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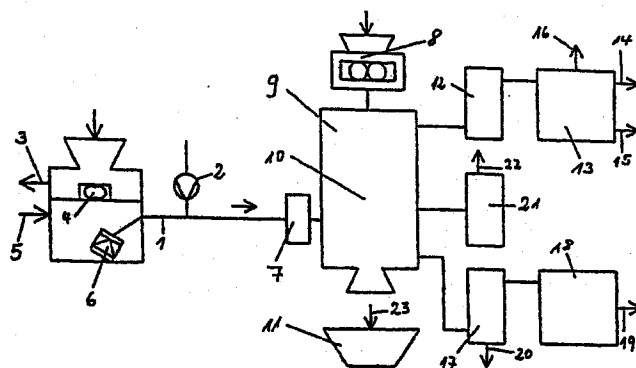
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54 Titre : System for collecting, transporting and recycling domestic sewage, biowastes, black waters and other biodegradable substances.

57 Abrégé : The invention relates to a system for collecting, transporting and recycling domestic sewage, biowastes, black waters and other organic substances, comprising a receiving station (4), a pipeline system (1) connected to different buildings and at least one recycling device with a closed pressurised or vacuum conduit system (1) to which the domestic sewage biowastes, black waters and other substances are jointly fed in a liquid and are subjected to at least one separation process, wherein the constituents are separated into solids and liquids, wherein the liquid substrate is fed to a first reactor (9) and the solid constituents are fed to a second reactor (10)



SYSTEM FOR COLLECTING, TRANSPORTING AND RECYCLING  
DOMESTIC SEWAGE, BIOWASTES, BLACK WATERS AND OTHER  
BIODEGRADABLE SUBSTANCES

The following invention deals with a claim for a system to collect, transport and utilize household wastewater, organic waste, fecal matter and other biodegradable substances, especially involving a network of pipes to transport the above named waste products.

5 Household wastewater is known to be removed through various systems that are different in both dimension and procedure. At present, the smallest processing method involves a three-chamber system where the wastewater is trapped, the solid components are removed, the liquid flows into the third chamber and everything is removed to different places. The disadvantages of this system are the hard usage of the ground water and the expensive cost of removing the solids.

10 Another waste disposal system uses a sloped sewer canal system to purification. The disadvantages of this system are the slow flow speed, and because of this, the fact is that the subsequent deposit of the waste in existing older sewer systems often causes defects, so while underway to the sewage plant considerable wastewater is lost, which again damages the ground water. There usually must also be hydraulic installations further along the way to the  
15 sewage plant, because a continual slope isn't normally available.

The removal of waste through small dimension pressure is another practiced waste disposal method. This method of disposal is for the most part acceptable, however it is unprofitable, as the pressurized removal of the waste has to cover several kilometres. This invention of an  
20 Alternative System supports the use of pressurized removal through a decentralization of the utilization equipment.

All of these known systems take the wastewater the entire way to the sewage plant. These sewage plants are normally open containers with mixing mechanisms and spoil the environment through the release of smells. In addition, the enclosures are very costly. The benefit of this invented Alternative System is completely avoid the use of sewage plants.

Users normally dispose of biological waste in "green" or "brown" bins which is then transported by garbage trucks to depos, incinerators, composting centers or biogascenters. The disadvantages of this approach is that the long time periods between collection causes smells and attracts vermin, which especially in summer annoys the surrounding population. Furthermore, high costs are associated with the collection process. Also disadvantageous is the disposal of biological waste doesn't follow the current waste-management policy of "reduce - reuse - recycle". The possible reuse in composting centers is, because of the requirement of regularly turning over the decomposing material, not practical because of the high costs. A disadvantage of the classic composting method is that large quantities of reusable energy are wasted and therefore only part of the waste is utilized. Which means, that "only composting" in the previously mentioned waste-management policy is not as well placed as the invented Alternative System.

The invented Alternative System relies upon the broad application of fully-automated handling and utilization of the biological waste in an emission-free, closed system together with household wastewater. In this invented Alternative System, coarse cuttings and branches, collected and supplied from consumers, are shredded to a defined grain size and then completely utilized by the equipment.

The handling of food remains by the previously described disposal or utilization systems is a large problem. The disposal of food remains in "green" or "brown" bins is often not allowed. The only known and reliable solution would be the disposal by the combustion with animal remains. The invented Alternative System in contrast can easily collect, transport and utilize both raw and cooked food remains along with the household wastewater and biological waste.

Therefore the main purpose of the stated invention is the establishment of a device and a process which is capable of almost completely recovering the available energy of biodegradable waste matter and also reducing the costs of such processing.

This approach with the identified distinguishing feature is the key claim. Further essential features are covered in related claims.

With the invented Alternative System, household wastewater containing fecal matter, together with biodegradable waste and food remains, will be transported to nearby collectors, where it will be automatically processed into a paste with defined grain size and then transported through small diameter pressure pipes directly to the next utilization plant. In this approach the liquid part of the household waste plays the role of a transport medium for problematic

solid biological material. Problematic material will be separated out at the collection stations. This will be removed at regular intervals and sent to the residual waste-processing centers.

5 The prepared waste mixture will be sent through the pressurized pipe system to the utilization equipment. In order to increase the flow speed and to avoid anaerobic decomposition in the pipe system, at regular intervals it will be cleaned out with pressurized air.

10 In the utilization equipment, the waste mixture flows through a hygienic cascade and then to a buffer vessel, preferably equipped with mixing mechanisms. The shredded material from the collection of cuttings is introduced at a defined dosage rate into the buffer vessel and improves the structure of the waste mixture by further processing of problematic fresh waste.

15 In the buffer vessel aerobic fermentation takes place due to the inventive injection of oxygen. In this case the solids in the mixture can be pressed out, isolated as fresh compost and utilized. The heavily biologically loaded waste fluid, or in the case of a single-step of the mixture, is taken from the collection container and passed through several anaerobic reactors, where with bacterial fermentation, methane production takes place.

20 The invented Alternative System uses the methane off-gas in gas turbines coupled to generators to produce electricity that can then be put into the electrical grid.

Through thermal energy connections, heat generated by the process will be supplied to nearby consumers.

25 In the anaerobic reactors, remaining solid material will be pressed out and utilized as fresh compost in conventional compost centers.

30 The water that remains after pressing the solids, that is no longer loaded with biological material will be prepared and sent to a storage container. From there the water will be supplied at a charge, for use in toilets, car washes, market gardens, water-intensive industries, etc.

35 Any gas possibly generated by the anaerobic part of the process will be cleaned according to government standards using specialized stripping units, activated carbon filters and released into the atmosphere.

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In the following sections, with the help of detailed drawings the components of the invention will be clarified.

Figure 1 a process flowchart of a part of the invented equipment;

5 Figure 2 a schematic flowchart of the invented system;

Figure 3 a process flowchart of the supply system;

Figure 4 a process flowchart of the rotating screen;

Figure 5 a process flowchart of the flotation system;

Figure 6 a process flowchart of the heavy-duty anaerobic system;

10 Figure 7 a process flowchart of the anaerobic fermentation system;

Figure 8 a process flowchart of the sedimentation system;

Figure 9 another process flowchart a flotation system;

Figure 10 a process flowchart of the pond purification system;

Figure 11 a process flowchart of the invented system.

15

The Alternative System built on the concept of removing kitchen waste and food remains with the household wastewater at the source through a closed pressure piping system.

20 A garbage disposer is installed above or below the kitchen sinks, which will with water, bring together and shred the kitchen waste and food remains and send the mixture to household wastewater system.

The wastewater mixture, made of wastewater, fecal matter, kitchen waste and food remains, is shredded more finely by vane pumps and pumpshafts and from there is sent through a closed  
25 pressure pipe system to one of each specialized wastewater treatment processes.

The preparation system of the Alternative System is primarily composed of:

- 30 - a methane generation plant, in which the wastewater mixture is fermented to produce a biogas mixture, generating electricity and secondary heating or cooling;
  - additionally various clarification stages in which the wastewater is processed to useable water quality; and
  - a composting system in which the remaining biological waste is composted.
- 35 The problematic matter separated out in the separation plant could be removed through thermal processing or statutory disposal.

The effective capacity of the Alternative System to cope with harmful materials is expected to be of the order of 30 000 resident equivalences by 60g BSB5 from household, business or industrial sources.

- 5 The preparation system can be designed to cope with the special requirements of industries and commercial units.

Especially in large tourists areas in southern countries the wastewater and garbage is disposed of in a unregulated manner.

10

Through often flawed modern sewer systems and unsatisfactory disposal in the sea or soakaways, the natural resources (countryside, wilderness, drinking water) are permanently spoiled.

- 15 The Alternative System brings together the most up-to-date technologies for independent, regulated disposal and utilization of biological and household wastewater.

It finds use in areas and regions that are not connected or cannot be connected to a regional disposal system.

20

With the installation of the Alternative System a drinking water system can simultaneously be installed parallel to the pressure piping system, thus saving money.

- 25 Through the removal of waste water fecal matter, kitchen waste and food remains in a complete closed pressure piping system at the point of generation is the loading of hygienically suspect and strong smelling problematic waste in the household garbage and/or Recycling containers no longer required.

- 30 Through the possibility of the removal of larger pieces of meat, fish and food remains in the pressure piping system, the alternative system is a cost effective utilization of this waste through a reduction of the biologic waste in the rubbish bins. The garbage cans no longer produce an unpleasant smell and therefore the collection times can be more widely spread out.

- 35 Rubbish transport and Personnel cost can be reduced by the transport of the fined shredded waste mixture with the household wastewater.

A time-consuming separation system in the Alternative System because of the broader material input.

5 The processing time in the utilization plant can be reduced because of the early preparation of the waste mixture and the its hydrolysis aerobic fermentation in pressure piping system.

Through cost-saving combination of clarification and methane generating components with lower overheads, an optimal energy can be found.

10 The biogas mixture can be used in many ways, for example, methanol generation, power generation and heating and/or cooling processes.

Because of controlled waste product addition, the compost produced can be used in agriculture.

15 Because of the conversion of wastewater into useable water that can be used in car washes, plant and lawn irrigation systems and toilets, water can be saved.

20 Because of the excavation involved with the installation of the pressure piping system, it is possible to in parallel, cheaply install a drinking water network or lay another network such electricity, gas or communication.

Because of the small diameter of the pressure piping system, it is possible to install the system in pre-existing piping systems such as sewer systems requiring renovation.

25 The capital costs of the AS are in comparison with a traditional sewer system and clarification plant, depending on circumstances, are 30 to 50% less.

## 30 2.1 Supply system

The diced food remains and wastewater from each house, hotel and restaurant will be sent to a local pumping station. These pumps are fitted with a device to further reduce the particle size and homogenize the waste.

## 35 *Figure 3*

Each small local pump station passes the water to a main pump station.

From here, the water will be hermetically sealed with pressurized air and sent for processing.

5 The pipes of the wastewater network can also be installed in an existing old sewage system because of their much smaller cross-sectional area.

Another advantage is the aerobic processing which avoids acidification.

### 10 2.3.1 Rotating sieve

Larger particles in the wastewater will be separated using a rotation sieve (screen gap 1mm).

*Figure 4*

15 The filtrate from the sieve is sent to the second pre-processing stage.

The filter cake is removed using metallic cleaners and is then sent to a dicer.

20 The filter cake will be homogenized with cuttings from vegetation and then sent to anaerobic fermentation stage.

### 2.3.2 Flotation

25 In the flotation stage, a large part of the particulate component of the wastewater will be removed.

The remaining organic material is in solution or in biodegradable micro particles.

*Figure 5*

30

Through this process we have the basis for a biological disposal.

Floating components and sediment are converted into a homogenous organic phase in the Gerator and then reduced in a simple mixer before being sent to the anaerobic fermentation.

35

|   |           |                               |                   |
|---|-----------|-------------------------------|-------------------|
| 5 | Parameter | Volume flow in outlet         | m <sup>3</sup> /h |
|   |           | Volume flow in float and s.   | m <sup>3</sup> /h |
|   |           | BSB5 in outlet                | mg/l              |
|   |           | BSB5 in float and s.          | mg/l              |
|   |           | TS - Quantity in outlet       | mg/l              |
|   |           | TS - Quantity in float and s. | mg/l              |

Here will be decided the layout of the anaerobic processing stages.

- 10 For a requirement for the heavy-duty anaerobic biology, is a high quantity of dissolved BSB5.

#### 2.4.1 Anaerobic Heavy-Duty Biology

- 15 The particle-free clarified outflow from the flotations unit is sent to the anaerobic heavy-duty biology unit.

Because of its construction and the point that the organic substances are mainly in the solution, this process requires a very small residence time in comparison to other anaerobic processes.

20

Because of this, the entire water quantity can be passed through the anaerobic unit.

#### Figure 6

- 25 The energy created in this process (Methane) relieves the following aerobic stage.

|    |            |                 |                   |
|----|------------|-----------------|-------------------|
| 30 | Parameters | Volume flow     | m <sup>3</sup> /h |
|    |            | BSB5 (complete) | mg/l              |
|    |            | TS - Quantity   | mg/l              |
|    |            | Residence time  | h                 |
|    |            | Gas generation  | m <sup>3</sup> /d |

#### 2.4.2 Anaerobic fermentation

- 35 The anaerobic fermentation stage receives all of the problematic organic solids from the system:

- homogenized filter cake from the rotating sieve
- cuttings from pool-/reed-clarification systems
- cuttings from areas and parks
- floating particles and sediment from the flotation system
- 5      - overflow sludge from the activated aerobic sludge

*Figure 7*

10      The sludge is thickened either through floatation or sieve-belt filtration or almost dry cutting material.

Because of the separation from the main liquid flow, a much smaller volume needs to be processed and the costs are corresponding lower. A much higher TS-value is also possible.

|    |           |                     |      |
|----|-----------|---------------------|------|
| 15 | Parameter | Volume flow (total) | m3/h |
|    |           | BSB5 (total)        | mg/l |
|    |           | TS value            | mg/l |
|    |           | Residence time      | h    |
|    |           | Gas generation      | m3/d |

20

## 2.5      Aerobic biology

25      The loading of the aerobic biology system is very low due to the organic components of the water and also the elimination particulate materials through pre-clarification and the combination of the rotating sieve and the floatation unit.

The residence time and with it the volume of active sludge and also the oxygen requirements which must added through nozzles is reduced as are the corresponding capital cost.

30      This effects also the quantity of the overflow sludge.

|    |           |                    |      |
|----|-----------|--------------------|------|
|    | Parameter | Volume flow        | m3/h |
|    |           | BSB5 (total)       | mg/l |
|    |           | TS value (outflow) | mg/l |
| 35 |           | TS value (biology) | mg/l |
|    |           | Residence time     | h    |
|    |           | Basin volume       | m3   |

## 2.6 Further clarification

For the clarification after aerobic biology stage, 2 processes are used:

- Sedimentation
- Flotation

Through both these processes, the activated sludge is separated out and split into recycled sludge (back to the aerobic biology stage) and overflow sludge.

The overflow sludge after thickening is sent to the aerobic fermentation stage.

### 2.6.1 Sedimentation

Sedimentation takes place normally in round or rectangular settlement basins with bottom- and floating sludge removal or with emscher respectively Dortmundbrunnen with sludge removal via a steep conical base.

Individual diagonal plate clarifiers are installed.

An advantage of this system is that it produces relatively small amounts of aggregate.

The disadvantages should not be underestimated.

- large volumes, therefore long residence times and unwanted anaerobic processes.
- the elimination of suspended particles is only possible through the addition of flocculating additives

Figure 8

| Parameters               | Volume flow (maximum) | m <sup>3</sup> /h |
|--------------------------|-----------------------|-------------------|
| TS - quantity in inflow  |                       | mg/l              |
| TS - quantity in outflow |                       | mg/l              |
| TS - quantity in sludge  |                       | mg/l              |
| Residence time           |                       | h                 |

### 2.6.2 Flotation

Flotation is rarely used in day-to-day applications for the further clarification in sewage plants.

People say that the design bureaus earn less money by proposing flotation basins as compared with sedimentation systems.

Flotation systems have higher technical requirements (mainly because of gas-saturation system), however, they have large advantages.

- they use only one quarter of the volume needed for sedimentation systems
- removal of suspended particles without flocculation
- higher TS quantity in the floating particles
- aerobic process without creating smells

### Figure 9

The further thickening of the overflow sludge is simpler and is sometimes not required.

| Parameter | Volume flow (maximum)    | m <sup>3</sup> /h |
|-----------|--------------------------|-------------------|
|           | TS - quantity in inflow  | mg/l              |
|           | TS - quantity in outflow | mg/l              |
|           | TS - quantity in sludge  | mg/l              |
|           | Residence time           | h                 |

### 2.7 Pool clarification unit

The pool clarification unit has several functions.

- further reduction of water pollutants
- a safety function when there is overflow, system failure or overloading
- the process of anaerobically biodegrading useable material (cuttings)

The pool clarification units should be layed out in several stages. The injection of gas in several stages for a better biodegrading capability should be layed out in the ground work.

The water that comes out of the pool clarification unit is of a high quality and can be used for many water systems.

Further processing to allow for use of the water in toilets for example, can also be considered.

It should also be planned that water from swimming pools and saunas can be fed directly into the pool clarification unit.

The water should only slightly load wastewater processing unit, except that some biological material might have to be removed.

*Figure 10*

| Parameter                  | Volume flow (maximum) | m <sup>3</sup> /h |
|----------------------------|-----------------------|-------------------|
| BSB5 in outflow            |                       | mg/l              |
| BSB5 in flotation and sed. |                       | mg/l              |
| TS - quantity in inflow    |                       | mg/l              |
| TS - quantity in outflow   |                       | mg/l              |
| Residence time             |                       | h                 |

#### **The basic stages of the Alternative System**

The goal of the Alternative System is a complete processing of wastewater streams in which component streams (separated sludge, gases, outflow) are used in a productive manner.

Here is the main difference between existing systems and the Alternative System. Not only will water be purified, but also additional components can be utilized.

Therefore this system can also be called Material-Value-Recycling-System.

To implement this goal, several interdependent stages are required.

#### **Stage 1 Collection and pre-processing**

The pre-diced food remains and wastewater from every house, hotel, restaurant, supermarket, food-processing plant or even slaughterhouses and dairies is sent to a local pumping station.

These pumps are equipped with devices to shred and homogenize solid material. At this point a large fraction of organic material is dissolved.

**Stage 2 "Active biological transport"**

Each small pumping station sends the wastewater to a main pumping station.

- 5 From here, the wastewater is hermetically sealed with pressurized air and sent to the sewage plant.

The pipelines for the wastewater network can be installed in an existing sewage system because of the small cross-sectional area.

10

Because of the aerobic nature of the transport system, acidification is avoided and aerobic biological activity is encouraged.

15

This is a big advantage because one finds in one system a process for stirring and aerating the wastewater.

**Stage 3 Coarse separation**

Coarse particles in the wastewater are separated with a rotating sieve (gap distance 1mm).

20

These particles cannot be processed in conventional systems.

The filter cake is removed using metallic cleaners and sent to a shredder.

25

The filter cake is homogenized together with cuttings from vegetation or reed clarification and then sent to the anaerobic fermentation stage.

**Stage 4 Fine separation**

30

Using pressure-relief flotation, a large amount of the particulate matter in the pre-processed wastewater can be removed.

The remaining organic material is either in solution or in biodegradable microparticles. The outflow is ideal for further treatment in a heavy-duty anaerobic process.

35

Floating particles and sediment are passed through a shredder and using simple mixer, passed to the anaerobic fermentation stage.

**Stage 5 Anaerobic processing**

40

The anaerobic processing and with it the energy (methane) production is split into two subprocesses.

## 5a Anaerobic biology

The anaerobic biology is supplied with the particle free flow from the flotation system. The dissolved organic substances are broken down in a very short period of time in a conventional silo.

Therefore, it is possible to process the entire water quantity without uneconomic reactor volumes.

10

The energy produced (methane) is used to lower the load on the downstream aerobic stage.

## 5b Anaerobic fermentation

15 The anaerobic fermentation stage is supplied with all of the problematic organic solids.

- homogenized filter cake from the rotating sieve
- vegetation from pool and reed clarification basins
- vegetation from areas and parks
- 20 - floating particles and sediment from the flotation system
- overflow sludge from the activated aerobic sludge stage

The sludge is either thickened through floatation and band sieve filtration or with almost dry material, for example, vegetation.

25

The volume is reduced because of separation from the main water flow, thus reducing the process costs. Also a much higher TS - quantity is available.

## Stage 6 Aerobic biology

30

The loading of the aerobic biology system is very low due to the organic components of the water and also the elimination particulate materials through pre-clarification and the combination of the rotating sieve and the floatation unit.

35 The residence time and with it the volume of active sludge and also the oxygen requirements which must added through nozzles is reduced as are the corresponding capital costs. This also has an effect on overflow sludge.

For the further clarification the aerobic biology offers two process methods:

- Sedimentation
- Flotation

5

Through both these processes, the activated sludge is separated out and split into recycled sludge (back to the aerobic biology stage) and overflow sludge.

The overflow sludge after thickening is sent to the aerobic fermentation stage.

10

Flotation systems have higher technical requirements (mainly because of gas-saturation system), however, they have large advantages:

- they use only one quarter of the volume needed for sedimentation systems
- 15 - removal of suspended particles without flocculation
- higher TS quantity in the floating particles
- aerobic process without creating smells

The further thickening of the overflow sludge is simpler and is sometimes not required.

20

#### **Stage 7 Sludge processing**

In order to utilize the sludge from the active aerobic stage and especially from the sedimentation stage a further thickening is required.

25

Therefore, apart from the standard processes, decanter and chamber-filter press, the sieve band press should also be considered.

In contrast to the other two processes, it offers a simple to use and maintain system which none the less provides comparable performance.

30

The addition of flocculants (polymer) is unavoidable.

The stabilized sludge from the anaerobic fermentation can also, like the overflow sludge, be thickened with a sieve band press.

35

A project dependant decision must be made on whether further drying or direct disposal (for example, use as compost), is economic.

## PATENT CLAIM

1. System for collection, transportation and utilization of household wastewater, biodegradable waste, fecal matter and organic substances with a delivery station (4), a piping system (1) that is connected to different buildings ( ) and at least a utilization plant ( ), recognised through the following:
  - a closed pressure, or under pressure piping system (1) in which the household wastewater, biodegradable waste, fecal matter and other substances are transported together in a fluid and at least one separation process takes place in which the solid and fluid components are separated, also, the fluid component passes through a first reactor (9) and the solid component a second reactor (10).
2. A system related to claim 1 recognised through an energy-heating coupling system (13).
3. A system related to claim 1 recognised through a water purification system (17).
4. A system related to claim 1 recognised through a flotation system (7).
5. A system related to claim 1 recognised through an active sludge system (21).
6. A system related to claim 1 recognised through a pre-cleaning system ( ).
7. A system related to claim 1 recognised through at least one pressurized air transport system (2).
8. A system related to claim 1 recognised through at least one shredding device (4).
9. A system related to claim 1 recognised through at least one equilibrium container ( ).
10. A system related to claim 1 recognised through at least one pre-processing system (8) for the shredding of biodegradable substances.
11. A system for collection, transportation and utilization of household wastewater, biodegradable waste, fecal matter and organic substances with a delivery station (4), a piping system (1) that is connected to different buildings and with at least one pre-processing stage (13) recognised through the following process stages:
  - the simultaneous of household wastewater, biological waste, fecal matter and other substances in a mixture in a pressure or under pressure piping system (1);

- the holding of the mixture in a vessel ( ) and the separation into fluid and solid components;
  - the transport of the fluid component through a first reactor (9);
  - the transport of the solid component through a second reactor (10); and
  - 5 - the recovery of methane gas generated in the first and second reactors (9, 10) with at least one utilization system (17).
12. A process related to claim 11 recognised through the avoidance of early anaerobic fermentation in the pipeline network by regular cleaning with pressurized air from a
- 10 pressurized air station (2) in which the waste-laden wastewater is transported through a pressure-piping system (1) in the direction of the utilization system.
13. A process related to claim 11 recognised through the fact that in the collection station there is an isolation of the problematic material (3) and the biological waste and food
- 15 remains pass through a shredding device (4) together with the fecal matter laden water (5), the mixture will pumped through the pressure pipe system (1) by a pressure pump with a shredding system (6).
14. A process related to claim 11 recognised through the fact that the waste mixture is
- 20 stored in a buffer vessel (9) advantageously with mixtures; and that vegetation from the pre-processing stage (8) is also added; and that the waste mixture is passed through one or more anaerobic reactors (10) with the generation of methane and a pressed component which is isolated and stored in a transport vessel (11).
- 25 15. A process related to claim 11 recognised through that in utilization plant methane off-gas will be stored in gasometer (12) and from there will be continually supplied to a combined heat and power station (13) with the goal of generating and supplying electrical energy (14) and heat energy (15) of which the wastes gasses (16) will largely consist of H<sub>2</sub>O.
- 30 16. A process related to claim 11 recognised through that after the composting and methane production, the remaining water is purified in a purification stage (17) and stored in an outlying storage vessel (18) and is sent through a separate piping network (19) to suitable consumers, of which the remaining waste (20) is isolated and
- 35 disposed of.
17. A process related to claim 11 recognised through that in the system and in the utilization plant, off-gas will be cleaned in an air-cleaning unit (21) and through an outlet (22) released into the atmosphere.

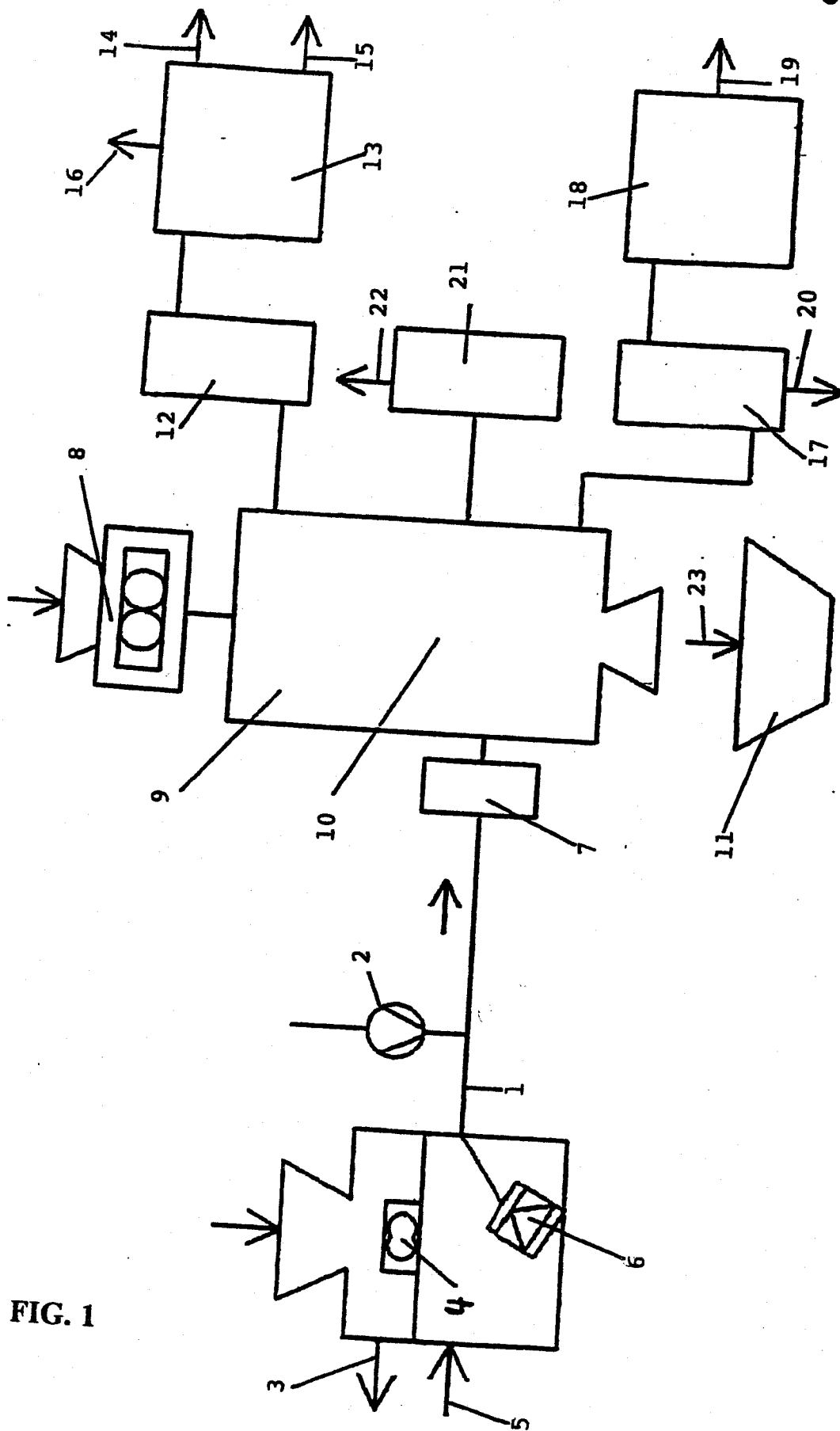


FIG. 1

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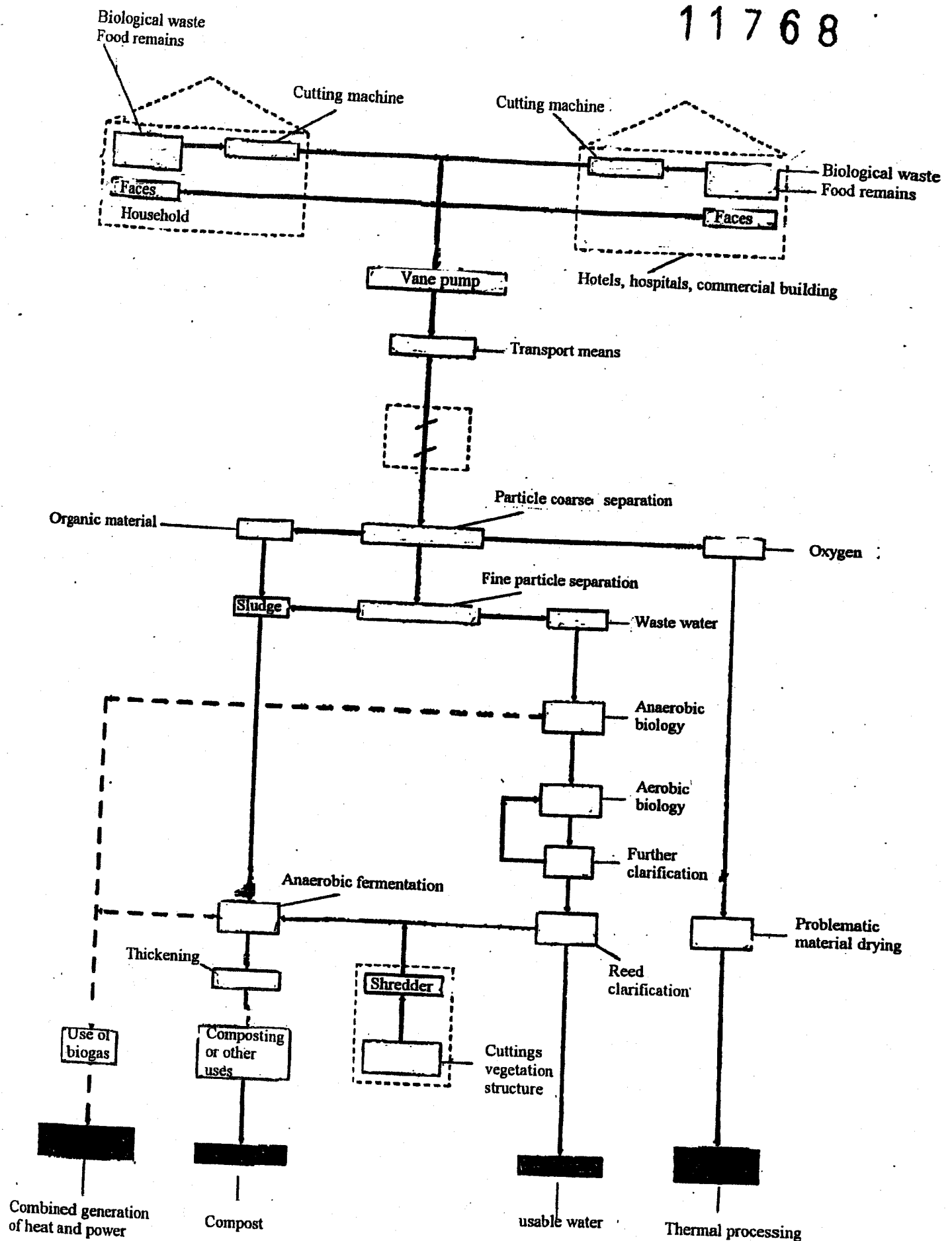


FIG. 2

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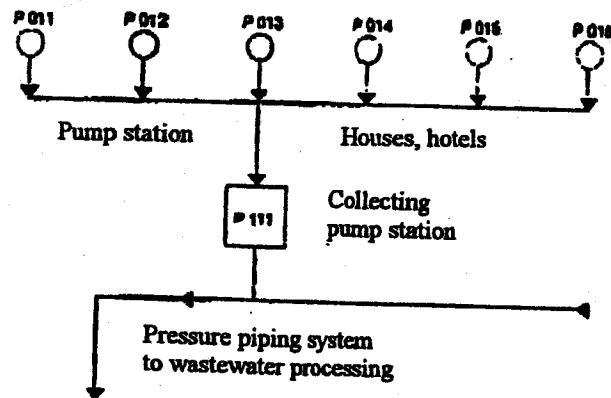


FIG. 3

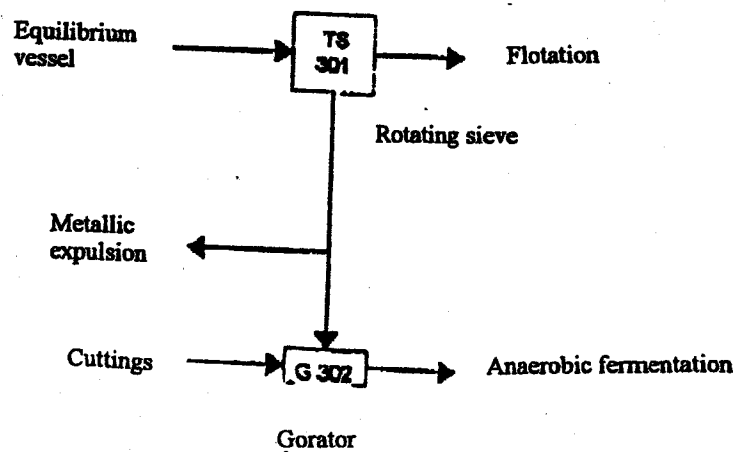


FIG. 4

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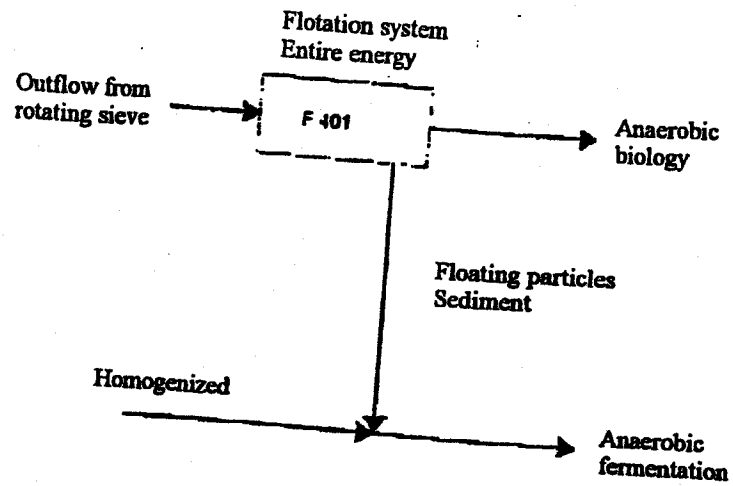


FIG. 5

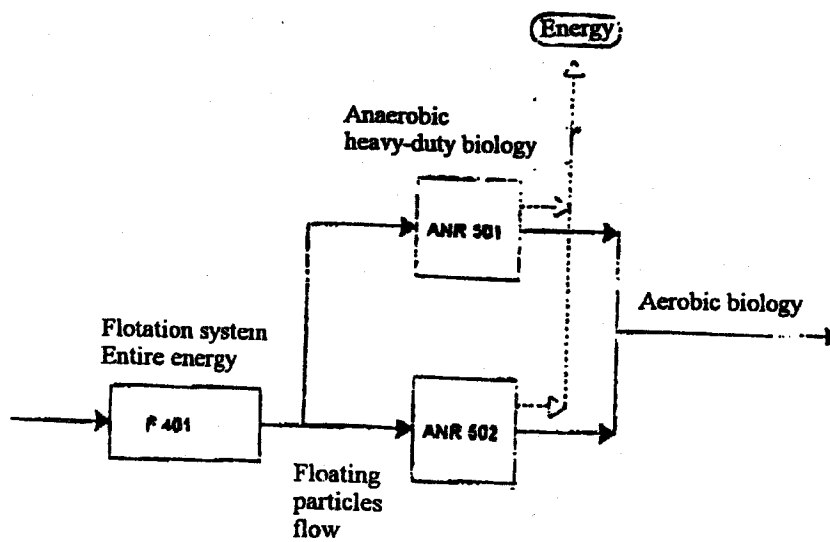


FIG. 6

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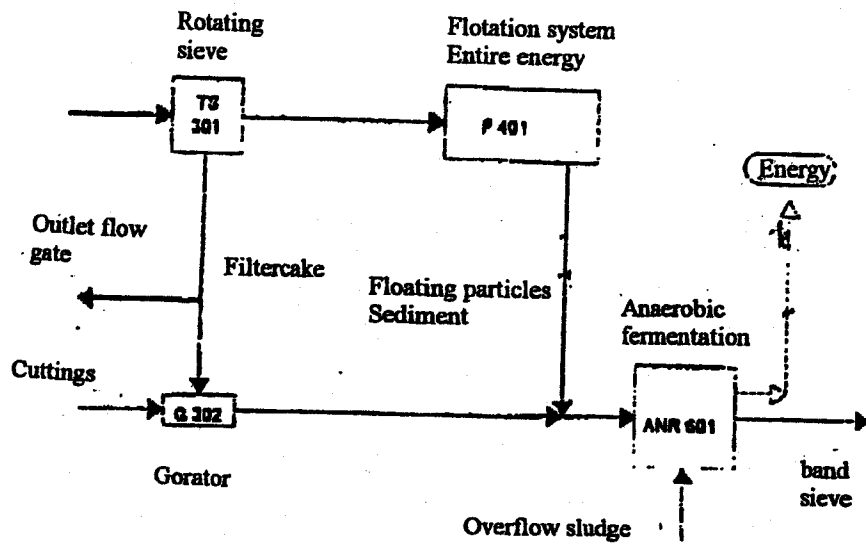


FIG. 7

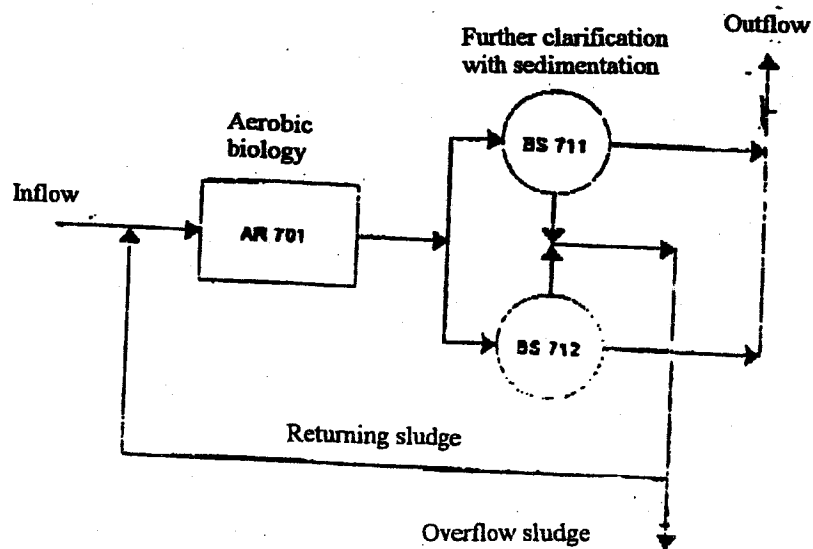


FIG. 8

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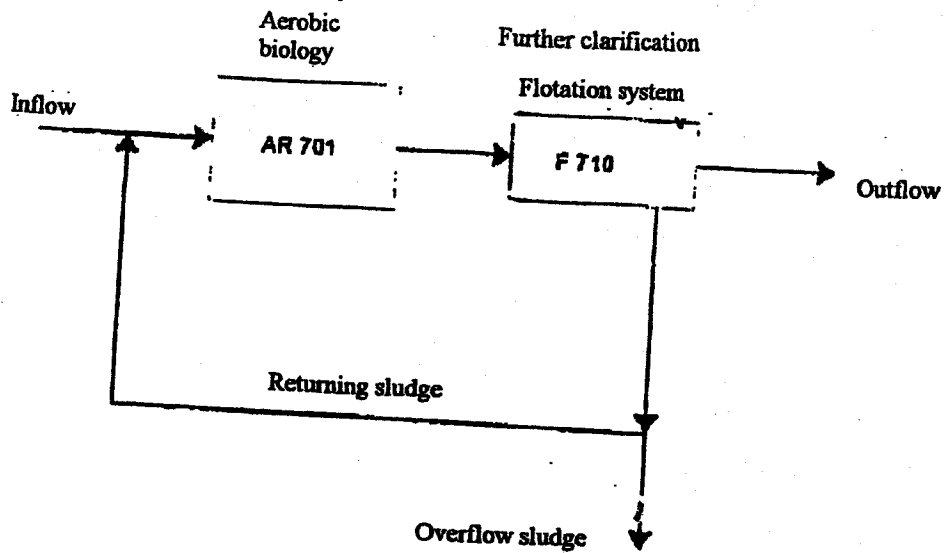


FIG. 9

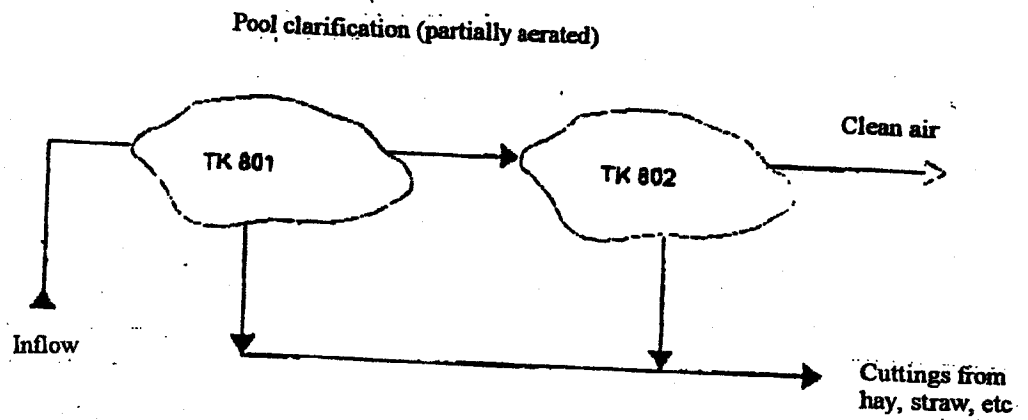


FIG. 10

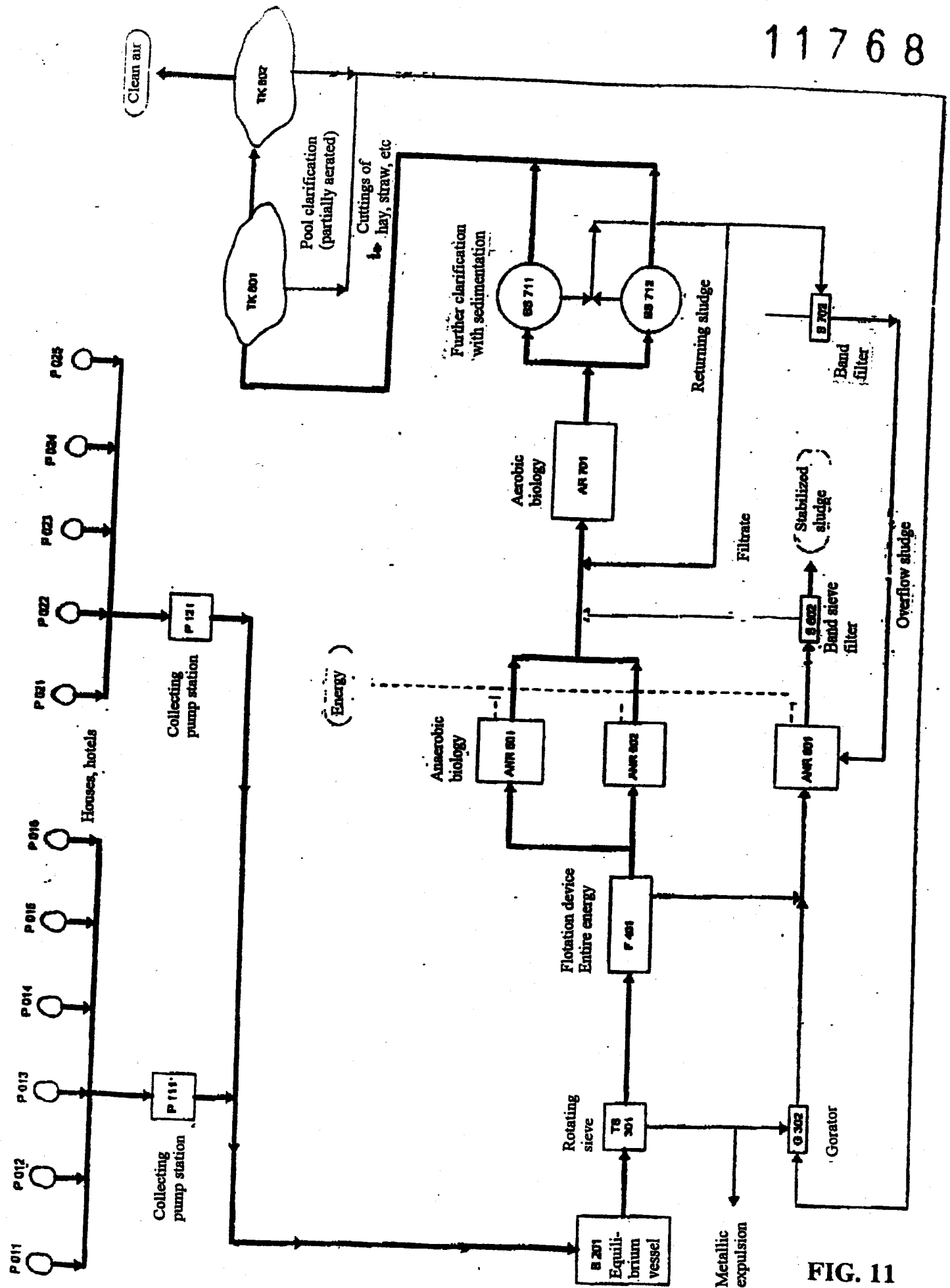


FIG. 11