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(54) **PUMP STATION, AND DEVICE TO BE USED IN SAME**

PUMPSTATION UND DARIN ZU VERWENDEnde VORRICHTUNG

STATION DE POMPAGE ET DISPOSITIF CORRESPONDANT

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## Description

**[0001]** The invention concerns a pump station for conveying liquids, e.g. waste water, said station preferably containing several submersible pumps. The invention also concerns a device to be used in a pump station.

### Background

**[0002]** In waste water systems pumping stations convey sewage solids (as slurry or sludge) from one level to another. A pump station is usually provided with one or several inlets for sewage water and an outlet pipe which is connected to the outlets of the pump or pumps arranged in a sump. The sump being the lower part of the pump station, where the liquid and solids accumulate to be conveyed by the pump.

**[0003]** One problem with earlier pumping stations is that they have a tendency to act as settling tanks. With traditional on-off mode of pump operation, there is no flow at all in a pump sump for extended periods of time. Then solids, of density different than water, tend to separate - heavy solids settle on the floor and light ones rise to the surface. During a pumping cycle, some part of the solids may enter the pump stream and are pumped away towards their final destination, such as a treatment plant, whereas some of the solids remain in the sump. The remaining solids tend to accumulate over time. The solids can obstruct normal operation of the pumps and cause environmental hazards. Periodic de-sludging then becomes a necessity, which is a costly and unwanted operational procedure.

**[0004]** The best way to handle the wastewater solids is to ensure their uninterrupted transport through pumping stations, so that they can be properly treated at the treatment plant. This requires that the pumps can handle the solids and that the pump sump and the operating scheme are designed adequately to lead the solids towards the inlets of the pumps.

**[0005]** There are known pump stations (e.g. SE 506889 C2) with several pump units, which are formed to eliminate stagnation zones and to enhance solid movements towards the pump inlets.

**[0006]** One common problem with especially relatively large pump stations is the air entrapment in the waste water. This is a problem arising especially at low water levels in the sump and/or by incoming liquid flow having high kinetic energy; air is mixed up in the water when the incoming flow meets the water surface. The intensity of air entrainment progresses with the height of fall. Low water levels involve an increase of the water velocity in the sump, which leads to that the entrained air cannot escape to the surface and is being transported to the pump inlets.

**[0007]** The air bubbles caused by the plunging inflow affect the pumps negatively. The ingested air and excessive swirl makes the pump vibrate, the pumping capacity decreases, the air bubbles create air cushions and caus-

es imbalance and uneven loads on the pump.

**[0008]** The pumps operate at intervals, and are arranged to automatically start and stop when the accumulated waste water has reached a certain level in the sump.

5 Another problem with pump stations with several pump units is to distribute the water fairly evenly to the pump units. An uneven flow velocity in the sump results in swirl, causing operational problems for the pumps.

**[0009]** Yet, another problem is that the solids (such as sludge), easily collect in calmer areas on the floor of the pump station and around a pump that is not operating. The collections have a tendency to build up and can eventually cause clogging of the pump inlet.

10 **[0010]** The common practice in designing pumping stations is to provide spare pump capacity - so that e.g. two out of three pumps should manage the maximum design flow rate. When one or two pumps operate, the distribution of flow in the sump cannot be uniform. When streams approach a pump inlet from different angles, a swirl can develop.

15 **[0011]** Document DE 197, 54, 272 A discloses a pump station with a pump and a baffle.

### Brief description

25 **[0012]** According to the invention a reduction of the above mentioned problems is obtained by help of the features stated in the claims.

**[0013]** According to one aspect of the invention, the pump station according to claim 1 is provided.

30 **[0014]** According to a further aspect of the invention the invention is characterized by ridges and/or a plane sloping towards the pump inlets.

35 **[0015]** One advantage with the invention is that the first baffle means and the second baffle means cooperates in order to decrease the kinetic energy of the incoming flow, which leads to a reduction of air entrapment and there through better conditions for the pumps.

40 **[0016]** Another advantage is that the flow is evenly distributed towards the pumps enabling an optimal operation of the pumps by way of several passages arranged in the first baffle means upstream the respective pumps.

45 **[0017]** Yet, another advantage is that the water (together with the solids) is transported towards the pump inlets by way of a sloping plane and/or ridges on the floor reducing the risk of solid collections.

**[0018]** A preferred embodiment of the invention is provided with first, second and third baffle means.

50 **[0019]** The invention offers considerable advantages with regard to solid transport as compared to conventional sumps. It allows effective transport of wastewater solids with a minimum of operator's intervention. Another benefit is that the size of construction of the sump according to the invention is smaller than that of a conventional sump of the same capacity.

55 **[0020]** It is an advantage to make the sump volume as small as possible in order to minimize the amount of water that remains in the tank. The bigger amount the bigger

risk for sludge banks being established. A smaller volume also means that the pumps have to operate at shorter intervals and thus the water residence time in the sump shortens. This is also an advantage as to the risks for clogging.

**[0021]** To prevent stagnant zones, flat areas of the sump floor are preferably limited to the nearest vicinity of the pump inlets. Other areas in front and behind the pumps may slope at preferably 45 degrees to the horizontal. As a result, this sump has a smaller footprint, a smaller volume, and a shorter distance between the pumps and the inlet pipe than a conventional sump of the same capacity. Consequently, stagnant zones are minimized in the sump and the operating conditions are more turbulent than in larger traditional sumps, which enhances the transport of solids.

**[0022]** These and other aspects of, and advantages with the present invention will be apparent from the detailed description and the accompanying drawings.

#### Short description of drawings

**[0023]** In the detailed description of the present invention reference will be made to the accompanying drawings, wherein,

- Fig 1 shows a perspective view of a lower part of a pump station according to the invention with two walls removed and an indicated water surface,  
 Fig 2 shows a plan view of the pump station in Fig 1,  
 Fig 3 shows a cross-section along line A-A in Fig 2,  
 Fig 4 shows a cross-section along line B-B in Fig 2.

#### Detailed description of the embodiments of the invention

**[0024]** Fig. 1 shows a lower part of a liquid pump station according to the invention, with an enclosing wall 11 and a floor 12. Thus, the floor 12 forming the bottom of the sump. The pump station comprises a liquid inlet 13 and a liquid outlet 14, and at least one submersible pump unit 20 arranged to the outlet 14.

**[0025]** First baffle means 30 is arranged downstream from the at least one inlet 13, capable of decreasing the energy of the incoming liquid. In this aspect a baffle is interpreted as a device such as a plate, wall, or screen to deflect, turn aside or regulate flow. The baffle means 30 stems the incoming flow and the kinetic energy is decreased.

**[0026]** Said first baffle means 30 may be arranged essentially transversally to the flow direction of the incoming liquid, and is further be provided with at least several passages 31.

**[0027]** The size and placement of the passage 31 is adapted to minimize swirling flow at pump inlets 21. Preferably, a passage 31 placed in front of the incoming flow is divided (Fig. 2) to split up the incoming flow. A division can also be made for structural reasons.

**[0028]** The passages 31 are arranged along the exten-

sion of the first baffle means 30, in the vicinity of and upstream the respective pump and being capable of directing the flow to the respective pump, thereby dividing the incoming flow into several smaller flows and directing them to the respective pumps. The passages 31 are preferably rectangular, but may have any other suitable form, e.g. triangular.

**[0029]** Further, the pump station comprises second baffle means 40 arranged essentially transversally to the first baffle means 30 cooperating with said first baffle means 30, and capable of further decreasing the energy of the incoming liquid.

**[0030]** Several second baffle means 40 may be arranged, for forming a dampening labyrinth for the liquid together with the first baffle means 30.

**[0031]** If several passages 31 and second baffle means 40 are arranged, one passage 31 is preferably arranged in the vicinity of where the incoming flow hits the first baffle means 30. The heaviest waste material would otherwise tend to stay in the space shut in by the first baffle means 30 and the second baffle means 40.

**[0032]** Third baffle means 50 may be arranged downstream the first baffle means 30, and arranged essentially parallel to the first baffle means 30. The third baffle means 50 further decreases the energy by obstructing the flow, and helps bring any possible remaining air bubbles to the surface of liquid.

**[0033]** At least one of the baffle means 30, 40, 50 is arranged on a plane 15 sloping towards the pump inlets 21. As shown in Fig. 3, the sloping plane 15 may form part of the wall 11 and/or floor 12. To prevent stagnant zones, flat areas of the sump are preferably limited to the nearest vicinity of the pump inlets 21. Other areas in front and behind the pumps 20 may slope at preferably 45 degrees to the horizontal (Fig. 3).

**[0034]** The baffle means 30, 40, 50 may be arranged to the wall 11.

**[0035]** To prevent any occurrence of excessive swirl, special floor features may be adopted such as ridges. Ridges 60 may be arranged on the floor 12, sloping towards the pump inlets 21. The sloping plane 15 and the ridges 60 help the solids to slide downwards to the floor where the pumps have their inlets 21.

**[0036]** The ridges 60, preferably being prismatic or any other suitable shape, divide the sump floor 12 into sections, one section per pump, Figure 2. Thus, the purpose of these ridges 60 is twofold; firstly to reduce negative effects of any cross flow that may occur in the sump 10, and secondly to direct settling solids into the vicinity of the pump inlets 21.

**[0037]** Additional arrangements, such as splitters, may be arranged in the vicinity of the pump inlets 21 to further reduce any tendencies of swirl at the pump inlet, and also effectively eliminate any floor vortices that tend to form there.

**[0038]** With reference to the embodiment in Fig. 3, the function of the invention will now be described. A liquid such as waste water enters the pump station through

inlet 13 arranged above the pump inlet 21. The first baffle means 30 dampens the kinetic energy of the incoming flow of water by stemming the water. The first baffle means 30 with its passages 31 splits the incoming flow into several streams towards the respective pumps 20: one passes straight on through the central passage 31, preferably being divided, and the others are being deflected to the sides. The side streams pass through labyrinths provided by the first baffle means 30 and second baffle means 40 before reaching the side passages 31 in the first baffle means 30.

**[0039]** The water continues down the sloping plane 15 reaching the third baffle means 50 that further dissipates the energy and helps bring possible remaining air bubbles up to the surface. When the water reaches bottom of the sump, the ridges 60 direct the water with the solids towards the pump inlets 21 and also reduces swirl. The pumps 20 convey the waste water with its solids further on to e.g. a treatment plant. In this manner, the invention prevents solids from staying in the pump station.

**[0040]** It has shown in tests with a pump station according to the invention equipped with three pumps, that practically no solids deposit on the floor when all three pumps operated, neither together nor individually in alternate cycles.

**[0041]** The present invention is preferably useful for large pumping stations, (> 300 l/s per pump), but can naturally be used for smaller stations with a successful result. The embodiment shown in the drawings is by example a rectangular sump with three submersible pumps. It should be noted that other geometrical designs are possible, and that other numbers of pumps may be used.

**[0042]** The invention may be used in other areas where reduction of energy, reduction of air entrapment and transportation of solids is desired. The invention may also be used for other liquids than waste water, even for liquids without solids.

**[0043]** The invention may be made of any suitable material such as concrete, metal, fibre glass or wood for example. The invention may also be arranged as a device adapted for installation in existing pump stations.

**[0044]** The embodiments shown in the drawings and put forward in the description should not be considered restricting, only as exemplifying.

## Claims

1. A liquid pump station with an enclosing wall (11) and a floor (12), the pump station comprises
  - at least one liquid inlet (13) for incoming liquid flow into the pump station and at least one liquid outlet (14) for outgoing liquid flow from the pump station,
  - at least one submersible pump unit (20) arranged to the liquid outlet (14),
  - first baffle means (30) arranged downstream

from the at least one liquid inlet (13), arranged essentially transversally to the flow direction of the incoming liquid and capable of decreasing the energy of the incoming liquid,

**characterized in that** said first baffle means (30) is provided with several passages (31), and **in that** at least one second baffle means (40) arranged essentially transversally to the first baffle means (30) cooperate with said first baffle means (30) and is capable of further decreasing the energy of the incoming liquid.

2. Pump station according to claim 1, **characterized in that** said passages (31) are arranged along the extension of the first baffle means (30) in the vicinity of and upstream the respective pumps and being capable of directing the flow to the respective pumps.

3. Pump station according to claim 1, **characterized in** at least two second baffle means (40) arranged for forming a dampening labyrinth for the liquid together with the first baffle means 30.

4. Pump station according to any of the preceding claims, **characterized in** at least one third baffle means (50) arranged downstream the first baffle means (30), and arranged essentially parallel to the first baffle means (30).

5. Pump station according to any of the preceding claims, **characterized in** at least one of the baffle means (30, 40, 50) is arranged on a plane (15) sloping towards the pump inlets (21).

6. Pump station according to any of the preceding claims, **characterized in** at least one ridge (60) arranged on the floor (12), sloping towards the pump inlets (21).

7. Device to be used in a pump station, comprising first baffle means (30) arranged in use downstream from the at least one inlet (13) of the pump station, arranged essentially transversally to the flow direction of the incoming liquid and capable of decreasing the energy of the incoming liquid,

**characterized in that** said first baffle means (30) is provided with several passages (31), and **in that** at least one second baffle means (40) arranged essentially transversally to the first baffle means (30) cooperate with said first baffle means (30) and is capable of further decreasing the energy of the incoming liquid.

8. Device according to claim 7, **characterized in that** it at least one third baffle means (50) arranged downstream the first baffle means (30), and arranged essentially parallel to the first baffle means (30).

9. Device according to any of the claims 7-8, **characterized in that** it further comprises at least one plane (15) sloping towards the pump inlets (21), and onto which plane (15) at least one of the baffle means (30, 40, 50) is arranged.

### Patentansprüche

1. Flüssigkeitspumpstation mit einer Einfassungswand (11) und einem Boden (12), welche Pumpstation enthält

- mindestens einen Flüssigkeitseinlass (13) für einen zufließenden Flüssigkeitsstrom in die Pumpstation und mindestens einen Flüssigkeitsauslass (14) für einen abfließenden Flüssigkeitsstrom von der Pumpstation,
- mindestens eine Tauchpumpeneinheit (20), die an dem Flüssigkeitsauslass (14) angeordnet ist,
- eine erste Ablenkplatteneinrichtung (30), die stromabwärts des mindestens einen Flüssigkeitseinlasses (13) angeordnet ist, im Wesentlichen quer zu der Fließrichtung der zufließenden Flüssigkeit angeordnet ist und in der Lage ist, die Energie der zufließenden Flüssigkeit zu verringern,

**dadurch gekennzeichnet, dass** die erste Ablenkplatteneinrichtung (30) mit mehreren Durchlässen (31) versehen ist, und dadurch, dass mindestens eine zweite Ablenkplatteneinrichtung (40), die im Wesentlichen quer zu der ersten Ablenkplatteneinrichtung (30) angeordnet ist, mit der ersten Ablenkplatteneinrichtung (30) zusammenwirkt und in der Lage ist, die Energie der zufließenden Flüssigkeit weiter zu verringern.

2. Pumpstation nach Anspruch 1, **dadurch gekennzeichnet, dass** die Durchlässe (31) entlang der Ausdehnung der ersten Ablenkplatteneinrichtung (30) in der Nähe von und stromaufwärts der jeweiligen Pumpen angeordnet sind und in der Lage sind, den Strom zu den jeweiligen Pumpen zu leiten.

3. Pumpstation nach Anspruch 1, **gekennzeichnet durch** mindestens zwei zweite Ablenkplatteneinrichtungen (40), die dafür angeordnet sind, zusammen mit der ersten Ablenkplatteneinrichtung (30) ein Dämpfungslabyrinth für die Flüssigkeit zu bilden.

4. Pumpstation nach einem der vorhergehenden Ansprüche, **gekennzeichnet durch** mindestens eine dritte Ablenkplatteneinrichtung (50), die stromabwärts der ersten Ablenkplatteneinrichtung (30) angeordnet ist und im Wesentlichen parallel zu der ersten Ablenkplatteneinrichtung (30) angeordnet ist.

5. Pumpstation nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** mindestens eine der Ablenkplatteneinrichtungen (30, 40, 50) auf einer zu den Pumpeneinlässen (21) hin abfallenden Ebene (15) angeordnet ist.

6. Pumpstation nach einem der vorhergehenden Ansprüche, **gekennzeichnet durch** mindestens einen auf dem Boden (12) angeordneten, zu den Pumpeneinlässen (21) hin abfallenden Grat (60).

7. In einer Pumpstation zu verwendende Vorrichtung, enthaltend eine erste Ablenkplatteneinrichtung (30), die im Betrieb stromabwärts des mindestens einen Einlasses (13) der Pumpstation angeordnet ist, im Wesentlichen quer zu der Fließrichtung der zufließenden Flüssigkeit angeordnet und in der Lage ist, die Energie der zufließenden Flüssigkeit zu verringern, **dadurch gekennzeichnet, dass** die erste Ablenkplatteneinrichtung (30) mit mehreren Durchlässen (31) versehen ist, und dadurch, dass mindestens eine zweite Ablenkplatteneinrichtung (40), die im Wesentlichen quer zu der ersten Ablenkplatteneinrichtung (30) angeordnet ist, mit der ersten Ablenkplatteneinrichtung (30) zusammenwirkt und in der Lage ist, die Energie der zufließenden Flüssigkeit weiter zu verringern.

8. Vorrichtung nach Anspruch 7, **dadurch gekennzeichnet, dass** sie mindestens eine dritte Ablenkplatteneinrichtung (50), die stromabwärts der ersten Ablenkplatteneinrichtung (30) angeordnet ist und im Wesentlichen parallel zu der ersten Ablenkplatteneinrichtung (30) angeordnet ist.

9. Vorrichtung nach einem der Ansprüche 7 bis 8, **dadurch gekennzeichnet, dass** sie ferner mindestens eine zu den Pumpeneinlässen (21) hin abfallende Ebene aufweist, auf welcher Ebene (15) mindestens eine der Ablenkplatteneinrichtungen (30, 40, 50) angeordnet ist.

### Revendications

1. Station de pompage de liquide avec une paroi (11) qui l'enserme et un plancher (12), la station de pompage comprenant :

- au moins une entrée de liquide (13) pour l'écoulement du liquide entrant dans la station de pompage et au moins une sortie de liquide (14) pour l'écoulement du liquide sortant de la station de pompage,
- au moins une unité de pompage submersible (20) aménagée à la sortie de liquide (14),
- un premier moyen déflecteur (30) aménagé en

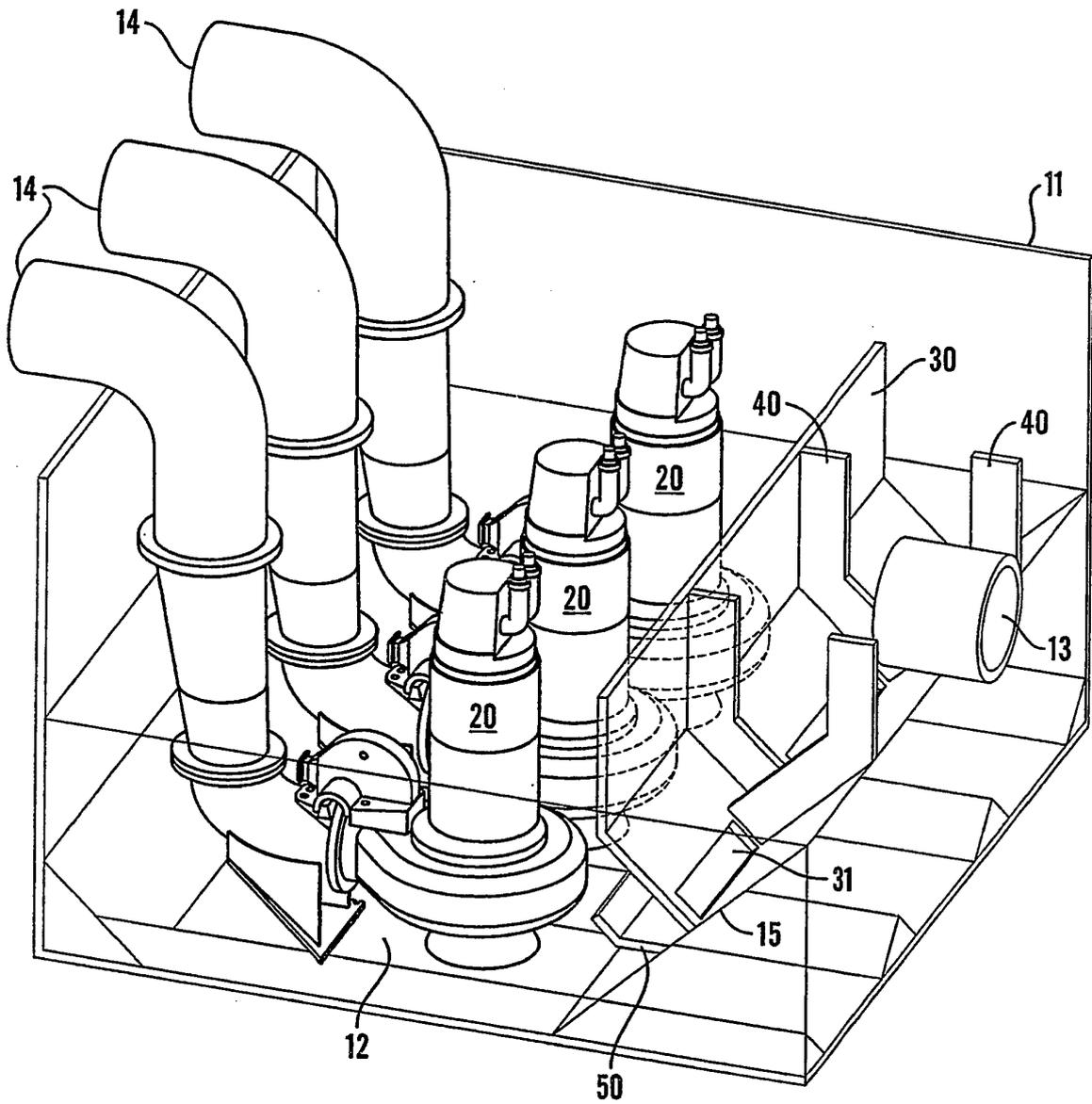
aval de la au moins une entrée de liquide (13), disposé sensiblement transversalement à la direction d'écoulement du liquide entrant et capable de réduire l'énergie du liquide entrant,

**caractérisée en ce que** ledit premier moyen déflecteur (30) est pourvu de plusieurs passages (31) et **en ce qu'**au moins un deuxième moyen déflecteur (40) aménagé sensiblement transversalement au premier moyen déflecteur (30) coopère avec ledit premier moyen déflecteur (30) et est à même d'encore réduire l'énergie du liquide entrant.

2. Station de pompage selon la revendication 1, **caractérisée en ce que** lesdits passages (31) sont aménagés le long de l'extension du premier moyen déflecteur (30) au voisinage et en amont des pompes respectives et sont à même de diriger l'écoulement vers les pompes respectives. 15
3. Station de pompage selon la revendication 1, **caractérisée en ce qu'**au moins deux deuxièmes moyens déflecteurs (40) sont aménagés pour former un labyrinthe d'amortissement pour le liquide conjointement avec le premier déflecteur (30). 25
4. Station de pompage selon l'une quelconque des revendications précédentes, **caractérisée en ce qu'**au moins un troisième moyen déflecteur (50) est aménagé en aval du premier moyen déflecteur (30) et disposé sensiblement parallèlement au premier moyen déflecteur (30). 30
5. Station de pompage selon l'une quelconque des revendications précédentes, **caractérisée en ce qu'**au moins l'un des moyens déflecteurs (30, 40, 50) est aménagé sur un plan (15) s'inclinant vers les entrées de pompe (21). 35
6. Station de pompage selon l'une quelconque des revendications précédentes, **caractérisée par** au moins une nervure (60) aménagée sur le plancher (12) et s'inclinant vers les entrées de pompe (21). 40
7. Dispositif à utiliser dans une station de pompage, comprenant un premier moyen déflecteur (30) aménagé en service en aval de la au moins une entrée (13) de la station de pompage, aménagé sensiblement transversalement à la direction d'écoulement du liquide entrant et capable de réduire l'énergie du liquide entrant, 45  
**caractérisé en ce que** ledit premier moyen déflecteur (30) est pourvu de plusieurs passages (31) et **en ce qu'**au moins un deuxième moyen déflecteur (40) aménagé essentiellement transversalement avec le premier moyen déflecteur (30) coopère avec ledit premier moyen déflecteur (30) et est à même d'encore réduire l'énergie du liquide entrant. 55

8. Dispositif selon la revendication 7, **caractérisé en ce qu'**au moins un troisième moyen déflecteur (50) est aménagé en aval du premier moyen déflecteur (30) et disposé sensiblement parallèlement au premier moyen déflecteur (30). 5

9. Dispositif selon l'une quelconque des revendications 7 et 8, **caractérisé en ce qu'**il comprend en outre au moins un plan (15) s'inclinant vers les entrées de pompe (21) et sur lequel plan (15) au moins l'un des moyens déflecteurs (30, 40, 50) est aménagé. 10



**Fig. 1**

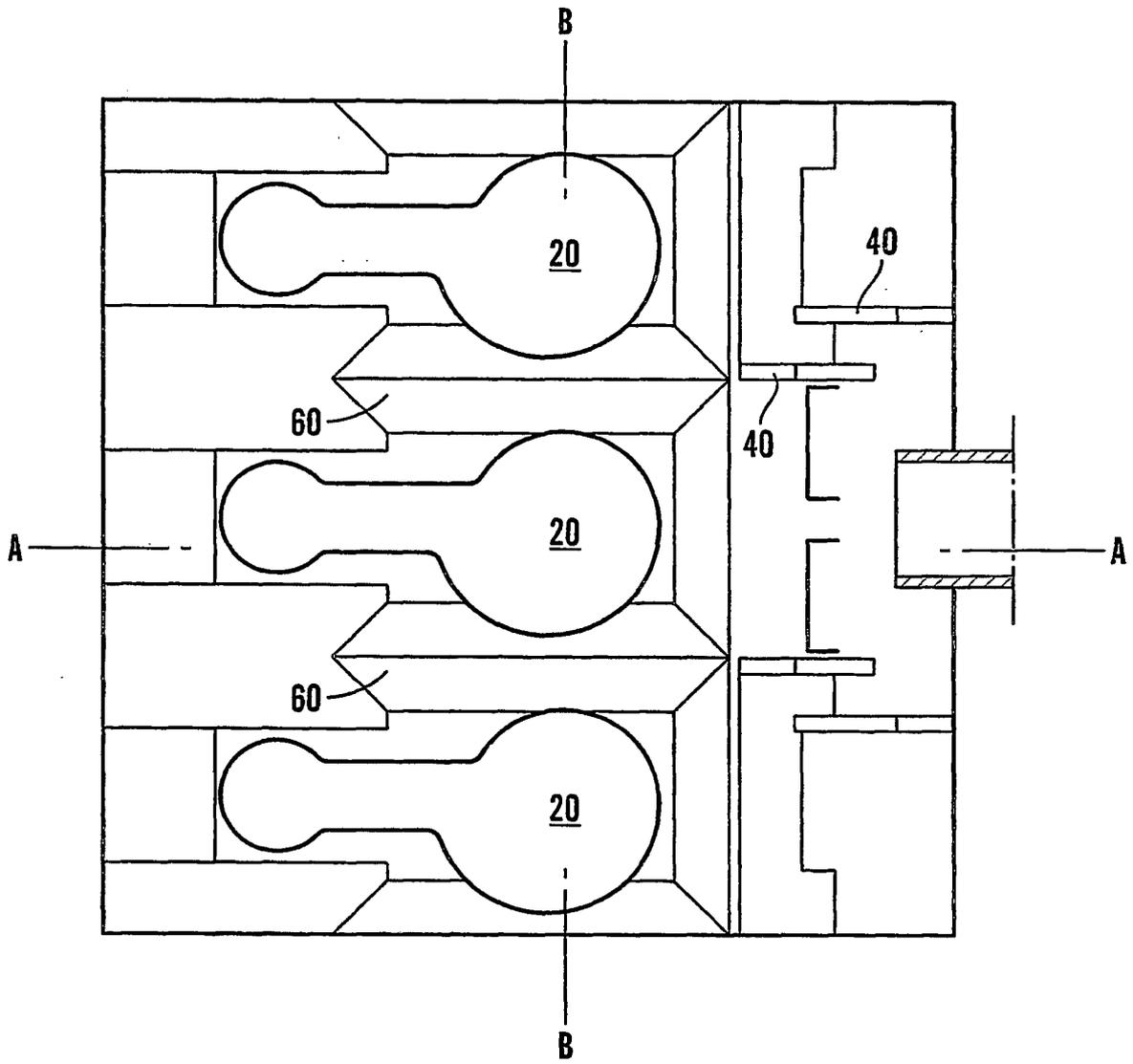


Fig.2

Fig.3 A-A

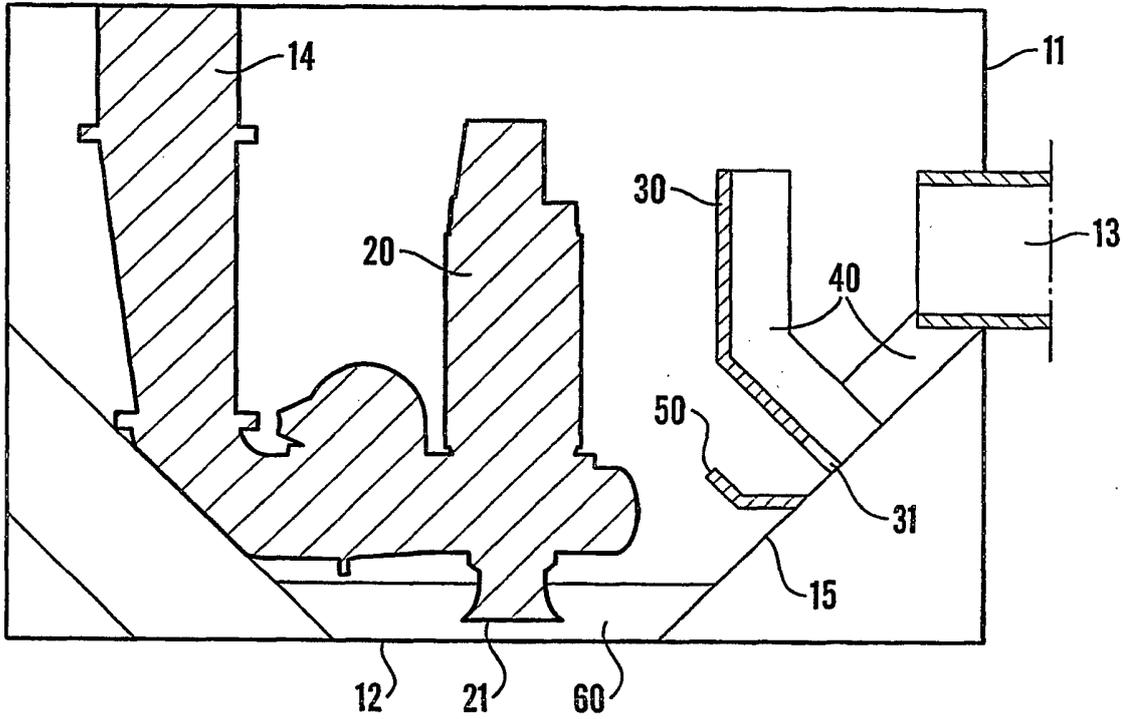
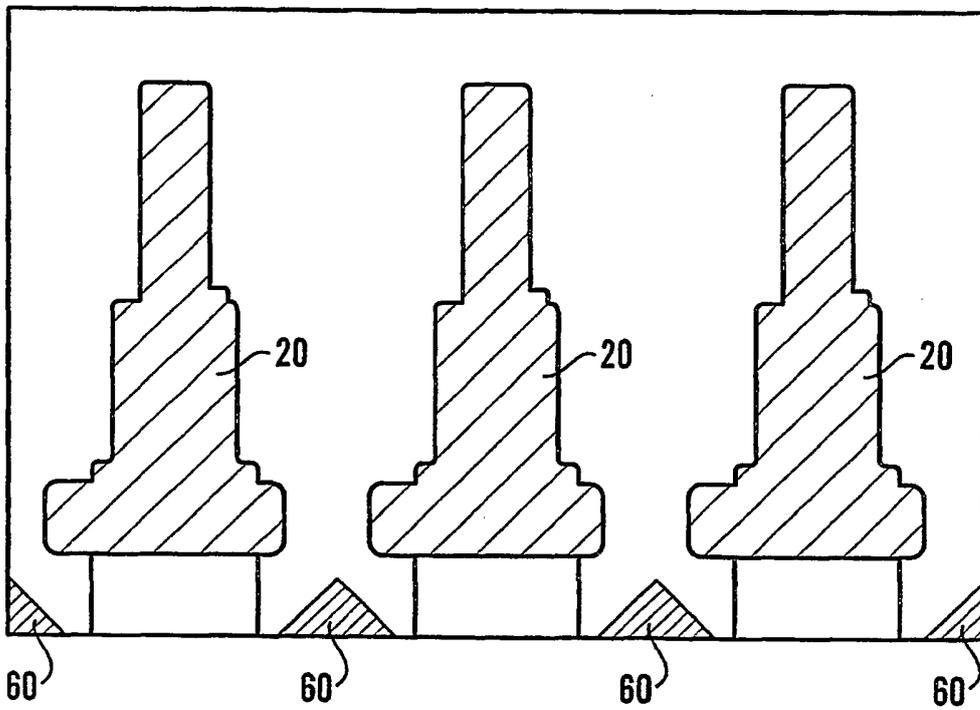


Fig.4 B-B



**REFERENCES CITED IN THE DESCRIPTION**

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