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(54) **ULTRASONIC SEALING ANVIL**

ULTRASCHALL-SCHWEISSBACKEN

ENCLUME DE SOUDAGE ULTRASONIQUE

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Description

[0001] The present invention relates to ultrasonic sealing anvil. Specifically, the present invention relates to an ultrasonic sealing anvil with acoustical insulation.

[0002] Gable-top cartons or containers are used widely for packaging milk, juices, and other foods, as well as a variety of other products. Such cartons are fabricated from a sheet material which is heat-sealable to itself. The typical material is paper board on both sides coated with polyethylene or another heat-sealable material.

[0003] Gable closures are conventionally sealed by folding the carton along preformed score lines to form an upstanding fin (or, for a bottom closure, a depending fin) having several thickness of heat sealable material. The fin is captured between an ultrasonic sealing horn and an anvil, and an ultrasonic energy transduced to the joint through the horn causes the heat-sealable material in the fin to fuse, forming a seal. An ultrasonic sealing horn and an anvil or anvil system is known from WO-A-9609958 and its counterpart US 5605026.

[0004] One problem which must commonly be addressed when ultrasonic sealing equipment is designed is how to prevent the intentionally separate moving parts of the equipment from being welded together, should they come into contact accidentally or intentionally during a sealing operation. Another problem is how to prevent ultrasonic vibrations from straying from the sealing site to other parts of the anvil or machinery. Yet another problem is cooling the anvil, or anvils, during the sealing operation without deterring from the sealing operation.

[0005] The present invention is directed at an anvil for utilization with an ultrasonic horn for sealing the closure of a carton having first and second sides and disposed at a closure sealing position. A typical closure which may be sealed by the anvil of the present invention is a gable-top or bottom closure for a liquid food carton. The anvil comprises an anvil body; a vibrating portion disposed forward from the anvil body; a sealing portion attached to the vibrating portion; means for acoustically insulating the anvil body disposed between the anvil body and the vibrating portion; and, a cooling system disposed within the anvil. According to the invention, the means for acoustically insulating the anvil comprises the anvil body connected to the vibrating portion by a pair of parallel bridges thereby forming an airspace slot separating the anvil body from the vibrating portion with the pair of parallel bridges forming a boundary around the airspace slot along the anvil body and the vibrating portion. The present invention is a component of a carton sealer which may be a station on gable-top carton packaging machine. The sealing portion will normally have a predetermined sealing pattern, and is usually disposed above the vibrating portion.

[0006] The present invention is also directed at an anvil system for utilization in conjunction with a multitude of ultrasonic horns. The anvil system includes an anvil bar connected to an anvil drive, the anvil drive providing movement to the anvil bar; a plurality of anvils of the invention as described above mounted on the anvil bar, each capable of performing individual sealing operations in conjunction with an ultrasonic horn; and a plurality of interanvil connecting tubes for the transference of the heat sink fluid between the cooling systems of the plurality of anvils. Each of the plurality of interanvil connecting tubes are typically sealed to each corresponding anvil of the plurality of anvils by at least one O-ring.

[0007] Each of the plurality of interanvil connecting tubes may be composed of a substantially stainless steel material. The plurality of interanvil connecting tubes permits each individual anvil to move independently of one another. Each of the multitude of ultrasonic horns may include a convertor and sonotrode. The sonotrode may have a plurality of pads projecting therefrom and disposed on the sonotrode to avoid interference with the ultrasonic sealing. Each of the plurality of pads have a predetermined length substantially corresponding to the minimal thickness of an object undergoing ultrasonic sealing.

[0008] The invention will now be described by way of example and with reference to the accompanying drawings wherein:

FIG. 1 shows a perspective view of one embodiment of the ultrasonic anvil of the present invention;

FIG. 2 shows an anvil system of the kind in which an anvil of the present invention may be used;

FIG. 3 is a partial cut-away view of an anvil system of FIG. 2;

FIG. 4 is a top plan view of an anvil of the prior art;

FIG. 5 is a side perspective of the anvil of FIG. 4;

FIG. 6 is a perspective view of an embodiment of the anvil of the present invention showing some additional features;

FIG. 7 is a side perspective view of an anvil of the present invention engaged with a sonotrode of an ultrasonic horn;

FIG. 8 is a top perspective view of an anvil of the present invention engaging a carton;

FIG. 9 is a top perspective view of an anvil of the present invention engaging a sealed carton;

FIG. 10 is a top perspective view of an ultrasonic carton sealer; and

FIGS 11-13 illustrate a sealing operation performed on a gable-top closure.

[0009] The ultrasonic anvil of the present invention may be used on a carton forming, filling and sealing machine such as the one described in Stark *et* al, U.S. Patent No. 5,488,812, issued on February 6 1996 for a Packaging Machine. The Stark *et al* packaging machine is only one example of the possible applications of the ultrasonic anvil of the present invention. Those skilled in the art are aware of many possible applications of the ultrasonic anvil which do not depart from the spirit and scope of the present invention.

[0010] As shown in FIG. 1, the anvil 20 has a forward end 21 and a rearward end 22. The anvil 20 includes an anvil body 23, a vibrating portion 24, a sealing portion 26 and means for acoustically insulating the anvil body which is an airspace 28 for this embodiment of the anvil 20. The airspace 28 is bordered by the vibrating portion 24 on the forward end, the anvil body 23 on the rearward end and by a pair of parallel bridges 30 and 32 on the sides. The parallel bridges 30 and 32 also connect the vibrating portion 24 to the anvil body 23. As is apparent from FIG. 1. the parallel bridges are outside of the predetermined length of the sealing portion 26. This design allows for the stability needed by the anvil 20 for an effective sealing of a carton, not shown. The airspace 28 provides for the insulation of the anvil body 23 from the vibrating portion 24 during the activation of the ultrasonic horn which transfers energy to the anvil during the sealing process, and decreases the amount of ultrasonic energy transferred to the anvil body 23. The airspace 28 allows for the energy to be kept in the vibrating portion 24 instead of being transferred to the frame, not shown, via the anvil body 23. The acoustical insulation means is further described below.

[0011] As shown in FIG. 2, the anvil system 36 includes an anvil bar 38. a series of anvils 20A-F and a plurality of interanvil connecting tubes 39. The six anvils 20A-F allow for the sealing of six cartons simultaneously with a single reciprocal stroke of the grouped anvils 20A-F. Although the present embodiment illustrates an anvil system with anvil bars, those skilled in the pertinent art will recognize that greater or lessor amounts of anvils may be used in practicing the present invention. The anvils 20A-F are removably mounted on the anvil bar 38 in order to facilitate replacement of the anvils 20A-F periodically.

[0012] The anvil bar 38 is arranged for traveling back and forth between an open position allowing a carton to pass, and a closed position for bearing against the one side of a closure located at the closure scaling position. In this manner, a multitude of cartons are sealed at once.

[0013] Some of the ultrasonic energy is transferred to the anvils 20A-F from the transducers or sealing horns during operation of the ultrasonic scaling device. This ultrasonic energy is dissipated from the anvils 20A-F in the form of heat. A cooling system may be utilized to prevent overheating of the anvils 20A-F during operation of the ultrasonic sealing device. The cooling system of the present invention is best illustrated in FIG. 3. As shown in FIG. 3, the cooling system consists of an internal passageway 40 through each of the anvils 20A-F, and more particularly an internal passageway 40 through the vibrating portion 24 of the anvils 20A-F. Each of the internal passageways 40 are of a predetermined diameter and extend from one side of the anvil 20 to an opposite side. The internal passageway 40 is located in a position which would have a minimal adverse effect on the operation of the anvil 20 while maximizing its cooling capabilities. The flow of the heat sink fluid through the internal passageway 40 is also a factor in the cooling capability of the internal passageway 40 since the flow rate will determine how quickly the absorbed heat is removed from the anvils 20A-F. A lower flow rate necessitates a greater surface area and viz. versa. Thus, the internal passageway 40 should have a sufficient surface area to absorb heat from the anvil 20 in a predetermined time period based on a fixed flow rate of the heat sink fluid.

[0014] The internal passageway 40 is also removed from any contact with the means for acoustically insulating the anvil slot 52. The need to avoid the acoustically insulating means is a factor in the size and placement of the internal passageways 40 in each of the anvils 20A-F. In order to optimize its cooling capabilities, the internal passageways 40 must have a sufficient surface area, however the size cannot interfere with the insulating means. Also the placement of the internal passageways 40 must not interfere with the insulating means, however, this factor must be balanced with the ability to effectively remove heat from the anvil 20.

[0015] Each of the internal passageways 40 of each of the anvils 20A-F is connected to one another through an interanvil connecting tube 39. Each of the interanvil connecting tubes 39 has a diameter which enables the tube 39 to be inserted into each of the internal passageways 40 and still allow for the effective flow of a fluid through the tube 39. Once inserted into the internal passageway 40, the interanvil connecting tube 39 is scaled to each of the anvils 20A-F through at least one, and preferably two, O-rings 42. The O-rings 42 enable each individual anvil 20 to move in relation to each other anvil 20 without disconnection of the interanvil connecting tube 39 disposed between neighboring anvils 20A-F. The interanvil connecting tubes 39 are of a predetermined length. which provides them with a sufficient length to maintain their connection between neighboring anvils 20A-F when an anvil 20 is moved out of alignment with its neighboring anvil 20. In a preferred embodiment, the interanvil connecting tubes 39 are composed of a plastic material. However, other materials such as stainless steel may be employed in practicing the invention. However, those skilled in the pertinent art will recognize that a multitude of other materials may be substituted for stainless steel without departing from the scope of the present invention. The interanvil connecting tubes 39 which are connected to the each of the two end anvils 20A and F on one end of each of the tubes 39 are con-

nected on the opposite end to an inlet tube 44 and an outlet tube 46 as shown in FIG. 2. In this manner, all of the internal passageways 40, all of the interanvil connecting tubes 39, the inlet tube 44 and the outlet tube 46 are all in flow communication with each other.

[0016] The inlet tube 44 is in flow communication with a heat sink fluid source 48, not shown, and the outlet tube 46 is in flow communication with a waste fluid depository 50, not shown. A heat sink fluid is defined as a fluid which substantially maintains the temperature through the transfer of heat between an object and the heat sink fluid. In the present invention, the heat sink fluid will probably only be utilized to transfer heat from the object, an anvil 20, to the heat sink fluid. A preferred heat sink fluid is water, however other fluids may be employed in practicing the present invention. The inlet tube 44 may be connected directly to the common source for water or connected to a device which might first chill the water. The water will flow through inlet tube 44 to the first interanvil connecting tube 39, into the internal passageway 40 of the first anvil 20A and then through the rest of the anvils 20B-F in a similar fashion. Once the water has flowed through the last anvil 20F, it will flow through the outlet tube 46 to the waste fluid depository 50 such as a sink which is in flow communication with a sewer system. Alternatively, the water may flow from the outlet tube 46 to a circulating system for recirculation of the water to the inlet tube 44. The use of a plastic or stainless steel material for the interanvil connecting tubes 39 will lessen the possibility of the tubes 39 being oxidized by the water.

[0017] In operation, the cooling system will provide a heat sink fluid such as chilled water to the anvils 20A-F which permits the transference of the heat from the anvils 20A-F to the fluid. As the fluid flows from the inlet tube 44 through the anvils 20A-F to the outlet tube 46, the transference of heat to the fluid will lower the operating temperature of the anvils 20A-F thereby reducing the possibility of deleterious effects arising from the overheating of the anvils 20A-F.

[0018] In an ultrasonic scaling operation, the anvil 20 is a part of the vibrating system and has to be acoustically insulated from the rest of the machine. The anvil must be acoustical insulated to avoid possible damage to the machine structure and also to reduce the loss of ultrasonic energy to the machine frame. Presently, this acoustical insulation is achieved by a rubber layer between the vibrating portion 24 and the anvil body 23. The rubber layer renders the forward end 21 of the anvil 20 (the sealing portion 26 and the vibrating portion 24) flexible, thus interfering with the pressure distribution of the sealing portion 26. If the rubber is hard and stiff, the insulating effect is low thereby allowing a greater amount of ultrasonic energy to be transferred to the machine frame. If there is a total absence of insulation, the amount of ultrasonic energy transferred is tremendous.

[0019] Presently, most anvils have the sealing pattern as an inseparable component of the anvil. The anvil 20 of the present invention, in addition to the previously mentioned aspects, also encompasses a novel construction which separates the sealing portion from the vibrating portion 24, and the rest of the anvil 20. As shown in FIG. 8, the anvil 20 of the present invention may be separated into the following general components: the anvil body 23; the vibrating portion 24; cooling system and the sealing portion 26. The multiple component anvil 20 allows for facilitated substitution or replacement of the components as compared to a typical anvil which must be replaced as an entire unit. The sealing portion 26 may be exchanged without disturbing the insulation between the vibrating portion 24 and the anvil body 23.

[0020] A set of screws 70 connect the sealing portion 26 to the vibrating portion 24 and allow for facilitated substitution of scaling portions 26. The screws 70 do not come in contact with the rubber membrane 52 or the internal passageway 40. Revulcanization of the rubber membrane 52 is also avoided when a new sealing portion is needed since the vibrating portion 24 and anvil body 23 which surround the rubber membrane 52 are not displaced during the substitution of scaling portions 26.

[0021] During ultrasonic sealing, it is obvious that the absence of an object to be sealed, such as packaging material, will result in damage to the anvil 20 and sonotrode 72 of the ultrasonic horn 74. In some specific sealing applications it is necessary to maintain a predetermined distance between the sonotrode72 and the anvil 20 during the ultrasonic sealing operation. Excess pressure on a packaging material undergoing ultrasonic sealing which results in melted packaging material being extruded from the sealing area is an example of a specific sealing application necessitating the maintenance of a minimal distance between the sonotrode 72 and the anvil 20. In order to prevent damage to the anvil 20 and the sonotrode 72, and to maintain a predetermined distance between the anvil 20 and the sonotrode 72, the present invention includes a plurality of support pads 76 for creating a gap between the sonotrode 72 and the anvil 20.

[0022] As shown in FIG. 9, the anvil 20 has a plurality of support pads 76 located in predetermined positions to prevent oversealing to a carton fin and damage to the sealing equipment. The plurality of support pads 76 are located on the anvil 20. The support pads 76 are composed of a heat resistant plastic material which has low creep and sufficient durability to withstand the repetitive sealing process. The length of the support pads 76 is determined by the sealing needs. As shown in FIGS. 10 and 11, the length of the support pads 76 is determined by the thickness of the closure to be sealed by the ultrasonic horn and the anvil. If the length is insufficient, then the closure material will extrude outward during the sealing operation. If the length is greater than necessary, the closure will not be properly scaled during the scaling operation. A preferred support pad 76 is com-

posed of a polyetheretherketone ("PEEK"). The PEEK material is capable of withstanding the tremendous loads, upwards of 3000 N, on the support pads 76.

Industrial Applicability

[0023] An ultrasonic carton sealer is illustrated in FIG. 10. As mentioned previously, the novel anvil of the present invention may be utilized as a component of a carton sealer on a carton filling and sealing machine such as described in Stark *et al.* As shown in FIG. 10, the carton sealer has numerous components for performing the sealing operation on a closure. Of interest are the anvils 20A-H, the anvil bar 38 and the ultrasonic horns.

[0024] FIGS. 11-13 illustrate a sealing operation performed on a gable-top closure. In FIG. 11, an anvil 20 is disposed opposite to an ultrasonic hom 74. In FIG. 12, a fin 80 of a gable-top closure is positioned between the anvil 20 and ultrasonic hom 74 in anticipation of being sealed through ultrasonic energy. In FIG. 13, the anvil 20 is engaged with the fin 80, forcing it up against the ultrasonic hom 74, in order to seal the closure together through ultrasonic energy generated from the ultrasonic horn 74. The means for acoustical insulation decreases the amount of ultrasonic energy transferred from the vibration portion 24 to the anvil body 23. This also decreases the amount of ultrasonic energy transferred to other components of the carton sealer and the machine.

Claims

1. An anvil (20) for utilization in conjunction with an ultrasonic hom, a forward end (21) of the anvil facing the ultrasonic horn, the anvil comprising: an anvil body (23); a vibrating portion (24) disposed forward from the anvil body; a sealing portion (26) attached to the vibrating portion; means for acoustically insulating the anvil body disposed between the anvil body (23) and the vibrating portion (24); and, a cooling system disposed within the anvil,
   CHARACTERIZED IN THAT
   the means for acoustically insulating the anvil (20) comprises the anvil body (23) connected to the vibrating portion (24) by a pair of parallel bridges (30,32) thereby forming an airspace slot (28) separating the anvil body (23) from the vibrating portion (24) with the pair of parallel bridges (30,32) forming a boundary around the airspace slot (28) along the anvil body (23) and the vibrating portion (24).

2. An anvil according to Claim 1 wherein the sealing portion comprises a bar having an upper surface and a lower surface, the upper surface having a sealing pattern thereon and the lower surface disposed to the vibrating portion, the sealing portion connected to the vibrating portion without contact with the means for acoustically insulating the anvil.

3. An anvil according to Claim 1 or Claim 2 wherein the cooling system comprises an internal passageway in the vibrating portion (24) for the flow of a heat sink fluid therethrough.

4. An anvil according to any preceding Claim including a plurality of pads (76) projecting from the sealing portion (26) and disposed on the sealing portion to avoid interference with the ultrasonic sealing, each pad having a predetermined length substantially corresponding to the minimal thickness of an object undergoing ultrasonic sealing.

5. An anvil system (36) for utilization in conjunction with a multitude of ultrasonic horns, an anvil bar (38) connected to an anvil drive, the anvil drive providing movement to the anvil bar; a plurality of anvils (20) according to any preceding claim mounted on the anvil bar, each capable of performing individual sealing operations in conjunction with an ultrasonic horn; and a plurality of interanvil connecting tubes (39) for the transference of the heat sink fluid between the cooling systems of the plurality of anvils (20).

6. An anvil system according to Claim 5 wherein each interanvil connecting tube (39) is sealed to each corresponding anvil of the plurality of anvils by at least one O-ring.

Patentansprüche

1. Gegenbacken (20) bzw. Amboss zur Verwendung in Verbindung mit einem Ultraschall-Schweissbakken (74), bei dem ein Frontende (21) des Gegenbackens zum Ultraschallbacken gerichtet ist, mit einem Backenkörper (23), einem vor dem Backenkörper angeordneten Vibrationsteil (24), einem am Vibrationsteil befestigten Versiegelungs- bzw. Schweisskörper (26), eine zwischen dem Backenkörper (23) und dem Vibrationsteil (24) angeordneten Isoliereinrichtung zum akustischen Isolieren des Backenkörpers (23) und einem im Amboss bzw. Gegenbacken angeordneten Kühlsystem,
   dadurch gekennzeichnet,
   dass die den Gegenbacken (20) akustisch isolierende Isoiereinrichtung ein Paar paralleler Brücken (30, 32) bzw. Stege aufweist, welche den Gegenbacken (23) mit dem Vibrationsteil (24) verbinden und dadurch einen Luftspalt bzw. Schlitz (28) bilden, der den Backenkörper (23) vom Vibrationsteil (24) trennt, und bei dem der Luftspalt bzw. Schlitz (28) längs des Backenkörpers (23) und des Vibrationsteils (24) durch das Paar paralleler Brücken (30, 32) als Begrenzung umschlossen ist.

2. Gegenbacken nach Anspruch 1,
dadurch gekennzeichnet,
dass die Versiegelungs- bzw. Verschweisseinrichtung einen Bügel aufweist, der eine obere und eine untere Oberfläche aufweist, von denen die obere Oberfläche ein Versiegelungs- bzw. Schweissmuster enthält und die untere Oberfläche am Vibrationsteil angeordnet ist, so dass der mit dem Vibrationsteil verbundene Schweissteil nicht in Kontakt kommt mit der Isoliereinrichtung zum akustischen Isolieren des Gegenbackens.

3. Gegenbacken nach Anspruch 1 oder 2,
dadurch gekennzeichnet,
dass das Kühlsystem einen inneren Durchgangskanal im Vibrationsteil (24) zum Durchströmen von Kühlfluidum enthält.

4. Gegenbacken nach einem der vorhergehenden Ansprüche,
dadurch gekennzeichnet,
dass von dem Schweisskörper (26) eine Mehrzahl von Puffern oder Dämpfungselementen (76) absteht, die am Schweisskörper angeordnet sind, um Interferenzen beim Ultraschallversiegeln zu vermeiden, und dass jedes Dämpfungselement (76) eine vorbestimmte Länge aufweist, die im wesentlichen der minimalen Dicke eines Objekts entspricht, welches dem Ultraschallverschweissen bzw. -versiegeln ausgesetzt wird.

5. Gegenbackensystem (36) bzw. Amboss zur Verwendung in Verbindung mit einer Mehrzahl von Ultraschall-Schweissbacken, bei dem ein Amboss- bzw. Gegenbackenbügel (38) an einen Gegenbakkenantrieb angeschlossen ist, der an den Gegenbackenbügel Bewegungen weitergibt, und mit einer Mehrzahl von Gegenbacken (20) nach einem der vorhergehenden Ansprüche,
dadurch gekennzeichnet,
dass die Gegenbacken (20) an dem Gegenbackenbügel (38) derart befestigt sind, dass jeder Gegenbacken in der Lage ist, individuelle Schweissvorgänge in Verbindung mit einem Ultraschall-Schweissbacken vorzunehmen, und dass eine Mehrzahl von die Gegenbacken verbindenden Rohren (39) zur Übertragung des Kühlfluidum zwischen den Kühlsystemen der Mehrzahl von Gegenbacken (20) dient.

6. Gegebackensystem nach Anspruch 5,
dadurch gekennzeichnet,
dass jedes Gegenbacken-verbindende Rohr (39) mit jedem zugehörigen Gegenbacken der Mehrzahl von Gegenbacken durch mindestens einen O-Ring abgedichtet ist.

Revendications

1. Enclume (20) destinée à être utilisée conjointement avec un émetteur d'ultrasons, une extrémité antérieure (21) de l'enclume faisant face à l'émetteur d'ultrasons, l'enclume comprenant : un corps d'enclume (23); une partie de vibreur (24) disposée à l'avant du corps d'enclume; une partie de soudure (26) fixée à la partie de vibreur; des moyens d'isolation acoustique du corps d'enclume disposés entre le corps d'enclume (23) et la partie de vibreur (24) et un système de refroidissement disposé au sein de l'enclume;
caractérisée en ce que
les moyens d'isolation acoustique de l'enclume (20) comprennent le corps d'enclume (23) relié à la partie de vibreur (24) grâce à un couple d'entretoises parallèles (30, 32) constituant ainsi un espace d'air (28) séparant le corps de l'enclume (23) de la partie de vibreur (24), le couple d'entretoises parallèles (30, 32) formant une limite autour de l'espace d'air (28) le long du corps d'enclume (23) et de la partie de vibreur (24).

2. Enclume selon la revendication 1, dans laquelle la partie de soudure comprend une barre possédant une surface supérieure et une surface inférieure, la surface supérieure présentant sur celle-ci un motif de soudure et la surface inférieure disposée sur la partie de vibreur, la partie de soudure étant reliée à la partie de vibreur sans contact avec les moyens destinés à l'isolement acoustique de l'enclume.

3. Enclume selon la revendication 1 ou la revendication 2, dans laquelle le système de refroidissement comprend un passage interne dans la partie de vibreur (24) destiné à la circulation d'un fluide de dissipation thermique.

4. Enclume selon l'une quelconque des revendications précédentes, comprenant une pluralité de pastilles (76) saillant de la partie de soudure (26) et disposée sur la partie de soudure pour éviter une interférence avec la soudure ultrasonique, chaque pastille présentant une longueur prédéterminée correspondant sensiblement à l'épaisseur minimale d'un objet soumis une soudure à ultrasons.

5. Système d'enclume (36) destiné à être utilisé conjointement avec une multitude d'émetteurs d'ultrasons, une barre d'enclume (38) reliée à un entraînement d'enclume, l'entraînement d'enclume fournissant un mouvement à la barre d'enclume ; une pluralité d'enclumes (20) selon l'une quelconque des revendications précédentes montée sur la barre d'enclume, chacune susceptible de réaliser des opérations de soudure individuelles en association avec un émetteur d'ultrasons et une pluralité de tu-

bes de liaison entre enclumes (39) pour le transfert du fluide de dissipation thermique entre les systèmes de refroidissement de la pluralité d'enclumes (20).

6. Système d'enclume selon la revendication 5, dans lequel chaque tube de liaison entre enclumes (39) est scellé à chaque enclume correspondante de la pluralité d'enclumes par au moins un joint torique.

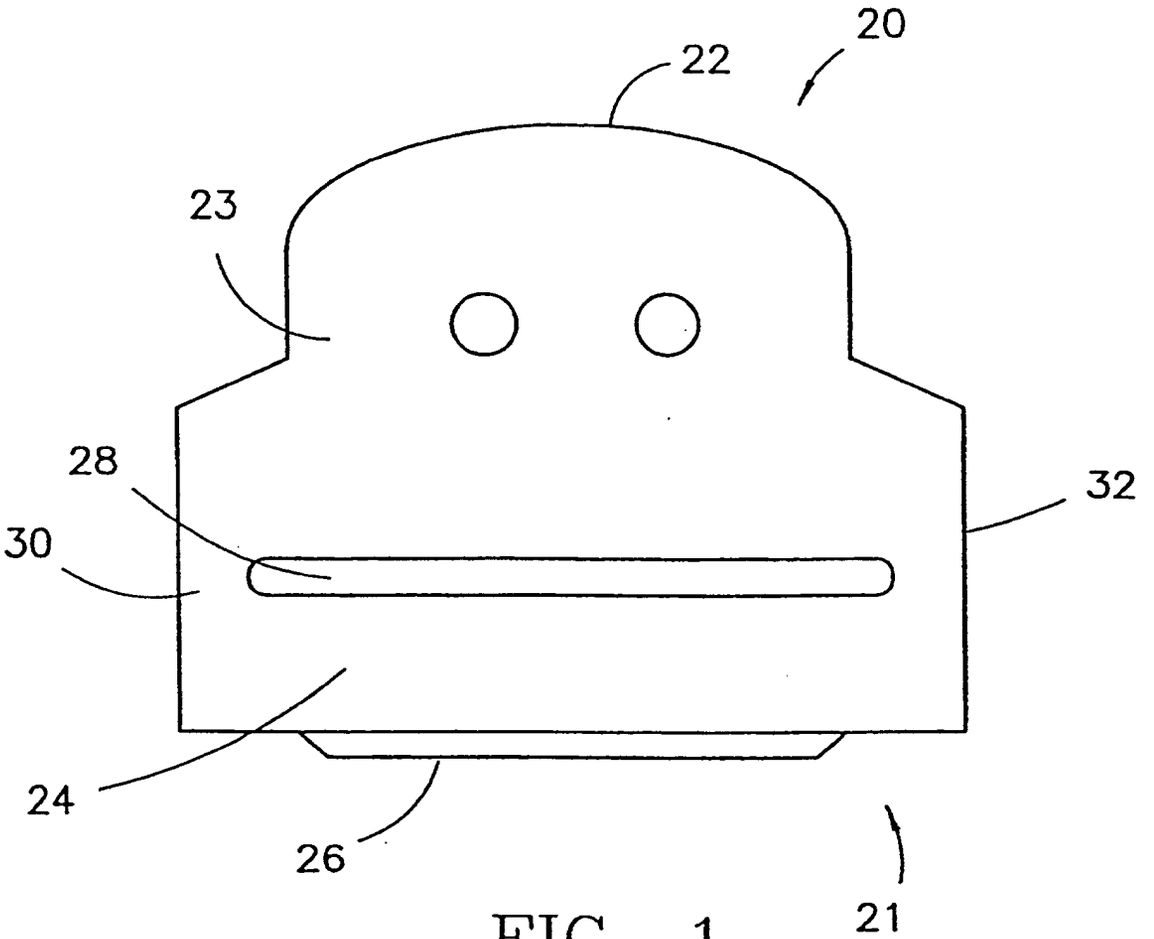

FIG. 1

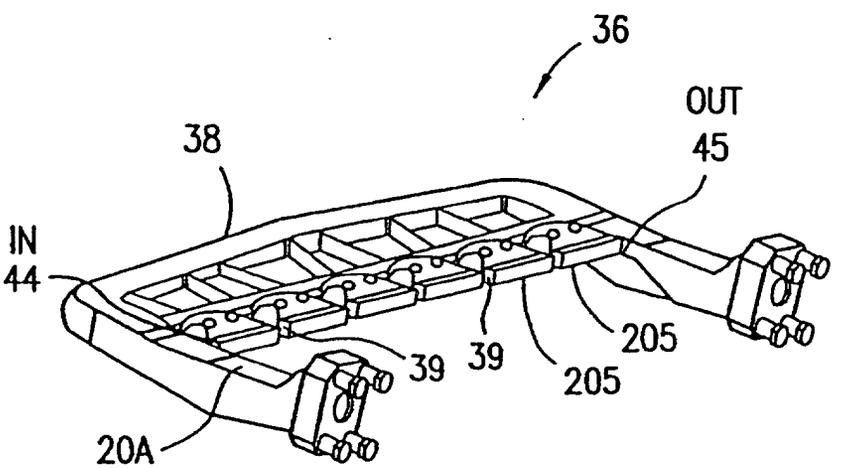

FIG. 2

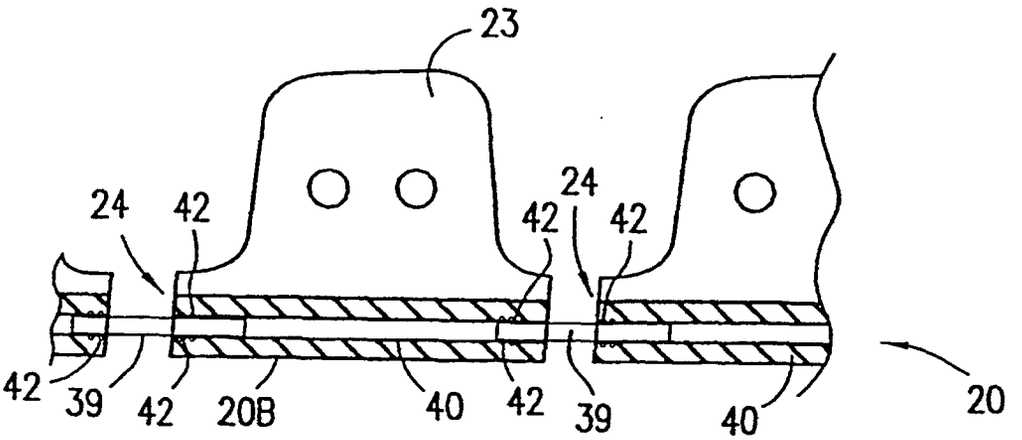

FIG. 3

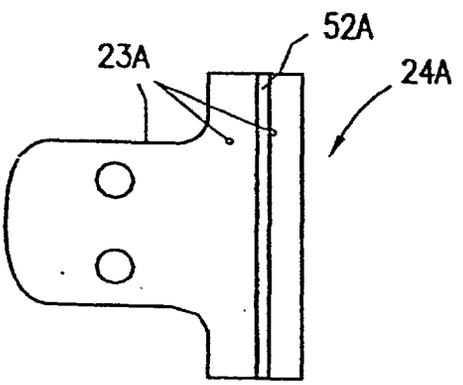

FIG. 4

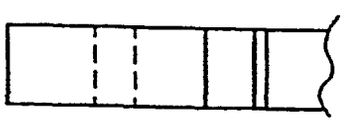

FIG. 5

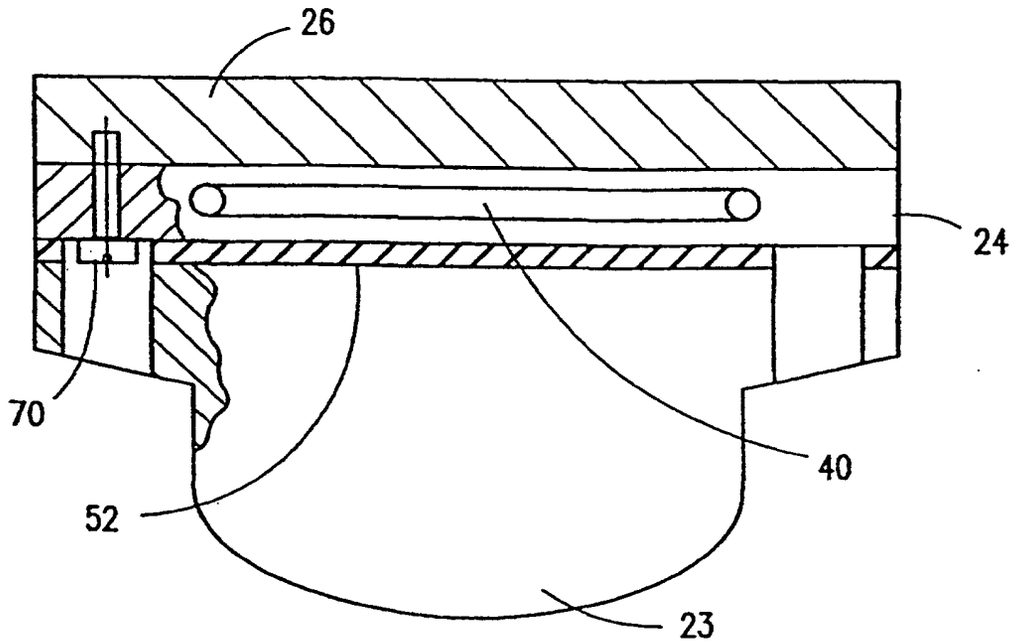

FIG. 6

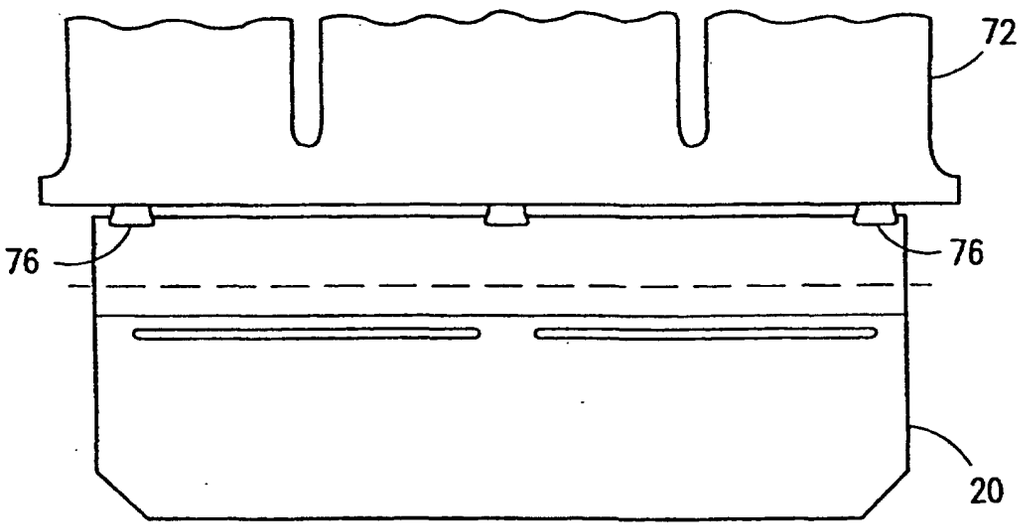

FIG. 7

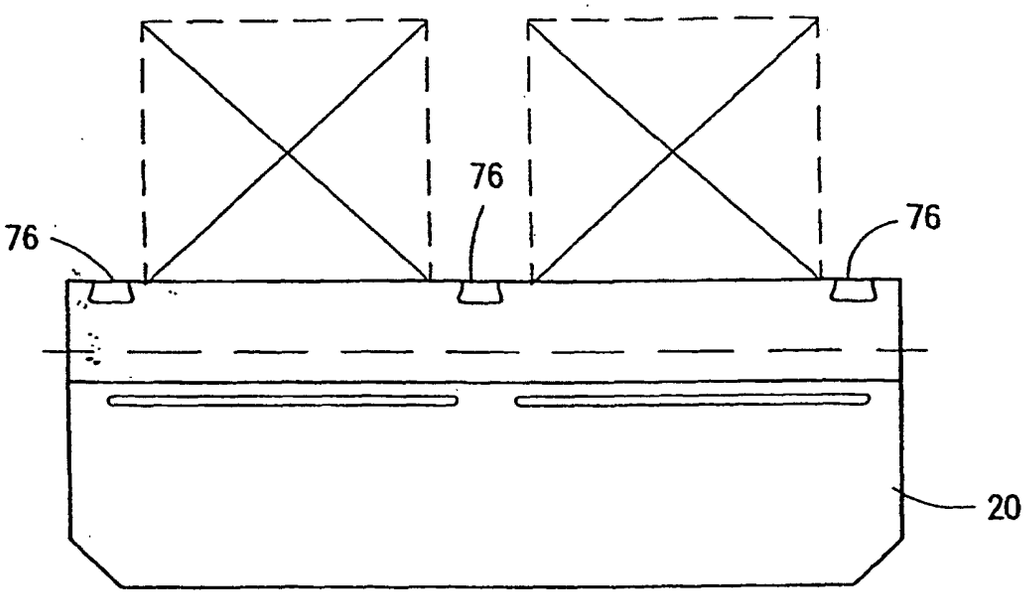

FIG. 8

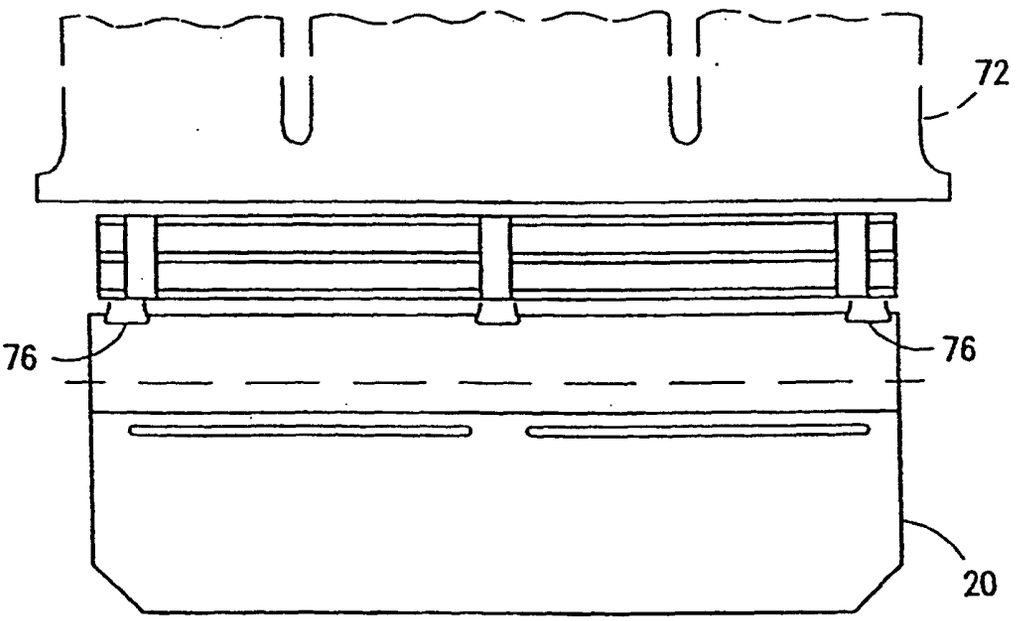

FIG. 9

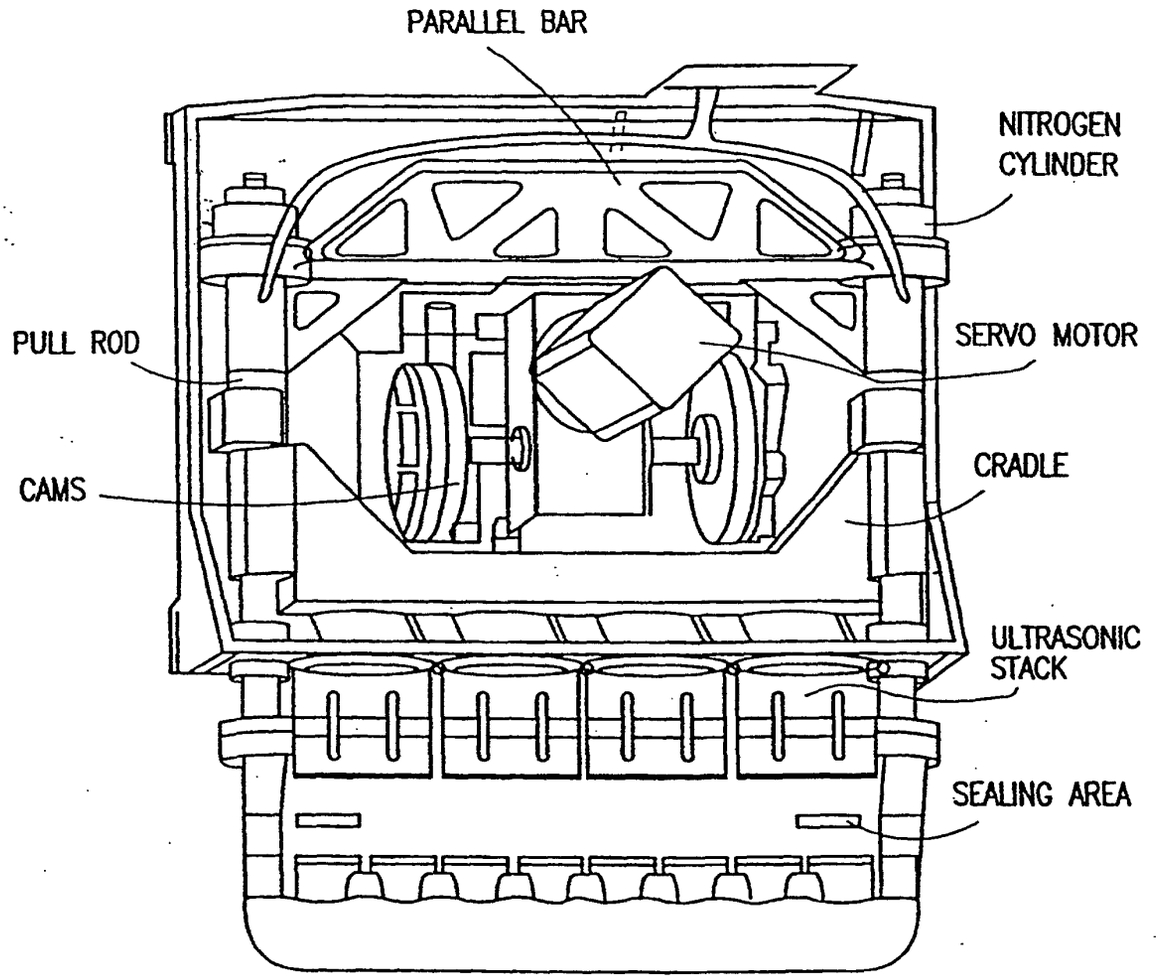
PARALLEL BAR
NITROGEN CYLINDER
PULL ROD
SERVO MOTOR
CAMS
CRADLE
ULTRASONIC STACK
SEALING AREA

FIG. 10

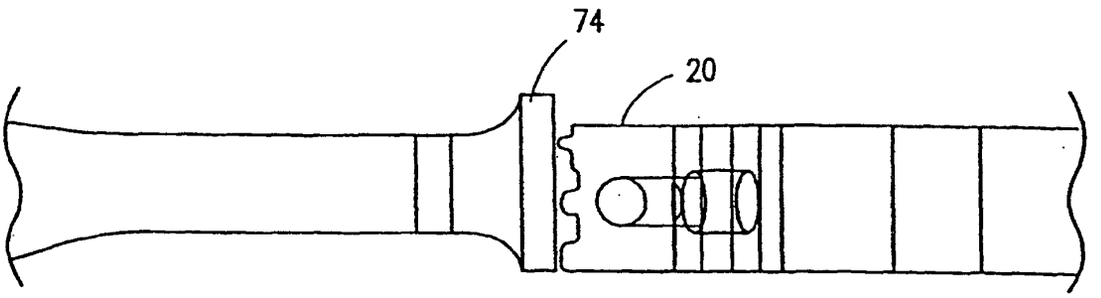

FIG. 11

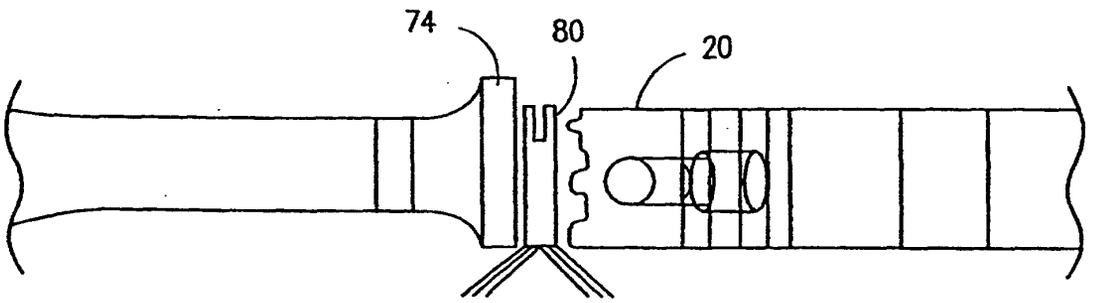

FIG. 12

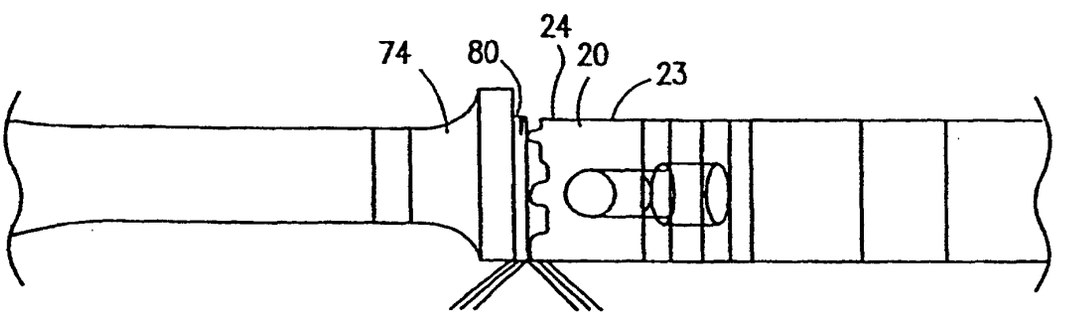

FIG. 13