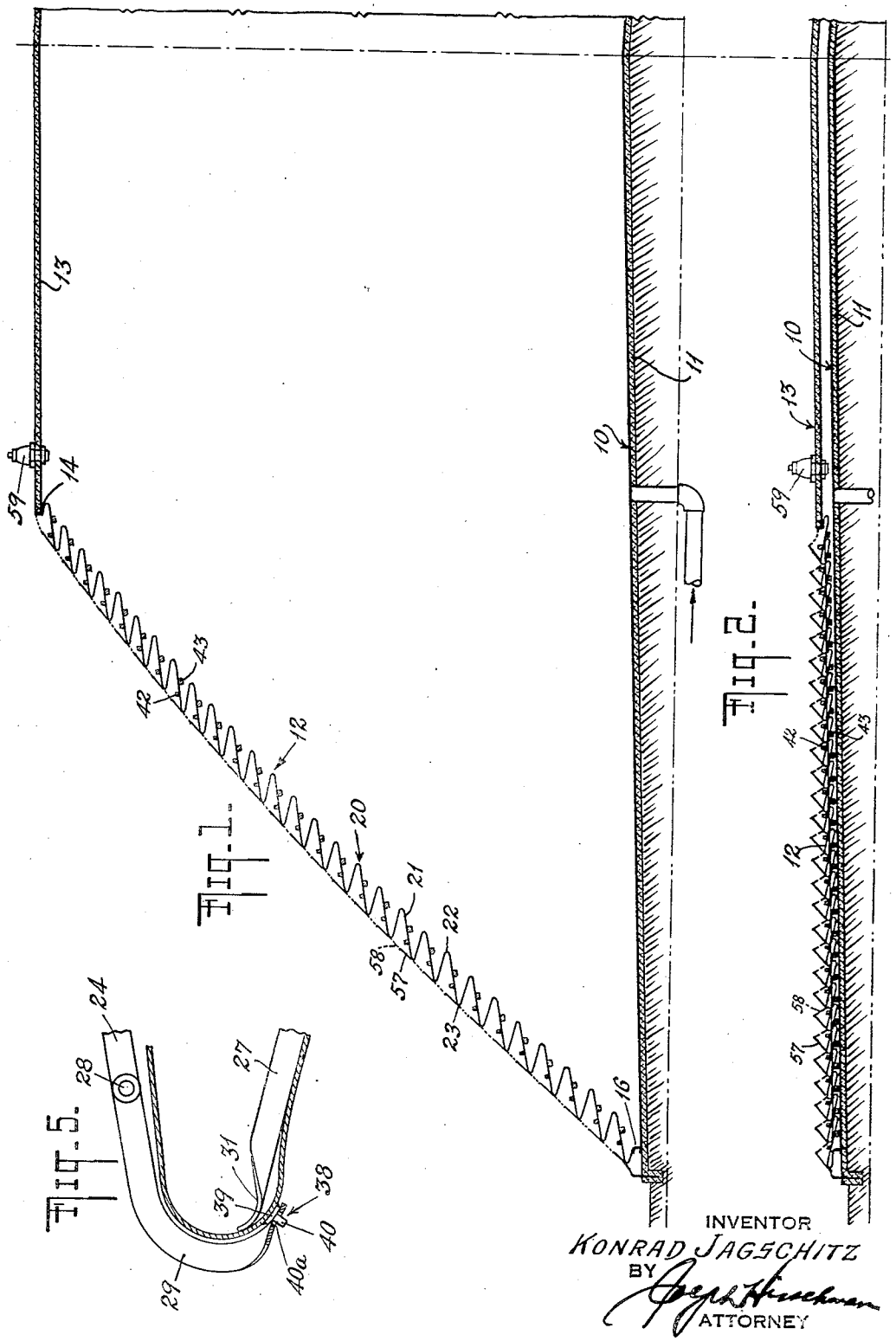
Sept. 5, 1939. K. JAGSCHITZ 2,171,567

COLLAPSIBLE GASHOLDER

Filed Feb. 21, 1936 2 Sheets-Sheet 1



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Filed Feb. 21, 1936 2 Sheets-Sheet 2

Fig. 3.

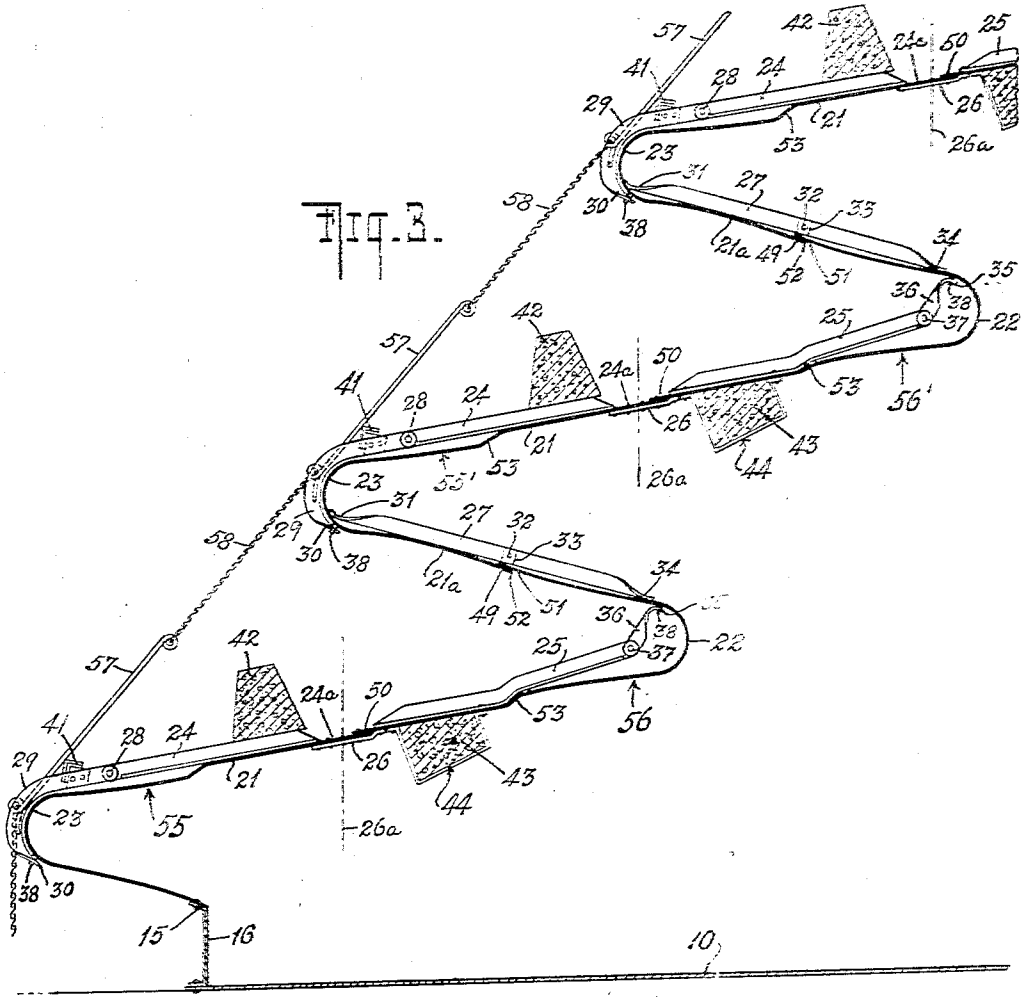
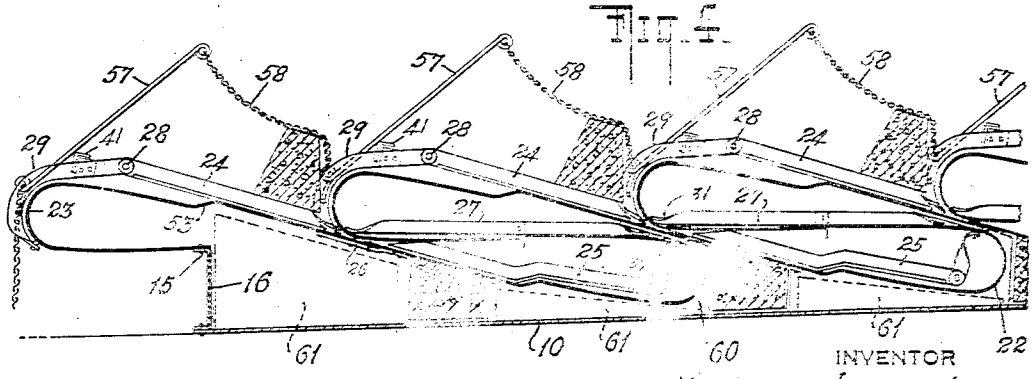


Fig. 4.



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COLLAPSIBLE GASHOLDER

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Application February 21, 1936, Serial No. 65,004

12 Claims. (Cl. 48—178)

The present invention relates to gasholders for the storage of large volumes of gas in the open, and is an improvement over the construction described in my copending application Ser. No. 10,533, filed March 11, 1935.

The construction of large gasholders has presented a number of difficult problems in connection with safety, cost of construction and maintenance, size of the "dead" space (residual gas volume in the "empty" condition of the gasholder), etc. Some of these problems have heretofore not been solved at all, while others have been solved only at the cost of creating or aggravating other difficulties. Thus, the matter of the dead space has presented a serious problem from the standpoint of safety, since air may leak into such space, or is deliberately forced thereinto to drive out the residual gas to enable workmen to enter the same for repairs; in both of these events there is danger of formation of an explosive mixture which is liable to be ignited by the spark or flame of welding or other tools used in making repairs. Also, the desirability of a constant gas pressure has long been recognized, but has not generally been obtained with the known telescopic gasholders, wherein the weight of the gas-suspended shell increases to greater extents as additional sections are lifted (the area against which the gas liftingly acts increasing only slightly), so that as the gasholder becomes filled to greater extents the gas pressure increases; while conversely, as the gasholder becomes depleted and the lower section or sections comes to rest on the bottom, the gas pressure falls. A further difficulty which has led to greatly increased constructional costs arises from the fact that in watersealed bell or telescopic gasholders, the foundation must be made strong enough to withstand the pressure not only of the gas and the weight of the shell, but of the enormous column of water, which may be 40 feet or more in height. In the case of the waterless gasholder, no column of water is supported by the foundation, but on the other hand the weight of the shell of the gasholder is concentrated upon the foundation area directly below such shell, so that at least at such area the foundation must be made much stronger and much more proof against settling than the central portion which resists only the pressure of the gas. Moreover, in both the water-sealed and the waterless gasholders, sealing devices are required to prevent the escape of gas; these seals require constant attention and thus incur continuous operating expense. Also, as is well known, the water-sealed gasholder requires elaborate and expensive guiding structures for the moving shell sections, which not only increases the cost of the apparatus, but affords opportunity for binding of the guides on the shell sections against framework, resulting in possible separation between the relatively movable parts. This causes not only loss of gas, but the more serious danger of entry of air into the gasholder and the formation of an explosive mixture therein. In the case of the waterless or disk gasholder, a dead space exists above the disk even in the uppermost position of the disk in order to accommodate the guiding structure for the disk and is confined by the shell and roof structure. This dead space not only keeps a considerable part of the shell structure idle so far as gas storage is concerned, but (especially as it increases in depth as the disc falls) requires special provisions for keeping it well ventilated to prevent gas that may leak thereinto from forming an explosive mixture.

It is the object of the present invention to provide a gasholder of simple construction in which the disadvantages of prior constructions are eliminated. In particular, it is the object of the invention to provide a collapsible gasholder which is so constructed that in the empty condition of the gasholder it lies flat upon the ground, like the upper half of a collapsed balloon, and encloses substantially no dead space.

It is also the object of the invention to provide a gasholder which, as it is filled to greater and greater extents, expands in such manner that the load on the body of gas remains substantially constant, so that the gas pressure likewise is constant.

A further object of the invention is to provide a gasholder which requires no packing or seal, so that the danger of leakage of gas or the infiltration of air through a packed space is eliminated.

It is a still further object of the invention to provide a gasholder construction in which the pressure upon the foundation is small, there being no water load; and is practically uniformly distributed, so that only a relatively inexpensive foundation is required.

These and other objects of the invention are attained by constructing the shell or side walls of the gasholder in the form of a series of convolutions, undulations or corrugations of more or less elastic, resilient, or pliable material. These convolutions, undulations or corrugations may take any of a great variety of shapes, being either continuously curved or angular, or composed of

a combination of planar and curved surfaces, the outline in the expanded condition tapering from the bottom toward the top roughly in the manner of the lateral surface of a truncated cone. The convolutions of the shell are so constructed that they have a certain degree of expansibility and compressibility, and are preferably so designed that in the collapsed condition of the gasholder the annular convolutions lie contiguously with respect to each other upon the floor or ground, the center being occupied by the top or roof of the gasholder which, together with the bottom, may be circular, polygonal, or be composed of so many sides that it is practically circular. The gasholder may be and preferably is reinforced or stiffened in any suitable manner and in the preferred embodiment of the invention, the reinforcement takes the form of an articulated skeleton framework which is attached to the various folds or convolutions of the shell and moves with the shell during its expanding and collapsing movements, the parts of the framework being so constituted and arranged as not to interfere with the movements of the shell.

The invention will be further described with the aid of the accompanying drawings, which show by way of example a preferred form of the invention, it being, however, understood that the invention is by no means limited to the specific embodiment illustrated. In said drawings,

Fig. 1 shows schematically and in vertical section a gasholder constructed in accordance with the invention, the gasholder being in the extended condition.

Fig. 2 is a fragmentary view similar to Fig. 1, but showing the gasholder in the collapsed condition in which the convoluted or undulated shell or wall and the top rest upon the ground or foundation.

Fig. 3 shows a partial section through the extended shell on an enlarged scale.

Fig. 4 is an enlarged view in vertical section of a portion of the completely collapsed gasholder; and

Fig. 5 illustrates a wear-proof connection between a part of the reinforcing framework and the shell.

As shown in Figs. 1 and 2, the gasholder consists in general of a bottom **10** resting upon the ground or foundation **11**, a shell or side wall **12** and a roof or top **13**. The bottom or base of the gasholder is considerably larger than the roof so that the shell extends from the bottom toward the top at an inclination to the vertical, the whole structure in the inflated condition shown in Fig. 1 resembling roughly a truncated cone or a truncated many-sided pyramid. The outline of the shell or side wall need not, however, follow a straight line from the bottom to the top, but may be slightly arched, as illustrated.

The shell is attached to the periphery of the top as shown at **14** and is anchored in or fixed to the bottom as shown at **15**, as by way of a fixed rail **16** which is attached to or embedded in the bottom in gas-tight relation. The bottom may be made of gas-proof concrete, which may be covered by metal plate, or may be constructed in any other suitable or known fashion.

The shell is formed of a series of convolutions, undulations or corrugations **20** and is made of suitably elastic, resilient or pliable material so as to be extensible and collapsible, somewhat in the manner of a bellows, with the important distinction, however, that in the completely deflated or empty condition of the gasholder the shell rests in the form of a series of contiguous convolutions or undulations upon the bottom of the gasholder, while the top or roof of the gasholder rests upon the central portion of the bottom, all of the shell preferably being located in the annular space between the top **13** and the circular or polygonal line of attachment **15**. In the empty condition of the gasholder, therefore, the shell consists of a series of annular convolutions extending more or less horizontally from the rim of the top to the place at which the shell is anchored in or attached to the bottom. To this end, the angle of inclination of the shell in the extended condition, in which the waves run in more or less stepwise fashion, must be so determined that adequate space is afforded between the top and the place of attachment to the bottom to receive the compressed convolutions without bulge or buckle of the shell. The convolutions are so formed and their number and degree of compressibility are so determined that when the gasholder is in the collapsed condition shown in Figs. 2 and 4, the compressed convolutions fit into the annular space between the outer rim of the top **13** and the anchored lower edge of the shell.

The convolutions of the side walls are made of such depth and of such length that no excessive stresses are imposed upon the material. In the preferred method of construction as described in detail hereinbelow, the parts are so designed and related that the side walls are practically in an unstressed condition in the average condition of the gasholder, that is, when it is about half full. The maximum strain in the material is thus set up upon movement of the walls for a distance corresponding to only about half the total height of the gasholder. The shell, moreover, yields quite readily to expansion and compression, so that only slight pressure differentials are required to effect extension or collapse of the gasholder.

The convolutions **20** may all be of the same configuration, as illustrated, or they may be of different sizes and shapes. Thus while I have shown each convolution to consist of the more or less straight portions **21**, **21***a*, an inner curved portion or bend **22** and an outer curved portion or bend **23**, the curved bends may be replaced by a multi-lateral shape or broken line outline.

In accordance with a further development of the invention, the gasholder is reinforced or stiffened by an articulated skeleton framework consisting of relatively pivoting skeleton sections which may be joined together into skeleton rings surrounding the gasholder at certain convolutions or at every convolution, but having freedom of movement relatively to each other so as to be capable of collapsing with the shell. This skeleton framework may be all arranged upon the exterior of the gasholder or part of it may be positioned within the gasholder upon the inside surfaces of the shell.

In the form of the invention illustrated the reinforcing members include the bars **24** and **25** secured to the exterior of the shell, and the plate **26** and bar **27** attached to the interior of the shell. Each pair of bars **24** and **25** is attached at their adjacent ends to the gasholder shell, such attachment being accomplished by welding, riveting or in any other suitable manner. Each plate **26** preferably underlies the adjacent ends of the associated bars **24** and **25** and is likewise secured to the shell, from the inside thereof by welding, riveting, etc., the bars **24** and **25** and

the plate 26 thus forming a more or less continuous rigid reinforcing structure which is secured to the portion 21 of the convolution at approximately its middle section. The adjacent ends of the bars are tapered and separated by a space 24a for a purpose to be explained below. The bars 24 and 25 may, however, be joined into a single integral member and the plate 26 dispensed with.

To the outer end of each bar 24 is pivoted, as at 28, a hook-shaped member 29 which curves about the outer bend 23 of a convolution, the free end of the hook being flattened as shown at 30. This free end underlies the preferably flattened end 31 of the bar 27, located upon the inside of the shorter portion 21a of each convolution, so that pressure can thus be transmitted by the shell from the bar 27 to the member 29 and vice versa.

The bar 27 is pivoted as indicated at 32 upon an angular plate 33 whose base is secured in any suitable fashion to the shell. The bar is thus free to move about a horizontal axis to accommodate itself to changes in the curvature in the shell portion 21a.

The other end 34 of the bar 27 may likewise be flattened and is arranged to overlie the preferably curved and flattened end 35 of a link 36 which is pivoted at 37 to the bar 25 and is located beneath the bar 27 upon the exterior of the shell.

To avoid wear upon the shell by the ends 30, and at the same time hold the parts 29 and 36 in proper relation to the shell, suitable buffer means may be provided. In the form of the invention illustrated, such means comprise a headed stud or rivet 38 whose head 39 is welded or clamped to the shell in gas-tight manner. The shank 40 of the stud is received within an enlarged aperture 40a in the end of the respective part 29 or 36 so that such end has a limited freedom of movement relatively to the shell, the shank being long enough to prevent disengagement between the stud or rivet and the associated part.

The bars 24, 25 and 27 may be of any desired shape; thus they may be of angular, channel, T, or flat form; or certain of them may be of one shape and others of another.

The inclined zig-zag series of bars and plates 25, 26, 24 and 27 and link 36 is attached about the shell at intervals, say at 3 or 4 foot distances. To secure greater rigidity and insure against distortion of the shell, especially in larger gasholders, the adjacent vertical series of reinforcing members may be connected by horizontal or diagonal bars or struts; thus the adjacent hook members 29 may be connected together by tie rods or bars 41 which may be of angular or other suitable shape. Similar connecting members may be attached to the adjacent bars 24 and/or the bars 25 and 27.

It will be seen from the above that the parts 24, 25 and 26 constitute local regions of greater rigidity and are connected by the pivoted members 29 and 36 to the adjacent bars 27 so that an articulated reinforcing latticework extends from the top to the bottom of the gasholder, which serves to stiffen the gasholder and assist the latter in resisting wind pressures. These reinforcements, furthermore, are so attached and arranged that the convolutions of the shell bear against them and transmit the gas pressure to them, the reinforcements acting at all times to prevent distortion of the shell out of its predetermined shape.

The reinforcing structure may also serve as a support for part of the weighting means whereby the desired gas pressure is maintained in the gasholder. These weighting means may consist of blocks of concrete extending along the convolutions of the shell, the blocks being spaced at certain distances along the circumference to permit relative movement therebetween. In the form of the invention illustrated, the blocks rest upon the bars 24 and span the distance between adjacent bars and extend beyond the bars somewhat less than half the distance to the next bar. All of the weights may be placed upon the outside of the shell, but some of the weights are preferably suspended from the interior surface of the shell, as shown at 43. In such case the blocks of concrete are received within casings or hangers 44 which are welded, riveted, or otherwise secured to the shell, preferably directly below the bars 25, so that the weight of such blocks is taken up by said bars. It will, of course, be understood that the concrete blocks may be replaced by slabs of iron or other suitable weighting means.

Where the blocks 43 are employed within the gasholder, it is preferable to shape the bottom surfaces 45 thereof in such a manner that when the gasholder is in the collapsed condition shown in Figs. 2 and 4, such blocks can rest flatly upon the floor of the gasholder, and thereby aid in preventing distortion of the collapsed shell.

All of the load can be placed upon the roof, but at least in certain cases it may be preferable to distribute some of it on the shell. The weights resting on the reinforcing bars 24 may be held in place by bands (not shown) or in any other suitable manner. To avoid excessive bending movements, the weights are positioned symmetrically with respect to the center 26a of the more or less rigid structure 24—26—25, and approximately midway between such center and the pivots 28 and 36.

The roof may be built up of sheet material and is attached in gas-tight relation with the shell. The load on the roof may take the form of a layer of concrete or of a large number of individual masses uniformly distributed. Suitable stiffening structure, for example, a truss frame, may be provided for the roof but has not been illustrated as it forms no part of the present invention.

As shown in Figs. 3 and 4, each convolution may be built up of two annular sections of sheet material, the first beginning at 49 and underlapping or overlapping the second section at 50, the second section terminating at 51 where it overlaps the next shell section. The ends of certain of the shell sections may be bent away from the surface of the shell to form a flange 52 which serves to stiffen the shell sections in the transverse direction. The plate 26 underlies the lap joint 50 and as already explained serves to produce a more or less rigid connection between the adjacent ends of the bars 24 and 25. To stiffen the other portions of the convolutions they may be crimped as shown at 53 to increase the resistance to transverse bending.

One of the important features of the gasholder above described is that it can be erected entirely upon the floor or bottom of the gasholder, no scaffolding or falsework of any kind being necessary. The cost of construction is thereby very considerably reduced. The successive annular

sections forming the series of convolutions are built up and attached to each other, preferably from the outermost diameter inwardly, all while the parts rest upon the bottom of the gasholder. Thus the first or outermost shell section **55** may be built up while the workmen remain upon the ground, and is attached to the rail **16** as indicated at **15**, such attachment being effected by welding, riveting, etc. After this first section has been built up into its annular form, or during the course of its construction, the second section **56** is attached thereto by being built up thereon. During these operations the parts **55** and **56** are not under external stress. The bars **24**, **25** and **41** are then attached and upon the bars **24** and **25** are supported or suspended the weighting means, **42** and **43**. The outer or left bend **23** is thus placed under compression while the upper part of the section **56** extends into the air without tension, or under very low tension. The next section **55'** is then attached to the section **56** and the section **56'** is then built up and attached to the section **55'**. After the bars **27** have been mounted within the convolutions, the weighting means are mounted upon the upper portion of the section **55'** and the lower portion of the section **56'**, so that the outer bend of the next convolution is placed under pressure while the inner bend **22** is more or less free of any stress. As the construction proceeds the successive convolutions take the position shown in Figs. 2 and 4 until finally the innermost convolution is attached to the one immediately preceding it and to the roof.

The degree of weighting or loading during the construction of the gasholder is preferably so determined that the stresses in the shell become zero when the gasholder is approximately half full; that is, in this condition of the gasholder the convolutions are under no pressure or tension. In this way the maximum stress in the shell is reduced.

In order to prevent excessive expansion of the gasholder, restraining means in the form of a chain or other flexible or semi-flexible device connecting the top with the bottom may be employed. In the form of the invention illustrated the chain consists of an alternating series of rigid bars or rods **57** and flexible chain members **58**. To prevent the chain from becoming twisted or frozen to the gasholder shell by snow and ice, the rods **57** may be secured in any suitable manner to the outer bends of the successive convolutions or to only certain of the convolutions, the rods being preferably secured to the reinforcing structures, for example, to the hook member **29**, as shown, or to the transverse connecting bars **41** between the individual, vertically extending reinforcing structures. The flexible chain attached to the unsecured end of a rod **57** may be connected to a succeeding outer bend **23**, preferably through the reinforcing member, each rod and its connected flexible chain portion thus limiting the degree of extension of the convolution or convolutions which they subtend.

The chains may be arranged in pairs at various places and provided with rings to serve as a collapsible ladder for scaling the gasholder.

To prevent dangerous rise of pressure within the gasholder any suitable safety device, such as a relief or blow-off valve **59**, may be provided in the roof of the gasholder.

In the normal operation of the gasholder the convolutions readily yield to increases in the volume of gas and as easily collapse as the volume is decreased. Because of the flexibility of the convolutions, only very slight differences in pressure are required to cause expansion of the gasholder to the fullest extent and collapse of the gasholder until it rests on the bottom. The reinforcing members follow the expansion and collapsing movements of the convolutions and at the same time preserve the predetermined shape of the latter and assist the shell in resisting wind pressures, as the individual series of bars **24**, **25**, **27** and plates **26** may be so constructed and related that the whole articulated and inclined zigzag framework is relatively rigid against horizontal forces. The reinforcing mechanism is thus in the form of a spider framework which embraces the shell and while articulated so as to follow the movements of the shell, nevertheless resists distortion of the flat portions of the shell by internal and external pressure.

The stability against wind pressures is greatly aided also by the fact that the bottom of the gasholder is considerably larger than the top, the structure as a whole thus possessing the highly stable equilibrium of a frustum of a cone or pyramid resting upon its larger base.

In the preferred form of the invention each convolution is composed of a broader portion (running from **23** to **22**) and a narrower portion (running from **22** to **23**), and the convolutions overlie each other to a certain extent in the collapsed condition of the gasholder, but each occupies part of the horizontal area between the roof and the rail **16**, so that the gas pressure acts on all of them and lifts them all substantially simultaneously as gas is admitted into the collapsed gasholder. As shown more clearly in Fig. 4 the outer bend of one convolution overlies the inner bend of the next outer convolution, its own inner bend being directed toward the floor of the gasholder successive convolutions thus partly overlying each other. The convolutions may rest one directly on top of the other, and in order better to accommodate the overlying convolution the adjacent ends of the bars **24** and **25** are tapered, as already described, so that the convolution together with its stiffening mechanism is received within the space between the bar ends. In the embodiment shown in Fig. 4, the angle of inclination of the shell as a whole is so chosen and the convolutions so dimensioned that, in the collapsed condition of the gasholder, successive convolutions have their bottom portions at substantially the same level and are individually supported directly upon the bottom of the gasholder, that is, without an intervening convolution. It will be understood that the weight **42** will be notched at suitable places to accommodate the hooks **29** where this should be necessary. It will be noted that in the collapsed condition of the convolutions the hook members **29** are rotated downwardly about their pivots, while the members **36** are moved outwardly upon their own pivots, so that the change in shape of the bends **23** and **22** as the shell collapses is not resisted. While the rest of the convolutions performs a limited rotational movement as the gasholder expands and contracts, the center points **26***a* as a rule move only vertically.

The inner tapered ends of the rod **27** are preferably so shaped that, as shown in Fig. 4, they provide a flat seat for the overlying inclined plate **26**.

Because the shell lies flat on the base in the collapsed condition of the gasholder the dead space, indicated at **60**, is extremely small. This

space may be still further reduced by providing a series of annular ribs or ridges 61 of concrete or the like which are shaped so as to fill substantially completely the space 60. If desired, and as shown in my copending application Ser. No. 10,533 filed March 11, 1935, the bottom may be filled with water, oil, tar or other liquid to a depth sufficient to occupy substantially all of the spaces 60.

It will be seen that when gas is admitted to the completely collapsed gasholder, the roof will rise first, but after rising for only a very short distance the whole of the shell is lifted with it by the pressure of the gas under the shell. The roof and shell thus both float upon the small body of gas in the gasholder. The gas is thus substantially immediately subjected to the complete dead weight of the gasholder and is subjected to no additional weight as the gasholder fills to greater and greater extents. The gas pressure thus remains substantially constant in all conditions of filling of the gasholder. To accomplish this result, the angle of inclination of the shell must be properly chosen, taking into consideration also the fact that the convolutions are all to lie on the bottom when the gasholder is collapsed or subtend different portions of the bottom. This angle can be determined approximately by equating the total load and weight of the shell with the total upward pressure on the shell exerted by the gas.

The base of the gasholder is preferably tapered, as illustrated, to facilitate drainage of condensed moisture. The roof may be correspondingly tapered, as shown in Fig. 2.

The gasholder shell may be made of iron, steel, aluminum, alloys, or any other metallic or non-metallic material having the necessary degree of elasticity or pliability.

The claims subjoined hereto are directed to my improved gasholder as an article of manufacture; the novel method of constructing a collapsible gasholder described herein forms the subject matter of my divisional application Ser. No. 132,981, filed March 25, 1937, now Patent No. 2,105,081, dated January 11, 1938, and is claimed therein.

It will be understood that the invention is capable of numerous structural embodiments and that various changes in the parts and in the details of construction may be resorted to without departing from the principles of the invention. Thus, the bottom plate 10, which is shown as being of metal, may be omitted, the bottom then consisting of a gas-impervious layer of concrete, stone, etc. Also, where gas of very low pressure is to be stored, no loading means being then used, the reinforcing framework may be omitted, as the shell will then not be subjected to distorting gas pressures.

I claim:

1. A collapsible gasholder comprising a bottom, a top of smaller diameter than the bottom, an inclined shell connected in sealing relation with the bottom and top, weighting means distributed upon said top, and weighting means distributed along the inclined shell.

2. A collapsible gasholder comprising a bottom, a top of smaller diameter than said bottom, an inclined convoluted shell connected in sealing relation with the top and bottom, the angle of inclination of said shell being so determined that in the collapsed condition of the gasholder the collapsed shell lies in an approximately horizontal plane between the top and the line of attachment to the bottom, and weighting means distributed upon said shell and including blocks attached to the inner surface of the shell and shaped so as to lie flat upon the bottom in the collapsed condition of the shell.

3. A collapsible gasholder comprising a bottom, a top and a convoluted shell connected in sealing relation with the top and bottom and adapted to be expanded or compressed as the gasholder fills or empties, each convolution consisting of a larger upper portion, and a shorter lower portion, reinforcing structure attached to approximately the middle section of the upper portion, a reinforcing member attached to the lower portion, the outer end portion of the upper reinforcing structure including a curved pivoted hook member extending around the bend between the upper and lower portions of the convolution into proximity with one end of the reinforcing member so that stresses can be transmitted from one to the other, the upper end of said reinforcing mechanism including a pivoted member extending toward the lower portion of the next adjoining convolution and connected to such last-mentioned lower portion.

4. A collapsible gasholder as set forth in claim 3, wherein the reinforcing member is pivotally mounted upon the lower portion of the convolution, so as to be able to accommodate itself to changes in the curvature of said portion.

5. A collapsible gasholder as set forth in claim 3, wherein the reinforcing member is mounted upon the inner surface of the lower portion of the convolution, the free ends thereof overlying the ends of the reinforcing structures of its own and the adjacent convolution.

6. A collapsible gasholder as set forth in claim 3, wherein the ends of the reinforcing structure and of the reinforcing member are connected to the shell by way of a headed member having a shank passing through an enlarged opening in said ends whereby the wear is taken up by said headed member.

7. A collapsible gasholder as set forth in claim 3, including weighting members mounted upon said reinforcing structure approximately symmetrically with respect to the center thereof.

8. A collapsible gasholder as set forth in claim 3, including a weight mounted upon the reinforcing structure outwardly of its center and upon the outside thereof, and a weight mounted inwardly of the said center and suspended in the inside of the gasholder from said reinforcing structure, the inward surface of such reinforcing structure being thus unobstructed by said weights and being free for receiving in supporting relation the adjacent convolution in the collapsed condition of the gasholder.

9. A collapsible gasholder comprising a bottom, a top of smaller diameter than the bottom, and an inclined convoluted shell connected in sealing relation with the top and bottom and forming a stepped surface therebetween in its extended condition; said shell and top resting upon the bottom in the collapsed condition of the gasholder with successive convolutions having their bottom portions at substantially the same level when collapsed and being individually supported directly on said bottom, the convolutions being then in partial overlapping relation in position to be substantially simultaneously lifted upon admission of gas to the gasholder.

10. A collapsible gasholder comprising a bottom, a top of smaller diameter than said bottom, and a collapsible shell connected in sealing

relation with the top and bottom and composed of a plurality of annular convolutions capable of expansion and contraction and extending from the top to the bottom and forming a stepped surface therebetween in its extended condition, each wave of the shell being formed of a broader portion and a narrower portion, and the connections between these portions and between the waves formed of such portions forming curvilinear external outlines, the dimensions of said wave portions being such that the broader portions are capable of overlapping the narrower portions in the completely collapsed condition of the shell, the narrower portions being capable of overlapping a part of the broader wave portions underlying the same, the angle of inclination of the shell as a whole in the extended condition of the gasholder being such that the shell is capable in the completely collapsed condition of the gasholder of supporting itself, along with the cover, between the latter and the line of attachment of the shell to the bottom, upon such bottom at substantially the same elevation as the cover by way of successive broader wave portions projecting beyond adjacent narrow portions.

11. A collapsible gasholder comprising a bottom, a top of smaller diameter than the bottom, a shell which in the completely extended condition of the gasholder forms a stepped surface, said shell being expansible and collapsible with the corresponding movements of the gasholder, and an articulated skeleton reinforcing framework composed of two portions connected with the shell, one portion being arranged upon the exterior of the shell and the other upon the inner side thereof.

12. A collapsible gasholder comprising a bottom, a top of smaller diameter than said bottom, and a collapsible shell connected in sealing relation with the top and bottom and composed of a plurality of annular convolutions capable of expansion and contraction and extending from the top to the bottom and forming a stepped surface therebetween, in its extended condition, the angle of inclination of the shell as a whole, in the extended condition of the gasholder, being such that the shell is capable in the completely collapsed condition of the gasholder of supporting itself, between the cover and the line of attachment of the shell to the bottom, upon such bottom at substantially the same elevation as the cover with successive convolutions individually supported directly upon the bottom.

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