material-containing fluid to use it again for a chemical reaction. Thus, an effective chemical reaction can be realized.

[0101] The circulating channel may be provided with a pump communicated thereto to feed fluid and a reservoir tank to store the supplied fluid temporarily, which is communicated with at least one inlet channel and at least one outlet channel. The fine channel device having such structure allows recovering and reuse of fluid in the fine channel substrate. This can provide a very compact device for chemical reaction.

[0102] Further, it is possible to feed effectively fluid in which a raw material for chemical reaction remains, to an inlet port after the chemical reaction. Further, it is possible to recovery a very expensive catalyst in particular, an asymmetric catalyst, a phase transfer catalyst, a biocatalyst (an enzyme) or the like, to use it again for a chemical reaction.

[0103] **FIG. 13** shows several embodiments of fluid supply/recovering system.

[0104] **FIG. 13**(*a*) shows an embodiment of the system. Fluid is supplied to a fine channel device **55** by using a liquid supply pump **56** located outside the device. The fluid discharged from a fluid outlet port **12** can be returned to a container **57** in which fluid fed by the liquid supply pump is previously stored, through a capillary tube **58**.

[0105] **FIG. 13**(*b*) shows another embodiment. A fine channel device **55** is provided with a reservoir tank **61** for storing fluid and an embedded micropump **59** for feeding fluid. Fluid is supplied to an fluid inlet port **11** from the reservoir tank by the action of the micropump, and the fluid discharged from a fluid outlet port **12** through a fine channel **19** can be returned again to the reservoir tank through a recovery channel **60** formed in the fine channel device, the returned fluid being circulated again by the micropump. In **FIG. 13**(*b*), characters Mp indicate the micropump **56**. The capacity of the reservoir tank **61** is not in particular limited as long as it can keep a sufficient volume of fluid even when the fluid is circulated in the entire of the fine channel. Further, the width and the depth of the recovery channel are not in particular limited, but these may have the same width and depth of the fine channel.

[0106] Further, the fine channel device of the present invention may be provided with means for supplying energy to the fluid flowing in the fine channel. Specifically, said means for supplying energy is a heating device and/or a light irradiation device. Thus, the irradiation of light by the light irradiation device and/or the application of heat by the heating device supplies energy to a fine channel portion to thereby obtain an effective chemical reaction.

[0107] Further, the fine channel device of the present invention may comprise a single substrate in which a plurality of the above-mentioned fine channels having features as described above in an integrated form, or may be formed by piling-up a plurality of such substrate in one piece. By using such fine channel device, chemical operations such as mixing of a large amount of fluid, a chemical reaction, solvent extraction, separation or the like can be carried out by taking the advantage of a small space.

[0108] A fine channel substrate having a fine channel which is a structural element of the fine channel device can be prepared by processing directly a substrate such as glass, quartz, ceramics, silicon, metal or resin by mechanically processing, laser processing or etching. When the substrate is ceramics or resin, a substrate can be prepared by a molding technique with use of a metallic mold having a shape corresponding to a fine channel. Generally, a fine channel device comprises the above-mentioned fine channel substrate and a cover member having orifices of about several mm in diameter formed at positions corresponding to fluid inlet ports, and outlet ports of each fine channel, the substrate and the cover member being laminated integrally. Several methods for bonding the fine channel substrate and the cover member can be used depending on material used for the cover member and the substrate. Namely, when the substrate is ceramics or metal, soldering or an adhesive is preferably used. When the substrate is glass, quartz or resin, they should be bonded by applying a load at a high temperature such as 100° C. to a thousand and several hundreds ° C. When the substrate is silicon, it should be bonded to the cover member at the room temperature after the surface of the substrate is activated by cleaning.

[0109] The chemically operating method for fluid according to the present invention means chemical operations such as mixing or chemical reaction of fluid, solvent extraction, separation, recovery and so on by using the fine channel device of the present invention as described above, and it means also chemical operations in a combination of at least two in the above chemical operations.

[0110] As a mixing method, there is a chemically operating method wherein at least one kind of fluid containing fine particles is supplied to a fine channel, and the fine particle containing fluid is subjected to stirring while the fluid boundary is maintained to thereby accelerate mixing. In such chemical operating method, the fine particles in the fluid move therein to change the flowing direction of the fluid, and only the fine particle containing fluid is stirred. Accordingly, the stirring is carried out in each kind of fluid while the fluid boundary is maintained whereby a material contained in the fluid is rapidly dispersed uniformly in each fluid, and a sufficient chemical reaction and solvent extraction become possible.

[0111] Further, since adjacent laminar flows of fluid maintain the fluid boundary, each flow of fluid can easily be separated. Further, the width of fine channel is in a range of from several μm to several hundreds μm, and the depth is about several tens μm. Accordingly, the fine particles flowing in the fine channel does not cause clogging. Therefore, the particle size of the fine particles should be about one figure smaller than values of the width or the depth of the fine channel. Specifically, it is preferably in a range of from submicron to about several tens μm.

[0112] Further, the number of particles to be mixed is not in particular limited as long as a predetermined stirring effect can be given to the particle-containing fluid and the fine particles flowing in the fine channel does not cause clogging.

[0113] There is no particular restriction for a material for the fine particles as far as the material is incapable of dissolving in the fluid to which the fine particles are incorporated, the material being, for example, an inorganic material such as silica or a resin material such as polystyrene or polyacrylate. Further, for the material itself of fine particles, the surface of fine particles may be modified to have