July 12, 1932. T. STROTHMANN 1,866,826

HILL DRAINING SYSTEM

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Fig. 1.

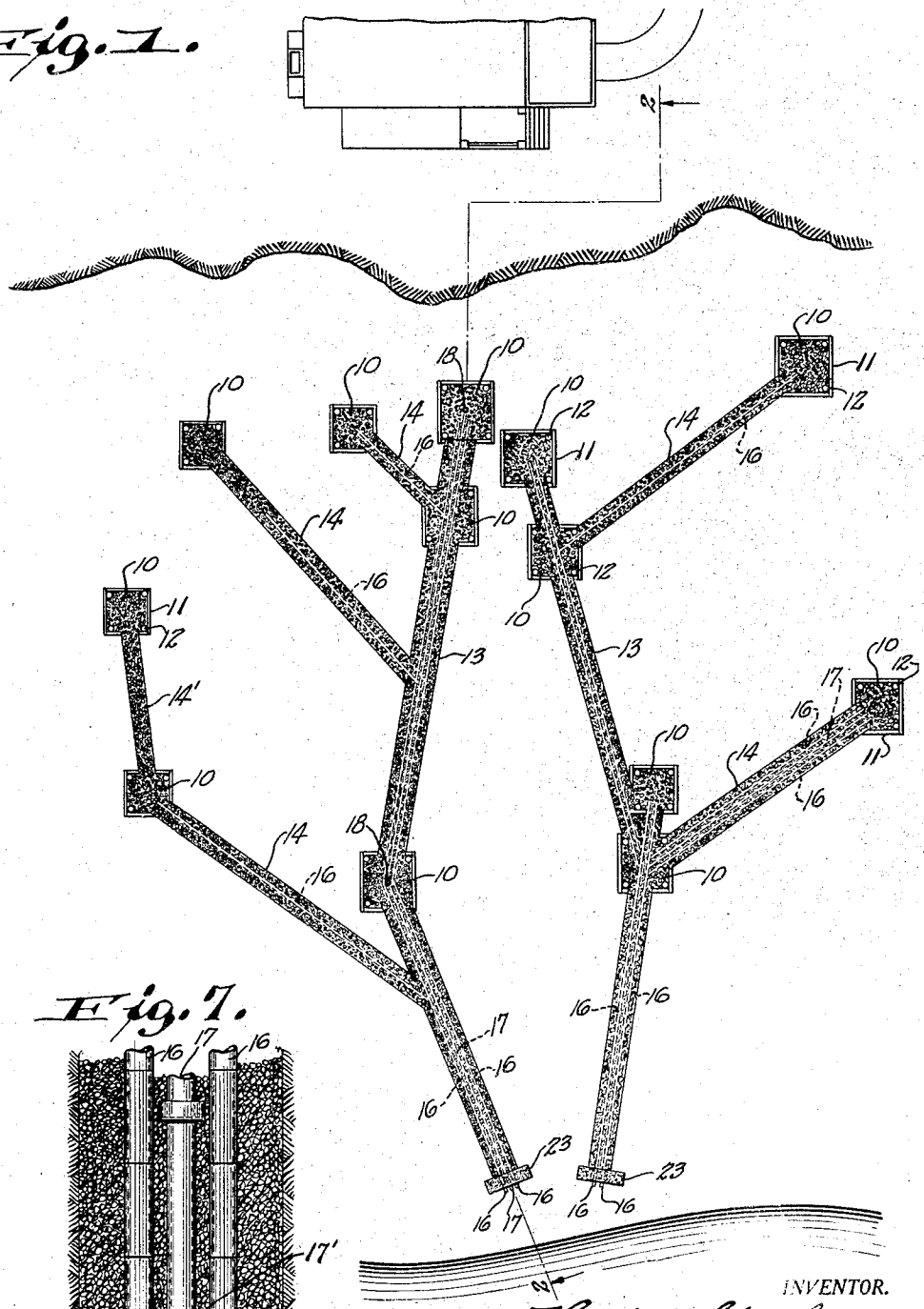



Fig. 7.




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Fig. 2.

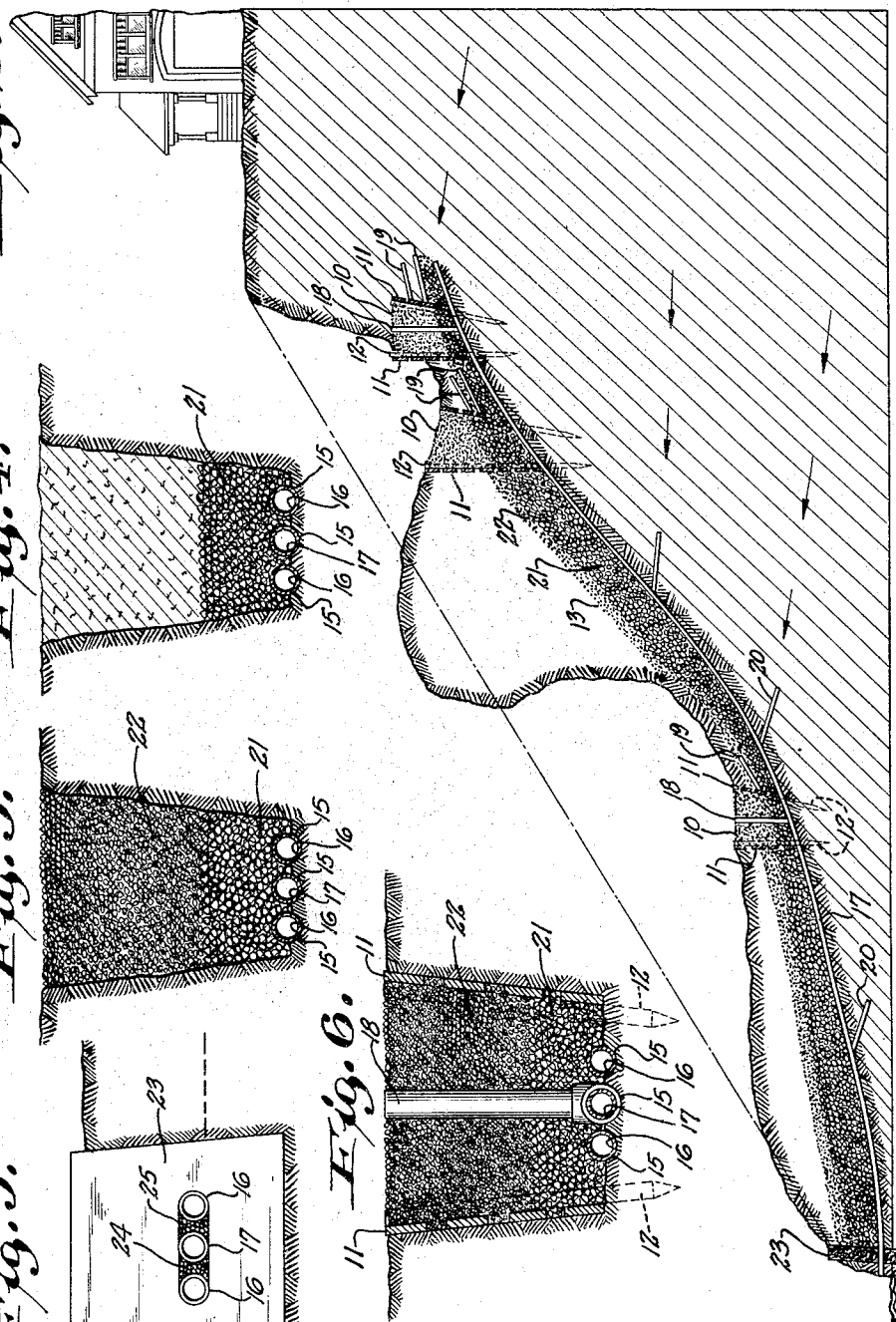


Fig. 4.



Fig. 3.



Fig. 5.



Fig. 6.



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# UNITED STATES PATENT OFFICE

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## HILL DRAINING SYSTEM

Application filed November 28, 1930. Serial No. 498,689.

This invention relates to improvements in hill draining systems and more particularly to systems for preventing landslides from undermining property located on a bluff.

Property located on the top of bluffs, and more particularly on bluffs bordering the shores of certain of the great lakes, is constantly being undermined by the breaking away of the soil on the slope of said bluffs. Frequently, this property is located in an exclusive residential district and has expensive dwellings built thereon. It will thus be seen that these landslides are constantly undermining and endangering valuable realty, and in a number of instances, houses built too close to the edge have had portions broken away and carried down the hillside. Up to the present time, the breaking away of hillsides and banks has been wrongly attributed to the constant washing of the waves against the lower edge of the bank, and large concrete walls have been built to endeavor to remedy the situation. These walls, however, in all instances where they were built several years ago have been broken down by subsequent landslides, proving that the action of the waves has little, if any, effect upon the banks.

The underlying theory of the present invention is based upon the fact that the landslides are caused by underground currents of water which are inherent in the ground and which are constantly working their way through stratas of quick sand toward an outlet in the hillside. When reaching the hillside, the water sometimes seeps through, but if it is hampered by heavy soil or artificial walls, it will accumulate for a period of time until enough strength has been gained for it to burst through, carrying large portions of the ground with it, the ground above breaking down as a result.

It is, therefore, one of the objects of this invention to provide an improved hill draining system which provides means for cooperating with the seepage water to conduct it to a free outlet, thereby preventing the above mentioned dangerous underground accumulations.

A further object of this invention is to provide drainage conduits which may comprise main lines and branches so positioned with relation to the contour of the hillside as to attract the seepage water for the purpose of conducting it to a free outlet.

A further object of this invention is to provide a hillside drainage system which includes drainage pockets and conduits leading therefrom to an outlet.

A more specific object of this invention is to provide a hillside drainage system wherein a plurality of trenches are utilized, in the bottom of which porous drain pipes are laid, said trenches being partially or entirely filled with small stones or the like to which the water will be attracted and through which it can readily seep to the drain pipes, the latter leading it to a suitable outlet.

It is a further object of this invention to provide a hill draining system which is relatively inexpensive to install, efficient in operation and well adapted for the purpose described.

With the above and other objects in view, the invention consists of the improved hill draining system and all its parts and combinations as set forth in the claims, and all equivalents thereof.

In the accompanying drawings illustrating one complete embodiment of the preferred form of the invention, in which the same reference numerals designate the same parts in all of the views:

Fig. 1 is a plan view of a hillside showing the system installed thereon;

Fig. 2 is a sectional view taken on line 2—2 of Fig. 1;

Fig. 3 is an enlarged cross-sectional view of one of the trenches;

Fig. 4 is a similar view showing another type of trench;

Fig. 5 is a front elevation of one of the walls at the outlet of a trench;

Fig. 6 is an enlarged cross-sectional view through one of the stone pockets; and

Fig. 7 is an enlarged fragmentary longitudinal section through one of the trenches showing a plan view of the pipes therein.

An undermined hillside which has had portions broken away at different intervals may

have the appearance shown in Fig. 2, wherein the broken line indicates the normal grade line and the full lines indicate the deformed contour of the land after landslides have occurred. In carrying out the present invention, the hillside is first surveyed to accurately ascertain the contour of the land and to locate weak portions of the hillside from which the water is most likely to emerge. These weak portions are frequently found near stratas of quick sand. At said portions stone pockets 10 are dug to a desired depth. The walls of these stone pockets may be lined with spaced-apart boards 11 supported upon cedar posts 12. From some of these stone pockets main line trenches 13 are dug which extend downwardly to the foot of the bank. Said trenches are usually extended at an angle as shown in Figure 1, said angle being determined by the contour of the ground so that the seepage water will most naturally flow into the trenches. From other stone pockets branch line trenches 14 are dug, the said branch trenches connecting with one of the main trenches 13. The branch trenches are also positioned at an angle to most effectively intercept the seepage water. These trenches may be from 6 to 15 feet deep, and may be approximately 3 feet wide, and often extend through several stratas of quick sand.

In the bottom of each of the stone pockets and trenches one or more grooves 15 is dug and in said grooves one or more lines of porous drain pipe 16 is laid, said lines in the case of a branch trench extending to the main trench, and in the case of a main trench extending downwardly to the outlet. In some of the trenches a line of non-porous sewer pipe 17 is also laid, said sewer pipe in the branch trenches being connected by means of a T with the sewer pipe of a main trench, and the sewer pipe of the latter extending downwardly to the outlet. The joints of the various sections of the sewer pipe are packed with oakum 17'. In some of the stone pockets 10 a sewer pipe connection 18 may lead up to the surface for the purpose of carrying away surface water and at the upper end of each trench the sewer pipe may be, if desired, connected to a sewer pipe leading from the surface of the bluff above to carry away water from the vicinity of the house. In one or more walls of each of the stone pockets holes 19 may be drilled into the soil for the purpose of more readily leading water to said pockets and similar holes may be drilled from portions of the trenches as at 20.

Each stone pocket is first partially filled with a layer of course stone 21 and then with fine stone 22, as shown in Fig. 6. The trenches 13 and 14 are also filled in a similar manner, as shown in Fig. 3. In some instances, the trenches may be partially filled with stone and then completely filled with ground, as shown in Fig. 4.

Certain of the branch trench lines and stone pockets may have the drain pipes and sewer pipes omitted completely as in the trenches 14', and other of the trenches may have only one or more lines of drain pipe without any sewer pipe therein. In at least one of the main trenches, however, it is preferred to utilize one central line of sewer pipe with a line of porous drain pipe on each side thereof, as shown in Fig. 7.

At the ends of the main trenches, small concrete walls 23 are constructed, said walls being for the purpose of holding back the material within the trenches. The walls are provided with elongated openings 24 therein through which the ends of the pipes project, and the spaces between the pipes in said opening may be filled with gravel as at 25.

When a system such as that disclosed in the drawings has been installed, the seepage water between the stratas of the ground will pass through the weak portions thereof, some proceeding directly to the stone pockets and other water entering the sides of the main and branch trenches. Where holes have been drilled into the earth as at 19 and 20, the entrance of the water at proper places will be facilitated. The water which has found its way into the stone pockets and trenches will immediately trickle through the spaces between the crushed stone and will soon find its way to the bottom of the trenches, where it will enter the sides of the porous piping and also between the joints of the abutting ends of said pipes. The water will then be led through the drain pipes to the outlets where it will flow into the lake or other body of water below. The sewer pipes 17 will carry any surface water to a suitable outlet. Due to the positions of the stone pockets and trenches, they will act as funnels to intercept the seepage water and lead it to the drain pipes. The water will always find the easiest outlet, and for this reason the trenches and stone pockets filled with crushed rock will naturally attract the water as indicated in the arrows in Fig. 2. The entire network of trenches and stone pockets is so located as to centralize the seeping water into one flow and to prevent the water from accumulating without a suitable outlet where such accumulations might prove dangerous. Where houses are built on the bluffs, it is found that the added weight of the structures stimulates a flow of seepage water and this renders a suitable drainage system all the more essential. It has been found that one trench line including the branches connected therewith will gather and discharge at its outlet a steady flow of water at the rate of about 350 gallons in every twenty-four hours. It can thus readily be seen how quickly a large body of water could accumulate underground if there were no proper outlet provided. A hillside pro-

tected by the improved system may be terraced and landscaped to add to the beauty of the property, and this terracing will be in no way endangered by subsequent landslides.

Although only one form of the invention has been shown and described, it is obvious that various modifications and changes may be made therein, and it is to be understood that all such modifications are contemplated as may come within the scope of the claims.

What I claim is:

1. A system of hillside drainage comprising a trench of substantial depth extending from an upper portion of a hill downwardly and having a groove in the bottom thereof, a porous drainage pipe line laid in said groove and extending downwardly to a point of discharge, a portion of the pipe line projecting above the groove into the trench, porous drainage material in said trench covering said projecting portion of the pipe line, the bottom of the trench being of such width as to provide a space on the side of the pipe line within which some of the porous drainage material is disposed, and substantially horizontal ducts for leading seepage water from strata of quick sand below the trench to said porous drainage material in the bottom thereof.

2. A hillside drainage system comprising, a main inclined drainage pipe embedded beneath the surface of the hillside and extending downwardly from the upper portion thereof to a lower point of discharge near the bottom, and substantially horizontal ducts extending away from said main pipe into the hill beneath said main pipe.

3. A hillside drainage system comprising, a main inclined drainage pipe embedded beneath the surface of the hillside and extending downwardly from the upper portion thereof to a lower point of discharge near the bottom, substantially horizontal ducts extending away from said main pipe into the hill beneath said main pipe, and substantially vertical ducts extending from adjacent the surface of the hillside to said main pipe.

In testimony whereof, I affix my signature.

THEODORE STROTHMANN.