In an effluent treatment system, effluent to be treated passes initially through a primary stage (1) in which it undergoes primary settlement (13) and anaerobic treatment (14). The substantially liquid effluent is withdrawn from stage (1) by means of a balanced flow arrangement (5, 6) to provide a uniform rate of withdrawal of effluent from stage (1) for downstream treatment in subsequent stages of the system. Secondary treatment (21, 41) consists of a succession of aerobic treatment stages (22a-22f; 42a-42d, 42f). At least one nitrification sub-stage (47e) is also provided during secondary treatment (21, 41), sub-stage (47f) representing a de-nitrification sub-stage. The effluent then passes (48) to clarification and settlement stage (62) before entering a disinfection stage (64) by way of a filter (65). The treated effluent is withdrawn from stage (64) by a pump (66) for dispersal (67, 71, 72, 73) directly into the soil of an area of land. The system incorporates features (81-89; 91-94) for withdrawal of sludge and/or active biological matter entrained in liquid from sub-stage (62, 42f) for selective return and redirection to primary settlement stage (13) in the case of sludge and to one or more secondary treatment sub-stages (22a, 42a, 42c, 42f), in the case of active material entrained in liquid.
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"EFFLUENT TREATMENT SYSTEMS"

This invention relates to effluent treatment systems. In particular, the invention relates to effluent treatment systems for use in situations where a conventional septic tank is either inadequate or unacceptable, but system demand does not justify a fullscale sewage treatment plant of traditional kind.

EP 0,378,288-A of Biocycle Pty Limited provides water treatment apparatus providing for one-tank treatment of domestic sewage in substitution for a traditional septic tank. According to this patent application, there is provided a septic tank assembly having a primary outer tank with a cylindrical wall. Within the primary outer tank, there is nested a second tank, also of cylindrical configuration. A dividing partition extends diametrically across each tank, to divided the two tanks up into four chambers which carry out, respectively, anaerobic, aerobic, clarification and disinfectant treatment steps. The arrangement includes an air pump and conduits for delivering air to the aerobic chamber, as well as a dispenser to discharge disinfectant material.
into the disinfection chamber in measured amounts. In the aeration chamber, where the aerobic treatment takes place, a medium to promote the growth of bacteria is suitably provided. This medium preferably consists of a plurality of partitioned corrugated sheets.

The invention of this patent application provides a compact and effective treatment unit especially suited to the processing and handling of domestic sewage. The system does not readily scale up to provide a plant suitable for small scale commercial and industrial use, such as for interpretative centres, club houses, for example, golf clubs, caravan parks, and the like. While it is possible to provide a multiplicity of individual units of the kind described by the above patent specification, to work in parallel, the economics of such an arrangement are however generally adverse.

It is accordingly an object of the present invention to provide an improved effluent treatment system suitable for relatively small scale industrial and/or commercial applications of the kind identified above, in which the advantages of the unit of EP 0,378,288-A are retained, but operating within a favourable technical and commercial configuration.

According to the invention, there is provided an effluent treatment system comprising, in succession:

(a) a primary settlement and anaerobic treatment stage,
(b) an aerobic treatment stage,
(c) a clarification and settlement treatment stage, and
(d) a disinfection treatment stage,
and means for direct dispersal to the soil of an area of land, of treated effluent leaving the final stage of said treatment stages.

In the effluent treatment system according to the invention, primary settlement and anaerobic treatment suitably comprise separate sub-stages of said primary settlement and anaerobic treatment stage, and said aerobic treatment stage may comprise a succession of
sub-stages, at least one of which comprises a nitrification process and at least one other of which comprises a de-nitrification process.

In an alternative definition therefore, the effluent treatment system may thus comprise, in succession:
(a) a primary settlement stage,
(b) an anaerobic treatment stage,
(c) a plurality of aerobic treatment stages,
(d) a nitrification treatment stage,
(e) a de-nitrification treatment stage,
(f) a clarification and settlement treatment stage, and
(g) a disinfection treatment stage,
and means for direct dispersal to the soil of an area of land, of treated effluent leaving the final stage of said treatment stages.

Preferably, the effluent treatment system according to to the invention comprises means for diffusing oxygen into said aerobic treatment, nitrification and de-nitrification stages. Said means for diffusing oxygen into effluent in said nitrification stage preferably provides for selective regulation of the quantity of oxygen released into said effluent in said nitrification stage for optimisation of the nitrification and de-nitrification processes. The system suitably comprises means for supply of atmospheric air for said diffusion of oxygen into effluent in said aerobic treatment, nitrification and de-nitrification stages.

In a favoured arrangement, the effluent treatment system of the invention comprises means for regulating flow of effluent from the anaerobic treatment stage to the aerobic treatment stage to provide for a steady rate of transfer of effluent between said stages substantially independent of the rate of inflow to the anaerobic treatment stage. Suitably, the system also comprises means for return of floating solid matter and/or non-floating sludge from the clarification and settlement treatment stage to at least the primary settlement treatment stage. Said return means may also provide for
selective redirection of liquid from at least one sub-stage of the aerobic treatment stage to one or more sub-stages of the aerobic treatment stage upstream of said at least one sub-stage. One of said one or more sub-stages of the aerobic treatment stage to which said liquid may be returned is suitably a de-nitrification sub-stage. Said return means is suitably selectively and intermittently activatable to selectively effect said return or selective redirection of solid matter and/or sludge and/or liquid.

In a particular embodiment of the invention, means are provided for driving at least one of said effluent dispersal means, said flow regulating means and said return means by solar power. The system may also comprise an alarm system for indicating failure of at least one of said effluent dispersal means, said flow regulating means and said return means. At least one of said flow regulating means and said return means may be air-driven, and the system then suitably comprises a blower for supply of air for drive of said flow regulating means and/or said return means and for diffusion into effluent in said aerobic treatment stage.

In a favoured construction, said direct dispersal means comprises a pump for directing flow of treated effluent to at least one duct extending through said area of land and having apertures for direct release of said treated effluent to said soil. Suitably, apertures of said duct provide for direct release of treated effluent into the soil when said duct is buried in the soil. Alternatively or in addition, said duct may provide for spray-form release of treated effluent to a surface region of the soil of said land area. A filter may be provided between said clarification and settlement and disinfection treatment stages.

In a practical construction of the invention, said treatment stages may be accommodated in a plurality of modular tanks, the number and size of said tanks being variable in dependence on the required capacity of the effluent treatment system.
Thus according to the invention in another aspect, there is provided an effluent treatment system comprising:

(a) at least one anaerobic primary treatment tank,
(b) at least one compartmented treatment tank in which at least one compartment contains a bacteria growth medium, and
(c) at least one tank containing a settling chamber.

Preferably the system according to the invention comprises at least two compartmented treatment tanks. At least one of said at least two compartmented treatment tanks suitably defines at least a portion of an aerobic treatment tank. Input of oxygen to said aerobic treatment tank may be effected by discharge of air from airducts located in the region of the base of the tank. At least one of said at least two compartmented treatment tanks may also comprise a nitrification compartment to which there is selectively controllable input of air.

In a further variant, a system according to the invention may comprise at least two anaerobic primary treatment tanks. Preferably, at least one anaerobic primary treatment tank comprises an internal baffle.

Alternatively, the system may have a primary settlement chamber in communication with said anaerobic primary treatment tank for flow of liquid effluent from said primary settlement tank to said anaerobic primary treatment tank.

In a favoured arrangement, the system according to the invention comprises means for returning sludge from said settling chamber to said at least one anaerobic primary treatment tank. Said sludge returning means suitably comprises a sludge pump, and said sludge pump is preferably intermittently activatable to effect return of sludge from said settling chamber to said at least one anaerobic primary treatment tank.
According to another advantageous construction of the system according to the invention, said at least one tank containing the settling chamber may be partitioned to provide a first region defining said settling chamber and a second region defining a pre-discharge portion of said tank. Suitably, said settling chamber comprises substantially two-thirds of the internal volume of said tank.

In any variant of the system of the invention, communication may be effected between the tanks of the system by duct means commencing and terminating in tank regions such that dead spots in fluid flow are substantially minimised and a dynamic circulatory action is achieved.

At least two of the tanks of a system according to the invention are suitably sealed to the exterior environment and means are then provided enabling communication between said at least two tanks for transfer of gases present in the tanks above the liquid level within the tank system.

According to a particular feature of an effluent treatment system according to the invention, a multiplicity of compartments of said at least one compartmented tank contain bacteria growth medium. In a favoured arrangement, all of the compartments of said at least one compartmented tank contain bacteria growth medium. Said bacteria growth medium suitably comprises a plurality of partitioned corrugated sheets.

In addition, at least one sub-stage of said primary settlement and anaerobic treatment and said aerobic treatment stages may comprise bacteria growth medium, in particular, said anaerobic treatment stage and each of a plurality of sub-stages of said aerobic treatment stage.

The invention also provides for any or all of the tanks of
the system to be present either singly or in multiple. Thus not only may the system comprise two or more anaerobic primary treatment tanks, working in parallel, but multiple tanks for aerobic treatment or de-nitrification may also be provided, connected in parallel. In addition, two or more settling chamber tanks may also be provided, again to work in parallel.

The invention will now be described having regard to the accompanying drawings, in which:

Figure 1 is a schematic side-sectional flow diagram of a multi-stage effluent treatment system according to the invention, identifying the individual treatment stages and the various interconnections between them.

Figure 2 is a enlarged representation in partly diagrammatic sectional side view of the primary treatment stage where anaerobic digestion and primary settlement of solids take place.

Figure 3 is an enlarged and more detailed representation, again in partly diagrammatic sectional side view, of a first portion or block of the secondary treatment stage, in which aerobic digestion takes place using submerged fixed film reactivator media.

Figure 4 is an enlarged and detailed representation in partly diagrammatic sectional side view of a further portion or block of the secondary treatment stage in which aerobic digestion again takes place in conjunction with submerged fixed film reactivator material, this further section of the secondary stage also providing for nitrification and denitrification of the effluent.

Figure 5 is an enlarged representation in partly diagrammatic and sectional side view of the clarification and disinfection stages of the effluent system of Figure 1.
Figure 6 is a partly diagrammatic side sectional view of an integrated and unitary secondary stage arrangement for a treatment system according to the invention, in which all of the features of the sectionalised or divided secondary stage of Figures 3 and 4 are combined in a single entity.

Figure 7 is an enlarged representation in partly diagrammatic side sectional view of an alternative embodiment of the primary treatment stage to that of Figure 3, in which primary settlement is physically separated from anaerobic digestion in successive sub-stages of the primary treatment step.

Figure 8 is an enlarged representation in partly diagrammatic side sectional view of a modified embodiment of the clarification and disinfection stages construction of Figure 5, in which tube settlement media are provided in the disinfection stage.

Figure 9 is a schematic representation in top view of an example of a practical installation embodying the system of the invention, comprising a multiplicity of interconnected tanks or chambers.

Figure 10 is a schematic representation, again in top or plan view, of an integrated embodiment of the invention particularly suitable for portable installations.

Figure 11 is a pictorial representation of an example of a practical installation according to the invention, having four cylindrical tanks.

Figure 12 is a schematic cross-sectional top view of the system of Figure 11, showing the internal arrangements within the various tanks.

Figure 13 is a schematic flow diagram in side sectional view
showing the progression of the treatment stages carried out within the plant of Figures 11 and 12.

Figure 14 is a detailed side view of an air diffuser used in the aerobic treatment stage of the system of the invention, for supply of oxygen to the effluent undergoing treatment in order to maintain continued aerobic action.

Figure 15 is a side view of a Tee piece used in intercommunication between the treatment chambers or tanks of the system of Figures 11 and 12, and

Figure 16 shows a modified embodiment of the construction of Figure 12, in which primary settlement and anaerobic digestion take place in succession in separate sub-stages of the primary treatment step, and tube settlement media are provided in the clarification stage.

Figure 1 is a schematic representation of a multi-stage effluent system according to the invention, in which the various treatment stages are shown in a notional side sectional view. The diagram of Figure 1 also shows the direction of flow of effluent through the stages of the system in accordance with the invention.

The first or primary stage 1 of an effluent treatment system according to the invention provides for primary settlement and anaerobic digestion of effluent material entering the stage 1 through a suitable inlet 2. Primary settlement suitably takes place in a settlement region 13 of primary treatment stage 1, with anaerobic activity being particularly concentrated in a second region 14, separated from settlement region 13 by a baffle 4. Liquid effluent is then drawn from the primary stage 1 in an outflow region 3 for transfer to a first block or region 21 of the secondary stage 21, 41. Within the primary stage 1, the baffle arrangement 4 is suitably also arranged to induce suitable swirling action for mixing
of effluent within the primary stage 1 and to develop active biological processes within the material undergoing treatment.

The preferred method for transfer of effluent from the primary stage 1 to the secondary stage 21, 41 is by means of a balanced flow arrangement 5, in which effluent is drawn at a substantially constant rate from the first stage 1 through a substantially siphonically arranged inverted U-tube arrangement interconnecting the primary 1 and secondary 21, 41 stages. Flow through this balanced flow transfer duct 5 is induced by an air-driven Venturi 6, the air being provided by a blower associated with the system of the invention, which also serves for further purposes to be described. The inlet leg 7 of the balanced flow U-tube 5 terminates at a predetermined distance above the floor level 8 of the primary stage 1, so that when the level of effluent within the primary stage 1 falls below the end 9 of the tube 7, discharge of effluent from the primary stage 1 and its transfer to the secondary stage 21, 41 is terminated. The spacing of the inlet end 9 of transfer or balanced flow U-tube 5 above the floor 8 of primary stage 1 is also selected so that excessive draw-off of effluent from stage 1 is excluded or prevented, and a minimum quantity of liquid effluent always remains in stage 1. Choking of the inlet 9 to the balanced flow feature 5 by solid material is prevented by its being protected by a suitably perforated baffle arrangement 11.

The purpose of this flow balancing or regulating interconnection 5 between the primary 1 and secondary 21, 41 stages is to ensure a substantially steady or metered flow of effluent out of the primary stage 1, irrespective of the input to the primary stage 1. Typically in an effluent system, material to be treated arrives at the primary stage 1 in batches depending very much on the time of day. Thus in the morning, substantial inflow takes place. The balanced flow feature 5 provides for controlled and metered transfer of effluent from the primary stage 1 to the secondary stage 21, 41 during the remainder of the day, and thereby ensures
sufficient retention time of effluent to be treated within the primary chamber 1 for the required level of settlement and anaerobic digestion to take place. Effectively therefore the balanced flow arrangement 5 evens out through flow along the succeeding stages of the system following the primary stage 1, irrespective of the rate of flow of material into the primary stage 1 and without regard also to its arrival in batches. As already noted, the balanced flow feature 5 also provides for retention of a minimum quantity of liquid effluent within the primary treatment stage 1. The balanced flow arrangement 5 therefore caters for peaks and valleys in the inflow.

A direct overflow connection 12 between the primary 1 and secondary 21, 41 stages enables however also any unforeseen build-up of material in the primary stage 1 to flood over into the secondary stage 21, 41, in the event of an emergency condition. Suitably however, the primary stage 1 is sized and dimensioned such as to be capable of taking the maximum expected peak load at any time without overflow, thereby facilitating continued balanced flow under all conditions.

In the secondary stage 21, 41, the effluent continues through a series of interconnected sub-stages 22a to 22f and 42a to 42f (Figures 3 and 4), the stages suitably being interconnected by passageways 23a, b, 24a-c, 43a-c and 44a, b of limited cross-sectional dimension for alternate high level 23a, b, 43a, b, c and low level 24a, b, c, 44a, b transfer between the sub-stages 22a-f and 42a-f, thereby maximising turbulence and mixing of the effluent within the sub-stages 22a-f and 42a-f of the secondary treatment stage 21, 41. The limited and predetermined cross-sectional areas for fluid flow defined by the interconnecting passageways or apertures 23a, b, 24a-c, 43a-c, 44a, b communicating between the successive sub-stages regulates the ratio of flow of effluent through the secondary treatment 21, 41 and ensures adequate retention time in each sub-stage to achieve the required level of aerobic activity. The secondary treatment 21, 41 provides for aerobic activity, to which end each sub-stage 22a-f and 42a-f is provided with submerged
fixed film reactivator support medium, also referred to as biofilm media, 25, 45, on which the required biological activity may take place and be engendered. In addition, oxygen is fed into each of sub-stages 22a-f of secondary stage section 21 and sub-stages 42a, b, c, d and f of secondary stage block or portion 41, suitably in each case by way of a diffuser 26, 46 which allows oxygen to pass into the effluent in a lower region of the respective sub-stage to activate and progress the biological treatment. This oxygen is suitably provided by blowing in atmospheric air, but alternatively a pure oxygen supply may be arranged, or the system may provide for supply of a gaseous medium in which oxygen is present in a greater concentration than in atmospheric air. Where air is used for oxygen supply, it is the oxygen content of the air that initiates and maintains and supports the biological activity in the aerobic stage. The air flow is suitably provided by the same compressor as that serving to drive the Venturi of the balanced flow arrangement 5.

As shown in Figure 1, the secondary treatment stage is sub-divided into two blocks 21, 41, for convenience of representation and in order to show the multiplicity of sub-stages 22a-f and 42a-f which may be effected during secondary treatment to provide the required high quality of effluent. Secondary treatment block 41 also includes nitrification (sub-stage 42e) and subsequent denitrification (sub-stage 42f). In order to achieve nitrification, one of the sub-stages (42e) of the secondary treatment 21, 41 is provided with a more limited oxygen feed than the other sub-stages of the secondary or aerobic stage. The oxygen feed to nitrification sub-stage 42e is however both controlled and controllable to obtain the required nitrification action in sub-stage 42e. The input of oxygen (or air) to sub-section 42e is regulated to achieve the required biological action to secure nitrification by limiting the oxygen or air input to sub-stage 42e. Thus diffuser 46 of sub-step 42e engenders a substantially less active bubbling action through the effluent within this sub-stage than is the case for the other sub-stages of treatment step 21, 41. The volume of oxygen or air
input to the nitrification stage 42e will vary depending on the characteristics or properties of the effluent, and the oxygen or air input to this stage is suitably regulated or fine-tuned in service to provide an optimum quality of effluent output from the system. Thus this sub-stage 42e essentially defines a partially anaerobic sub-stage of secondary treatment, or a stage in which aerobic activity is limited and regulated or controlled to a predetermined level, as distinct from the generally vigorous aerobic action of the remaining sub-stages 22a-f and 42a-d and f, engendered by vigorous oxygen input entrained in a continuous flow of air in greater volume bubbling through these highly or fully aerobic sub-stages, and nitrification of the effluent may therefore proceed in this sub-stage 42e. Subsequent denitrification takes place by the effluent flowing into a further sub-stage (42f) of the secondary treatment which is again provided with vigorous oxygen or air input 46 for diffusion into the effluent.

The final section 61 of the effluent treatment system according to the invention provides for clarification and disinfection of the effluent, preparatory to its dispersal by irrigation. Effluent transferred from the secondary stage 21, 41 to the final stage 61 passes first into a clarification region 62, where any heavy solid matter falls to the floor 63 of the stage 61, while any light solid matter floats on the surface of the liquid effluent. A sludge return arrangement, described below, provides for return of both settled and floating sludge to any one or more of the primary treatment stage and selected sub-stages of the secondary treatment step. The effluent passes from the clarification stage 62 into a disinfection sub-stage 64 through a suitable filter 65. From the disinfection stage 64, the finally-treated liquid effluent is drawn by a pump 66 for dispersal by means of irrigation. This latter capability of the system of the invention, which is suitably provided as an integral aspect of an installation incorporating the features of the invention, arises out of the very high quality of treated effluent leaving the final treatment stage 61. Disposal by
irrigation may take place by having a perforated irrigation line 71 passing through the area to be irrigated, buried in the topsoil. The effluent seeps out of this perforated line 71 into the topsoil, which may be a flower bed, a lawn or any other horticultural region. Alternatively or in addition to this sub-surface irrigation, surface irrigation may be provided, in which a distribution line 72 is provided with upstanding spray outlets 73 to distribute the disinfected clarified effluent in the form of a fine mist or spray onto topsoil, for example protected by woodbark or the like in a horticultural region. This unique capability of the system of the invention to enable the treated output of effluent such as household sewage to be recycled directly for irrigation purposes is a particular feature of the present invention.

Various recycling possibilities also apply within the system of the invention. In particular, any sludge and floating solid matter accumulating in clarification section 62 of the final treatment stage 61 is intermittently withdrawn from the clarification section 62 for transfer back to the primary stage 1. This is suitably effected again by a Venturi air drive 81, as shown in Figure 1, or alternatively a sludge pump of conventional design may be used. The low and high level sludge withdrawal lines 82 and 83 respectively and the sludge input line 84 to the primary stage 1 are suitably provided with valves 85, 86, 87 respectively, so as to enable control of the sludge and solid matter recycling operation as required. Typically, recirculation of sludge is conducted at intermittent intervals only, as build-up of sludge and solid matter takes place in stage 62 only relatively slowly.

The recycling feature as shown in Figure 1 offers further versatility, in that it also provides for withdrawal of liquid effluent from the final sub-stage 42f of the secondary treatment 21, 41 of the treatment system, i.e. the de-nitrification sub-stage, for redirection to one or more of sub-stages 22a, 42a, 42c and 42e of the secondary treatment 21, 41, i.e. one or more of a number of
sub-stages of the secondary treatment 21, 41 upstream of the
sub-stage 42f from which the liquid is withdrawn. One of these
sub-stages is nitrification sub-stage 42e. Liquid is withdrawn from
sub-stage 42f along line 89 through valve 88 by Venturi 81 and
redirected to sub-stage 22a by line 91 through valve 92 and to
sub-stages 42a, 42c and 42e by line 93 and branch-lines 93a, 93b and
93c through respective valves 94a, 94b and 94c. Selective
redirection of liquid from sub-stage 42f is achieved by opening and
closing the appropriate valves. The purpose of providing for liquid
return in this manner is to ensure the continuation of a required
level of biological activity at all stages of the secondary
treatment, by enabling the return of active biological material
entrained in liquid in the final (de-nitrification) sub-stage of
secondary treatment to reactivate earlier stages of the secondary
treatment, thus as it were, providing "food" for the active
biological processes. Biological activity will not take place, if
there is no food for such activity in the form of appropriate
biological material. Depending on the nature of the effluent and
the quality of treatment, it is possible for biological activity to
be reduced in level, in particular in the sub-stages of the second
block 41 of the secondary treatment. By returning liquid from the
final sub-stage of the secondary treatment in small quantities to
appropriate upstream sub-stages of the secondary treatment, and in
particular to the first sub-stage 42a of the second block of
secondary treatment and to the denitrification sub-stage 42f, feed
material may be provided to engender biological activity at these
sub-steps. The return of this material is suitably effected at
intermittent intervals either under manual control during service
attention, or alternatively in a pre-programmed and automatic or
automated manner during normal operation, without operative
intervention. In this way, not only is the system kept clear of
sludge at the final downstream stage 61 by its removal and return to
the primary settlement feature 13, but also the biological
characteristics of the secondary treatment stage 21, 41 in particular
may be maintained at their optimum, by feeding active biological
material returned from a later sub-stage of the system back to the appropriate earlier sub-stage, as required.

The sludge and liquid recycling or return system described allows great flexibility in adapting or fine-tuning an individual effluent treatment system to the particular requirements of the location of installation and the nature and quality or characteristics of the effluent to be handled. It will be appreciated that sludge could in fact also be withdrawn from the clarification and settlement stage 62 for redirection, if required, to one or more of the secondary treatment sub-stages to which recycling or redirection of material is available. Withdrawal of liquid for recirculation from the final secondary treatment stage 42f, rather than from the clarification stage 62, is however preferred, as this ensures minimal disturbance of effluent undergoing settlement in the clarification and settlement stage 62. Nonetheless, alternative arrangements for recirculation of liquid and/or solid material may also be envisaged within the scope of the present invention.

Figures 2 through 5 show various practical details in semi-schematic sectional side view for the primary treatment stage 1, Figure 2, secondary treatment 21, 41, Figures 3 and 4 representing first 21 and second 41 blocks of such treatment, and final treatment 61, Figure 5. It will be appreciated that the representations of Figures 1 through 5 are entirely diagrammatic, and that practical chambers or tanks embodying these various treatment stages or steps will typically in practice in any application of the system of the invention, be laid out on a single level, for continuous forward flow of effluent from the primary stage to the final discharge outlet 67 for dispersal, and may be of any suitable configuration, whether upright cylindrical, rectangular, or square.

Further features of Figures 3, 4 and 5 in particular, not already specifically identified, include partitions 27a-e and 47a-e in secondary stage blocks 21 and 41 respectively, between which the
sub-stages 22a-f and 42a-f are defined, and through which flow of effluent takes place in controlled manner by way of flow passages or apertures 23a, b, 24a-c, 43a-c, 44a, b, the rate of flow being regulated by the cross-sectional dimensions or size of these flow passages, which may suitably be merely circular openings or bores in the partitions. Transfer of effluent from block 21 to block 41 takes place by means of interconnector 28, the manner of operation of which is subsequently described in connection with a practical embodiment of the system of the invention. A similar interconnector 48 provides for flow of effluent from secondary stage block 41 to the final treatment stage 61. Within this final treatment stage 61, a partition 68 separates the clarification region 62 from the disinfection region 64 of the stage 61. Filter 65 controls therefore the passage of liquid effluent from the clarification region 62 to the final disinfection region 64.

Figure 6 is a partially diagrammatic side sectional view of a unitary secondary stage arrangement for a treatment system according to the invention, in which all of the features of the divided or two-part secondary stage of Figures 3 and 4 are integrated into a single entity. Thus in the arrangement of Figure 6, the secondary stage is neither sectionalled nor divided in any way.

As shown therefore in Figure 6, secondary stage 51 has sub-stages 52a through k, separated by partitions 57a through j. Initial outflow from sub-stage 52a takes place through a low level interconnection 54a to sub-stage 52b and from sub-stage 52b to sub-stage 52c through high level interconnection 53a, rate of advance of effluent through stage 51 being again regulated by the area in cross-section of the interconnecting flow communication locations 53a-e and 54a-e. Transfer of effluent from sub-stage to sub-stage alternates through low level and high level connections 54b through e and 53b through e respectively. All of the sub-stages are again provided with biofilm 55, in other words submerged activator support media, and air diffusers 56 for oxygen supply or input or feed are
again provided in all of the sub-stages, with restricted or specially
controlled air release in sub-stage 52j to achieve the required
nitrification in this sub-stage. Infeed and sludge recycling
arrangements correspond to those for stage 21, 41 of Figures 3 and 4,
while outflow to the final treatment stage 61 is effected by
interconnector 58. In every other aspect, the secondary treatment
stage of Figure 6 is identical with the divided or sectionalised
secondary treatment stage 21, 41 of Figures 3 and 4.

Figure 7 shows an alternative arrangement for the primary
treatment stage shown in Figure 1 and in further detail in Figure
2. Features 221 to 223, 225, 227 to 229, 231 and 232 correspond to
the similar features of the arrangement of Figure 2 identified in the
numerical sequence 1 through 12, with the addition of 220 in the
present variant. Differences from the arrangement of Figure 2
reside in the baffle 4 of Figure 2 being replaced by a dividing
partition 224, so that the primary treatment stage 221 is now divided
into a primary settlement sub-stage 223 and an anaerobic digestion
primary treatment sub-stage 234, this sub-stage also comprising
biofilm or biological reactor medium of the kind already described in
connection with the aerobic treatment stage, to provide for enhanced
anaerobic bacteria growth in sub-stage 234 to take place on the
bacteria growth medium 235. Because the sub-stage 233 is now
physically separated from the anaerobic sub-stage 234, a transfer
arrangement 236 for liquid effluent is now provided, substantially
similar to the arrangements 28, 48 for transfer of liquid effluent
between the first and second sections of the secondary treatment 21,
41 and between the termination of secondary treatment and the
clarification and disinfection stage 61, respectively, as shown in
Figure 1. Transfer feature 236 consists therefore of a vented U
tube arrangement, of a type to be further described in connection
with a practical embodiment of the invention, providing for
equalisation of liquid levels or hydrostatic pressure as between the
sub-stages 233 and 234, with upwardly opening gas vents defined by
Tee pieces communicating with upwardly open tube portions extending
into the upper regions of the respective sub-stages 233 and 234. The function of these gas pressure equalising features will be subsequently further described.

Within the primary settlement sub-stage 233, the settling out of solid matter takes place, most commonly by the formation of a crust 237 established by the floating of the solid matter to the surface of the effluent within the sub-stage 233. Alternatively, or in addition, settled solids 238 may accumulate on the floor of the sub-stage 233, normally however in relatively small quantities only. The manner of accumulation of solids, whether by the formation of a crust 237 or by settlement on the floor of stage 233, is essentially a function of the nature and characteristics of the incoming effluent, but is generally relatively slow. Liquid effluent flows from the settlement region 233 into the anaerobic stage 234 in such a manner as to equalise the liquid levels between these two chambers or to equalise the hydrostatic pressure in the event of the crust 237 forming in a sealing manner above the maximum liquid level which can be accommodated in region 233. The balanced flow feature 225 then provides for further draw-off of liquid effluent from the anaerobic stage 234 in the manner already described in connection with Figures 1 and 2, for advance to the aerobic treatment stage. The biofilm 235 in chamber of stage 234 is positioned so as to be at all times submerged, i.e. the highest point of the body of biological activator medium must be below the lowest liquid level, i.e. corresponding to the lower end 229 of withdrawal duct 227. In this manner, biological activity is maintained in chamber 234 at all times and the biofilm is not uncovered at any time.

Figure 8 shows a variant in the clarification stage of the final clarification and disinfection steps of the system of Figures 1 and 5, in which clarification is further engendered or enhanced by the provision of tube settlement media within the clarification stage. Again in Figure 8, the relevant features are identified by the same reference numerals as those of Figure 1 and Figure 5, with
the addition of 200. The tube settlement media is indicated in diagrammatic manner only by reference 269. The feature in question provides for a convoluted path of flow for the effluent during this downstream treatment step, to thereby achieve a high quality of clarification of effluent leaving the step in question.

An example of a sectionalised arrangement of effluent treatment system according to the invention in a multitank configuration is shown in Figure 9, in which the primary treatment stage 201 comprises three interconnected tanks 201a, b, c, defining a primary treatment stage of the kind indicated in Figures 1 and 2, suitable for receiving large volumes of effluent from inflow lines 202a, b, c such as may arise under peak inflow conditions. As shown in Figure 9, secondary treatment 203 comprises four tanks 203a, b, c, d, each of which is sub-divided to provide sub-stages of the kind identified in Figures 1, 3, 4 and 6. An individual tank may be devoted if appropriate to nitrification and denitrification. As shown in Figure 9, the final treatment stage 204 comprises two tanks 204a, b, one of which caters for clarification and settlement, the final tank providing the disinfection of the effluent for final discharge 205 for dispersal and irrigation. Such a system may be further modified in accordance with Figures 7 and 8.

The system of the invention may alternatively be provided in a more compact integral structure 211 as shown in Figure 10, for example for portable or temporary use. In the arrangement of Figure 10, the primary 212, secondary 213 and final 215 treatment stages are all comprised within a single overall rectangular envelope 216, each stage comprising a sub-section of the region within this rectangular envelope 216 as seen in top view. Thus the system of the invention may readily be incorporated within the cubic volume of for example a standard transportable lift on and off container or road trailer, for ease of conveyance to a location of use.
The system of the invention thus provides a modular scalable packaged effluent treatment system, which may be embodied in a multiplicity of adaptations suited to virtually any operating circumstance. The variety of process steps used within this compact overall package provides a very high quality of treatment such that the effluent requires no further attention before being used for irrigation or other human purposes, normally excluding however human washing and consumption, although such use could be envisaged in conjunction with further possible treatment downstream of the system of the invention. The tanks or other structures incorporating the treatment stages of the system of the invention are readily located below ground level and may be concealed and landscaped. The system may function without any mechanical moving parts whatever, in that flow transfer may be effected by the Venturi arrangements shown. An external blower is provided to drive these Venturi transfer features and also to supply oxygen for the aerobic action in the secondary treatment stage by the diffusion of atmospheric air into the sub-sections of this stage. The pump for effecting dispersal of the final effluent may if desired also be located externally of the system. The power consumption of the blower and motor for a typical installation capable of handling effluent from up to ten dwellings is suitably less than 1 kilowatt, e.g. 800 W. The system of the invention is thus highly suitable for being driven by solar power without any mains supply. An alarm system is suitably however associated with an effluent system according to the invention to ensure that the user's attention is drawn to any failure of either the air supply or any of the other drive features of the system, or to any interruption of the power supply, whether mains or solar or otherwise local.

Minimal maintenance attention is required. The primary treatment stage requires occasional desludging, but other than this, intermittent visits by service staff are all that are required. The recycling capabilities of the system also enable it to be fine-tuned to suit any particular requirements unique to the installation, such
as the characteristics or nature of the effluent handled or
received, while the flow rates may also be varied for this purpose.
In particular, aeration or oxygen input ensures that the quality of
treatment remains high, even at very low or fluctuating rates of
throughput. Retention of biological activity of the sludge is
facilitated by the recycling feature.

While the recycling may be operated on an intermittent
basis, either manually or preprogrammed, further preprogramming is
also possible to provide for motor drive of the various valves, which
are suitably ball valves, for transfer and redirection of sludge, as
required at any time. Integration of the alarm system with a
telephone alarm to a central control facility may also be provided.
The fine filter for final treatment of effluent at the last stage may
be made self-cleaning by a suitable backflow arrangement. Provision
may also be made for phosphate removal.

Tanks or structures defining the treatment stages of the
system of the invention may be formed from concrete, if sub-surface
installation is in question. However, the tanks or holding units
may also be formed from fibreglass, and such a construction is
favoured where portable or temporary installations are required, for
lightness and ease of handling. The system of the invention is
especially suited to treating effluent which would be damaging if
allowed to flow into rivers or other water courses, and the dispersal
feature enables such effluent to be disposed of harmlessly into the
soil. In arid areas, the dispersal feature of the invention also
facilitates irrigation of growing crops in horticultural
circumstances.

As shown in Figure 11 in schematic pictorial representation,
a practical construction of a system 101 according to the invention
comprises four tanks 102 to 105. Tank 101 is a primary treatment
tank in which the effluent passes through a primary settlement and
anaerobic stage. Tanks 103 and 104 define an aerobic treatment
stage, or alternatively, tank 104 may provide for de-nitrification, with controlled input of oxygen, following fully aerobic treatment in tank 103. Finally, tank 105 provides a clarification and settling and discharge feature, from which selective sludge return to the first tank may also be effected. Arrangements for redirection of liquid matter, if required, may also be provided. Each tank is of substantially cylindrical configuration having a side wall 106 and is closed at the top by a respective cover 107. The tanks may be buried or otherwise concealed or landscaped at the location of use.

Referring now to Figure 12, in which the tanks are shown in diagrammatic sectionalised plan view, primary anaerobic treatment tank 102 has a main soil inlet 111, a transverse baffle 112 extending from side wall 106 of the tank across the greater part of a diameter of the tank, and an outlet 113. The inlet 111 and outlet 113 are located approximately 135° apart, and the transverse baffle 112 substantially bisects this angular separation, so as to divide the chamber defined by tank 102 into two half-chambers, communication between which takes place on the opposite side of the chamber from the 135° sector, i.e. in the 225° sector, so as to substantially maximise flow through the half-chambers and thereby bring about settlement out of solids in the material received as well as engendering active biological processes within the material to be treated.

From outlet 113, liquids separated from solids in tank 102 flow to first aerobic treatment tank 103, entering through inlet 121. Tank 103 is divided into two semi-cylindrical regions by a diametrical partition 122. A further sub-division into two concentric cylindrical regions is provided by an inner cylindrical partition 123, itself in turn also bisected into two semi-cylinders by the diametrical partition 122. Outer diametral partition portions 124a and 124b further sub-divide the sectoral cylindrical spaces between the tank wall 106 and the inner cylindrical partition 123 into smaller sectoral compartments. The end result of this
internal construction is to define a plurality of compartments 125a to 125f through which the liquid to be treated flows in succession. The four outer compartments are sectoral portions of a generally annular aggregate configuration, while the inner compartments 125c and 125d are each semi-cylindrical. Flow takes place between the respective compartments at points indicated by references 136a through 136e. These flow communication locations are alternately at a high level or a low level from compartment to compartment, again so as to maximise turbulence of flow through the system and to minimise any inclination for the development of flow dead spots or stagnant eddies or vortices. The succession of flow communication point levels is further described in connection with a subsequent Figure. The flow communication points 136c-c are of limited cross-sectional area or dimension, being essentially apertures or openings connecting the chambers or compartments 125a-f to one another, so that the rate of forward flow of effluent is essentially substantially controlled or regulated to a value such that full aerobic action is facilitated and achieved.

In order to also advance aerobic treatment, diffusers 127 provide for the dissemination of oxygen in the form of air bubbles into the liquid to be treated in each of the various compartments 125a-f. Each compartment 125a-f is also suitably charged or packed with bacteria growth medium, suitably in the form of blocks 128 comprising a plurality of partitioned corrugated sheets, such as are described in EP 0,378,288A. Discharge from aerobic treatment tank 103 takes place through outlet 129, from compartment 125f.

A further stage of aerobic treatment takes place in tank 104, which is essentially identical with tank 103 already described. Precisely the same reference numerals are used for the features of this tank as for those of tank 103, but in the series 131 to 139, as compared with 121 to 129. The sequence of high or low in the flow communication locations between the successive compartments is however reversed as compared with the sequence of tank 103, as
will be described in connection with Figure 13. The treated liquids leave tank 103 via outlet 139 and then pass into tank 105, where settling and final discharge takes place.

In tank 104, the second last compartment 135e is suitably a nitrification sub-stage, in which the flow of air through diffuser 137 is cut down to a low but controlled and controllable level, such as to engender nitrification in the effluent passing through this sub-stage. As previously described, the delivery of oxygen to this sub-stage by way of the diffuser 137 is regulated in a manner such as to achieve the required degree of nitrification necessary to bring about a quality of final effluent in accordance with the requirements of the system. In use of the system, the air flow through the diffuser 137 in compartment 135e is therefore adjusted to achieve the required level of performance. The final compartment 135f of tank 104 then defines the denitrification stage previously discussed, in which there is essentially restoration of full input of air through diffuser 137, in the manner prevailing also in the other earlier sub-stages of the aerobic secondary treatment section of the system, upstream of nitrification chamber or sub-section 135e.

Liquids entering tank 105 through inlet 141 enter a clarification and settlement chamber 142 defined between a partition 143 and the wall 106 of tank 105. Partition 143 divides tank 105 into two regions, the chamber region 142 comprising substantially two-thirds of the internal volume of the tank and a final discharge or disinfection region 144 occupying approximately one-third of the tank volume. Any solid matter remaining in the treated material at this stage settles out in chamber 142 and is returned to primary tank 102 by means of a valved (145a, 145b) sludge return line or conveyor 145, which provides for the removal of both high-level or floating sludge or solid matter, such as floc or foam, and also heavier-than-water solids or sludge accumulating on the floor of tank 105. This return line is activated by a sludge pump or other sludge collection means, identified by reference 146, and shown in Figure 12.
in the particularly favoured embodiment of an air-driven Venturi. Suitably the Venturi or sludge pump operates at intermittent intervals, such as for a short period during each day of system operation. A further line 171 provided with a valve 181 provides for selective withdrawal of liquid from the final aerobic treatment stage 135f, as required, also by way of Venturi 146, for selective redirection as required by way of line 172, valve 182, to initial secondary treatment chamber 125a, and/or to one or more selected sub-stages 135a, 135c and 135e of the secondary treatment by way of line 173 and branches 173a, b and c and valves 183, b and c respectively. In this manner, by selective and intermittent operation of transfer or return or redirection Venturi 146 and opening or closing of the appropriate valves 145a, 145b, 181, 182, and 183a, 183b and 183c, sludge and floating matter may be withdrawn from clarification stage 142 for redirection to the primary treatment tank 106, or alternatively, liquid may be withdrawn from the final aerobic sub-stage 135f for redirection to one or more aerobic treatment stage sub-stages upstream of stage 135f. These upstream sub-stages include the nitrification sub-stage 135e. This sludge return feature is similar to that already described in connection with Figure 1 and certain of the drawings subsequent to Figure 1, and fulfills all of the objectives identified in connection with the description of those drawings, and also provides all of the facilities already identified in connection with these previous Figures.

Following clarification and settling, the remaining fluid material passes into the discharge region 144 by way of a filter 147. A discharge pump 148 then transfers the liquid, again on an intermittent basis, to an irrigation line 149, for disposal by spraying onto vegetable material, or by discharge into a suitable soak-away region. A standby pump 148a may also be provided.

Figure 13 is a schematic representation of the flow path of materials to be treated passing through the system of the invention,
in which the tanks of Figures 11 and 12 have as it were been rolled out to be represented as linear structures or stages, rather than in terms of the circular or cylindrical arrangements shown in Figures 11 and 12. This representation is particularly advantageous in showing the sequence of movement of material to be treated through the aerobic treatment tanks 103 and 104. The alternating sequence of high and low transfer points between the successive compartments 125a-f and 135a-f will be noted, as also the fact that the alternation of this sequence is reversed as between tanks 103 and 104.

At each input and discharge point to a respective tank, the feed or discharge line is suitably brought in at a point within the tank such that turbulence and biological action will be maximised and dead points or stagnant regions within the fluid flow minimised. In order to achieve this in for example the aerobic tanks 103 and 104, where the inlet points are located at a substantially central location in the walls of the initial compartments 125a and 135a, the inlet pipes may be carried down diagonally to a corner region of their respective compartment for discharge of liquid being transferred. Similar provisions may be made at discharge locations.

Figures 14 and 15 show in schematic form the air diffuser head 127 or 137 used in tanks 103 and 104 and also a Tee piece arrangement for use at the points of communication between the respective tanks. As shown in Figure 14, the diffuser head arrangement provides a downwardly extending air pipe 152, at the end of which an inverted Tee piece arrangement 151 terminates in bubble discharge features 153 defined by tubular portions of a porous suitably plastics material blanked off at their free ends, a respective portion being provided on each laterally extending arm or limb of the inverted Tee 151. The purpose of the air diffusion is to provide feed of oxygen for aerobic biological activity. This is achieved using the diffusers described to develop an even pattern of air bubbling through the chamber or compartment or sub-stage of the
system of the invention, with essentially no dead spots where biological activity is constrained or restricted. In the nitrification sub-section by contrast, the level of air flow or oxygen input is reduced, so that there is controlled and substantially minimal release of air into the effluent contained within the relevant chamber or compartment of the system. In this way nitrification proceeds and subsequent denitrification is then brought about by restoring full air supply within the succeeding sub-stage or chamber of compartment of the system of the invention. In the nitrification sub-stage, the rate of oxygen release or air input is regulated in use of the system to achieve the required quality of treatment of the effluent as measured in the characteristics of the exiting downstream liquid material.

Figure 15 shows a tubular Tee piece arrangement for use at the various inlet and outlet connections, 121, 129, 131 and 139, in which the arms of the Tee extend vertically and the main stem extends transversely to connect with the inlet or outlet pipe as appropriate. A Tee piece 161 is provided at the upper end of each downwardly extending inlet or outlet pipe portion 162. An open stub end of the Tee piece 161 is defined by the upwardly extending or directed arm of the Tee 161, and is open to the gas space above the liquid level within the respective tank, the tanks being sealed against the external environment. The other downwardly directed limb of the Tee is connected to pipe portion 162. In this manner, any build up of gas pressure within one tank can be communicated to the other tanks of the system by way of the fluid transfer ducts and the open-ended upper Tee piece arms, and thereby any inhibition of fluid transfer is prevented. These diffuser and interconnection details as now described also apply to the representations of the treatment stages of the system of the invention as depicted in Figures 1 to 8, and in particular to the liquid effluent transfer feature 236 provided in the modified primary treatment structure of Figure 7 for the advance of liquid effluent from the primary settlement stage 233 to the anaerobic stage 234 of this variant of
the primary treatment stage of a system in accordance with the invention.

In use of the system of the invention in the construction of Figures 11 to 15, soil enters the primary tank 102. Separation of solid matter takes place, but the build-up of solid matter within this tank is relatively slow, because of the highly active biological processes taking place within the system. Fluid material advances to the treatment tanks 103 and 104, where the presence of the biological medium 128, 138 ensures a very active progression of the purification processes, this being further advanced by the convoluted flow path and the general turbulence of flow through these tanks as well as input of oxygen. Treated fluid then enters the clarification and settlement chamber 142, where any remaining solids are deposited. The sludge conveyor or transfer arrangement provides for return of any such solids to the primary tank 102, as well as for selective optional return or redirection of liquid effluent, as required, from a downstream sub-stage of the aerobic treatment to one or more upstream sub-stages. The accumulation of solids in the clarification region 142 is however relatively modest, and intermittent and short-term operation of the sludge conveyor is quite sufficient to achieve the desired result of keeping chamber 142 substantially clear of sludge and floating solid matter. The quality of final liquid output from the system is very high and is accepted by competent standards authorities as appropriate for disposal by soakage or spray onto vegetation.

A Venturi type arrangement is preferably provided for sludge and/or liquid return, but alternatively a sludge pump of other design may be used. Suitably, the tanks are approximately 2.2 metres in diameter, but this dimension is not to be regarded as limiting. The nested partition arrangement described in respect of tanks 103 and 104 is also in no way limiting, and alternative arrangements may be provided, within the parameters of the invention.
At least one of the compartments or sub-stages of the second aerobic treatment tank of Figure 12, tank 104, may also be adapted for de-nitrification, by having controlled oxygen input to the material to be treated, as already described. In tank 105, the final settlement and discharge tank, the filter between the two regions of the tank may also be adapted to provide water of substantially drinking water quality at the final exit from the system. This arrangement may serve as an alternative to the irrigation or soakage arrangement previously described. In the case of irrigation, discharge of effluent by by spray over suitable plants enables speedy evaporation of the sprayed liquid material. With this arrangement, a disposal rate of up to 5 litres per square metre per day is acceptable.

Any or all of the tanks of the system may also be doubled-up, by providing two tanks operating in parallel, to enhance the capacity of the system. The capabilities of the system may be still further raised by placing three, four or more tanks in side by side multiple operation, again connected in parallel, as already indicated in connection with a previous Figure.

Finally, Figure 16 shows a modification of the tank arrangement of Figure 12, in which the primary treatment stage has been divided into primary settlement and anaerobic digestion sections in the manner already shown in Figure 6. Thus in Figure 16, the primary treatment tank 241 has an effluent inlet 242 admitting soil to a settlement section 253. Settlement section 253 is separated from anaerobic section 254 by diametral partition 244. Settlement of solids takes place in section 253 and transfer of liquid effluent from settlement section 253 to 254 takes place through transfer feature 256, which is of the kind already described in connection with Figure 7. Anaerobic action then takes place in section 254 which contains biological reactor medium 255 (biofilm) of the kind already described. Discharge of effluent from section 254 to the secondary treatment stages takes place by way of outlet 245, in the
manner already described in connection with previous drawings. The inlet 242 to section 253 is positioned for maximum flow action within section 253 to engender the required settlement action.

Figure 16 also shows a variant from Figure 12 in respect of the clarification sub-section, which is provided with tube settlement media 279 of the kind discussed in connection with Figure 8. All other features of Figure 16 are otherwise identical with those of Figure 12 and are identified by the same reference numerals.
CLAIMS

1. An effluent treatment system comprising, in succession:
   (a) a primary settlement and anaerobic treatment stage,
   (b) an aerobic treatment stage,
   (c) a clarification and settlement treatment stage, and
   (d) a disinfection treatment stage,
   and means for direct dispersal to the soil of an area of land, of
treated effluent leaving the final stage of said treatment stages.

2. An effluent treatment system according to Claim 1, wherein
   primary settlement and anaerobic treatment comprise separate
   sub-stages of said primary settlement and anaerobic treatment stage,
   and said aerobic treatment stage comprises a succession of
   sub-stages, at least one of which comprises a nitrification process
   and at least one other of which comprises a de-nitrification process.

3. An effluent treatment system comprising, in succession:
   (a) a primary settlement stage,
   (b) an anaerobic treatment stage,
   (c) a plurality of aerobic treatment stages,
   (d) a nitrification treatment stage,
   (e) a de-nitrification treatment stage,
   (f) a clarification and settlement treatment stage, and
   (g) a disinfection treatment stage,
   and means for direct dispersal to the soil of an area of land, of
   treated effluent leaving the final stage of said treatment stages.

4. An effluent treatment system according to Claim 2 or Claim
   3, comprising means for diffusing oxygen into said aerobic treatment,
   nitrification and de-nitrification stages.

5. An effluent treatment system according to Claim 4, wherein
   said means for diffusing oxygen into effluent in said nitrification
   stage provides for selective regulation of the quantity of oxygen
released into said effluent in said nitrification stage for optimisation of the nitrification and de-nitrification processes.

6. An effluent treatment system according to Claim 4 or Claim 5, comprising means for supply of atmospheric air for said diffusion of oxygen into effluent in said aerobic treatment, nitrification and de-nitrification stages.

7. An effluent treatment system according to any preceding claim, comprising means for regulating flow of effluent from the anaerobic treatment stage to the aerobic treatment stage to provide for a steady rate of transfer of effluent between said stages substantially independent of the rate of inflow to the anaerobic treatment stage.

8. An effluent treatment system according to any preceding claim, comprising means for return of floating solid matter and/or non-floating sludge from the clarification and settlement treatment stage at least to the primary settlement treatment stage.

9. An effluent treatment system according to Claim 8, wherein said return means also provides for selective redirection of liquid from at least one sub-stage of the aerobic treatment stage to one or more sub-stages of the aerobic treatment stage upstream of said at least one sub-stage.

10. An effluent treatment system according to Claim 9, wherein one of said one or more sub-stages of the aerobic treatment stage to which said liquid may be returned is a de-nitrification sub-stage.

11. An effluent treatment system according to any of Claims 8 to 10, wherein said return means is selectively and intermittently activatable to selectively effect said return or selective redirection of solid matter and/or sludge and/or liquid.

12. An effluent treatment system according to any of Claims 8 to
11, comprising means for driving at least one of said effluent dispersal means, said flow regulating means and said return means by solar power.

13. An effluent treatment system according to any of Claims 8 to 12, comprising an alarm system for indicating failure of at least one of said effluent dispersal means, said flow regulating means and said return means.

14. An effluent treatment system according to any of Claims 8 to 13, wherein at least one of said flow regulating means and said return means is air-driven.

15. An effluent treatment system according to Claim 6 or Claim 14, comprising a blower for supply of air for drive of said flow regulating means and/or said return means and for diffusion into effluent in said aerobic treatment stage.

16. An effluent treatment system according to any preceding claim, wherein said direct dispersal means comprises a pump for directing flow of treated effluent to at least one duct extending through said area of land and having apertures for direct release of said treated effluent to said soil.

17. An effluent treatment system according to Claim 16, wherein apertures of said duct provide for direct release of treated effluent into the soil when said duct is buried in the soil.

18. An effluent treatment system according to Claim 16 or Claim 17, wherein said duct provides for spray-form release of treated effluent to a surface region of the soil of said land area.

19. An effluent treatment system according to any preceding claim, comprising a filter between said clarification and settlement and disinfection treatment stages.
20. An effluent treatment system according to any preceding claim, wherein said treatment stages are accommodated in a plurality of modular tanks, the number and size of said tanks being variable in dependence on the required capacity of the effluent treatment system.

21. An effluent treatment system comprising:
   (a) at least one anaerobic primary treatment tank,
   (b) at least one compartmented treatment tank in which at least one compartment contains a bacteria growth medium, and
   (c) at least one tank containing a settling chamber.

22. An effluent treatment system according to Claim 20 or Claim 21, comprising at least two compartmented treatment tanks.

23. An effluent treatment system according to Claim 22, wherein at least one of said at least two compartmented treatment tanks defines at least a portion of an aerobic treatment stage.

24. An effluent treatment system according to Claim 23, wherein input of oxygen to said aerobic treatment stage is effected by discharge of air from air ducts located in the region of the base of the tank.

25. An effluent treatment system according to any of Claims 22 to 24, wherein at least one of said at least two compartmented treatment tanks comprises a nitrification compartment to which there is selectively controllable input of air.

26. An effluent treatment system according to any of Claims 20 to 25, comprising a primary settlement chamber in communication with said anaerobic primary treatment tank for flow of liquid effluent from said primary settlement tank to said anaerobic primary treatment tank.

27. An effluent treatment system according to any of Claims 20
to 26, wherein communication is effected between the tanks of the system by duct means commencing and terminating in tank regions such that dead spots in fluid flow are substantially minimised and a dynamic circulatory action is achieved.

28. An effluent treatment system according to any of Claims 20 to 27, wherein at least two of the tanks are sealed to the exterior environment and means are provided enabling communication between said at least two tanks for transfer of gases present in the tanks above the liquid level within the tank system.

29. An effluent treatment system according to any of Claims 20 to 28, wherein at least one of a multiplicity of compartments of at least one compartmented tank of the system contains bacteria growth medium.

30. An effluent treatment system according to Claim 29, wherein all of the compartments of said at least one compartmented tank contain bacteria growth medium.

31. An effluent treatment system according to any preceding claim, wherein at least one sub-stage of said primary settlement and anaerobic treatment and said aerobic treatment stages comprises bacteria growth medium.

32. An effluent treatment system according to Claim 31 wherein said anaerobic treatment stage and each of a plurality of sub-stages of said aerobic treatment stage comprise bacteria growth medium.

33. An effluent treatment system according to any of Claims 29 to 32, wherein said bacteria growth medium comprises a plurality of partitioned corrugated sheets.

34. An effluent treatment system substantially as described herein with reference to and as shown in any one or more of the accompanying drawings.
INTERNATIONAL SEARCH REPORT

I. CLASSIFICATION OF SUBJECT MATTER

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 C02F3/12; C02F3/30

II. FIELDS SEARCHED

Minimum Documentation Searched

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<td>C02F</td>
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Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched

III. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of Document, with indication, where appropriate, of the relevant passages</th>
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<tr>
<td>X</td>
<td>EP,A,0 302 030 (OMNIA RESINA MAZZOTTI S.R.L.) 1 February 1989 see the whole document</td>
<td>1,4,6</td>
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IV. CERTIFICATION

Date of the Actual Completion of the International Search 19 MAY 1993

Date of Mailing of this International Search Report 16.06.93

International Searching Authority

EUROPEAN PATENT OFFICE

Signature of Authorized Officer

GONZALEZ ARIAS, M.L.
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