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A. E. CRAWFORD
 APPARATUS FOR EFFECTING ULTRASONIC CLEANING
 OF THE INTERIOR OF VESSELS
 Filed Aug. 8, 1963

3,175,567

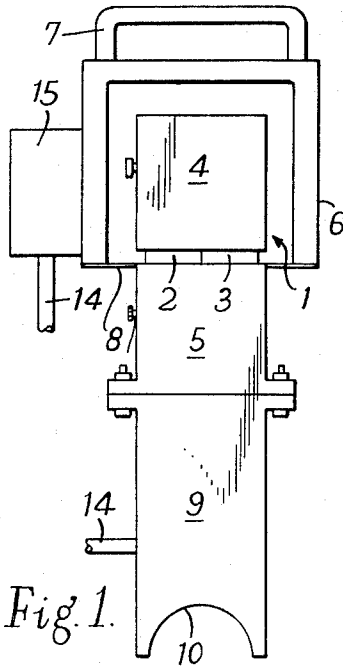


Fig. 1.

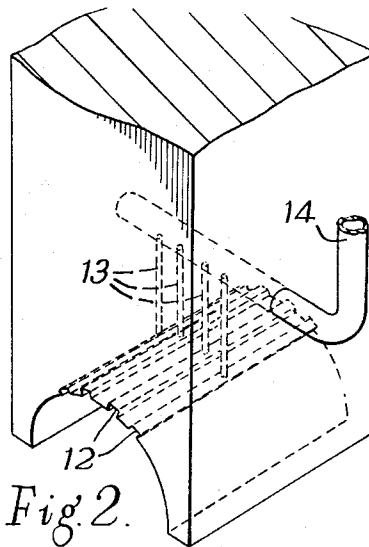


Fig. 2.

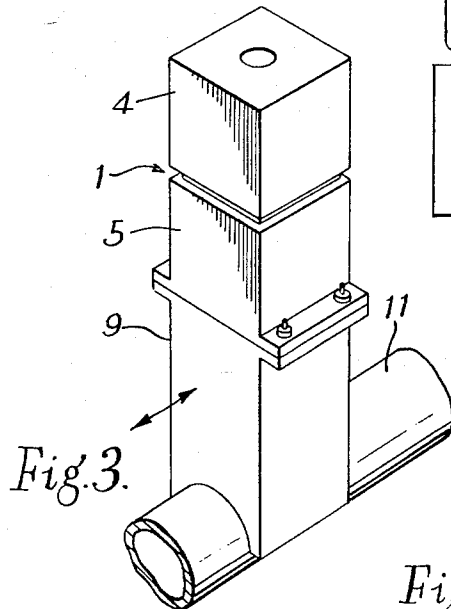


Fig. 3.

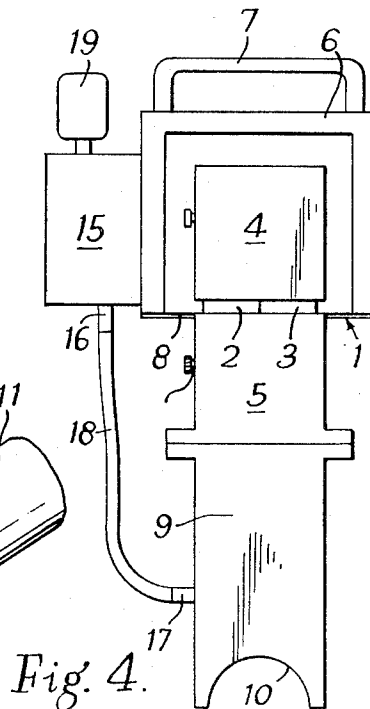


Fig. 4.

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APPARATUS FOR EFFECTING ULTRASONIC CLEANING OF THE INTERIOR OF VESSELS

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2 Claims. (Cl. 134—169)

This invention relates to the cleaning by ultrasonic means of the interior of liquid containing vessels including pipes, ducts, conduits and the like, access to which for the application of normal cleaning methods is difficult or inconvenient.

The use of ultrasonics for cleaning articles adulterated with grease and other soils is well known. It is normally necessary to immerse the article to be cleaned in a bath of liquid containing a suitable solvent. The bath is subjected to ultrasonic vibrations produced by an electromechanical transducer which may be mounted on the sides or face of the bath or may be built into a sealed container which is immersed in the bath.

Cleaning action occurs when the intensity of the ultrasonic waves existing in the liquid reaches a value where active cavitation results. The cleaning action is based on rapid acceleration of particles of cleaning fluids against the soiled surface combined with a scrubbing action produced by the cavitation implosions.

These known methods cannot be readily applied to the cleaning of the interior walls of vessels forming part of a liquid system without dismantling and even then it may not be possible to pass a transducer in a sealed container into the interior of the vessel.

It is accordingly an object of the present invention to provide an improved apparatus for cleaning the interior of vessels and the like and one which may be used in the case of vessels which form part of a liquid system without dismantling the system and even while it is in normal operation.

The invention also includes an improved electromechanical transducer for use in cleaning the interior of vessels and the like, said transducer comprising a shoe, preferably detachably secured to a vibratory part of the transducer and having a surface contour of such a form that intimate contact can be made between the external surface of the vessel and the face of the shoe. The improved transducer preferably includes means for supplying the contact surface between the shoe and vessel with a suitable liquid that will promote easy transfer of vibratory energy from the shoe to the liquid contained in the vessel.

Many forms of transducer such as magnetostrictive, piezoelectric and electrodynamic transducers may be used in the application of the invention. One suitable transducer is the mass loaded piezoelectric type such as described in British Specification No. 868,784 where relatively low frequency ultrasonic vibrations are obtained with thin sections of piezoelectric ceramic. A transducer of this type provides a large amplitude at the active face and a nodal point determined by the relative masses of the loads. Since the active face is metallic in nature it is readily possible to arrange for the detachable mounting thereon of a shoe of a corresponding cross section. In a free face of this shoe a semi-circular groove may be cut corresponding to the external radius of a pipe or other vessel to be cleaned. The dimensions of the shoe would correspond to a half-wave length of sound in the material at the frequency of operation of the transducer.

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This would be calculated to give a mean energy point at approximately two-thirds the depth of the groove. The shoe is arranged to be quickly removable in order that it may be replaced by shoes of different form or by a flat surface for use on plane surfaces.

In use, the transducer may be mounted in a suitable holder by means of a diaphragm which is fixed to the transducer at the nodal point, thus to maintain rigidity without imposing a load on the vibrating system. The shoe is applied to the surface of the vessel under treatment, and slowly moved therealong. The vessel can previously be filled with suitable detergent, or solvent liquids, or alternatively the liquid normally in the vessel can be used as the medium supporting cavitation. Longitudinal waves of an ultrasonic frequency are generated at the face of the shoe and pass through the wall of the vessel into the liquid. A standing wave system will be set up within the liquid, due to reflections from the face of the far side of the vessel and active cavitation will result if the ultrasonic intensity within the liquid is high enough. Since cavitation generally occurs more actively near a boundary face, the inside of the vessel walls will be subjected to an intense cleaning action removing the soil.

The transmission of ultrasonic waves from one solid surface to another is materially assisted if a film of liquid is present. Before applying the transducer to the vessel the mating surfaces of both vessel and shoe should be wetted with a suitable liquid such as a low viscosity silicone oil or under certain circumstances water.

An alternative method of supplying a liquid interface would be to machine channels in the face of the shoe and to continuously supply these channels with a suitable liquid from a reservoir. The reservoir would be contained in the transducer housing to enable easy manipulation.

This invention provides apparatus for using ultrasonic energy to carry out a cleaning action on the insides of vessels such as pipes or ducts without dismantling them at each end. The vessels may be of metal, glass or plastic and many applications where periodic cleaning is necessary are found in breweries, chemical plants and other industrial processes where liquids containing suspended solids are required to flow from one point to another.

One form of apparatus in accordance with this invention is illustrated in the accompanying drawing, in which:

FIGURE 1 is an elevation, partly in section, of the apparatus;

FIGURE 2 shows a detail of the apparatus shown in FIGURE 1; FIGURE 3 is a schematic diagram illustrating one method of cleaning the interior of a pipe; and

FIGURE 4 shows a modified form of the apparatus.

Referring to FIGURES 1 and 2, an electromechanical transducer 1 comprises transducer elements 2, 3 mounted between metal blocks 4 and 5. The block 4 and elements 2 and 3 are housed in a casing 6 having a carrying handle 7, the casing being closed at its lower end by a nodal diaphragm 8. An applicator shoe 9 is bolted to the active face of the block 5, and the lower face 10 of the shoe 9 is shaped so as to fit closely over the exterior surface of the vessel to be cleaned. In this case the lower face 10 is hemicylindrical in form whereby it is adapted to fit closely over the surface of a pipe 11 as shown in FIGURE 3. Grooves 12 or like cavities are formed in the face 10, which grooves communicate by ducts 13 with a pipe 14 connected between the shoe 9 and a reservoir 15 which is detachably secured to the outside of the casing 6. By this means liquid is supplied from the reservoir 15 to the contact face of the shoe for the purpose of promoting easy transfer of vibratory energy from the shoe to the liquid in the vessel to be cleaned.

FIGURE 3 shows the manner in which the apparatus is applied to the exterior surface of the pipe 11 filled with

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liquid 16. The shoe is moved along the pipe as indicated by the arrows A.

Referring now to FIGURE 4, in which parts corresponding to similar parts in FIGURES 1 and 2 have the same reference numerals, a sealed reservoir 15 is detachably secured to the casing 6. This reservoir has an outlet 16 which is connected to an inlet 17 of the shoe 9 by means of a flexible pipe 18 which enables the position of the reservoir with respect to the transducer to be varied as required. The reservoir is pressurized by carbon-dioxide to provide a force feed of the liquid therein, a carbon-dioxide cylinder 19 being connected to the upper part of the reservoir for this purpose.

I claim:

1. Apparatus for cleaning the interior of vessels, comprising an electromechanical transducer having a vibratory part, a shoe secured to said vibratory part, said shoe having an application surface of such a contour as to make intimate contact with the external surface of the vessel and to be movable thereover, said shoe having duct means therein terminating in openings at said application surface, and means coupled to said shoe for supplying liquid to said duct means.

2. Apparatus for cleaning the internal surface of a pipe which is filled with liquid, comprising an electromechan-

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ical transducer for producing ultrasonic vibrations, a housing for said transducer, said transducer comprising a transducer element, means providing electrical connections to said transducer element, and a vibratory block secured to said transducer element, an applicator shoe secured to said vibratory block, said shoe having an application surface of part-cylindrical shape adapted to fit closely against the external surface of the pipe and to be moved along said external surface, means coupled to said transducer for energizing the transducer to impart electromechanical vibrations to the shoe, said shoe having ducts therein terminating in openings at said contoured surface, a liquid reservoir, and means coupled between said reservoir and said shoe for conveying liquid from said reservoir to said ducts.

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