Jan. 27, 1953 H. A. FROMSON 2,626,859

GAS HOLDER

Filed Jan. 8, 1951

Fig:1.

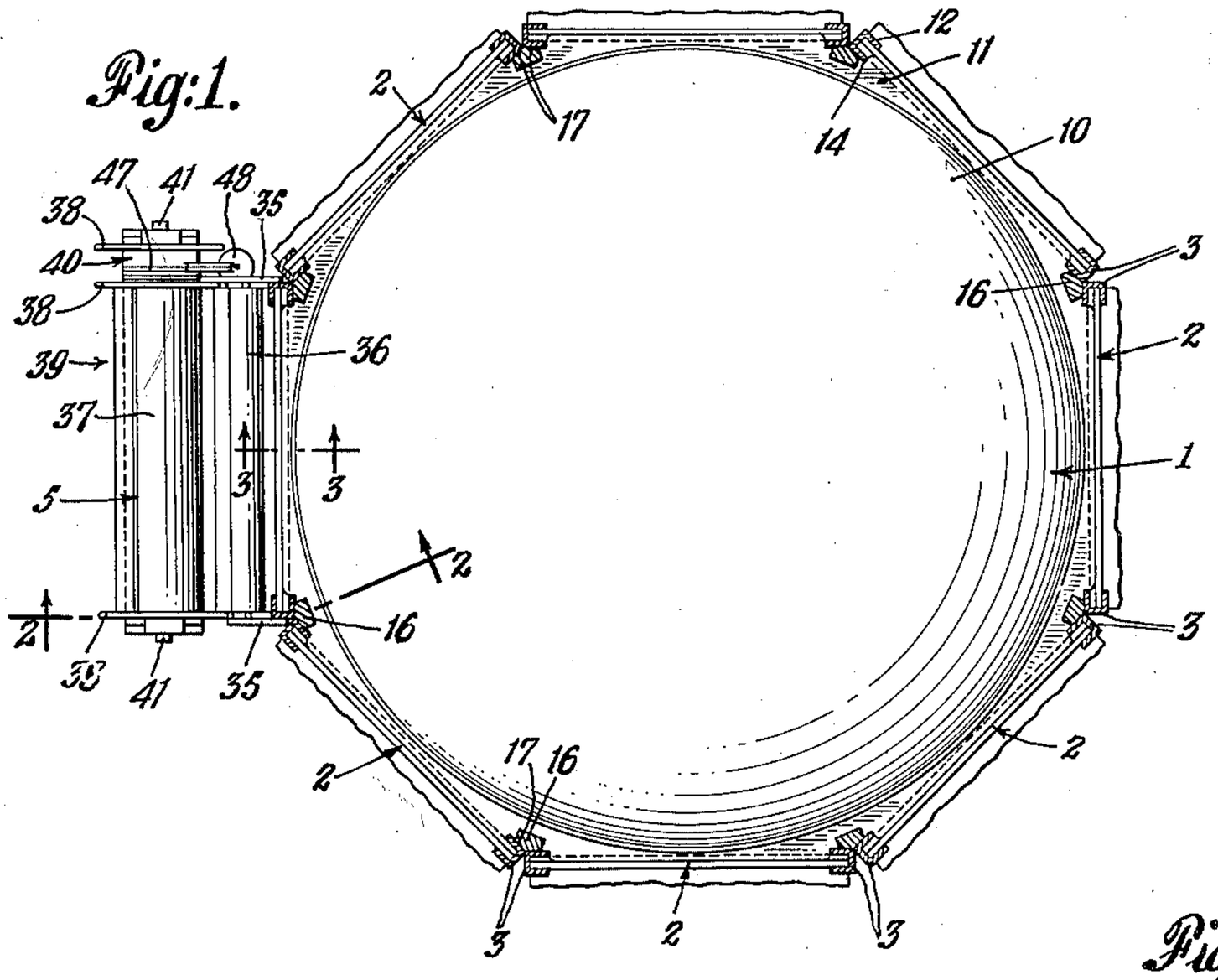


Fig:3.

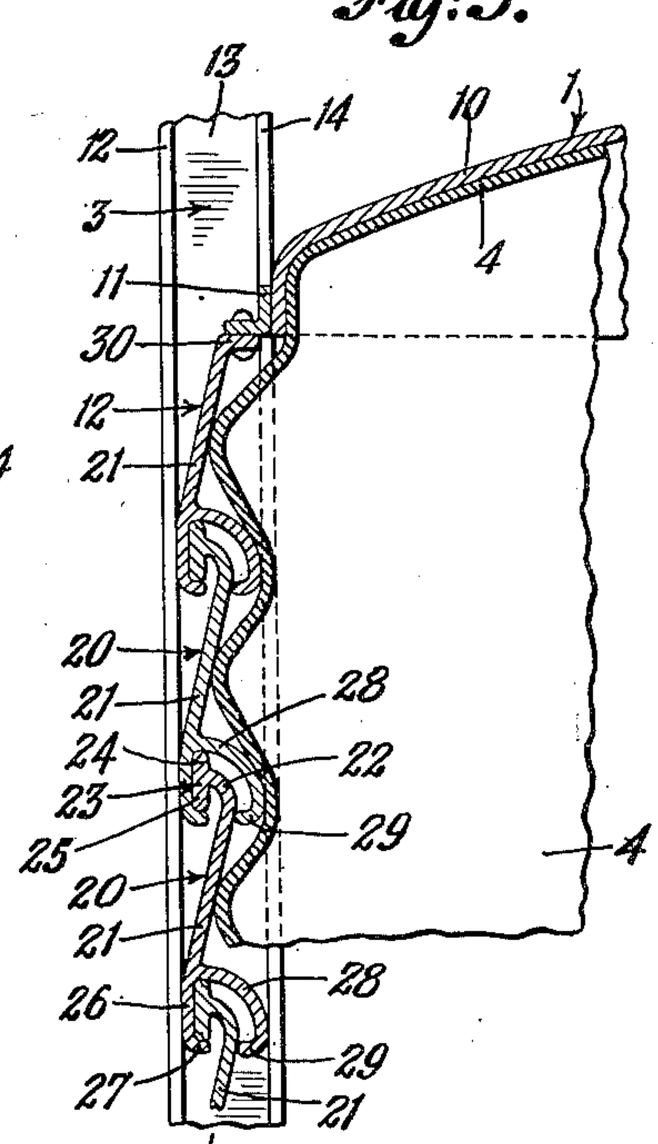
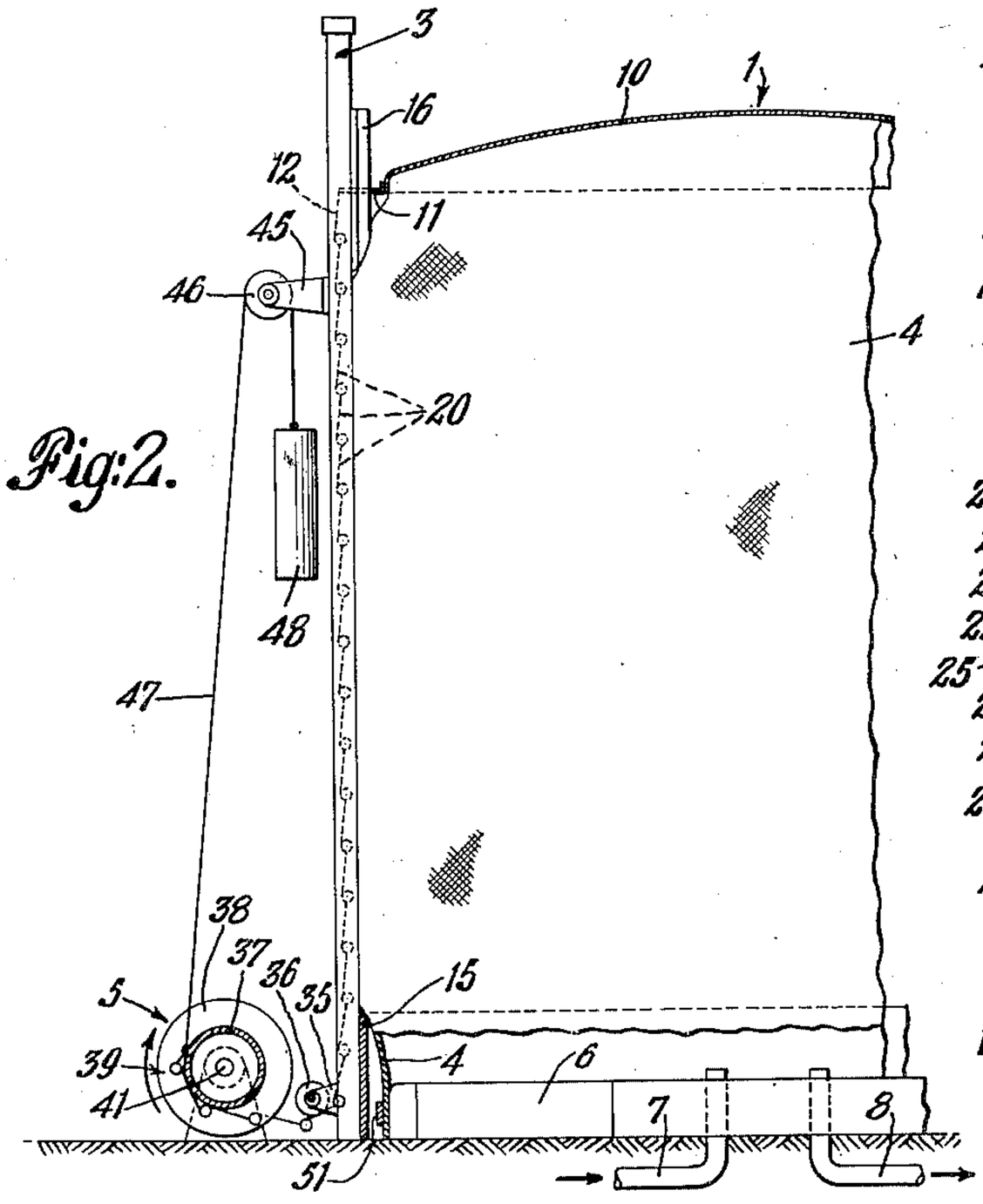


Fig:2.



INVENTOR.
HOWARD A. FROMSON

BY
Cleveland B. Hollabaugh.

ATTORNEY

Patented Jan. 27, 1953 2,626,859

UNITED STATES PATENT OFFICE

2,626,859

GAS HOLDER

Howard A. Fromson, New York, N. Y.

Application January 8, 1951, Serial No. 204,939

7 Claims. (Cl. 48—178)

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This invention relates to a gas-holder which maintains varying volumes of gas stored therein within a relatively narrow predetermined pressure.

The gas-holder, in accordance with this invention, comprises essentially a gas-impermeable, flexible bag or envelope positioned within and against a metal supporting structure which varies in cubic capacity with the volume of gas in the impermeable bag, while maintaining a pressure on the gas within a relatively narrow range.

The metal structure supporting the gas impermeable bag consists of a solid metal top attached to and supporting at its edge a plurality of series of articulated metal slats or bars which form the side walls of the structure. The slats of each series are positioned horizontally with their ends held in vertical channels in which they are free to slide. The lower end of each series of slats is attached to a reel through which tension is exerted on the slats. The series of slats and their supporting end channels form, in plan, a square or, preferably, a polygon.

The metal top of this supporting structure is free to move up or down as the volume of gas in the supported bag is varied. Such movement of the top causes the slats of the side walls to slide up or down in the supporting end channels and the lower slats of each series to be unwound or wound on the reel to which the lower end of each series is attached. Thus, the height of the side walls of this structure varies with the volume of gas within the gas impermeable bag which it supports.

Each series of metal bars or slats comprising the side walls of my supporting structure are articulated at their edges to form a continuous metal surface. The metal bars or slats which I utilize are relatively long in proportion to their width and have parallel edges. One of the parallel edges of each slat carries a continuous female articulation channel, while the other edge carries a male articulation element adapted to articulate with a female articulation channel identical with that along its opposite edge. The joint formed by the articulation of the male articulation element of one slat with the female articulation channel of an adjacent slat is weathertight when the slats are positioned in a wall of my supporting structure.

The joints between adjacent slats of these walls allow an angular rotation of each slat with respect to the adjacent slat, which permits the slats to be rolled into a compact cylinder when they are withdrawn from their supporting end channels. This feature permits the lower slats of each series forming the wall of my supporting structure to be wound on a reel as the height of the wall decreases.

The slats and other parts of my supporting structure may be made of any of the metals ordinarily used for structural purposes. I prefer to use aluminum, particularly for the top and the slats, since it is light in weight, mechanically strong, and highly resistant to corrosion. Furthermore, it is particularly well adapted for extrusion to form slats and end-channels having the particular cross-sections which I utilize. As will be brought out hereinafter, it is desirable to have the top and side walls relatively light in weight, which again causes aluminum to be a particularly suitable material for them. In general, it is desirable to make all parts of the supporting structure of the same metal to avoid electrolytic corrosion.

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Having now indicated in a general way the nature of my invention, I will proceed with a more detailed description thereof with reference to the accompanying drawing in which like reference characters are used to refer to like parts.

In the drawing:

Figure 1 is a partial, plan view of the gas-holder, in accordance with this invention,

Figure 2 is a partial, cross-sectional, elevation view thereof along the section line 2—2 of Figure 1, and

Figure 3 is an enlarged, fragmentary cross-section view along the section line 3—3 of Figure 1.

Referring to the figures, it will be seen that the embodiment of the gas-holder, in accordance with this invention, there illustrated is in the form of an octagon and comprises a top 1 carrying around its edge eight series of slats 2, the ends of which are positioned in the end channels 3, which forms a supporting structure for a gas-impermeable envelope or bag 4 positioned within the structure. The lower end of each series of slats is attached to a reel 5 on which they may be rolled. The reel 5 is maintained under a tension which causes it to tend to roll the slats onto its surface. The bottom of the gas-holder consists of a relatively shallow gas-tight pan or tray 6 to which the lower edge of the bag 4 is attached by a gas tight joint. The wall surfaces of the pan 6 form an octagon, which is very slightly smaller in dimensions than that formed by the end channels 3. Conduits 7 and 8 are inlets and exits, respectively for gas entering and leaving the holder.

The top 1, in the embodiment of this invention illustrated by the figures consists of a circular dome 10 which forms the major part of the top and carries around its edge an apron 11, the outer edge of which is an octagon, to which the top slat 12 of each series of slats 2 is attached. I prefer to utilize a top which is generally dome-shaped to provide drainage of water from its upper surface and resistance to gas-pressure on its lower surface. This form permits the top to ride smoothly on the upper surface of the gas-bag 4 when it is inflated with gas.

Although an octagonal gas-holder has been

shown for the purposes of illustration, it will be appreciated that the gas-holder may have any desired number of sides. It may have as few as four sides, but a greater number of sides is usually desirable to allow the side walls to approach a cylindrical form. The preferred number of sides to be utilized in any particular holder depends largely on the size of the holder, with the larger holders having the greater number of sides, to avoid the use of slats of any great length. The shape of the outer edge of the apron 11 will, of course, be determined by the number of sides utilized in the wall of the gas-holder, since it must have the same number of straight edge sections as the holder has sides.

Referring to Figures 1 and 3, it will be seen that the end channels 3, 3 consist of three sides 12, 13 and 14 which, in cross-section, form three sides of a square or rectangle. These channels may be single channels as illustrated by Figure 1, positioned in pairs with the sides 14, 14 at the same angle as that formed by the intersection of the two flat edges of the apron 11. As an alternative to the use of pairs of single channels, as illustrated, double channels may be utilized which are, in effect, a pair of single channels positioned in respect to one another as described above, with the sides 13, 13 and the triangular space between them being solid metal.

The pairs of channels 3 are positioned vertically and may be held in that position in any desired manner. Thus, the ends may be anchored to a foundation band 15 as shown in Figure 2, and if desired, they may be attached together at their tops by cross-braces, not shown by the drawing, positioned above the upper-most position reached by the top 1. The foundation band is in the form of an octagon, and is proportioned so that the slats held in the end channels 3, 3 are positioned against its outer surface.

A guide 16 is positioned at the intersection of each of the straight segments of the edge of apron 11 and firmly attached thereto with its long dimension at right angles to the surface of the apron. Each of these guides has two bearing surfaces 17, 17 positioned in the same angular relationship to each other as the outer-surfaces of the sides 14, 14 of each pair of end channels 3—3. Each of the guides 16 are positioned on the apron 11 to bear against the outer surfaces of the sides 14, 14 or each pair of end channels and to slide up and down those surfaces as the top 1 rises and falls, thereby keeping the top 1 properly positioned with the surface of its apron 11 in the horizontal plane.

Figure 3 shows the cross-section of two of the duplicating slats 20, 20 of the type I prefer to use for the wall sections of my supporting structure. It will be noted that these slats are identical in cross-section. Each of them consists of a relatively flat body-section 21 which forms a major part of the width of each slat. The width of this body-section 21 can be varied extensively, but is relatively narrow as compared with its length, and is determined by the compactness desired of the cylinder formed by a roll of the slats on a reel 5.

The body section 21 of each individual slat has a structure along one edge forming a male articulation element which consists of an outwardly curved section 22 which terminates in a cross-bar 23 consisting of an upper section 24 and a lower section 25, each of which has a rounded edge. The opposite edge of each slat forms a female articulation element which consists of a flat section 26 at the edge of body-section 21, an

inwardly curved section 27 which forms a stop, a reverse curved section 28, and a curved section 29 which forms a second stop along the lower edge of the articulation channel. The curvature of section 28 is the same as the line described by the curved edge of section 24 of the cross-bar 23 of the male articulation element when the cross-bar is rotated with the rounded edge of section 25 acting as a pivot on the curved surface of section 29.

The dimensions and curvatures of these sections of the articulation channel are proportioned with respect to those of the male articulation element along the opposite edge of the slat to permit a plurality of duplicating slats to be joined together. Each slat is joined to an adjacent slat by sliding the bar 23 of the male articulation element into the articulation channel of the adjacent slat.

Slat 12 is identical with slats 20, 20 as to its body section 21 and as to its female articulation channel, but instead of a male articulation element has a flat section 30 positioned along the edge and at an angle to its body-section 21 to provide a surface for attachment to the edge of the apron 11 of top 1.

As illustrated by Figure 3, I prefer to position an articulated series of slats in the wall of my gas-holder with the male articulation element positioned along the upper edge of the slat in a horizontal plane. When adjacent slats are articulated in this manner and have their ends positioned in end channels, the outer surface and edges of the bar 23 of the male articulation elements are in contact with one edge of the inner surface of section 28 and the entire inner surfaces of section 26 and 27 of the female articulation channel. Furthermore, the surface of body-section 21 of the male articulation element is positioned against the outer edge of stop 29 of the channel. These lines of contact form a joint which is weather-tight, so that the slat wall protects the gas-impermeable bag positioned against its inner surface from exposure to the weather.

The articulated joint between adjacent slats permits an angular rotation of the body-section 21 of one slat with respect to that of an adjacent slat in the direction of the curved arrow of Figure 3, when the ends of the slats are not held by the end channels 3, 3. During such rotation the rounded edge of section 25 of the male articulation element pivots on section 27 of the female articulation channel, while the edge of section 24 sweeps the inner surface of section 28. Such angular rotation is stopped by the inner surface of section 24 coming to rest against stop 29 of the female articulation channel. The joint cannot be disarticulated by such rotary movement since in its most acute angular position sections 24 and 25 rest against stops 29 and 27, respectively, of the female articulation channel. The only way that an articulated joint between two adjacent slats can be disarticulated is by a lengthwise movement of one slat with respect to the adjacent slat.

The sides 12, 12 of each pair of end channels 3 extend along the channel down to a point slightly below the top of the foundation band 15. Below that point the slats of each wall section are free to swing outwardly and to rotate with respect to each other. Each of the channels has attached thereto a bracket 35 at a point below that at which its side 12 is discontinued. The brackets 35, 35 on each pair of end channels which cooperate in holding the ends of a series

of slats are each provided with a bearing and cooperate to carry the shaft of a guide roll **36**.

A reel **5** is positioned adjacent to and aligned with the guide roll **36**. It consists of a drum **37** carrying three guide rings **38, 38, 38**, which divide the drum into two sections **39** and **40**. Section **39** is adapted to receive a roll of slats, while section **40** is adapted to receive a coil of cable. The drum **37** is mounted on a shaft **41** which has each end positioned in bearings carried by suitable supports. The lower end of each series of slats passes under the guide roll **36** and has its end slat attached to section **39** of drum **37**.

Each end channel **3** adjacent to section **40** of each drum **37** has a bearing bracket **45** attached thereto near its upper end. The bearing bracket **45** carries a grooved pulley **46**. Section **40** of drum **37** has the end of cable **47** attached to its surface and a series of turns of the cable passing around its surface in the direction of the curved arrow of Figure 2. The cable **47** passes upwardly over pulley **46** and has a weight **48** attached to its free end. The weight **48** is free to move up and down in the space below pulley **46**. The tension placed on cable **47** by weight **48** causes the drum **37** to revolve in the direction of the curved arrow of Figure 2 and to wind the slats onto its section **39** at any time the series of slats are under less tension than that on cable **47**. At the same time the cable **47** is unwound from its section **40** and the weight **48** drops downwardly. Conversely, when the series of slats are under greater tension than that on cable **47**, drum **37** will revolve in the opposite direction and unroll slats from its section **39**, while winding additional turns of cable **47** onto its section **40** and thereby raising weight **48**.

The bag **4** may be made of any flexible material which is impermeable and chemically inert to the particular gas to be stored therein. It is preferable that the material be slightly elastic, but it need not have sufficient strength to withstand the pressure of the gas stored therein, since it is supported by the metal parts of the gas holder. The bag **4** is of the shape and dimensions of the interior of the metal supporting structure when its top **1** is in its uppermost position. It consists of a domed top and side walls and is open at the lower end.

The lower portion of the side walls of the bag **4** are positioned on and around the outside surfaces of the walls of the pan **6** and held thereon by means of a band **51** extending around the walls of the pan. The band **51** functions as a clamp and makes a gas-tight seal between the pan **6** and the gas-bag **4**. The assembly of the pan **6** and the attached gas bag **4** is proportioned to fit snugly within the foundation band **15**.

During the operation of this gas-holder, the bag **4** is maintained in inflated condition by gas flowing under pressure into the holder from conduit **7**. Pressure is maintained on the gas in the holder by the weight of top **1** and the series of slats attached thereto and by the tension on each of the series of slats created by the weight **48**. This pressure is maintained as gas is withdrawn from the holder since the top of the holder descends to reduce its internal volume with any decrease in the supporting pressure on its inner surface.

As the top **1** descends to reduce the volume of the gas in the holder, the slats of each series forming the walls of the holder slide downwardly in their respective end channels **3, 3** and those

slats which clear the lower ends of the sides **12, 12** of the channel pass under the guide roll **36** and are wound on reel **5**. At the same time, the lower portion of the bag **4** is folded into the pan **6** under the guidance of the upper edges of the foundation band **15**. As the gas pressure in the holder tends to rise because of gas entering the holder, the reverse series of operations take place, during which the top **1** rises and, thereby, automatically maintains the gas in the holder at a substantially constant level.

The pressure maintained on the gas in the holder may be adjusted to any desired level by alteration of the weight of each of the weights **48**, and it is desirable to have the weights **48** relatively heavy as compared with the weight of the series of slats forming each wall section, and more particularly, the weight of the slats which are rolled onto the reel **5** during the fall of the top **1**.

As the slats of each wall-section pass under guide roll **36** and are wound on reel **5**, the top **1** is relieved of their weight. At the same time, however, the cable **47** is unwound and its weight increases the tension exerted on the slats and, therefore, partly counter-balances the loss of the weight of the slats. This reduction in the weight of top **1**, reduces the gas pressure required to support the top **1**, and therefore, the gas pressure in the holder drops as the top descends and conversely rises as the top rises. However, this progressive drop is reduced in relation to the pressure maintained in the holder by the tension exerted by weight **48** on each series of slats.

The percentage fluctuation of the gas pressure in the holder with the rise and fall of the top **1** is minimized by the use of a weight **48** and a cable **47** with each series of slats which are heavy in relation to the weight of the slats rolled and unrolled by reel **5**. Design of slats **20, 20**, which I prefer to use, makes them strong in terms of the thickness of their sections. By the use of such slats made of aluminum as the side walls of my holder it is possible to reduce the percentage fluctuation in the gas to a very small figure.

The pressure exerted on the gas in the holder remains constant when gas is entering and leaving the holder at the same rate with the result that there is no rise or fall of the top **1**. It can be set at any predetermined level by the adjustment of the weights exerting pressure on the top and the fluctuation from the predetermined level maintained within any desired range by controlling the range through which the top **1** is allowed to rise or fall. The design of this holder makes it possible to control the pressure within a narrow range even with a relatively wide variation of the quantity of gas stored in the holder.

What I claim and desire to protect by Letters Patent is:

1. A gas-holder consisting of a gas-impregnable, flexible bag positioned within a metal supporting structure having at least four sides of variable height, which comprises a metal top positioned on top of the gas-impregnable bag and supported thereby when the bag is inflated with gas; at least four series of articulated metal slats attached to the outer edge of the said top; at least four pairs of end channels positioned vertically at spaced intervals around the edge of the said top but not attached thereto, each of which carries one end of the upper part of a series of slats; a reel attached to the last slat and means by which tension is maintained on the said reel

which tends to cause it to wind slats of the attached series onto its surface.

2. A gas-holder consisting of a gas-impregnable, flexible bag positioned within a metal supporting structure the walls of which are in the plan of a polygon and are of variable height, which comprises a metal top positioned on top of the gas-impregnable bag and supported thereby when the bag is inflated with gas, which is in the shape of a polygon; a series of articulated, rigid metal slats attached at their upper end to each of the straight edges of the said top; a pair of end channels positioned vertically at each angle of the edge of the said top but not attached thereto, each of which carries one end of the upper part of a series of slats; a reel attached to the lower slat of each series; and means by which tension is maintained on the said reel which tends to cause it to wind slats of the attached series onto its surface.

3. A gas-holder consisting of a gas-impregnable, flexible bag attached to a lower base pan which carries an inlet and outlet for gas, by means of a gas-tight joint, the said flexible bag being positioned within a metal supporting structure, which comprises a metal top positioned on top of the gas-impregnable bag and supported thereby when the bag is inflated with gas, which is in the shape of a polygon; a series of articulated, rigid metal slats attached at their upper end to each of the straight edges of the said top; a pair of end channels positioned vertically at each angle of the edge of the said top but not attached thereto, each of which carries one end of the upper part of a series of slats; a reel attached to the lower slat of each series; and means by which tension is maintained on the said reel which tends to cause it to wind slats of the attached series onto its surface.

4. A gas-holder consisting of a gas-impregnable, flexible bag attached to a lower base pan which carries an inlet and outlet for gas, by means of a gas-tight joint, the said flexible bag being positioned within a metal supporting structure, which comprises a metal top positioned on top of the gas-impregnable bag and supported thereby when the bag is inflated with gas, which is in the shape of a polygon; a series of articulated, rigid aluminum slats attached at their upper end to each of the straight edges of the said top; the said slats being characterized by being relatively long in proportion to their width and by being attached along their entire lengths by continuous articulated joints which allow angular rotation of any slat with respect to the adjacent slat to which it is attached when the slats are not otherwise held in fixed positions; a pair of end channels positioned vertically at each angle of the edge of the said top but not attached thereto, each of which carries one end of the upper part of a series of slats; a reel attached to the lower slat of each series; and means by which tension is maintained on the said reel which tends to cause it to wind slats of the attached series onto its surface.

5. A gas-holder consisting of a gas-impregnable, flexible bag attached to a lower base pan which carries an inlet and outlet for gas, by means of a gas-tight joint, the said flexible bag being positioned within a metal supporting structure, which comprises a metal top positioned on top of the gas-impregnable bag and supported thereby when the bag is inflated with gas, which is in the shape

of a polygon; a series of articulated, rigid aluminum slats attached at their upper end to each of the straight edges of the said top; each of said aluminum slats being relatively narrow in comparison with its length and each, except the end slats, having a male articulation element along one edge and an articulation channel along the other edge proportioned and designed to receive a male articulation element identical with that along its opposite edge; a pair of end channels positioned vertically at each angle of the edge of the said top but not attached thereto, each of which carries one end of the upper part of a series of slats; a reel attached to the lower slat of each series; and means by which tension is maintained on the said reel which tends to cause it to wind slats of the attached series onto its surface.

6. A gas-holder consisting of a gas-impregnable, flexible bag attached to a lower base pan which carries an inlet and outlet for gas, by means of a gas-tight joint, the said flexible bag being positioned within a metal supporting structure, which comprises a metal top positioned on top of the gas-impregnable bag and supported thereby when the bag is inflated with gas, which is in the shape of a polygon; a series of articulated, rigid aluminum slats attached at their upper end to each of the straight edges of the said top; each of said aluminum slats being relatively narrow in comparison with its length and each, except the end slats, having a male articulation element along one edge and an articulation channel along the other edge proportioned and designed to receive a male articulation element identical with that along its opposite edge; a pair of end channels positioned vertically at each angle of the edge of the said top but not attached thereto, each of which carries one end of the upper part of a series of slats; a reel attached to the lower slat of each series; a weight carried by a cable passed over a pulley and wound around a portion of the said reel in the direction which causes tension on the drum tending to wind slats onto its surface.

7. A gas-holder consisting of a gas-impregnable, flexible bag attached to a lower base pan which carries an inlet and outlet for gas, by means of a gas-tight joint, the said flexible bag being positioned within a metal supporting structure, which comprises a metal top positioned on top of the gas-impregnable bag and supported thereby when the bag is inflated with gas, which is in the shape of an octagon; a series of articulated, rigid aluminum slats attached at their upper end to each of the straight edges of the said top; each of said aluminum slats being relatively narrow in comparison with its length and each, except the end slats, having a male articulation element along one edge and an articulation channel along the other edge proportioned and designed to receive a male articulation element identical with that along its opposite edge; a pair of end channels positioned vertically at each angle of the edge of the said top but not attached thereto, each of which carries one end of the upper part of a series of slats; a reel attached to the lower slat of each series; and means by which tension is maintained on the said reel which tends to cause it to wind slats of the attached series onto its surface.

HOWARD A. FROMSON.

No references cited.