This invention relates to a composition used in recovering lost circulation in drilling wells and to the method of using the same. The application is a continuation-in-part of my copending application, Serial No. 213,800, filed March 3, 1951 (now abandoned).

In drilling wells, such as oil and gas wells, by the rotary method of drilling circulation is frequently lost. This may be occasioned by any one of a number of different circumstances. Usually it occurs when the well bore traverses a cracked earth formation or passes through a highly porous formation. When this occurs the circulation fluid or drilling mud that is pumped into the well through the rotary drill string enters the cracks in the cracked formation or the interstices in the porous formation and escapes from the well bore surface that is not returned to the surface.

Many different attempts have been made to plug such cracks and interstices against the escape of the circulation fluid and a large variety of different materials have heretofore been pumped with the circulation fluid into the well in an effort to either bridge or fill such cracks or interstices. Some of such materials have proven successful under certain conditions and have proven unsuccessful under others.

In endeavoring to recover lost circulation a number of problems and objections are presented such as:

1. The material used must be capable of being mixed with water to form an aqueous, pumpable, homogeneous mass that can be pumped down the drilling string to the source of the lost circulation in batches or slugs of anywhere from a few cubic feet to several hundred followed by the regular circulation fluid.

2. The material used must be such that it is capable of entering the cracks, crevices and swell therein to lock the entire mass in place, thereby making an impervious seal, not on the face of the well bore but in the cracks, crevices, etc., away from or remote from the face of the well bore.

3. Finally, the material employed should be of such a character that once it has lodged itself in the cracks or interstices and has bridged across them it will tend to lock itself in plugging position instead of being washed by the circulation fluid farther into the cracks or interstices by the drilling fluid when drilling operations are resumed.

The material must form an impervious plug in the cracks, crevices, etc.

An object of the present invention is to provide an improved composition for this purpose which possesses all of the desirable characteristics required to effectively seal off cracks, interstices, or other passages through which circulation fluid is apt to become lost under the circumstances or conditions when this usually occurs.

Still another object of the invention is to provide a composition that can be transported in a dry state to wells located in remote localities and at the well site be mixed with water to make an aqueous, pumpable, homogeneous mass or mixture that can be pumped down the well to the area of lost circulation.

Another object of the invention is to provide a method of recovering lost circulation in drilling wells wherein the dry composition embodying the present invention is advantageously used.

One form of the composition embodying the present invention consists of substantially equal parts by weight of diatomaceous earth, expanded perlite, and coarse ground dry, expandable-type bentonite clay. The diatomaceous earth used is in a finely powdered condition and ultimately performs the function of forming a type of filter cake. The expanded perlite performs the function of a lightweight and relatively coarse aggregate. Perlite is in the nature of a mineral and is basically aluminum silicate although it contains usually appreciable amounts of other substances, such as soda, potash, lime, and magnesia. It usually contains in excess of 2% of water of crystallization and when this mineral is quickly subjected to a high temperature it begins to melt or become plastic. The water content is quickly converted into steam and expands the softened mineral, puffing it or popping it into a volume many times greater than its original volume in its natural state. The resulting product is in the nature of an expanded glass which is highly cellular, having a relatively low specific gravity. The expanded perlite that I employ is of the type now generally available on the market and is usually in the form of particles ranging from as small as 300 mesh particles (particles capable of passing through a screen having 300 meshes per inch) up to particles \( \frac{1}{4}'' \) in diameter and even larger. The aqueous, pumpable, homogeneous mass or mixture enters the cracks, crevices, interstices, etc., and forms an impervious plug or seal.

The bentonite clay used in the dry mix is in a dry or dehydrated condition. It is of the type commonly referred to as coarse ground, expandable-type bentonite clay. Its particle sizes run from 300 mesh size particles to as large as \( \frac{1}{4}'' \) in diameter and larger. This prod-
Product is merely coarse ground, dehydrated, expandable-type bentonite clay, no effort being made to screen the product or to reduce the particle size materially below in the manner although this naturally occurs in the crushing. Ordinarily the commercial product will have approximately 75% of its particles between 3½ mesh and 13 mesh. The commercial product is not absolutely dry or dehydrated but may contain a small percentage of water, such as from 5 to 15%. The bentonite clay in this condition possesses the property of absorbing water and expanding ten to fourteen times its original volume upon the absorption of water. The complete absorption of water by the dehydrated bentonite clay does not take place immediately upon its being mixed with water or introduced into the circulation fluid but requires a considerable time to complete its absorption and consequently its expansion. The dried or dehydrated bentonite clay, when mixed with water, will be found to continue to absorb water and to continue its expansion many hours after it has been wetted. The size of particle used to some extent contributes to the delay in water absorption and consequently in the expansion in that the larger the particle the more time is required for the water to penetrate the particle to its center, particularly when the exterior of the particle is absorbing water and is undergoing expansion.

I prepare my dry mixture by merely mixing thoroughly together equal parts by weight of the diatomaceous earth, expanded perlite, and dry bentonite clay. This composition may be shipped in bags or other containers to the well site of the well in which circulation has been lost. At the well site an aqueous mixture is prepared, mixing the composition with water in the proportions of 50 to 80 pounds of the dry mixture per barrel of water, and after being thoroughly mixed, the aqueous, pumpable, homogeneous mass or mixture is pumped as a unitary mass into the well down through the drill string. When it issues from the bottom of the drilling string the mixture follows the path of the lost circulation fluid, and on reaching the locality where the circulation fluid has been escaping it enters the cracks, crevices, and interstices. The coarse ground dried bentonite which forms part of the material which is distributed therethrough continues to absorb water and to swell, locking the other particles of the mixture in place forming an impervious plug or seal which arrests and prevents further loss of circulation fluid when drilling operations are resumed. As the mixture enters the cracks and crevices and forms the plug therein, it will not be scraped off or removed during subsequent drilling operations. In this manner, an effective seal is produced in that the expansion of the bentonite tends to wedge or tighten the lodged particles of expanded perlite in place.

While sand or fine gravel can or may be used in lieu of the expanded perlite as the coarse aggregate, the perlite is preferred due to its lightness and its ability to be carried along with the fluid to the location where circulation fluid is being lost. Sand known commercially as Santa Margarita sand is a suitable substitute for the expanded perlite. Santa Margarita sand is in the nature of a sandstone occurring in large massive beds and found exposed in the southern end of the San Joaquin Valley in California. It is in the nature of a soft white to light gray and greenish gray sandstone and is composed largely of angular grains of quartz, feldspar and granite. The commercial product usually consists of more than 50% of particles of 10 to 40 mesh size. The remainder of the particles in the commercial product consists of fines or particles running down to a particle size of 300 mesh or finer. In using the Santa Margarita sandstone, approximately one-third by weight of the coarse ground, dried bentonite clay is thoroughly mixed with two-thirds by weight of the Santa Margarita sand. This mixture with the addition of water can likewise be made into an aqueous, homogeneous, pumpable mass which can be used to recover lost circulation.

When using my composition, if all of the cracks or interstices have become closed or plugged before all of the composition pumped into the well has been consumed or used up the balance may be readily flushed out of the well by the circulation fluid when drilling operations are resumed.

The proportions of equal parts of diatomaceous earth, expanded perlite, and dried bentonite clay are not critical. These may vary considerably under varying well conditions. Likewise, the proportion of the dry material is not critical and may be varied. The amount of water used, however, should be sufficient to render the aqueous mixture readily pumpable and flowable down the drilling string. It should not be so thin that the effectiveness of the ingredients is lost by prolonging the rate of deposit in the cracks or interstices through which the circulation fluid is escaping. It is highly desirable that the plugging action takes place as quickly as is reasonably possible.

In lieu of diatomaceous earth I find that an excellent composition is obtainable by substituting therefor a corresponding weight or proportion of “baghouse fines.” These fines are small particles of expanded perlite usually approximating 300 mesh size. While the commercial grade of expanded perlite contains particles this small, as above mentioned the number of such small particles per given volume or weight of expanded perlite is insufficient to form an adequate filter cake. Consequently, I supplement the number of small particles of expanded perlite that normally exist in the commercial grade of expanded perlite by adding thereto baghouse fines of an amount equal to that of the expanded perlite. This composition consequently contains approximately equal proportions of commercial expanded perlite, baghouse fines, and dehydrated or dried coarse ground bentonite clay. When this composition is mixed with water as above described, and pumped into the well it performs substantially the same function as previously described. The bentonite clay particles are distributed therethrough and continue their water absorption and consequently their expansion, locking the coarse as well as the fine expanded perlite particles in their lodged positions.

Diatomaceous earth and the baghouse fines are both finely divided siliceous materials having particle sizes of approximately 300 mesh size. Either may be substituted in the composition, entirely or in any proportion with equal results.

It will be appreciated from the above described disclosure that the composition which I employ is relatively inexpensive and can be easily transported to the well site in a dry state. At the well site the aqueous mixture can be made and pumped down into the well. As the materials used are relatively inert the seal produced will not deteriorate under the pressure, tempera-
nature, or chemical conditions that normally exist in drilling oil and gas wells. As the bentonite clay continues its expansion after it has been lodged in place, the composition is effectively locked therein and remains locked due to the continued expanded condition of the bentonite clay.

Various changes may be made in the details of construction without departing from the spirit and scope of the invention as defined by the appended claims.

I claim:

1. A composition for use in recovering lost circulation in drilling wells comprising an aqueous mixture consisting of expanded perlite, diatomaceous earth and coarse ground, expandable, dehydrated bentonite clay.

2. The method of recovering lost circulation in drilling wells which consists of pumping down into the well an aqueous mixture containing expanded perlite, diatomaceous earth and coarse ground, expandable, dehydrated bentonite clay in about equal proportions by weight.

3. The method of recovering lost circulation in drilling wells which consists of pumping down into the well an aqueous mixture containing expanded perlite, diatomaceous earth and coarse ground, expandable, dehydrated bentonite clay in about equal proportions by weight and thereafter pumping into the well the normal drilling fluid.

4. A composition for use in recovering lost circulation in drilling wells comprising a dry mixture of approximately equal parts by weight of expanded perlite, diatomaceous earth, and coarse ground dehydrated bentonite clay.

5. A composition for use in recovering lost circulation in drilling wells comprising a dry mixture of approximately equal parts by weight of expanded perlite, perlite baghouse fines, and coarse ground dehydrated bentonite clay.

6. A composition for use in recovering lost circulation in drilling wells comprising a dry mixture adapted to be mixed with water at the well site to produce a pumpable mixture, said dry mixture comprising approximately one-third by weight of coarse ground, dried, expandable-type bentonite clay, one-third of one of the group consisting of expanded perlite and Santa Margarita sand, and one-third of at least one of the group consisting of perlite baghouse fines and diatomaceous earth.

7. A composition for use in recovering lost circulation in drilling wells comprising a dry mixture adapted to be mixed with water at the well site to produce a pumpable mixture, said dry mixture comprising approximately one-third by weight of coarse ground, dried, expandable-type bentonite clay, and two-thirds by weight of Santa Margarita sand.

8. A composition for use in recovering lost circulation in drilling wells comprising an aqueous mixture of water and a dry mixture, said dry mixture comprising approximately one-third by weight of coarse ground, dehydrated, expandable type bentonite clay, and two-thirds by weight of Santa Margarita sand.

9. The method of recovering lost circulation in drilling wells which consists of pumping down into the well an aqueous mixture containing approximately one-third by weight of coarse ground, dehydrated, expandable type bentonite clay, and two-thirds by weight of Santa Margarita sand.

10. A composition for recovering lost circulation in drilling wells comprising a dry mixture adapted to be mixed with water at the well site to produce a pumpable mass, said dry mixture comprising approximately one-third by weight of coarse ground, dehydrated, expandable type bentonite clay, and the remainder being formed of a finely divided siliceous material containing at least one of the group consisting of expanded perlite, diatomaceous earth, perlite baghouse fines, and Santa Margarita sand.

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