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ULTRASONIC TREATING METHOD AND APPARATUS

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Fig. 1

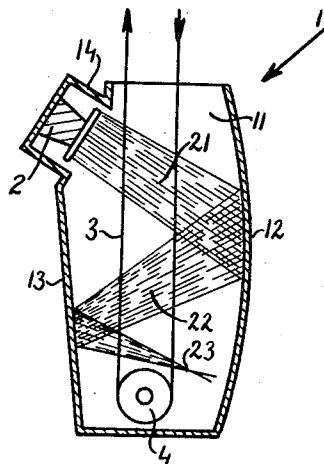
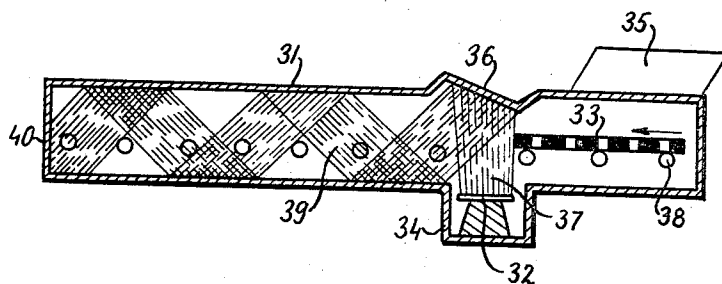


Fig. 2



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ULTRASONIC TREATING METHOD
AND APPARATUS

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6 Claims

ABSTRACT OF THE DISCLOSURE

An ultrasonic treating device includes a container, a plurality of reflector means within the container, arranged in two spaced rows extending in a common direction, a source of a beam of ultrasonic radiation, the beam to be angularly and sequentially reflected between the two rows of reflector means, and means for guiding an object to be exposed to ultrasonic radiation along a path between said two rows, which intersect the reflected beam portions. A method of exposing an object to ultrasonic radiation provides angularly directing a beam of ultrasonic radiation against a first wall, angularly reflecting the beam toward a second wall and again against said first wall, and so on, the two walls being spaced from each other and extending in a common direction, and passing said object through the reflected beam portions.

This invention relates to a method of treating objects by exposure to ultrasonic radiation, and to apparatus for performing the method. In its more specific aspects, the invention is concerned with the cleaning of wire, strip, and other objects by liquid cleaning compositions in a field of ultrasonic radiation.

The generation and application of ultrasonic energy requires equipment which is costly to build and to operate. Yet, it is difficult to use ultrasonic energy efficiently in cleaning metal and other objects, and only a small fraction of the generated energy is usually applied to the object to be cleaned. This is particularly true when the objects to be cleaned present to the ultrasonic beam either a face which is in at least one dimension much smaller than the corresponding cross section of the beam, as in the case of wire or narrow metal strip, or a face which is perforated over a significant portion of its area, as in wire screens and similar shapes. It is not practical to concentrate a beam of ultrasonic radiation on such targets as wires or narrow strips or the individual wire squares of a wire screen. A very large portion of the ultrasonic energy emitted from a transducer in the general direction of the object to be cleaned passes the object and is dissipated in the coupling fluid.

Because of this well-known problem, continuous lengths of material, such as wire or narrow strips, are commonly passed back and forth through an ultrasonic field to increase the effectiveness of the equipment. The method, however, is limited, to objects pliable enough to pass repeatedly over guide rolls which reverse the direction of movement, and to materials which are not unfavorably affected by such reversal. This method, moreover, is least successful at the otherwise desirable radiation frequencies of 300 to 400 kilocycles per second which are not propagated rectilinearly, but are dispersed by the coupling fluid.

It has been found that the shortcomings of the known devices can be overcome by repeatedly reflecting the beam of ultrasonic radiation emitted from a suitable

source between two rows of reflecting elements which extend in a common direction and are spaced transversely of that direction in such a manner that the beam travels back and forth between successive elements of the two rows and is displaced during each reflection in the aforementioned common direction. The treated object is guided between the two rows in that direction so that it sequentially intersects the several reflected portions of the beam.

This arrangement permits the effective exposure of an unlimited variety of objects to ultrasonic radiation since the path of movement of the object may be straight, and deformability of the object is not necessary. Any portion of the beam which is not intersected by the moving object, is reflected toward another portion of the object in another portion of the path thereof. This arrangement is particularly useful in the treatment of screens and similar perforated objects in which only a small portion of the ultrasonic energy of an incident beam is utilized for the intended purpose, while a major portion of the beam passes through the openings.

The walls of the container employed for holding a coupling fluid may themselves furnish the reflecting surfaces required for this invention, or reflectors may be arranged on such a container in a suitable manner.

Other features and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description of preferred embodiments when considered in connection with the accompanying drawings in which:

FIG. 1 shows an apparatus for cleaning wire or strip in continuous length in an ultrasonic field, the view being in side-elevational section; and

FIG. 2 shows a screen cleaning apparatus in a view corresponding to that of FIG. 1.

Referring now to the drawing in detail, and initially to FIG. 1, there is seen an upright tank 1, whose side walls 11 are flat and parallel, only one side wall being visible in the drawing, whose rear wall 12 is approximately cylindrically curved about a horizontal axis of curvature far outside the tank 1, and whose front wall 13 slopes upward in a direction away from the rear wall 12.

A casing 14 integral with the front wall 13 and open to the tank 1 encloses a transducer 2 which, when energized in a conventional manner by a high-frequency electrical generator, not shown, emits a beam 21 directed toward the rear wall 12 in an obliquely downward direction. The portion 22 of the beam 21 reflected from the concave rear wall 12 toward the front wall 13 at an angle to the incident beam portion 21 converges. It is further reflected from the front wall and focussed at 23 until it again impinges on the rear wall 13. The further path of the beam has not been illustrated for the sake of clarity.

A narrow metal strip 3 is trained over a guide roll 4 which is rotatably mounted near the bottom of the tank 1, and is continuously moved into the tank 1 from a non-illustrated storage reel, around the roll 4, and back outward of the tank to a driven take-up reel, the reels and other auxiliary equipment, such as rinse sprays and driers not being shown, and the direction of strip movement being indicated by arrows. The strip intersects the primary beam 21 directly emitted from the transducer 4 as it enters the tank 1, and again passes through the same portion of the beam when it leaves the tank. It similarly passes twice through the reflected beam portion 22, and twice more intersects the path of ultrasonic energy nearer the focus 23. The chances of interaction between the strip and the various portions of the ultrasonic beam are as frequent as if the strip were led back and forth through a single beam over at least five guide rolls instead of the single guide roll 4.

The concave reflecting face of the rear wall 12 tends to maintain the radiation intensity in the reflected beam portion near the intensity of the original beam portion 21. While only three passes of the beam across the dual path of the traveling strip have been shown for the sake of clarity the angle of incidence of the primary beam 21 may be chosen for more frequent reflection of the beam across the path of the strip 3.

The apparatus shown in FIG. 2 is particularly suitable for cleaning screens and similar perforated flat elements which cannot be bent even over a single guide roll, and which have to be cleaned as individual pieces of limited size.

The tank 31 is shallow, long, and as wide as needed to accommodate a screen 33 which is to be exposed to the ultrasonic radiation emitted by a transducer 32. The top of the casing is provided with an upwardly open feed chute 35, but is otherwise closed. A casing 34 in the bottom wall of the tank 31 accommodates the transducer assembly. The ultrasonic beam of the transducer 32 is directed vertically upward against a reflector portion 36 of the top tank wall which is obliquely inclined relative to the otherwise horizontal top wall.

The primary radiation beam 37 of the transducer 32 divides the tank 31 into two portions. A roller conveyor whose driven rollers 38 are relatively widely spaced extends horizontally through both portions. The screen 33 is located on the roller conveyor below the feed chute 35 in one of the tank portions, whereas the primary beam 37 is reflected into the other tank portion by the reflector portion 36 as such an angle to the top and bottom walls of the tank 31 that the reflected beam moves away from the chute 35 as it being reflected back and forth between the tank walls.

The two devices of the invention illustrated in the drawing are normally filled with a hot detergent solution which serves as a coupling fluid when they are operated. The solution level is well above the transducer 2 in the apparatus of FIG. 1, and the detergent solution completely fills the tank 31 and partly fills the chute 35 in the apparatus of FIG. 2. The solution has been omitted from the drawing for the sake of clarity.

In the apparatus of FIG. 1, the strip 3 to be cleaned is unreel from the non-illustrated storage reel, passed through the detergent solution while exposed to the ultrasonic beam from the transducer 2, and is withdrawn from the tank 1 by the non-illustrated take-up reel. In the screen cleaning apparatus of FIG. 2, individual screens are introduced into the apparatus through the chute 35 and placed on the rollers 38 as shown in FIG. 2. The conveyor then is driven to cause the screen 33 to move through the beam 37 and its reflected portions 39 etc. toward the vertical end wall 40 of the tank 31, whereupon the direction of rotation of the rollers 38 is reversed, and the cleaned screen 33 is ultimately lifted from the apparatus through the chute 35.

It should be understood, of course, that the foregoing disclosure relates only to preferred embodiments of the invention, and that it is intended to cover all changes and modifications of the examples of the invention herein chosen for the purpose of the disclosure which do not

constitute departures from the spirit and scope of the invention set forth in the appended claims.

What is claimed is:

1. A method of exposing an object to ultrasonic radiation which comprises:
 - (a) directing an incident portion of a beam of ultrasonic radiation against a first portion of a first wall at an oblique angle;
 - (b) reflecting said beam from said wall at an angle to said incident portion toward a second wall, said walls extending in a common direction, whereby the reflected beam is intersected by said second wall;
 - (c) reflecting said intersected beam from said second wall toward a portion of said first wall spaced from said first portion in said common direction; and
 - (d) sequentially passing an object to be exposed through said incident beam portion, the beam reflected from said first wall, and the beam reflected from said second wall.
2. An ultrasonic treating device comprising, in combination:
 - (a) a container defining a cavity adapted to hold a coupling fluid;
 - (b) a plurality of reflector means arranged in said cavity in two rows extending in a common direction and spaced transversely of said direction;
 - (c) a source of a beam of ultrasonic radiation directed toward one of said reflector means for sequential reflection of said beam by the reflector means of said two rows in such a manner that the beam is reflected toward and back between said two rows while being displaced in said common direction; and
 - (d) guide means for guiding an object to be exposed to said radiation in a path extending between said two rows in said common direction and intersecting the reflected portions of said beam.
3. A device as set forth in claim 2, wherein said reflector means are integral face portions of said container in said cavity.
4. A device as set forth in claim 2, wherein at least one of said reflector means is concave.
5. A device as set forth in claim 2, wherein the reflector means of one of said rows jointly constitute a face of a wall of said container parallel to said common direction, said source including means for directing said beam obliquely toward said wall.
6. A device as set forth in claim 2, wherein one of said reflector means has a reflecting face obliquely inclined relative to said common direction.

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