

MANUFACTURING METHOD OF LIQUID CRYSTAL DISPLAY APPARATUS AND SUBSTRATE ASSEMBLING APPARATUS

BACKGROUND OF THE INVENTION

5 The present invention relates to an assembly method for
the liquid crystal display apparatus and a substrate assembly
apparatus in which a couple of substrates to be laminated are
supported respectively and placed so as to be opposed to each
other in the vacuum chamber, and those substrates are brought
10 together in face-to-face relationship with the gap between
those substrates being narrowed down in a reduced pressure
state.

 There are two methods for the assembly of the liquid
crystal display. In one method, a couple of glass substrates
15 having transparent substrates and thin film transistor arrays
are brought together in face-to-face relationship in a distance
as small as several μm with the adhesive agent (hereinafter
referred also to as sealing material) (the finished substrate
is hereinafter referred to as cell), and the airspace formed
20 between those substrates is filled with the liquid crystal
material. In the other method, the liquid crystal material is
drip-fed on the surface of one substrate on which such a closed
pattern is formed with the sealing material so that the filler
hole may not be provided, and the other substrate is placed on

the former substrate and those substrates are brought together in face-to-face relationship so as to be very close to each other.

As for the assembly apparatus for the liquid crystal display apparatus for bringing together the substrates in face-to-face

5 relationship, there is such a substrate assembly apparatus for supporting the upper-side substrate prior to applying the applied pressure as disclosed in Japanese Patent Laid-Open Number 2001-133745 (2001), in which the upper-side substrate

is supported by the adhesion means, and the substrates are

10 brought together in face-to-face relationship by narrowing down the distance between the substrates. In its preferred embodiment, what are disclosed include a method using an

adhesive sheet as the adhesive means and a configuration in which an open port is provided in side the pressurizing plate

and an actuator is provided above the pressurizing plate so that

15 the adhesive member ay flows up and down in the open port.

In the configuration of the above prior art, the substrate is supported so as to contact to the adhesive means in an atmospheric pressure. In case that the substrate is supported

20 by using the adhesive means in an atmospheric pressure, there

may such a problem that an air is penetrated through between the substrate and the adhesive means due to the concave and/or

convex surface of the substrate and the deflection of the substrate, and as the internal pressure of the chamber is

reduced, the air contained between the substrate and the adhesive means expands, leading at worst to disabling to support the substrate.

5 SUMMARY OF THE INVENTION

An object of the present invention is to provide a substrate laminating apparatus enabling to support definitely the substrate with the pressurizing plate, a substrate assembly apparatus for laminating the liquid crystal substrates, and an
10 assembly method using the apparatus thereof for the liquid crystal display apparatus, in order to laminate the substrates with a high degree of accuracy in a high-vacuum pressure in which there may not occur defects in the liquid crystal display even if attempting to increase the size of the substrate and reduce
15 the thickness of the substrate.

In order to achieve the above object, the present invention is characterized by providing a plural of suction ports for suction and adsorption on the pressurizing plate for supporting one of the substrates; a plural of adhesive means
20 for supporting the substrates by adhesive force; and a pressure reduction channel for reducing the pressure inside the airspace formed by the open port provided with said adhesive means and the substrate. In addition, a plural of suction ports for suction and adsorption and a plural of adhesive means are

provided on the table for supporting the other substrate as well as the pressurizing plate. And furthermore, after reducing the pressure inside the airspace formed between the open port having the adhesive means and the substrate, the adhesive means is made
5 imposed on the substrate and supported with the substrate.

In another embodiment, at least in the pressurizing plate, the substrate is attracted and adsorbed as well as supported adhesively in an atmospheric pressure, and then, after bonding the substrates under pressure with the adhesive agent provided
10 either one of the substrates by narrowing down the distance to substrate placed on the table in a given depressurized atmosphere, and finally, the adhesive member is removed from the surface of the laminated substrates by operating a plural of removing mechanisms provided at the pressurizing plate for
15 removing the adhesive member,

With the pressurizing plate provided inside the vacuum chamber and the table placed at an opposed position in a distance to said pressurizing plate, one of the liquid crystal substrate is supported by a plural of adhesive means provided at said
20 pressurizing plate and the sealing material is coated in a loop shape on this liquid crystal substrate, the other liquid crystal substrate on which the liquid crystal agent is quantitatively dropped in a closed loop area formed by the sealing material is placed on said table and supported with a negative pressure

or by the adhesive means, the internal pressure of the vacuum chamber is reduced, and after positioning the both substrate to each other, followed by laminating tentatively the substrates by narrowing down the distance between said table
5 and said pressurizing plate, and then the adhesive means provided at said pressurizing plate is removed, and, finally the liquid crystal display apparatus is completed with both substrates contacted firmly by restoring the pressure inside the vacuum chamber to the atmospheric pressure after separating
10 the pressurizing plated from one of the substrates.

BRIEF DESCRIPTION OF DRAWINGS

The present invention will be understood more fully from the detailed description given hereinafter and from the
15 accompanying drawings of the preferred embodiment of the present invention, which, however, should not be taken to be limitative to the invention, but are for explanation and understanding only.

In the drawings:

20 FIG. 1 is a schematic cross-sectional view of the substrate assembly apparatus illustrating one embodiment of the present invention.

FIG. 2 is a detail view of one example of the adherence holding mechanism.

FIG. 3 is a flowchart for laminating the substrates.

FIG. 4 is a cross-sectional view of the major part for illustrating the process for laminating the upper and lower substrates.

5 FIG. 5 is a schematic diagram for illustrating the operation of lamination by the adherence holding mechanism.

FIG. 6 is a schematic diagram for illustrating the operation of removal from the surface of the substrate by the adherence holding mechanism.

10 FIG. 7 is an illustration showing an example of the case that an enhanced abrasive member is provided at the pressurizing plate and the table.

FIG. 8 is a cross-sectional view of the substrate laminating apparatus in another embodiment of the present
15 invention.

FIG. 9 is a flowchart of the procedural steps for laminating operation in the apparatus shown in FIG. 8.

FIG. 10 is an illustration showing a state in which the vacuum chamber is formed for applying the substrate laminating
20 operation shown in FIG. 8.

FIG. 11 is a partial magnified view for illustrating the procedure for removing the adhesive sheet shown in FIG. 8 from the surface of the substrate (liquid crystal cell pc).

FIG. 12 is a block diagram of the adhesive member removing

mechanism in another embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention will be discussed hereinafter in
5 detail in terms of the preferred embodiment according to the
present invention with reference to the accompanying drawings.
In the following description, numerous specific details are
set forth in order to provide a thorough understanding of the
present invention. It will be obvious, however, to those
10 skilled in the art that the present invention may be practiced
without these specific details. In other instance, well-known
structures are not shown in detail in order to avoid unnecessary
obscurity of the present invention.

Now, one embodiment of the present invention is described
15 by referring to the attached figures. FIG. 1 shows an overall
configuration of the substrate laminating apparatus in
accordance with the present invention.

In FIG. 1, the substrate assembly apparatus 100 in
accordance with the present invention is composed of the lower
20 chamber T1 and the upper chamber T2, and the $XY\theta$ -direction drive
mechanism (not shown) is provided below the lower chamber T1.
With the $XY\theta$ -direction drive mechanism, the lower chamber T1
can moves freely in the X axis defined to be in the right-and-left
direction and in the Y axis vertical to the X-axis. In addition,

with the θ -direction drive mechanism, the table 4 on which the lower substrate is mounted can be moved rotationally on the vertical plane with respect to the lower chamber unit through the shaft 2 to the vacuum seal 3. When the lower substrate 1a is mounted on the table 4, suction and adsorption operation is applied by the suction port 7c provided at the table 4. One end of the pipe 16a is connected to the suction port 7c, and the pressure reduction (negative pressure) source is connected to the other end of the pipe through the valve not shown. What is provided is such a mechanism that the lower substrate 1a is attracted and adsorbed to the suction port 7c with the negative pressure provided by this negative pressure source.

The upper chamber T2 is configured by providing the upper chamber unit 6 and the pressurizing plate 7 installed therein, in which the upper chamber unit 6 and the pressurizing plate 7 can move up and down independently. That is, the upper chamber unit 6 has a housing 8 including a linear bush and a vacuum seal inside, and, guided by the shaft 9, moves in the vertical direction (in the Z-axis) by the cylinder 11 fixed at the frame 10. The pressurizing plate 7 moves in the vertical direction (in the Z-axis) by the drive apparatus (not shown) provided at the shaft 9.

The upper substrate 1b is attracted and adsorbed to the suction port 7d provided on the lower face of the pressurizing

plate 7. One end of the pipe 16b is connected to the suction port 7d, and the negative pressure source is connected to the other end of the pipe 16b through a valve not shown. In this configuration, by supplying a negative pressure from the negative pressure source, the upper substrate 1b is attracted and adsorbed to the pressurizing plate 7.

As the lower chamber part T1 above the $XY\theta$ -direction drive mechanism moves directly below the upper chamber part T2 and then the upper chamber unit 6 moves down, the flange of the upper chamber unit 6 contacts to the O-ring 12 provided around the lower chamber unit 5. Then, those chamber units are integrated into a single unit as a vacuum chamber. The ball bearing 13 provided in the periphery of the lower chamber unit 5 is used for adjusting the amount of elastic deformation of the O-ring 12 in the vacuum, which can be adjusted at arbitrary positions in the vertical and horizontal directions. The position of the ball bearing 12 is adjusted for optimizing the amount of elastic deformation of the O-ring 12 so that the pressure inside the vacuum chamber may be kept in a given reduced pressure state and that a maximum elasticity may be obtained. The large amount of force generated by reducing the pressure inside the chamber is supported by the lower chamber unit through the ball bearing 13. Owing to this configuration, when laminating the upper and lower substrates to be described later, the precise positioning

for those substrates can be established easily by fine adjustment of the lower chamber part T1 within the elastic region of the O-ring 12.

The housing 8 has a built-in vacuum seal so as to move
5 up and down so that any pressure leakage may not occur even if the upper chamber unit is deformed when the pressure inside the vacuum chamber formed by coupling the upper chamber unit 6 and the lower chamber unit 5 is reduced. Owing to this configuration, the applied force to the shaft 9 developed by the deformation
10 of the vacuum chamber can be absorbed, and the deformation of the pressurizing plate 7 supported by the shaft 9 can be prevented generally. Thus, the upper substrate 1b attracted and adsorbed to the lower surface of the pressurizing plate 7 by the adhesive member 18b and the lower substrate 1a supported
15 by the table 4 can be laminated while their horizontal situation can be maintained. The up-and-down movement of the pressurizing plate 7 is performed by the drive mechanism, not shown, installed at the upper part of the shaft 9.

The vacuum pipe 14 installed at the side surface of the
20 upper chamber unit 6 is connected to the negative pressure source through the vacuum valve and the pipe hose, not shown. These components are used for reducing the pressure inside the vacuum chamber to a given pressure level. The leak valve 17 is provided for adjusting the vacuum level (reduced pressure

level) inside the vacuum chamber to increase the pressure at an arbitrary pressure level. The gas purge valve and tube 15 is connected to the pressure source such as Nitrogen gas (N₂) or clean dry air, and used for restore the pressure inside the vacuum chamber to the atmospheric pressure.

The image recognition cameras 22a and 22b are installed for reading the positioning markers provided on the upper and lower substrates 1b and 1a. Transparent view ports 23a and 23b for the image recognition cameras 22a and 22b are provided above the holes 6a and 6b formed in the upper chamber unit 6 in order to establish the vacuum sealing to prevent the air from flowing through the holes 6a and 6b into the chamber. The small-sized holes 7a and 7b are provided also on the pressurizing plate 7, the image recognition cameras can view the positioning marks formed on the substrate through those holes 7a and 7b.

Next, by referring to FIG. 1 and FIG. 2, the mechanisms of the adhesion part supporting the upper substrate 1b and its drive part. FIG. 2 shows a detail structure of the adhesion and support mechanism part.

As shown in FIG. 2, an open port 30 is provided at the pressurizing plate 7 or the table 4, and the cartridge 35 having the adhesive member 18 is installed at one end part of the rotating shaft 33 inside the open port 30 and this cartridge can be replaced. The rotating actuator 32 is provided at the

other end part of the rotating shaft 33, and the rotating actuator 32 is fixed at the movable table 36. One end of the up-and-down drive shaft 38 moving in the vertical direction is connected and fixed at the fixing member 37, and the up-and-down
5 actuator for driving in the vertical direction is provided at the other end of the up-and-down drive shaft 38. In addition, the cavity route 39 connected to the negative pressure source is provided inside the pressurizing plate 7 and the table 4, and a plural of suction ports 7d and 7c are provided so as to
10 pass through from the cavity route 39 to the surface of the pressurizing plate 7 and the table 4. The cavity route 39 also connects to the open port 30.

For the individual actuators 31 and 32 shown in FIG. 2, the symbol "a" is assigned to one in associate with the
15 pressurizing plate and the symbol "b" is assigned to the other in associate with the table. In responsive to the operation of the actuators 31b and 32b at the pressurizing plate, the adhesive member 18b moves up and down and rotates within the open port 30b. The shaft 33b is sealed by the seal 34b so as
20 to move up and down and rotate freely directly below the actuator 31b. The open port 30b connects to the cavity route 39b, and connects to the negative pressure source through the valve not shown, and thus such a structure that the upper substrate 1b can be attracted and adsorbed is established. In stead of making

the open port 30b and the suction port 7d connected to each other within the pressurizing plate 7 as shown in the figure, it is allowed that those can be connected by the channel formed on the surface of the pressurizing plate 7 contacting to the substrate for connecting between the open port 30b and the suction port 7d.

The upper substrate 1b can be supported so as to contact firmly to adhesive member 18b due to its adhesive action without making the upper substrate attracted and adsorbed to the lower surface of the pressurizing plate 7. In this configuration, in order to support the upper substrate 1b so as to be horizontally opposed to the lower substrate 1a, a plural of adhesive members 18b are provided at designated positions accordingly with their spacing and adhesive area for the size and the shape of the upper substrate 1b.

In this embodiment, in which the rotating actuator 32 for rotating the adhesive members 18b and the up-and-down actuator 31 for moving vertically the adhesive members are provided independently, it is allowed that a single actuator having those functions may be configured by using a ball screw and like. The actuator in this embodiment can be realized by either of one using a compression air or the other using an motor drive mechanism.

As described above, the lower substrate 1a is attracted

and adsorbed by the configuration in which the lower substrate is connected to the pipe 16a, the valve and the negative pressure source, both not shown, on the table 4. In this embodiment, the adhesive member 18a is provided inside in the similar configuration to that for the pressurizing plate 7. The actuators 31a and 32a are installed below a plural of open ports 30a provided at the table 4. The adhesive member 18a is provided at the top end of the shaft 33a extending upward from the actuators 31a and 32a. The adhesive member 18a moves up and down and rotates inside the open port 10a by the operation of the actuators 31a and 32a. The shaft 33a is sealed by the seal 34a as in the similar manner to the shaft 33b so as to move up and down and rotates directly below the actuator 31a. The open port 30a connects to the suction port 7c, and connects to the pipe 16a and the negative pressure source through the valve not shown, and thus such a structure that the upper substrate 1a can be attracted and adsorbed is established.

In order to support the lower substrate 1a stably, the adhesive members 18a are also provided at the table 4 at designated positions accordingly with their spacing and adhesive area for the size and the shape of the upper substrate 1a. In stead of using the adhesive members 18a for fixing the lower substrate 1a on the table 4, it is allowed to use mechanical pins and rollers. There is a reasonable rationale why the lower

substrate 1a is fixed by pins and rollers in stead of using attractive and adsorptive means; in the process of reducing the pressure inside the chamber, the lower substrate 1a can not fixed on the table 4 due to the pressure difference occurred
5 when the vacuum level (reduced pressure level) inside the chamber excesses the vacuum level (reduced pressure level) required for attracting and adsorbing the lower substrate 1a. In order to solve this problem, the mechanism in this embodiment supports the lower substrate 1a by mechanical pins and rollers
10 in order to prevent the offset of the lower substrate 1a due to the vibration generated by the excitation source such as various drive sources originated from the apparatus itself, the floor and the negative pressure source, or the resistance generated in contacting the seal and the liquid crystal panel
15 when laminating the upper and lower substrates.

Next, by referring to FIGS. 3 to 6, what are described are the procedures for manufacturing the liquid crystal display apparatus in the substrate assembly apparatus in accordance with the present invention. FIG. 3 shows a flowchart for
20 procedures for laminating the liquid crystal substrates. FIG. 4 shows the operation states of the apparatus at the individual procedural steps. FIG. 5 shows the operations of the adhesion and support mechanism in laminating the substrates. FIG. 6 is a schematic diagram for the operation of removing the adhesion

support mechanism from the surface of the substrate after the primary laminating operation.

At first, the upper liquid display substrate 1b is carried in below the pressurizing plate 7 by using a robot hand and like (Step S1). Next, the upper liquid crystal substrate 1b is attracted and adsorbed and supported by supplying the negative pressure to the attraction and adsorption port formed at the pressurizing plate 7 (Step S2). The lower liquid crystal substrate 1a is carried in above the table 4 by a robot hand or like (Step S3), and after positioning the lower liquid crystal substrate with respect to the table 4, the lower liquid crystal substrate 1a is fixed by the attraction and adsorption operation (Step S4). The sealing agent 19 is coated in a closed loop pattern on the peripheral of the upper surface of the lower liquid crystal substrate 1a, and the liquid crystal agent 20 is quantitatively dropped inside the closed pattern. In this embodiment, in which the sealing agent 19 is provided at the lower liquid crystal substrate 1a, it is allowed to provide the sealing agent on the upper liquid crystal substrate or on both of the liquid crystal substrate. The state processed up to this step is shown in FIG. 4 (a).

Subsequently, the lower chamber part T1 is moved to the position for the upper chamber part T2 (Step S5). FIG. 4 (b) illustrates the state in which the lower chamber part T1 above

the XY θ -direction drive mechanism moves to the position directly below the upper chamber part T2, and the lower liquid crystal substrate 1a and the upper liquid crystal substrate 1b are located to be opposed to each other. As described above,

5 the upper liquid crystal substrate 1b is supported by the attraction and adsorption operation by the suction port 7d with respect to the pressurizing plate 7. In addition, as the open port 30b also connects to the negative pressure source in this configuration, the upper liquid crystal substrate is also

10 attracted and adsorbed to the open port 30b. At this time, the surface of the upper liquid crystal substrate 1b and the adhesive member 18b are located apart from each other as shown in FIG. 5 (a), and the airspace between the adhesive surface of the adhesive member 18b and the upper liquid crystal

15 substrate 1b is in a designated reduced pressure (vacuum) state. Starting from this state, as shown in FIG.5 (b), the adhesive member 18b is moved toward the surface of the upper liquid crystal substrate and attracted to the upper liquid crystal substrate 1b by the operation of the actuator 31b (Step S6).

20 Thus, when attracting the adhesive member 18b to the upper liquid crystal substrate 1b, the airspace formed between the open port 30b and the surface of the substrate is in the pressure reduction state owing to the vacuum tube 16b used for the attraction and adsorption operation. Thus, it will be

appreciated that a designated adhesive force can be established even by reducing the pressure inside the vacuum chamber without the air penetrating between the substrate and the adhesive member. For example, as the pressure inside the vacuum chamber is made
5 reduced in case that an air penetrates between the substrate and the adhesive member without reducing the pressure in the airspace between the open port 30b and the surface of the substrate, the airspace between the substrate and the adhesive member expands. This makes the adhesive force decrease, which
10 cannot make the substrate attracted and supported.

This operation is also applied between the lower liquid crystal substrate 1a and the adhesive member 18a almost at the same time (Step S6), in which, as the lower liquid crystal substrate 1a is located above the table 4 in the direction of
15 the gravitational force, it is allowed that the lower liquid crystal substrate may be supported by mechanical pins and rollers instead of fixing with the adhesive member 18a.

Thus, after fixing the upper and lower substrates 1b and 1a, the upper chamber unit 6 is moved downward by the cylinder
20 1 as shown in FIG. 4 (c), and then, making the flange of the upper chamber unit 6 contact to the O-ring 12 arranged in the periphery of the lower chamber unit 6, the upper and lower chamber parts T1 and T2 are integrated to a single body (Step S7). Then, the air inside the chamber is exhausted through the

vacuum pipe 14. As the pressure inside the vacuum chamber formed by integrating the upper chamber unit 6 and the lower chamber unit 5 decreases, the difference between the pressure reduction level for attracting the upper liquid crystal substrate 1b to the pressurizing plate 7 and the pressure reduction level inside the vacuum chamber gets smaller, and the attraction and adsorption force by the pressurizing plate 7 disappears, while the upper liquid crystal substrate 1b does not come down because it is supported by the adhesive member 18b.

10 In this state, as the air does not penetrate between the adhesive surface of the adhesive member 18b and the upper substrate 1b, their fixing state can be maintained without the adhesive force changed. Thus, there is no such a problem that the adhesive force reduces due to the expansion of the air in the process of reducing the pressure and that the upper liquid
15 crystal substrate 1b comes down. As for the lower liquid crystal substrate 1a, in which the adhesive surface of the adhesive member 18a and the lower liquid crystal substrate 1a are fixed adhesively to each other without any air inserted between them,
20 the adhesive force does not decrease due to the expansion of the air or the displacement of the upper liquid crystal substrate 1b does not occur.

When the pressure inside the vacuum chamber reaches a designated vacuum level, as shown in FIG. 6 (a), the

pressurizing plate 7 is moved downward by operating the up-and-down drive mechanism on the shaft, not shown, while positioning the upper and lower substrates 1b and 1a. The operation of the up-and-down drive mechanism can generate the applied pressure having an enough intensity to enable the upper liquid crystal substrate 1b to contact firmly to or squeeze the sealing agent 19 coated in a closed loop pattern on the peripheral of the upper surface of the lower liquid crystal substrate 1a, and the upper and lower liquid crystal substrates 1b and 1a are laminated with a designated gap (Step S9). FIG. 6 (a) shows a magnified view of this state. At this step, the lower liquid crystal substrate 1a and the upper liquid crystal substrate 1b are laminated firmly with the sealing agent 19. Thus, in this configuration, even if the pressure inside the vacuum chamber is increased, the air tightness of the space inside the closed seal pattern can be maintained in a certain level, and consequently the amount of the air penetrating into the space between the finished laminated liquid crystal substrates becomes extremely small.

Next, as described above, a small amount of air is introduced into the vacuum chamber through the leak valve 17, the pressure inside the vacuum chamber is increased to a designated reduced pressure level higher than the negative pressure inside the suction port 7d, and the support of the upper

and lower liquid crystal substrates is established by the pressure difference between them (Step S10). Further positioning operation is performed by using this supporting force and the applied pressure is generated by the pressurizing plate 7 and a designated final pressuring force is attained (Step S11). This operation is required because the substrates may be displaced due to the resistance of the liquid crystal and the sealing agent when applying the pressure if additional positioning operation is not performed in the pressuring process after the upper substrate 1b contacts to the sealing agent 19.

In positioning the substrates, their positions are measured by reading the positioning markers formed on the upper and lower substrates through the view ports 23a and 23b formed at the upper chamber unit 6 with the image recognition cameras 22a and 22b and by image processing, and a high precision positioning is performed by operating finely the XY θ -direction drive mechanism, not shown, at the lower chamber T1. In this fine adjustment, the gap between the upper and lower chamber units 6 and 5 is maintained to a designated distance by the ball bear 13 so that the O-ring 12 may not be deformed extremely and a designated reduced pressure level may be established.

When removing the adhesive members 18b and 18a from the upper and lower liquid crystal substrates 1b and 1a after

laminating the substrates, the further operation is performed as shown in FIG. 6 (b). For the upper liquid crystal substrate 1b, making the actuator 32b rotate in the direction shown by the arrow, and operating the actuator 31b while or after
5 twisting the adhesive member 18b, the adhesive member 18b is lifted up from the surface of the substrate. For the lower liquid crystal substrate 1a, in the similar manner, making the actuator 32a rotate in the direction shown by the arrow, and operating the actuator 31a while or after twisting the adhesive member
10 18a, the adhesive member 18a is lifted up from the surface of the liquid crystal substrate (Step S12). This twisting operation is a necessary means for making it easier to remove the adhesive member from the liquid crystal substrate. This twisting operation may be in the direction opposite to that
15 shown in FIG 6 (b). When lifting up the adhesive members, the peripheral parts of the individual open ports 30a and 30b blocks the movement of the liquid crystal substrate 1b and 1a. Thus, those twisting operation and lifting-up operation makes it possible to remove easily the adhesive members from the liquid
20 crystal substrate.

Subsequently, the inside of the vacuum chamber is purged and its internal pressure is restored to the atmospheric pressure by introducing Nitrogen gas (N_2) or clean dry air and like into the vacuum chamber by opening the gas purge valve 15

(Step S13), and the pressurizing plate 7 is moved up by releasing the attractive operation of the suction port 7d for the liquid crystal substrate (Step S14). Next, the upper chamber unit 6 is moved up and the lower chamber part T1 is moved to its initial position (shown in FIG. 4 (a)) (Step S15), and then the laminated cell pc is extracted out from the table 4 (Step S16). The upper and lower surfaces of the laminated upper and lower substrates, that is the cell pc, is uniformly pressed by the environmental atmospheric pressure, and the gap between them reaches a designated cell gap precisely. In the end of the above procedural steps, the laminating operation for the substrates is completed. After the gap between the substrates reaches a designated cell gap in the atmospheric pressure, the laminating work is finished by hardening the sealing agent by exposing the light onto the sealing agent. There is an alternative way for fixing temporarily the sealing agent by exposing the light after completing a mechanical pressurizing operation (after completing Step S12). In this embodiment, in which the substrate is supported by the adhesive member after moving the lower chamber T1, it is allowed to perform this operation before moving the lower chamber. In addition, as for the operation for removing the adhesive member from the surface of the substrates, it is allowed to perform this operation after restoring the pressure inside the vacuum chamber to the atmospheric pressure.

In this embodiment described above, the operation for removing the adhesive member at the pressurizing plate is performed after completing the final phase of pressuring by the pressurizing plate. It is alternatively allowed that, after
5 applying a preliminary press operation to the substrates in such a state that the substrates can not be supported by attractive and adsorptive operations (only supported by contacting the adhesive members to the substrates), then the final applied pressure is applied along with the positioning of the substrates
10 by using the pressurizing plate after removing the adhesive members from the surface of the substrate while twisting the adhesive members in the state that the substrate is supported by attractive and adsorptive operations by increasing the pressure inside the chamber.

15 Next, by referring to FIGS. 6 and 7, a manufacturing method of the liquid crystal display apparatus in another embodiment of the present invention is described.

In this embodiment, after setting the upper and lower liquid crystal substrates onto the pressurizing plate and the
20 table in the similar way to that in the previously described embodiment, the pressure inside the vacuum chamber is reduced to a designated reduced pressure level. Then, as described by referring to FIG. 6 (a), the pressurizing plate 7 is moved down by operating the up-and-down drive mechanism, not shown, on the

shaft 9 while positioning the upper and lower substrates 1b and 1a. The upper liquid crystal substrate 1b is moved toward the lower liquid crystal substrate 1a until it contacts firmly to or squeeze the sealing agent 19 coated in a closed loop pattern on the peripheral of the upper surface of the lower liquid crystal substrate 1a. In the previously described embodiment, after this operation, the pressure inside the vacuum chamber is increased to a designated reduced pressure level higher than the negative pressure inside the suction port 7d, and the support of the upper and lower liquid crystal substrates is established by the pressure difference between them, and finally, the applied pressure is generated by the pressurizing plate 7 while the positioning operation is performed and a designated final pressuring force is attained.

However, in this embodiment, the pressure difference due to increasing the pressure inside the vacuum chamber is not used. In this embodiment, as shown in FIG. 7, resin 24 or rubber 25 materials having a large friction coefficient are formed partially on the surfaces of the pressurizing plate 7 and the table contacting to the substrates. When applying the positioning and pressurizing operations, the sliding motion of the liquid crystal substrates 1a and 1b in the vertical direction to the pressurizing plate 7 and the table 4 is prevented by the friction force. Owing to this configuration,

in the state that the pressure inside the chamber is not increased but kept in its reduced pressure level, finally, the applied pressure is generated by the pressurizing plate 7 while the positioning operation is performed and a designated final
5 pressuring force is attained. The above resin 24 or rubber 25 material may be formed on the whole surface area of the contacting surface of the pressurizing plate and the table. For the simplicity of the explanation, the suction port, the open port, the adhesive member and their surrounding area are not
10 shown in FIG. 7.

The operations when and after the adhesive members are removed individually from the laminated upper and lower substrates are the same as those in the previously described embodiment.

15 The present invention is not limited to the above-described embodiment but may be implemented in the following manners.

(1) In the configuration of the above embodiment, the adhesive surface of the adhesive member 18b and the upper liquid
20 crystal substrate 1b can be laminated without air inserted between them. This configuration is not used, but it is allowed that one or more suction and adsorption ports for attracting the liquid crystal substrate are provided also on the adhesive surface of the adhesive member 18b, and after contacting the

adhesive surface to the liquid crystal substrate and supporting those components with the attracting adsorbing operations in the atmospheric pressure, in order to prevent the liquid crystal substrate from falling down by extracting the expanded air
5 between the adhesive surface and the substrate promptly when generated in the process of reducing the pressure by the attracting and adsorbing means of the adhesive surface. In this case, the open port 30b is made connected to the inside of the vacuum chamber. The configuration for the lower liquid crystal
10 substrate 1a is the same as that described above. In addition, it is allowed that the open port 30b is not made connected to the suction port 7d but made connected to another negative pressure source.

(2) As for alternative way of the method (1), it is allowed
15 that the adhesive surface of the adhesive member 18b is formed in a concave and convex surface in order to prevent the air from staying in the convex part of the adhesive surface when laminating the substrates in the atmospheric pressure, and that the expanded air staying between the convex part of the adhesive
20 surface and the liquid crystal substrate generated in the process of reducing the pressure released promptly from the concave part into the inside of the vacuum chamber in order to prevent the upper liquid crystal substrate from falling down. In this case, the open port 30b is made connected to the inside

of the vacuum chamber. The configuration for the lower liquid crystal substrate 1a is the same as that described above.

(3) It is allowed that the function of the suction port is implemented by the dimples formed on the surface of the pressurizing plate 7 or the table 4 in order to attract and adsorb the individual liquid crystal substrates by using the channels formed between the dimples.

Next, by referring to FIG. 8, another embodiment of the present invention will be described.

10 In FIG. 1, a substrate supporting mechanism comprising a plural of adhesive parts and driving parts is provided in the pressurizing plate 7 or the table 4. In contrast, in the configuration shown in FIG. 8, the adhesive parts forming the substrate supporting mechanism are provided on the whole surface of the pressurizing plate 7 and the table 4. In addition, 15 in this configuration, in order to remove the adhesive members provided on the whole surface of the pressurizing plate 7 and the table 4, a plural of adhesive members removing mechanisms for removing the adhesive members from the substrate are 20 provided so as to extend from the surface of the adhesive members and contact to the surface of the substrate.

The substrate supporting mechanism in this embodiment will be described below.

The substrate supporting mechanism at the table 4 in this

embodiment comprises the iron plate 41a and the adhesive sheet 42a as an adhesive member fixed and bonded on the iron plate. In the following description, the substrate supporting mechanism is also called a laminating and supporting mechanism.

5 A suction port 7c is provided at the table 4, and this suction port 7c is provided so as to connect through the iron plate 41a and the adhesive sheet 42a of the substrate supporting mechanism. The lower substrate 1a is loaded on the substrate supporting mechanism provided on the table 4. The loaded lower substrate
10 1a is attracted and adsorbed by the suction port 7c formed at the adhesive sheet and fixed adhesively on the adhesive sheet 42a. One end of the pipe 16a is connected to the suction port 7c and the other end of the pipe is connected to the reduced pressure (negative pressure) source through the valve, not
15 shown. In this configuration, the lower substrate 1a is attracted and adsorbed to the suction port 7c with the negative pressure supplied by the negative pressure source.

The previously described substrate supporting mechanism is positioned by pressing one end of the iron plate 42a onto
20 the stopper 44a provided on one end surface of the table 4, and its position is maintained by the press screw 45a pressing the other end surface of the iron plate 41a through the bracket 44a provided on the other end surface of the table 4. A plural of magnets 43a are provided inside the table 4, and the iron plate

41 is adsorbed and supported by the magnetic force. In this configuration, the substrate supporting mechanism is supported on the table 4 by the magnetic force of the magnet and the force of the press screw 45a.

5 The substrate supporting mechanism for the pressurizing plate is provided on the surface of the pressurizing plate 7 facing to the table 4. This substrate supporting mechanism has the iron plate 41b on its part for the pressurizing plate 7 as similarly for the table side, and has the adhesive sheet 42 on
10 its part for the table 4.

 The suction port 7d for attraction and adsorption operation is provided at the pressurizing plate 7, and the suction port 7d is connected through the iron plate 41b and the adhesive sheet 42b of the substrate supporting mechanism. The
15 upper substrate 1b is attracted and adsorbed to the suction port 7d provided on the lower surface of the adhesive sheet 42b. One end of the pipe 16b is connected to this suction port 7d, and the negative pressure source is connected to the other end of the pipe 16b through the valve, not shown. In this configuration,
20 by supplying the negative pressure from this negative pressure source, the upper substrate 1b is attracted and adsorbed to the surface of the adhesive sheet 42b, and fixed adhesively.

 In the similar manner to the previously described case for the table 4, the substrate supporting mechanism is

positioned to and supported by a plural of magnets 43b arranged inside the pressurizing plate 7, the stopper 44b for positioning the substrates, and the pressurizing plate 7 by the press screw 45b for pressing the end surface of the iron plate 41b through the bracket 46b provided at the pressurizing plate 7.

A plural of removing mechanisms are provided on the table 4 and the pressurizing plate 7 in order to remove the adhesive sheets 42a and 42b from the surface of the substrates. Those removing mechanisms comprise the press shafts (press member) 48a and 48b, and the actuators 47a and 47b for forming the drive mechanism for driving the press shaft in the vertical direction. In this configuration, the open ports 30a and 30b in which the press shafts 47a and 47b moves are connected to the fluid channels of the suction ports 7c and 7d, and thus, the attractive and adsorptive forces may be developed at the open ports 30a and 30b. In stead of making the open port 30b and the suction port 7d connect to each other inside the pressurizing plate 7 as shown in the figure, it is allowed that a channel bridging the open port 30b and the suction port 7d is formed on the surface of the pressurizing plate 7 contacting to the substrate in order to make the open port 30b and the suction port 7d connect to each other. In case that the attracting and adsorbing operations by the open port 30b and the pressurizing and separating operations are not applied, it is allowed that the open port

30b is extended outside the pressurizing plate 7 instead of sealing with the seal 34b in order to make the pressure inside the open port 30b equivalent to the pressure inside the chamber.

The upper substrate 1b can be supported firmly on the lower
5 surface of the adhesive sheet 42b with its adhesive action without attracting and adsorbing the substrate on the lower surface of the pressurizing plate 7. The adhesive sheets 42b are provided accordingly with their spacing and adhesive area for the size and the shape of the upper substrate 1b so as to
10 support the upper substrate 1b horizontally facing to the lower substrate 1a. In this embodiment, the lower substrate 1a has the same structure with respect to the table 4 as described above.

Next, by referring to FIG. 9, the process for
15 manufacturing the liquid crystal display apparatus will be described. FIG. 9 shows a flowchart of laminating procedures. At first, the upper liquid display substrate 1b is carried in by using a robot hand and like (Step S100) and supported by the adhesive action and the attracting and absorbing operations at
20 the adhesive sheet 42b below the pressurizing plate 7 (Step S102). As the substrate is attracted and adsorbed by applying the negative pressure to the suction port as well as supported by the adhesive action of the adhesive sheet 42b, the probability that the airspace remains between the liquid

crystal substrate and the adhesive sheet owing to the negative pressure for the suction work may be reduced in comparison with the case that the substrate is supported only by the adhesive action without attracting and adsorbing operations. In case
5 that the pressure of the circumferential region of the liquid crystal substrate is made reduced while any airspace remains between the liquid crystal substrate and the adhesive sheet, the airspace remaining between the adhesive sheet 42b and the upper liquid crystal substrate 1b may expand, and hence there
10 is such a potential that the reduced adhesive force may cause the upper liquid crystal substrate 1b to fall down. In the previously described embodiment, the surface of the adhesive sheet contacting to the liquid crystal substrate is made flat. In order to increase further the security for preventing the
15 upper liquid crystal substrate from falling down, by forming convex and concave parts or channels in the region on the surface of the adhesive sheet broader than the area of the liquid substrate in order to prevent the growth of the remaining airspace due to the negative pressure applied onto the adhesive
20 surface, and it is allowed to form the convex and concave parts so that the contained air may be released outside the substrate through the convex part of the adhesive surface even if there may occurs a remaining airspace and the remaining airspace may expand due to the pressure reduction in the circumferential area.

In one method for implementing this configuration, the suction port for attracting and adsorbing the liquid crystal substrate is formed on the convex surface. In the other method for implementing this configuration, making the region for convex and concave parts and channels slightly smaller than the periphery of the substrate and forming the suction port on the concave surface in order to extracting the air from the concave surface, it will be appreciated that the liquid crystal substrate can be prevented from falling down. In this case, it is more effective that the formation of the suction port on the convex surface makes it possible to suck the expanded air remaining in the convex surface from the convex surface as well as from the concave surface.

The lower liquid crystal substrate 1a is also carried in by a robot or like (Step S103) and is fixed to the adhesive sheet 42a located above the table 4 with the adhesive action and the vacuum adsorbing operation (Step S104). In this embodiment, the liquid crystal agent 20 is dropped on the lower liquid crystal substrate and the adhesive agent 19 for sealing the circumferential area is coated on the lower liquid crystal substrate. As there is such a potential that the airspace remaining between the adhesive sheet 42a and the lower liquid crystal substrate 1a may expand and the lower liquid crystal substrate 1a may be displaced in case of reducing the pressure

at the circumferential area of the liquid crystal substrate, the convex and concave parts and the channels are formed on the adhesive sheet in the similar manner to the case for the upper liquid crystal substrate 1b. As the lower liquid crystal substrate 1a is located above the table 4 in the direction of the gravitational force, it is allowed to fix the lower liquid crystal substrate 1a with the mechanical pins or rollers instead of using the adhesive sheet 42a. In this embodiment, in which the adhesive agent 19 is coated on the lower liquid crystal substrate 1a, it is allowed to coat the adhesive agent 19 on the upper liquid crystal substrate 1b.

As shown in FIG. 8, starting from the state in the end of Step S104, the lower chamber part T1 above the XY -direction drive mechanism moves to the position directly below the upper chamber part T2 (Step S105). The lower liquid crystal substrate 1a and the upper liquid crystal substrate 1b face to each other, and the cylinder 11 makes the upper chamber unit 6 moves down and the flange of the upper chamber unit 6 contact to the O-ring 12 arranged at the periphery of the lower chamber unit 5, and finally the upper and lower chamber units T1 and T2 are integrated into a single body (Step S106). Then, the pressure inside the chamber is reduced and the exhausted air is led out from the vacuum pipe 14. (Step S107). As the pressure inside the vacuum chamber formed as a single body with the upper chamber

unit 6 and the lower chamber unit 5 integrated together reduces, the difference between the reduced pressure level for adsorbing the upper liquid crystal substrate 1b at the pressurizing plate 7 and the reduced pressure level inside the vacuum chamber becomes small and then the attracting and adsorbing action at the pressurizing plate 7 disappears. However, the adhesive sheet 42 supports the upper liquid crystal substrate 1b adhesively. At this time, as above described convex and concave surfaces and channels are formed on the adhesive surface of the adhesive sheet 42b, there never occurs such a problem as the reduction of adhesive force or the drop-down of the upper liquid crystal substrate 1b due to the air expansion in the pressure reduction operation. In addition, as above described convex and concave surfaces and channels are also formed on the adhesive surface of the adhesive sheet 42a for the lower liquid crystal substrate 1a, there never occurs such a problem as the reduction of adhesive force or the displacement of the lower liquid crystal substrate 1a due to the air expansion in the pressure reduction operation.

Now that the pressure inside the vacuum chamber reaches a designated reduced pressure level, the pressurizing plate 7 is moved down by operating the up-and-down drive mechanism, not shown, on the shaft 9 while positioning the upper and lower liquid crystal substrates 1b and 1a, and then the upper and lower

liquid crystal substrates 1b and 1a are laminated with a designated applied pressure (Step S108).

In positioning the substrates, at first, the positioning markers formed on the upper and lower substrates are read through the view ports 23a and 23b formed at the upper chamber unit 6 with the image recognition cameras 22a and 22b. In the image processing part, the image signals transmitted from the cameras are processed and the position of the makers are estimated, and then, a high precision positioning is performed by operating finely the $XY\theta$ -direction drive mechanism, not shown, at the lower chamber T1. . In this fine adjustment, the gap between the upper and lower chamber units 6 and 5 is maintained to a designated distance by the ball bear 13 so that the O-ring 12 may not be deformed extremely and a designated reduced pressure level may be established.

After laminating the substrates, the procedural step enters the operation for removing the adhesive members 42b and 42a from the upper and lower liquid crystal substrates, that is, cell pc. This operation is performed in the process shown by FIG. 10 and FIG. 11. FIG. 10 and FIG. 11(a) shows the state after laminating the substrates in the chamber with its inside pressure reduced. In this state, as shown in the figures, the press shafts 48b and 48a (hereinafter referred to also as press pin) inside the open ports 30b and 30a are located apart from

the liquid crystal substrates 1b and 1a of the cell pc. Next, as shown in FIG. 11(b), for the upper liquid crystal substrate 1b forming the cell pc, the press shaft 48b is moved down in the direction shown by the arrow by operating the actuator 47b, and the surface of the laminated upper liquid crystal substrate 1b is pressed with a designated pressure level (Step S109), and the pressurizing plate 7 is moved up in this state (Step S110). At this time, as the press shaft 48b presses down the upper liquid crystal substrate 1b of the cell pc with a designated pressure, it can remove the adhesive sheet 42b from the upper liquid crystal substrate 1b (this removing method is hereinafter referred to also as pressurizing removing) (Step S111). Then, the press shaft 48b is moved up and set apart from the upper liquid crystal substrate 1b (Step S112). Next, the pressure inside the chamber is recovered to the atmospheric pressure, and the upper chamber unit 6 is moved up (Step S113). The remaining cell pc can be removed from the adhesive sheet 42a by moving up the lower press shaft 48a (Step S114). After all, the laminated liquid crystal substrate (liquid crystal cell pc) is carried out by moving the lower chamber in the horizontal direction (Step S115).

For the step of removing the adhesive sheet 42b from the upper liquid crystal substrate 1b of the cell pc, what is described in the above embodiment is a pressurizing removing

process in which the press shaft 48b applies a designated pressure level to the upper substrate 1b. Alternatively, it is allowed that the stop position of the shaft 48b is fixed temporarily when the press shaft 48b moves down and contacts
5 to the upper liquid crystal substrate 1b, and then the pressuring plate 7 is moved up and the press shaft 48b is moved down synchronously in the length equivalent to the length for moving up the pressurizing plate 7, in order to remove the adhesive sheets without altering their positions (this removing
10 method is hereinafter referred to also as position fixing removing).

It will be appreciated that, if the surface of the adhesive sheet is partially separated from the adhesive sheet 42b and the upper liquid crystal substrate 1b by ejecting the
15 positive-pressure air or gas to the surface of the upper liquid crystal substrate 1b from the suction port 7d and the open port 30b prior to removing the adhesive sheet 42b from the upper substrate 1b of the cell pc with the press operation of the press shaft 48b, the substrate can be removed only by pushing the press
20 shaft 48b without applying any excessive pressure forced to the upper liquid crystal substrate. When removing the lower liquid crystal substrate 1a of the cell pc from the adhesive sheet 42a, it will be appreciated that, if the surface of the adhesive sheet is partially separated from the adhesive sheet 42a and the lower

liquid crystal substrate 1a by ejecting the positive-pressure air or gas to the surface of the lower liquid crystal substrate 1a from the suction port 7c and the open port 30a prior to the pushing operation with the press shaft 48a, the substrate can
5 be removed only by pushing the press shaft 48a without applying any excessive pressure forced to the lower liquid crystal substrate. In the above embodiments, in which the adhesive member is composed of a single adhesive sheet, it is allowed that, in case that the size of the substrates to be laminated
10 is larger, that is, the size of the pressurizing plate 7 and the table 4 is larger, a plural of separated adhesive sheets may be provided on the surface of the pressurizing plate 7 and the table 4.

In addition, in this embodiment, in which the adhesive
15 mechanism is provided on the pressurizing plate 7 with the aid of the table 4 with the iron plates 41 and 41b, it is allowed that plate members such as plastic or ceramic may be provided instead of using the iron plates. In this case, it is required to make robust the mechanism for fixing the plate member made
20 of plastic or ceramic at the pressurizing plate 7 and the table 4. In addition, the adhesive mechanism in this embodiment is also realized as another method in which the adhesive member is directly provided on the surface of the table or the pressurizing plate.

It is allowed that the actuator 44b embedded inside the pressurizing plate 7 may be configured as a single unit for driving a plural of press shafts 48b. The actuator 44a embedded inside the table 4 may be configured in the similar structure.

5 Next, by referring to FIG. 12, another embodiment of the present invention will be further described.

In this embodiment, the configuration of the removing mechanism for removing the adhesive member from the surface of the substrate is modified. In the removing mechanism in this
10 embodiment, the pin support plate 55 (fixing plate) on which a plural of press pins (press shafts) 48 extending toward the pressurizing surface are provided are fit with the press spring support pin 56, the press spring 54 and the pin support plate stopper 53 provided on the pressurizing surface plate 7n of the
15 pressurizing plate 7 so as to move upward and downward feely inside the pressurizing plate 7. The support plate 57 is provided above the pin support plate 55 (at the surface opposite to the pressurizing surface), and the adhesive member 42 is removed from the surface of the upper liquid crystal substrate
20 with the press spring 48 pushing the surface of the upper liquid crystal substrate 1 by means that the support plate 57 pushes the pin support pushing shaft 51 expanded by the cylinder 50 mounted at the drive plate provided at the shaft 9 driving the pressurizing plate. The bellows 58 is provided between the drive

plate of the shaft 9 and the upper chamber 6, which makes it possible to maintain the reduced pressure state inside the chamber even if reducing the pressure inside the chamber. In addition, the seal member 52 is also provided between the pin support plate pushing shaft 51 and the upper chamber unit 6, which enables to maintain the reduced pressure state inside the chamber.

The table 4 side has almost the same structure as the pressurizing plate side. The difference from the pressurizing plate side is that the cylinder 60 used as the drive source for moving upward and downward the pin support plate pushing shaft 62 is provided at the lower chamber unit. Though it is allowed that the cylinder 50 is also provided at the upper chamber unit 6 for the pressurizing plate side, it is required to make the stroke for the pin support plate pushing shaft 51 larger by the displacement of the pressurizing plate 7 for its compensation because the pressurizing plate 7 moves upward and downward in this case.

As described above, in this embodiment, there is such an advantageous effect that the individual drive source is not required to be provided for the individual push pin, and that the configuration of the apparatus can be simplified.

As described above, in this embodiment, an attraction and adsorption mechanism comprising a plural of adsorption holes

and an adhesive support mechanism having a adhesive member formed in a sheet are provided at either one of the pressurizing plate or the table, and the substrate is attracted and supported as well as adhered and supported in the atmospheric pressure, 5 the substrate is supported by the adhesive force even if the attracting and adsorbing force may be reduced in the process of reducing the pressure inside the chamber, the substrates are laminated by pressing the substrates in a designated reduced pressure level, and finally, after laminating the substrates, 10 the adhesive member is removed from the surface of the laminated substrates by using the removing mechanism comprising a plural of pushing shafts provided at the pressurizing plate and the table.

As described above, by combining both of the attractive 15 force and the adhesive force, it will be appreciated that the liquid crystal substrates can be supported without displacement even if the pressure of the chamber is reduced while the liquid crystal substrate supported under the atmospheric pressure, and a high-precision lamination work can be established, and that 20 the adhesive members can be removed from the surface of the liquid crystal substrate after the lamination work is completed.

In the above description, it is assumed that the substrate is used for the liquid crystal display apparatus, but it is

apparent that the present invention can be applied to the substrates used for the plasma display and electro-luminescence (EL) display apparatus and the assembly process of those display apparatus.

5 According to the present invention, it will be appreciated that the manufacturing process failure in the vacuum processing environment can be prevented even if the size of the liquid crystal substrate becomes larger and its thickness becomes smaller, and that the liquid crystal substrates can be
10 laminated with high precision.

 Although the present invention has been illustrated and described with respect to exemplary embodiment thereof, it should be understood by those skilled in the art that the foregoing and various other changes, omission and additions
15 may be made therein and thereto, without departing from the spirit and scope of the present invention. Therefore, the present invention should not be understood as limited to the specific embodiment set out above but to include all possible embodiments which can be embodied within a scope encompassed
20 and equivalent thereof with respect to the feature set out in the appended claims.

WHAT IS CLAIMED IS:

1. A liquid crystal display apparatus manufacturing method in which one of a pair of liquid crystal substrates to be laminated is supported by an adhesion and support mechanism mounted to a pressurizing plate, the other of the pair of liquid crystal substrates to be laminated, on which an adequate amount of liquid crystal is dropped, is supported on a table, and the pair of liquid crystal substrates face to each other and are laminated by an adhesive agent placed on either of the pair of liquid crystal substrates with a narrowed gap in a reduced pressure, wherein

the one of the pair of liquid crystal substrates is attracted and adsorbed to the pressurizing plate by applying an attractive and adsorbing force in an atmospheric pressure;

an open port, accommodating an adhesive member of the adhesion and support mechanism, of the pressurizing plate is maintained in a negative pressure state for attraction and adsorption; and

the one of the pair of liquid crystal substrates is supported by the adhesive member by operating the adhesion and support mechanism for exerting an adhesive force of the adhesive member on the one of the pair of liquid crystal substrates with the open port maintained in the negative pressure state.

2. A liquid crystal display apparatus manufacturing method according to claim 1, wherein after supporting the one of the pair of liquid crystal substrates with the adhesive member of the adhesion and support mechanism and laminating both the liquid crystal substrates with a designated applied pressure, the adhesive member is removed from a surface of the one of the pair of liquid crystal substrates while or after twisting the adhesive member.

3. A liquid crystal display apparatus manufacturing method according to claim 1 or 2, wherein both the liquid crystal substrates are laminated within a chamber with its designated reduced pressure level, and next, after maintaining the chamber in an atmospheric condition by pressurizing the chamber, the adhesive member is removed from the surface of the one of the pair of liquid crystal substrates by driving the adhesion and support mechanism while causing a pressurizing force provided by the pressurizing plate to be exerted.

4. A liquid crystal display apparatus manufacturing method in which one of a pair of liquid crystal substrates to be laminated is supported by an adhesion and support mechanism mounted to a pressurizing plate, the other of the pair of liquid crystal substrates to be laminated is supported on a table, and the pair of liquid crystal substrates face to each other and are laminated by an adhesive agent placed on either of the pair of liquid crystal substrates with a narrowed gap in a reduced pressure environment, wherein the one of the pair of liquid crystal substrates is supported by an adhesive member of the adhesion and support mechanism, the adhesive member being included in an open port, maintained in a negative pressure state of the pressurizing plate; and

after laminating the pair of liquid crystal substrates, the adhesive member is moved away from the one of the pair of liquid crystal substrates into the open port while or after being twisted.

5. A liquid crystal display apparatus manufacturing method according to claim 4, wherein a chamber formed so as to house said substrates is depressurized to a designated reduced pressure level, said pressurizing plate is operated, said substrates are laminated by squeezing an adhesive agent placed on either one of said substrates, said chamber is pressurized up to such a reduced pressure level as required to enable to support said substrates by attraction and adsorption, positioning markers are observed in an attraction and adsorption state, an applied pressure is applied to said pressurizing plate while positioning until a designated applied pressure level is attained, and then said adhesive

member is twisted and moved away from the one of the substrates.

6. A substrate assembly apparatus, comprising a pressurizing plate for supporting one of a pair of liquid crystal substrates to be laminated, an adhesion and support mechanism mounted to said pressurizing plate, and a table supporting the other of said pair of liquid crystal substrates to be laminated, in which a gap between said pair of substrates is narrowed by a drive mechanism mounted to at least either of said pressurizing plate and said table, and said substrates are laminated with an adhesive agent placed on at least one of said substrates in a reduced pressure atmosphere, wherein

said pressurizing plate is provided with a plurality of suction ports through which a negative pressure acts on the one of the substrates to thereby support the one thereof; and

a gas flow channel is provided, said gas flow channel connecting said suction port to an open port in which an adhesive member of said adhesion and support mechanism is contained.

7. A substrate assembly apparatus according to claim 6, wherein said adhesion and support mechanism has a drive mechanism for twisting and moving said adhesive member away from the one of the substrates.

8. A substrate assembly apparatus according to claim 6 or 7, wherein an adhesion and support mechanism is mounted to said table.

9. A liquid crystal display apparatus manufacturing method in which one of a pair of liquid crystal substrates to be laminated is supported by a pressurizing plate, the other of the pair of the liquid crystal substrates to be laminated, on which an adequate amount of liquid crystal is dropped, is supported on a table, and the pair of liquid crystal substrates are faced to each other and laminated by an adhesive agent placed on either of the pair of liquid crystal substrates with a narrowed gap in a vacuum, wherein the one of

the pair of liquid crystal substrates is attracted with a negative pressure supplied through an attraction and adsorption hole and is supported by an adhesive member having a convex and concave surface and removably mounted to the pressurizing plate, and after laminating both the liquid crystal substrates, the adhesive member is removed from a liquid crystal substrate by extending at least one or more pushing member from the pressurizing plate in order to push the liquid crystal substrate.

10. A liquid crystal display apparatus manufacturing method according to Claim 9, wherein the other of the pair of liquid crystal substrates is supported by an additional adhesive member mounted to the table, and after laminating both the liquid crystal substrates, the additional adhesive member is removed from a liquid crystal substrate by causing at least one or more pushing member mounted to the table to protrude from the surface of the other of the pair of liquid crystal substrates in order to push the other of thereof.

11. A substrate assembly apparatus in which one of a pair of substrates is supported at an upper area of a vacuum chamber, the other of said pair of substrates to be laminated is supported at a lower area of said vacuum chamber, and said substrates face to each other and are laminated with an adhesive agent placed on at least either of said substrates in a reduced pressure atmosphere with a gap between said substrates narrowed, comprising:

- a pressurizing plate and a table adapted to support the one of the substrates and the other thereof respectively;

- a plurality of adsorption holes which said pressurizing plate has, attraction and adsorption being performed through said plurality of adsorption holes with said chamber maintained in an atmospheric pressure;

- an adhesion and support mechanism having an adhesive member formed in a sheet so as to be added to and removed from said pressurizing plate; and

- a removing mechanism comprising a substrate pushing shaft for

removing said adhesive member from the surface of the one of said substrates supported by said adhesion and support mechanism by performing said attraction and adsorption and a drive mechanism for driving said substrate pushing shaft.

12. A substrate assembly apparatus according to claim 11, wherein an adhesion and support mechanism and a removing mechanism comprising a substrate pushing shaft and a drive mechanism for driving said pushing shaft are provided which are suitable for said table.

13. A substrate assembly apparatus according to claim 11 or 12, wherein said adhesion and support mechanism is so configured that said adhesive member is bonded to an iron plate and that a support action is established by a magnet mounted to said pressurizing plate or said table.

14. A substrate assembly apparatus according to claim 11 or 12, wherein a penetration hole is provided at a part of said adhesion and support mechanism where said substrate pushing shaft of said removing mechanism can move.

15. A substrate assembly apparatus according to Claim 11, wherein a suction port for attracting and adsorbing operation is provided at said pressurizing plate and a penetration hole for attracting and adsorbing operation is provided at said adhesion and support mechanism so as to connect continuously to a surface to be used for attracting operation on the one of said substrates in association with said suction port, and an adhesive member is so as to extend outside from said penetration hole.

16. A substrate assembly apparatus according to Claim 11, wherein said removing mechanism is composed of a fixing plate provided with a plurality of pushing shafts and a drive mechanism for driving said fixing plate.