

[54] APPARATUS FOR MIXING FLUIDS ON
STREAM

[75] Inventor: Fred F. Spaziani, Winthrop, Mass.

[73] Assignee: Orion Research Incorporated,
Cambridge, Mass.

[22] Filed: Nov. 12, 1973

[21] Appl. No.: 414,779

[52] U.S. Cl. 259/4; 259/DIG. 46

[51] Int. Cl. B01f 5/00; B01f 13/08

[58] Field of Search 259/1 R, 6, 7, DIG. 46,
259/4

[56] References Cited

UNITED STATES PATENTS

3,219,318	11/1965	Hershler.....	259/1 R
3,689,033	9/1972	Holmstrom	259/DIG. 46 X

Primary Examiner—Harvey C. Hornsby

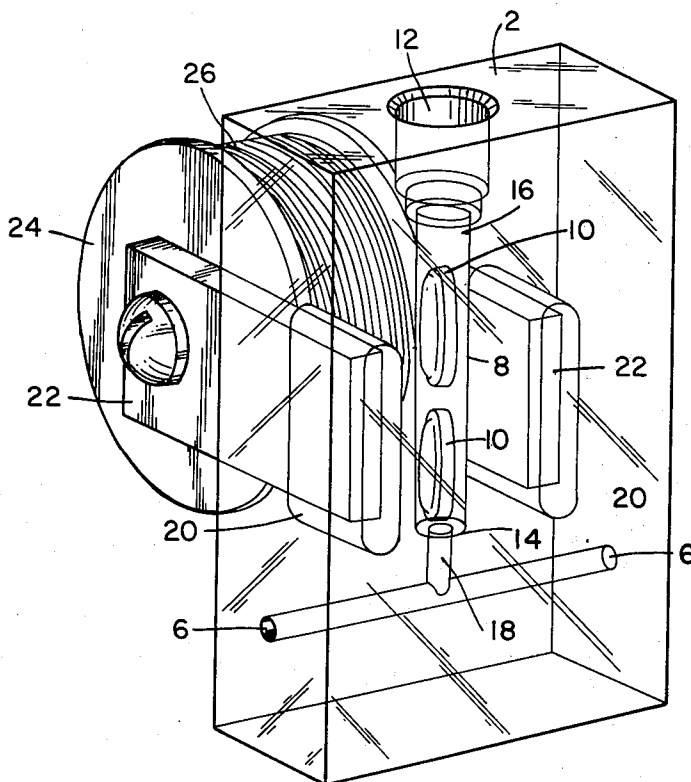
Assistant Examiner—Alan Cantor

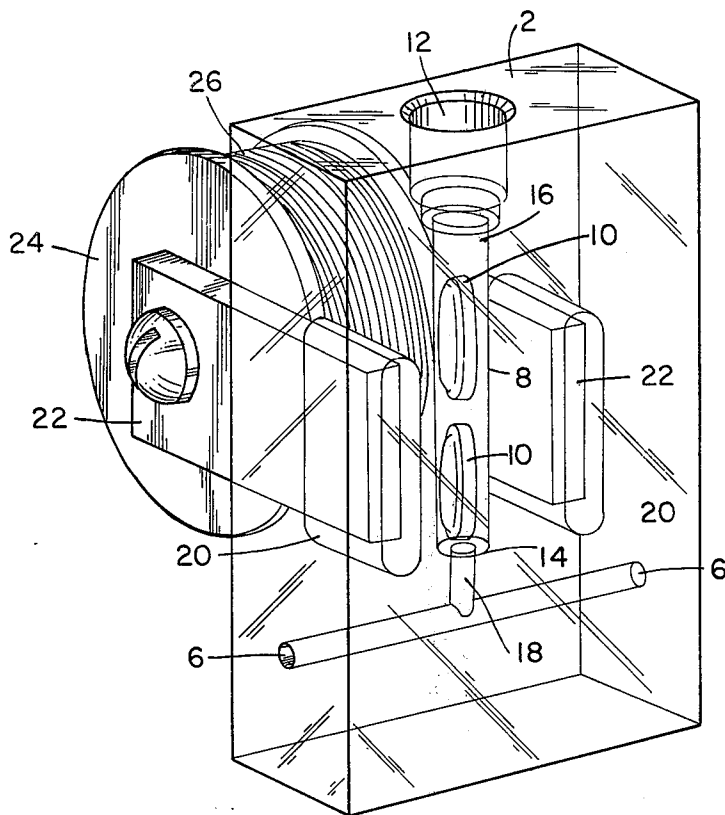
Attorney, Agent, or Firm—Schiller and Pandiscio

[57] ABSTRACT

Apparatus and method for mixing and/or agitating fluids on stream comprising a non-magnetic conduit, means for producing an alternating magnetic field, and magnetic stirring elements. At least one permanently magnetized stirring element is positioned in the conduit transverse to the magnetic field. The element is sized so that it is longer than, and has a cross-sectional dimension smaller than the cross-section of the conduit. The alternating magnetic field causes the bar to move in an oscillatory fashion. The resulting motion is utilized to mix or agitate fluids passing through the conduit.

6 Claims, 1 Drawing Figure





APPARATUS FOR MIXING FLUIDS ON STREAM

This invention relates generally to a process and apparatus for agitating and/or mixing fluids and more specifically to an electromagnetic process and apparatus for agitating and/or mixing one or more fluids.

Many mixing devices are well known in the prior art which mix and/or agitate fluids, particularly fluids on stream, i.e. where the device is inserted in the stream of one or more fluids for the purpose of either mixing fluids together thereby providing a mixed output, or for the purpose of agitating fluids. It is desirable that such devices adequately mix the fluids to provide a homogeneous fluid mix. Many mixing devices however are complex in construction and accordingly very costly.

Accordingly, objects of the present invention are to provide a simply constructed, inexpensive, reliable apparatus which is capable of continuously agitating fluids as well as mixing two or more fluids on stream.

These and other objects of the invention are achieved by an apparatus comprising a hollow non-magnetic conduit having permanently magnetized stirring means positioned therein. The stirring means is constructed so that when the stirring means is subjected to an alternating magnetic field, the field will cause the stirring means to move in an oscillatory fashion in the conduit, providing agitation and/or mixing of fluids in the conduit.

The invention accordingly comprises the method and apparatus involving the several steps and relation and order of one or more of such steps with respect to each of the others and the apparatus possessing the construction, combination of elements and arrangement of parts which are exemplified in the following detailed disclosure, and the scope of the application of which will be indicated by the claims.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawing wherein the FIGURE shows an axonometric view of a preferred embodiment of the invention.

Referring to the drawing, the foregoing and other objects of the present invention are achieved by a device comprising a block 2 having a conduit or pipe extending therethrough. The block is formed of a nonmagnetic material such as any of the plastics or nonferrous metals. The conduit comprises horizontal sections 6 and vertical section 8. The horizontal sections 6 function as inlets for introducing fluids into the device. It will be understood that two inlets are shown for purposes of illustration only, and that the number of inlets employed is dependent on the maximum number of fluids to be mixed. The horizontal sections or inlets 6 all communicate with the vertical section 8. The vertical section 8 functions to retain stirring elements 10 (explained hereinafter in greater detail) and terminates at the fluid outlet 12. Section 8 is reduced in diameter at 14, thereby forming portion 16 of a predetermined diameter and portion 18 of a diameter which is smaller than the diameter of portion 16.

Block 2 also is provided with a pair of elongated slots or apertures 20 for receiving pole elements 22 of electromagnetic device 24 which will be explained in greater detail hereinafter. Each of the apertures 20 is elongated in a plane, and each is disposed on opposite

sides of and parallel with the axis of portion 16 of section 8.

Elongated stirring elements 10 are inserted in the portion 16 of section 8. The stirring elements 10 are made of a magnetic material, such as any of the ferrous metals, which has been permanently magnetized in accordance with methods well known to those skilled in the art so that the opposite ends of each stirring element along its axis of elongation have opposite magnetic polarities. Although the specific dimensions of the stirring elements 10 are not critical, in the preferred embodiment the cross-sectional diameter or width of each element should be less than the minimum internal cross-sectional diameter or width of the portion 16, but larger than the maximum internal diameter or width of portion 18 of section 8. Thus, the stirring elements will be constrained in portion 16 by the reduction in diameter at 14. The length of each stirring elements should be longer than the maximum internal cross-sectional diameter of portion 16, the reasons for which will become more apparent hereinafter.

The number of stirring elements 10 employed is a matter of choice depending upon the degree of mixing or agitation required. The greater the degree of mixing or agitation required, the greater the number of stirring elements should be employed. Thus, although two elements are illustrated, only one element need be employed to accomplish the objects of the invention.

When more than one stirring elements is employed, the preferable arrangement is that like poles be positioned adjacent one another, such that the elements will repel each other and remain separated.

The electromagnetic device 24 comprises two pole elements 22 and an armature 26. The pole elements 22 which are each elongated in a plane, are disposed on each side of the armature 26 so that the plane of each pole element is parallel to the plane of the other element. The pole elements 22 are spaced from one another so that they are received in the slots or apertures 20 of the block 2 and are long enough so that the stirring elements 10 will be disposed in between.

In operation, an alternating current is applied to the armature 26 wherein an alternating magnetic field is provided between the pole elements 22. Thus, when one pole element is positive and the other pole is negative, thereby providing a magnetic moment in between, the positive (north) and negative (south) pole ends of the stirring element will be attracted to the negative and positive pole elements, respectively. Since the length of each of the stirring elements is greater than the maximum internal diameter of the portion 16 of conduit section 8, the ends of each stirring element will strike the interior portion of the wall of the conduit and thus be prevented from being oriented in a direction normal to the planes of the pole elements. Since the magnetic field is alternating, the pole elements will provide an alternating magnetic moment. Thus, the pole element which was previously positive will go negative and the pole element which was previously negative will go positive. This results in the positive or north poles of the stirring elements which had been attracted to one pole element to be repelled by that element and attracted to the other element. Similarly, the negative or south poles which had originally been attracted to the other pole element, will be repelled by the other element and attracted to the first mentioned element. Thus, by virtue of the alternating magnetic field which

provides an alternating magnetic moment, the stirring elements will move in an oscillatory fashion from one position to the other. At the same time, if individual fluids are introduced at each inlet 6 the fluids will flow in inlets 6 through portion 18, around the oscillating bars 10 in portion 16 wherein they will be mixed by the agitation caused by the oscillatory motion. The resulting mixed fluid will exit at the output 12.

The frequency and amplitude of the alternating field, which can be controlled in a well known manner is dependent on the viscosity of the fluids to be mixed, the flow rates, and the width or diameter of the portion 16 of the conduit.

It should be noted that if the flow rate of the fluids through the device is comparatively high, it is possible that the elements 10 can be pulled out of the magnetic field between the pole elements 22. Accordingly, means may be incorporated to prevent this, such as a screen placed in the portion 16 of conduit 8, upstream from elements 10, i.e., on the side of elements 10 opposite the portion 18, or; the portion 16 may be reduced in diameter as it is at 14, upstream from elements 10 opposite the portion 18.

It will be obvious that several modifications may be made to the device without departing from the scope of the invention. For example, if the stirring elements are constrained in portion 8, both upstream and downstream from the stirring elements, the pole elements can be positioned on top of and below the portion 16 of conduit 8, i.e. the axis of portion 16 is positioned perpendicular to the planes of the pole elements. In this situation an alternating magnetic field will cause the stirring element to alternatively move up and down or parallel to the axis of elongation of the conduit portion 16 in an oscillatory fashion which will provide for the mixing of fluids flowing therethrough. Further, a combined effect may be achieved by orienting the pole elements at an angle to be axis of elongation of the conduit portion 16. In such a situation the component of the field produced which is normal to the axis of elongation will cause the stirring elements to strike the interior portions of the wall of the conduit as described with reference to the preferred embodiment, while the component parallel to the axis of elongation will cause the stirring elements to move in a parallel direction to said axis.

Since certain other changes may be made in the abovedescribed apparatus without departing from the scope of the invention herein involved, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted

as illustrative and not in a limiting sense.

What is claimed is:

1. An apparatus for agitating and/or mixing one or more fluids on stream comprising:

an elongated conduit of substantially non-magnetic material;

at least one elongated element permanently magnetized in its longitudinal direction for stirring said fluids and disposed in at least a portion of said conduit, said element being substantially longer than the maximum cross-sectional inner width of said portion of conduit, and having a maximum cross-sectional width which is less than the minimum cross-sectional inner width of said portion of conduit; and

means for producing an alternating magnetic field through said portion of conduit.

2. An apparatus in accordance with claim 1 wherein said alternating magnetic field has at least one component substantially normal to the axis of elongation of said portion of conduit.

3. An apparatus in accordance with claim 1 wherein said apparatus includes at least two elongated permanently magnetic elements, said elements being positioned in said portion of conduit with like poles being adjacent.

4. An apparatus in accordance with claim 1 wherein said means for producing an alternating magnetic field comprises an electromagnet, said electromagnet including a pair of planar pole elements, each of said pole elements having a planar surface, said planar surfaces being disposed in parallel relation to the axis of elongation of said portion of conduit.

5. An apparatus in accordance with claim 1 further comprising means for containing said magnetized elements within said magnetic field.

6. A method of mixing and/or agitating one or more fluids comprising the steps of:

positioning at least one elongate element permanently magnetized in its longitudinal direction in at least a portion of elongated conduit of substantially nonmagnetic material so that said element is substantially longer than the maximum cross-sectional inner width of said portion of conduit and so that the maximum cross-sectional width of said element is less than the minimum cross-sectional inner width of said portion of conduit;

applying an alternating magnetic field through said portion of conduit; and

moving said fluids through said conduit.

* * * * *