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APPARATUS FOR MINING SULFUR.

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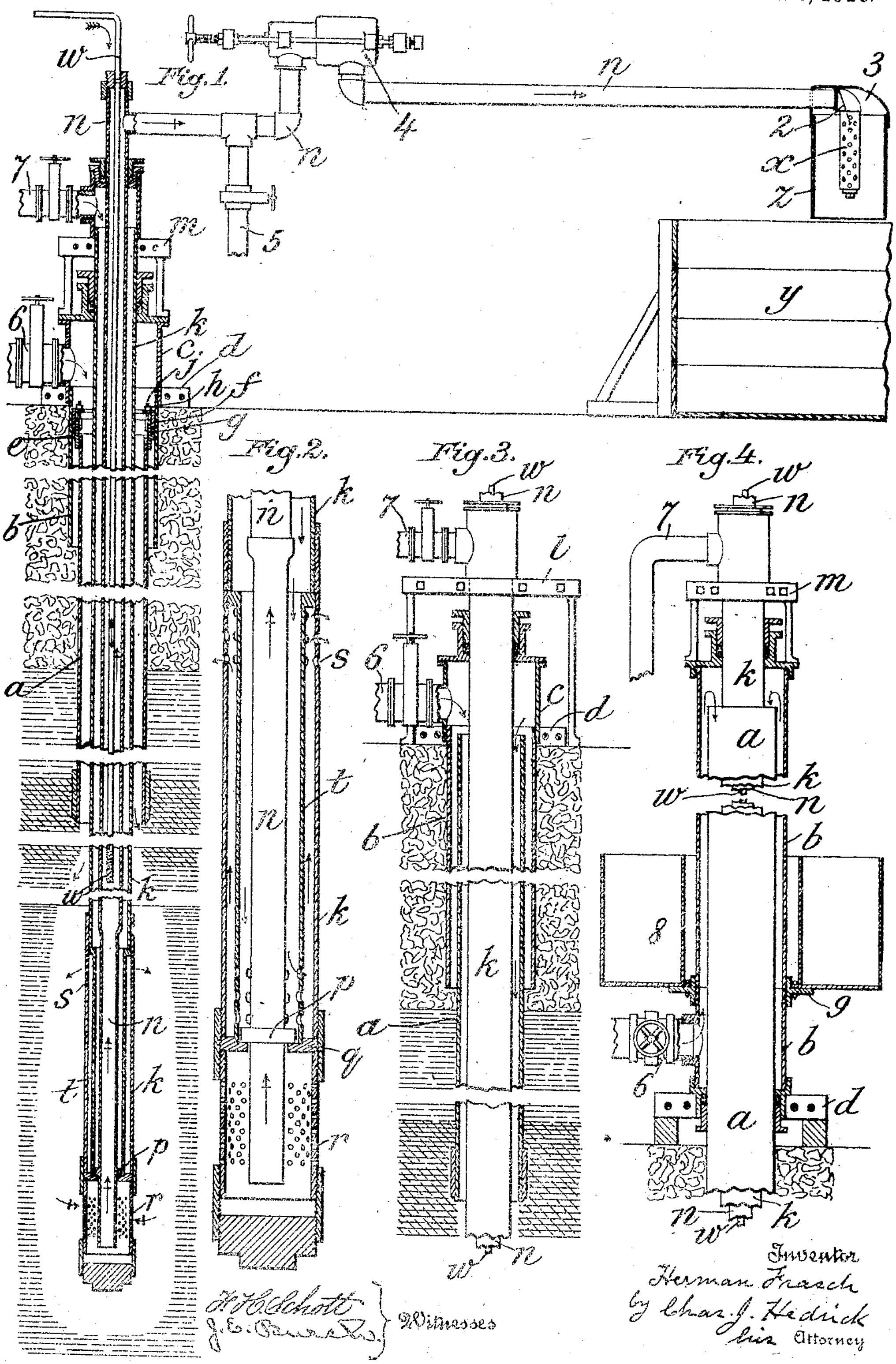
977,444. Patented Dec. 6, 1910.



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Witnesses

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APPARATUS FOR MINING SULFUR.

977,444. Specification of Letters Patent. **Patented Dec. 6, 1910.**

Application filed October 30, 1903. Serial No. 179,233.

To all whom it may concern:

Be it known that I, HERMAN FRASCH, a citizen of the United States, residing at New York city, borough of Manhattan and county of New York, in the State of New York, have invented new and useful Improvements in Apparatus for Mining Sulfur, of which the following is a specification.

This invention relates more particularly to the mining of sulfur by fusion, or, in other words, to the obtainment of sulfur from an underground deposit by melting it therein and then raising it in the melted state to the surface of the ground; but each of the improvements constituting said invention is intended to be secured for all the uses to which it may, with or without modification, be adapted. Heretofore Patents 461,429 and 461,430, both dated October 20, 1891, were granted to me for, respectively, such process and for apparatus to be used in carrying the same into effect. Subsequently, on May 27, 1897, an application, officially numbered 638,357, was filed for an improved process and apparatus more particularly designed to meet difficulties incident to mining sulfur by fusion in porous deposits, which are naturally flooded with water. As a result of official requirement, said application was divided. Patents No. 799,642 and No. 800,127 were granted September 19, 1905, the former on the original and the other on the divisional application. In all these prior apparatus there was a system of piping for conveying fusing fluid under pressure to the underground deposit, and in the case of the said patents there was mine piping for returning the fusing fluid under pressure to the surface of the ground. Sometimes the fluid-conveying piping has parted underground and the fluid has escaped through the surrounding earth with violence, projecting dirt and stones in all directions before the supply of fluid under pressure could be stopped. The lower portion of the fluid-conveying piping was found to have settled and in some instances to have disappeared. The parting and settling are attributed to a sinking or caving in of the rock containing or overlying the sulfur deposit; and they have taken place, unexpectedly, without apparent warning. They have happened in recovering sulfur from a porous water flooded deposit, with hot water introduced without return as the fusing fluid; but it is possible that they may otherwise occur; and the present invention is not restricted to the use of hot water as the fusing fluid, nor to the introduction of the fusing fluid without return.

In accordance with the present invention, the difficulty is overcome or ameliorated by making the mine piping for conveyance underground of the fusing fluid under pressure, or an appropriate part of such piping, in telescoping sections, so that the lower section can be carried down without interrupting the continuity of the piping. In order to raise the melted sulfur, an appropriate pipe is employed, and it has been found advantageous to have a discharge for the fusing fluid in proximity to the intake for the melted sulfur. Such an arrangement of discharge (for the fusing fluid) and intake (for the melted sulfur) is shown in my said apparatus patent of October 20, 1891, and in both my said patents of September 19, 1905. As so shown, however, fusing fluid (namely, hot water) is apt to enter with the sulfur to such an extent as to be objectionable. Water, for example, at the temperature of melted sulfur has to be held under considerable pressure; and, unless the melted sulfur is discharged under sufficient pressure (as shown in my said patents of October 20, 1891, but since dispensed with), the water turns into steam in the sulfur pipe, and in so doing absorbs heat, so that, if present in sufficient amount, its vaporization will cool the sulfur enough to interfere with its flow.

In accordance with the present invention, the discharge for the fusing fluid is placed less near the sulfur intake, say, about two and a half feet above said intake, or as much more or less as may be found expedient, and a close heater is interposed between the said discharge and the said intake, in order to keep, or aid in keeping, the sulfur in the melted state. This close heater is most conveniently made by having a return bend or passage for the fusing fluid below its said discharge.

To deliver the melted sulfur, the sulfur pipe is provided with a new or improved nozzle, which forms part of the invention and which has a side delivery (most advantageously consisting of a number of small holes) and is inclosed in a wider casing for stopping the projection laterally of the melted sulfur. When the melted sulfur is delivered by the aid of compressed air introduced near the lower part of the sulfur column and is liable to contain more or less water, it is apt to be delivered spasmodically and with some violence. The new or improved nozzle arrests the laterally delivered sulfur, letting it drop quietly into the vat, while the air and steam pass off into the atmosphere.

The invention also comprises such further parts, improvements and combinations as are hereinafter set forth.

The following description, in connection with the accompanying drawing, sets forth what is considered the best mode of carrying the invention into effect, water being used as the fusing fluid, and it also sets forth certain modifications. It will be understood that other modifications can be made and any suitable fusing fluid employed so long as the substance is taken of any one or more of the hereinafter written claims.

Figure 1 is a diagram, illustrating sulfur-mining apparatus in accordance with the invention; Fig. 2 is a detail view, in section, of the lower part of the sulfur pipe and the inner hot water pipe; Figs. 3 and 4 are diagrams illustrating other forms of mine piping in telescoping sections, also within the invention.

The lower section *a* of the outer hot water pipe rests at the bottom on the rock, while the upper section *b*, which is provided with the casing head *c* and telescopes with the lower section, is supported in any suitable way, as, for example, by the clamp *d* at the surface of the ground.

As shown in Fig. 3, the upper section overlaps the lower section so much, say, 250 feet, that the tendency of the water to force itself between the sections and out under the bottom of the upper section, is resisted by the earth. In Fig. 1, however, the upper section is shorter (say, 40 feet in length) and there is a packing between the two sections to prevent the passage of the water. This packing is of a sort (herein termed slidable) to allow the sections to move longitudinally with reference one to the other without destroying the tightness of the joint between them and is best made after the manner of a stuffing box, with a gland *e* in the form of a ring screwed on the top of the lower casing section and a follower *f* in the form of a ring adjustably held against the packing *g* by means of nuts *h* on the ends of bolts *j* whose lower ends are anchored in the body of the gland *e*. The pipe *k* for conducting hot water to the bottom of the mine may be supported in any suitable way. In Fig. 3 it is shown as suspended from a clamp *l*, which is upheld by feet resting on the ground, and in Fig. 1 from a clamp *m*, which is upheld by feet resting on the casing head *c*.

There is an advantage in having the clamp *m* supported by the casing head, especially when the upper pipe section *b* is short, in that the weight of the interior pipes aids in holding down said section against the pressure of the hot water inside, which tends to raise the same. The section *b* could also be additionally loaded as hereinafter described with reference to Fig. 4.

The sulfur pipe *n* has a collar *p* near the bottom which rests upon the pipe closure or plug *q* in the interior of the water pipe *k*, the lower end of the sulfur pipe projecting into the strainer *r* at the bottom of the water pipe *k*. The plug *q* normally separates the strainer from the bore of the water pipe, but, when the sulfur pipe is lifted out, the water from the pipe *k* can enter the strainer and clear its perforations.

Instead of allowing the hot water to escape immediately above the strainer *r*, the discharge (composed of openings *s*) is placed higher up, in order to diminish the liability of the water getting into the sulfur pipe. In order, however, to insure the liquid condition of the sulfur below said discharge *s*, the bore of the water pipe *k* is extended below said discharge *s* and is returned upon itself. This return bend or passage is best made by a partition *t* in the water pipe *k*, which partition is annular as shown and has a flange at the top and perforations at the bottom. The water passes down between the sulfur pipe *n* (which is here preferably reduced in diameter as shown) and the annular partition *t*, out through the perforations in the partition, up between the annular partition *t* and the wall of water pipe *k* and out through the openings *s* into the mine cavity.

The pipe *w* delivers compressed air into the melted sulfur, so that the average density of the column is lessened sufficiently for the pressure in the mine to force the melted sulfur to the surface of the ground and out through the nozzle *x* into the vat *y*, built up of ordinary wooden boards and timbers. The nozzle *x* is closed at the bottom, but has perforations in the sides, of smaller diameter than the bore of the sulfur pipe, through which perforations the melted sulfur and air, with more or less water vapor, are delivered. Around the nozzle is the casing *z* which catches the fluids ejected from the nozzle, causing the melted sulfur to fall into the vat *y*, while the air and water vapor escape, passing out of the bottom and rising into the atmosphere. As shown, the casing *z* is upheld by a wire bail 2 and has a cover 3.

When the vat has been filled, the supply of compressed air to the pipe *w* is stopped, and, if desired, the sulfur pipe is closed by the sulfur valve 4, which may be of any suitable description. Its construction is no part of the present invention. I have, however, devised a valve which is specially adapted for pipes which convey melted sulfur, the same forming the subject of my application No. 179,231, filed of even date herewith; and Fig. 1 exhibits such valve in elevation. The nozzle x is moved to another vat, and the sulfur valve being reopened (if previously closed) the introduction of compressed air and the delivery of the melted sulfur are resumed.

At 5 is shown a valved hot water pipe connected with the sulfur pipe between the sulfur valve 4 and the well. When desired, the sulfur valve 4 being closed and the delivery of compressed air being stopped, hot water can be forced down the sulfur pipe, in order to clean the strainer (without lifting the sulfur pipe) or to increase the water for melting. The sulfur which is then melted collects in the bottom of the mine cavity, and is subsequently removed.

At 6 is the hot water pipe connected with the casing head c. The water from it passes through the lower section a of the outer hot water pipe into the upper part of the mine cavity.

At 7 is the branch through which hot water is supplied to the inner hot water pipe k, whose discharge s is near the bottom of the mine cavity.

In Figs. 1 and 3 the telescoping sections a and b of the outer hot water pipe are both embedded in the ground. The lower section a is necessarily so embedded; but, the telescoping portion thereof, with the section b, need not be underground, either in whole or in part.

In Fig. 4, the section b is entirely above ground, and has the supporting clamp d at its lower end, instead of at its upper end, as in Figs. 1 and 3. There is an advantage in this arrangement in giving more convenient access to the stuffing box or slidable packing means between the sections a and b; but the length of the mine piping is greater than in the arrangement of Fig. 1, which exhibits what is considered the best form of apparatus.

The clamp m rests, as in Fig. 1, on top of the upper telescoping section a of the outer hot water mine pipe; but, according to the arrangement of Fig. 4, it would be elevated about forty feet, more or less (or to such distance as may be thought best), above the surface of the ground.

The pipe section b, to guard against its not being sufficiently weighted otherwise to resist the inside pressure, may be provided with additional weights in any suitable way. For example, there may be a tank 8 resting on the flange 9 on the pipe section b and the tank may be filled with water or any other material. The pipes n and w being supported by the pipe k (through collar p, Figs. 1 and 2) and the pipe k by the pipe section b through the clamp m, the weight of these pipes tends, as in Fig. 1, to hold down the pipe section b.

In Fig. 1, the lower section a is embedded in the ground below the bottom of the upper section b for the whole depth between the surface of the ground and the rock which contains or overlies the sulfur deposit and on which the lower section rests, except for about forty feet at the top, where it is inclosed by the upper section b. In Fig. 3 the embedded portion would be less than such whole depth by about 250 feet (that having been mentioned above as the amount of overlap for the sections in Fig. 3). In Fig. 4 it is embedded below the bottom of the upper section b for the whole distance to which the pipe (composed of said sections) extends below ground, the upper section being shown as wholly above ground. In any case, therefore, the lower section is shown as embedded in the ground below the bottom of the upper section for not less than a substantial portion of the well's depth. Consequently, subsidence of the ground at the lower part of the well may take place over many feet without drawing down the upper section. Moreover, the lower section telescopes with the upper for a great enough distance to allow a considerable sinking without breaking the continuity of the pipe a b.

The figures (of forty feet and 250 feet, respectively, for the upper section b) are given by way of example. They are each intended for a well much more than 250 feet deep. A substantial portion of the depth of any well to which a mine pipe in telescoping sections is likely to be employed may be taken as not less than ten feet; although it is not intended to assert that the embedded portion of the lower section below the bottom of the upper section would probably in any case be as small in actual practice as this minimum, or even two, three, four, or five times the same.

There is an advantage in having the lower section a of smaller diameter than the upper section b; for the well hole where it receives the lower section may then be no larger in diameter than suffices to receive such section of smaller diameter; whereas, if the lower section were the larger in diameter, all the well hole above the lower end of such section must be of correspondingly large diameter.

Referring to Figs. 1 and 2, it will be observed that the pipe k forms a close heater below the discharge s, between said discharge and the sulfur intake at the lower end of the pipe n, and that there is no discharge for fusing fluid below such close heater.

The hot water introduced by the outer telescoping pipe a b and the inner pipe k, or by said pipes and the sulfur pipe n when sulfur is not being raised, is forced out through the porous rock, and made to flow away underground. The melted sulfur collects in a pool around the lower end of the pipe *n* and seals the same against ingress of water (unless in small amounts) during the sulfur-raising operation. This is raised by the available pressure in the deposit when the average density of the column of melted sulfur is sufficiently reduced by the compressed air from pipe *w*.

I claim as my invention or discovery:

1. Apparatus for mining by fusion, having three mine pipes, namely, a mine pipe for raising the melted material provided with a discharge above ground, a mine pipe for the fusing fluid having a discharge near the bottom of the mine cavity, and a mine pipe in telescoping sections embedded in part in the ground and inclosing the other mine pipes, substantially as described.

2. The combination with piping for introducing fusing fluid into an underground deposit, of a mine pipe for raising the melted material provided with a discharge nozzle which is closed at the end and has a lateral discharge, and a casing which incloses said nozzle at the level of said discharge and is open below for the escape of the melted material, substantially as desribed.

3. The combination with piping for introducing fusing fluid into an underground deposit, of a mine pipe for raising the melted material provided with a discharge nozzle which is closed at the end and has a lateral discharge, a casing which incloses said nozzle at the level of said discharge and is open below for the escape of the melted material, and a pipe delivering compressed air or other aeriform fluid into the lower part of the before mentioned pipe, substantially as described.

4. In apparatus for mining by fusion, a mine pipe for raising the melted material, which pipe has valved branches, one for discharging the melted material, the other for the introduction of fusing fluid when the former branch is closed, in combination with a mine pipe for the fusing fluid having a return passage below the discharge, substantially as described.

5. Apparatus for mining by fusion, in which a mine pipe for the introduction of fusing fluid has its discharge located in the deposit of fusible material being mined and is provided below said discharge with a return passage through which the fusing fluid is delivered into said deposit, substantially as described.

6. A mine pipe having discharge openings near its lower end and an extension below the discharge openings divided by a partition so as to form a return passage leading to the discharge, substantially as described.

7. The combination with a continuous pipe having its bore closed and its wall perforated above such closure and provided with an intervening imperforate portion, of an annular partition located at a distance from the upper end of said pipe and fitting at its own upper end against the inside of said pipe, said partition having an imperforate portion opposite the perforations in the pipe wall and a perforated portion opposite said imperforate portion of the pipe wall, substantially as described.

8. A pipe having its bore closed above the extremity of said pipe and perforated both above and below such closure, in combination with a pipe extending through said closure and opening into the space below the same, and a partition located at a distance from the upper end of the first mentioned pipe and arranged to form a return passage therein leading to the perforations above said closure, substantially as described.

9. Apparatus for mining by fusion, having a mine pipe for the introduction of fusing fluid with a discharge near the lower end of the pipe and also with an extension below said discharge, in which extension a return passage leading back to the discharge is located, and the said apparatus also having a mine pipe for raising the melted material extending below the first mentioned pipe and opening into the space occupied by the fused material, substantially as described.

10. Apparatus for mining by fusion, in which a mine pipe for the introduction of fusing fluid has a return passage below the discharge, and in which also the mine pipe for raising the melted material extends below the bottom of said return passage, said discharge being located in the deposit of fusible material being mined, substantially as described.

11. Apparatus for mining by fusion, having fluid conveying piping with one or more fluid discharges in the deposit of fusible material being mined, a mine pipe with an intake located below said discharges in the space occupied by the melted material for raising such material, and a close heater intermediate the intake for the melted material and a fluid discharge, to wit, the lowermost discharge when there is more than one, substantially as described.

12. Apparatus for mining by fusion, having two pipes which convey fusing fluid into an underground deposit and open at different levels into said deposit, and also having a pipe for raising the melted material and a close heater between the intake for the melted material and the lowermost discharge for fusing fluid, substantially as described.

13. Apparatus for mining by fusion, having two pipes which convey fusing fluid into an underground deposit and open at different levels into said deposit, the outer pipe be-

ing in telescoping sections, and also having a pipe for raising the melted material and a close heater between the intake for the melted material and the lowermost discharge for fusing fluid, substantially as described.

14. Mining apparatus which has means for delivering mining fluid to an underground deposit and for enabling the material mined by the aid of said fluid to be brought to the surface of the ground and which includes a conveying pipe embedded in the ground for a large part of its length and provided with a telescoping joint by the aid of which continuity of pipe connection is preserved while such subsidence of the lower part of said conveying pipe is permitted as might result from a caving in of the ground in and above the deposit without involving the overlying earth, said conveying pipe having an inlet and an outlet which communicate respectively with said deposit and with an above ground portion of the apparatus, substantially as described.

15. Mining apparatus which has means for delivering mining fluid to an underground deposit and for enabling the material mined by the aid of said fluid to be brought to the surface of the ground and which includes both conveying piping interposed between said deposit and an above ground portion of the apparatus and also an inclosing pipe embedded in the ground for a large part of its length and provided with a telescoping joint by the aid of which continuity of inclosure is preserved while such subsidence of the lower part of said inclosing pipe is permitted as might result from a caving in of the ground in and above the deposit without involving the overlying earth, said piping being surrounded by said inclosing pipe and projecting beyond the bottom of the same, substantially as described.

16. Mining apparatus which has means for delivering mining fluid to an underground deposit and for enabling the material mined by the aid of said fluid to be brought to the surface of the ground and which includes both conveying piping interposed between said deposit and an above ground portion of the apparatus and also a conveying and inclosing pipe embedded in the ground for a large part of its length and provided with a telescoping joint by the aid of which continuity of pipe connection is preserved while such subsidence of the lower part of said conveying and inclosing pipe is permitted as might result from a caving in of the ground in and above the deposit without involving the overlying earth, said piping being surrounded by said conveying and inclosing pipe and projecting beyond the bottom of the same, and the latter having an inlet and an outlet which communicate respectively with said deposit and with an above ground portion of the apparatus, substantially as described.

17. Mining apparatus which has means for delivering hot fluid for fusion purposes to an underground deposit of fusible material and for enabling the material melted by the aid of said fluid to be brought to the surface of the ground and which includes a conveying pipe in telescoping sections with protection against escape of fluid by way of the telescoping joint when extended arranged to maintain continuity of pipe connection, the lower pipe section being embedded in the ground for a large part of its length and having an outlet which communicates with the deposit, and the upper pipe section having an inlet which communicates with a source of hot fluid under pressure for fusion purposes, substantially as described.

18. Mining apparatus which has means for delivering hot fluid for fusion purposes to an underground deposit of fusible material and for enabling the material melted by the aid of said fluid to be brought to the surface of the ground and which includes both conveying piping interposed between said deposit and an above ground portion of the apparatus and also an inclosing pipe in telescoping sections with protection against escape of fluid by way of the telescoping joint when extended arranged to maintain continuity of inclosure, the lower pipe section being embedded in the ground for a large part of its length, and said piping being surrounded by said inclosing pipe and projecting beyond the bottom of the same, substantially as described.

19. Mining apparatus which has means for delivering hot fluid for fusion purposes to an underground deposit of fusible material and for enabling the material melted by the aid of said fluid to be brought to the surface of the ground and which includes both conveying piping interposed between said deposit and an above ground portion of the apparatus and also a conveying and inclosing pipe in telescoping sections with protection against escape of fluid by way of the telescoping joint when extended arranged to maintain continuity of pipe connection, the lower pipe section being embedded in the ground for a large part of its length and having an outlet which communicates with the deposit, and the upper pipe section having an inlet which communicates with a source of hot fluid under pressure for fusion purposes, and said piping being surrounded by said conveying and inclosing pipe and projecting beyond the bottom of the same, substantially as described.

20. Mining apparatus which has means for delivering hot fluid for fusion purposes to an underground deposit of fusible material and for enabling the material melted by the aid of said fluid to be brought to the surface of the

surface of the ground and which includes a conveying pipe in telescoping sections with protection against escape of fluid by way of the telescoping joint when extended arranged to maintain continuity of pipe connection, the upper and lower pipe sections being each of them embedded in the ground for a large part of its length, the lower section having an outlet which communicates with the deposit, and the upper section having an inlet which communicates with a source of hot fluid under pressure for fusion purposes, substantially as described.

21. Mining apparatus which has means for delivering hot fluid for fusion purposes to an underground deposit of fusible material and for enabling the material melted by the aid of said fluid to be brought to the surface of the ground and which includes both conveying piping interposed between said deposit and an above ground portion of the apparatus and also an inclosing pipe in telescoping sections with protection against escape of fluid by way of the telescoping joint when extended arranged to maintain continuity of inclosure, the upper and lower pipe sections being each of them embedded in the ground for a large part of its length, and said piping being surrounded by said inclosing pipe and projecting beyond the bottom of the same, substantially as described.

22. Mining apparatus which has means for delivering hot fluid for fusion purposes to an underground deposit of fusible material and for enabling the material melted by the aid of said fluid to be brought to the surface of the ground and which includes both conveying piping interposed between said deposit and an above ground portion of the apparatus and also a conveying and inclosing pipe in telescoping sections with protection against escape of fluid by way of the telescoping joint when extended arranged to maintain continuity of pipe connection, the upper and lower pipe sections being each of them embedded in the ground for a large part of its length, the lower section having an outlet which communicates with the deposit, the upper pipe section having an inlet which communicates with a source of hot fluid under pressure for fusion purposes, and said piping being surrounded by said conveying and inclosing pipe and projecting beyond the bottom of the same, substantially as described.

23. Mining apparatus which has means for delivering mining fluid to an underground deposit and for enabling the material mined by the aid of said fluid to be brought to the surface of the ground and which includes a pipe in telescoping sections with protection against escape of fluid by way of the telescoping joint when extended arranged to maintain continuity, the lower section of smaller diameter than the upper section and fitting within it being open at the bottom and being embedded in the ground for a large part of its length, substantially as described.

24. A mine pipe which conveys hot fluid underground for fusion purposes and is in telescoping sections, the lower section being embedded in the ground below the bottom of the upper section for not less than a substantial portion of the well's depth, and the upper section being additionally weighted, substantially as described.

25. A mine pipe which conveys hot fluid underground for fusion purposes and is in telescoping sections, the lower section being embedded in the ground below the bottom of the upper section for not less than a substantial portion of the well's depth, in combination with mine piping suspended from the upper section of the first mentioned pipe, substantially as described.

26. Mining apparatus which has means for delivering mining fluid to an underground deposit and for enabling the material mined by the aid of said fluid to be brought to the surface of the ground and which includes a pipe in telescoping sections with protection against escape of fluid by way of the telescoping joint when extended arranged to maintain continuity, the lower section being of smaller diameter than the upper section and being open at the bottom, and each of said sections being embedded in the ground for a large part of its length, substantially as described.

27. Mining apparatus which has means for delivering mining fluid to an underground deposit and for enabling the material mined by the aid of said fluid to be brought to the surface of the ground and which includes a pipe in telescoping sections with slidable packing between the sections, the said pipe being arranged to maintain continuity, the lower section being of smaller diameter than the upper section and being open at the bottom and being embedded in the ground for a large part of its length, substantially as described.

28. Mining apparatus which has means for delivering mining fluid to an underground deposit and for enabling the material mined by the aid of said fluid to be brought to the surface of the ground and which includes a pipe in telescoping sections with slidable packing between the sections, the said pipe being arranged to maintain continuity, the lower section being of smaller diameter than the upper section and being open at the bottom, and each of said sections being embedded in the ground for a large part of its length, substantially as described.

29. Mining apparatus which has means for delivering mining fluid to an under-

ground deposit and for enabling the material mined by the aid of said fluid to be brought to the surface of the ground and which includes a pipe in telescoping sections with a follower and a gland on one of said sections and with intervening slidable packing between said follower and gland, the said pipe being arranged to maintain continuity, and the lower section being open at the bottom and embedded in the ground for a large part of its length, substantially as described.

30. Mining apparatus which has means for delivering mining fluid to an underground deposit and for enabling the material mined by the aid of said fluid to be brought to the surface of the ground and which includes a pipe in telescoping sections with a follower and a gland on the section whose overlapped end terminates the nearer to the surface of the ground and with intervening slidable packing between said follower and gland, the said pipe being arranged to maintain continuity, and the lower section being of smaller diameter than the upper section and being open at the bottom and embedded in the ground for a large part of its length, substantially as described.

31. Mining apparatus which has means for delivering mining fluid to an underground deposit and for enabling the material mined by the aid of said fluid to be brought to the surface of the ground and which includes a pipe in telescoping sections with a follower and a gland on the upper end of the lower section and with intervening packing between said follower and gland, the said pipe being arranged to maintain continuity, the lower section being of smaller diameter than the upper section and being open at the bottom, and each of said sections being embedded in the ground for a large part of its length, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

HERMAN FRASCH.

Witnesses:

F. W. Lothman,

J. C. Updegrove.