United States Patent [19]

Roulet et al.

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[45] **Jan. 9, 1973**

[54] **IMMERSIBLE RESERVOIR**

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[73] Assignee: **Sea Tank Co.,** Paris, France

[22] Filed: **July 31, 1970**

[21] Appl. No.: **59,911**

[52] **U.S. Cl.** .....**61/46,** 114/0.5 T
[51] **Int. Cl.** **E02d 29/06**
[58] **Field of Search**.....61/46, 46.5, 69, 0.5; 114/0.5 T

[56] **References Cited**

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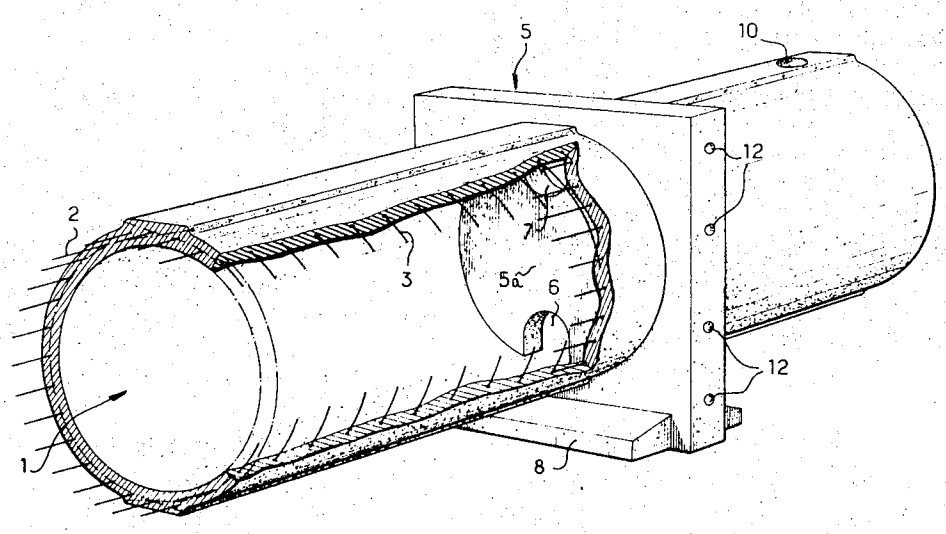
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Attorney—Holcombe, Wetherill & Brisebois

[57] **ABSTRACT**

A reservoir, for example, for liquids capable of being immersed under water and being formed of prestressed concrete. The reservoir has a cylindrical body closed at its ends and lying with its axis horizontal. The reservoir is provided with two partitions which extend from the interior of the body outwards and each of which presents a support foot such that the reservoir can be supported on an emplacement under water at only two points along its length, the partitions inside the body are provided with access openings to permit liquid flow past the partitions and the body may also include other partitions which do not extend out of the cylindrical body and which are also provided with openings for liquid flow.

4 Claims, 9 Drawing Figures



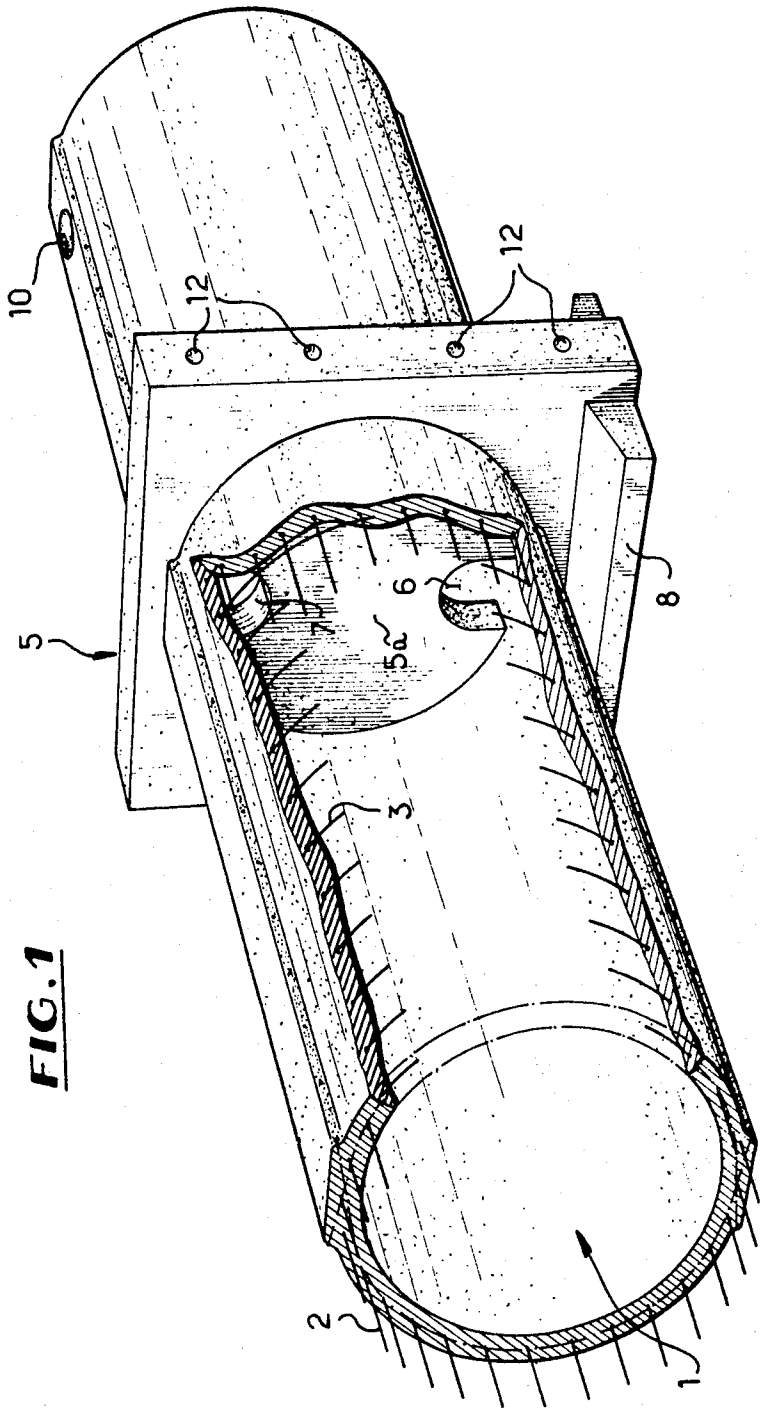


FIG. 1

FIG. 3

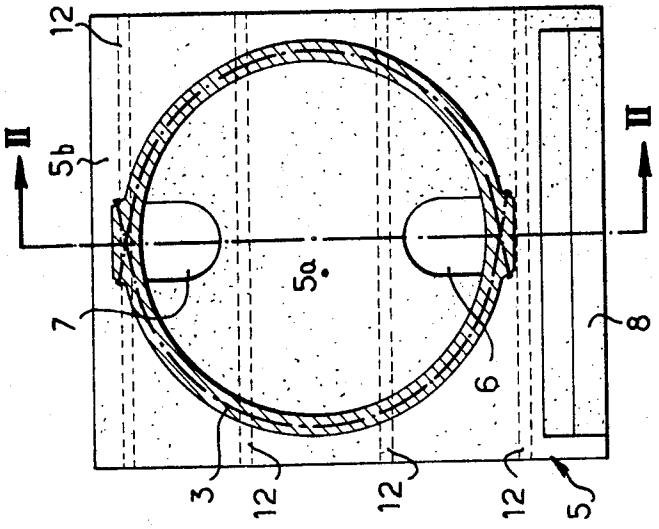
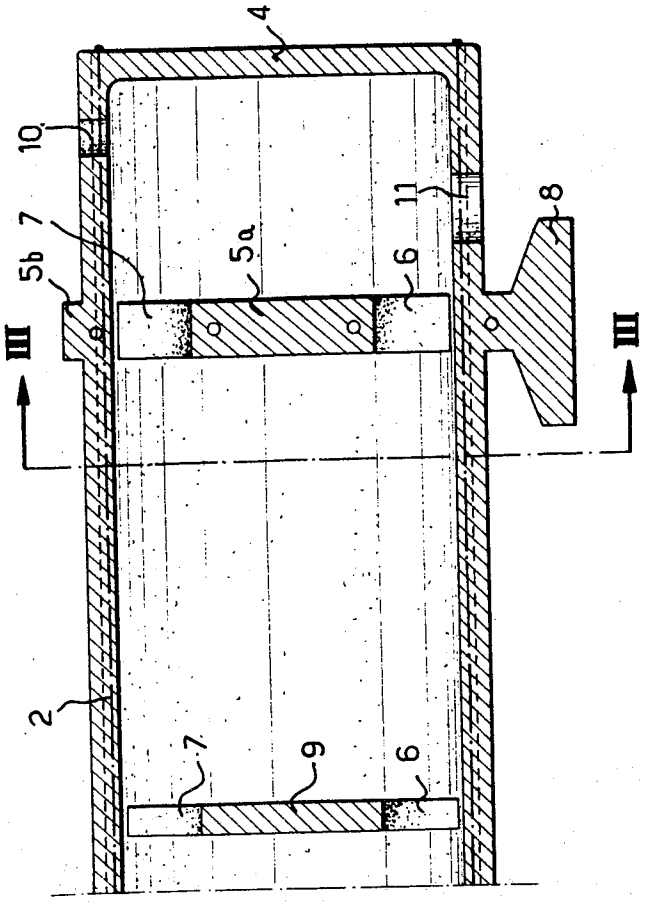


FIG. 2



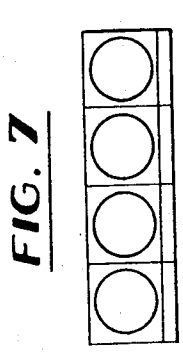


FIG. 7

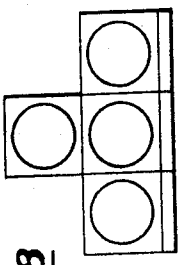


FIG. 8

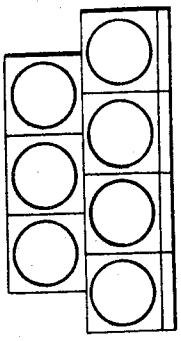


FIG. 9

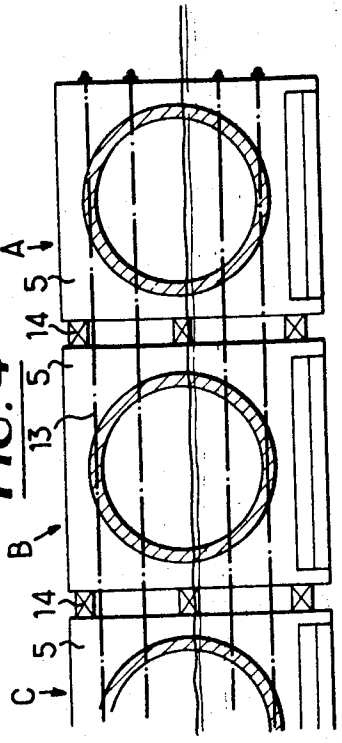


FIG. 4

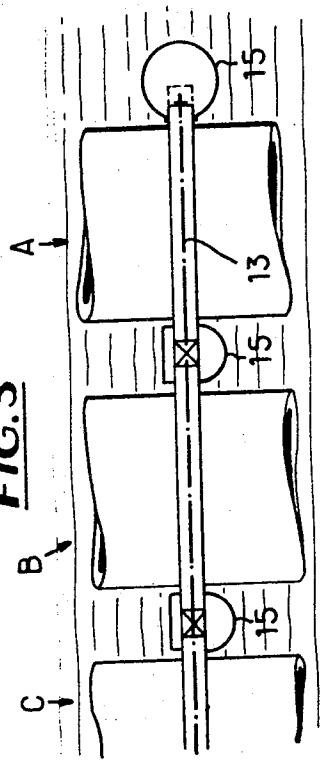


FIG. 5

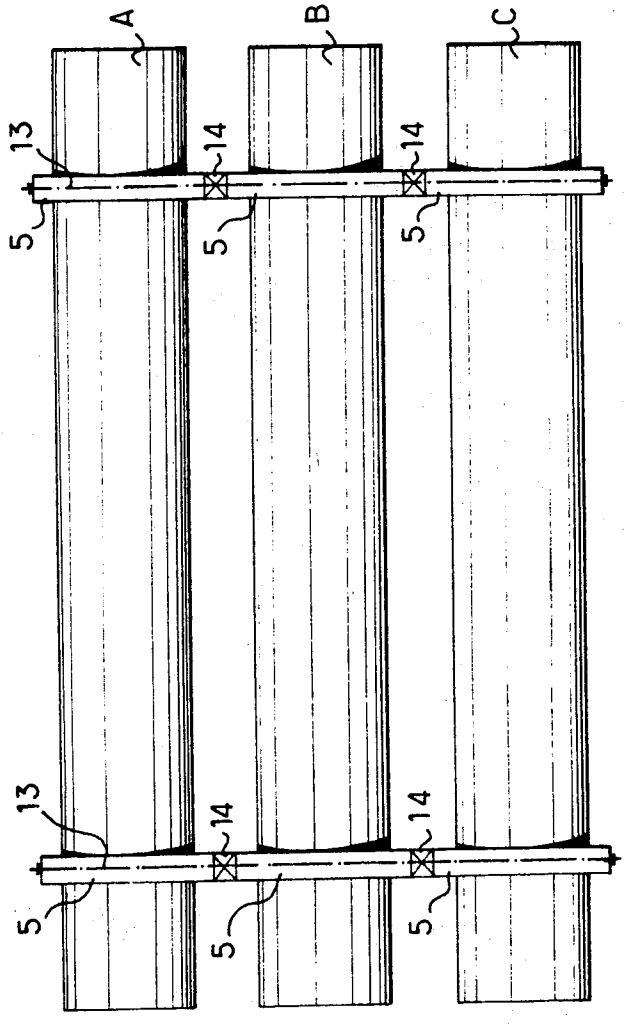


FIG. 6

IMMERSIBLE RESERVOIR

This invention relates to a reservoir made preferably of prestressed concrete, which is adapted to be immersed and which is capable of being assembled together with other similar or identical reservoirs.

It is already known to produce reservoirs of prestressed concrete of large capacity which are in the form of cylinders with horizontal axes which reservoirs rest, for a major part of their length, on a bed or base.

The production and the locating of such reservoirs involve substantial difficulties.

The present invention relates to a reservoir presenting novel features which mitigate or obviate these difficulties.

The present invention has for one of its objects a new industrial product which is constituted by an immersible reservoir of large capacity and preferably in prestressed concrete, having the form of a cylindrical body, the reservoir comprising at least two partitions integral with the cylindrical body and perpendicular to the axis of the latter, the partitions extending to the exterior of the cylinder and each presenting a support foot by which the reservoir rests on a site or emplacement provided to receive it, the partitions, preferably in their lower and upper parts having orifices which permit flow of liquids in the reservoir from one side to the other of the partitions.

In one particular embodiment of the invention, the reservoir also has other intermediate partitions which do not extend to the exterior of the cylindrical body and which are also provided with orifices provided for the passage of liquids.

It can thus be seen that, according to the invention, the cylindrical body constituting the reservoir proper is reinforced or strengthened by a certain number of partitions which act as stiffeners, at least two of these partitions extending to the exterior of the cylinder to constitute support feet which permit the reservoir to rest on a limited number of points.

The preparations of the substructure for supporting the reservoir is thus considerably facilitated due to the fact that the support surfaces or feet do not extend over the major part of the reservoir. In a preferred embodiment of the invention, the partitions which include the support feet, extend to the exterior of the cylindrical body in the form of a square and a rectangle whereof the foot forms one of the sides.

This embodiment has the advantage of permitting a simple assembly of several reservoirs which constitutes another object of the invention.

The present invention also has for its object an assembly of reservoirs as hereinbefore defined in which the partitions extending to the exterior of the cylindrical body have a square or rectangular form, the different reservoirs being connected side-by-side by cables or tie rods extending through holes provided in the partitions and parallel to the feet.

In another embodiment of reservoir assembly, a plurality of reservoirs or rows of reservoirs are connected one above the other by supporting one another on the sides of the partitions extending to the exterior of the cylindrical bodies of the reservoirs which are maintained assembled on each other by cables or tie rods passing through holes provided in the partitions perpendicularly and parallel to the plane of the support feet.

In this embodiment it is not necessary that the reservoirs of the higher rows be provided with feet.

Blocks or other intermediate members can be interposed between the partitions of different reservoirs, which permits an assembly by means of cables or tie rods and which makes it possible then to proceed to another connection obtained, for example, by concreting so as to form, all things considered, a monolithic reservoir assembly.

The reservoirs of the superimposed rows can be located directly one above the other or alternatively they can be stacked in staggered relation by forming pyramid-like structures.

The present invention also has for one of its objects a process for producing and locating assemblies of reservoirs as hereinbefore defined, this process comprising the steps of forming the different reservoirs independently of one another, partially immersing the reservoirs by making them float in calm water with the same degree of immersion, locating the different reservoirs side-by-side by placing the partitions which ensure assembly in correspondence, passing cables or tie rods into holes in those parts of the partitions which are not immersed thus effecting a first interconnection of the different reservoirs locating other cables are placed in position then tensioning them by forming with the aid of shuttering, access shafts to the different points of connection of the partitions, forming a concrete connection between the different partitions leading the assembly of reservoirs thus formed to the location where it is to be immersed and immersing the reservoir assembly by filling so that the support feet come to rest on foundations provided for this purpose.

According to a modification of this process, assemblies of several rows of superimposed reservoirs are formed by immersing to the necessary depth a first row of assembled reservoirs as is described above and by connecting on this first row of reservoirs a second row of reservoirs by cables or tie rods extending through holes formed in the partitions perpendicularly to the support feet.

Embodiments of the present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

FIG. 1 is a fragmentary perspective view of one end of a reservoir according to the invention;

FIG. 2 is a longitudinal sectional view of the reservoir of FIG. 1;

FIG. 3 is a sectional view on the line III—III OF FIG. 2;

FIG. 4 is a schematic sectional view showing as assembly of a row of reservoirs according to the invention;

FIG. 5 is a plan view of FIG. 4;

FIG. 6 is a plan view of three assembled reservoirs; and,

FIGS. 7, 8 and 9 show different reservoir assemblies according to the invention.

There is shown schematically on FIGS. 1 to 3 one end of a reservoir according to the invention.

This reservoir comprises an enclosure or cylindrical body 1 formed of prestressed concrete which constitutes the body proper of the reservoir. There is shown schematically in dot-dash lines, longitudinal cables 2 and circular cables 3 which ensure the strengthening or reinforcement of the reservoir.

The anchoring arrangements of these cables are conventional and have not been described in a detailed manner due to the fact that they do not constitute one of the features of the invention.

The cylindrical reservoir **1** is closed at each of its ends by a wall **4** which is advantageously of prestressed concrete.

In accordance with the invention, the cylindrical body **1** is provided with at least two partitions such as the partition **5** which is shown in FIGS. **1** to **3**. This partition **5**, in reinforcement concrete, has a part **5***a* disposed inside the cylindrical body **1** and a part **5***b* located as an extension of the part **5***a* on the outside of the cylindrical body **1**.

The interior part **5***a* has, in the present case, two orifices **6** and **7** serving for the passage of liquids from one side to the other of the partition **5***a* on the inside of the reservoir.

The external part **5***b* of the partition **5** has an external form essentially square or rectangular, this form extending on all sides around the external surface of the cylindrical body **1**.

As can be seen clearly on the drawing, the lower side of the part **5***b* of the partition is provided with a foot **8** which presents a surface sufficient to permit the reservoir to rest on foundations provided therefor.

As is shown in FIG. **2**, the cylindrical body **1** of the reservoir also includes intermediate partitions **9** which are located only inside the cylindrical body and which are also provided with orifices **6** and **7** for the flow of liquids in the interior of the reservoir. These partitions serve to reinforce the structure of the cylindrical body of the reservoir.

There is also schematically shown an orifice **10** which permits the introduction of liquids to the inside of the reservoir, and an access door **11**.

It can be seen that the reservoir, according to the invention, which has a cylindrical body of very large capacity rests on the ground under water only through the intermediary of two support feet **8** (whereof only one is shown in FIGS. **1** to **3**) which are located in alignment with the partitions occupying the whole cross-section of the cylindrical body of the reservoir and which extend to the exterior of the latter.

As a result, the reservoir according to the invention, constitutes a robust structure which rests on the ground only on two support points which facilitate substantially the formation of foundations and the location of the reservoir.

By way of example, a reservoir, according to the invention, of 10,000m³ has a length of 100 meters and a diameter in the region of 12 meters.

Such reservoirs immersed on a under-sea foundation permit an easy stockpiling of hydrocarbons which, when introduced into the reservoirs, progressively drive out sea water contained in the reservoir.

As can be seen, such a reservoir can be of a relatively light weight construction since the greatest stresses result from its manufacture and its emplacement, the stresses during use being only due to slight differences of pressure.

There is shown in FIGS. **4** to **9** different embodiments of assemblies of reservoirs such as have been described.

FIGS. **4**, **5** and **6** shown how it is possible according to the invention to assemble a horizontal row of reservoirs such as shown in FIGS. **1** to **3**.

For this purpose each reservoir is partially immersed such that its upper half is above the level of the water. The reservoirs which are to be assembled are then led to calm waters by being placed side-by-side as the reservoirs A, B and C illustrate.

In view of this assembly, the partitions **5** are provided with holes **12** disposed parallel to the feet **8** as can be seen on FIGS. **1** to **3**.

Cables or tie rods **13** schematically shown in dot-dash lines on FIGS. **4** to **6** are introduced into the holes **12** located above the water and are tensioned in such a manner as to connect the partitions **5** of the different reservoirs A, B and C together.

Preferably, there is placed between the sides of the different partitions blocks **14** or like members serving to ensure points of support between the different reservoirs.

To finalize the assembly it is then convenient to put in place cables **13** which are located above the water line shown in FIG. **4**.

For this purpose, one can for example, form with the aid of water-tight shuttering shafts **15** from the interior of which the water is eliminated and which permit access along the sides of the partitions **5**. Other cables **13** can also be introduced and put under tension. A concrete connection can also be fOrmed between the different reservoirs thus fastening or covering the heads of the cables.

It can thus be seen that, according to the invention, there is effected an assembly of three cylindrical reservoirs which are rendered integral one with another by joining them together in a continuous manner along the partitions **5** by which means they rest on their face due to the feet **8**.

There is shown schematically in FIG. **7** an assembly of four reservoirs similar to those which have been described.

FIGS. **8** and **9** show a variation of assembly in which two rows of reservoirs are superimposed. In this case it is unnecessary that the reservoirs of the upper rows should have feet **8**, the partitions **5** having the same thickness over all their periphery.

The assembly of the different horizontal rows is effected in a like manner to that which has been described by cables or tie rods which pass into vertical holes in the partitions **5** and which are put under tension. As is shown in FIGS. **8** and **9**, the reservoirs can be directly superimposed or staggered relative to each other.

It will be well understood that the embodiments which have been described are not limitative and that modification can be made without departing from the scope of the accompanying claims.

In particular, it will be clear that the reservoirs, according to the invention, can comprise, if necessary, more than two partitions extending to the exterior of the cylindrical body.

Similarly, the partitions which do not extend to the exterior of the cylindrical body can be of any convenient number; and this number is determined as a function of the mechanical characteristics which one desires to provide in the reservoir.

Further, it will be clear that the different reservoirs can be assembled by the edges of their partitions **5** by means other than the described cables or tie rods.

What is claimed is:

1. A process for producing and locating an assembly of immersible reservoirs formed of prestressed concrete, each of which reservoirs comprises a cylindrical body, at least two partitions integral with said cylindrical body and perpendicular to the axis thereof and projecting beyond the exterior of the cylindrical body, together with support feet for supporting said reservoir on an emplacement, which process comprises the steps of forming a plurality of said reservoirs independently of one another, partially immersing said reservoirs in calm water so that they float at the same level, locating said reservoirs side by side with the partitions therein in alignment, passing tie means into the holes in said partitions to interconnect the different reservoirs, tensioning said tie means, forming a concrete interconnection between the partitions of adjacent reservoirs, floating the resulting assembly of reservoirs to a position above a foundation on which it is to be permanently located, and completing the immersion of said reservoirs by filling them until said support feet come to rest on said foundation.

2. A process according to claim **1**, in which, before tensioning of the cables or tie rods, blocks are located between the partitions of different reservoirs.

3. A process according to claim **2**, in which the different partitions are continuously interconnected by concreting.

4. A process according to claim **1**, in which a plurality of rows of superimposed reservoirs are interconnected.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,708,986 Dated January 9, 1973

Inventor(s) JEAN ROULET and ARMAND CIMADEVILLA

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

[30] Foreign Application Priority Data

August 5, 1969 France 6926827

Signed and sealed this 10th day of July 1973.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

Rene Tegtmeyer
Acting Commissioner of Patents

FORM PO-1050 (10-69)

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