June 10, 1969 J. K. WARREN 3,449,759

ELECTRON BEAM RECORDER HAVING SEALING MEANS

Filed Feb. 27, 1967 Sheet 1 of 2

FIG. 1

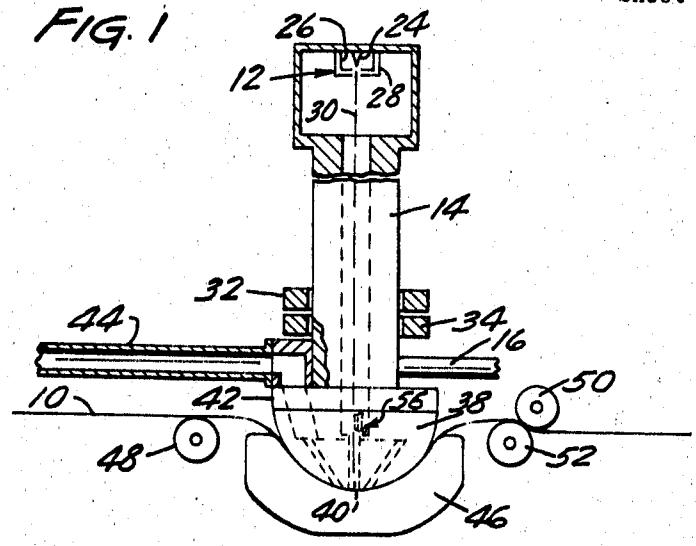


FIG. 2

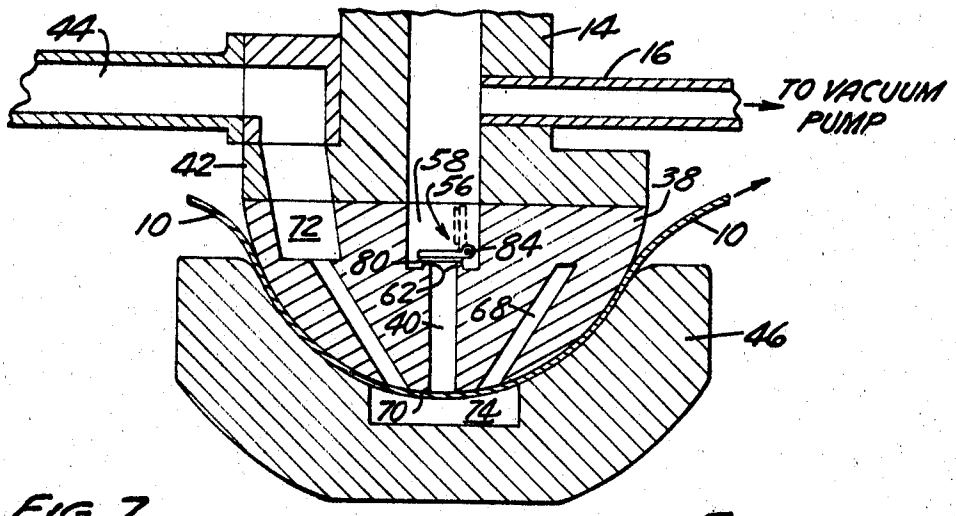


FIG. 7

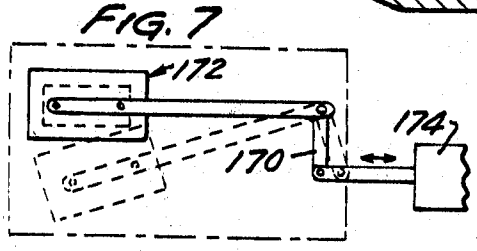


FIG. 6

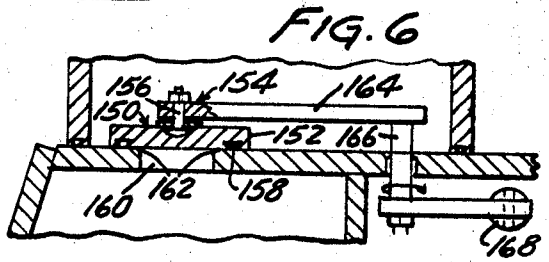
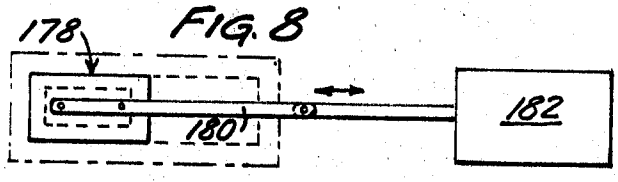


FIG. 8



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Filed Feb. 27, 1967 Sheet 2 of 2

FIG. 4

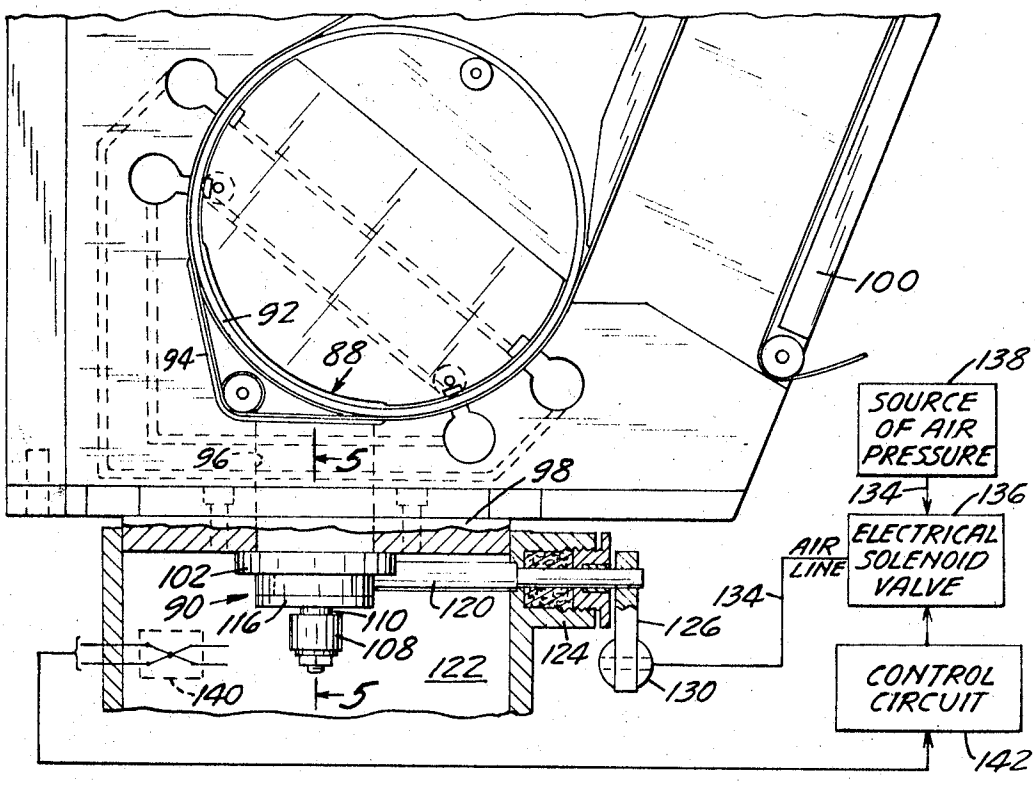


FIG. 5

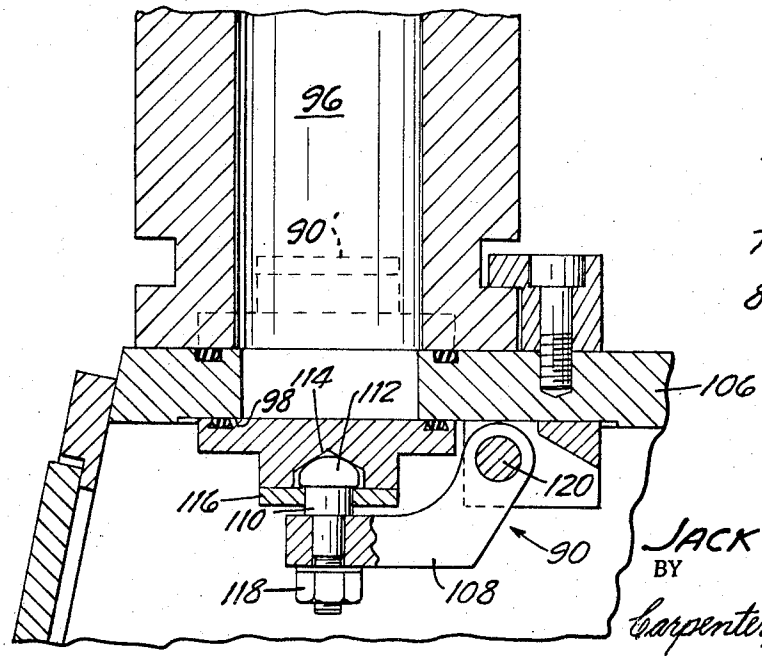
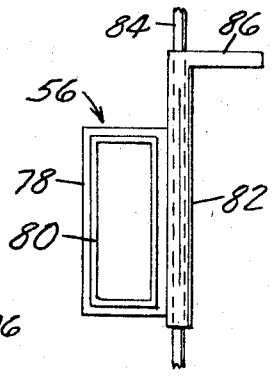


FIG. 3



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United States Patent Office 3,449,759 Patented June 10, 1969

3,449,759

ELECTRON BEAM RECORDER HAVING SEALING MEANS

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Filed Feb. 27, 1967, Ser. No. 618,656
Int. Cl. G01d 9/42
U.S. Cl. 346—110 15 Claims

ABSTRACT OF THE DISCLOSURE

Apparatus comprising in combination an evacuated chamber capable of being pumped to a partial vacuum and a sealing means, such as a valve, is disclosed. The chamber encloses means for generating and directing an energy or corpuscular beam, such as an electron beam, through an aperture in the chamber which under certain conditions is sealed by the sealing means. The sealing means is adapted for movment between an unsealing and sealing position to isolate and maintain the vacuum within the chamber.

Movement of a web through a gas seal or vacuum seal into a high vacuum chamber for treatment or bombardment by an energy beam is shown by the prior art. Such apparatus is disclosed in Patent No. 3,222,678 to D. A. Jones, and Jones application Ser. No. 515,049, filed Dec. 20, 1965, now abandoned and replaced with pending application Ser. No. 667,016, filed June 30, 1967, and Jones application Ser. No. 613,215, filed Jan. 31, 1967.

The apparatuses referenced above are used as recording and/or reproducing systems which bombard one surface of a moving web with a corpuscular beam, such as an electron beam. A high vacuum in an electron gun chamber is maintained by the vacuum seal and the effectiveness of the vacuum seal.

In apparatus disclosed in Patent No. 3,222,678, the surface of the web being treated is in sliding engagement with an outer wall of the chamber. Further, the surface of the web forms part of the vacuum seal by physically engaging and sealing an aperture in the chamber wall through which the electron beam passes to treat the web. Conversely, in apparatus disclosed in Jones application Ser. No. 515,049, and Jones application Ser. No. 613,215, filed Jan. 31, 1967, the surface of the web being treated by the electron beam through an opening in the chamber wall does not contact any part of the chamber wall and does not contact the aperture or opening. Effectiveness of the vacuum seal in this apparatus is dependent on continuously pumping a small volume or space which exists between the surface of the web being treated and the chamber wall.

In either of the above apparatuses, the surface of the web breakage thereby protecting the beam generating through an aperture in the chamber wall is in operative relationship with that aperture. The transporting and gas restricting means restricts movement of gas molecules from an ambient higher pressure atmosphere to the aperture as the one surface of the web is transported past the aperture.

If the moving web breaks thereby rupturing the vacuum seal, the electron beam chamber and the beam generating means are engulfed in the higher pressure atmosphere which normally contains oxygen, nitrogen and other gases. Sudden exposure of an operating beam generating means to oxygen in particular causes some elements, such as the cathode, to be either immediately destroyed or poisoned. When this occurs and before the apparatus can be rendered operative, the affected elements need to be replaced and the electron beam chamber repumped back to the desired vacuum.

The vacuum chamber valve of the present invention overcomes the disadvantages of the prior art in that the valve is capable of immediately isolating and retaining a vacuum within an evacuatable chamber in the event of web breakage thereby protecting the beam generating means.

Another advantage of the present invention is that the vacuum chamber valve is capable of maintaining a vacuum within the evacuatable chamber during web unloading and loading.

Yet another advantage of the present invention is that the vacuum chamber valve can be located either within the evacuatable chamber or alternatively in the ambient atmosphere surrounding the aperture directly communicating with the evacuatable chamber.

These and other advantages of the present invention will become readily apparent when considered in light of the following description taken in connection with the following drawing wherein:

FIGURE 1 is a diagrammatic representation of a front elevation view of a recording and/or reproducing apparatus having a vacuum chamber valve wherein a vacuum seal is utilized to maintain a high vacuum in an evacuatable chamber and afford movement of a web therethrough for bombardment of the web by an energy beam;

FIGURE 2 is a diagrammatic representation of a fragmentary vertical sectional view of the vacuum seal of FIGURE 1 illustrating one embodiment wherein the vacuum chamber valve is located within the high vacuum chamber;

FIGURE 3 is a detailed plan view of the vacuum chamber valve of FIGURE 2;

FIGURE 4 is a diagrammatic fragmentary elevational view, with a front plate removed and partly in cross-section, of a recording and/or reproducing apparatus wherein the vacuum chamber valve is located in the evacuatable chamber and is operated by a pneumatic member;

FIGURE 5 is a fragmentary detailed sectional view of the automatic vacuum chamber valve taken along the line 5—5 of FIGURE 4;

FIGURE 6 is a fragmentary detailed sectional view of yet another embodiment of the vacuum chamber valve which is slideably moved in an arcuate path between its sealing and unsealing position;

FIGURE 7 is a pictorial representation of a valve similar to that of FIGURE 6 showing a different arcuate movement for the valve; and

FIGURE 8 is a pictorial representation of a valve similar to that of FIGURE 6 wherein the valve is slideably moved in a straight path between its sealing and unsealing position.

Briefly, the present invention relates to apparatus comprising in combination means for defining a chamber capable of being evacuated wherein the chamber includes a terminal wall portion having an aperture therein. The chamber encloses means for generating and directing an energy beam, such as an electron beam, through the aperture. Means which are operatively connected to the chamber are used for producing at least a partial vacuum within the chamber. Sealing means, for example a flap valve, are disposed adjacent the aperture and are adapted for movement into sealing position with the aperture for isolating and maintaining vacuum in the evacuated chamber when a condition occurs wherein the vacuum within the chamber would be poisoned from a higher pressure ambient atmosphere. The sealing means is adapted for movement into an unsealing position away from the aperture when the vacuum condition can be safely maintained

within the chamber for permitting the energy beam to pass through the aperture.

FIGURE 1 illustrates one embodiment of an apparatus for bombarding one surface of a web **10**. The apparatus is in the form of an information recording system which includes means for generating an energy beam or a corpuscular beam, such as the illustrated electron gun **12**. The electron gun **12** is enclosed within an electron gun chamber **14**, which is at least a portion of an evacuatable chamber. The electron gun chamber **14** is capable of being evacuated by means for producing at least a partial vacuum in the chamber, such as a vacuum pump (not shown) through a conduit **16**. The electron gun **12** typically includes a cathode **24**, a control grid **26** and an accelerating grid **28** which produces an electron beam **30** which is directed in an axial direction through the chamber **14**. The electron beam **30** is focused and deflected by conventional focusing and deflecting means, such as for example electromagnetic focusing coil **32** and electromagnetic deflecting coil **34**.

In this embodiment, the chamber **14** encloses the electron gun **12**. The web to be bombarded by the resulting electron beam is located outside of the chamber. Alternatively, the chamber **14** could be of sufficient size to enclose both the generating means and web. In such apparatus, the generating means is located in at least a portion of the chamber, say for example at one end thereof, which communicates via an aperture with the web enclosing portion of the chamber located, for example, at the other end thereof. Thus, the generating means enclosing portion of the chamber is capable of being physically separated from the web enclosing portion of the chamber.

The chamber **14** terminates in a terminal member **38** having an aperture **40** formed therein through which the electron beam **30** is directed. An outer surface **42** of terminal member **38** forms an outer terminal wall portion. The outer surface **42** defines a surface around which the web **10** travels as it is passed to and through an area exposed to the chamber **14** for bombardment of one surface thereof by the electron beam **30**. It is contemplated that terminal member **38** and aperture **40** could be located in other than axial alignment with the electron gun **12**, such as for example at a 90° angle. In such an apparatus, the electron beam **30** is deflected through a 90° angle by conventional beam deflection means.

A conduit **44** is connected between the cylindrical chamber **14** including terminal member **38** and a source of reduced pressure or means for producing at least a partial vacuum, such as a vacuum pump (not shown). The conduit **44** serves to supply subatmospheric pressure to the terminal member **38**.

A complementary shaped guide member **46** is positioned below the terminal member **38** and is mounted to be readily removed and replaced to facilitate threading the web **10** in the apparatus. The guide member **46** also coacts with the terminal member **38** to maintain the web **10** in its path and under desired pressure conditions. The web **10** in the illustrated embodiments is a medium sensitive to an electron beam, for example a film or treated paper. The web **10** is progressively unwound from a supply roll (not shown) over a roller **48** and between the terminal member **38** and guide member **46**. The web **10** is threaded between a driven capstan **50** and a resilient pressure roller **52** which coacts with the capstan **50** to maintain web **10** in frictional contacting driving engagement therebetween. During a recording operation, the capstan **50** is adapted to drive the web **10** at a constant speed and the web **10** is rewound upon a take-up spool (not shown). A vacuum chamber valve, generally designated as **56**, is located in the terminal member **38**.

FIGURE 2 illustrates a preferred embodiment of the vacuum chamber valve of the present invention. In this embodiment, the terminal member **38** is joined with the cylindrical chamber **14** to form a lower terminal chamber, generally designated as **58**, of the electron gun chamber.

The chamber **58** within the terminal member **38** has the opening or aperture **40** formed therein. In this embodiment, the aperture **40** contains a relatively smooth planar surface which is in the form of a raised protruding lip or border **62** on the inner surface of terminal member **38** within chamber **58**. In other applications, it may be desirable to have the smooth planar surface recessed. In either application it is desirable to have the surface relatively well-machined.

A sealing means, such as flap valve **56**, is disposed adjacent the aperture **40** and is adapted for movement into sealing engagement across the aperture **40** as illustrated in FIGURE 2. Alternatively, the flap valve **56** is adapted for movement into an unsealing position away from the opening in the position illustrated by the dotted lines.

The outer surface **42** of terminal member **38** is smooth to provide a low friction surface over which the web **10** may be passed as indicated by the arrow in FIGURE 2 without wrinkling. The outer surface **42** is arcuate in the lengthwise direction of the web and has a straight dimension in the transverse or widthwise direction of the web. The aperture **40** is positioned intermediate the ends of this surface **42** and communicates directly with the chamber **58**. The arcuate surface **42** of terminal member **38** has a groove **68** disposed therein which surrounds the aperture **40**. A surface portion or land **70** remaining between the groove **68** and the aperture **40** forms a sealing lip around the aperture **40**. A suitable passage **72** is formed in the terminal member **38** and is connected to the conduit **44** such that the groove **68** is connected to a source of subatmospheric pressure to draw at least a partial vacuum in the groove **68**.

The guide member **46** is formed with a generally rectangular dished-out cavity or recess **74** generally centrally thereof. The recess **74** has a transverse dimension equal to the transverse length of the groove **68**. The recess **74** communicates through the end portions of the groove **68** with the source of subatmospheric pressure to which the passage **72** is connected such that the pressure in the recess **74** is substantially identical to the pressure in the groove **68** during operation of the apparatus.

The groove **68** forms areas of reduced pressure at the surface of the terminal member **38** forwardly and rearwardly of the aperture **40**, in the direction of movement of the web **10**, such that any gas molecules trapped between the web **10** and the outer surface **42** of the terminal member **38** are drawn away before the web crosses the land **70** and aperture **40**. These areas of at least a partial vacuum serve to prevent any gas from being carried into the chamber **58** and thus form at least a partial seal between the treatment chamber and the atmosphere. In this embodiment, the surface of web **10** is in operative engagement with the aperture **40** by physically contacting land **70** which forms a border around aperture **40**. The partially evacuated recess **74** in the guide member **46** serves to withdraw any gas which otherwise might reach the aperture **40** and provides an equilibrium condition on the web **10** tending to negate the force on said web and to reduce the frictional force present between the web **10** and the surface of the terminal member **38**.

In operation, the curved surface **42** of the terminal member **38** around which the web **10** is drawn permits said web to be brought into operative engagement with aperture **40**. The web intimately contacts the land **70** around the aperture **40** and the force placing the web in contact with terminal member **38** may be increased by applying a controlled braking force such that a tension is placed in the web between the nip area of the driven capstan **50** and the pressure roller **52** and the supply roll (not shown). In this embodiment, as the web **10** is drawn across the aperture **40** the electron beam **30** (see FIGURE 1) scans the exposed surface portion of the web and as the electrons strike the web,

they treat the surface thereof to produce a latent or a visible image on the surface of said web as defined by the information-input to the electron gun **12** and type of web material.

In the event the web **10** becomes broken, the surface of the web **10** no longer engages land **70** of aperture **40**. When the surface of the web **10** ceases to contact land **70**, the effective seal between the chamber **58** and the ambinet hgher pressure atmosphere surrounding the terminal member **38** and guide member **46** is either reduced or terminated. When this occurs, the higher pressure atmosphere enters the aperture **40** and chamber **58** thereby decreasing the vacuum and eventually engulfing the electron gun **12** in a poison atmosphere. Certain of the electron gun elements, such as the cathode **24**, may need replacement because of exposure to the higher pressure atmosphere as discussed hereinbefore.

The flap valve **56** can be operatively connected to an acuating means which is responsive to an abrupt change in vacuum in the proximity of the aperture **40**. A vacuum sensing transducer may be positioned within the aperture **40**, the chamber **58** or groove **68**. The vacuum sensing transducer may comprise, for example, a known vacuum gauge which employs a thermocouple whose voltage varies in proportion to the number of air molecules in the vacuum. In the event the vacuum pressure within the aperture **40**, chamber **58** or groove **68** reaches a predetermined low level, the vacuum sensing transducer activates an actuating means which rapidly closes the flap valve **56** into sealing engagement with lips **62**. A loss of vacuum in chamber **58** is almost immedately followed by a reduced vacuum or vacuum loss in both the chambers **14** and **58** and within groove **68**. Thus, detection of vacuum loss in any of the above areas provides sufficient reliability for purposes of actuating an actuating means to move the flap valve **56** into sealing engagement across aperture **40**.

In this manner, the vacuum in the chamber **58** is isolated and maintained while only the vacuum in the aperture **40** is destroyed by the higher pressure atmosphere. When the web **10** is rethreaded into the apparatus and into sealing engagement with land **70** around aperture **40**, the flap valve **56** is moved into its open or unsealing position. The small volume of gas molecules contained within the aperture **40** is easily removed by the vacuum pump pumping the chambers **14** and **58**.

Alternatively, the flap valve **56** can be used during unloading and loading of the web **10**. Closure of the flap valve **56** during reloading isolates the partial vacuum in the chamber as described. The cycle time of unloading and reloading of web **10** and pumping the chamber **58** is a function of pump down time required for obtainng the necessary vacuum in chambers **14** and **58** and aperture **40**. The reloading cycle is substantially reduced by the teachings of the present invention since only a small volume of atmosphere need be removed after the reloading operation.

It is contemplated that the sealing means of the present invention could be used equally well in the apparatus described hereinbefore wherein the evacuatable chamber encloses both the generating means and the web. During operation, the entire chamber is pumped to approximately the same vacuum level. In this type of apparatus, the vacuum sealing means, such as a flap valve, is moved into a sealing position relative to the aperture between portions of the chamber. In this manner, the vacuum level in at least the generating means enclosing portion of the evacuatable chamber can be isolated and maintained independent of the vacuum level in the web enclosing portion of the chamber. With the flap valve in sealing position, the vacuum in the web enclosing portion of the vacuum chamber can be safely reduced and the web reloaded. After reloading, the web and the web enclosing portion of the chamber are repumped back to the desired vacuum level and the flap valve is moved to its unsealing position whereby the electron beam can bombard the web through the unsealed aperture.

FIGURE 3 is a diagrammatic represenation of an elevated view of the flap valve **56**. The flap valve **56** comprises a planar valve member **78** which has a resilient sealing insert **80** attached thereto. The resilient sealing insert **80** is formed in the shape of the lip **62** to be covered thereby. The valve member **78** has a hollowed-out edge wall **82** through which a pin member **84** projects and about which the valve member **78** of flap valve **56** pivots. The edge wall **82** extends to the outside surface of the terminal member **38** and has a lever arm **86** keyed thereto. The lever arm **86** can either be flipped manually and held in place by a spring means (not shown) or alternatively operatively connected to an actuating means such as an electric solenoid (not shown). When the flap valve **56** is in sealing position, the resilient sealing insert **80** (as illustrated in FIGURE 2) is in sealing engagement with the lip **62**.

In one application, a rotary valve was used in place of the flap valve **56** in FIGURE 2. Due to space requirements and other operating problems, the rotary valve, although operative, did not provide the flexibility and operating characteristics as desired, and the flap valve **56** is preferred for these reasons. One such disadvantage is the increased spacing between the outer surface of the terminal member and the chamber **58**.

In the embodiment of FIGURE 2, a holding pressure is necessary to hold the flap valve **56** in a closed position. By experimentation, it appears that a holding force in the order of 1¼ times that of the ambient atmosphere assures a good seal between the flap valve **56** and the lips **62**.

FIGURE 4 illustrates another embodiment of the vacuum chamber valve in its sealing position adapted for use in a 35 mm. electron beam recording and/or reproducing system. FI1URE 4 is a fragmentary elevational view, having a front plate removed and partly in cross-section to illustrate the interior members, and discloses the relationship between the vacuum seal, designated generally as **88**, and a flap valve, designated generally as **90**, disposed in the end of a chamber **122** housing generating means for a corpuscular beam. In this embodiment, a continually moving band **92** moves a media **94**, which is in intimate removable contact therewith, such as a 35 mm. film, through an arcuate high impedance path forming the vacuum seal **88** between a higher atmospheric pressure to an inner chamber or evacuated area and a treatment aperture or opening **96**. When the media **94** is disposed in register with the aperture **96**, the flap valve **90** is normally in the open position. When the flap valve **90** is in the open position, an electron beam is used to bombard the media **94** which is disposed in a planar position across the aperture **96** and at this time has been lifted from the transport band **92**. In this apparatus, the width of spacing between the media **94** and a chamber wall **98** is in the order of ½ the media thickness. Thus, when the media is within the vacuum seal, only a small space in the order of ½ the width of the media need be continuously pumped to maintain the vacuum. In this vacuum seal, the surface of the media to be treated or bombarded does not engage or touch any surface of the chamber wall **98** but is maintained in operative relationship with opening **96**.

The remaining portion of a transport means, generally designated as **100**, illustrates associated elements of a recording and/or reproducing apparatus.

The flap valve **90** in FIGURES 4 and 5 comprises an impervious rigid support member **102**, such as steel, having an external dimension and cross-section which adequately covers aperture **96**. The member **102** has a resilient sealing insert **104** capable of providing a good seal between the member **102** and the chamber wall **98**. A connecting link **108** is operatively connected to a

fastener **110**, which fastener **110** has an enlarged end **112** which is movably secured by means of plate **116** in a centrally recessed or hollowed-out area **114** in member **102**. The end **112** and hollowed-out area **114** provide a "ball and socket" therebetween. The use of a "ball and socket" or universal connection is preferred but it is contemplated that a rigid connection could be employed as in FIGURE 2. This connection permits flap valve **90** to be self-aligning such that when member **102** covers aperture **96**, sealing insert **104** comes into positive engagement with chamber wall **98** around the periphery of aperture **96**. Fastening means, in the form of a nut **118**, secures the fastener **110** to link **108**.

Connecting link **108** is rigidly connected to a rotatable shaft **120**. Shaft **120** extends from within an electron beam chamber **122** through a hermetically sealed bearing **124** to a crank arm **126**. Crank arm **126** is operatively connected to an actuation device such as a pneumatic cylinder **130**. The cylinder **130** is operated by air pressure applied thereto through various air lines, generally represented by line **134**. An electrically operated solenoid valve **136** is utilized to direct the air pressure from a source of air pressure **138** to cylinder **130** via the air lines **134** in response to a signal from a sensing device, such as a pressure sensing transducer **140**, located within the chamber **122**, for example.

The transducer **140** is electrically connected to and is capable of actuating a control circuit **142** when a vacuum loss in chamber **122** exceeds a predetermined level. The reference to the type of and placement of the vacuum or pressure sensing transducer described relative to FIGURE 2 is equally applicable in this embodiment and therefore does not need to be repeated here.

Control circuit **142**, when actuated by pressure sensing transducer **140**, energizes the electrical solenoid valve **136** which applies an air pressure from air pressure source **138** via air lines **134** to actuate pneumatic cylinder **130** which abruptly moves the flap valve **90** from its open or unsealing position to its closed or sealing position. When closed, the flap valve **90** has a holding force of at least 1¼ times atmosphere applied thereto from the cylinder **130** via crank arm **126**, shaft **120**, connecting link **108** and fastener **110**. The holding force exerted on valve **90** is sufficient to urge the support member **102** and sealing edge against wall **98** to form an effective hermetic seal between aperture **96** containing a higher pressure atmosphere and the evacuated electron beam chamber **122**.

In the event of web breakage, immediate closure of flap valve **90** isolates the partial vacuum in electron beam chamber **122** from the higher external pressure in aperture **96**. When the broken media is replaced and the vacuum seal **88** is rendered operative, flap valve **90** is moved back to its open or unsealing position.

The atmosphere within the aperture **96** immediately dissipates into the much larger electron beam chamber **122** and is removed by means of the vacuum pumps (not shown). In FIGURE 4, the volume of aperture **96** is generally substantially smaller than the total volume of the electron gun chamber **122** such that the air molecules from aperture **96** which immediately dissipate within the vacuum do not significantly change the vacuum level in the chamber **122**.

It is envisioned that the vacuum chamber valve of the present invention could be utilized in other embodiments. For example, the vacuum chamber valve could be positioned adjacent the opening but external to the chamber. In FIGURE 5, this would be paramount to placing the flap valve **90** in aperture **96** as depicted by the dotted lines which illustrate a flap valve **90'**. In such an embodiment, the higher pressure atmosphere exerts a holding force on the member **102** due to the pressure differential developed thereacross between aperture **96** and electron beam chamber **122**. In such an arrangement, the aperture **96**, of necessity, would be increased both in cross-sectional area and in axial length to provide clearance for movement of flap valve **90** between its sealing position and unsealing position. Use of the vacuum chamber valve in such an apparatus requires increasing the volume of aperture **96** which may or may not be desirable depending on the application and apparatus.

FIGURE 6 is a fragmentary detailed sectional view of a slideably operating vacuum chamber valve **150**. Valve **150** includes a rigid member **152** which is secured to a "ball and socket" joint **154** by means of a fastener **156** in a manner similar to that in the valve of FIGURES 4 and 5. The rigid member **152** has a resilient sealing insert **158** operatively connected thereto. An aperture **160**, which is to be sealed by the valve **150**, has rounded edges **162** around the outer border thereof. The rounded edges **162** permit the resilient sealing insert **158** to yieldably slideably engage the rounded edges **162** without damage to the resilient sealing insert **158**, as the valve **150** is slideably moved into sealing position. In the embodiment of FIGURE 6, the valve **150** is slideably moved in an arcuate path between its unsealing and sealing positions by connecting link **164** being moved in an arcuate path due to angular rotation of shaft **166** by a selectively actuatable device, such as pneumatic cylinder **168**.

FIGURE 7 depicts an alternate arrangement wherein a bell crank **170** is rigidly connected to and moves a valve **172** between its sealing and unsealing positions. In FIGURE 7 reciprocal motion is applied to bell crank **170** by means of an actuating device, such as a pneumatic cylinder **174**.

FIGURE 8 is a pictorial representation of yet another valve which is similar to that of FIGURE 7. In FIGURE 8 a valve **178** is slideably moved in a straight path between its sealing and unsealing positions by means of a rigid support member **180** operatively connected to a pneumatic cylinder **182** which selectively supplies the reciprocal motion.

The apparatus of FIGURE 6 can be easily modified to provide the necessary volume and pivot points such that the various valves of FIGURES 6 through 8 can be slideably moved in a predetermined path between their sealing and unsealing positions.

The vacuum chamber valve described in FIGURES 6 through 8 are located external to the electron gun chamber. The presence of an external higher pressure atmosphere, after the valves are in sealing position, urges the valves into effective sealing engagement across the aperture being sealed by the valves due to the pressure differential thereacross.

It is contemplated that the valves could similarly be located within the electron gun chamber. For example, the valve **160** of FIGURE 6 could be located on the opposite side of aperture **160**. In such an application, the resilient sealing insert **158** is selected to be a material which can withstand both the slideable contact with the rounded edges of the aperture **160** and application of a sealing pressure necessary to overcome the pressure differential from the higher pressure surrounding aperture **160** thereby providing an effective seal between aperture **160** and the external higher pressure.

What is claimed is:

1. Apparatus comprising in combination

means defining a chamber capable of being evacuated, said chamber including a wall portion having an aperture therein;

means enclosed within said chamber for generating an energy beam adapted to be directed through said aperture;

means positioned relative to said generating means and said chamber for directing said energy beam through said aperture;

means operatively coupled to said chamber for producing at least a partial vacuum therein;

sealing means disposed adjacent said aperture and adapted for movement into sealing position with said aperture for selectively isolating and maintaining the

vacuum in at least the portion of the evacuated chamber enclosing said generating means, said sealing means being adapted for movement into an unsealing position away from said aperture when said vacuum in at least said portion of the chamber enclosing said generating means can be retained while said energy beam is directed through said aperture;

actuating means operatively coupled to said sealing means for selectively moving said sealing means between said sealing position and unsealing position; and

pressure sensing means disposed in proximity of said aperture for detecting an abrupt loss in vacuum in the vicinity of said aperture and when said vacuum loss exceeds a predetermined level for energizing said actuating means to move said sealing means from an unsealing position into a sealing position.

2. The appartus of claim **1** wherein said generating means is located at one end of said chamber and said wall portion containing said aperture is located at an opposite end of said chamber and in a generally aligned relationship with said generating means and wherein said sealing means comprises a flap valve having a resilient sealing insert which hermetically seals about said aperture when said flap valve is in said sealing position.

3. The apparatus of claim **1** wherein said sealing means is located within said evacuated chamber and wherein said actuating means urges and holds said sealing means in sealing engagement across said aperture with sufficient force to overcome the pressure differential existing between said evacuated chamber and a higher pressure ambient atmosphere located in the vicinity of said aperture.

4. The apparatus of claim **1** wherein said sealing means is located in an external higher pressure atmosphere located in the vicinity of said aperture, said sealing means being urged into said sealing position by said actuating means and being held in sealing engagement across said aperture by said higher pressure atmosphere due to the pressure differential across said sealing means between said atmosphere and evacuated chamber.

5. The apparatus of claim **1** wherein said sealing means comprises

an impervious rigid support member having a cross-sectional area which is slightly greater than the cross-sectional area of said aperture; and

a resilient sealing insert connected to said support member, said sealing insert having a shape which conforms to the border of said aperture such that when said support member is in said sealing position said sealing insert is in sealing engagement with said aperture border forming a vacuum tight seal.

6. The apparatus of claim **5** wherein said chamber aperture has a rectangular border and wherein said support member is rectangular in cross-section having dimensions which are slightly greater than those of said aperture and said resilient sealing insert is rectangular in shape having dimensions which are substantially the same as said aperture border whereby when said support member is in sealing position said resilient sealing insert is in sealing engagement with said aperture border forming a vacuum tight seal.

7. The apparatus of claim **5** wherein said support member is adapted to be self-aligning to urge said resilient sealing insert into positive sealing engagement across said aperture.

8. The apparatus of claim **5** further including actuating means operatively coupled to said support member adapted to be selectively energized to move said support member containing said resilient sealing insert between its sealing position and its unsealing position.

9. The apparatus of claim **8** further including a pressure sensing transducer for detecting vacuum loss in proximity of said aperture and for actuating said actuating means when said vacuum loss exceeds a predetermined level.

10. The apparatus of claim **9** wherein said pressure sensing transducer is positioned within said evacuated chamber adjacent said aperture.

11. The apparatus of claim **9** wherein said pressure sensing transducer is positioned within said aperture.

12. The apparatus of claim **9** wherein said pressure sensing transducer is positioned within said vacuum seal.

13. The apparatus of claim **5** further including a connecting member operatively coupled to said support member, said connecting member being adapted to slideably move said support member and said sealing insert across said aperture when traversing said support member and said sealing insert between said sealing and unsealing positions.

14. Apparatus for bombarding one surface of a web with a beam of energy in the presence of at least a partial vacuum comprising

means defining a chamber capable of being evacuated, said chamber including a wall portion having an aperture therein extending into said chamber through which said energy beam is to be directed to bombard said one surface of a web;

means located within said chamber for generating an energy beam;

means positioned relative to the energy beam for directing said energy beam through said aperture to bombard said one surface of the web;

means for producing at least a partial vacuum in said chamber;

transporting and gas restricting means for restricting movement of gas molecules from an ambient higher pressure atmosphere to said aperture as said one surface of said web is transported past said aperture;

a vacuum chamber valve positioned adjacent said wall portion, said vacuum chamber valve being capable of movement into sealing engagement across said aperture when said partial vacuum producing means becomes incapable of forming a partial vacuum to prevent said vacuum in said chamber and said generating means from being poisoned by gas molecules from said ambient higher pressure atmosphere, said vacuum chamber valve being capable of movement to an unsealing position when said partial vacuum producing means is capable of forming a partial vacuum and said web is positioned relative to said aperture for bombardment by said energy beam;

actuating means operatively coupled to said sealing means for selectively moving said sealing means between said sealing position and said unsealing position; and

pressure sensing means disposed in proximity of said aperture for detecting an abrupt loss in vacuum in the vicinity of said aperture and when said vacuum loss exceeds a predetermined level for energizing said actuating means to move said sealing means from an unsealing position into a sealing position.

15. The apparatus of claim **14** adapted for a recording/reproducing system wherein said web is a photographic film and said beam of energy is an electron beam and wherein said vacuum chamber valve comprises

an impervious rigid support member having a cross-sectional area which is slightly greater than the cross-sectional area of said aperture; and

a resilient sealing insert connected to said support member, said sealing insert having a shape which conforms to the border of said aperture such that when said support member is in said sealing position said sealing insert is in sealing engagement with said aperture border forming a vacuum tight seal.

(References on following page)

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References Cited

UNITED STATES PATENTS

2,276,639	3/1942	Ackermann	313—175
3,222,678	12/1965	Jones	346—1
3,345,639	10/1967	Dubbe	346—110
2,200,095	5/1940	Marton	346—107

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2,292,087	8/1944	Ramo	250—49.5

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