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Lu et al.

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[54] **MAGNETIC MIXER FOR DISCRETE SAMPLE SYSTEMS**

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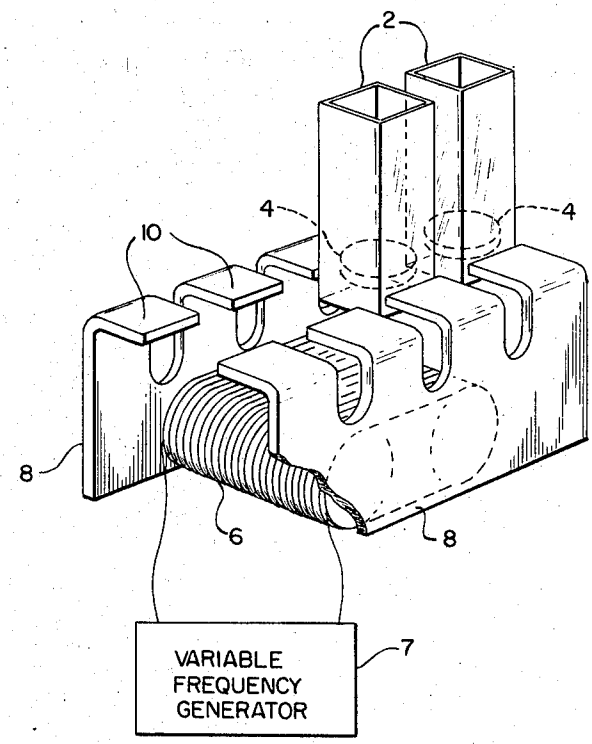
[57] **ABSTRACT**

There is disclosed a sample mixing system having a multiplicity of sample containers into which are inserted magnetic stirring rods. Each of a pair of pole pieces is connected to an alternating current electromagnet between which pole pieces the sample containers are positioned to intercept the alternating magnetic field generated by the electromagnet causing the magnetic stirring rods to move, thereby stirring the contents of the containers.

1 Claim, 1 Drawing Figure



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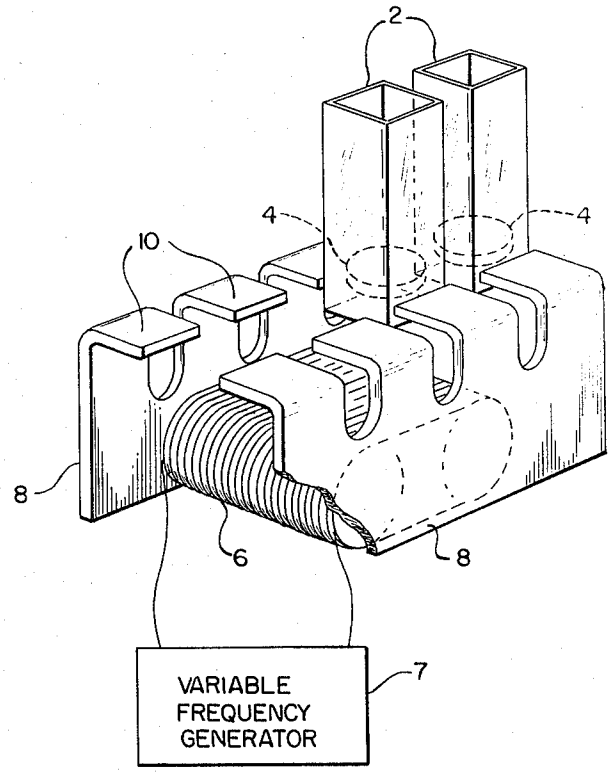

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MAGNETIC MIXER FOR DISCRETE SAMPLE SYSTEMS

The present invention relates to liquid sample mixing systems and more particularly to discrete liquid sample mixers having magnetic stirring rods moved in response to an applied changing magnetic field.

In the field of discrete sample analysis of liquids, it has been the general practice to employ permanent magnetic stirring bars or pellets having a variety of shapes which are inserted into the liquid sample and rotated by the application of a rotating magnetic field produced by a motor driven permanent magnet to stir, mix or agitate the liquid sample. Although such devices have served the purpose, they have not proved entirely satisfactory under all conditions of service for the reason that considerable difficulty has been experienced in the failure and the wearing out of rotating parts, difficulties encountered in producing a magnetic field of sufficient strength and proper location and in finding sufficient space to locate the magnet and motor drive when used with analyzer apparatus.

The motor driven magnet has received wide acceptance due to its ability to operate over a wide range of speeds to accommodate a wide variety of liquid viscosities which may be encountered from sample to sample. Those concerned with the development of discrete sample liquid analyzers have long recognized the need for mixing systems in which there are a minimum of moving parts. The present invention fulfills this need for a variable speed mixer with a minimum of moving parts.

One of the most critical problems confronting designers of magnetically driven stirring bars or pellets has been to obtain a sufficient magnetic field in the vicinity of the stirring bar to obtain force of sufficient magnitude to move the stirring bar in the liquid sample. This problem is overcome by the present invention.

A further difficulty encountered in the development of magnetic stirrers has been the limit on the number of samples that can be mixed simultaneously by one rotating magnet and motor drive. The present invention overcomes this difficulty.

The general purpose of this invention is to provide a magnetic mixing system which embraces all the advantages of similarly employed motor driven magnetic mixers and possesses none of the aforedescribed disadvantages. To attain this, the present invention contemplates a unique arrangement using an alternating magnetic field rather than the prior art rotating magnetic field thereby avoiding motor driven moving parts. In addition, the present invention contemplates the use of magnetic field pole pieces to shape and direct the alternating magnetic field into a predetermined air gap through which the liquid sample cell containers are passed and in which containers the magnetic stirring rods are inserted to respond to the alternating magnetic field.

An object of the present invention is to provide a magnetic mixer in which a multiplicity of liquid sample containers can be mixed simultaneously.

Another object is the provision of an alternating magnetic field produced by a stationary electromagnet to move magnetic stirring bars located in liquid sample containers.

A further object of the invention is to provide a magnetic mixing system with a minimum of moving parts.

Still another object is to provide an alternating magnetic field which is shaped and directed through the region of a liquid sample container at which a magnetic stirring bar is located.

Other objects 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 when considered in connection with the accompanying drawing in which is illustrated a combination of a pictorial view and block diagram of a preferred embodiment of the present invention.

Referring now to the drawing, there are illustrated two sample cells **2** into which are inserted permanent magnet stirring rods or pellets **4**. An electromagnet **6** formed by a multiplicity of turns of wire wound around a core of magnetic material generates a magnetic field in response to electrical excitation by variable frequency generator **7** attached to the coil. Pole pieces **8** are attached to each end of the electromagnet **6** to shape and direct the generated magnetic field. Each pole piece has fingers **10** formed thereon. When the pole pieces are mounted correctly at the ends of the electromagnet **6**, the fingers **10** of one pole piece are located directly opposite the corresponding fingers of the other pole piece to form an air gap through which the alternating magnetic field is directed and in which the liquid sample cells **2** are placed. The pole piece fingers concentrate the magnetic field in the region of the sample cells containing the magnetic stirring bars.

In order to accommodate a wide variety of viscosities in the liquid samples, the frequency of variable frequency generator **7** can be changed, the frequency being set to a low value for high viscosity liquids and to a higher value for low viscosity liquids.

The pole pieces **8** can be shaped to accommodate simultaneously any number of liquid sample cell containers as may be desired for a given application. The sample cells may be placed on a stationary platform located between the pole pieces or a moving belt conveyor may be utilized to pass the sample cells between the pole pieces either manually or automatically in response to a predetermined program.

In operation, the alternating magnetic field impressed upon the magnetic stirring bar causes the bar to align its permanent magnetic field with the instantaneous direction of the applied alternating magnetic field. Therefore, as the alternating magnetic field changes direction, the magnetic stirring bar will change its position to align itself with the new direction of the alternating magnetic field. In the process of changing its position, the magnetic stirring bar moves through the liquid thereby agitating and stirring the contents within the sample cell in which it is located, the only moving part in the mixing system being the rotating mixing bar.

It now should be apparent that the present invention provides a magnetic mixer which may be employed with a multiplicity of liquid sample cells containing magnetic stirring bars to simultaneously stir the contents of the sample cells in response to the applied alternating magnetic field.

Although particular components have been discussed in connection with a specific embodiment of a magnetic mixer constructed in accordance with the teachings of the present invention, others may be utilized. Furthermore, it will be understood that although

an exemplary embodiment of the present invention has been disclosed and discussed, other applications and arrangements are possible and that the embodiments disclosed may be subjected to various changes, modifications and substitutions without necessarily departing from the invention.

What is claimed is:

1. In a discrete liquid sample analyzer of the type wherein liquids to be analyzed must be thoroughly agitated, a magnetic mixing system comprising:

a two pole electromagnet having a multiplicity of turns of alternating current conducting wire for generating an alternating magnetic field;

a pole piece fastened one to each pole of said electromagnet, each of the pole pieces having a plurality of uniformly spaced fingers, said pole pieces being oppositely disposed to form a corresponding plurality of air gaps between said fingers through which air gaps said alternating magnetic field is directed;

a multiplicity of sample cells into which the liquids to be analyzed are placed, one of said cells being positioned in each of the air gaps between said pole pieces; and

a plurality of magnetic stirring rods, one of said rods being placed within each of said sample cells, each rod being rotated in response to said alternating magnetic field to mix the contents of said multiplicity of sample cells.

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