAPE DATA
NEEDLE TRANSFER DATA

FRAME TYPE BASED FRAME DATA

ID
FRAME (SEW AREA) SIZE
AMOUNT OF OFFSET OF ORIGIN IN SEW AREA

GUI DATA ETC.

FIG. 14
FIG. 15
AREA FOR ALLOCATING STACK AND STORING PARAMETERS FOR EXECUTION OF CONTROL PROGRAM

AREA FOR STORING PATTERN INFORMATION LIST

<table>
<thead>
<tr>
<th>ID</th>
<th>PATTERN INFORMATION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>ID</td>
<td>PATTERN INFORMATION</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**FIG. 16**
POWER ON S101

INITIALIZE EACH DEVICE PARAMETER AND PATTERN INFORMATION LIST

SET MAIN MENU MODE AND MAKE DISPLAY UPDATE REQUEST S102

FRAME DATA ACQUISITION PROCESS S103

DISPLAY PROCESS S104

MAIN MENU MODE? YES S106

NO MAIN MENU PROCESS

PATTERN SELECTION MODE? YES S108

NO PATTERN SELECTION PROCESS

PATTERN RELOCATION MODE? YES S110

NO PATTERN RELOCATION PROCESS

COMMUNICATION MODE? YES S112

NO COMMUNICATION PROCESS

FIG. 18
FRAME DATA ACQUISITION PROCESS

S201
CHANGE IN FRAME ATTACHMENT STATUS?

S202
FRAME ATTACHED?

S203
YES
READ FRAME TYPE (FRAME ID) BY SENSOR

S204
ACQUIRE FRAME DATA FROM FRAME ID AND SET TO PATTERN INFORMATION

S205
MAKE DISPLAY UPDATE REQUEST FOR DISPLAYING SEWABLE AREA

S206
CLEAR FRAME DATA IN PATTERN INFORMATION

RETURN

FIG. 19
DISPLAY PROCESS

S301 DISPLAY MOUSE POINTER

S302 DISPLAY UPDATE REQUESTED?
    NO

S303 YES

S304 RETURN

S305 FRAME ATTACHED?
    YES

S306 CLEAR SEW AREA BOUNDARY

S307 MAIN MENU MODE?
    YES

S308 DISPLAY MODE BUTTON ETC.

S309 MODE BUTTON ETC. DISPLAYED?
    YES

S310 PATTERN SELECTION MODE?
    YES

S311 DISPLAY PATTERN SELECTION LIST, PATTERN SELECTION STATE, AND OK BUTTON ETC.

S312 PATTERN SELECTION LIST ETC. DISPLAYED?
    YES

S313 CLEAR PATTERN SELECTION LIST, PATTERN SELECTION STATE, AND OK BUTTON ETC.

FIG. 20A
DISPLAY MOUSE POINTER

S401
CHANGE IN POSITION POINTED BY MOUSE POINTER? NO

S402
YES
UPDATE DISPLAY OF MOUSE POINTER

S403
PATTERN RELOCATION MODE? NO

S404
YES
POINTER PLACED OVER MENU HOT POINT? NO

S405
YES
MAKE DISPLAY UPDATE REQUEST

RETURN

RETURN

FIG. 26
FROM S506

S521 WRITE BUTTON DEPRESSED?
  YES

S522 WRITE EMBROIDERY INFORMATION INTO CARD

S523 DISPLAY MESSAGE "WRITING"

S524 WRITE COMPLETED?
  NO

S525 CLEAR "WRITING" MESSAGE

RETURN

FIG. 28
3

S621 PREVIOUS PAGE SIDE OF PAGE NAVIGATION BUTTON DEPRESSED?

YES

S622 DECREMENT PAGE NUMBER OF PATTERN SELECTION LIST BY "-1"

NO

S623 PAGE NUMBER OF PATTERN SELECTION LIST REDUCED TO "0"?

YES

S624 UPDATE PAGE NUMBER OF PATTERN SELECTION LIST TO LAST PAGE

NO

S626 IS PATTERN IN SELECTED STATE?

YES

S627 UNSELECT SELECTED PATTERN

NO

S628 MAKE DISPLAY UPDATE REQUEST

RETURN

FIG. 30
PATTERN RELOCATION PROCESS

S701
IS MOUSE CLICKED?

S702
PATTERN DEPRESSED?

S703
DEPRESSED PATTERN IN SELECTED STATE?

S704
YES
UNSELECT PATTERN IN SELECTED STATE

S705
PLACE NEWLY SELECTED PATTERN IN SELECTED STATE

S706
MAKE DISPLAY UPDATE REQUEST

RETURN

FIG. 31A
COMMUNICATION PROCESS
S801 MOUSE CLICKED? NO
YES
S802 RETURN BUTTON DEPRESSED? NO
RETURN
S803 SET TO MAIN MENU MODE
S804 MAKE DISPLAY UPDATE REQUEST
S805 SEND BUTTON DEPRESSED? NO
YES RETURN
S806 PREPARE FOR USB CONNECTION
S807 COMMUNICATION ESTABLISHED? NO
YES
S808 SEND EMBROIDERY INFORMATION TO DESTINATION
S809 DISPLAY MESSAGE "SENDING"
S810 TRANSMISSION COMPLETED? NO
YES
S811 CLEAR MESSAGE "SENDING"
RETURN

FIG. 34
EMBROIDERY STITCHER AND SEWING MACHINE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is based upon and claims the benefit of priority from the prior Japanese Patent Applications 2009-033930, 2009-033931, and 2009-033932, filed on Feb. 17, 2009, the entire contents of which are incorporated herein by reference.

FIELD

[0002] The present disclosure relates to an embroidery stitcher and a sewing machine.

BACKGROUND

[0003] Conventional sewing machines have been provided with embroidery frame transfer devices that transfer embroidery frames, in two predetermined directions. In such sewing machines, the embroidery frame transfer device is controlled based on various embroidery data such as embroidery pattern data to form embroidery stitches on a workpiece cloth held by the embroidery frame. In doing so, the position in which the embroidery pattern is sewn on the workpiece cloth held by the embroidery frame relies on the start point of embroidery stitching. Thus, if the start point is not properly specified, the sewing machine may fail to form embroidery stitches within the embroider area or in the desired position.

[0004] To address such concerns, a template for use in a sewing machine has been suggested that comes in the form of an electronic paper that displays the embroidery pattern to be sewn. The electronic paper is configured to retain the information displayed on the display area without power supply. Thus, template configured by the electronic paper displays one or more patterns selected from multiple embroidery patterns preset in the template. The user is allowed to visually recognize the position and the shape of the to-be-formed embroidery pattern by superimposing the workpiece cloth with the embroidery pattern displayed in the template. The electronic paper template is thus, easy to use because multiple types of embroidery patterns can be selected from a single template.

[0005] The disadvantage of the above described template is that it does not consider the positioning of the template relative to the embroidery frame. Thus, the user is required to verify the positioning of the workpiece cloth mounted on the embroidery frame with the embroidery frame displayed in the template so that the embroidery pattern is sewn in the desired position of the workpiece cloth.

SUMMARY

[0006] An object of the present disclosure is to provide an embroidery stitcher and a sewing machine capable of locating the embroidery pattern with the workpiece cloth with ease and reliability.

[0007] In one aspect of the present disclosure, the embroidery pattern stitcher includes an embroidery frame that holds a workpiece cloth and that is provided with a sewable area for sewing the held workpiece cloth; a display device that has a transparent display area that provides visibility behind thereof and that is capable of displaying embroidery pattern information of at least an embroidery pattern to be sewn; and an attachment mechanism that allows detachable attachment of the display device at a position that renders the display area and the sewable area to at least partially overlap.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Other objects, features and advantages of the present disclosure will become clear upon reviewing the following description of the illustrative aspects with reference to the accompanying drawings, in which.

[0009] FIG. 1 is a perspective view of an embroidery stitcher and a sewing machine according to a first exemplary embodiment of the present disclosure;

[0010] FIG. 2 is a schematic plan view of an embroidery frame;

[0011] FIG. 3 is a schematic plan view of an embroidery frame;

[0012] FIG. 4 is a schematic plan view of a display device with the embroidery frame attached;

[0013] FIG. 5 is a schematic front view of the display device with the embroidery frame attached;

[0014] FIG. 6 is a cross sectional view taken along line VI-VI of FIG. 2;

[0015] FIG. 7 is a cross sectional view taken along line VII-VII of FIG. 10;

[0016] FIG. 8 is a partial cross sectional view schematically depicting the process of attaching the embroidery frame to a holder unit;

[0017] FIG. 9 is a partial cross sectional view schematically depicting the process of attaching the embroidery frame to a retainer unit;

[0018] FIG. 10 is a partial cross sectional view schematically depicting the process of attaching the embroidery frame to a retainer unit;

[0019] FIG. 11 is a schematic plan view of a display and retainer unit;

[0020] FIG. 12 is a perspective view schematically depicting the configuration of display and embroidery frame;

[0021] FIG. 13 is a block diagram of an electrical configuration of the embroidery stitcher and the sewing machine according to the first exemplary embodiment; and

[0022] FIG. 14 is a schematic view of a memory map of Read Only Memory;

[0023] FIG. 15 is a perspective view schematically depicting the configuration of the display device being attached with the embroidery frame;

[0024] FIG. 16 is a schematic memory map of Random Access Memory;

[0025] FIG. 17 schematically indicates the data configuration of pattern information;

[0026] FIG. 18 is a flowchart indicating the process flow of the main routine executed at the display device according to the first exemplary embodiment;

[0027] FIG. 19 is a flowchart indicating the process flow of a frame data acquisition process of the display device according to the first exemplary embodiment;

[0028] FIGS. 20A and 20B are flowcharts indicating the process flow of a display process executed at the display device according to the first exemplary embodiment;

[0029] FIG. 21 is a schematic view of the display presenting the main menu;

[0030] FIG. 22 is a schematic view of the display presenting a pattern selection list and a pattern selection menu;

[0031] FIG. 23 is a schematic view of the display presenting a pattern relocation menu;

[0032] FIG. 24A schematically indicates a pattern image;
FIG. 24B schematically indicates a selection frame surrounding the pattern image;

FIG. 24C schematically indicates a selection frame with a resize handle surrounding the image pattern;

FIG. 24D schematically indicates a selection frame with a rotate handle surrounding the image pattern;

FIG. 25 schematically depicts the display presenting a communication menu;

FIG. 26 is a flowchart indicating the process flow of a mouse pointer display process according to a first exemplary embodiment;

FIG. 27 is a flowchart indicating the process flow of a main menu process according to the first exemplary embodiment;

FIG. 28 is a flowchart indicating the process flow of a modified main menu process according to the first exemplary embodiment;

FIGS. 29A and 29B are flowcharts indicating the process flow of a pattern selection process according to the first exemplary embodiment;

FIG. 30 is a flowchart indicating the process flow of the pattern selection process according to the first exemplary embodiment;

FIGS. 31A and 31B are flowcharts indicating the process flow of a pattern relocation process according to the first exemplary embodiment;

FIG. 32 is a flowchart indicating the process flow of the pattern relocation process according to the first exemplary embodiment;

FIG. 33 is a flowchart indicating the process flow of the pattern relocation process according to the first exemplary embodiment;

FIG. 34 is a flowchart indicating the process flow of a communication process according to the first exemplary embodiment;

FIGS. 35A and 35B are flowcharts indicating the process flow of the processes executed by an embroidery stitcher and a sewing machine second exemplary embodiment;

FIG. 36 is a plan view of the embroidery frame and the display device according to a third exemplary embodiment in detached state;

FIG. 37 is a cross sectional view of the embroidery frame and the display device according to the third exemplary embodiment in attached state;

FIG. 38 is a plan view of the embroidery frame and the display device according to a fourth exemplary embodiment in detached state;

FIG. 39 is a front view of the embroidery frame and the display device according to the fourth exemplary embodiment in detached state; and

FIG. 40 is a plan view of the embroidery frame and the display device according to a fourth exemplary embodiment in attached state.

DETAILED DESCRIPTION

FIG. 1 shows an embroidery stitcher and a sewing machine employing the same according to a first exemplary embodiment of the present disclosure. As indicated by the arrows given in FIG. 1, the following description will be based upon an assumption that the direction in which the user positions him/herself relative to the sewing machine is the front.

Referring to FIG. 1, provided integrally with sewing machine 10 are bed 11, pillar 12, arm 13, and head 14. Bed 11 constitutes the lower end of sewing machine 10 and pillar 12 extends upward from the right end of bed 11. From the upper end of pillar 12, arm 13 extends leftward substantially parallel to bed 11 and the left end extreme of arm 13 defines head 14. Inside head arm 13, a sewing machine main shaft not shown extends in the left and right direction which is driven in rotation by a sewing machine motor not shown also provided inside arm 13.

Head 14 is provided with a needle bar having sewing needle 15 attached to its lower end. In the proximity of sewing needle 15, a presser foot 16 is provided for pressing down the workpiece cloth when it is being stitched. Arm 13 further contains a needle bar drive mechanism not shown that drives the needle bar up and down in response to the rotation of the sewing machine main shaft, a needle bar swing mechanism not shown that swings the needle bar to the left and right, in other words, the lateral direction orthogonal to the direction of cloth feed, and a thread take-up drive mechanism that drives a thread take-up not shown and down in synchronism with the up and down movement of the needle bar.

On the upper surface of bed 11, needle plate 17 is provided so as to oppose arm 13. Within sewing machine bed 11 below needle plate 17 are components such as a cloth feed mechanism not shown that drives a feed dog up and down and also back and forth, a horizontal shuttle mechanism not shown containing a bobbin thread bobbin not shown and that forms stitches in cooperation with sewing needle 15, and a thread cutter mechanism not shown that cuts needle thread and bobbin thread.

On the front face of arm 13, various operation switches 18 are provided, whereas on the front face of pillar 12, a sizable and vertically elongate liquid crystal display 19 capable of displaying in full color is provided, which is hereinafter simply referred to as LCD 19. LCD 19 displays various information such selection of patterns including embroidery patterns and utility stitches, names of various functionalities to be executed in a sewing operation, and various other information related to the sewing operation. On the front face of LCD 19, a touch panel is provided that has multiple touch keys comprising transparent electrodes. Selection of embroidery patterns to be sewn, instructions for executing the desired function and setting various parameters such as feed amount and needle swing amount can be made through operation of the touch keys.

Bed 11 allows detachable attachment of embroidery frame transfer device 21 at its left end. Embroidery frame transfer device 21 transfers embroidery frame 20 over bed 11 in two predetermined directions. Embroidery frame transfer device 21 comprises carriage 22, an X-direction transfer mechanism and Y-direction transfer mechanisms that are neither shown. Carriage 22 supports embroidery frame 20 which is detachably attached to it. The X- and Y-direction transfer mechanism are each provided with a dedicated step motor, for instance, an X-direction step motor and a Y-direction step motor not shown to drive carriage 22 supporting embroidery
frame 20 in the X and Y directions respectively. Sewing machine 10 operates under different sewing modes such as, for instance, a normal sewing mode and an embroidery mode. When embroidery frame transfer device 21 is attached to bed 11, the sewing mode is switched from the normal sewing mode to the embroidery sewing mode. The X-direction step motor and Y-direction step motor are driven independently to transfer embroidery frame 20 attached to carriage 22 in the X direction representing the left and right direction and the Y direction representing the front and rear direction based on the selected embroidery pattern.

Next, a description will be given on the configuration of embroidery frame 20 with reference to FIGS. 2 to 7.

Embroidery frame 20 allows detachable attachment of a display device 23 on its upper surface. Display device 23 is mechanically connected to embroidery frame 20 by way of attachment mechanism 24. Embroidery frame 20 is provided with engagement subject 32. As shown in FIGS. 2 and 3, embroidery frame 20 comes in various sizes and shapes. Embroidery frames shown in FIGS. 2 and 3 are identified with identical reference symbols where applicable.

Embroidery frame 20 being primarily configured by inner frame 34 and inner frame 34 is a generally rectangular frame and holds workpiece cloth 35 as can be seen in FIG. 4. As shown in FIG. 2, engagement subject 32 is mechanically connected to outer frame 33 of embroidery frame 20 by way of joint 36. Referring to FIG. 5, the upper end of joint 36 receives display device 23 so that it rests horizontally on it in parallel with embroidery frame 20. Embroidery frame 20 is provided with a fastening element 37 that is operated for mounting and dismounting of workpiece cloth 35 to and from embroidery frame 20. Fastening element 37 is also operated to make adjustments in the hold of workpiece cloth 35. The number of fastening element 37 may be varied depending upon the size of embroidery frame 20. For instance, if embroidery frame 20 is relatively large as shown in FIG. 2, fastening element 37 may be provided on the two lateral ends of embroidery frame 20. If embroidery frame 20 is relatively small as shown in FIG. 3, fastening element 37 may be provided on either of the two lateral ends. Engagement subject 32, as shown in FIGS. 2 and 3, is located on the left end side of embroidery frame 20 and is provided with detection subject 38 which is configured by one or more of convexconcave(s). A unique pattern of convexconcaves is assigned to each embroidery frame 20 differing in size and/or shape.

To elaborate, as shown in FIGS. 6 and 7, engagement subject 32 is provided with lower step 321, mid step 322, and upper step 323. Upper step 323 as shown in FIGS. 8, 9, and 10 is provided with guide surface 324 on its front and rear ends that are downwardly sloped toward the edges. Detection subject 38, being provided integrally with embroidery frame 20, projects towards the side surface of mid step 322. Engagement subject 32 is further provided with a guide bump 326 extending in the front and rear direction and projecting downward.

Display device 23 is provided with display 41 and display frame 42. Display 41 is capable of displaying information pertaining to embroidery sewing including information on at least embroidery pattern 43. The display 41 is made of transparent or semi-transparent see through material that provides visibility beyond it, meaning that it provides visibility of embroidery frame 20 placed below it. Display frame 42 holds display 41 at its inner peripheral side. Display device 23 is further provided with a holder unit 44 provided at display frame 42. Display frame 42 holding display 41 has its left end detachably attached to holder unit 44. Attachment or the mechanical connection between display frame 42 and holder unit 44 establishes electrical connection between them. Holder unit 44 is provided with an engagement portion 45 that has opening 46 opening up toward engagement subject 32 of embroidery frame 20. Display device 23 attached to embroidery frame 20 is attached to carriage 22 of embroidery frame transfer device 21 by way of holder unit 44.

Next, a brief description will be given on display 41. Display 41 is provided with a so-called electronic paper. The electronic paper, for instance, is configured as a highly flexible thin sheet driven by a known microcapsule electrophoresis method. The electronic paper comprises a display layer and a transparent driver layer. Display layer comprises a matrix of multiplicity of microcapsules arranged in rows and columns in a density of 400 dpi (dots per inch) that are capable of displaying in monochrome. The transparent driver layer is provided on the underside of the display layer and comprises transparent electrodes that electrically control the microcapsules. The display layer and the transparent driver layer are provided between two plastic sheets. Each microcapsule has a black fluid liquid and white positively charged microparticles such as titanium oxide particles sealed into it. The transparent driver layer is provided with scan lines, data lines, active elements, and microelectrodes. Scan lines comprise a multiplicity of fine wires arranged in the X direction corresponding to the row direction of the microcapsules. Similarly, data lines comprise a multiplicity of fine wires arranged in the Y direction corresponding to the column direction of the microcapsules. Active elements are provided at the intersections of the scan lines and the data lines. A dedicated microelectrode is provided for each microcapsule.

Each active element in the drive layer transmits an “H” level signal to each of the scan lines at a small time interval and “H” or “L” level signal to each of the data lines at a small time interval in synchronism with the signal transmitted to the scan lines. Thus, each active element is selectively turned on at the intersection of the scan line and the data line. When the active element is turned on, each of the microcapsules, that is, the microelectrodes residing at the intersection is momentarily applied with “H” level voltage and the positive charge particles of the microcapsule rises to the top side of the microcapsule to present a white dot on the display layer. In the active element which is turned off, the corresponding microcapsules, that is, the microelectrode maintains the “L” level to draw the positive charge particles to the bottom side of the microcapsules to present a black dot on the surface layer. Thus, an electronic paper is driven and controlled by the active matrix method which is substantially identical to that of a liquid crystal display. Hence, electronic paper is capable of displaying graphics and characters in 400 dpi resolution, for example, and maintains what was being displayed when power was supplied even after the power is turned off. Further, in the present exemplary embodiment, the electronic paper is configured by two types of capsules that are equally spaced and aligned in matrix in the display layer, the first type being sealed with black insulation liquid and electrically charged particles, and the second type being a transparent capsule in which neither of the foregoing substances are sealed. As a result, the electronic paper is rendered light transmissive and transparent or semi-transparent.
Display device 23 allows detachable attachment of embroidery frame 20 by way of attachment mechanism 24 as shown in FIG. 12. Holder unit 44 of display device 23 is provided with engagement portion 45 as described earlier and engagement portion 45 has opening 46 opening up toward engagement subject 32 of embroidery frame 20. Engagement subject 32 of embroidery frame 20 is inserted into opening 46 provided at engagement portion 45 of holder unit 44 as shown in FIGS. 8 to 10. Attachment mechanism 24 is provided with lock mechanism 51 which effects a lock to maintain the engagement between engagement portion 45 and engagement subject 32 and which is unlocked to allow the detachment of embroidery frame 20. To elaborate, lock mechanism 51 has a lever 52 that is rotated to the upright position as shown in FIGS. 8 and 9 to cancel the engagement between engagement portion 45 and engagement subject 32 to allow the detachment of embroidery frame 20. Contrastingly, by reclining lever 52 as shown in FIG. 10 after inserting engagement portion 45 into engagement subject 32, engagement portion 45 and engagement subject 32 are locked together to prohibit detachment of embroidery frame 20. As described above, engagement portion 45 provided at holder unit 44 of display device 23 and engagement subject of embroidery frame 20 together constitute attachment mechanism 24.

Next, a description will be given on the connection between embroidery frame 20 and display device 23.

Engagement subject 32 of embroidery frame 20 is detachably attached to engagement portion 45 of holder unit 44 provided at display device 23. As shown in FIGS. 7 and 8, engagement portion 45 of holder unit 44 includes a bottom wall 441, a wall 442, and an opening 443 for receiving engagement subject 32. Bottom wall 441 has guide groove 444 for receiving guide bump 326 of engagement subject 32 and provides guidance in the movement of guide bump 326 in the front and rear direction. Bottom wall 441 is provided with stopper 445 on its rear end side which is on the opposite side of the front end from which engagement subject 32 is inserted. Stopper 445 and bottom wall 441 are integrally bent upward. Stopper 445 determines the rearmost position of the engagement subject 32. Engagement subject 32 is disengaged from engagement portion 45 through open end 446 of holder unit 44.

As shown in FIGS. 8 and 9, on engagement portion 45 of holder unit 44 of display device 23, frame type detection switch 53 is provided for detecting the type of embroidery frame 20 attached. More than one frame type detection switch 53 is provided in the front and rear direction so as to be associated with detection subject 38 of embroidery frame 20. Frame type detection switch 53 comprises a micro switch, for instance, that is provided with detection lever 531 capable of contacting detection subject 38 of embroidery frame 20 as shown in FIG. 7. Frame type detection switch 53 establishes or cancels the pressure by establishing contact with the convexes and concaves of detection subject 38 of embroidery frame 20. Thus, frame type detection switch 53 outputs detection signal corresponding to the frame type of embroidery frame 20 attached based on the presence/absence of pressure exerted on each switch.

Engagement portion 45 of holder unit 44 is provided with upper leaf spring 447 provided below upper wall 443. Upper leaf spring 447 comprises a piece of spring having a free end and presses down the upper step 323 of engagement subject 32. Engagement portion 45 of holder unit 44 is further provided with rear side leaf spring 448 provided at the rear side of upper wall 443. Rear side leaf spring 448 presses the rear side of the engagement subject 32 forward to prevent rattling of engagement subject locked by lock mechanism 51.

Display device 23 is further provided with a detector 54 that detects whether or not display 41 is attached as shown in FIG. 11. Detector 54 is provided on upper wall 443 of holder unit 44. Detector 54 is configured to open/close the connection point by, for instance, sensing the approaching or distancing of permanent magnet 55 provided on display frame 42. Detector 54 determines whether or not display 41 is attached based on the opened/closed status of the connection point.

Display frame 42 has engagement pin 421 that protrudes toward holder unit 44, whereas holder unit 44 is provided with hole 451 that receives the insertion of engagement pin 421. The insertion of engagement pin 421 into hole 451 allows display 41 to be located with holder unit 44 as well as establishing the connection between them. Display frame 42 and holder unit 44 are also secured by a screw element not shown.

On sidewall 442 of holder unit 44, screw hole 449 is provided on both of its front and rear portions that correspond to the screw holes not shown provided on carriage 22 as shown in FIG. 1. Thus, by screw fastening screw holes 449 formed on sidewall 442 of holder unit 44 and the screw holes not shown formed on carriage 22 by screws penetrating through the through holes, holder unit 44 is located with carriage 22 as well as being disconnectably connected with carriage 22.

As described above, holder unit 44 is also located with carriage 22.

Display 42 may be configured to establish detachable attachment with holder unit 44 and holder unit 44 may be provided at carriage 22 in advance. Display 41 has display area A1 as shown in FIGS. 1, 4, and 12. Embroidery frame 20, on the other hand, has sewable area A2 that allows embroidery patterns to be formed within the bounds of embroidery frame 20, especially, within the bounds of inner frame 34. Attachment mechanism 24 comprising engagement portion 45 of display device 23 and engagement subject 32 of embroidery frame 20 allows embroidery frame 20 and display device 23 to be connected at the predetermined position. Thus, display device 23 can be attached to embroidery frame 20 at the position in which at least a portion of display area A1 overlaps with sewable area A2 of embroidery frame 20.

Holder unit 44 has mouse 61 and communication cable 62 connected to it as shown in FIGS. 1 and 12. Mouse 61 serves as a pointing device and allows the user make editing operations including relocation of the pattern displayed on display area A1 of display device 23. Communication cable 62 allows data communication to be established between display device 23 and sewing machine 10. Communication cable 62 may be replaced by other wired communication through USB (Universal Serial Bus) or LAN (Local Area Network) connection or wireless communication using Bluetooth or infrared rays. Alternatively, data may be communicated between display device 23 and sewing machine 10 by a non-volatile memory card configured by memory such as EPROM.

Next, a description will be given on the electrical configuration of the above described sewing machine 10 and display device 23. Display device 23 is provided with a controller 70 that is primarily configured by a microcomputer including CPU 71, ROM 72, RAM 73, input interface 74,
output interface 75, communication interface 76, and bus 77 interconnecting the foregoing elements. Input interface establishes connection with components such as mouse 61, frame type detection switch 53, and detector 54. Output interface 75 is connected to display 41 whereas communication interface 76 is connected to sewing machine 10 by way of communication cable 62. Sewing machine 10 is provided with controller 81. Controller 81 establishes connection with operation switches 18, LCD 19, and sewing mechanism 82. Sewing mechanism 82 is provided with mechanisms such as drive motor not shown that executes a sewing operation.

[0078] ROM 72 of controller 70 pre-stores items such as pattern data, frame data, pattern selection program, embroidery pattern relocation program, and electronic paper display control program. The pattern data comprises needle transfer data, pattern shape data that correspond to multiple stitch patterns and multiple embroidery patterns. The frame data includes data indicating locations and sizes of sewable area A2 for each type of embroidery frame. Electronic paper display control program is a program for displaying contents such as stitch pattern images and embroidery pattern images on display 41. RAM 73, as well known, is configured to temporarily save data in an unoccupied work area.

[0079] Controller 70 controls the image presentation of display 41 by supplying drive control signals to the scan lines and data lines of display 41 in accordance with the above described items such as pattern data and display control program. Controller 70 further associates embroidery information pertaining to embroidery patterns 43, etc., with sewable area A2 of embroidery frame 20 when displaying such embroidery information on display area A1 of display 41.

[0080] Next, a description will be given on the operation of the above described display device 23.

[0081] First a brief description will be given on data configuration, in other words, the memory maps of ROM 72 and RAM 73. ROM 72 stores memory map 101 configured by items such as control program 102, pre-stored embroidery pattern data 103, frame data 104 for each frame type, and GUI (Graphical User Interface) data 105. Control program 102, as described earlier, controls display device 23. Pattern data 103 representing the pre-stored embroidery patterns is configured by multiple shape data and needle transfer data that are each associated with an ID. The shape data is image data such as bit map for displaying embroidery pattern 43 on display area A1 of display device 23. Needle transfer data, on the other hand, specifies the movement of sewing needle 15 in sewing, for instance, embroidery pattern 43.

[0082] Frame data 104 specifies multiple entries of data pertaining to the size of embroidery frame 20, in other words, the size of sewable area A2 and offset of the origin of sewable area A2 from the origin of display area A1. The multiple entries of the above described data are associated with a unique ID. To elaborate, as shown in FIG. 15, when embroidery frame 20 is attached to display device 23, the location of display area A1 and sewable area A2 can be represented by plotting origin P1 at the left and rearmost point of display area A1 and plotting origin P2 at the left and rearmost point of sewable area A2, respectively. The distance between origins P1 and P2 can be represented by predetermined distance L which indicates the offset between origins P1 and P2. This offset is predetermined for each type of embroidery frame 20. Thus, frame data 104 stores the offsets with their associated IDs to allow the distinction of frame types.

[0083] GUI data 105 includes data such as icons displayed on display 41 for facilitating user operation. As shown in FIG. 16, memory map 111 of data stored in RAM 73 is configured by area 112 that includes stack area for storing parameters running the control programs and by area 113 that stores pattern information list. Pattern information list stores pattern data 103 selected from those pre-stored in ROM 72 and its ID, which taken together constitute pattern information 120. Pattern information 120 can be broken down to pattern data 121, relocation data 122, and frame data 123 as shown in FIG. 17. Pattern data 121 can be further broken down to pattern shape data 1211 and needle transfer data 1212. Relocation data 122 indicates the location within sewable area A2 where the embroidery pattern is to be sewn and include location information 1221, rotational angle information 1222, inverse information 1223, and resize information 1224. Frame data 123 indicates parameters that are unique to each frame type and includes frame size information, that is, size information 1231 representing the size of sewable area A2, and offset information 1232 representing the offset of origin P2 of sewable area A2 from origin P1 of display area A1.

[0084] Next a description will be given on the main routine executed by display device 23 based on FIG. 18. The following description will focus on the mainstream flow of the process flow and the details will be addressed individually.

[0085] Controller 70 initializes each device, parameters and pattern information list (step S101) when power of sewing machine 10 and display device 23 are turned on, meaning that controller 70 initializes each functional elements of sewing machine 10 and display device 23, their specified values, and pattern information. Controller 70, when completing the initialization at step S101, specifies the main menu mode and requests for display update (S102). Then, controller 70 proceeds to execute frame data acquisition process (S103), and display process (S104). The frame data acquisition process at S103, and display process at S104 will be detailed afterwards.

[0086] Controller 70, when completing the display process at S104, determines whether or not the main menu mode has been specified (S105). Controller 70, when determining that the main menu mode has been specified (S105: Yes), executes the main menu process (S106). The main menu process will be detailed afterwards.

[0087] When controller 70 determines that the main menu process has not been specified (S105: No), proceeds to determine whether or not the pattern selection mode has been specified (S107). Controller 70, when determining that the pattern selection mode has been specified (S107: Yes), executes the pattern selection process (S108) which will be detailed afterwards. Controller 70, when determining that pattern selection process has not been specified (S107: No), determines whether or not the pattern relocation mode has been specified (S109). Controller 70, when determining that pattern relocation mode has been specified (S109: Yes), executes the pattern relocation mode (S110) which will be detailed afterwards. Controller 70, when determining that pattern relocation mode has not been specified (S109: No), proceeds to determine whether or not the communication mode has been specified (S111). Controller 70, when determining that the communication mode has been specified (S111: Yes), executes the communication mode (S112) which will be detailed afterwards. Controller 70, when determining that the communication mode has not been specified (S111: No), returns to S103 and repeats S103 to S112 until sewing machine 10 and display device 23 have been turned off.
Controller 70, when determining that embroidery frame 20 is attached (S202: Yes), acquires the type of embroidery frame 20 (S203). Controller 70 acquires the frame type by reading the type of embroidery frame 20, that is, the frame ID unique to each type of embroidery frame 20 attached to holder unit 44 based on the output of frame detection switch 53 which varies depending on detection subject 38. Based on the acquired frame ID, controller 70 acquires frame data 104 and specifies it as frame data 123 of pattern information 120 (S204). To elaborate, based on the acquired frame ID, controller 70 acquires frame data 104 classified by frame type stored in ROM 72 and writes the acquired information into RAM 73 as frame data 123 to be contained in pattern information 120. Then, controller 70 makes a display update request for displaying sewable area A2 that corresponds to embroidery frame 20 attached to the holder unit 44 to display 41 (S205).

On the other hand, when controller 70 determines that embroidery frame 20 is not attached (S202: NO), frame data 123 contained in pattern information 120 is cleared (S206). Then, controller 70 makes a display update request (S207) to clear sewable area A2 displayed on display 41. After making a request of display update at S205 or S207, controller 70 returns to the main routine.

Next, the display process executed at the above described S104 will be described in detail with reference to FIG. 20.

Controller 70, when proceeding to the display process at S104 of the main routine, executes a later described mouse pointer display process (S301) and at the same time determines whether or not a display update request has been made (S302).

Controller 70, when display update request has been made (S302: Yes), determines whether or not embroidery frame 20 is attached (S303). When display update request has not been made (S302: No), on the other hand, controller 70 returns to the main routine.

Controller 70, when embroidery frame 20 is attached (S303: Yes), displays boundary line B that indicates sewable area A2 (S304). That is, as shown in FIG. 15, controller 70 displays boundary line B indicating the outline of sewable area A2 on display area A1 of display 41. When embroidery frame 20 is not attached (S303: No), on the other hand, controller 70 clears the display of boundary line B indicating sewable area A2 (S305). That is, since sewable area A2 need not be displayed when embroidery frame 20 is not attached, controller 70 clears the display of boundary line B.
placed on its left side and clicked, the previous page is displayed. When mouse pointer 135 is placed on OK button 143 and clicked, the pattern selected from pattern selection list 140 is validated and the process flow proceeds to the pattern relocation mode. When mouse pointer 135 is placed on return button 144 and clicked, the process flow returns to the main menu mode.

[0099] On the rearward right side corner of pattern selection list 140, page number 145 is displayed. Page number 145 is displayed as “...”, for instance, when the currently displayed page of pattern selection list 140 is the first out of seven page. As one may readily understand, pattern selection list 140 is displayed to allow selection of a given embroidery pattern to be sewn from the choice of multiple embroidery patterns. Since the embroidery pattern to be sewn can be chosen without visually sizing up with embroidery frame 20 and workpiece cloth 35, display area 1A may be made non-transparent when displaying pattern selection list 140. Controller 70, after presenting pattern selection list 140, page navigation button 142, OK button 143, and return button 144, returns to the main routine.

[0100] Controller 70, after determining at S310 that the current process flow is not running under the pattern selection mode (S310: No), further determines whether or not items such as pattern selection list 140 and pattern selection menu 141 are displayed on display area A1 of display 41 (S312). If pattern selection list 140, etc. are displayed on display 41 (S312: Yes), controller 70 clears the items such as pattern selection list 140, page navigation button 142, OK button 143, and return button 144 (S313).

[0101] Controller 70, when determining at S312 that items such as pattern selection list 140 are not displayed (S312: No), or has cleared those items at S313, further determines whether or not the current process flow is running under the pattern relocation mode (S314). If controller 70 determines that the current process flow is running under the pattern relocation mode (S314: Yes), mouse pointer 135 determines whether or not mouse pointer 135 resides over menu hot point 150 (S315). Controller 70, after determining that mouse pointer 135 resides over menu hot point 150 (S315: Yes), displays the pattern relocation menu such as edit buttons (S316).

[0102] As shown in FIG. 23, menu hot point 150 is displayed at the rearward right side of display area A1 of display 41. When controller 70 determines that mouse pointer 135 is placed over menu hot point 150, pattern relocation menu 151 comprising pattern selection button 152, resize button 153, rotate button 154, inverse button 155 and delete button 156, and return button 157 are displayed. Hereinafter, pattern selection button 152, resize button 153, rotate button 154, inverse button 155, delete button 156, and return button 157 will be collectively referred to as edit buttons.

[0103] When mouse pointer 135 is placed over the arrow shaped pattern selection button 152 and clicked, pattern selection is initiated in which selection is made from pattern image 158 displayed on display area A1. Pattern image 158 corresponds to embroidery pattern 43 shown in FIG. 1. When mouse pointer 135 is placed over resize button 153 and clicked, the process flow proceeds to the resize mode in which the selected pattern image 158 is increased/reduced in size. When mouse pointer 135 is placed over rotate button 154 and clicked, the process flow proceeds to the rotate mode in which the selected pattern image 158 is rotated. When mouse pointer 135 is placed over inverse button 155 and clicked, the process flow proceeds to the inverse mode in which the selected pattern image 158 is inversely/uninversed. When mouse pointer 135 is placed over delete button 156 and clicked, the process flow proceeds to the delete mode in which the selected pattern image 158 is deleted. When mouse pointer 135 is placed over return button 157 and clicked, the process flow returns to the main menu mode.

[0104] Controller 70, displays pattern relocation menu 151 such as the edit buttons and also displays a handle on pattern image 158 displayed on display area A1 that indicates the state of selection of pattern image 158 (S317). When pattern image 158 displayed on display area A1 is not in a selected state, nothing is displayed around pattern image 158 as exemplified in FIG. 24A. When pattern image 158 is in the selected state, on the other hand, selection frame 161 is displayed around pattern image 158 as shown in FIG. 24B. Selection frame 161 is also an indication of a normal mode when no handles are present. When pattern image 158 is in the selected state and rotate button 154 is clicked, a rotate mode selection frame 165 including rotate handle 164 is displayed as shown in FIG. 24D. As described above, display 41 displays resize handle 162, rotate handle 164, and selection frames 161, 163, and 165 depending on the mode of pattern image 158 displayed on display area A1.

[0105] Controller 70, when determining at S314 that the current process flow is not running under the pattern relocation mode (S314: No), or that mouse pointer 135 is not placed in contact with menu display hot point 150 (S315: No), further determines whether or not pattern relocation menu 151 such as the edit buttons is displayed on display area A1 of display 41 (S318). If pattern relocation menu 151 such as the edit buttons is displayed on display area A1 (S318: Yes), controller 70 clears the display of pattern relocation menu 151 such as edit buttons displayed on display area A1 (S319).

[0106] If controller 70 determines that pattern relocation menu 151 is not displayed (S318: No) when displaying resize handle 162, rotate handle 164, or selection frames 161, 163, or 165 are displayed; or when pattern relocation menu 151 such as the edit buttons is cleared at S319, further proceeds to determine whether or not the current process flow is running under the communication mode (S320). If controller 70 determines that the current process flow is running under the communication mode (S320: Yes), items such as the send button is displayed (S321). In the communication mode, communication menu 170 such as the send button is displayed on the rearward right side of display area A1 of display 41 as shown in FIG. 25. Communication menu 170 includes send button 171 and return button 172. When mouse pointer 135 is placed over send button 171 and clicked, pattern information 120 pertaining to the selected pattern image 158 is transmitted to sewing machine 10. When mouse pointer 135 is placed over return button 172 and clicked, the process flow proceeds to the main menu mode.

[0107] Controller 70, when determining at S320 that the current process flow is not running under the communication mode (S320: No), further determines whether or not communication menu 170 such as send button 171 is displayed on display area A1 of display 41 (S322). When communication menu 170 is displayed on display area A1 of display 41 (S322: Yes), controller 70 clears the display of communication menu 170 of display area A1 of controller 70 (S323).
[0108] Controller 70, after displaying communication menu 170 such as send button 171 at S321, determines at S322 that communication menu 170 such as send button 171 is not displayed (S322: No), or after clearing communication menu 170 such as send button 171 at S323, the content being displayed in drawable area A2 of display 41 is cleared (S324). In other words, controller 70 temporarily deletes the images displayed in display area 41 within drawable area A2. Then, controller 70 determines whether or not pattern information 120 exists (S325). In other words, controller 70 determines whether or not pattern information 120 to be displayed exists in RAM 73. Controller 70, when determining that pattern information 120 exists (S325: Yes), displays pattern image 158 corresponding to embroidery pattern 43 displayed on display area A1 at a predetermined location of drawable area A2 based on the relocation data contained in pattern information 120 (S326). Controller 70, when determining that pattern information 120 does not exist (S325: No), or after displaying pattern image 158, returns the process flow to the main routine.

[0109] Next, a detailed description will be given on mouse pointer display process executed at S301 of display process.

[0110] Controller 70, after proceeding to the mouse pointer display process at S301 of the display process, determines whether or not any change has taken place on the position where mouse pointer 135 is pointing (S401). Controller 70, when determining that, change has taken place (S401: Yes), updates the display of mouse pointer 135 (S402). The movement of mouse pointer 135 can be visually perceived on display area A1.

[0111] Controller 70, after updating the display of mouse pointer 135, determines whether or not current process flow is running under the pattern relocation mode (S403). Controller 70, when determining that current process flow is running under the pattern relocation mode (S403: Yes), further determines whether or not mouse pointer 135 resides over display hot point 150 (S404). Controller 70, when determining that mouse pointer 135 resides over hot point 150 (S404: Yes), makes a display update request (S405) to display pattern relocation menu 151 including edit buttons such as pattern selection button 152 and resize button 153. Thus if pattern relocation menu 151 is currently displayed, it is refreshed by the display update. If pattern relocation menu 151 is not displayed on the other hand, it is displayed in response to the display update. When mouse pointer 135 is placed over menu hot point 150, edit buttons of pattern relocation menu 151 are displayed as a pull down menu. When mouse pointer 135, on the other hand, is removed from menu hot point 150, pattern relocation menu is pulled up and disappears. In other words, pattern relocation menu 151 expands/retracts depending upon the location of mouse pointer 135. Thus, even if multiplicity of buttons are included in pattern relocation menu 151, there is smaller possibility of pattern relocation menu 151 overlapping with drawable area A2 and degrading the visibility of drawable area A2 and pattern image 158.

[0112] Controller 70, when the position indicated by the mouse pointer 135 at step S401 is not changed (S401: No), or when determining at step S403 that the current process flow is not running under the pattern relocation mode (S403: No), the process flow returns to the display process. Further, when controller 70 determines at S404 that mouse pointer 135 is not placed over menu hot point 150 (S404: No), or after making a display update request at S405, returns the process flow to the display process.

[0113] Next, the main menu process executed at S106 of the main routine will be described in detail based on FIG. 27.

[0114] The main menu process is the process carried out when the main menu mode is set at S102 of the main routine and when main menu 130 is displayed in display area A1 as shown in FIG. 21. Controller 70, when proceeding to the main menu process, determines whether or not mouse 61 has been clicked at a given position within display area A1 (S501) as shown in FIG. 21. Controller 70, when determining that mouse 61 has been clicked (S501: Yes), further determines whether or not pattern selection button 132 has been pressed (S502). When controller 70, on the other hand, determines that mouse 61 has not been clicked (S501: No), returns to the main routine.

[0115] Controller 70, when determining that pattern selection button 132 has been pressed (S502: Yes), initializes the pattern selection mode (S503). To elaborate, controller 70 initializes pattern selection list 140, as such indicated in FIG. 22, displayed in display area A1 in the pattern selection mode to the first page and unselects the multiple display patterns contained in pattern selection list 140 to the unselected state if any of the display patterns are in the selected state. Then, controller 70 specifies the pattern selection mode, makes a display update request (S504), and returns to the main routine.

[0116] If controller 70 determines that pattern selection button 132 has not been pressed (S502: No), further proceeds to determine whether or not the count of pattern information 120 within the pattern information list stored in RAM 73 as shown in FIG. 16 is “0” (S505). Controller 70, when determining that the count of pattern information 120 within the pattern information list is “0” (S505: Yes), returns to the main routine.

[0117] Controller 70, when determining that the count of pattern information 120 within the pattern information list is not “0” (S505: No), further determines whether or not the click of mouse 61 determined at S501 was a depression of pattern relocation button 133 (S506). Controller 70, when determining that pattern relocation button 133 has been depressed (S506: Yes), initializes the pattern relocation mode (S507). To elaborate, controller 70 assumes that pattern image 158 to be displayed on display area A1 in the pattern relocation mode is pattern information 120 at the first entry of the pattern information list stored in RAM 73 and places pattern information 120 coming at the first entry of the pattern information list in the selected state. Then, controller 70 specifies the pattern relocation mode, makes a display update request (S508) and returns to the main routine.

[0118] On the other hand, when controller 70 determines that pattern relocation button 133 has not been pressed (S506: No), further proceeds to determine whether or not clicking of mouse 61 determined at S501 was the depression of communication button 134 (S509). Controller 70, when determining that communication button 134 has been pressed (S509: Yes), initializes the communication mode (S510). That is, controller 70 initializes each component of the communication apparatus such as a USB device. In addition to the specification of the communication mode, controller 70 makes a display update request (S511) and returns to the main routine. Further, if controller 70 determines that communication button 134 has not been pressed at S509 (S509: No), terminates the process and returns to the main routine. This means that even if clicking of mouse 61 has been detected at S501, if it is determined not to be a depression of communication button.
at S509, it is an indication that mouse pointer 135 resides at a location where main menu 130 is not displayed. Thus, controller 70 terminates the process and returns to the main routine.

[0119] The communication between display device 23 and sewing machine 10 need not be carried out by way of communication cables such as USB as described above but may utilize a nonvolatile memory card instead. When using a memory card not shown, when determining that pattern relocation button 133 has not been pressed at the above described S506 (S506: No), controller 70 proceeds to S521 of shown in FIG. 28 instead of S509. That is, controller 70 determines whether or not the write button has been depressed by the clicking of mouse 61 determined at S501 (S521). When removable medium such as memory cards are used for communication between display device 23 and sewing machine 10, the write button is displayed instead of communication button 134 on main menu 130 of display area A1. Accordingly, at step S521, controller 70 determines whether or not the write button has been pressed at S521.

[0120] Controller 70, when determining that the write button has been depressed (S521: Yes), writes pattern information 120 stored in RAM 73 into the memory card (S522) and displays a message that reads “writing” on display area A1 of display 41 which is an indication that information is being written in the memory card. Then, controller 70 determines whether or not writing of pattern information 120 into the memory card has been completed (S524) and if not (S524: No), repeats S522 and S523. When controller 70, on the other hand, determines that writing has been completed (S524: Yes), clears the “writing” message displayed on display area A1 and returns to the main routine. Further, when controller 70 determines at S521 that the write button has not been pressed (S521: No), terminates the process and returns to the main routine.

[0121] Next, a description will be given in detail on the pattern selection process executed at S108 of the main routine based on FIGS. 29 and 30.

[0122] The pattern selection process is a process executed when the pattern selection mode is specified at S504 of the main menu process and when pattern selection menu 141 such as pattern selection list 140 etc. are displayed on display area A1 as shown in FIG. 22. Controller 70, when proceeding to the pattern selection process, determines whether or not mouse 61 has been clicked at a given position within display area A1 when pattern selection menu 141 is being displayed at display area A1 (S601). Controller 70, when determining that mouse 61 has been clicked (S601: Yes), further proceeds to determine whether or not any of the displayed patterns on pattern selection list 140 has been depressed (S602). If controller 70, on the other hand, determines that mouse 61 has not been clicked (S601: Yes), returns to the main routine.

[0123] Controller 70, when determining that any one of the pattern images contained in pattern selection list 140 has been depressed (S602: Yes), further determines whether or not the depressed pattern image is already in the selected state (S603). Controller 70, when determining that the depressed pattern image is already in the selected state (S603: Yes), places the pattern image having been placed in the selected state to the unselected state (S604). On the other hand, when controller 70 determines that the selected pattern image has not already been placed in the selected state (S603: No), proceeds to S605 to place the selected pattern into the selected state. Then, controller 70 makes a display update request (S606) and returns to the main routine.

[0124] Controller 70, when determining that none of the patterns displayed have been depressed (S602: No), further determines whether or not OK button 143 shown in FIG. 22 has been depressed (S607). Controller 70, when determining that OK button 143 has been depressed (S607: Yes), determines whether or not any of the pattern images contained in pattern selection list is in the selected state (S608) as earlier described in S603 to S606.

[0125] Controller 70, when determining that any of the pattern images contained in pattern selection list 140 has been selected (S608: Yes), extracts the pattern data corresponding to the selected pattern image from pattern data 103 of the pre-stored embroidery patterns stored in ROM 72 as shown in FIG. 14. Then controller 70 appends the extracted data as pattern information 120 to the pattern information list 20 stored in RAM 73 as shown in FIG. 16 (S609). Then, controller 70 initializes relocation data 122 contained in the pattern information 120 appended to the pattern information list of RAM 73 (S610). Then, controller 70 specifies the pattern selection mode (S611), makes a display update request (S612), and returns to the main routine. Controller 70, when determining that none of the patterns contained in pattern selection list 140 is in the selected state (S608: No), returns to the main routine without executing S609 to S612.

[0126] When controller 70, on the other hand, determines that OK button 143 has not been depressed (S607: No), further determines whether or not return button 144 shown in FIG. 22 has been depressed (S613). When determining that return button 144 has been depressed (S613: Yes), controller 70 determines that a return request is made to the main menu from the pattern selection process and proceeds to specify the main menu mode (S614), make a display update request (S615), and return to the main routine.

[0127] Controller 70, when determining that return button 144 has not been depressed at S613 (S613: No), further proceeds to determine whether or not the next page side of page navigation button 142 has been depressed (S616). Controller 70, when determining that the next page side on the right side of page navigation button 142 has been depressed (S616: Yes), increments the page number displayed on pattern selection list 140 by “1” (S617). Then, controller 70 further proceeds to determine whether or not the incremented page number of pattern selection list 140 has exceeded the total page number of pattern selection list 140 (S618). Controller 70, when determining that the incremented page number has exceeded the total page number of pattern selection list 140 (S618: Yes), sets the page number of pattern selection list 140 to “1”, meaning that the first page is set (S619). Controller 70, after setting the page number to the first page at S619 or determining that the total page number of pattern selection list 140 has not been exceeded (S618: No), makes a display update request (S620), and returns to the main routine. As described above, when the next page side of page navigation button 142 is depressed when the final page of pattern selection list 140 is being displayed, the page number of pattern selection list 140 returns to the first page.

[0128] When controller 70 determines that the next page side of page navigation button 142 has not been depressed (S616: No), further proceeds to determine whether or not previous page side in the left side of the navigation button 142 has been depressed (S621). Controller 70, when determining that previous page side of navigation button 142 has been
depressed (S621: Yes), decrements the page number of pattern selection list 140 by “−1” (S622). Then, controller 70 further proceeds to determine whether or not the decremented page number of pattern selection list 140 has been reduced to “0” (S623). Controller 70, when determining that the page number of pattern selection list 140 has been reduced to “0” (S623: Yes), sets the page number of pattern selection list 140 to the final page (S624). Controller 70, after setting the page number to the final page at S625 or when determining that the page number of pattern selection list 140 has not been reduced to “0” (S623: No), makes a display update request (S625) and returns to the main routine. As described above, when the previous page side of page navigation button 142 is depressed when the first page of pattern selection list 140 is being displayed, the page number of pattern selection list 140 returns to the final page.

[0129] Further, when controller 70 determines at S621 that the previous page side of navigation button 142 has not been depressed (S621: No), proceeds to determine whether or not any of the patterns contained in the pattern selection list 140 is in the selected state (S626). As described above, when it has been determined that the previous page side of page navigation button 142 has not been depressed, it is an indication that mouse 61 has been clicked at a location where pattern selection list 140 or any of the buttons of pattern selection menu 141 does not exist. Controller 70, when determining at step S626 that any of the patterns contained in pattern selection list 140 is in the selected state (S626: Yes), places the selected pattern in the unselected state (S627), makes a display update request (S628), and returns to the main routine. That is, when mouse 61 is clicked at a location where pattern selection list 140 or any of the buttons of pattern selection menu 141 does not exist, the selected state of the patterns contained in pattern selection list 140 is cancelled. When controller 70, on the other hand, determines that the patterns contained in the pattern selection list 140 is not in the selected state (S626), the process flow returns to the main routine without having to execute the processes of S627 and S628.

[0130] Next, a description will be given in detail on pattern relocation process executed at S110 of the main routine based on FIGS. 31 to 33.

[0131] The pattern relocation process is a process executed when the pattern relocation mode is set at S611 of the pattern selection process and when items such as the selected pattern image 158 and pattern relocation menu 151 are displayed on display area A1 as shown in FIG. 23. Controller 70, after proceeding to the pattern relocation process, determines whether or not mouse 61 has been clicked (S701). That is, controller 70 determines whether or not mouse 61 has been clicked at a given position within display area A1 when items such as the selected pattern image 158 and pattern relocation menu 151 are displayed as shown in FIG. 23. Controller 70, when determining that mouse 61 has been clicked (S701: Yes), further proceeds to determine whether or not pattern image 158 has been depressed (S702).

[0132] Controller 70, when determining that pattern image 158 has been depressed (S702: Yes), further proceeds to determine whether or not the depressed pattern image 158 or any other pattern image 158 has already been placed in the selected state (S703). Controller 70, when determining that pattern image 158 has already been placed in the selected state (S703: Yes), places pattern image 158 already placed into the selected state into the unselected state (S704) and places the newly selected pattern image 158 into the selected state (S705). In the example shown in FIG. 23, only pattern image 158 is displayed on display area A1. However, depending on the desired embroidery pattern, more than one display pattern corresponding to more than one embroidery patterns may be displayed on display area A1. In such case, the pattern selected by mouse 61 is placed into the selected state and the remaining other patterns are placed into the unselected state. Once controller 70 places pattern image 158 in a selected state, a display update request is made (S706), and the process flow is returned to the main routine.

[0133] Controller 70, when determining at step S702 that pattern image 158 has not been depressed (S702: No), further proceeds to determine whether or not pattern selection button 152 shown in FIG. 23 has been depressed (S707). Controller 70, when determining that pattern selection button 152 is depressed (S707: Yes), sets selection frame 161 surrounding pattern image 158 to the normal mode (S708) as shown in FIGS. 23 and 24A, makes a display update request (S706), and returns to the main routine.

[0134] Controller 70, when determining at S707 that pattern selection button 152 has not been depressed (S707: No), further proceeds to determine whether or not resize button 153 shown in FIG. 23 has been depressed (S709). Controller 70, when determining that resize button 153 has been depressed (S709: Yes), sets selection frame 163 surrounding pattern image 158 to a resize mode including resize handle 162 (S710), makes a display update request (S706), and returns the process flow to the main routine.

[0135] Controller 70, when determining that resize button 153 has not been depressed at S709 (S709: No), further proceeds to determine whether or not rotate button 154 shown in FIG. 23 has been depressed (S711). Controller 70, when determining that rotate button 154 has been depressed (S711: Yes), sets selection frame 165 surrounding pattern image 158 to a rotate mode including rotate handle 164 (S712), makes a display update request (S706), and returns the process flow to the main routine.

[0136] Controller 70, when determining at S711 that rotate button 154 has not been depressed (S711: No), further proceeds to determine whether or not return button 157 shown in FIG. 23 has been depressed (S713). Controller 70, when determining that return button 157 has been depressed (S713: Yes), determines that a return request has been made from the pattern relocation process to the main menu. Then, controller sets the main menu mode (S714), makes a display update request (S715) and returns the process flow to the main routine.

[0137] When controller 70, on the other hand, determines at S713 that return button 157 has not been pressed (S713: No), further proceeds to determine whether or not pattern image 158 displayed on display area A1 is in a selected state (S716). Controller 70, when determining that pattern image 158 is in the selected state (S716: Yes), further proceeds to determine whether or not inverse button 155 shown in FIG. 23 has been depressed (S717). Controller 70, when determining that inverse button 155 has been depressed (S717: Yes), flags an inverse in relocation data 122 contained in pattern information 120 stored in RAM 73, more specifically, turns inverse flag 1223 “ON” (S718). Thus, pattern image 158 displayed on display area A1 is inversed, meaning that its front side and the back side are turned over. Controller 70, after flagging an inverse in relocation data 122 at S718, makes a display update request (S719), and returns the process flow to the main routine. Further, when controller 70 determines at S716 that
pattern image 158 is not in the selected state (S716: No), returns the process flow to the main routine. That is, if pattern image 158 is not in the selected state at step S716, mouse 61 has not selected pattern image 158 but has been clicked where pattern relocation menu 151 is not displayed. In such case, no change occurs in the display of pattern image 158 or pattern relocation menu 151.

[0138] Controller 70, when determining at step S717 that inverse button 155 has not been depressed (S717: No), further proceeds to determine whether or not delete button 156 shown in FIG. 23 has been depressed (S720). Controller 70, when determining that delete button 156 has been depressed, deletes pattern information 120 corresponding to the selected pattern image 158 (S721) from pattern information 120 contained in the pattern selection list stored in RAM 73. Then, controller 70, after deleting pattern information 120 corresponding to the selected pattern image 158, or when determining at S720 that delete button 156 has not been depressed (S720: No), places pattern image 158 into the unselected state (S722), makes a display update request (S719), and returns to the main routine.

[0139] When controller 70, on the other hand, determines at the above S701 that mouse 61 has not been clicked (S701: No), proceeds to S723 shown in FIG. 33 and determines whether or not pattern image 158 displayed on display area A1 has been dragged (S723). Controller 70, when determining that pattern image 158 has been dragged (S723: Yes), further proceeds to determine whether or not pattern image 158 has been dragged into the boundary of sewable area A2 (S724). Then, when controller 70 determines that pattern image 158 has been dragged into sewable area A2 (S724: Yes), location information 1221 of relocation data 122 for pattern image 158 contained in pattern information 120 is updated to the relocated position (S725), a display update request is made (S726), and the process flow is returned to the main routine. When controller 70 determines that pattern image 158 has not been dragged into sewable area A2 (S724: No), a display update request is made (S726) without executing the process of S725 and the process flow is returned to the main routine. The above process updates the display position of pattern image 158 if pattern image 158 has been dragged within the bounds of sewable area A2. Contrastingly, if pattern image 158 has not been dragged within the bounds of sewable area A2, display position of pattern image 158 remains unchanged from its original position.

[0140] Controller 70, when determining that pattern image 158 has not been dragged at S723 (S723: No), further proceeds to determine whether or not resize handle 162 shown in FIG. 24C has been dragged (S727). Controller 70, when determining that resize handle 162 has been dragged (S727: Yes), further proceeds to determine whether or not pattern image 158 resized by dragging resize handle 162 resides within sewable area A2 (S728). Then, controller 70, when determining that resized pattern image 158 resides within sewable area A2 (S728: Yes), specifies resize information 1224 of relocation data 122 contained in pattern information 120 to the resized size (S729), makes a display update request (S726), and returns the process flow to the main routine. Further, controller 70, when determining that resized pattern image 158 does not reside within sewable area A2 (S728: No), makes a display update request (S726) without executing the process of S729, and returns the process flow to the main routine. According to the above described process, pattern image 158 is resized if pattern image 158 resized by dragging resize handle 162 resides within sewable area A2. As opposed to this, if pattern image 158 resized by dragging resize handle 162 does not reside within sewable area A2, pattern image 158 is not resized.

[0141] Controller 70, when determining at S727 that resize handle 162 has not been dragged (S727: No), further proceeds to determine whether or not rotate handle 164 shown in FIG. 24D has been dragged (S730). Controller 70, when determining that rotate handle 164 has been dragged (S730: Yes), further proceeds to determine whether or not pattern image 158 rotated by dragging rotate handle 164 resides within sewable area A2 (S731). Then, controller 70, when determining that the rotated pattern image 158 resides within sewable area A2 (S731: Yes), updates rotate angle information 1222 of relocation data 122 contained in pattern information 120 to the rotated location (S732), makes a display update request (S726), and returns the process flow to the main routine. When controller 70 determines that the rotated pattern image 158 does not reside within sewable area A2 (S731: No), makes a display update (S726) without executing S729, and returns the process flow to the main routine. According to the above described process, if pattern image 158 rotated by dragging rotate handle 164 resides within sewable area A2, pattern image 158 is rotated and if it does not reside within sewable area A2, it is not rotated.

[0142] When controller 70 determines at S730 that rotate handle 164 has not been dragged (S730: No), the process flow is returned to the main routine. If rotate handle 164 has not been dragged at S730, it is an indication that mouse 61 was neither clicked or dragged, meaning that mouse 61 was merely moved and hence, no change takes place in the presentation of items such as pattern image 158 and pattern relocation menu displayed on display area A1.

[0143] Next, a description will be given in detail on the communication process executed at step S112 of the main routine based on FIG. 34.

[0144] The communication process is executed when the communication mode is set at S511 of the main menu process and communication menu 170 of the communication mode is displayed on display area A1 as shown in FIG. 25. Controller 70, when proceeding to the communication process, determines whether or not mouse 61 has been clicked (S801) on a given position of display area A1 when communication menu 170 is displayed as shown in FIG. 25. Controller 70, when determining that mouse 61 has been clicked (S801: Yes), further proceeds to determine whether or not return button 172 of communication menu 170 has been depressed (S802). Controller 70, when determining that return button 172 has been depressed (S802: Yes), determines that a request has been made to return to the main menu from the communication mode and thereafter specifies the main menu mode (S803), makes a display update request (S804), and returns the process flow to the main routine. Controller 70 also returns the process flow to the main routine when mouse 61 has not been clicked.

[0145] On the other hand, when controller 70 determines at S802 that return button 172 has not been depressed (S802: No), further proceeds to determine whether or not send button 171 has been depressed (S805). Controller 70, when determining that send button 171 has been depressed (S805: Yes), prepares for communication with medium such as USB (S806), and determines whether or not communication link has been established (S807). Controller 70, when determin-
that communication link has not been established (S807: No), stands by until the communication link has been established. [0146] Controller 70, when determining that communication link has been established (S807: Yes), transmits pattern information 120 stored in RAM 73 to sewing machine 10 (S808) while displaying a message that reads “sending” on display area A1 indicating that pattern information 120 is being transmitted and further proceeds to determine whether or not the transmission has been completed (S810). Controller 70, when determining that the transmission of pattern information 120 has not been completed (S810: No), repeats S808 and S809 until the transmission is completed.

[0147] Controller 70, when determining that the transmission of pattern information 120 has been completed (S810: Yes), clears the “sending” message indicating that pattern information 120 is being transmitted (S811) and returns to the main routine. Further, controller 70, when determining at S805 that send button 171 has not been depressed (S805: No), terminates the process and returns to the main routine. This means that, though clicking of mouse 61 was indeed detected at S801 it was not a depression of send button 171 at S805, which is an indication that mouse pointer 135 of mouse 61 is not placed over communication menu 170. Thus, controller 70 terminates the process and returns to the main routine.

[0148] When the processes described above based on FIGS. 18 to 20 and FIGS. 26 to 34 have been completed, the embroidery pattern selected by display device 23 and relocated and resized relative to workpiece 35 as required is sewn by sewing machine 10. When sewing the embroidery pattern with sewing machine 10, embroidery frame 20 holding workpiece cloth 35 is attached to carriage 22 of embroidery frame transfer device 21. Pattern information 120 may be transferred from embroidery frame 20 to sewing machine 10 either before or after attaching carriage 22 to embroidery frame 20.

[0149] After starting the sewing operation, sewing machine 10 controls the motion of sewing needle 15 based on pattern information 120 transmitted from display device 23 and controls the transfer of embroidery frame 20 by embroidery frame transfer device 21. Thus, the selected embroidery pattern 43 is sewn in the desired position and in the desired form on workpiece cloth 35 held by embroidery frame 20 based on pattern information 120. When detector 54 provided at display device 23 detects the attachment of display 41, controller 70 outputs instructions to prohibit sewing machine 10 from executing the sewing operation. Thus, sewing machine 10 does not execute a sewing operation of embroidery pattern 43 while display 41 is attached.

[0150] Embroidery frame 20 and sewing machine 10 according to the above described first exemplary embodiment has the following effects.

[0151] By attaching display device 23 to embroidery frame 20 by way of attachment mechanism 24 before initiating the sewing operation, workpiece cloth 35 held by embroidery frame 20 is located with the embroidery pattern displayed on display 41. Display 41 displays pattern image 158 so that it overlaps with sewable area A2 of embroidery frame 20 on which the sewing operation is actually performed. Further, because display 41 is configured by an electronic paper capable of providing visibility of the back side of display area A1, when display 41 is attached, the size of the embroidery pattern and images of where to form the stitches and how the finished pattern will look on workpiece cloth 35 held at sewable area A2 of embroidery area 20 can be presented to the user. Thus, the embroidery pattern to be sewn can be located with workpiece cloth 35 with greater ease and reliability.

[0152] Controller 70 detects the type of embroidery frame 20 attached by frame type detection switch 53. Thus, display 41 is capable of displaying the sewable area A2 and embroidery pattern to be sewn depending upon the type of embroidery frame 20 detected even if embroidery frames 20 come in different shapes and sizes. The above described feature also provides greater ease and reliability in locating the embroidery pattern to be sewn with the workpiece cloth 35.

[0153] Pattern image 158 displayed on display area A1 of display 41 is editable in its sew position, size, and shape etc. from mouse 61 input depending upon the desired embroidery pattern. Thus, the desired size and/or shape of the embroidery pattern may be edited in view of pattern image 158 displayed on display area A1 and workpiece cloth 35 held by embroidery frame 20. Thus, the embroidery pattern can be readily edited with accuracy depending upon workpiece 35 as well as being located in the desired position.

[0154] The pattern image displayed on display area A1 is outputted to sewing machine 10 through medium such as USB so that patterns based on the outputted embroidery pattern can be sewn by sewing machine 10 provided with embroidery frame transfer device 21.

[0155] Attachment mechanism 24 comprises engagement portion 45 of display device 23 and engagement subject 32 of embroidery frame 20. Display device 23 and embroidery frame 20 are located with each other by way of the engagement between engagement portion 45 and engagement subject 32. The above described arrangement allows display device 23 and embroidery frame 20 to be reliably and readily located with each other in a less complex configuration.

[0156] Because sewing machine 10 of the first exemplary embodiment is provided with display device 23 producing the above described effects, embroidery pattern 43 can be sewn accurately on the desired position of workpiece cloth 35 based on pattern image 158 displayed on display 41.

[0157] Next, a description will be given on a display device and a sewing machine according to a second exemplary embodiment of the present disclosure based on FIG. 35.

[0158] The mechanical and electrical configuration of display device 23 and sewing machine 10 are identical to those of the first exemplary embodiment. Furthermore, the data configuration of the data used is also identical to the data types shown in FIGS. 14, 15 and 16. The second exemplary embodiment differs from the first exemplary embodiment in that pre-stored pattern data 103 is stored in the ROM, not shown, of sewing machine 10 instead of being stored in ROM 72 of display device 23 and in that the process flow of the embroidery sewing process flows differently. This means that not only ROM 72 and RAM 73 but also the ROM not shown of sewing machine 10 stores embroidery pattern data.

[0159] First, a description will be given on the flow of the process executed at display device 23 side. The processes that are identical to those of the first exemplary embodiment are identified with identical step number and will not be explained.

[0160] In initiating the main process, in other words, when power is turned ON, controller 70 initializes display device 23 in its entirety (S1001). Then, as in the first exemplary embodiment, controller 70 acquires the frame type of embroidery frame 20 attached to attachment mechanism 24. Then, display device 23 is attached to sewing machine 10 (S1002). More specifically, display device 23 is connected in data
communication with sewing machine 10 by way of medium such as USB. Controller 70 determines whether or not connection with display device 23 and sewing machine 10 has been established or not (S1003). Controller 70, when determining that connection between display device 23 and sewing machine 10 has not been established (S1003: No), stands by until the connection is established.

[0161] Controller 70, when determining that the connection has been established between display device 23 and sewing machine 10 (S1003: Yes), proceeds to determine the presence/absence of send request of pattern information 120 (S1004). That is, controller 70, when display device 23 is connected in data communication with sewing machine 10, determines the presence/absence of send query. Controller 70, when determining that no send request of pattern information 120 has been made (S1004: No), stands by until a send request is made. When, controller 70, on the other hand, determines that send request of pattern information 120 has been made (S1004: Yes), transmits an “accept” signal for allowing the transmission of pattern information 120 from sewing machine 10 to controller 70. Controller 70 thus, retrieves pattern information 120 from sewing machine 10 (S1006) and stores it into RAM 73. Then, controller 70 determines whether or not retrieval of pattern information 120 has been completed (S1007) and when determining that retrieval of pattern information 120 has not been completed (S1007: No), repeats the process S1006 until the retrieval of pattern information 120 has been completed.

[0162] Controller 70, when determining that the retrieval of pattern information 120 has been completed (S1007: Yes), displays pattern image 158 corresponding to pattern information acquired from sewing machine 10 on display area A1 of display 41 (S1008). Using the pattern image 158 displayed on display 41, the user is allowed to make adjustments in the positioning of the pattern to be formed with workpiece cloth 35. In the present exemplary embodiment, the user is allowed to relocate, resize, and rotate pattern image 158 displayed on display area A1 using mouse 61. The editing, that is, relocation, resizing, and rotation of pattern image 158 can be executed as described in pattern relocation process shown in FIGS. 31 to 34 of the above described first exemplary embodiment and thus will not be explained.

[0163] The positioning of pattern image 158 displayed on display area A1 of display 41 relative to workpiece cloth 35 can be carried out when the connection between display device 23 and sewing machine 10 is canceled. As described above, display 41 comprising electronic paper retains the latest image displayed before the cancellation of connection with sewing machine 10. Thus, pattern image 158 can be located with workpiece 35 even if display device 23 having embroidery frame 20 attached to it is removed from sewing machine 10. The above described configuration facilitates the relative positioning of pattern image 158 and workpiece cloth 35 since no structural elements such as sewing machine 10, and embroidery frame transfer device 21 exists in the periphery of embroidery frame 20 that are likely to interfere with the positioning work. If sewing machine 10 is provided with a frame retraction functionality that retracts embroidery frame from its sewing position, the frame retraction may be executed instead of removing embroidery frame 20. In this case also, the relative positioning of pattern image 158 and workpiece 35 will not be interrupted by sewing machine 10 and embroidery frame transfer device 21, etc. as was the case when display device 23 is removed from sewing machine 10.

[0164] Controller 70, when completing the pattern relocation process at S1009, determines whether or not display device 23 and sewing machine 10 are connected (S1010). Controller 70, when determining that display device 23 and sewing machine 10 are not connected (S1010: No), stands by until connection is established between display device 23 and sewing machine 10 (S1011) while repeating S1010 until verifying the connection between display device 23 and sewing machine 10.

[0165] Controller 70, when determining that display device 23 and sewing machine 10 are connected (S1010: Yes), sends a send request to sewing machine 10 (S1012). To elaborate, controller 70 requests for a permission to send pattern information 120 edited by the pattern relocation process. Then, controller 70 determines whether or not the send request has been acknowledged by sewing machine 10 (S1013). Controller 70, when determining that send request has not been acknowledged (S1013: No), repeats S1012 until sewing machine 10 acknowledges the send request.

[0166] Controller 70, when determining that send request has been acknowledged (S1013: Yes), transmits pattern information 120 to sewing machine (S1014). Then, controller 70 determines whether or not transmission of pattern information 120 has been completed (S1015) and when determining that transmission of pattern information 120 has not been completed (S1015: No), proceeds to step S1004 and repeats S1004 onwards.

[0167] Next, a description will be given on the process flow executed at sewing machine 10 side.

[0168] In initiating the main process, in other words, when power is turned ON, controller 81 of sewing machine 10, initializes sewing machine 10 in its entirety (S1021). Then, controller 81 executes the pattern selection process (S1022). This means that in the second exemplary embodiment, the pattern selection process for selecting embroidery pattern 43 is executed at sewing machine 10. More specifically, the user is to select an embroidery pattern from the pattern selection list displayed on LCD 19 of sewing machine 10. The pattern selection process can be executed as described in FIGS. 29 and 30 of the above described exemplary embodiment except for the process being primarily executed by controller 81 of sewing machine 10 and thus, will not be described in detail.

[0169] Controller 81, after starting the execution of the pattern selection process, determines whether or not the pattern selection process has been completed (S1023). Controller 81 when determining that pattern selection process has not been completed (S1023: No), stands by until the pattern selection process at S1022 is completed. When controller 81 determines that the pattern selection process has been completed (S1022: Yes), sewing machine 10 is connected to display device 23 (S1024). As described above, controller 81 verifies whether or not connection is established between sewing machine 10 and display device 23 (S1025). The connection of sewing machine 10 to display device 23 (S1024) corresponds to the connection of display device 23 to sewing machine 10 in the above described S1002. Likewise, verification of whether or not sewing machine 10 has been connected to display device 23 at S1025 corresponds to the verification of whether or not display device 23 has been connected to sewing machine 10 at S1003.

[0170] Controller 81, when determining that display device 23 has been connected at S1025 (S1025: Yes), issues a send request to display device 23 (S1026). When controller 81 on the other hand, determines that display device 23 is not con-
nected at S1025 (S1025: No), stands by until display device 23 is connected. Controller 81 may be configured to acquire the type of embroidery frame 20 mounted on attachment mechanism 24 from display device 23 side when transmitting the send request.

[0171] At S1004 described above, controller 70 of display device 23 determines whether or not send request of pattern information 120 has been issued by sewing machine 10. Thus, controller 81 issues a send request to display device 23 at S1026 in which return controller 70 of display device 23 sends a permission for sending pattern information 120 to sewing machine 10. After transmitting the send request of pattern information 120 to display device 23 at S1026, controller 81 of sewing machine 10 determines whether or not the send request has been acknowledged by display device 23, in other words, whether or not send request of pattern information 120 has been acknowledged/permitted by display device 23 at S1005 (S1027).

[0172] Controller 81, when determining that permission has been obtained from display device 23 in response to the send request (S1027: Yes), sends pattern information 120 to display device 23 (S1028). Controller 70 of display device 23 receives pattern information 120 at S1006 which was sent from sewing machine 10 at S1028. When controller 81, on the other hand, determines that it has not obtained permission from display device 23 in response to the send request (S1027: No), stands by until obtaining permission from display device 23.

[0173] Controller 81, after sending pattern information 120 at S1028, determines whether or not transmission of pattern information 120 has been completed (S1029). Controller 81, when determining that transmission of pattern information 120 has been completed, further proceeds to determine the presence/absence of send request of pattern information 120 (S1030). Controller 70 of display device 23, after executing the pattern relocation process at S1009, sends a send request to sewing machine 10 at S1012. Responsively, sewing machine 10 determines at S1030 whether or not the send request for the edited pattern information 120 has been issued from display device 23. Controller 70 of display device 23 determines at S1010 whether or not display device 23 and sewing machine 10 are connected. Likewise, determination may be made on sewing machine 10 side as to whether or not display device 23 is connected. Controller 81, when determining at S1030 that the send request for the edited pattern information has not been issued from display device 23 (S1030: No), stands by until the send request has been sent from display device 23.

[0174] Controller 81, when determining at S1030 that the send request for the edited pattern information 120 has been issued from display device 23, (S1030: Yes), retrieves the edited pattern information 120 from display device 23 (S1031). In other words, at step S1031, controller 81 retrieves pattern information 120 sent by display device 23 at S1014. Then, controller 81 determines whether or not the retrieval of edited pattern information 120 has been completed (S1032). Controller 81, when determining that the retrieval of the edited pattern information 120 has not been completed (S1032: No), stands by until the retrieval of pattern information 120 is completed.

[0175] Controller 81, when determining at S1032 that retrieval of edited pattern information 120 has been completed (S1032: Yes), proceeds to the sewing process of the embroidery patterns (S1033). Controller 81 further determines by way of detector 54 as to whether or not display 41 is attached to display device 23 (S1034). More specifically, controller 81, when determining that display 41 is attached to display device 23 (S1034: Yes), displays a message that reads “error” on LCD 19 (S1035) indicating that the sewing operation cannot be started because display 41 is attached. When controller 81, on the other hand, determines that display 41 is not attached to display device 23 (S1034: No), executes formation of embroidery pattern (S1036). Then, controller 81 determines whether or not formation of embroidery pattern has been completed (S1037), and if not completed (S1037: No), continues with embroidery pattern formation. When controller 81, on the other hand, determines that the embroidery pattern formation has been completed (S1037: Yes), returns the process flow to S1022.

[0176] The above described second exemplary embodiment provides the following effects in addition to those provided in the first exemplary embodiment. Selection of a given embroidery pattern from multiple embroidery patterns is executed on the sewing machine 10 side whereas the pattern relocation process of the selected embroidery pattern is executed on pattern device 23 side. Thus, tasks can be allocated to both sewing machine 10 and display device 23 to allow optimization of sewing machine 10 and display device 23.

[0177] Next a description will be given on a third exemplary embodiment based on FIGS. 36 and 37 focusing primarily on the difference from the first exemplary embodiment.

[0178] In the third exemplary embodiment, display frame 842 of display 23 is generally formed as a frame. The structure for establishing connection with holder unit 44 will not be described for simplicity.

[0179] Further, display frame 842 has an outer peripheral edge that gradually curves along the inner periphery of inner frame 34. On the lengthwise mid portion of each of the four sides of display frame 842, a notch 843 is formed that serves as an engagement portion.

[0180] Inner frame 34 of embroidery frame 20 is dimensioned so that it can accommodate display frame 842 within it and is provided integrally with bottom support 844 that supports display frame 842. Bottom supports 844 define a rectangular sewable area A2 within inner frame 34 of embroidery frame 20 as viewed in plan view. Bottom supports 844 are each provided integrally with rib 845 in its lengthwise mid portion that serves as and engagement subject. Rib 845 is fitted with notch 843 of display frame 842. Engagement subject 32 is integrally provided with a dedicated detection subject 38 on embroidery frame 20. Joint 36 is provided with cover 846 that stores controller 81. Controller 81 has communication cable 62 connected to it that communicates with sewing machine 10.

[0181] When display device 23 is attached onto embroidery frame 20 configured as described above, the outer peripheral edge, in other words, display frame 842 is supported by bottom support 844. At this instance, rib 845 of bottom support 844 is fitted with notch 843 of display frame 842. Thus, embroidery frame 20 and display device 23 are located such that the display area and the sewable area A2 are substantially located at the same predetermined position. Though not shown, display device 23 and controller 81 are connected by wireless communication.

[0182] According to the third exemplary embodiment, embroidery frame 20 can be attached to display device 23 by merely fitting rib 845 into notch 843. This means that attach-
ment mechanism 24 merely comprises rib 845 and notch 843 to minimize cost and complexity of structure. Further, embroidery frame 20 can be located with and attached to display device 23 by merely locating the outer profile of display device 23 with embroidery frame 20, thus, further improving the work efficiency and simplifying the configuration of display device 23. Further, the third exemplary embodiment provides the effects similar to those provided in the first exemplary embodiment such as allowing the user to visually recognize the actual size and the finished image of the embroidery pattern in view of sewable area A2 of embroidery frame 20 holding workpiece cloth 35.

[0183] Further, in the third exemplary embodiment, a retaining structure similar to holder unit 44 can be preinstalled at carriage 22 of embroidery frame transfer device 21. Thus, when executing the embroidery sewing operation, attachment of holder unit 44 to carriage 22 can be eliminated.

[0184] Next, a description will be given on a fourth exemplary embodiment of the present disclosure with reference to FIGS. 38 to 40.

[0185] The fourth exemplary embodiment employs cap frame 181 for use in an embroidery sewing machine for embroidering a brimmed cap 200, hereinafter simply referred to as a cap. Cap frame 181 is attached to a rotary frame not shown that is connected to a feed mechanism of a single headed or a multiple headed embroidery sewing machine. The feed mechanism not shown is provided with a Y drive mechanism that transfers the rotary frame in the front and rear direction represented as the Y direction and an X drive mechanism that rotates the rotary frame about a shaft oriented in the Y direction by way of a rotary mechanism provided on the rotary frame. The embroidery sewing machine according to the fourth exemplary embodiment executes embroidery sewing operation on cap 200 mounted on cap frame 181 by transferring cap frame 181 with the rotary frame by way of the feed mechanism.

[0186] Cap frame 181 is provided with cap frame body 182, presser frame 183, and holder frame 184. Cap frame 182 is formed into a loop and detachably attached to the rotary frame not shown. Presser frame 183 is placed over cap frame body 182 and has one end connected to cap frame body 182 so as to clamp cap 200 therebetween to allow the cap 200 to be releasably held by cap frame 182. Holder frame 184 supports cap 200 from below.

[0187] Cap frame body 182 is provided with a looped mount frame 185 that is mounted on the outer side of the rotary frame. Mount frame 185 is provided with flange 186. Flange 186 is provided with flange support 187 that rises obliquely rearward and upward from the uppermost center of mount frame 185. Flange support 187 is provided with trim presser 189 that presses trim 201 of cap 200. The structure of cap frame body 182 comprising trim presser 189 and flange support 187 being known in the art will not be described.

[0188] As shown in FIGS. 38 and 39, holder frame 184 is curved in front view and rectangular in plan view in order to support the front face of cap 200, referred to as embroidery portion 203, on which embroidery is formed in a tensed state. Holder frame 184 is secured on the upper portion of cap frame body 182 to hold cap 200 from the inner bottom side.

[0189] Presser frame 183 is bendable and is curved in front view and rectangular in plan view just like holder frame 184. Thus, embroidery portion 203 of cap 200 is removably secured between the presser frame 183 on the upper side and holder frame 184 on the lower side. On the lower end side of cap frame body 182, a forwardly oriented rod 190 that rotatably supports the left end of presser frame 183 and support element 191 for locking the right end of presser frame 183 is disposed. Support element 191 is provided with hook 1911 which is engaged with ring 1831 that is provided on the right end of presser frame 183. By engaging ring 1831 on hook 1911, the right end of presser frame 183 is mounted removably on support element 191. Further, holder frame 184 and presser frame 183 clamp embroidery section 203 from the lower side, that is, the inner side and the upper side, that is, the outer side. The inner side of presser frame 83 constitutes sewable area A2 which is rectangular in plan view.

[0190] Presser frame 183 is provided with cylindrical ribs 192 on both ends of its upper side, which protrude outward. As shown in FIG. 39, ribs 192 are provided symmetrically on presser frame 183 and serves as an engagement subject for engagement with display device 223.

[0191] Display device 223 is provided with display 241 and display frame 242. Display frame 242 is bendable and holds display 241 in curved profile so as to curve along presser frame 183. Display frame 242 is curved in front view and rectangular in plan view. Display frame 242 comprises a plurality of frame segments 193, and each of the right side frame segment and the left side frame segment has notch 194 that serves as an engagement portion as shown in FIG. 38. At the circumferential center of notch 194, fitting portion 195 is provided for fitting insertion of rib 192. Also, the mouth located at the lower portion of each notch 194 as viewed in FIG. 38 spreads axially to define taper 196.

[0192] When display device 223 is placed onto the above configured presser frame 183 from above, display device 223 receives insertion of rib 192 from taper 196 side of notch 194. The fitting of the inserted rib 192 with fitting groove 95 establishes the hold of display device 223 by presser frame 183. Thus, display device 223 and cap frame 181 are attached such that display 41 and sewable area within presser frame 183 are coincidental. The electrical configuration of display device 223 may employ an equivalent of the third exemplary embodiment and thus, will neither be shown nor explained.

[0193] According to the above described configuration, display device 223 and cap frame 181 can be attached to the other by merely fitting notch 194 with rib 192. This means that the attachment mechanism can be configured merely by notch 194 and rib 192 to reduce the cost and simplify the structure as much as possible. Further, as described above, display device 223 can be placed on cap frame 181 from above and allow visual recognition of the top view of the aforementioned image of finished embroidery while maintaining the attachment of cap frame 181 and display device 223 to provide user friendliness.

[0194] In the above described exemplary embodiments, display device 23 is provided with controller 70 that controls embroidery pattern selection and embroidery pattern editing, and ROM 72 and RAM 73 that store data pertaining to embroidery patterns. Display device 23 further establishes connection with mouse 61 through which user operation is inputted, and communication cable 62 through which data communication is carried out. Alternatively, controller 70, ROM 72, and RAM 73 may be provided at embroidery frame 20 instead of display device 23, while mouse 61 and communication cable 62 is connected to display device 23. In such case, the processes carried out in the first and the second exemplary embodiments are executed at embroidery frame 20.
Further, the above exemplary embodiments have been described based on display device 23 provided with display 41 comprising electronic paper. However, display 41 may comprise medium other than electronic paper such as a liquid crystal display, organic electroluminescence, and projector that are transparent to provide visibility of the object placed behind it. When employing a projector as display 41, a transparent screen providing visibility behind it, in other words, its back side, constitutes display area A1 on which images are projected from a projector provided on attachment mechanism side 24.

Yet, further in the above described exemplary embodiments, mouse 61 was given as an example of a pointing device for editing pattern image 158 presented on display 41. However, display 41 may be configured as a touch panel so that image pattern image 158 may be edited through touch operation of display 41.

While various features have been described in conjunction with the examples outlined above, various alternatives, modifications, variations, and/or improvements of those features and/or examples may be possible. Accordingly, the examples, as set forth above, are intended to be illustrative. Various changes may be made without departing from the broad spirit and scope of the underlying principles.

What is claimed is:

1. An embroidery stitcher comprising:
   an embroidery frame that holds a workpiece cloth that is provided with a sewable area for sewing the held workpiece cloth;
   a display device that has a transparent display area that provides visibility behind thereof and that is capable of displaying embroidery pattern information of at least an embroidery pattern to be sewn; and
   an attachment mechanism that allows detachable attachment of the display device at a position that renders the display area and the sewable area to at least partially overlap.

2. The embroidery stitcher according to claim 1, wherein the display device further includes:
   a frame type detector that detects a type of the embroidery frame attached to the attachment mechanism;
   a controller that controls the display device based on the type of embroidery frame detected by the frame type detector to display the embroidery pattern to be sewn on the display area overlapping with the sewable area.

3. The embroidery stitcher according to claim 1, wherein the display device further includes:
   an embroidery pattern storage that stores information pertaining to the embroidery pattern to be sewn as embroidery pattern data;
   an embroidery pattern selector that selects a desired embroidery pattern from the embroidery pattern data stored in the embroidery pattern storage;
   an embroidery pattern editor that executes editing of the embroidery pattern including at least a relocation of the embroidery pattern selected by the embroidery pattern selector; and
   an operation input element that inputs edit operations for editing the embroidery pattern by the embroidery pattern editor.

4. The embroidery stitcher according to claim 1, wherein the display device further includes a communication element that communicates with external elements.

5. The embroidery stitcher according to claim 1, wherein the embroidery frame includes:
   a communication element that communicates with external elements;
   an operation input element that inputs edit operations for editing at least a location of embroidery pattern to be sewn displayed on the display area; and
   a controller that displays the embroidery pattern to be sewn on the display area based on display data of the embroidery pattern to be sewn inputted from external elements by way of the communication element and that outputs information pertaining to the embroidery pattern to be sewn displayed on the display area to the external elements after the embroidery pattern to be sewn has been edited by the edit operations inputted by the operation input element.

6. The embroidery stitcher according to claim 1, wherein the embroidery frame includes a detector that detects whether or not the display device has been attached.

7. The embroidery stitcher according to claim 1, wherein the attachment mechanism includes:
   an engagement portion that is provided at the display device; and
   an engagement subject that is provided at the embroidery frame and that is engagable with the engagement portion.

8. The embroidery stitcher according to claim 7, further comprising an embroidery frame transfer device that transfers the embroidery frame in two predetermined directions; the engagement subject being detachably attached to the embroidery frame transfer device.

9. The embroidery stitcher according to claim 7, wherein the embroidery frame includes a lower frame and an upper frame that clamp the workpiece cloth from lower and upper sides, and wherein the engagement subject is provided at the upper frame.

10. The embroidery stitcher according to claim 7, wherein either of the engagement portion and the engagement subject has a groove and the remaining other has a rib such that the display device and the embroidery frame are coupled by a fitting engagement of the groove and the rib.

11. A sewing machine comprising:
   an embroidery stitcher including:
   an embroidery frame that holds a workpiece cloth and that is provided with a sewable area for sewing the held workpiece cloth;
   a display device that has a transparent display area that provides visibility behind thereof and that is capable of displaying embroidery pattern information of at least an embroidery pattern to be sewn; and
   an attachment mechanism that allows detachable attachment of the display device at a position that renders the display area and the sewable area to at least partially overlap.