

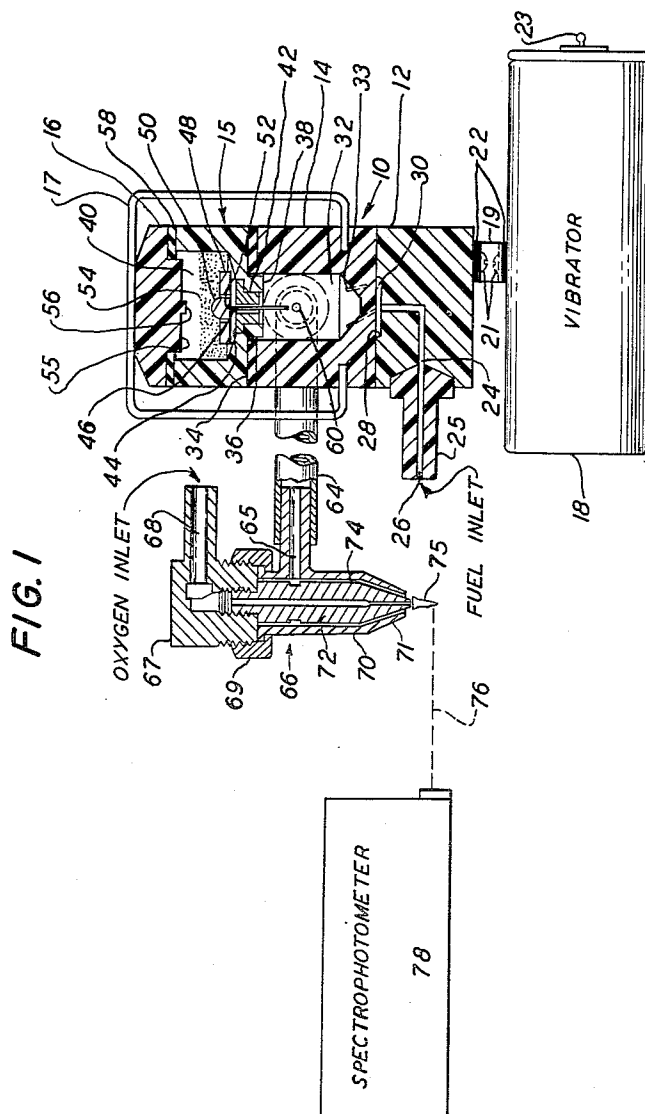
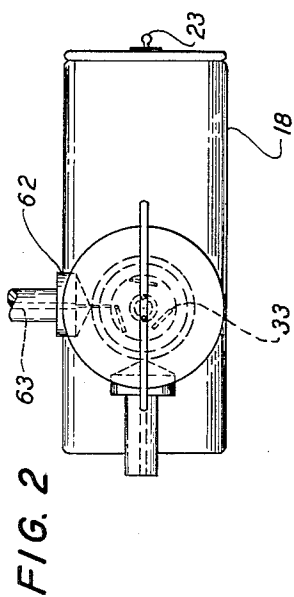
May 27, 1958

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2,836,097

APPARATUS FOR INTRODUCING A SAMPLE INTO A FLUID

Filed Feb. 7, 1955



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2,836,097

APPARATUS FOR INTRODUCING A SAMPLE INTO A FLUID

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Application February 7, 1955, Serial No. 486,405

3 Claims. (Cl. 88—14)

This invention relates to an improved apparatus for mixing a solid material in a fluid.

In various industrial processes and analytical procedures it is often desirable to entrain a solid material or sample in a fluid phase such as a gas. For example in flame spectrophotometry, in which a sample is to be introduced into a hot flame to cause the sample to emit characteristic light radiations and serve as a light source for a spectro-photometer, it is common practice first to dissolve the sample in a suitable solvent and then aspirate the solution into the hot flame. This procedure is usually satisfactory except that it requires the step of dissolving or digesting the solid sample to obtain it in liquid form. This step is often time consuming and sometimes makes spectrophotometric analysis impractical for certain samples which can be dissolved only with great difficulty.

This invention makes it possible to eliminate this step by providing apparatus for introducing a solid directly into the fuel stream to eliminate the step of dissolving the sample. This reduces the time required for measurements of conventional samples and makes spectrophotometric analysis practical for many samples which are not readily dissolved.

In terms of apparatus for introducing a sample into a fluid, the invention comprises a mixing chamber having a fluid inlet and outlet, a sample chamber opening into the mixing chamber and means introducing the sample into the mixing chamber.

These and other aspects of the invention will be more clearly understood in the light of the following detailed description of the invention taken in conjunction with the accompanying drawing in which:

Fig. 1 is a vertical section of a presently preferred embodiment of the invention associated with a spectrophotometer; and

Fig. 2 is a plan view of the mixing apparatus and vibrator of Fig. 1.

A mixing apparatus 10 comprises an upright cylindrical base 12, an upright cylindrical body 14 bonded collinearly to the top of the base, an upright cylindrical sample holder 15 detachably mounted collinearly on top of the body and a removable cap 16 arranged to be held on top of the sample holder by means of an inverted U-shaped bail 17 having its lower ends pivotally embedded in diametrically opposed portions of the body. Conveniently the base, body, sample holder and cap are made of a clear plastic such as Lucite, although any suitable material may be used. The mixing apparatus is mounted on top of a vibrator 18, which may be of conventional type, by means of a bracket 19 secured to the base and the vibrator with screws 21. Although a separate mechanical vibrator is shown, any type of suitable vibrating means may be used and the term "vibrator" is used in connection with this invention to include any means for vibrating the sample. Rubber pads 22 are disposed between the bracket and the base and the vibrator. The amount of vibration

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imparted to the apparatus may be controlled by adjusting the tension on the screws, the tighter the screws, the greater the vibration of the apparatus. The operation of the vibrator is controlled by means of a switch 23.

The base is provided with an inlet bore 24 extending horizontally from its side to its center and turning vertically upwardly to extend to the top of the base. The inlet bore is of enlarged diameter at the side of the base to provide a seat for a fuel inlet nipple 25 which is bonded in the enlarged portion of the inlet bore so that a longitudinal bore 26 in the inlet nipple is in alignment with the horizontal portion of the inlet bore. The inlet nipple is adapted to be connected to a source of fuel (not shown) by any suitable means, e. g., a flexible hose (not shown).

A shallow, circular recess 28 is formed in the upper surface of the base directly over the vertical bore in the base to form a gas header space 30 directly under the center of the flat bottom of the body which is bonded to the upper surface of the base. An upright, cylindrical mixing chamber 32 having an inverted frusto-conical bottom is formed in the center of the body and extends from near the body bottom to the top of the body. Three inclined inlet jets 33 are bored in the bottom of the body and extend from the periphery of the gas header space and enter the bottom of the mixing chamber in a tangential direction so as to discharge gas into the bottom of the mixing chamber and cause it to swirl in a clock-wise direction as viewed in Fig. 2.

The bottom of the sample holder is provided with an annular shoulder 34 around its periphery which rests on a sealing gasket 36 disposed between the shoulder and the upper edge of the body. An annular boss 38 formed on the bottom of the sample holder projects into the upper portion of the mixing chamber. An upright, cylindrical sample chamber 40 having an inverted frusto-conical bottom is formed in the sample holder. A vertical stepped bore 42 having a relatively large diameter at its upper end and a smaller diameter at its lower end extends through the bottom of the sample holder and opens into the top of the mixing chamber. An insert 44 shaped to match the stepped bore and having a vertical orifice 46 through its length is friction fitted in the stepped bore so that the upper surface of the insert is flush with the upper edge of the step bore. A horizontal agitating disk 48 having a small dome 50 located in the center of its upper surface is movably disposed over the insert and has a diameter slightly greater than the maximum diameter of the insert. The upper end of a guide rod 52 is attached to the lower surface of the agitating disk and the rod extends down through the orifice of the insert into the mixing chamber. The guide maintains the alignment of the disk within the sample chamber and movement of the guide within the orifice helps prevent blocking of the orifice with a powdered sample 54 which is placed in the sample chamber as shown in Fig. 1. The disk is provided with a pair of vertical perforations on diametrically opposed sides of the dome on the disk. These bores help to promote circulation of the powdered sample within the sample chamber when the disk is moved up and down by the vibrator and prevents the sample from packing in the sample chamber. Conveniently, the disk, rod and insert are made of some durable material such as stainless steel.

The lower surface of the cap is provided with a first downwardly extending boss 55 of relatively large diameter and a second downwardly extending boss 56 of smaller diameter in the center of the first boss. The smaller boss limits the upward travel of the disk as the mixing apparatus is vibrated and prevents the guide rod from coming out of the orifice. An annular gasket 58

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between the periphery of the cap and the sample holder seals the sample chamber.

The body is provided with a small horizontal outlet bore 60 communicating with the intermediate portion of the mixing chamber and having an enlarged section at its outer end to accommodate an outlet nipple 62 bonded in the enlarged portion of the outlet bore. The outlet nipple is provided with a horizontal bore 63 collinear with the outlet bore and is connected by means of a flexible hose 64 to a horizontal fuel inlet 65 on a burner 66 which is arranged in an inverted position. The burner comprises a burner base 67 having an oxygen inlet conduit 68 extending through the side of the bore and out the lower end of the base. Oxygen may be supplied by conventional means (not shown). The lower portion of the base is threaded externally and internally to receive a cap nut 69 holding an external jacket 70 having an inverted frusto-conical lower portion 71, and to receive a tubular insert 72 having its external lower portion tapered to match that of the jacket and leave an annular space 74 between the tube and jacket. The fuel inlet opens into the jacket adjacent an external annular notch provided around the tubular insert in the burner. Oxygen enters the burner base and passes through the insert and out the end of the burner while fuel enters the annular space between the jacket and insert to pass out the end of the burner where it is mixed with the oxygen to a hot flame 75. Usually the fuel is acetylene and the resulting hot flame is positioned in alignment with the optical axis 76 of a conventional spectrophotometer 78.

The apparatus of Figs. 1 and 2 is operated as follows: The bail on the mixing apparatus is pulled over to one side and the sample chamber cap is removed. A dry sample, such as drill cuttings from a well, is ground to a powder (preferably less than 60 mesh) and placed in the sample chamber. The cap and bail are replaced to the position shown in Figs. 1 and 2 and the oxygen and fuel flow rates are adjusted to give a flame of conventional quality. The vibrator is turned on causing the mixing apparatus to vibrate as a unit and impart a reciprocating motion to the disk and guide rod. This causes the sample to circulate within the sample chamber and move past the disc and down through the orifice into the mixing chamber. The fuel entering the mixing chamber swirls up from the jets in a clockwise direction as viewed in Fig. 2 and entrains the powdered sample to form an intimate dispersion of the sample in the gas. The fuel gas and sample then pass into the burner, down the annular space between the tube and jacket, and into the hot flame where the sample emits its characteristic

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color which is analyzed by the spectrophotometer. The inverted position of the burner is preferable because it reduces the tendency for the sample to pack in the burner. Thus rapid spectrophotometric analysis of all types of solid samples may be made without having first to prepare a solution of the sample.

I claim:

1. Apparatus for introducing a sample into a fluid comprising a mixing chamber having a fluid outlet and an inlet below the outlet and adapted to introduce fluid tangentially into the mixing chamber above the inlet to impart a swirling motion to the fluid therein, a sample chamber above the mixing chamber and opening through an orifice into the mixing chamber above the inlet, a movable disc disposed over the orifice, a guide rod attached to the disc and extending down into the orifice, and means for vibrating the apparatus to cause the disc and guide rod to stir the sample and promote sample flow into the top of the mixing chamber.

2. Apparatus for introducing a sample into a fluid comprising a mixing chamber having a fluid outlet and an inlet below the outlet, a sample chamber disposed above the mixing chamber and opening through an orifice into the mixing chamber above the inlet, a movable disc disposed over the orifice, a guide rod attached to the disc and extending down into the orifice, means for vibrating the apparatus to cause the disc and rod to stir the sample and cause it to flow down into the mixing chamber where it is mixed with the fluid, a burner, and a conduit connecting the fluid outlet to the burner so that the sample and fluid mixture is burned to produce a flame.

3. Apparatus for introducing a sample into a fluid comprising a mixing chamber having a fluid outlet and a fluid inlet below the outlet and adapted to introduce fluid tangentially into the mixing chamber to impart a swirling motion to the fluid therein, a sample chamber opening into the mixing chamber above the inlet, and means for vibrating the sample to cause it to flow into the mixing chamber.

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