July 26, 1966 M. F. PETERS 3,262,566

DETERGENT, FAT, OIL AND GREASE REMOVING APPARATUS

Filed Sept. 3, 1963

4 Sheets-Sheet 1

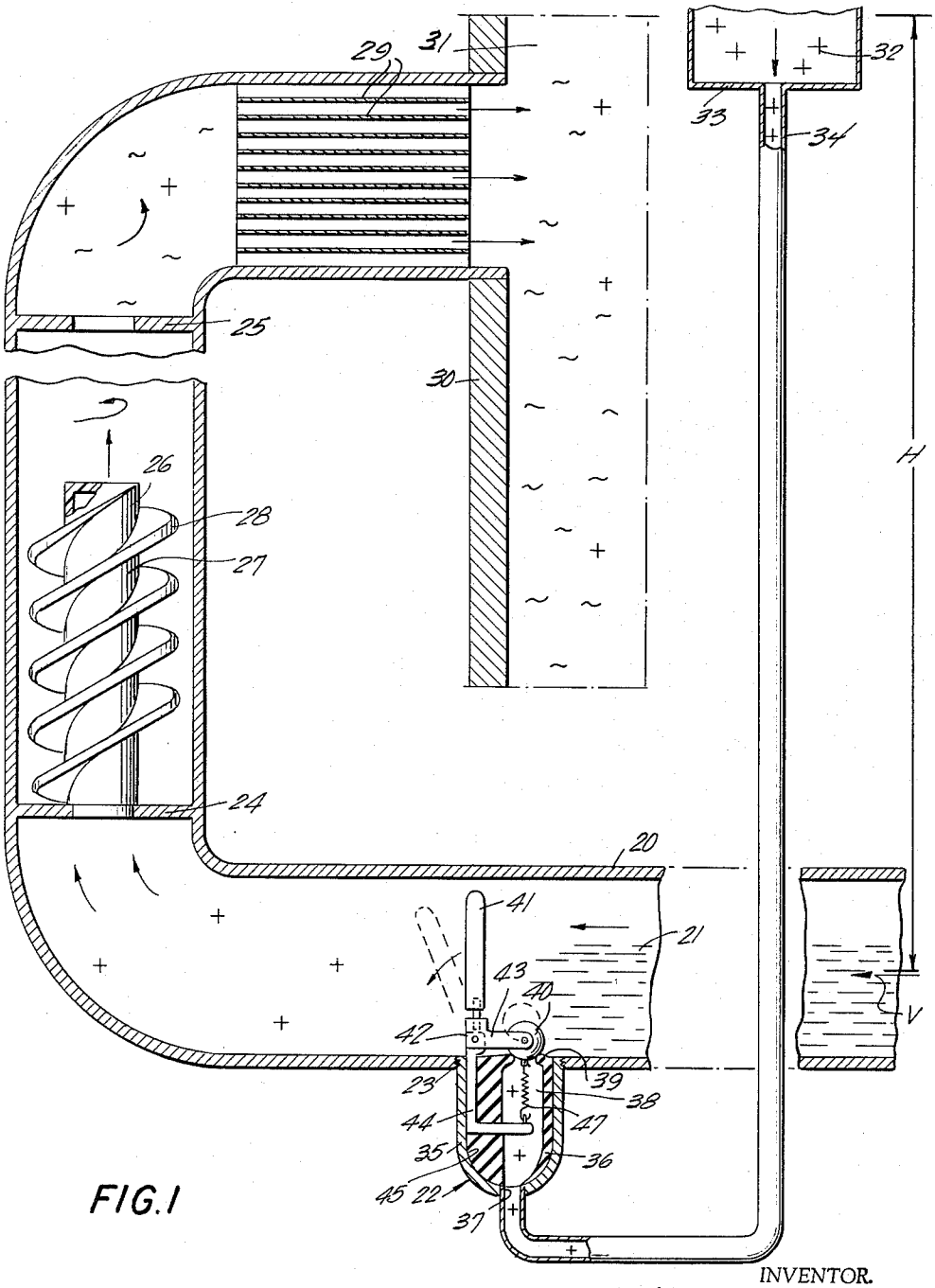


FIG. 1

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Filed Sept. 3, 1963 4 Sheets-Sheet 2

FIG. 2

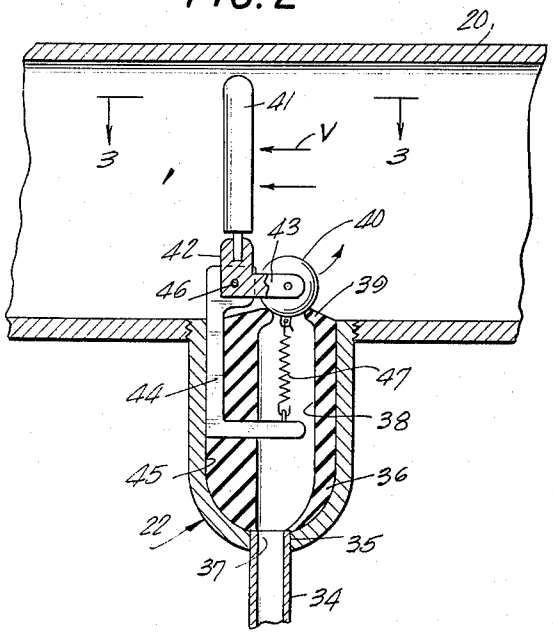
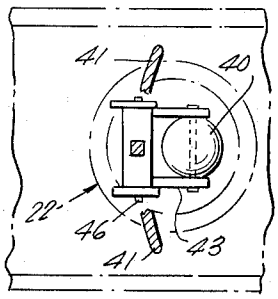



FIG. 3



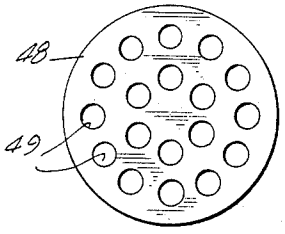




FIG. 5

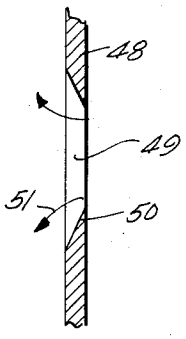



FIG. 6

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July 26, 1966 M. F. PETERS 3,262,566

DETERGENT, FAT, OIL AND GREASE REMOVING APPARATUS

Filed Sept. 3, 1963 4 Sheets-Sheet 3

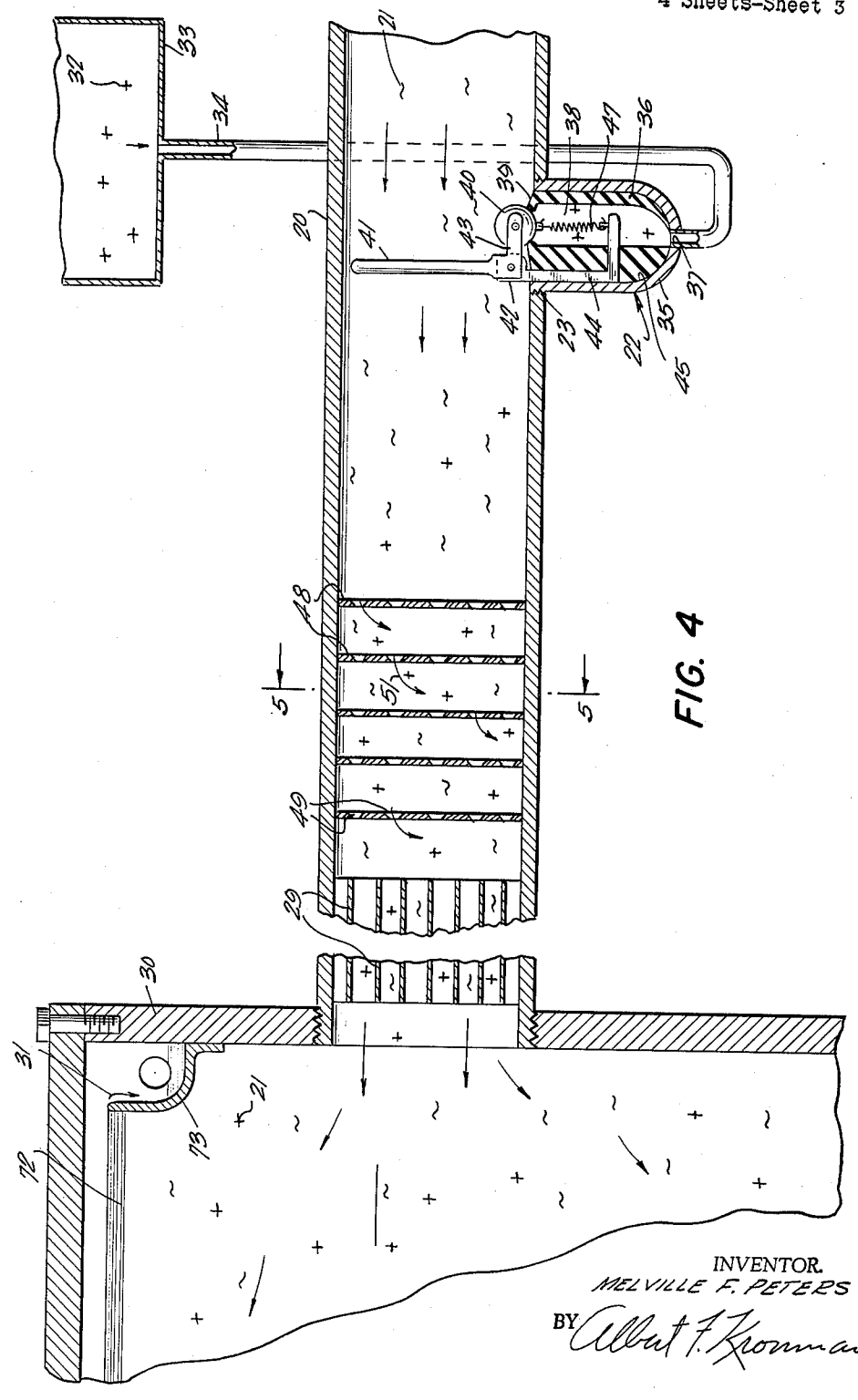


FIG. 4

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July 26, 1966 M. F. PETERS 3,262,566

DETERGENT, FAT, OIL AND GREASE REMOVING APPARATUS

Filed Sept. 3, 1963

4 Sheets-Sheet 4

FIG. 7

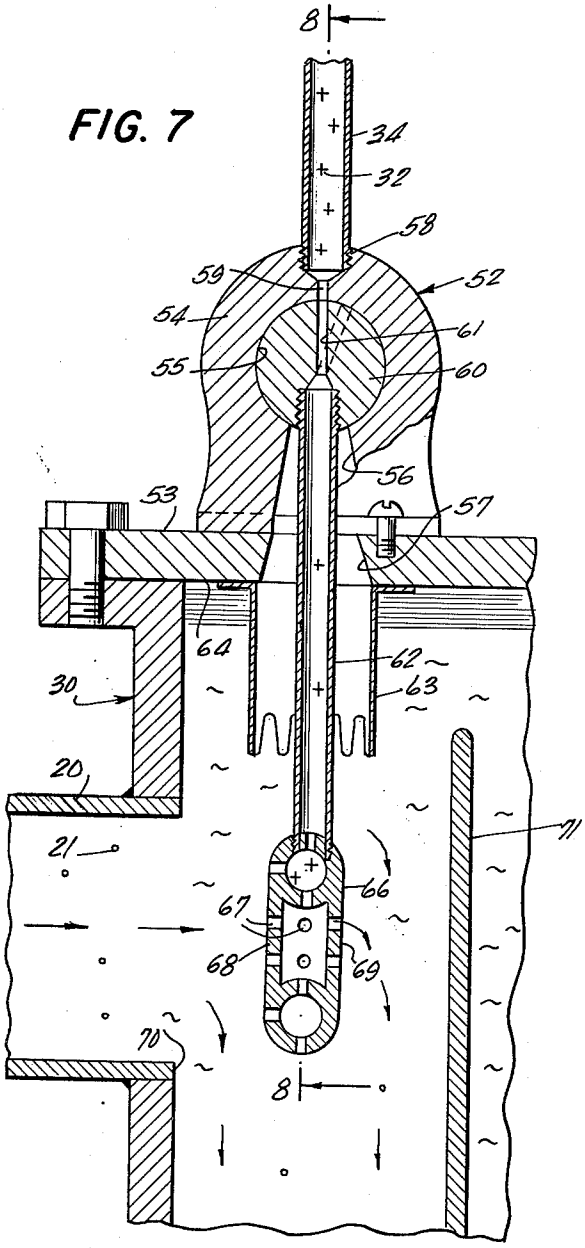
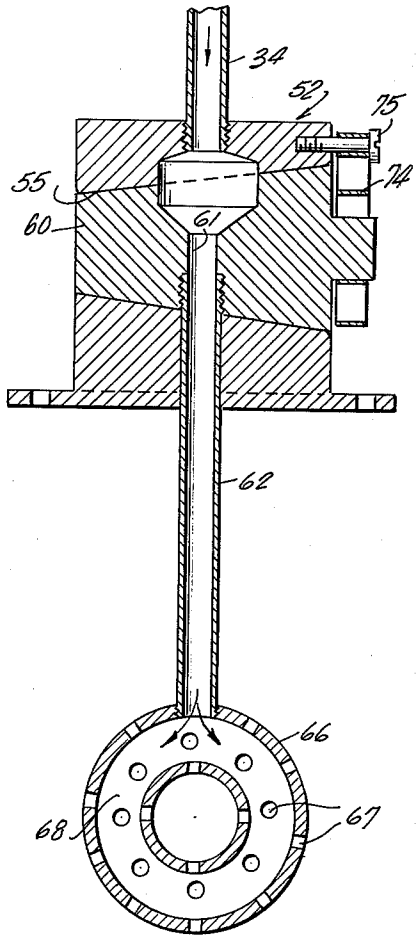



FIG. 8

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United States Patent Office

3,262,566

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3,262,566

# DETERGENT, FAT, OIL AND GREASE REMOVING APPARATUS

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3 Claims. (Cl. 210—101)

This invention relates to apparatus and methods for removing fats, greases, oils and detergents from water and particularly to the elimination of such materials from waste water in which they may be finely dispersed in a caustic alkali, soap or detergent solution.

As used hereinafter, the word hydrocarbons is meant to indicate the presence of fats, greases, oils and detergents separately or in combination.

It is well known that soaps, detergents and many soap builders are excellent emulsifiers for oil-in-water emulsions. The active molecules in a soap or detergent must consist of two groups. One group in the molecule, said to be hydrophilic is soluble in water and the other group, said to be hydrophobic is soluble in hydrocarbons. The effectiveness of detergents or soaps as emulsifiers is readily demonstrated by first pouring a small amount of salad oil or melted bacon fat into a flask partly filled with water. Regardless of how hard the flask and contents are shaken, it will be found that after the flask is allowed to remain at rest for a few minutes the fat and oil will come to the surface without any measurable decrease in the quantity of fat or oil added to the mixture. If a soap or detergent is added to the water in the flask, after which fat or salad oil is added to the mixture, it will be found after the flask and contents are shaken and allowed to stand for some time, that a portion of the fat and oil will be floating on the surface and a portion of the fat and oil will be suspended in the water in the form of an emulsion.

Emulsions of hydrocarbons in water formed in the presence of soap and soap builders are relatively stable and it is believed that each particle of fat, grease and oil in the emulsion has dissolved the hydrophobic portion of the carbon chain of the soap or detergent and allowed the hydrophilic portion which is the water soluble portion of the molecule, to remain or project into the water. Either because of the detergent, soap or detergent and soap builders, the water soluble end of the detergent will cause the particles of hydrocarbons to be surrounded by positive or negative electrical charges and these electrical charges will give the particles of emulsified hydrocarbons an electrical charge. Since the particles of like hydrocarbons in the emulsified state have electrical charges of the same sign, the particles will repel each other and the emulsified hydrocarbons in water can be said to be of a permanent nature when gravity separation of emulsified hydrocarbons in water must take place in periods of time which must be measured in minutes.

The stability of the emulsion can be destroyed or the emulsion defloculated by the removal or neutralization of the electrical charges from the emulsified particles of hydrocarbons, since removal of the charges allows the particles of fats, grease, oils, and detergents to come together to form larger fat particles, larger grease particles, larger oil particles and larger detergent particles. These detergent particles are known as micelles or colloids. The larger particles of fats, grease, oil and detergents having no electrical charges will rise to the surface in a relatively short time and form a continuous layer of fat, grease, oil and scum over the surface of the waste water. If the fat and grease is soluble in the oil, the fat, grease and oil may combine while suspended in the liquid, or the oil may dissolve the fat and grease after they reach the surface. Regardless of whether the oil dissolves the fat



and grease while both fat, grease and oil are suspended in the liquid, or after the fat, grease and oil reaches the surface, or whether each hydrocarbon is soluble in the others, a single layer of liquid consisting of fat, grease, oil and scum together with air bubbles will cover the surface of the water. If the temperature of the liquid in the separator is lowered below the hardening temperature of the mixture of the hydrocarbons, the mixture will float on the surface of the water in the solid state.

Removal of electrical charges from the particles of emulsified fat, grease oil-in-water and colloidal detergent is most readily accomplished by adding an electrolyte to the water. Experiments have proved that detergents which form particles or micelles with negative charges and are said to be anionic, or form particles with positive charges and are said to be cationic, will have their charges removed by the addition of an electrolyte. These uncharged particles have been found to coagulate, rise to the surface with the uncharged fats, grease and oils and remain there long enough to be removed by flushing into an overflow trough each time waste water passes through the separator. Other methods which have proved effective is to scrape the scum into the overflow with a mechanical wiper or add a compound to the water which produces a great enough surface tension as it spreads over the surface of the water to force the scum into the trough.

Electrolytes will produce soaps which are insoluble in water if the metal ions are not one of the alkali metals. For example, when an electrolyte containing calcium or magnesium is added to the soap solution, the sodium in the soap is replaced by the calcium or magnesium to produce an insoluble soap, so that with the addition of an electrolyte containing a non-alkali metal to the soap solution to defloculate the water-oil emulsion, a curd will be formed that will rise to the surface of the water with the grease and oil.

Electrolytes containing calcium ions will combine with many organic compounds dispersed in water. These calcium compounds will rise and form a brittle non-elastic mono-layer over the surface of the water. It is known that these brittle non-elastic layers will not support foams or froths and consequently calcium salts can be used to collapse the bubbles when solutions of water and detergents are agitated. The presence of these bubbles have been found to interfere with the flowing of liquid through conduits and to reduce the effective volume of the chamber in the separator reserved for the water during its stand-by period. This decrease in effective separator volume has the same effect as using an undersized separator and reduces the percentage of hydrocarbons removed from the waste water.

Over 95 percent of the fats, greases and oils similar to the hydrocarbons found in the drain water from dish washers can be recovered from a separator such as is used in the plumbing industry, providing the water does not contain detergents which hold these hydrocarbons in an emulsified form. When the hydrocarbons are emulsified by adding detergents to the dish water and the mixture shaken violently such as takes place during the dish washing cycle, the percentage of hydrocarbon recovered in the separator is only of the order of 40 percent.

It was found in conducting tests on waste water containing soap, fats, grease, oil and detergents, that three conditions had to be closely followed to cause the hydrocarbons to be economically separated from the waste water by rising to the surface of the water in a reasonable length of time. First, an electrolyte must be added and thoroughly mixed with the waste water, second, the electrolyte must be metered into the waste water, as an insufficient amount of electrolyte will not completely defloculate the emulsion and too much electrolyte will

add to the cost of operating the unit, or delay deflocculation of the emulsion and third, the waste waters should enter the separator quietly so as not to disturb the layer of hydrocarbons which were collected on the surface of the waste water during previous operations of the hydrocarbon separator.

Practically these three conditions are satisfied by first introducing the electrolyte into the system with a metering valve which introduces a quantity of electrolyte proportional to the volume of waste water and soap entering the inlet pipe, second, passing the waste water and electrolyte through a mixing assembly and third, introducing between the mixing assembly and the separator a device to remove the whirling action from the waste waters, so that the waste water flows gently into the separator without a cavitating or whirling action.

Accordingly it is an object of the present invention to remove fat, grease, oil, soap and detergents from water containing these compounds dispersed in a caustic alkali detergent solution.

Another object of the present invention is to provide an economical continuous means for removing hydrocarbons from water.

A further object of the present invention is to provide apparatus and a method for removing hydrocarbons from water which is compatible with presently used equipment.

Still another object of the present invention is to reduce the stability of hydrocarbons-in-water emulsions to effect hydrocarbon separation.

An object of the present invention is to provide apparatus for the separation of hydrocarbons from water which may employ gravity as well as centrifugal separation as the final step.

A feature of the present invention is its use of one or more compounds as an additive to hydrocarbon bearing waste waters to reduce the stability of the emulsions.

Another feature of the present invention is its use of centrifuges to remove the hydrocarbons from the waste water treated in accordance with the present invention.

A feature of the present invention is its use of settling tanks whereby the hydrocarbons in the treated waste water will rise to the surface for easy removal.

Still another feature of the present invention is its use of a controlled temperature to convert the separated hydrocarbons into a curd or cake for easy removal.

A further feature of the present invention is its use of de-emulsifying reagents in waste water in metered quantities proportional to the volume of the waste water, or the amount of hydrocarbons therein.

A feature of the present invention is its use of the rate of flow of the waste water in the inlet conduit to control the amount of electrolyte introduced into the waste water.

Still another feature of the present invention is the mixing of the de-emulsifying agent with the waste waters by means of a rotating or spinning member which is supported and turned by the flowing waste water.

A feature of the present invention is its use of fixed louvers and screens to impart a whirling action to aid in the mixture of waste water and additives and thereafter pass the mixed liquids through a second series of louvers to remove the whirling motion therefrom to promote hydrocarbon separation.

The invention consists of the construction, combination and arrangement of parts and steps of the method, as herein illustrated, described and claimed.

In the accompanying drawings, forming a part hereof are illustrated several embodiments of the invention, and in which:

FIGURE 1 is a fragmentary view in vertical section of one complete embodiment of the present invention.

FIGURE 2 is a view in vertical section on an enlarged scale of the metering device shown in FIGURE 1.



FIGURE 3 is a sectional view taken on line 3—3 in FIGURE 2 looking in the direction of the arrows.

FIGURE 4 is a fragmentary view in vertical section of a second complete embodiment of the present invention.

FIGURE 5 is a sectional view taken on line 5—5 in FIGURE 4 looking in the direction of the arrows.

FIGURE 6 is a fragmentary view in cross section somewhat enlarged showing the manner in which a mixing turbulence is created by the openings in the disc shown in FIGURE 5.

FIGURE 7 is a fragmentary view in vertical section of still another embodiment of the present invention.

FIGURE 8 is a sectional view taken in line 8—8 in FIGURE 7 looking in the direction of the arrows.

Referring to the drawings and particularly to FIGURES 1 and 2, **20** indicates a pipe or conduit through which flows a liquid **21** such as waste water. The liquid **21** may contain hydrocarbons such as oil, grease, fats and the like in a fine emulsion together with a soap, or detergent.

A metering valve assembly **22** is secured to the pipe **20** in any suitable manner as indicated by the threads **23**. The metering valve assembly **22** serves to dispense a quantity of an electrolyte into the flowing liquid **21** in a hereinafter more fully explained manner.

Spaced shoulder or stop members **24**, **25** are disposed within the pipe **20** beyond the metering valve assembly **22**. The shoulders limit the longitudinal movement of an impeller **26** carried within the pipe **20** between the shoulders **24**, **25**. The impeller **26** is in the form of a cylinder **27** having a series of helical vanes **28** extending therefrom. The impeller **26** is preferably closed at each end so that the liquid **21** in flowing through the pipe **20** must pass through the vanes **28**.

Since the impeller is freely carried within the pipe **20** and of a small mass it will be spun by the moving liquid and impart an agitation to the liquid **21** which will thoroughly mix the electrolyte with the waste water **21**. Particles of food or solids in the water **21** can not stop the operation of the impeller since there are no bearings in the structure to become clogged. Moreover, the ability of the impeller to shift longitudinally between the shoulders **24**, **25** enables it to free itself from solid particles which may traverse the pipe **20**.

A series of parallel louvers **29** are supported within the pipe **20** beyond the impeller **26**. The mixed turbulent liquid **21** containing the electrolyte passes through the louvers **29**. The parallel louvers **29** substantially eliminate the turbulence from the liquid **21** which is thereafter discharged into a separator **30**.

It has been found that the yield of grease and oil in the waste water can be increased if the lines of flow of the liquid **21** entering the separator **30** are all substantially parallel to the axis of the inlet conduit. The louvers **29** are thus disposed parallel to the longitudinal axis of the pipe **20**. In addition, removing the whirling motions from the liquid **21** reduces agitation in the separator **30** so that layers of oil or hydrocarbons **31** previously collected on the surface of the liquid in the separator will be only slightly disturbed.

Within the separator **30** gravitational forces separate the lighter liquids from the heavier liquids. The hydrocarbons **31** being lighter rise to the surface from which they can be removed in any well-known manner.

In order to destroy the emulsion of hydrocarbons in the liquid **21** and cause them to rise to the surface of the separator **30** within a suitably short period of time, it is necessary to introduce and mix a metered amount of an electrolyte into the waste water.

Electrolytes having bivalent, trivalent, or higher valence ions are more effective in neutralizing the charges on the particles than univalent ions. Calcium chloride dissolved in water provides bivalent ions which have been found to neutralize the charges on the emulsions as well

as to cause the dissolved soap and detergent compounds to grow into micelles in the presence of the strong alkali solution supplied by the body builders used in combination with the detergents. It is these micelles collecting on the surface of the water which is called the curd or scum to differentiate it from the fat and grease particles.

Concentrated sea water, is another suitable electrolyte for the practice of the present invention.

The electrolyte **32** indicated by the + signs in FIGURES 1 and 2 is led from a reservoir **33** through a line **34** into the metering valve assembly **22**, best shown in FIGURES 1 and 2. The electrolyte **32** is led into the bottom of the metering valve housing **35** by the line **34**.

An elastomer insert **36** is carried within the housing **35**. The insert **36** is open at its lower end as indicated at **37** to admit the electrolyte **32** entering the housing **35**. A chamber **38** is provided in the insert **36** through which the electrolyte **32** passes into the pipe **20**. The top of the elastomer insert is moulded to form a seat **39** for a ball **40** whereby the passage of electrolyte out of the chamber **38** and into the pipe **20** may be regulated.

In order for the device shown in FIGURE 1 to operate successfully the amount of electrolyte entering the pipe **20** must be carefully controlled. A close relationship must be maintained between the quantity of waste water passing through the pipe **20** and the amount of electrolyte dispensed by the metering valve assembly. This relationship is maintained by the metering valve assembly **22** by means of a vane **41** which extends into the pipe **20** in the path of the liquid **21**. The vane **41** is secured at its lower end to an L shaped arm **42** the horizontal portion **43** of which is bifurcated as shown in FIGURE 3 to receive the ball **40**.

A bracket member **44** of somewhat "C" shape is secured to the inner wall **45** of the housing **35**. The upper portion of the bracket **44** extends above the housing **35** and serves as the bearing for a pin **46** upon which the arm **42** is journaled. The lower, horizontal portion of the bracket **44** serves to secure one end of a coil spring **47**. The opposite end of the spring **47** is secured to the ball **40**. The spring **47** holds the ball **40** upon the seat **39** of the insert **36** until the velocity V, of the liquid **21** passing through the pipe **20** is great enough to exert a force on the vane **41** in excess of the tension of the spring **47**. Since the quantity of liquid **21** passing through the pipe **20** is proportional to its velocity a direct relationship is maintained between the amount the ball **40** is lifted from the seat **39** and the amount of liquid **21** flowing past the metering valve assembly. The more the ball is lifted from the valve seat, the greater the amount of electrolyte entering the liquid **21** from the chamber **38**. The electrolyte **32** is maintained at a head H or pressure P, which for all practical purposes is constant, so as to insure the proportional metering of the electrolyte in response to displacement of the ball **40**.

The embodiment shown in FIGURE 4 is a particularly useful in installations where the pipes conducting the waste waters must be kept in a horizontal orientation. In this form of the invention, the pipe **20** on the down-stream side of the metering valve assembly **22** is provided with a series of discs **48** having a plurality of holes **49** therein. The holes **49** best shown in FIGURE 5 converge in the upstream direction as illustrated in the enlarged section of FIGURE 6. A sharp edge **50** is thus first encountered by the liquid **21** as it traverses the holes **49**. The sharp edge **50** causes the liquid **21** to cavitate or rotate as indicated by the arrows **51**. In this manner the liquid **21** and electrolyte **32** are caused to intermix as they traverse the discs **48**.

Following the mixing of the liquid **21** and electrolyte **32** it is necessary to introduce them into the separator or settling tank **30** with a minimum agitation of the materials already in the separator **30**. The louvers **29** which are identical in construction and disposition to those previously described in connection with FIGURE 1 serve this purpose.



The fats, grease, oils in combination with soaps and detergents, together with unused or excess detergents in wash water **21**, will rise to surface **72** to form a mixture of grease, fats, oils and precipitated detergents **31**. Tests made with the tracer dyes indicate that there is between fifty and sixty percent of the total quantity of detergent added to the wash water in the mixture of hydrocarbons and scum **31** floating on the surface **72** of wash water **21**. This fifty to sixty percent of detergent is in addition to the 40 to 30% of the detergent which has combined with the fats, grease and oils, to give an overall detergent recovery of 90% or more.

The mixture of hydrocarbons and scum **31** can be removed by forcing it into the over-flow trough **73** by scraping, or by increasing the height of wash water **21** as occurs when additional water flows into separator **30**, or by putting a chemical mixture on surface **72** opposite the overflow trough **73** which has a high enough surface tension to force residue **31** into the trough, such a mixture consists of five parts cetyl alcohol to one part stearic acid.

Another way of removing the scum or residue **31** is to reduce the temperature of the separator until scum **31** freezes into a solid when it may be removed as a cake.

The metering valve assembly **22** shown in FIGURE 4 and its associated reservoir **33** and line **34** are the same in structure and operation as that previously described in conjunction with FIGURE 1.

Referring to FIGURES 7 and 8 there is shown still another embodiment of the present invention in which the electrolyte is introduced into the waste water or liquid **21** after it enters the separator. The electrolyte **32** is led into the separator **30** through a modified stop cock valve assembly **52** which is secured to the cover **53** of the separator **30**. The body **54** of the valve **52** is provided with a tapered bore **55**. A somewhat rectangular opening **56** is machined in the body **54** and leads from the bore **55** to an aperture **57** in the cover **53**. A line **34** for leading the electrolyte **32** into the valve **52** is connected to the valve body **54** in any suitable manner as by the threads **58**. A somewhat rectangular chamber **59** in the valve body **54** connects the line **34** with the tapered bore **55**.

A tapered plug **60** of matching shape is received within the bore **55**. The plug **60** is transversely bored as indicated at **61** in FIGURES 7 and 8 to permit the electrolyte **32** to pass through the valve **52**. An elongated stem **62** is threadably secured within the lower portion of the transverse bore **61** and extends through the aperture **57** in the cover **53** into the separator **30**. The stem **62** can swing within the separator **30** as the plug **60** is rotated within the body **54** of the valve **52** in accordance with well-known stop cock operations. The extent of the stem swing is limited by the size of the aperture **57** and the opening **56** in the valve body **54**.

The moving valve members are protected from foreign matter and grease introduced into the separator **30**, by a cap **63** which is secured to the inside surface **64** of the cover **53**. The cap **63** overlies the aperture **57** and is disposed around the stem **62**. The free end of the cap **63** is closed by a bellows **65** which is secured at its outer edge to the cap and at its inside edge to the stem **62**.

The electrolyte **32** traverses the hollow stem **62** and enters a dispenser **66** on the free end of the stem within the separator **30**. The dispenser **66** is in the form of a hollow ring and is provided with a plurality of spaced holes **67** around its peripheries and on each of its faces **68, 69**. Electrolyte within the dispenser **66** passes into the liquid **21** entering the separator **30** through the pipe **20**. The dispenser is preferably disposed adjacent the inlet end **70** of the pipe **20** in such manner that the liquid **21** will mix with the electrolyte **32** by cavitation.

In order to prevent the cavitating and whirling liquid **21** and electrolyte **32** from disturbing the remainder of the material within the separator one or more baffles **71** are provided between the dispenser **66** and that portion of the separator in which the fats, oils and greases rise to the top of the liquid.

The amount of electrolyte entering the separator **30** in FIGURE 7 may be regulated by rotating the tapered plug **60** within the body **54** of the valve in accordance with stop cock type valve operations. Where the flow of waste liquid is intermittent, the tapered plug **60** may be provided with a helical spring **74** as shown in FIGURE 8. One end of the spring **74** is secured to the plug **60** and the opposite end to the body **54** of the stop cock valve **52** by means of a bolt **75**. The spring **74** normally holds the valve in a closed position as indicated by the dashed lines in FIGURE 7. When the waste water enters the separator **30** it forces the dispenser **66** to swing into the position shown in FIGURE 7, thereby permitting the electrolyte to flow into the waste water through the valve **52**. When the waste water stops flowing the spring **74** will again close the valve thereby conserving electrolyte.

The embodiment illustrated in FIGURES 7 and 8 while requiring a greater period of time for separation of the grease, fats, oils and detergents from the waste water will be particularly advantageous in collecting particles of soap precipitated by the electrolyte at the top of the separator. Since the electrolyte is mixed with the waste water within the separator the system can be made to occupy a small space.

While the separators shown and described herein have been of the gravity type it is within the purview of the present invention to employ other types of separators such as centrifugal separators in the final stage of the practice of the present inventions. Centrifugal separators will operate more efficiently and remove a greater proportion of the fats, grease, oils and detergents in waste water when preceded by the electrolyte dispensing and mixing elements described herein.

From the foregoing it will be seen that there has been provided devices and a method for eliminating a high percentage of fats, oils, greases, detergents and similar substances from waste water. The devices lend themselves to installation in conventional waste lines and will operate in a trouble-free manner over long periods of time. Since the hydrocarbons form a layer or curd at the top of the separator they can easily be removed from time to time as previously described. The high percentage of hydrocarbon and detergents extraction, moreover makes it possible to recover the purged waste water and reuse it for certain purposes.

Having thus fully described the invention, what is claimed as new and desired to be secured by Letters Patent of the United States, is:

**1.** A device for removing grease, oil, fats, detergents and the like from waste water comprising a pipe for the conduction of waste water, an electrolyte dispenser in communication with the waste water, comprising a source of electrolyte, valve means disposed between the source of electrolyte and the waste water conduction pipe comprising a housing in communication with the interior of the pipe, a chamber in the housing to receive the electrolyte, a valve portion at the top of the housing between the chamber and the pipe, and a vane extending into the pipe and responsive to the flow of waste water therethrough operatively secured to the valve portion to control the amount of electrolyte passing through the valve and into the waste water, whereby a quantity of an electrolyte is added to the waste water, means to mix the electrolyte and waste water, means to reduce the agitation of the waste water and electrolyte caused by said mixing, and a separator to receive the intermixed electrolyte and waste water.

**2.** A device for removing grease, oil, fats, detergents and the like from waste water comprising, a pipe for the conduction of waste water, an electrolyte dispenser responsive to the volume of waste water passing through the pipe in communication with the waste water, whereby a metered quantity of an electrolyte is added to the waste water, means disposed in the path of the waste water to mix the electrolyte and waste water comprising a helically vaned member freely carried within the pipe, means to reduce the agitation of the waste water and electrolyte caused by said mixing, and a separator to receive the intermixed electrolyte and waste water.

**3.** A device for removing grease, oil, fats, detergents and the like from waste water comprising a pipe for the conduction of waste water, an electrolyte dispenser responsive to the volume of waste water passing through the pipe in communication with the waste water, whereby a metered quantity of an electrolyte is added to the waste water, means disposed in the path of the waste water to mix the electrolyte and waste water, comprising a series of foraminous discs disposed across the pipe, means to reduce the agitation of the waste water and electrolyte caused by said mixing, and a separator to receive the intermixed electrolyte and waste water.

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