United States Patent [19]

Friedl

[11] **3,899,153**

[45] **Aug. 12, 1975**

[54] **HOLLOW INFLATABLE FORMWORK ELEMENTS FOR PRODUCING CONCRETE STRUCTURES**

[75] Inventor: **Franz Friedl**, Vienna, Austria

[73] Assignee: **Semperit Aktiengesellschaft**, Austria

[22] Filed: **Jan. 15, 1973**

[21] Appl. No.: **323,355**

[30] **Foreign Application Priority Data**

Jan. 13, 1972 Austria 253/72

[52] **U.S. Cl.** **249/65**; 249/178

[51] **Int. Cl.**[2] **B28B 7/32**

[58] **Field of Search** 249/65, 178

[56] **References Cited**

UNITED STATES PATENTS

1,600,353	9/1926	Nose	249/65 X
1,964,386	6/1934	Nose	249/65
2,485,898	10/1949	Mathews et al.	249/65
2,579,423	12/1951	Ford	249/65
3,104,441	9/1963	Smith	249/65
3,352,529	11/1967	Haas	249/65 X
3,648,963	3/1972	Smith	249/65

Primary Examiner—Francis S. Husar
Assistant Examiner—John McQuade
Attorney, Agent, or Firm—Ernest F. Marmorek

[57] **ABSTRACT**

The present invention relates to reusable hollow formwork elements of elastic material which may be used for the concreting of pipelines, and which by filling with a gaseous or liquid medium, can be given compressive resistance. The invention also relates to a method of operating such formwork elements.

3 Claims, 7 Drawing Figures

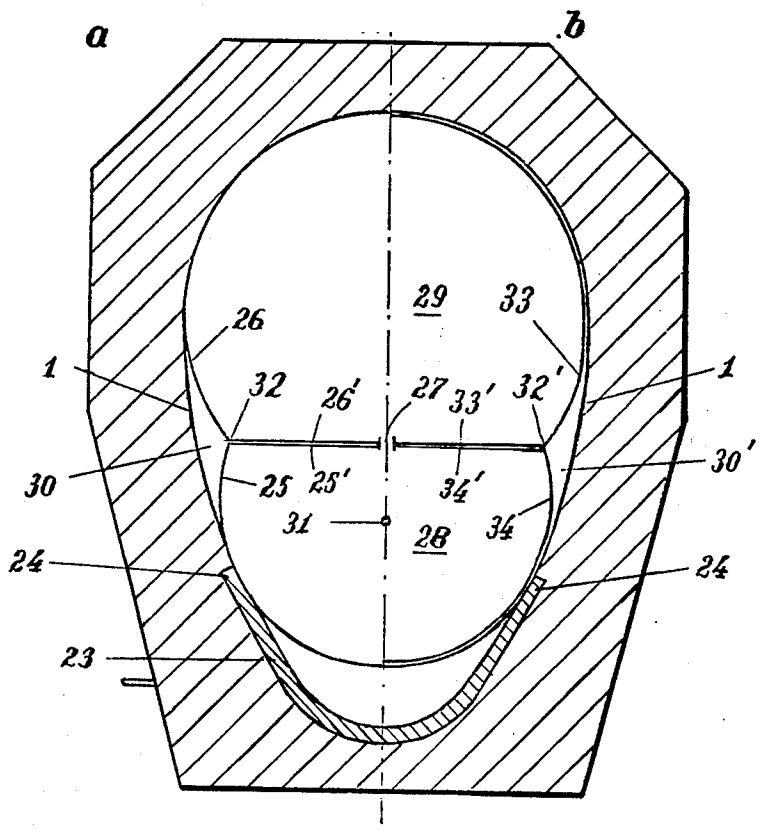


Fig. 1

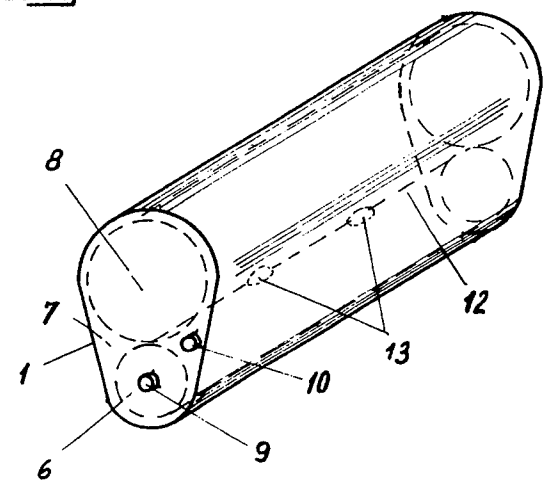


Fig. 2

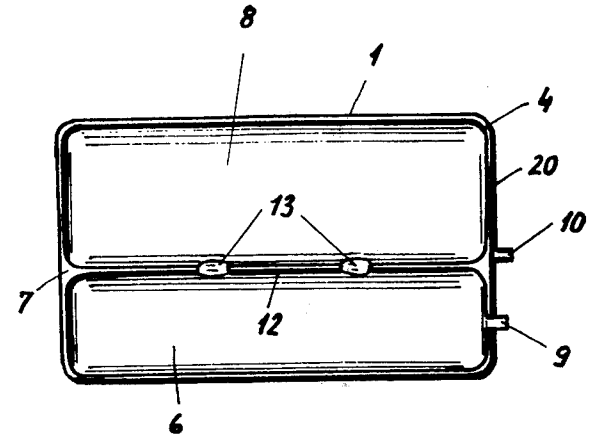


Fig. 3

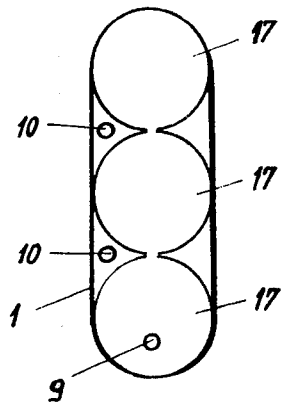


Fig. 4

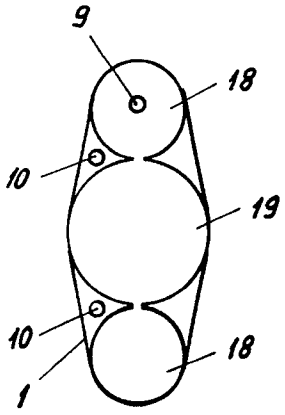
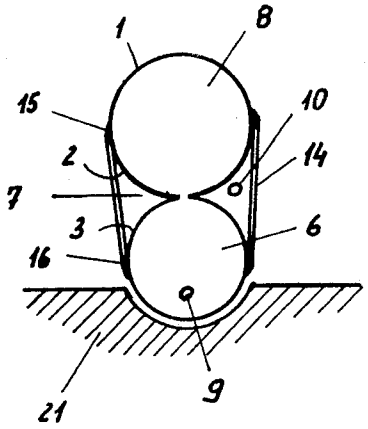


Fig. 5



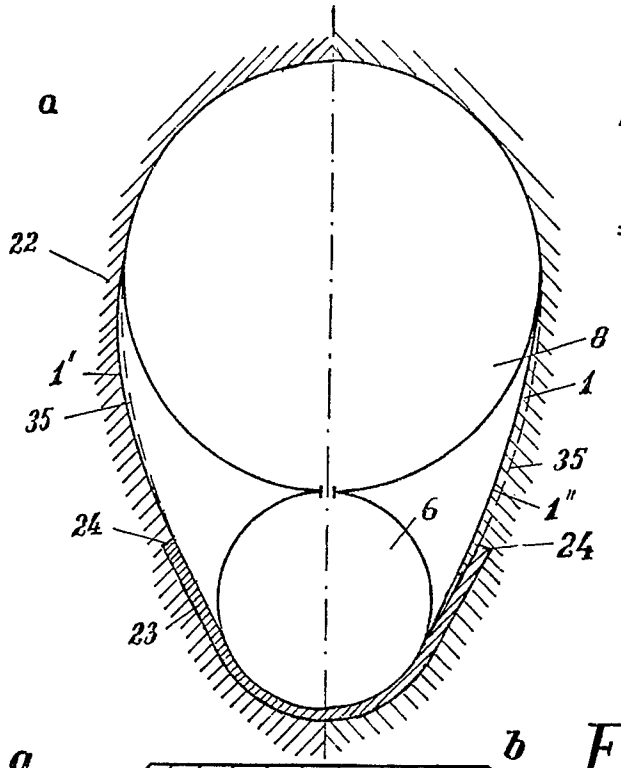

a
b
22
1'
35
24
23
8
1
35
1"
24
6

Fig.6

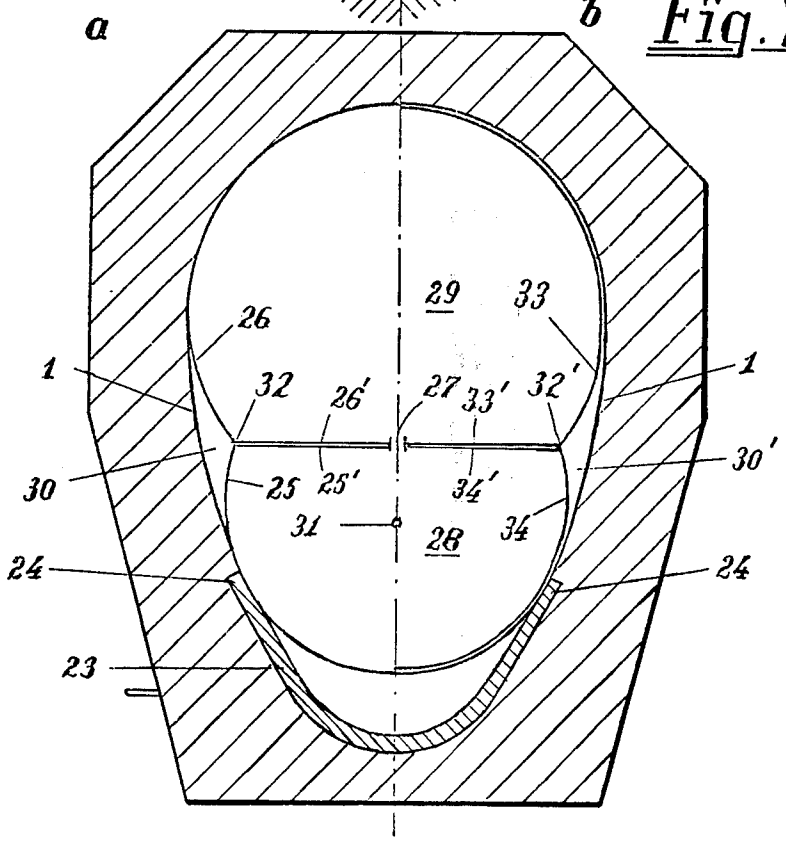

a
b
29
33
26
1
32
26'
27
33'
32'
1
30
25
25'
34'
30'
31
28
34
24
24
23

Fig.7

HOLLOW INFLATABLE FORMWORK ELEMENTS FOR PRODUCING CONCRETE STRUCTURES

BACKGROUND OF THE INVENTION

By way of formwork material for concreting purposes, wood, sheet metal and, more recently, flexible materials such as synthetic plastics material sheets or foamed synthetic materials, have been used. In order, however, to be able to use a flexible formwork skin, it is necessary to maintain the desired forwork shape by using internal spacers of suitable material. By the incorporation of spacers, however, so-called lost formwork, i.e. the synthetic plastics material formwork remains in situ in the concreted components.

On the other hand, so-called telescopic formwork arrangements of steel or light alloy are known, which are used in tunnelling work and consist of a multipart formwork system arranged on a mobile assembly. The use of this kind of system makes it possible to build a tunnel lining in a continuous manner. The use of formwork sections of this kind or formwork elements which do not have a uniform, smooth surface, necessitates considerable subsequent work because the concrete surface has to have the flash witnesses removed from it. The use of formwork removal agents which are applied to the formwork before the concreting operations are commenced, although ensuring trouble-free removal of the formwork nevertheless means that subsequent treatment of the surface, at least at the points of connection, is essential.

Also known are tubelike or sacklike formwork arrangements for the concreting of ceilings and particularly for reinforced concrete ribbed ceilings, these arrangements being made of a slack, flexible material such as rubber tubing or sacking. Tubes of this kind can be operated by filling them with air, water or sand and providing a closable insert.

The tubes consist of a sheet of synthetic plastics material as the envelope with tensile tensioning inserts and stiffening inserts which are applied to fixing points and in this fashion ensure that a specific cross-sectional shape is maintained. Even under conditions of intensive maintenance, however, devices made of flexible material are subjected to relatively heavy wear because the tensioning inserts and reinforcing inserts make it very difficult to introduce the devices into position and align them and it is extremely difficult to introduce the devices into position and align them and it is extremely difficult to re-use such hollow formwork elements. A great deal of extra labour is thus involved and efforts have therefore been made to use hollow elements of cheap material in order to use them at lost formwork. Quite apart from this, however, the compressive resistance of this kind of tube of synthetic plastics material foil, is too low to justify regarding such an element as a fullgrade piece of formwork.

Such hollow formwork elements made of elastic material may also be used for the manufacture of tubes or channels as is well known having a cross-section approximating that of an egg. This is conventionally achieved by providing a cylinder of a larger diameter and another cylinder of a smaller diameter which are interconnected along a superficies line. In this case the connecting bridges, which extend tangentially as viewed in a cross-section, form an oval.

Assuming now that in the gusset formed by the two cylindrical walls on the one hand and the connecting bridge on the other hand, there exists a pressure which is too low, then the connecting bridge is pressed inwards or alternatively an undesired concrete wedge is formed at the base or bottom plate. On the other hand if a higher pressure is selected which avoids both of these disadvantages then an appreciable deviation from the oval form is caused by a bulging out of the connecting bridge within the region of the bottom plate.

SUMMARY OF THE INVENTION

An object of the invention is to overcome the drawbacks of known hollow formwork elements and to provide a formwork element of elastic material, which can be erected on site in its final form, quite simply by filling it with a gaseous or fluid medium, and which can also be positioned very simply.

Another object of the present invention is to provide improved hollow formwork elements which may be used to cast pipelines having the desired oval cross-section by simple means and which provide in greater approximation the desired cross-section of the pipeline.

The invention therefore consists in a re-usable hollow formwork element of elastic material, which element by filling it with a gaseous or liquid fluid medium can be given compressive resistance, comprising a formwork skin and internal walls attached thereto, said internal walls forming at least three separate cavities extending over the full length of the formwork element and the hollow element formed by the skin being closed at its ends by covers fitted with fluid valves.

One or more of the cavities can be arranged to have a circular cross-section in the filled state. Alternatively, the cavities may have a prismatical cross-section instead of a circular cross-section.

Preferably, the diameters of two cavities which are circular in the filled state are in the ratio of approximately 1:2. It has also been found convenient to attach the internal walls forming the cavities to one another over the full length of the formwork element at the common tangent or chord, with the cavities communicating with one another through one or more openings so that selected cavities can be filled with fluid medium through a common valve.

In order to cast tubes of oval cross-section another embodiment of the hollow formwork elements of the invention may be used. In this case one of the cylindrical, hollow spaces has such a diameter that it touches tangentially the two upper edges of the bottom plate. It has also been found to be suitable that if at least two of the hollow spaces in the filled or inflated state have the shape of hollow cylinders from each of which a segment of equal cord length has been cut away and which are connected to each other along the section plane. In order to obtain an oval cross-section of the hollow framework element in the inflated state, it is preferred to provide one hollow cylinder with a diameter which may, for example, be approximately 20% larger than that of the other adjacent hollow cylinder. Furthermore, it has been found suitable for concreting pipelines which have an oval cross-section and by utilizing a gutter-like bottom plate when the two hollow spaces are interconnected by at least one opening of the inner wall disposed in the section plane.

From another aspect the invention consists in a method of operating the hollow formwork element wherein selected combinations of the cavities are filled with fluid medium independently of one another

through respective valves, the formwork skin being made to adopt the required profile by adjusting the pressure in the cavities. To achieve a substantially elliptical or oval cross-section two cavities which have a circular cross-section in the filled state, are maintained at the same pressure, whilst the remaining cavity or cavities is or are maintained at a lower pressure. For example, a pressure difference of between 0.1 and 0.5 atm may be provided.

The hollow formwork element is preferably made from a fabric with an oil-resistant coating e.g. a cotton fabric or a polyester fibre fabric with a coating of a butadiene-acrylonitrile copolymer or a layer of poly-2-chlorobutadiene (Neoprene). Thus, normaly rubberized fabrics which are designed for engineering applications, can be used. The formwork skin must be made of oil-resistant material because it is essential to use formwork release agent based upon lubricating oils in order to prevent the concrete from adhering to the formwork.

This kind of formwork element can, for example, be manufactured as follows:

First, two cylinders closed at their ends, are manufactured from rubberized fabric and attached to one another by bonding, whereafter they are covered by an envelope wall which serves as a formwork skin. The open hollow element obtained in this way is then closed off at its ends by dish-shaped covers, each of which contains a valve.

The application of re-usable hollow formwork elements is indicated wherever the in situ building of concrete pipes is required. The formwork in accordance with the invention can be used to build pipelines of all kinds, including curved ones. It is possible to produce different profiles using one and the same element, merely by altering and adapting the pressures in the cavities provided. The profile can be varied in this context from the elliptical to the circular. With an element of this kind it is possible without particular difficulties, to carry out improvement works, the element being placed in a pipe which is to be improved and concrete introduced into the interspace formed between the envelope wall of the element and the pipe.

Using a formwork element in accordance with the invention it is even possible to take account of changes in profile during the manufacture of a pipeline. These elements are particularly suitable for application at points where access is difficult and space restricted.

In building concrete pipelines using a formwork element in accordance with the invention, it is first of all necessary to provide a suitable base or foundation. For example such a base or foundation is preliminarily produced by concreting or a substrate suitable to perform this function is laid down. Then external formwork and possibly reinforcing is introduced. The hollow formwork element is then inserted and inflated using compressed air and built-in pressure-reducer valves may be provided to ensure that the correct pressure is established. In this context, in order to achieve an elliptical or oval cross-section, of the kind often required in ducting, the pressure ratio is so contrived, that the two circular tubes are maintained at the same pressure whilst the remaining cavity is inflated to a lower pressure.

During the concreting operation, the hollow element is held down at the top to prevent it floating off. After the concret has cured, the compressed air is blown off from the hollow form-work element and the element, which then lies slack in the finished pipeline, can be withdrawn. It is possible too, of course, simply to blow off a small quantity of air and to shift the element onwards by a distance corresponding to the concreted length of pipe.

BRIEF DESCRIPTION OF THE DRAWINGS

Exemplary embodiments of the invention will now be described with reference to the drawings forming part of this Specification, in which:

FIGS. **1** and **2** show a hollow formwork element in a perspective view and in section along the longitudinal axis,

FIGS. **3** to **5** show further embodiments of the hollow formwork in section,

FIG. **6** is a cross-sectional view of a pipeline with egg-shaped profile and having a known hollow formwork element, the figure being divided by a vertical, symetrical line into two portions, and

FIG. **7** is a cross-sectional view of such a pipeline provided with a hollow formwork element in accordance with the present invention, the figure being again divided by a vertical, symetrical line into two portions.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

As shown in FIG. **1**, a hollow formwork element comprises two elongated tubes **6** and **8** which in the filled or inflated state have an approximately circular cross-section and whose diameters are approximately in the ratio **1:2.** The two tubes are attached to one another along the line **12** and transfer orifices **13** for the filling medium, are provided therebetween. The two tubes are surrounded by a formwork skin **1** of rubberized fabric having a tearing strength of around 320 kg per square centimeter. The tubes **6** and **8** are provided at their ends, as shown in FIG. **2**, with caps **4** to close them off. One of these caps contains a common filling and blow-off valve **9** for both tubes. The filling medium, e.g. compressed air, passes unimpededly through the openings **13** from one tube to the other. The intermediate space, or spaces **7** which are formed between the formwork skin **1** and the tubes **6** and **8**, is or are inflated or filled through the valve **10.** The valve **10**, as FIG. **2** shows, is contained in one of the two end covers **20** of the formwork skin **1.** Consequently, the cavity **7** between the tubes **6** and **8** and the formwork skin **1** is filled with the pressurized medium.

In the embodiment shown in FIG. **3**, three tubular elements **17** of the same diameter, are arranged one above the other. FIG. **4** on the other hand, shows a substantially elliptical hollow formwork element comprising a central tubular element **19** with a diameter at most equal to the minor axis of the desired elipse to which two tubular elements **18** of smaller diameter are attached.

FIG. **5** shows a further embodiment of a hollow formwork element in accordance with the invention in operation. Set up on a pre-concreted foundation **21**, there is shown an approximately elliptical hollow formwork element comprising a formwork skin **1.** The internal wall parts **2** and **3** do not themselves define closed cavities but are attached to the formwork skin **1** along lines **15** and **16** to form corresponding cavities **6, 7** and **8,** and between these two attachment lines **15** and **16,** the formwork skin **1** is reinforced by a reinforcing insert

14. After the placing of the hollow formwork element on the pre-concreted foundation, the two tubes 6 and 8 which can be commonlyinflated by a valve 9, are inflated with compressed air to around 1.375 atm, whilst the remaining cavity 7, between the formwork skin 1 and the two tubes 6 and 8, is inflated through the valve 10 to about 1.1 atm. A formwork with an approximately oval cross-section is thus produced. The hollow formwork element is subsequently surrounded with concrete in the desired fashion and left in the cavity thus formed, until the concrete is cured. Then, the pressure in the two elongated tubes of circular cross-section is reduced slightly so that the hollow formwork element lifts away from the inner wall of the pipe which has been thus formed and can be moved longitudinally for further use.

Referring now to FIG. 6, there is shown a channel 22 within which there are disposed again two superimposed, elongated tubes or hoses 6 and 8. A prefabricated base or bottom plate 23 extends with its ends 24 beyond the lower elongated tube 6. The elongated tubes 6 and 8 are interconnected by a formwork skin 1.

Assuming now that the hollow formwork element has been inflated in such a manner that the formwork skin 1 touches the ends 24 of the bottom plate. This has been illustrated on the left-hand side of the vertical symmetry axis shown at a. In this case the skin 1 forms a bulge 1' which deviates from the prescribed or desired line 35.

On the other hand, if a lower inflating pressure is selected as illustrated in FIG. 6 on the right-hand side at b, there is also a deviation 1'' of the formwork skin 1 from the prescribed line 35. This is primarily caused by the fact that concrete enters between the skin 1 and the bottom plate 23.

In order to obtain the desired oval cross-section of the channel the shape of the inflatable, hollow element of elastic material is selected in accordance with the present invention as illustrated in FIG. 7. The hollow element is provided, as illustrated, to the left of the vertical symmetry plane at a with an outer formwork skin 1. The skin 1 is closed upon itself to form an elongated tube and is of such size which corresponds in the inflated state to the desired cross-section of the canal and which also touches the prefabricated bottom plate 23 of the canal. The hollow element is further provided with two inner strip-shaped portions 25 and 26 which are adjacent to the surfaces 25' and 26' and which are connected with each other at least at the borderline 32 of these surfaces. By means of these portions 25 and 26 the egg shape is maintained. In the middle of the two surfaces 25' and 26' disposed adjacent to each other there is provided at least one corresponding opening 27 which serves the purpose to connect with each other the two spaces for the purpose of inflating them.

The diameter of the upper hollow space 29 is approximately 20% larger than the diameter of the lower hollow space 28. The latter has such a diameter that in its inflated state it touches tangentially the two upper ends 24 of the bottom plate 23.

As previously described, at one of the walls disposed at the two ends of the elongated hollow body, there is provided a valve 31 by means of which air may be forced into the hollow spaces 28 and 29. In order to inflate the two gussets 30 which are formed at the side walls of the tube-like hollow spaces 28 and 29, it is also required that a filling valve be provided at one of the end walls of the formwork skin 1.

It is also feasible in accordance with the present invention to arrange the hollow formwork element as shown on the right-hand side of the symmetry plane shown at b. In this case elongated closed hollow flexible bodies or tube-like portions 33 and 34 are disposed within the formwork skin 1. These parts again meet each other at the surfaces 33' and 34' and are at least connected with each other along the borderline 32'. In this case also a gusset 30' is formed. This results, when the hollow formwork elements are inflated, in the hollow formwork elements having the shape of hollow cylinders with equal cord length segments cut away whereby the hollow cylinders may be connected at a section plane.

I claim:

1. A re-usable hollow formwork element, for use in concrete pipe casting and operable to be rendered pressure resistant by filling it with a fluid medium,

comprising in combination,

an elongated, inflatable flexible closed outer casing of predetermined shape when inflated,

at least two elongated adjacent superposed closed hollow flexible bodies positioned along a substantially vertical axis whereby one hollow flexible body is positioned lower than all other hollow flexible bodies, within, and extending over the entire length of, said outer casing, whereby an elongated closed cavity is formed intermediate said outer casing and said bodies, said bodies as well as said cavity being operative to be pressurized by said fluid medium,

each of said hollow bodies having at least one portion facing the respective portion of the adjoining body, and each defining an opening in said portion, the adjoining bodies intercommunicating interiorly through said openings,

a first valve connected to one body operable for introducing said fluid medium thereinto for pressurizing thereby both said bodies to inflate them,

a second valve connected to said outer casing adjacent said elongated cavity, operable for introducing said fluid medium into said elongated cavity for pressurizing thereby said cavity, whereby the outer casing will be inflated to its predetermined shape, and

support means operable for supporting the casing when inflated where the lower of said bodies touches said casing, said support means stopping short of said elongated cavity and

including a gutter-like bottom plate having two ends at an angle to each other,

a part of said casing adjacent said one hollow flexible body being disposed above said bottom plate and when inflated having an external arcuate surface touching tangentially said ends of said bottom plate when inflated, whereby said inflated casing will be supported substantially only by said ends.

2. A re-usable hollow formwork element, for use in concrete pipe casting and operable to be rendered pressure resistant by filling it with a fluid medium,

comprising in combination,

an elongated, inflatable flexible closed outer casing of predetermined shape when inflated,

at least two elongated adjacent superposed closed hollow flexible bodies positioned along a substan-

tially vertical axis whereby one hollow flexible body is positioned lower than all other hollow flexible bodies, within, and extending over the entire length of, said outer casing, whereby an elongated closed cavity is formed intermediate said outer casing and said bodies, said bodies as well as said cavity being operative to be pressurized by said fluid medium,

each of said hollow bodies having at least one portion facing the respective portion of the adjoining body, and each defining an opening in said portion, the adjoining bodies intercommunicating interiorly through said openings,

wherein at least two of said bodies have the shape of hollow cylinders when inflated, a segment of each of said hollow cylinders being cut away to form a section plane, said segments having equal cord lengths, and said cylinders being connected with each other at the section plane,

a first valve connected to one body operable for introducing said fluid medium thereinto for pressurizing thereby both said bodies to inflate them,

a second valve connected to said outer casing adjacent said elongated cavity, operable for introducing said fluid medium into said elongated cavity for pressurizing thereby said cavity, whereby the outer casing will be inflated to its predetermined shape, and

support means operable for supporting the casing when inflated where the lower of said bodies touches said casing, said support means stopping short of said elongated cavity.

3. A formwork element as claimed in claim 2, wherein said cylinders are connected to one another over the full length of the formwork element at the section plane.

* * * * *