PUBLISHED

MAY 25, 1943.

BY A. P. C.

A. SCHREIBER

METHODS AND MEANS FOR PURIFYING SEWAGE AND THE LIKE

Filed Nov. 10, 1939

Serial No. 303,853

3 Sheets-Sheet 1

Fig.1 (A-B-C)

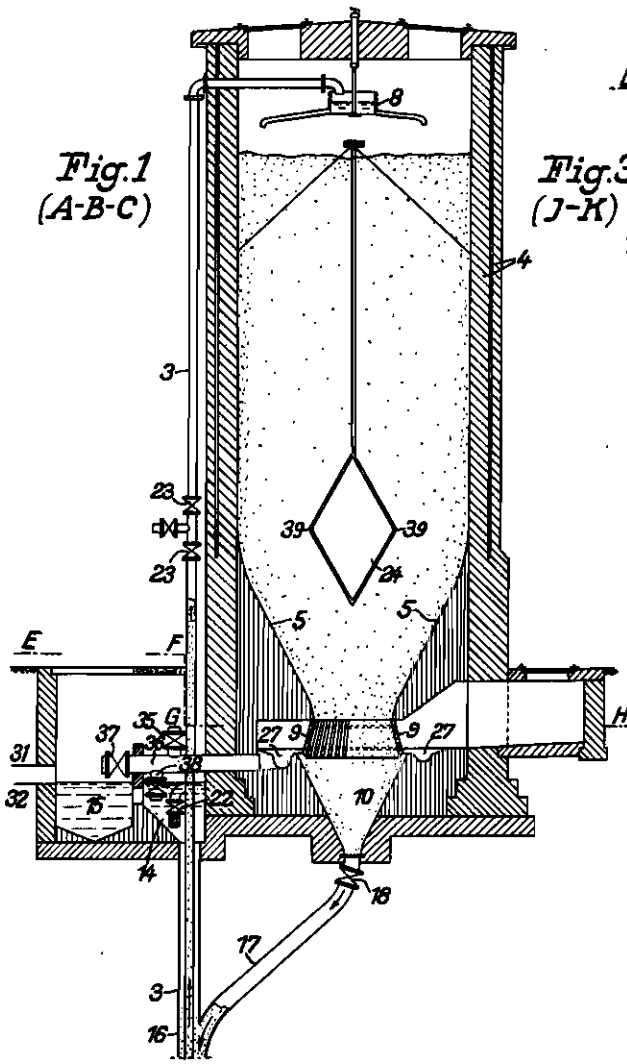
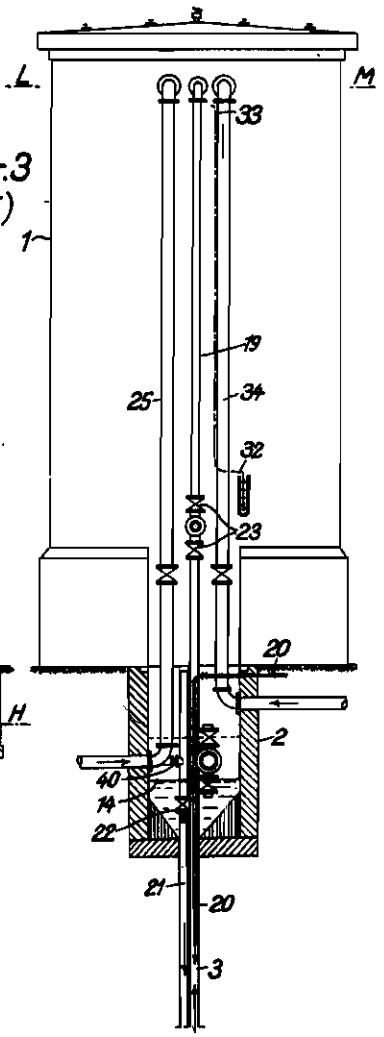


Fig.3 (J-K)



Inventor:
August Schreiber
By Peter, Rinn & Schaffer,
attorneys.

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Fig. 2
(E-F-G-H)

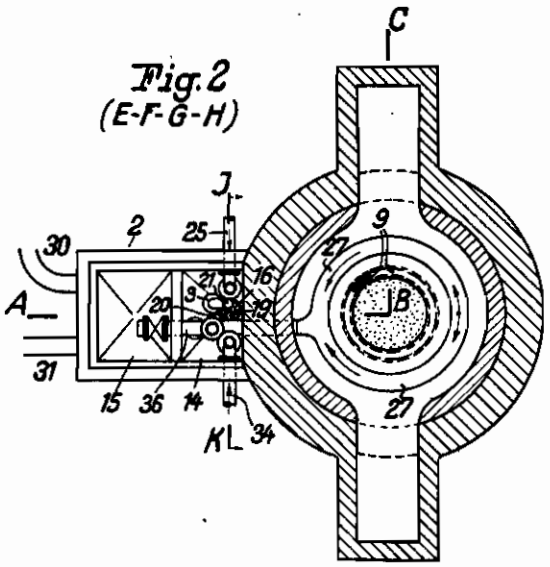
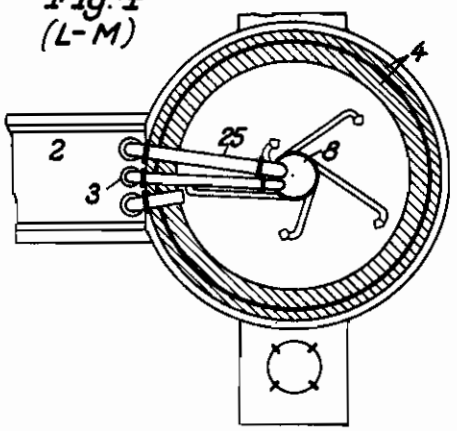


Fig. 4
(L-M)



Inventor:
August Schreiber,
By Peter, Pierce & Schaffler,
attorneys.

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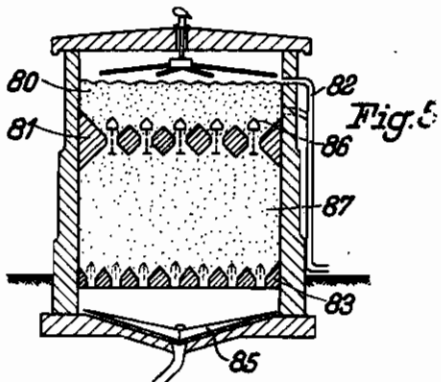

Fig. 5

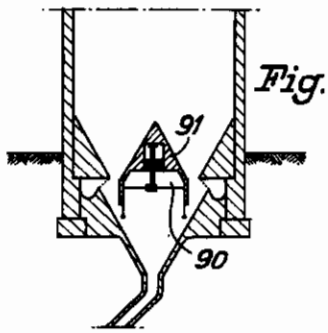

Fig. 6

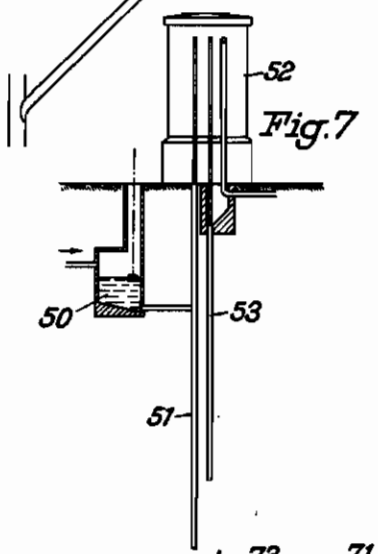

Fig. 7

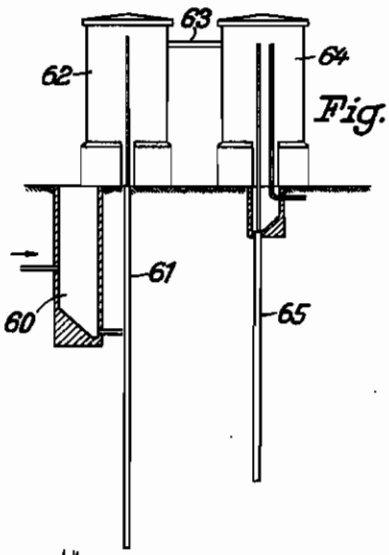

Fig. 8

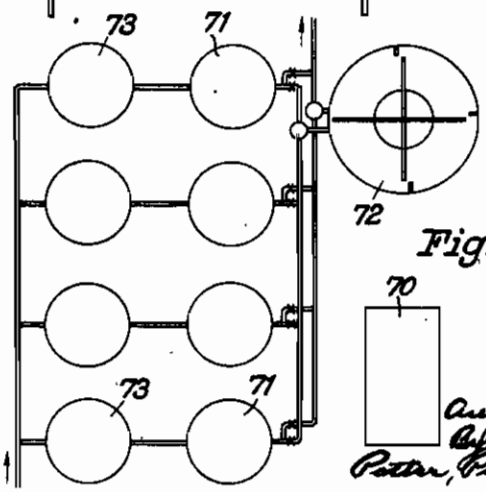

Fig. 9

Inventor:
August Schreiber,
By
Paton, Pierce & Scheffler
Attorneys.

Published May 25, 1943 Serial No. 303,853

ALIEN PROPERTY CUSTODIAN

METHODS AND MEANS FOR PURIFYING SEWAGE AND THE LIKE

August Schreiber, Stahnsdorf/Berlin, Germany; vested in the Alien Property Custodian

Application filed November 10, 1939

The present invention relates to methods and means for purifying sewage, other foul waters and the like, and it is more particularly concerned with improved methods and means for the biological purification of sewage and the like.

It is known to use for the biological purification of sewage so-called trickling or percolating bodies, the liquid being fed to the top of these bodies which are filled with comparatively coarse particles of a suitable filling material or filtering medium such as slag, coke, clinker or other materials. The sewage, while slowly passing through the filling medium, is acted upon by microorganisms, whereby purification is attained.

It has now been found that the purification may be rendered more efficient and that the cubic capacity of a trickling or percolating body may substantially be incerased, if the filling material of the trickling or percolating body is turned over or repiled.

The invention enabled the use of a substantially finer grade of filling material than was hitherto used for the afore-mentioned purposes.

It is an object of the prescnt invention to purify biologically sewage and the like, by allowing the sewage to trickle or pass slowly through a body or pile of filling material which is turned over or repiled in the course of the purification process.

In a preferred form of the invention, the withdrawing and repiling of the filling material is carried out at intervals and without interrupting the passage of the sewage through the trickling body.

It is a further object of the invention to purify the portion of the filling material withdrawn from the trickling body, before returning it to the latter.

In a preferred modification of the invention, the filling material which is to be turned over, is drawn off at the bottom of the trickling body, and is then returned to the top surface of the body. The respective portion of the filling material may be added to the sewage, and fed to the top surface of the trickling body, together with the sewage. Before returning the filling material, it may be freed from sludge and other impurities, for instance by washing the filling material. Or the sludge may be sucked off while the filling material is being turned over. The washing of the filling material may be carried out in a separate tank or within the apparatus which serves for withdrawing and returning the filling material.

The air required for biological purification may be fed through the trickling body in the direction of sewage or in a counter-stream. The air under pressure of the apparatus serving for turning over the filling material, as well as the air under pressure of the lifting means for the sewage, may be used for this purpose.

The invention is also concerned with improved means for carrying out the improved purification method. These means comprise a filtering or trickling body filled with a suitable filling material, means for feeding the sewage and for discharging the purified sewage from the trickling body, and means for withdrawing the filling material from, and returning it to, the body.

In a preferred form of the improved apparatus, the means for feeding the sewage serve at the time for the distribution of the filling material on the top surface of the body. Said means may be actuated automatically by the sewage, turbine-like distributors being particularly adapted for that purpose.

For the turning over and the repiling of the filling material, mammoth pumps may be used. Other objects of the invention will be apparent as the description proceeds and when taken in conjunction with the accompanying drawings, representing schematically and by way of example preferred embodiments of the invention.

Figure 1 is a longitudinal section through a filtering or trickling body on line ABC of Figure 2.

Figure 2 is a cross-section taken on line EFG of Figure 1.

Figure 3 is a side-view, partly in section on line IK of Figure 2.

Figure 4 is a cross-section taken on line LM of Figure 3.

Figure 5 is a longitudinal section through a modified structure with a two-step trickling body.

Figure 6 shows a further modified structure of the lower part of the trickling or filtering body.

Figure 7 illustrates schematically in an outline-sketch a purification plant of the type described, together with the sewage lifting plant.

Figure 8 shows schematically in an outline-sketch a similar plant as illustrated in Figure 7, however with the interpolation of a mechanical purification.

Figure 9 illustrates the coordination of a plurality of trickling bodies with a common purifying or settling tank for after-treatment.

The purification plant according to Figures 1 to 4 comprises the trickling or filtering body proper 1 and the rinsing pit 2. The wall 4 of the trickling body is provided in its lower portion with gliding faces 5 along which the filling of the trickling or filtering body, hereinafter called filling charge slides down during the turnover or repiling process. The even sliding down of the slag is supported by the guiding element 24. The latter is preferably designed in the shape of a double cone and is so arranged that its corner points 39 are on substantially the same level with the starting points of the gliding faces 5.

The surface of the lower cone preferably extends parallel with the gliding faces. The lower portion of the trickle or filter plant is formed by a funnel **10**. Between the latter and the filtering body proper a grate **9** is arranged which is surrounded by a gully **27**.

A pipe **25** conducts the sewage to be purified to the upper part of the plant, where it is distributed over the top surface of the filling charge by a rotating distributor **8**. The latter is preferably designed in the shape of a rotating sprinkler having several arms differing in length. Then the sewage trickles through the filling charge, and is conducted away by a discharge pipe **36**.

A filling charge discharge pipe **17** provided with a valve **18** is connected to the lowermost portion of the funnel **10**. During the turnover or repiling step, the filling charge is delivered through pipe **17** to the mammoth pump pool **18**, from where it is also fed to the rotating distributor **8** by the mammoth pump **3** through the raising tube **19** of the mammoth pump, said tube being provided with stop valve means **23** with branch line.

The rinsing pit **2** is subdivided in a return pit **14** and a sand-basket **15**, from which discharge pipes **30** and **31** lead to an additional purifying or settling tank and the pre-flooder respectively.

For the airing of the purification plant there are provided an upper aeration pipe **34** and a lower conduit **35**. For the airing the compressed air of the sewage lifting device or of the filling charge turnover pump may be used. It is also possible to use the air from the mechanical preliminary purification for the airing of the biological trickling or filtering plant. It is advisable to control the air supply of the trickling or filtering body by means of a pressure measuring instrument **32** which, in the form of appliance shown, is connected to the interior of the body at **33** (Figure 3).

If the purifying effect of the filtering body decreases, or if the pressure indicated at the super-pressure measuring instrument **32** rises, it is advisable to repile the filling charge. For this purpose, the stop valve **18** of the filling charge pipe **17** is opened, the mammoth pump **3** is connected, and the valves **23** of the raising-tube conduit **19** are opened. The mammoth pump then withdraws filling material from the lower part of the purification plant and returns the withdrawn material through raising-conduit **19** to the upper part of the plant. Part of the sludge adhering to the filling material is brushed of at grate **9** while the filling material moves downwardly through the interior of the grate. This sludge is then washed off by the sewage which flows to the gully **27** passing through the openings of the grate from the interior to the exterior. The sewage and the sludge are then drained off through pipe **38**.

The bulk of the filling material to be turned over is withdrawn through pipe **17**. However, at the same time, during this working step, individual particles of the filling charge pass through the openings of grate **9** together with the sewage flowing off. It is suitable not to directly conduct, during this period, the sewage from the sewage discharge tube **38** into the sandbag compartment **15** of the rinsing pit, but to conduct it, by appropriate adjustment of the valve, into the return pit **14**. The particles of the filling charge separate there and unite in the mammoth pump with the main portion of the filling material, while sludge and sewage, together with the finest particles of the filling material flow over into the sandbag **15**.

In the outer pipe of the mammoth pump **3** containing the raising-conduit **19** and the air supplying tube **20** of the mammoth pump, a rinsing pipe **21** may be arranged, having stop valve **22** provided with a protecting basket. By means of this pipe additional rinsing water may be supplied to the lower portion of the mammoth pump in order to make sure that the amount of water required for the conveyance of the filling material is always available. The rinsing tube feeds additional rinsing water, if valve **22** is open, from return pit **14**, or it may be directly connected to a pressure line of the sewage supply **25**, as indicated in Figure 3 at **40**. With the pressure line **40** open, the great super-pressure causes part of the water or sewage in the outer pipe of the mammoth pump to flow through the filling material upwards, bringing about a very efficient additional separation of sludge from the filling material.

Figure 5 shows a trickling or filtering body working on the same principle, namely with a turning over and repiling of the filling charge. This body, however, is adapted to carry out the method in two steps. The respective plant is sub-divided into an upper compartment **80** and a lower compartment **87** by an intermediary bottom **81** provided with valves **86** for the passage of sewage, air and filling material. The bottom **83** of the lower compartment **87** is also provided with valves for the passing through of filling material. At **85** a scraper for the filling charge is indicated. If with this construction the filling charge is to be turned over or repiled, first of all the upper compartment **80**, which is most of all silted up, is washed out. To this end, the upper valves **86** of the intermediary bottom **81** are closed, and the filling charge of compartment **80** is washed out by means of compressed air and/or liquid under pressure. The sludge is then drawn off through line **82**. Only after this had been done, the filling charge is turned over after the same principle as described in connection with Figures 1 to 4. For this purpose, it is necessary to open the valves of the intermediary bottom **81** as well as the valves in the bottom **83**. The valves may be actuated for example by air pressure, or in any other suitable way.

Instead of a plant subdivided into two compartments, a plant subdivided into three or more compartments may be provided, in which would be provided a correspondingly increased number of intermediary bottoms.

Figure 6 illustrates a special design of the lower portion of the trickling or filtering plant. In the place of the mechanically actuated stop valve **18** designated in Figures 1 to 4, a stop device is provided which keeps the lower-most portion **10** of the plant free from filling material during the normal operation of the plant. This device consists of a bell valve **90** which, for example, may be lifted and lowered by compressed air, said bell valve opening, in the lifted position indicated in Figure 6, a passage for the filling material, while, when the valve is in a lowered position, the discharge and turning over conduit **18** for the filling material is shut off. Part **91** corresponds to guiding element **24** of the structure shown in Figures 1 to 4. The design of the lower part of the purification plant according to Figure 6, has the advantage of no unaired

filling material being present in the funnel-like lowermost part, during normal operation of the plant.

In most cases, the sewage arrives on a lower level than that of the inlet into the trickling plant. It is therefore necessary to lift the sewage. In cases like that, a simple and suitable design of the plant is achieved by utilizing for the raising of the sewage the mammoth pump plant for the turning over of the filling charge. By doing this, an additional compressor aggregate is dispensed with. This is schematically indicated in Figure 7. The sewage to be purified flows into a sewage pond **50** and from there into the mammoth pump **51** which lifts it on top of the trickling element **52**. The same compressing aggregate drives the mammoth pump **53** for the turning over of the filling charge.

It is also possible to provide for a plurality of smaller plants a common transportable air compressor for the turning over of the filling charge.

In the case of provisional purifying plants, the outer walls of the trickling elements may be made of wooden staffs held together by iron rings. The bottom and the upper wall, as well as the mammoth pump and the machine house, may be made transportable.

In most cases the sewage must be subjected to a mechanical pre-clarification before being biologically purified in a trickling or filtering body. Figure 8 shows schematically an appropriate design of such a plant. The fresh sewage flows into a sewage pond **60** from where it is fed to mammoth pump **61** which lifts the sewage to plant **62** for mechanical pre-purification. From there the mechanically pre-purified sewage is conveyed via conduit **63** to the trickling body **64**. The mammoth pump **61** for the unpurified sewage and the mammoth pump **65** for turning over the trickling body **64** are actuated by a common air compressor aggregate.

It is generally advisable to select the size of the trickling body in proportion to the amount of sewage daily to be purified in such a manner that the turning over of the filtering material need be undertaken only after long periods of time, say, for example, every fifth or sixth day. During the step of turning over the filling material, or respectively in the case of the arrangement according to Figure 5 during the turning over and the washing out filling material, the purified sewage leaving the purification plant carries pretty much sludge, which makes it advisable to conduct the sewage during these steps not directly to the pre-flooder but to an additional clarification or settling tank. During the remaining working operations of the purifying plant, however, this is in most cases not necessary. A plant according to the scheme illustrated in Figure 9 will answer this purpose. A number of filtering or trickling plants **71** (four of which are indicated in Figure 7) cooperate with a common settling tank **72** for after-treatment. A plant **73** for mechanical pre-purification is coordinated to each of the trickling bodies. The discharge of each trickling body may be conducted selectively either to the additional clarifying tank **72**, or immediately to the pre-flooder. The discharge conduit is connected in each case in a manner such that the discharge from the trickling body just about to be repiled is fed to the additional clarifying tank **72**, whereas the discharge of the remaining, normally working trickling bodies, is conducted away without passing the additional clarifying tank. At **70** is indicated schematically engine-house.

Instead of delivering to an additional clarifying tank the portion of the sewage, which accumulates during the turning-over step and thus still carries considerable quantities of sludge, this relatively small portion of the total amount of accumulating purified sewage may be returned to the mechanical pre-clarifier, thus enabling to work without an additional clarifying tank.

Instead of withdrawing and repiling the filling material at intervals the plant may be also operated with continuously carrying through this measure.

Furthermore, the plant may be operated in such a manner as to inundate the entire filtering material, the plant operating then as a regular underwater filter.

Volcanic gravel, light chemical slag, stone splinters and the like may be for example used as filling material. There is, however, a great variety of other suitable materials as is known to the man skilled in the art.

The method of repiling brings about an exceedingly great increase in the output of the purifying plant. While it was hitherto possible to purify in the customary trickling bodies a quantity of sewage per day which corresponded approximately to the simple or twofold volume of the trickling body, it is possible when using the methods of the invention, to purify for example an amount of sewage corresponding to the tenfold volume of the trickling body within a day. Under favourable conditions, it is even possible to increase the quantity of sewage to the thirty-fold volume of the trickling body per day.

The invention allows the use of filling material of considerably smaller pieces, or finer grade as was hitherto used for the purification of sewage. For example, for sewage purifying plants with a volume of 11 to 12 cbm., filling charges have shown to be suitable with which the largest dimension of the single particle was between 5 to 10 mm. However, even finer granulation may be used. Hitherto, fine granulations like that were regarded as unsuitable in sewage purification, because it was experienced with the customary trickling or filtering bodies without the method of turning over and repiling, that when using fine granulations, silting up and processes of decay took place which gradually destroyed the efficiency of the sewage purifying plant.

In order to increase the effect of purification and to facilitate the drawing off of the sludge, additional substances may be admixed with the filling material during the turning over, which cause neutralization, flocculation and/or binding of substances to be removed from the sewage, more particularly of such of the impurities which are present in the sewage in excess. For example, if purifying chemical sewage containing sulfuric acid, it is recommended to add during the turning over to the withdrawn part of the filling material lime-stone splinter which is then fed to the trickling body, when repiling the filling charge and is decomposed in the trickling body, while binding the sulfuric acid. When the turning over is repeated, the decomposed splinter may be replaced by adding a fresh supply of lime-stone splinter.

AUGUST SCHREIBER.