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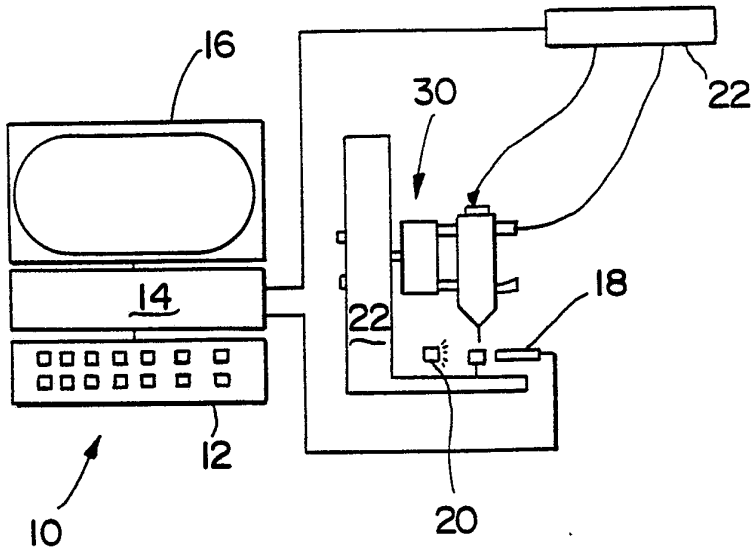
(54) Title: METHOD FOR CONTROLLING ACCURATE DISPENSING OF ADHESIVE DROPLETS



(57) Abstract

This device relates to the field of adhesive application more particularly to applying small amounts of adhesive to read-write slides to secure microcomponents. It is difficult to regulate the amount of adhesive dispensed when only small amounts are required, it is also difficult to accurately position these adhesive droplets on the read-write slide to secure microcomponents in the proper location. The adhesive dispensed is optically monitored using a camera (18) and monitor (16). The adhesive is dispensed through an orifice but does not contact the target surface until it is visually found to be within pre-established limits, once within these limits the adhesive is dispensed to the slide. The dispensing system also includes: a console (10), including a keyboard (12), an illuminating source (20), a dispenser (30) and a pneumatic power source (22).

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TITLE

Method for Controlling Accurate Dispensing of Adhesive Droplets

BACKGROUND AND BRIEF SUMMARY OF THE INVENTION

The invention relates to a dispensing system for depositing discrete amounts of adhesives on a surface. More particularly, the system monitors and controls the amount of adhesive deposited on a surface to which a microcomponent is secured.

In electronics many assembled parts are exceedingly small such that vision systems are necessary to view the movement, placement and securing of the parts one to the other. Securing of the parts usually includes bonding by solder or adhesives. In some applications, the parts are pretreated by coating with a solder or adhesive, engaging the parts and then being cured by heat. These bonding techniques are suitable for components that once assembled remain static except possibly for the flow of electrons. In some applications the assemblies are subjected to varying mechanical stresses during curing process. In this environment, a thin film coating of adhesive is usually not sufficient. One such component that is subject to stress is a read-write slide which is secured to a supporting resiliant arm. In a typical application, one end of the supporting arm is fastened to a base. The other end of the arm supports the read-write slide. The head is joined to the other end of the arm by adhesive, usually a drop of epoxy adhesive.

Epoxy dispensing systems for joining a read-write slide to a supporting arm are currently in use. The average deposit of epoxy on the arm will vary between 2 to 8 X 10^{-6} cubic inches. Typically, the deposits are discharged through an orifice in timed sequence or manually.

The amount to be deposited is initially calibrated. Once a dispensing system is calibrated, the viscosity and

rheology of the adhesive may change with temperature and with time. Also the homogenity of the adhesive is not always uniform. The adhesive may include dissolved gases. However, with the small amounts involved, slight temperature changes will affect the physical properties of the adhesive. If the deposit becomes too small, an incomplete bonding results. If the deposit becomes too great, the bond may be sufficient but because of the size and delicate nature of the assembly, the excess adhesive can interfere with the proper functioning of the assembly. Therefore, dispensing systems which depend upon a fixed pulsed displacement of adhesive by the precalibrated movement of a piston or the like are subject to variations in the amounts of adhesive dispensed.

Our invention overcomes these problems of variations in the amounts of deposited adhesive by optically controlling the amount of adhesive dispensed from an orifice. The adhesive is discharged through an orifice but does not contact a target surface. The amount of adhesive depending from the orifice is continuously monitored by a vision system. When the amount or size of adhesive depending from the orifice is within pre-established limits, the adhesive is then transfered to the target surface.

In a preferred embodiment, a camera system views the amount of the adhesive extruded from the orifice. Based on this information, the adhesive stops flowing or continues to flow through the orifice until the proper amount is reached. At this time, the flow ceases and some of the adhesive is transferred. The amount of adhesive which remains depending from the orifice after transfer is measured to ensure the correct amount was transfered. Therefore, our invention overcomes the problems inherent with those systems where the adhesive is subject to variations in viscosity and homogenity.

Our invention, in a preferred embodiment, comprises

flowing an adhesive through an orifice, measuring the amount of adhesive being extruded from the orifice, stopping the flow of adhesive through the orifice when a predetermined amount of adhesive has been extruded and transferring the adhesive to a target site, measuring the amount of adhesive remaining on the orifice after transfer and confirming the amount transferred was within pre-established limits.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a block diagram of a dispensing system embodying the invention;

Figure 2 is a front view of the dispenser;

Figure 3 is a plan view of the dispenser of Figure 2;

Figure 4 is a right side view of the dispenser of Figure 2;

Figure 5 is a front view of the needle holder assembly;

Figure 6 is a left side view of Figure 5;

Figure 7 is a right side view of Figure 5; and

Figures 8a through 8g are illustrations of the transfer of adhesive.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Our invention will be described in reference to a stand alone adhesive dispensing system which is easily intergrated into existing systems for the automatic manipulation of microcomponents. Further, the invention will be described with particular reference to applying discrete amounts of adhesive to the arm of a read-write slide. The acquisition of the arm, its movement to an assembly station where the adhesive is applied, its removal from the assembly station, and the subsequent engagement of the read-write slide to the adhesive on the arm are all steps within the skill of the art and need not be described in detail.

The dispensing system 10 is shown generally in Figure 1 and comprises a computer console 10 which includes a keyboard 12, a terminal 14 and a video display 16; a vision system with a camera 18 and an illumination source 20; a dispenser 30 and a pneumatic power source 22.

Referring to Figures 2, 3 and 4, the dispenser 30 is shown in greater detail and comprises a mounting plate 32 through which passes four alignment screws, three shown 34a-34c, and a fastening screw 36. Secured to the plate 32 by the screw 36 is a bracket 40. The bracket 40 includes a double acting pneumatic cylinder 42 which drives a linkage plate 44. The linkage plate 44 drives a needle assembly. The cylinder includes a pneumatic line 46 and is secured to the bracket 40 by a lower plate 46. An upper plate 50 is parallel to the plate 48. Each of the plates 46 and 48 carry limit screws 52 and 54 respectively.

Referring to Figures 6, 7 and 8, the needle assembly comprises a needle holder 60 which has a wall 62 joined to the linkage plate 44. Secured to the wall 62 is a stop member 64 which travels between the limit screws 52 and 54.

Referring to Figure 2, the holder 60 includes an upper arm 66 and a lower arm 68. A cylindrical shaped needle body 70 is received in the lower arm 68 and passes through the upper arm 66. A dispensing needle 72 is carried in the body 70. A cap 74 is secured to the upper arm 66 sealingly engaging and enclosing the upper end of the needle 72 and the body 70 and defining a chamber 76. An O-ring 78 ensures a fluid tight seal between the cap 74 and the body 70. A pneumatic line 80 is joined to the cap 74.

The area of measurement of adhesive is therefore viewed from one side although multiple cameras may be used. The input from the camera 18 is processed in the terminal 14 and displayed on the screen 16.

In the operation of the invention the dispenser 30 is first calibrated. Adhesive is placed in the needle 72. Discrete droplets are extruded from the needle until the predetermined amount is reached, the amount of droplet is measured, the needle is moved down to tranfer the adhesive to the target site the needle is withdrawn to its original

position. A measurement is taken of the residue left over on the needle. (The amount of adheisve deposited on the target site may also be viewed, if the nature of the application allows to do so). By calculating the difference of the amount of epoxy before and after the dispensing, the actual amount dispensed can be computed and compared to the target amount.

The viewing of an object with a camera to determine its size and/or volume, the display of the viewed object and the comparison of the viewed object to pre-established limits are well-established techniques. The application of these techniques for this invention have not heretofore been known.

Referring to Figures 8a through 8g, the tip 82 of the needle 72 is shown with adhesive 84 depending therefrom (Figure 8a) from a previous application. A target site 86 to which the adhesive is to be transferred is directly below.

The air pressure through line 80 functions as the driving force for the movement of the epoxy through the needle. The camera 18 continuously measures the amount of epoxy being extruded from the end of the needle. The pressure stops when the precalibrated amount is reached - Figure 8c. Actuation of the cylinder 42 moves the needle with the dispensing adhesive a predetermined distance into engagement with the target site. Figure 8d. Epoxy is in contact with the target surface.

The tip is retracted to its initial position by the cylinder 42. In the process of retracting, part of the epoxy pulls down due to the nature (viscosity) of the epoxy. Figure 8e. The needle retracts to its initial position, Figure 8f, by reversing the cylinder 42. At this time, the amount of epoxy left over on the tip is measured by the vision system and compared to the amount from Figure 8c. Based on this information, it is determined if sufficient

adhesive has been transfered to the arm.

In some applications, the dispensed amount can be measured by the vision system providing that a side view can be obtained Figure 8g.

Having described out invention, what we now claim is:

Claim 1. A method for controlling the amounts of adhesive deposited on micro components which includes:

extruding an adhesive through an orifice;

measuring visually the volume of adhesive extruded from the orifice;

stopping the flow of adhesive through the orifice when a predetermined volume of adhesive has been extruded;

transferring the adhesive to a target site;

measuring visually the volume of adhesive transferred; and

confirming the volume transferred was within pre-established limits.

Claim 2. The method of Claim 1 wherein the measured volume of adhesive transferred includes:

measuring visually the volume of adhesive remaining on the orifice after the transfer has been made; and

comparing said remaining volume to the amount of adhesive extruded from the orifice prior to transfer to the target site.

Claim 3. The method of Claim 1 wherein the measurement of the adhesive includes:

measuring visually the volume of adhesive on the surface.

Claim 4. The method of Claim 1 wherein the adhesive is an epoxy adhesive.

Claim 5. The method of Claim 1 which includes:

applying the adhesive to a read-wright slide.

Claim 6. The method of Claim 1 which includes:

viewing with a camera system.

Claim 7. The method of Claim 1 which includes:

extruding pneumatically the adhesive.

Claim 8. The method of Claim 1 wherein the adhesive is extruded and transferred along a vertical axis and which includes:

measuring along a horizontal axis.

Claim 9. A system for controlling the amounts of adhesive deposited on micro components which comprises:

a dispenser having an orifice including:

means to extrude an adhesive through the orifice;

means to measure visually the volume of adhesive depending from the orifice;

means to move the dispenser from a first upper position to a second lower position to place the adhesive into engagement with a target site;

means to move the dispenser from its lower position;

means to measure visually the amount of adhesive remaining on the orifice when it is withdrawn from its lower position; and

means to control the extrusion of the adhesive and the movement of the dispenser based upon the amount of adhesive transferred to the target site.

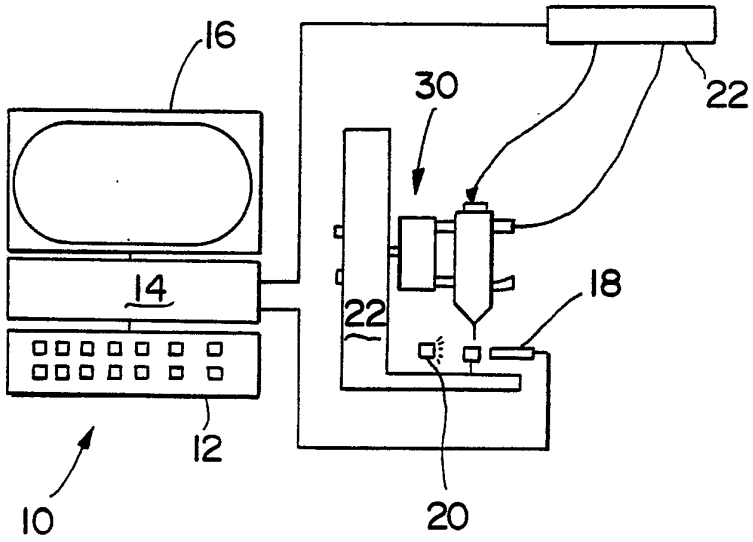
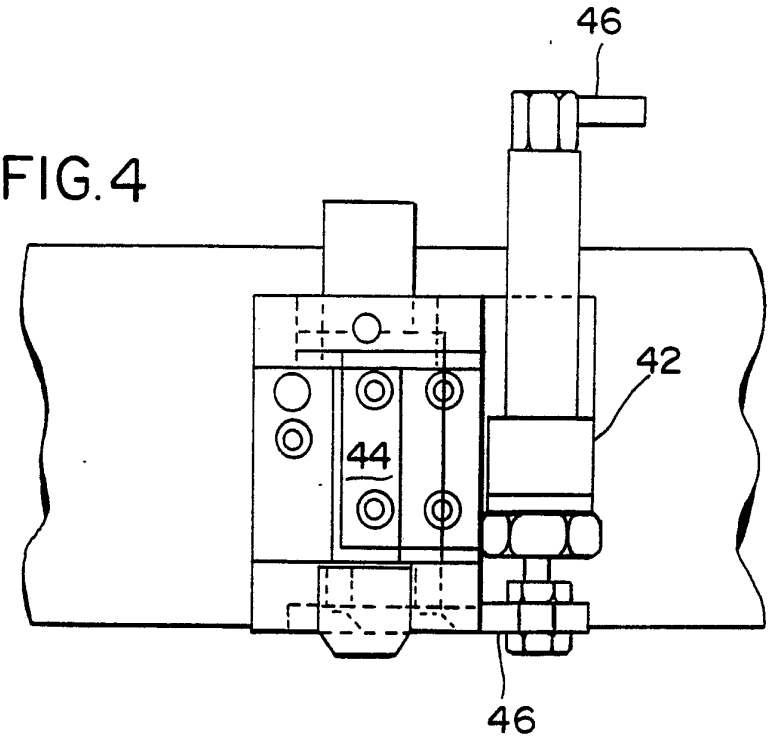


FIG. 1

FIG. 4



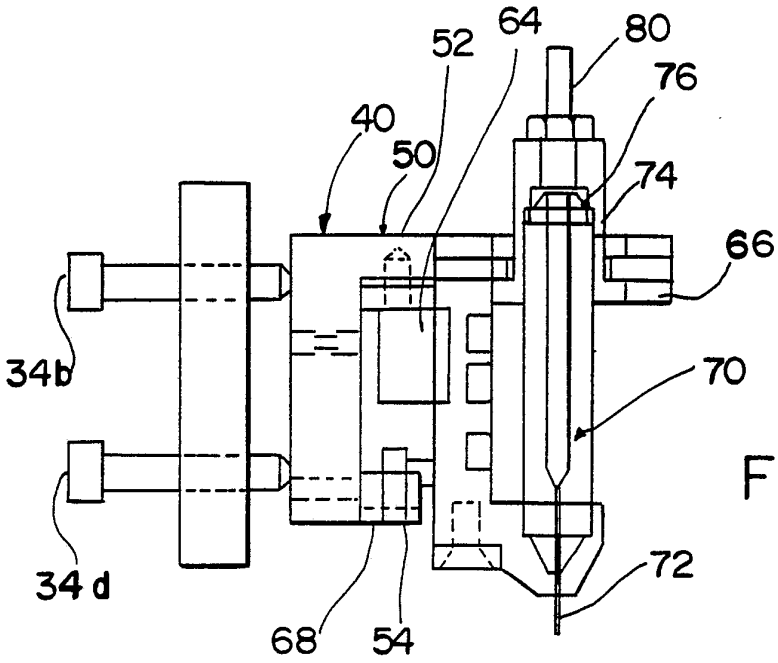


FIG. 2

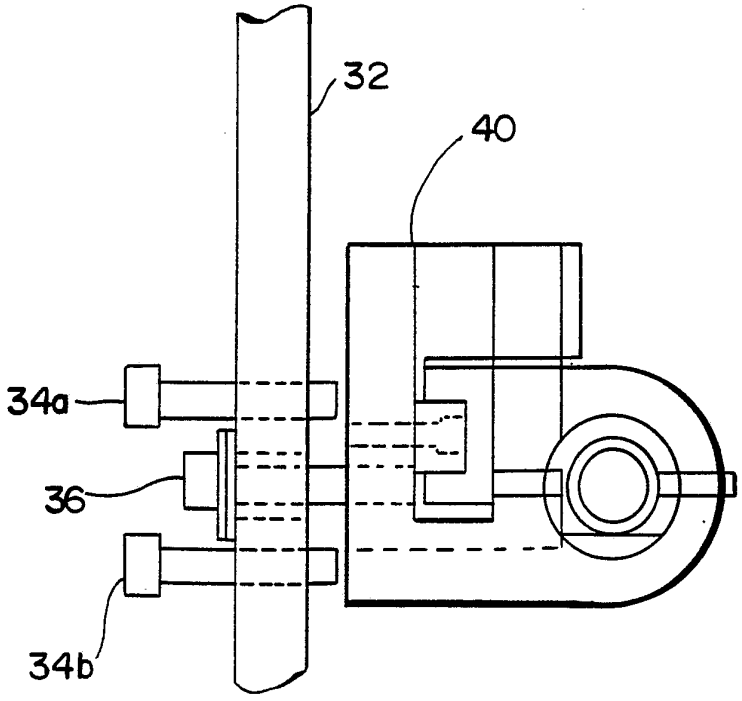


FIG. 3

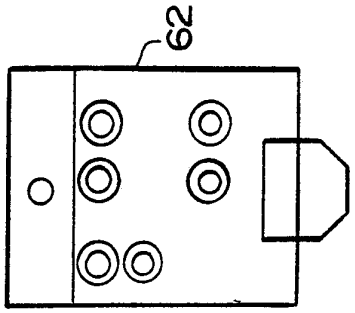


FIG.7

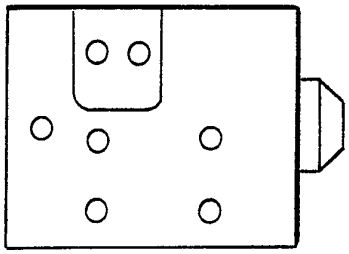


FIG.6

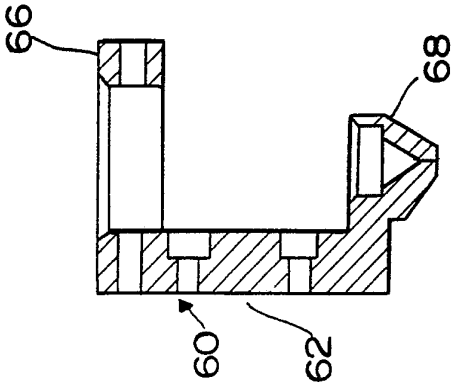


FIG.5

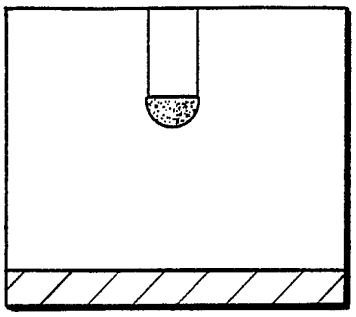


FIG.8A

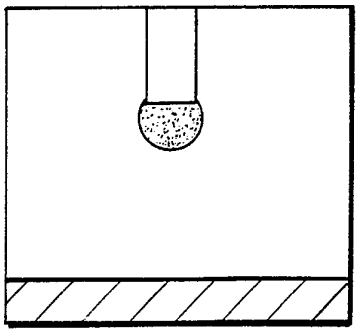


FIG.8B

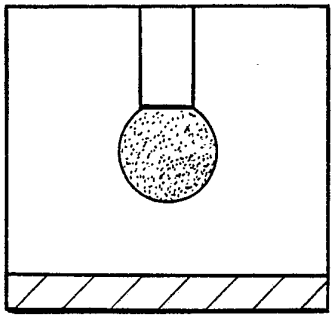


FIG.8C

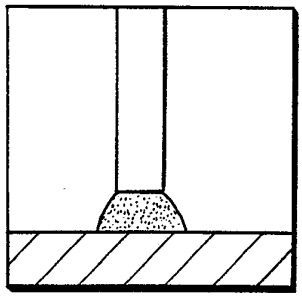


FIG.8D

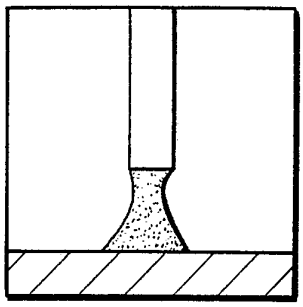


FIG.8E

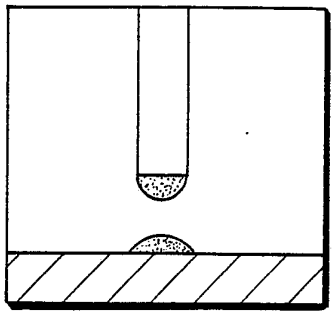


FIG.8F

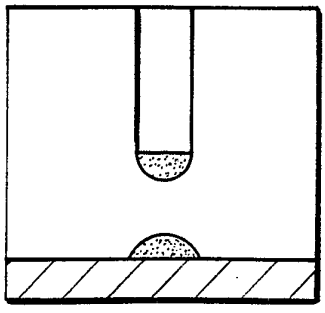


FIG. 8G

INTERNATIONAL SEARCH REPORT

International Application No. PCT/US89/04487

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

I PC (5) : B05D 7/24

US. CL. 427/10

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
U.S.	427/10

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
A	DE, A, 2631-951 (SCHEIF) 19 January 1978. See entire document.	
A	US, A, 4,661,368 (ROHDE ET AL) 28 April 1987. See entire document.	
A	US, A, 3,825,153 (PATRICK ET AL) 23 July 1974. See entire document.	
A	US, A, 4, 513,796 (MILLER ET AL) 30 April 1985. See entire document.	
A	US, A, 4,030,640 (CITRIN ET AL) 21 June 1977. See entire document.	
A	US, A, 3,476,291 (GLASER) 04 November 1969. See entire document.	
A	US, A, 4,041,995 (Columbus) 16 August 1977. See entire document.	
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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
05 MARCH 1990	09 APR 1990
International Searching Authority	**Signature of Authorized Officer**
ISA/ US	W. TODD WAFFNER

Form PCT/ISA/210 (second sheet) (Rev.11-87)

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
A	US, A, 4,683,143 (RILEY) 28 July 1987. See entire document.	
A	US, A, 4,218,989 (FUJITA ET AL) 26 August 1980. See entire doucment.	