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(54) Improved mounting arrangement for resonator.

(57) A mounting arrangement for an ink jet printing device has a drop generator for producing continuous streams of ink drops from at least one orifice in an array. The mounting arrangement comprises vertical slots located perpendicular to the longitudinal axis of the array and body. One or more of the slots may include a retaining portion near a nodal plane of the resonator body. Hollow mounting tubes are insertable into the retaining portion in a press fit relationship.

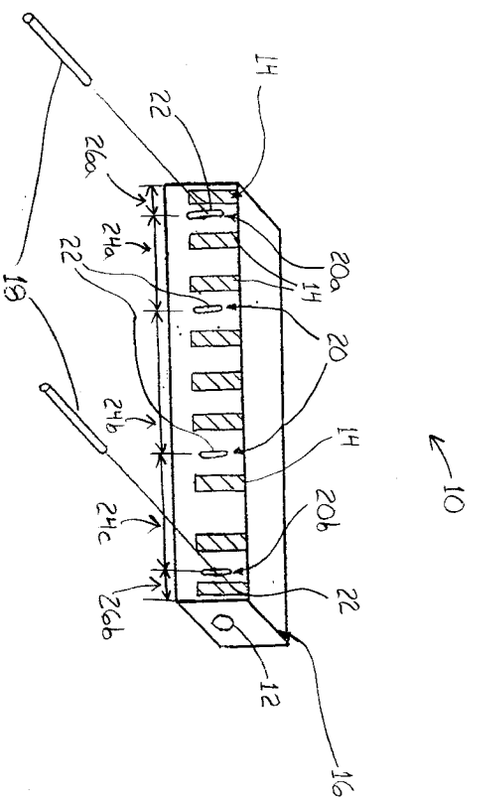

Fig. 1

EP 0 639 458 A2

Technical Field

The present invention relates to continuous ink jet printing systems and, more particularly, to an improved means for constructing a resonant body to provide a synchronous break up of jets in an array in such printing systems.

Background Art

In continuous ink jet printing, ink is supplied under pressure to a manifold region that distributes the ink to a plurality of orifices, typically arranged in a linear array(s). The ink discharges from the orifices in filaments which break into droplet streams. The approach for printing with these droplet streams is to selectively charge and deflect certain drops from their normal trajectories.

In such continuous ink jet printing systems, graphic reproduction is accomplished by selectively charging and deflecting drops from the drop streams and depositing at least some of the drops on a print receiving medium while other of the drops strike a drop catcher device. In order to provide precise charging and deflecting of the drops, it is important that the drop break-up process produce uniformly sized and timed drops. Drop generators for such printers produce the required drop formation by vibrating the orifices from which the ink emerges.

In the field of ink jet printers, it is desirable from the standpoint of throughput to utilize long arrays of ink jets. For example, U.S. Patent No. 4,999,647 discloses a system for achieving synchronous stimulation across a long array at a low frequency, approximately 50 KHz. The system of that patent uses a rectangular solid printhead body of high acoustic Q material, stainless steel, with vertical slots perpendicular to the array to provide a plurality of approximately identical resonant bodies. The slots are spaced equidistant from each other to provide for uniform vibrational amplitude across the major surface. The slots divide the drop generator into segments so that segment height, in the predominant vibration direction, is greater than the other dimensions of each segment.

As described in the '647 patent, an ink manifold and orifice plate are located at one of the longitudinal ends parallel to the overall greatest length of the resonant body. The orifice plate provides for a continuous stream of jets to form drops at a frequency equivalent to the resonance of the body. The resonant body is excited by piezoelectric strip pairs mechanically attached to the sides so as to expand and contract in the desired direction. The resonator is mounted at the nodal plane by means of solid pins that are pressed into holes in the resonator body.

It has been found that this mounting system works well for a drop generator having a 4½ inch array with a resonant frequency near 50 KHz. However, for higher frequencies, on the order of 100 KHz, it is seen that the solid pins induce undesirable resonant modes. These resonant modes can produce unacceptably large variations in break-off phase across the array. Additionally, the holes in which the pins are mounted can further adversely affect the resonance.

It is seen then that there is a need for an improved mounting arrangement for the resonator, which overcomes the problems associated with the prior art.

Summary of the Invention

This need is met by the resonator mounting arrangement of the present invention, wherein hollow tubes are mounted in slots, eliminating the adverse resonant effects of solid pins and pin retaining holes.

In accordance with one aspect of the present invention, a mounting arrangement for an ink jet printing device has a drop generator for producing continuous streams of ink drops from at least one orifice in an array. The mounting arrangement comprises vertical slots located perpendicular to the longitudinal axis of the array and body. One or more of the slots may include a retaining portion near a nodal plane of the resonator body. Hollow mounting tubes are insertable into the resonator body to mount the resonator. The tubes may be located in retaining points in the slots, or elsewhere along the body.

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 a perspective view of a droplet generator assembly illustrating the mounting arrangement of the present invention.

Detailed Description of the Preferred Embodiments

Referring to the drawing, Fig. 1 illustrates a droplet generator 10 which is used to create streams of ink, thus producing droplets used for printing in a continuous ink jet printer. Devices used for controlling these drops in a printer (not shown) are aligned with the droplet generator 10 in a print head device to cooperate for printing purposes.

The droplet generator 10 is typically constructed of a high acoustic Q material, such as stainless steel, in predetermined dimensions for length, height, and width. A through bore means 12 provides an inlet and an outlet for fluid flow into the drop generator 10. Piezoelectric strips 14 are affixed to the drop generator 10 with the longest length of the strips being perpendicular to the longitudinal axis of the drop generator, to encourage vibration, i.e., expansion and contraction, in the vertical direction.

The droplet generator 10 is designed to provide

a synchronous array of droplets for printers. The droplet generator includes a resonator/manifold body 16, the plurality of piezoelectric strips 14, an orifice plate (not shown), and a mounting arrangement means including mounting tubes 18. The mounting tubes 18 are used to mount the resonator 16 on a frame (not shown), to provide a means for mechanically aligning the resonator or drop generator to charge electrodes, and also to rigidly maintain that alignment. Consequently, the mounting arrangement of the present invention not only provides for isolating the drop generator from the frame to allow the drop generator to resonate properly, but also allows for a rigid mount to provide secure alignment.

In accordance with the present invention, the mounting tubes 18, typically constructed of a steel material, have a diameter of 0.065 to 0.078 inches, and are hollow. The hollow tubes 18 typically have a wall thickness of 0.010 inches to 0.015 inches. If the diameter of the mounting tubes is too small, there is less contact area between the tubes and the resonator, so the tubes are more likely to slide. Larger mounting tubes with a diameter of 0.090 inches or greater, were found to adversely affect stimulation uniformity. Consequently, the tubes preferably have a diameter of 0.078 inches to give sufficient contact area for reasonable resistance to sliding.

The tubes are mounted in a tube receiving means, such as slots already existing in the resonator body, or additional apertures located along the resonator body added for the tube receiving purpose. In a preferred embodiment, the tubes 18 are insertable into vertical slots 20, located perpendicular to the longitudinal axis of the array and body. The width of each slot 20 is typically 0.062 inches. One or more of the slots 20 may include a widened retaining portion 22, as illustrated at end slots 20a and 20b. The widened retaining portion 22 is located along or near the nodal plane of the resonator, for receiving the tubes 18. The diameter of the retaining portion 22 is typically 0.078 inches to provide for a tight press fit between the tubes 18 and the retaining portion 22 of the slots 20. The vertical slots 20, with retaining portions 22, provide a radius, then, for the mounting tubes 18.

In the present invention, interior segments 24a, 24b, and 24c, located between each adjacent pair of slots 20, actually have a larger width dimension than a height dimension. End segments 26a and 26b, located between end slot 20a and one end of the resonator body 16 and end slot 20b and the other end of the resonator body 16, are narrower than the centrally situated interior segments 24a, 24b, and 24c, in order to improve vibrational uniformity across the array. The width of each slot 20 is typically 0.062 inches. With the narrower slots of the present invention, as compared to slots of the prior art, vibrational uniformity and separation from undesirable resonant modes is improved by increasing the width of the interior segments beyond that of their height. This clearly counters the teachings of the prior art, which required that the width of each segment be less than the height of each segment.

The tubes 18 should be tightly press fit into the retaining portion 22 of the slot 20. The tight fit of the tubing provides electrical contact between the droplet generator 10 and the tubes 18. The droplet generator 10 may therefore be grounded by means of a grounding point on the frame. Additional rigidity may be achieved by also using a bonding agent such as cyanoacrylate.

Providing hollow mounting tubes eliminates the undesirable high frequency resonances introduced by solid tubes. Additionally, mounting the tubes in the slots 20 results in only negligible changes in the resonant characteristics of the droplet generator 10, as opposed to the more noticeable and less desirable effects resulting from the use of separate holes for receiving mounting tubes 18. Of course, it will be obvious to those skilled in the art that the concept of the hollow tubes can reduce adverse effects, even when the hollow tubes are mounted in additional holes, rather than in the slots.

Although the tubes 18 have been described as being hollow, it is occasionally desirable to secure the tubes into the frame by means of a clamp. With the hollow tubes of the present invention, the clamping force may distort the tube, which, unfortunately, relieves the clamping force. To prevent this, the end portion of the tube at the clamp point may be filled with a solid material, such as a dowel pin, to avoid the tube distortion while allowing for sufficient clamping force, without adverse effects.

Industrial Applicability and Advantages

The present invention is useful in the field of ink jet printing, and has the advantage of improving the mounting of a resonator by eliminating adverse resonant characteristics.

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.

Claims

1. A mounting arrangement for an ink jet printing device having a drop generator with a resonator body, the generator capable of producing continuous streams of ink drops from at least one orifice in an array, the mounting arrangement comprising:

   vertical slots located perpendicular to the longitudinal axis of the array and body;

a retaining portion near a nodal plane of the resonator body located in at least one of the vertical slots; and

at least one mounting tube insertable into the retaining portion.

2. A mounting arrangement for an ink jet printing device as claimed in claim 1 wherein the at least one mounting tube is hollow.

3. A mounting arrangement for an ink jet printing device as claimed in claim 2 wherein a solid material is provided in a clamp point of the at least one mounting tube to prevent distortion of the tube during clamping.

4. A mounting arrangement for an ink jet printing device as claimed in claim 1 further comprising an interior segment between each adjacent pair of vertical slots, and an end segment between each end vertical slot and each end of the resonator body, each interior segment having a greater width dimension than a height dimension, and each end segment being narrower in width than each interior segment.

5. A mounting arrangement for an ink jet printing device having a drop generator with a resonator body having a plurality of vertical slots, the generator capable of producing continuous streams of ink drops from at least one orifice in an array, the mounting arrangement comprising:

a plurality of hollow mounting tubes; and

a tube receiving means for receiving the plurality of mounting tubes.

6. A mounting arrangement for an ink jet printing device as claimed in claim 5 wherein the tube receiving means comprises the plurality of vertical slots and each of the plurality of vertical slots further comprises a retaining portion near a nodal plane of the resonator body for receiving each of the plurality of hollow mounting tubes in a press fit relationship.

7. A mounting arrangement for an ink jet printing device as claimed in claim 5 wherein a solid material is provided in a clamp point of each of the plurality of mounting tubes to prevent distortion of each tube during clamping.

8. A mounting arrangement for an ink jet printing device as claimed in claim 5 further comprising an interior segment between each adjacent pair of vertical slots, and an end segment between each end slot and each end of the resonator body, each interior segment having a greater width dimension than a height dimension, and each end segment being narrower in width than each interior segment.

9. A mounting arrangement for an ink jet printing device having a drop generator with a resonator body, the generator capable of producing continuous streams of ink drops from at least one orifice in an array, the mounting arrangement comprising:

vertical slots located perpendicular to the longitudinal axis of the array and body;

interior segments situated between each adjacent pair of vertical slots, each interior segment having a greater width dimension than a height dimension; and

end segments situated between each end vertical slot and each end of the resonator body, each end segment being narrower in width than each interior segment.

10. A mounting arrangement for an ink jet printing device as claimed in claim 15 further comprising a retaining portion near a nodal plane of the resonator body located in at least one of the vertical slots, at least one hollow mounting tube being insertable into the retaining portion.

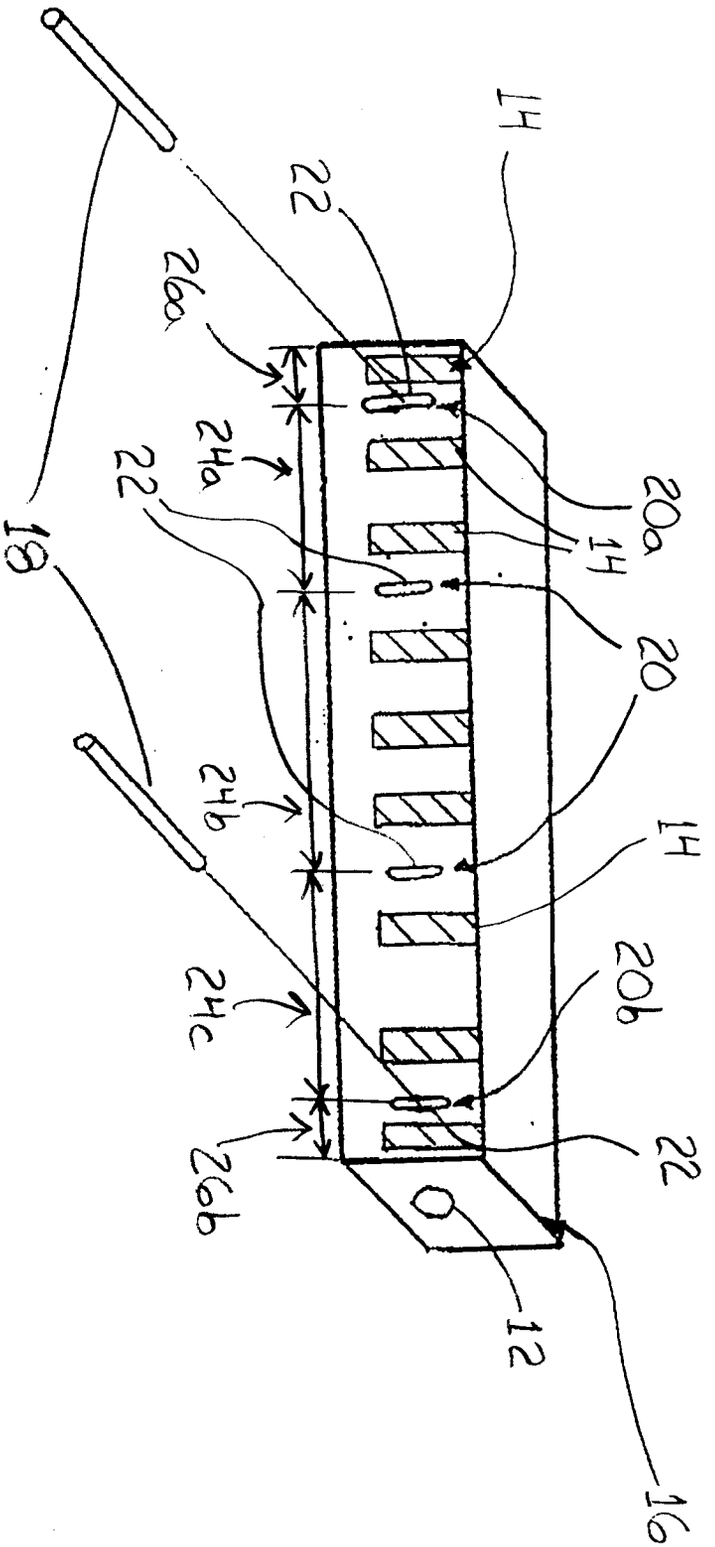

Fig. 1