Sept. 2, 1969 M. SPANOVICH 3,464,215

FOUNDATION SYSTEMS

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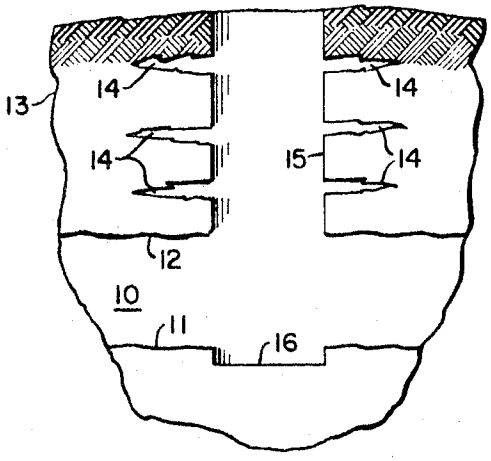


Fig. 1.

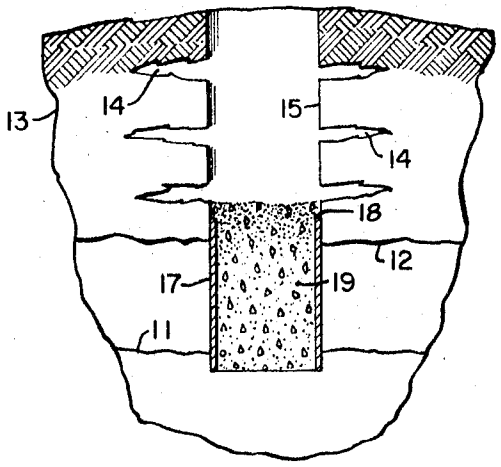


Fig. 2.

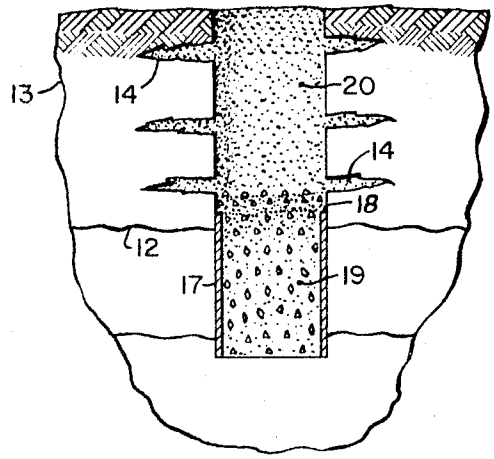


Fig. 3.

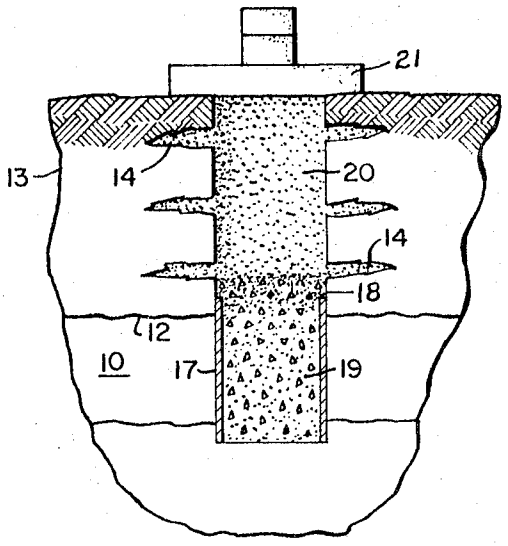


Fig. 4.

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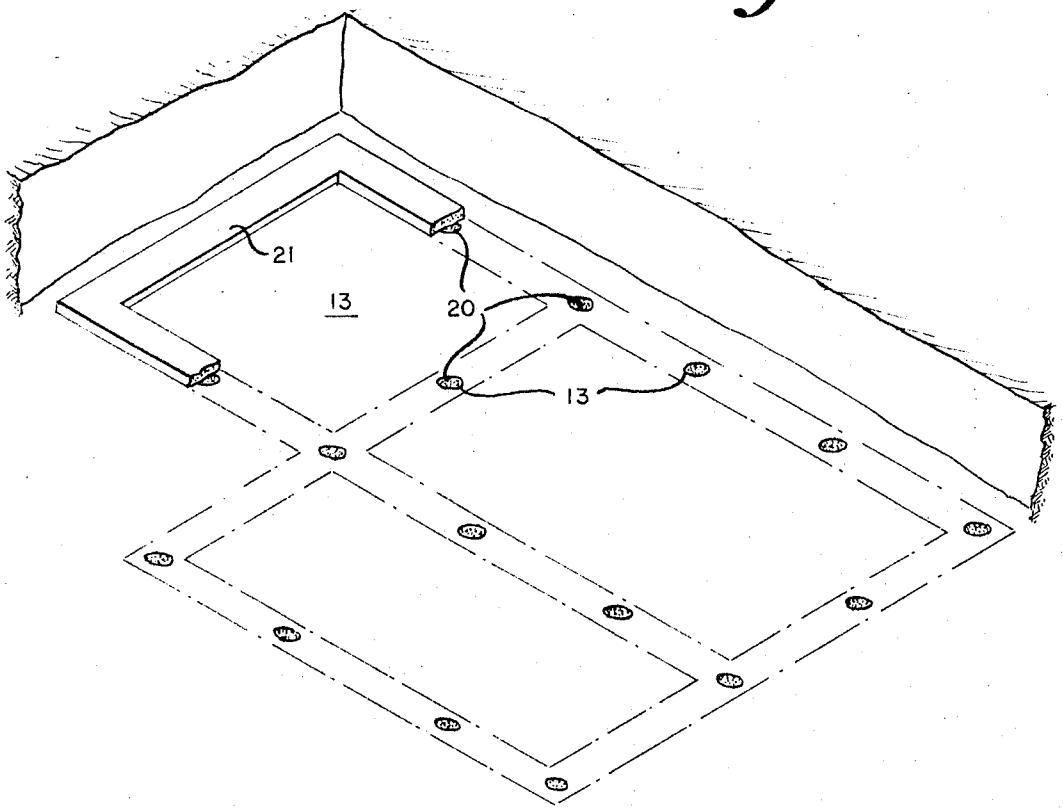
BY Buell Blenko & Ziesenheim

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FOUNDATION SYSTEMS

Filed Feb. 15, 1968 2 Sheets-Sheet 2

Fig. 5.



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FOUNDATION SYSTEMS

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Int. Cl. E02d 5/34
U.S. Cl. 61—53.52 5 Claims

ABSTRACT OF THE DISCLOSURE

A method of forming a foundation system over a void including the steps of drilling a hole to the bottom of the void, inserting a casing to the base of the drilled hole extending through the void and into the roof of the void, filling the casing with high compressive strength concrete, pouring a lean cement grout into the remainder of the hole under pressure as required to fill any intermediate voids and installing footings over the area treated.

This invention relates to foundation systems and particularly to foundations for buildings placed over areas having subterranean faults, mine shafts, caves and the like which would furnish questionable support for the structure to be built.

As the population of the land increases, the demand for increased utilization of the land surface for dwelling and commercial construction has dictated the use of more and more of what was formerly considered "unusable" land for construction purposes. There has as a result been a notable increase in construction in areas which overlie voids produced by mining activity as in the bituminous mining areas of western Pennsylvania or natural leaching as in the cavernous limestone areas of central and eastern Pennsylvania.

In the past, two basic systems have been employed to facilitate construction in such areas: the structure was either placed on concrete-filled caissons founded below the base of the void; or the voids themselves were filled with a cement grout. For low-rise structures such as dwellings or commercial buildings, the caisson support system is normally economically feasible to depths of 30 to 40 feet. In order to prevent bonding between the rock overburden and the caisson it is necessary to install a steel shell for the entire length of the caisson hole which adds substantially to the cost of the installation. In addition, this scheme requires a reinforced concrete grade beam system to transfer building loads to the caissons, further increasing the cost.

The grout support scheme usually requires drilling a series of six-inch diameter holes on a grid pattern spaced from 10 to 15 feet on centers over the area included by projecting the plan of the structure on an angle of draw of 20 degrees to the void level. The grout is inserted by either of the two methods: local grout columns; or complete grouting of the voids. Complete grouting of the voids in a mine is very costly and, because of this, it is rarely used. However, local grout columns installed at 10- to 15-foot centers are common, but have certain disadvantages—the major of which is the lack of positive control in placing the aggregate prior to grouting. This scheme entails dumping of coarse aggregate into the six-inch diameter holes to the roof of the mine forming a truncated cone shape. Obviously, the contact area at the roof of the mine cannot be more than six inches. A small diameter (¾"±) pipe is then lowered into the cone and cement grout is forced into the aggregate under gravity pressure. With this scheme conventional foundations are constructed at grade. Another disadvantage of this grouting method is the lack of assurance that full contact is

being achieved at the roof of the mine. This system becomes competitive with caissons at depths exceeding 40 feet, where casing costs become excessive.

The present invention overcomes the disadvantages of both of these systems and provides a system which is far superior to either the caisson or the grout system. Basically the system of my invention entails the drilling of a normal caisson hole to the floor of the void where a steel casing is installed—*but only to the height of the void plus three feet.* That is, the steel pipe projects about three feet into the roof of the void while its base is seated positively into the floor beneath the void. Standard concrete is poured into the steel shell to about three feet above the roof of the void and permitted to set overnight. A high slump cement is then poured into the shaft and permitted to disperse into the fissures in the rock overburden to strengthen the rock structure and provide a bond between the rock overburden and the concrete shaft. Grouting is continued to ground surface. The caisson portion acts as support for the loads imposed by the overburden while the grout provides bonding between the shaft and rock while strengthening the rock by injection. At the completion of the installation of the "Groutcase" system, the structure can be supported conventionally at grade with no abnormal provisions. The merits of this system over the others is that it retains the positive control of the caisson system with the economic advantage of the grout system.

Preferably the method of my invention comprises the steps of drilling a hole to the bottom of the void, inserting a casing to the base of the drilled hole extending through the void and a substantial distance into the roof of the void, filling the casing with high compressive strength concrete and permitting the same to set at least partially, pouring a lean cement grout into the remainder of the hole under pressure as required to fill any remaining voids and installing footings at grade over the area so treated. Preferably I drill holes and fill them according to my invention over a grid pattern corresponding to the outline of the foundation to be installed. The casing is preferably a steel cylinder of substantially the same diameter as the hole. Preferably the casing extends into the roof of the void at least three feet and is filled with a 3000 pound per inch^2 or higher concrete which is permitted to set overnight before the lean cement grout is pumped into the hole. The lean cement grout is preferably added at a minimum pressure of ten pounds per square inch and up to 40 pounds per square inch or the maximum head or grout whichever is lower.

In the foregoing general description of my invention I have set out certain objects, purposes and advantages of my invention. Other objects, purposes and advantages of the invention will be apparent from a consideration of the following description and the accompanying drawings in which:

FIGURE 1 is a fragmentary section showing a hole drilled through a void according to my invention;

FIGURE 2 is a fragmentary section showing the casing and concrete in position according to my invention;

FIGURE 3 is a fragmentary section showing the casing, concrete and grout in position in the earth according to my invention;

FIGURE 4 is a fragmentary section showing a conventional footing installed to complete the foundation according to my invention; and

FIGURE 5 is a top plan view of a foundation grid according to my invention.

Referring to the drawings, I have illustrated a void **10** having a bottom **11** and roof **12** covered by an earthy overburden **13** having smaller voids **14**. A hole **15** is drilled through the overburden **13** and into bottom **11**

to form a base **16** on which is placed a steel casing **17**. The casing **17** extends above roof **12** three feet or more to a point **18**. The casing **17** is filled with high compressive strength concrete **19** which is permitted to set overnight. The remainder of hole **15** is filled with lean grout **20** which is forced into the surrounding voids **14** so that overburden and grout become one structure supported on the concrete column extending through the void. The conventional building footing **21** is placed on the area over the grout in usual manner.

The method of my invention can be practiced at costs which are about fifty percent less than the prior art caisson system and about twenty percent less than the prior art grout system and with savings in time of about a like magnitude.

The system of this invention is relatively simple yet far superior to any system heretofore available to solve the problems inherent in fissured and undermined areas.

I claim:

1. A method of forming a foundation system for building over subterranean void such as fissures, mine shaft, caves, and the like comprising the steps of drilling a hole to the bottom of the principal void, inserting a casing to the base of the drilled hole extending through the void and a substantial distance into the roof of the void, filling the casing with high compressive strength concrete, permitting the concrete to set at least partially, pouring a lean cement grout into the remainder of the hole under

pressure as required to fill any intermediate voids and installing footings at grade over the hole and area treated.

2. A method as claimed in claim **1** wherein the pressure applied to the cement grout is in the range of about 10 to 40 pounds per square inch.

3. A method as claimed in claim **1** wherein the concrete filling in the casing is a 3000 pound per square inch or greater concrete.

4. A method as claimed in claim **1** wherein the steel casing extends into the roof of the void at least three feet.

5. A method as claimed in claim **1** wherein a series of holes are drilled in a grid pattern over an area to be covered by a building.

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U.S. Cl. X.R.

61—53.64; 52—169, 294, 747