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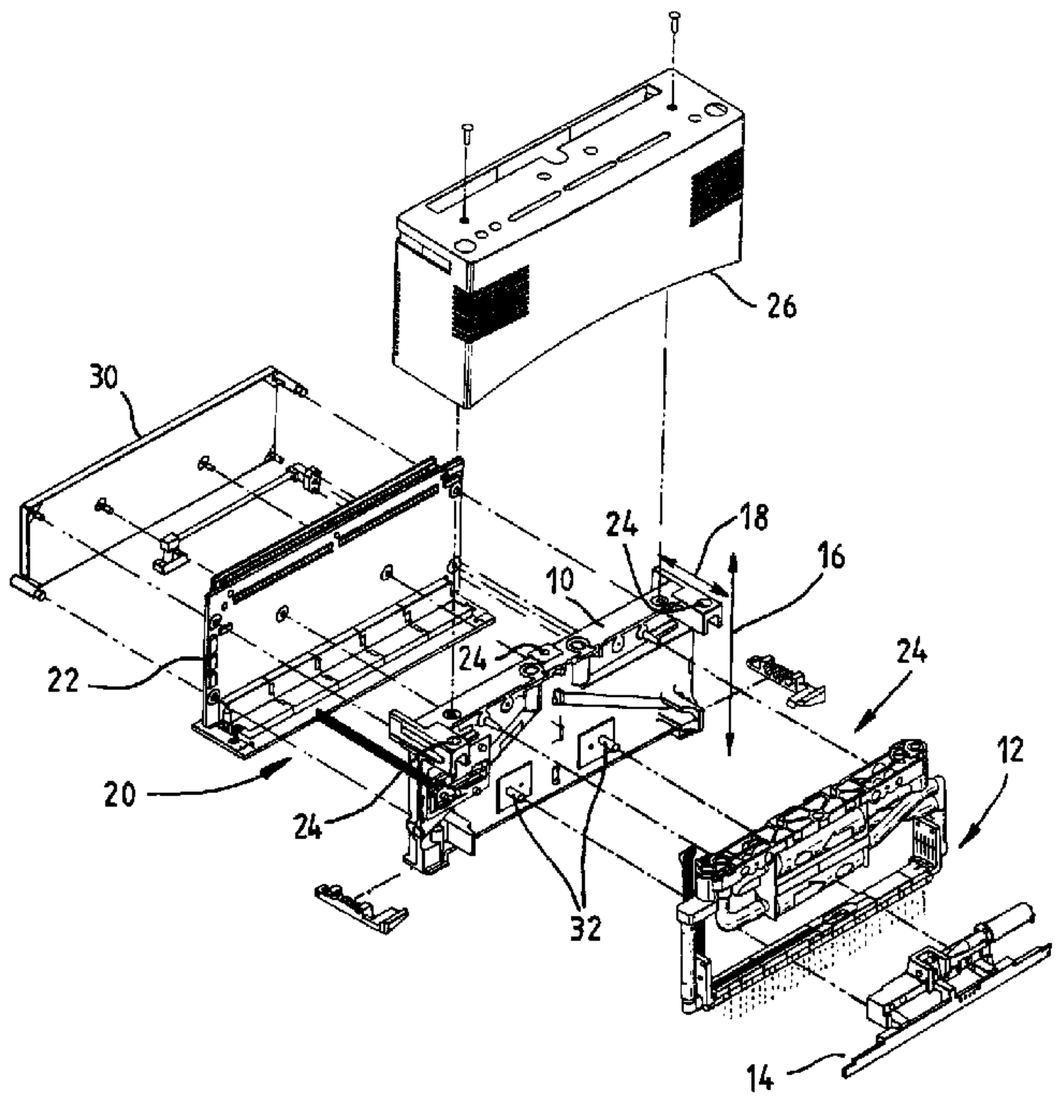
(54) **CHASSIS MONOLITHIQUE D'IMPRESSION A JET D'ENCRE**
(54) **MONOLITHIC INK JET PRINTING CHASSIS**



(57) A printhead alignment apparatus is provided for use with a continuous ink jet printer. A single chassis maintains alignment of the droplet generator and the catcher/charge plate assembly. Electronic and fluidic components are attached to the single chassis, with the single chassis separating the electronic and fluid related functions of the printhead. Also, mounting features and connections of the electronic and fluid related functions are separated from mounting features of the catcher and the droplet generator. Connections for the electronic and fluid related functions are in a plane parallel to the plane of the catcher. The single chassis also accurately locates an eyelid mechanism relative to the droplet generator and the catcher/charge plate assembly. Finally, the single chassis has a z-axis length larger than its x-axis depth, with the z-axis length being perpendicular to a plane of the catcher.

ABSTRACT OF THE DISCLOSURE

A printhead alignment apparatus is provided for use with a continuous ink jet printer. A single chassis maintains alignment of the droplet generator and the catcher/charge plate assembly. Electronic and fluidic components are attached to the single chassis, with the single chassis separating the electronic and fluid related functions of the printhead. Also, mounting features and connections of the electronic and fluid related functions are separated from mounting features of the catcher and the droplet generator. Connections for the electronic and fluid related functions are in a plane parallel to the plane of the catcher. The single chassis also accurately locates an eyelid mechanism relative to the droplet generator and the catcher/charge plate assembly. Finally, the single chassis has a z-axis length larger than its x-axis depth, with the z-axis length being perpendicular to a plane of the catcher.

MONOLITHIC INK JET PRINTHEAD CHASSIS

Technical Field

The present invention relates to the filed of continuous ink jet printers and, more particularly, to a device that provides a structurally sound and precision platform that facilitates mounting of electrical, mechanical, and fluidic ink-jet printhead components while keeping size and part count to a minimum.

Background Art

High resolution ink-jet printheads use a droplet emitter, known as a droplet generator, and a plurality of droplet deflection electrodes, known as a catcher/charge plate, in precise alignment to create the "ink-jet" technology area of a printhead. A bridge, structure, chassis, or even the catcher itself is normally used as a rigid link to hold the droplet generator and catcher/charge plate in precise alignment, as is described and claimed in U.S. Patent Nos. 5,455,611; 5,475,411; and 5,475,409. As these components must be critically aligned, the aligned structure is normally designed to be a customer replaceable service component.

Printheads for long array continuous ink jet printers include, in addition to these components, support electronics such as data handling electronics including charge plate drivers, fluid filters, and connections. These components normally are attached to a second frame or chassis. The structure which maintains the alignment of the ink jet components is then attached to this second chassis. The printhead covers are also attached to this second chassis. The printhead is typically

located at the print station by a combination of features, some associated with the first chassis and some associated with the second chassis.

The customer replaceable printheads for short array printers, for example printers having a print swath of about 1", typically do not include many of these fluid and electronic support components. Rather, they are attached to a structure or chassis which is part of a print station which is not customer replaceable. The chassis or frame of the aligned customer replaceable printhead also attaches to the chassis of the print station. Covers and locating features for locating the print station/printhead are attached to this second chassis which is part of the print station.

The current art, which includes a bridge, locking structure, or chassis to maintain alignment of the droplet generator and catcher/charge plate, and a second frame or chassis to hold the electronic and fluid support components, exhibits many undesirable traits and functional deficiencies. For instance, the "foot-print" (square inch area around print array that is dedicated to the chassis that holds the droplet generator and catcher/charge plate together) and surrounding geometry (also known as the base) is described by dividing the square inch area at the base by the print array length. The foot-print ratio is 14 on current wide bar products and is considered to be quite large. A low single digit number is desirable.

Another problem with the current art is that current continuous ink-jet printheads require a plethora of discrete electrical, mechanical, and fluidic connections to be made by the end user. Prior art attempted to address this issue, but still

required connections to be made in several planes. This made printhead construction difficult.

A third problem with the current art is that mechanical forces that are used to constrain ink-jet printheads in their working environment can be large. With the mix of locating features attached to the ink jet alignment chassis and the support component chassis, movement can and does occur between the drop generator and the catcher/charge plate. This is a very undesirable because it will degrade printhead life and can cause a complete printhead failure. Thermal gradients between the droplet generator, catcher/charge plate, and the ink jet alignment chassis can also cause movement and shorten printhead life.

Yet another problem with the existing art is that all continuous ink-jet printheads require positive pressure purified air around the ink-jet array which improves printhead life. This can prove difficult to achieve in current art because of the cavernous areas created by the large foot-print described above. For the shorter array printhead, the critical ink-jet components are exposed to a dirty environment during handling and installation since the covers are attached to the print station, not the customer replaceable printhead.

The use of a two chassis system is also a problem with the internal "eyelid" of a printhead. The eyelid functions as a shutter for the ink-jet array and needs to maintain a precise relationship to other ink-jet components. The eyelid actuation components have been attached to the support component chassis. The alignment of the eyelid to the ink jet components has been less than ideal as a result. Current art continuous ink-jet printheads

with two chassis ~~has~~ **have** produced a system having over-constrained or complex mechanical interfaces. An over-constrained printhead has undesirable internal movement and can have a complex mechanical interface which will lead to difficult mating designs.

Yet another problem with the existing art is that EMI shielding and "skins" are attached to the support component chassis which also supports the ink-jet alignment chassis. These shielding covers have been found to distort the support component chassis, which in turn can distort the ink-jet alignment chassis, resulting in movement between critical ink-jet components.

It is seen, therefore, that it would be desirable to have an ink jet printhead chassis system capable of overcoming the problems associated with the prior art.

Summary of the Invention

This need is met by the monolithic ink jet printhead chassis that allows ink-jet printhead mechanical, electrical, and fluidic functions to be precisely and rigidly tied together.

In accordance with one aspect of the present invention, the problems with the prior art are overcome by using a single highly rigid frame or chassis which serves to maintain the alignment of the ink-jet components and to which all the electronic and fluid components are attached. The central location of this chassis serves to isolate the electronic support components from the fluid related components, minimizing the risk to the electronic components due to a catastrophic failure

of an ink jet component. It further serves to improve the flow of clean air around the critical ink jet components.

Accordingly, it is an advantage of the present invention that it provides a structurally sound and precision platform for the ink jet printhead. It is a further advantage of the present invention that the monolithic ink jet printhead chassis facilitates mounting of electrical, mechanical, and fluidic printhead components. Finally, it is an advantage of the present invention that it minimizes part numbers and structure size.

Other objects and advantages of the invention will be apparent from the following description, the accompanying drawing and the appended claims.

Brief Description of the Drawing

Fig. 1 is an exploded view of a printhead with monolithic printhead chassis, constructed in accordance with the present invention.

Detailed Description of the Preferred Embodiments

The novel design of the present invention enhances ink-jet performance, increases printhead ruggedness, and serves as a precision chassis. Referring to Fig. 1, a structural beam or monolithic frame 10 has been created that is similar in length to the drop generator 12 and catcher of assembly 14. This beam 10, which comprises the monolithic frame, has a fairly large vertical axis, as indicated by z-axis direction arrow 16, so that the rectangular moment of inertia is large. This beam attaches to the top of the catcher charge plate assembly 14 and its length along the z axis, perpendicular to the

plane of the catcher, is quite large. One manner by which the catcher-charge plate assembly can be attached to the frame is described and claimed in commonly assigned, co-pending patent application Serial No. _____ (Attorney Docket SDP216PA), totally incorporated herein by reference.

The long z-axis length of the frame 10 makes the frame very stiff and, therefore, immune to distortion caused by loads to the top surface. The value of this will be discussed later. The beam depth along the x axis indicated by arrow 18 is shallow, yet sufficient as the external loads in this direction are minimal. This allows for an incredibly small foot print ratio, for example a foot print ratio of only five.

The accessible, and rigid monolithic printhead frame 10 solves the problem of different electrical, mechanical, and fluidic connections being in several different planes, which has heretofore required the end user to make many different connections. As a result of the large z axis extension of the monolithic frame, the new structure 10 has enough stiffness to allow all of these connections simultaneously. The new structure has the necessary rigidity as a result of locating all these connection at the upper surface of the frame, and orienting all these connections so that the insertion forces are directed down, parallel to the large z axis of the frame. Furthermore, by locating these connections and the mounting features at the top of the monolithic frame and locating the mounting features for the charge plate/catcher assembly and the droplet generator near the bottom of the frame, the risk of the critical alignment of the drop generator to the charge plate/catcher

assembly being altered by a printhead installation is minimized.

The force required to mate all the fluid and electrical connections is applied to the printhead by means of a lift mechanism with engages dovetail grooves on each end of the monolithic frame. Clearance holes are provided in the cover, so that the lifting force is applied only to the monolithic frame. The lifting mechanism is part of a suitable printhead latch mechanism, such as is described and claimed in commonly assigned, co-pending application Serial No. _____ (Attorney Docket SDP208PA), totally incorporated herein by reference.

To dock or mate printheads with other ink-jet hardware, prior art used "tooling balls" and "vees" that would contact multiple planes, and rectangular shapes that would nest and couple with multiple planes. This required complex mating structures to be developed. The monolithic frame structure 10 of the present invention allows the printhead to be located to a rigid three area (flat) reference plane 24 on the top of the monolithic frame. This facilitates a simple tripod type mating surface on the printhead docking station. Pins that pilot into apertures machined into the monolithic frame 10 are used to help guide the fluid and electrical connection to engage properly. It should be noted that the printhead cover 26 is not used to locate or hold the printhead in place, as has been required in the prior art. As mentioned earlier, the cover has openings to allow the lift mechanism to engage the frame directly, as can be seen in the exploded view of Fig. 1. Furthermore, the cover has clearance holes so that contact to the reference

plane of the frame, not to the cover, determines the printhead location. These printhead locating features are also described more fully in commonly assigned, co-pending application Serial No. _____ (Attorney Docket SDP208PA).

The drop generator is mounted to the frame at 42 by means of freeze blocks 28. These freeze blocks are attached to the drop generator by means of thin wall tubing which is bonded into dovetail grooves in the top of the drop generator. The freeze blocks are typically cyanoacrylate bonded to mating surfaces on the monolithic frame. These freeze blocks and the manner in which they are bonded to the frames are described and claimed in commonly assigned, co-pending application Serial No. _____ (Attorney Docket SDP223PA), totally incorporated herein by reference. This structure has resulted in a printhead which is much more rugged than the prior art. Accelerations as small as 15g's, for example, could cause permanent deformation to the two chassis structures of the prior art, producing alignment shifts of precision parts. The monolithic frame 10 of the present invention can sustain "g" loads as high as, for example, 70g's, without any associated movement, thereby providing a design which yields extremely high shock load capacity for the continuous ink-jet printhead.

With the structure and configuration proposed by the present invention and illustrated in Fig. 1, the ink-jet components are on one side 24 of the frame 10, and the electronics and the their required cooling system, including cooling device 30, are on the other side 20 of the frame 10. This configuration simplifies assembly while allowing for

a smaller printhead size. The centrally located frame also isolates the electronic components from the ink, In the prior art the electronics could be exposed detrimentally to ink mist produced during normal operation or to ink from a printhead failure.

Continuous ink-jet printheads run at high frequencies and emit electrical "noise". EMI shielding is required to contain this noise that could cause failures in other sensitive electronic devices. Current art has resolved this dilemma with metal covers on the printhead. As the prior art did not isolate the electronic components from the ink jet ones, it was necessary to install these EMI shielding covers after the printhead was completely aligned, to provide the necessary access for alignment. When cover pieces were fastened to the printhead chassis, the chassis could be twisted, causing undesirable movement in critical ink-jet components. Furthermore, the numerous seams between the cover pieces and the printhead chassis tended to allow excessive electrical noise leak out of the printhead.

These problems are resolved by the present invention. The monolithic frame 10 of the present invention is extremely rigid and resolves the movement issues related to the prior art. Furthermore, the cover, which is a one piece unit, attaches to the printhead only at two locations on the top of the frame. It therefore does not induce any shift of the critical ink jet components. The monolithic frame 10 bisects the printhead into two sections, an electronics side 20 and an ink jet side 24. This allows the noise emitting "charge driver board" 22 to be isolated by a wall of metal, i.e.,

the frame 10. The single piece cover 26, eliminating all seams, is attached to the monolithic frame 10. Flexible EMI shielding gaskets or seals between the frame and the cover and around the cover ports complete the EMI shielding of the electronics without affecting the alignment of the ink jet components.

It is known in the art to be desirable for continuous ink-jet printheads to maintain purified positive air pressure around the print array. The positive air chamber shape and size around the print array affects the uniformity of this air flow. The positive air chamber should closely match the array in length and, if designed effectively, print head life and performance will be greatly enhanced. The monolithic frame 10 facilitates this by reducing the volumetric area to be pressurized to 99 cubic inches versus 717 cubic inches on current art. The primary structure of the monolithic frame is also aligned parallel to the array so that the air flow can be more readily distributed down the length of the array. The use of a single piece cover 26 eliminates the possibility of air leaks at any seams so that the supplied air can be more effectively used. This positive air chamber is described and claimed in commonly assigned, co-pending application Serial No. _____ (Attorney Docket SDP222PA), totally incorporated herein by reference.

Thermal gradients in the printhead structure can cause differential movement in critical ink-jet printhead hardware. In accordance with the present invention, these thermal gradients have been greatly reduced. This is accomplished by circulating the printing fluid that normally flows through the drop generator and catcher/charge plate

assembly also through the monolithic frame 10. In this way, the temperature of the frame 10 tracks that of the drop generator and the catcher due to the flow of the same ink through each component. This is facilitated by the size and rigidity of the frame 10 which allow it to serve as a fluid manifold. The proximity of the frame 10 to the print array also helps in reducing the thermal gradients in the printhead. Ideally, the frame should be made of a material having a similar thermal expansion to that of the catcher charge plate assembly and of the drop generator. In this way distortions of the printhead caused by thermal gradients are minimized.

A shutter device known as an "eyelid" 14 is used for maintenance and as an air flow control tool. The eyelid registration to other ink-jet printhead components is critical. In the prior art, the eyelid was located though a sheet metal support component chassis or with loosely tied linkage. As a result of poor alignment, there have been problems with leaky eyelid seals. The monolithic frame 10 has built in registration pins 32 and pads that are rigidly coupled to other critical ink-jet components. This facilitates improved registration and rigidity which improves printhead performance and reliability.

The invention has been described in detail with particular reference to certain preferred embodiments thereof, but it will be understood that modifications and variations can be effected within the spirit and scope of the invention.

What is claimed is:

1. A printhead alignment apparatus for a continuous ink jet printer having a droplet generator and a catcher/charge plate assembly, the alignment apparatus comprising:

a single chassis for maintaining alignment of the droplet generator and the catcher/charge plate assembly; and

attachment means for attaching electronic and fluidic components to the single chassis.

2. A printhead alignment apparatus as claimed in claim 1 wherein the single chassis separates electronic and fluid related functions of the printhead.

3. A printhead alignment apparatus as claimed in claim 2 wherein connections for the electronic and fluid related functions are in a plane parallel to a plane of the catcher.

4. A printhead alignment apparatus as claimed in claim 3 wherein printhead mounting features and connections are separated from mounting features for the catcher and the droplet generator.

5. A printhead alignment apparatus as claimed in claim 1 wherein the single chassis comprises means for accurate location of an eyelid mechanism relative to the droplet generator and the catcher/charge plate assembly.

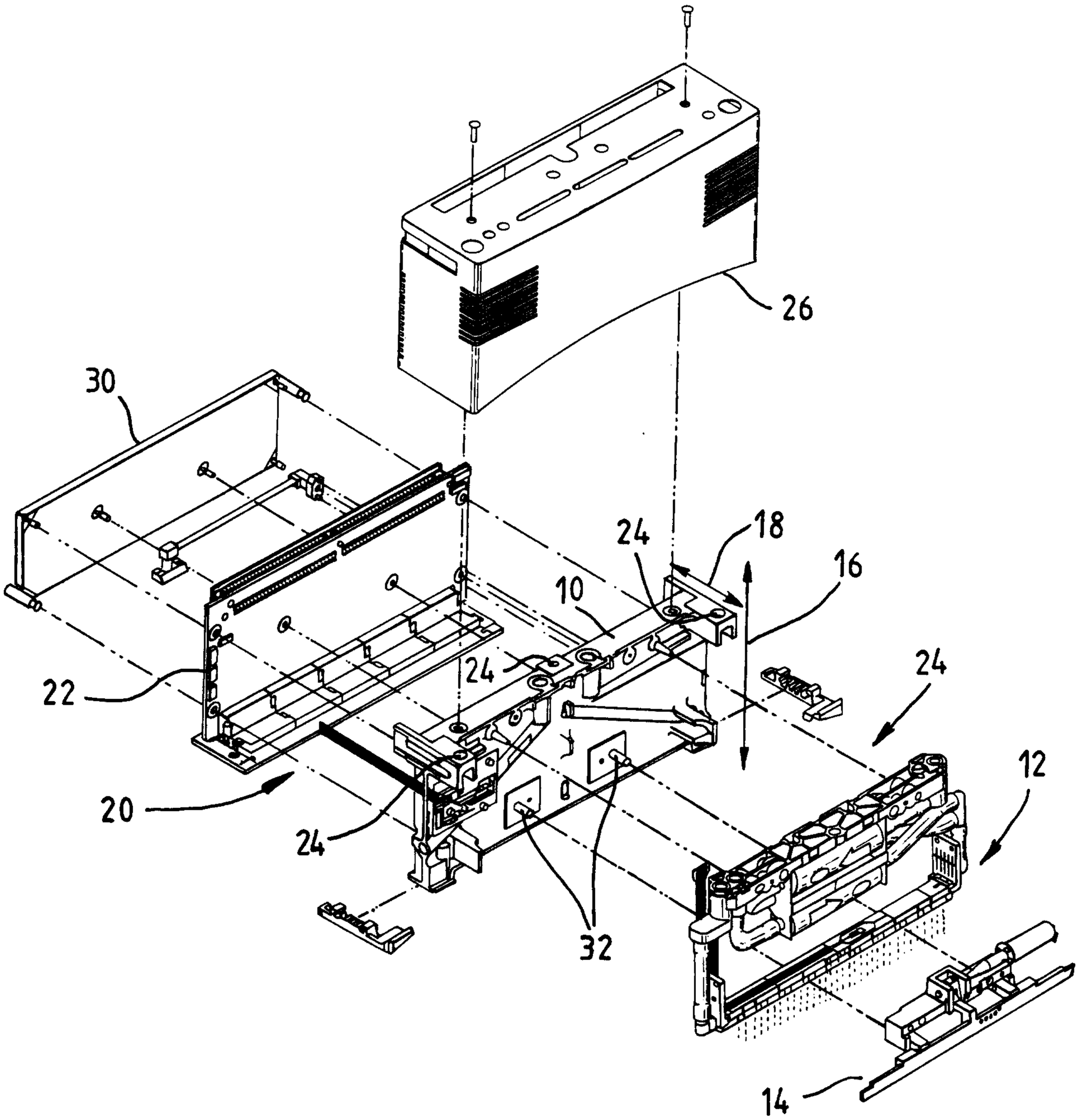
6. A printhead alignment apparatus as claimed in claim 1 wherein the single chassis comprises a fluid

manifold.

7. A printhead alignment apparatus as claimed in claim 1 wherein the single chassis has a z-axis length larger than its x-axis depth, with the z-axis length being perpendicular to a plane of the catcher.

8. A printhead alignment apparatus as claimed in 7 further comprising insertion forces for making multiple fluidic and electrical connections to the printhead, the insertion forces being directed parallel to the large z axis.

9. A printhead alignment apparatus as claimed in claim wherein the single chassis further comprises all printhead installation features to install the printhead at a print station.



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