

MACHINE FOR FORMING SUBTERRANEAN PASSAGES AND LINING THE SAME WITH EARTHENWARE,
ARTIFICIAL STONE, OR THE LIKE.

Patented May 13, 1919.

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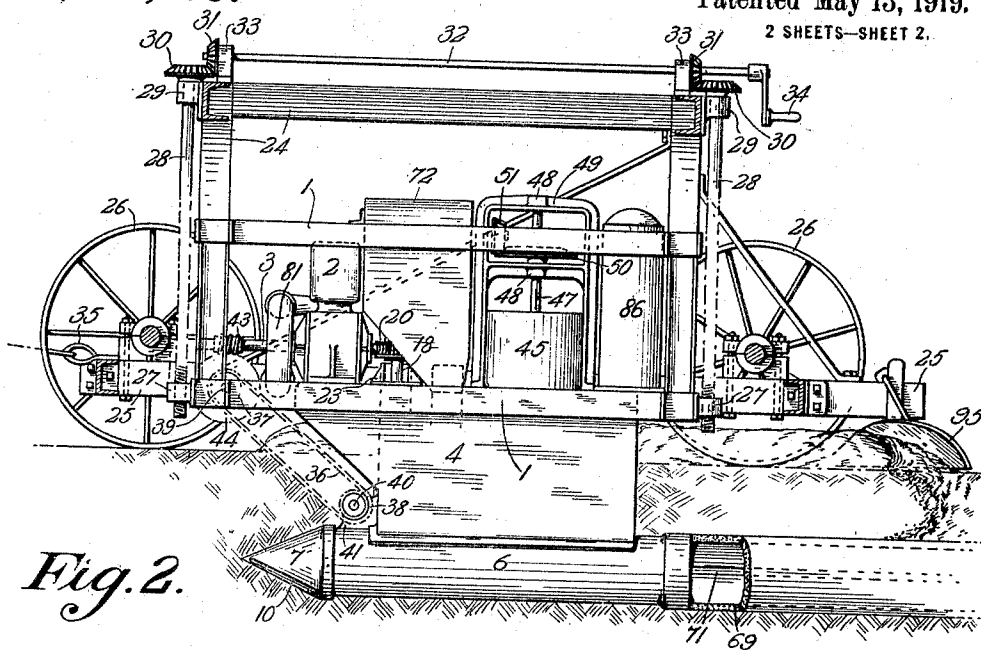


Fig. 2.

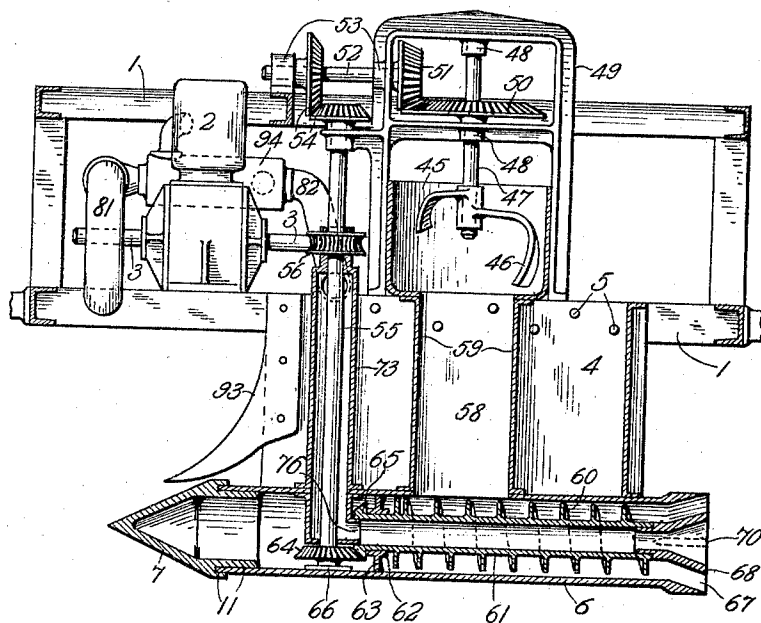


Fig. 3.

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UNITED STATES PATENT OFFICE.

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MACHINE FOR FORMING SUBTERRANEAN PASSAGES AND LINING THE SAME WITH EARTHENWARE, ARTIFICIAL STONE, OR THE LIKE.

1,303,399.

Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, NETA MURIEL RYAN, of 97 Westgarth street, Northcote, in the State of Victoria, Commonwealth of Australia, married woman, a subject of the King of Great Britain, have invented certain new and useful improvements in a new or improved machine for forming subterranean passages and lining the same with earthenware, artificial stone, or the like, of which the following is a specification.

This invention relates to a new or improved machine for forming subterranean passages and lining the same with earthenware, artificial stone or the like material and it has been devised in order to provide means whereby inclosed irrigation, draining and like subterranean passages can be expeditiously formed in a very rapid and durable manner.

Ordinarily, drainage, irrigation and like channels are formed by making open "cuts" of suitable width and depth in the surface of the earth and earthenware pipes or pipes of concrete or other artificial stone are placed therein in sections. In order to protect the pipes when placed in the channels the earth thrown up in forming the channels is replaced thereby effectually covering the sections of pipe.

The above mentioned method of laying drainage, irrigation and like pipes entails a great amount of time and labor and consequently expense to accomplish while considerable care and skill must be exercised to insure the sections of pipe being placed in such a way that they will remain in correct alinement.

Now the present invention provides means whereby a channel or passage can be made horizontally with or at an angle beneath the surface of the earth and be simultaneously lined with earthenware or artificial stone piping in a continuous operation.

Reference being had to the accompanying explanatory drawings:—

Figure 1 is an enlarged view partly in side elevation and partly in section showing the essential features of the machine constructed in accordance with the present invention.

Fig. 2 is a view partly in side elevation

and partly in section of the machine shown in Fig. 1, mounted upon transport wheels and fitted with elevating and lowering gear hereinafter fully described.

Fig. 3 is a view partly in side elevation and partly in section of a modification of the invention.

In these drawings like characters of reference denote similar parts and the numeral 1 designates a strong rectangular frame preferably constructed of iron or steel upon and to which the component parts of the machine are securely fixed as by bolting or other approved means.

An internal combustion engine 2 or other suitable engine is mounted upon the frame 1 and provides power for operating the machine. The main shaft 3 of the engine 2 extends outwardly on both sides thereof, and the various units of the machine are operated by said main shaft 3.

A strong casing 4 depends downwardly from the frame 1, and is secured thereto as by rivets 5 (see Fig. 3) or by other approved means, and to the lower end of the casing 4 is similarly attached a strong cylindrical tube or casing 6.

The forward end of the tube or casing 6 is provided with a hollow conical boring head 7 which can be furnished with a worm or thread 8 to enable said boring head 7 to freely enter the ground.

The boring head 7 is moreover provided with inclined cutters 9 which are fixed adjacently to longitudinal openings or slots 10, through which the soil excavated by the cutters 9 is directed into the interior of the boring head 7. The boring head 7 is supported by flanges 11 upon the end of the casing 6 and the thrust of said boring head 7 is transmitted to the end of said casing 6 by the inclosed ball thrust bearing 12.

A hollow cylindrical shaft 13 extends backwardly from the boring head 7 and is rotatably mounted in a bearing 14 carried by a diaphragm 15 fixed transversely in the casing 6.

A bevel gear wheel 16 is rigidly attached to the rear end of the hollow shaft 13 and meshes with a similar bevel gear wheel 17 secured to the lower end of a vertical shaft 18 carried in a bearing 19 fixed to the cas-

ing 6. This shaft 18 which is driven by worm gearing 20 from the shaft 3 carries an Archimedean screw 21 inclosed in a cylindrical tubular casing 22 which passes vertically upward through the casing 4, and is provided at its upper end with a lateral chute 23.

In operation the boring head 7 is driven by the vertical shaft 18 through the bevel gears 16 and 17 and hollow shaft 13. The excavated soil passes from the interior of the boring head 7 through the hollow shaft 13 and escapes therefrom into the lower end of the casing 22, whence it is elevated by the Archimedean screw 21 and finally discharged through the lateral chute 23.

As shown in Fig. 2 the frame 1 of the machine is mounted so as to be vertically slidable upon a frame work 24 fixed upon a truck or transporter 25 supported on transport wheels 26, and in order that the frame 1 may be readily raised and lowered strong lugs or fixed nuts 27 are secured thereto, through which threaded shafts 28 pass. These threaded shafts 28 are rotatably mounted in bearings 29 fixed to the upper part of the framework 24 and to the upper ends of shafts 28 bevel gear wheels 30 are secured. The bevel gear wheels 30 mesh with bevel gear wheels 31 fixed upon a shaft 32 rotatably mounted in bearings 33 secured to the top of the framework 24.

A cranked handle 34 is mounted upon one end of the shaft 32, and by means of said handle 34, the threaded shafts 28 can be operated to raise or lower the casing 6 as required.

The front of the truck 25 is fitted with haulage bars or hooks 35 to which a traction engine or draft animals can be connected.

In order that a slot may be made in the ground to permit of the passage of the casing 4 therethrough, a chain excavator is arranged in the fore part of the machine and immediately in front of the casing 4.

This excavator comprises a chain 36 mounted on sprocket wheels 37 and 38, the sprocket wheel 37 being securely fixed to the horizontal shaft 39 supported in bearings (not shown) attached to the frame 1 at the fore part thereof and the sprocket wheel 38 being rotatably mounted upon a shaft 40 fixed in brackets 41 attached to the cylindrical casing 6.

As shown in Fig. 1, excavating tines 42 are attached to the chain 36 and these tines 42 excavate a slot to permit of the passage of the casing 4 through the soil as the machine travels over the ground. This excavator is driven by the worm 43 fixed to the engine shaft 3, said worm 43 engaging with and operating a worm wheel 44 fixed to the shaft 39.

Fitted upon the frame is a mixer 45 into which is fed concrete, clay, artificial stone,

or other preferred material to form a lining for the passage or tunnel made by the boring head 7.

An agitator 46 is provided in the mixer 45 for thoroughly mixing the material placed therein, and this agitator 46 is securely fixed to a vertical shaft 47 rotatably mounted in bearings 48 formed in the frame 49.

A bevel gear wheel 50 is firmly secured to the vertical shaft 47 and meshes with and is driven by a bevel gear wheel 51 fixed to a horizontal shaft 52. This horizontal shaft is rotatably mounted in bearings 53 and is driven through miter gears 54 by the vertical shaft 55, which is operated by worm gearing 56 driven by the engine shaft 3.

A helical impeller or continuous feeder 57 is fixed to the lower end of the vertical shaft 47 and this impeller 57 with the agitator 46 insures thorough mixing of the ingredients or materials placed in the mixer 45. The impeller or feeder 57 moreover directs the materials downwardly through the vertical passage 58 located between the transverse diaphragms 59 and leading at its lower end into the cylindrical casing 6.

The material passing from the passage 58 into the casing 6 is directed to the rear end thereof by an Archimedean screw or spiral conveyer 60. This spiral conveyer 60 is formed around the outside of a hollow shaft 61, rotatably mounted in a bearing 62 formed in a diaphragm 63 fixed transversely in the cylindrical casing 6. This hollow shaft 61 is driven by the vertical shaft 55 through miter gears 64 and 65, and the lower end of the shaft 55 is supported in a bearing 66 secured to casing 6.

The material is forced rearwardly by the spiral conveyer 60 through the opening 67 in a die 68 which directs it outwardly so as to form a lining 69 around the walls of the passage or tunnel made by the boring head 7. This die 68 can be fixed to the casing 6 by means of a bridge-piece 70, shown by broken lines in Figs. 1 and 3, which extends radially across the opening 67 in the die 68.

This bridge-piece 70 forms a longitudinal slot or opening 71 in the lining 69, which is of great use when the passage or tunnel is being used for agricultural purposes, as it forms a means for freely draining the ground, and also permits of water and liquid artificial manures being supplied thereto for subsoil irrigation.

In order to dry and harden the lining of the tunnel or passage, or bake the same when the material used is clay, fuel and air are passed from the rear of the casing 6 into said tunnel and said fuel is burnt therein, the heat emitted by the combustion thoroughly drying and baking the lining and thereby forming a hard and durable pipe.

For this purpose a hopper 72, containing

fuel preferably charcoal, is fixed upon the frame 1 and communicates at its lower end with the inside of a tubular casing 73 which concentrically surrounds the vertical shaft 55.

5 A helical screw 74 is fixed to the vertical shaft 55 and feeds fuel into the upper end of the casing 73, whence it gravitates to the lower sloping end 75 thereof, and is thereby directed through a lateral opening 76 formed in the casing 73 into the interior of the hollow shaft 61.

A shaft 77 is arranged concentrically within the hollow shaft 61 and is secured at its forward end in a boss 78 formed integrally with the sloping end 75 of the casing 55, said shaft 77 being thereby fixed and being incapable of rotation. The shaft 77 is supported at the rear end by a spider 79 fixed to the die 68.

20 An Archimedean conveyer screw is fixed to the shaft 77 and is thereby held stationary, and owing to the rotation of the hollow shaft 61 around the fixed conveyer screw 80 the fuel is passed along the interior of the shaft 61 and is discharged through the inside of the die 68 into the tunnel or passage aforesaid.

In order to insure the ready ignition and combustion of the solid fuel in the interior of the tunnel or passage a mixture of gas and air is passed from the casing 6 into said tunnel and burns at rear of said casing 6.

For the purpose of supplying this air and gas to the tunnel or passage a fan or blower 35 81 is coupled to the engine shaft 3. The air delivered by the fan 81 passes through a pipe 82 to a valve casing 83 and into an annular chamber 84 surrounding the shaft 55. The air passes from the annular chamber 84 40 through slots 85 into the interior of the shaft 55 which is made hollow to provide a passage for the air and gas.

Gas is supplied by a container 86 and passes through a pipe 87 to the valve casing 45 83 into the annular chamber 88 thence through the slots 89 into the shaft 55 where it mixes with and is carried downwardly by the air to the lower end of said shaft 55.

A valve casing 90 is formed in the sloping end 75 of the casing 73, and in this casing 90 is formed an annular chamber 91 into which air and gas pass from the hollow shaft 55 through ports 92.

The gas and air mixture finally passes 55 through the fixed shaft 77 which is made hollow for this purpose, and escapes at the rear end of said shaft where it burns as hereinbefore described.

In Fig. 3 is shown a modification of the 60 invention, which is intended for forming pipes of concrete or artificial stone at comparatively shallow depths. The excavating chain 36 is replaced by a colter 93, which forms the slot for the passage of the casing 4.

65 The material is fed into the mixer 45 and

conveyed to and delivered through a die 68 to form the lining 69. In order to insure the rapid drying and setting of the material forming the lining 69 hot air is delivered thereto from the rear of the die 68. The air 70 is supplied by the fan 81 and passes through a heater 94 which can be heated by the exhaust gases of the engine 2 as shown or in other approved way.

After leaving the heater 94 the hot air 75 goes through the pipe 82 to the top of the casing 73 down which it passes to the lateral outlet 76 into and through the hollow shaft 61, finally escaping through the die 68.

In order to fill up the slot formed by the 80 excavating chain 36 a mold-board 95 is attached at the rear end of the truck or transporter 25. This mold-board diverts the soil delivered from the lateral chute 23 into the slot which is thereby filled up.

85 In operation a hole is dug in the ground sufficiently long to admit the casing 6 which is then lowered by the handle 34 and gear connected therewith to the required depth.

The engine 2 is then started and the machine 90 drawn along and the boring head 7 entering the ground removes the soil thereby forming a tunnel for the passage of the cylindrical casing 6, at the rear of which the lining is formed as hereinbefore described.

95 The machine described in the foregoing specification can be modified and altered, and the engine can be arranged to drive and operate the different units thereof in various ways without departing from the spirit 100 or scope of the invention.

What I do claim is:—

1. A machine for forming and lining subterranean passages or tunnels, comprising a frame adjustably mounted upon a transporter, an engine for driving the machine mounted upon the frame, a vertical casing fixed to and depending from said frame, a cylindrical casing fixed to the vertical casing, a boring head rotatably mounted at the 110 front of the cylindrical casing adapted to excavate a tunnel by the rotation thereof, a discharging elevator working in conjunction with the boring head, an excavator adapted to form a slot extending from the 115 surface of the ground to the cylindrical casing, a mixer carried on said frame and supplying lining material for the tunnel, means for conveying said material to the rear of the casing and forming a lining around said 120 tunnel made by the boring head, and means for supplying air and fuel to dry or bake said lining.

2. In a machine of the class described, means for excavating a subterranean pas- 125 sage or tunnel, comprising a frame mounted to have vertical adjustment upon a transporter, power means mounted on the frame, a vertical casing fixed to and depending from said frame, a cylindrical casing fixed 130

to the lower end of the vertical casing, a hollow conical boring head rotatably mounted on the cylindrical casing, a screw thread on the outside of the boring head, cutters fitted to said boring head, a thrust bearing interposed between the boring head and the end of the cylindrical casing, a hollow driving shaft fixed to the boring head and extending rearwardly therefrom, said driving shaft being rotatably mounted in a bearing supported by a diaphragm, a bevel gear wheel fixed to the driving shaft meshing with a bevel gear wheel fixed to the lower end of a vertical shaft driven through worm gearing by the power means.

3. In a machine of the class described, the combination of a cylindrical casing; a boring head rotatably carried by the casing; and means for discharging soil excavated by the boring head, comprising slotted openings in the boring head adjoining the cutters thereof, a spiral conveyer fixed to a vertical shaft, a cylindrical casing inclosing the spiral conveyer, and a lateral chute at the top of the conveyer casing, the excavated soil being delivered through the boring head into the lower end of the conveyer casing and being discharged by said spiral conveyer through the casing and chute.

4. In a machine of the class described, the combination with a transporter, of a cylindrical casing carried by the transporter; a boring head rotatably carried by the casing and arranged to excavate the soil and deliver it through the head coaxially of the casing; means to elevate the excavated soil to the surface of the ground as it is delivered by the boring head; means for excavating a vertical slot extending from the tunnel to the surface of the ground, comprising a shaft rotatable on a horizontal axis driven through worm gearing, a sprocket wheel fixed to the shaft, brackets secured to the cylindrical casing, a shaft fixed therein, a sprocket wheel rotatably mounted on the shaft, and a chain provided with excavating tines mounted on said sprocket wheels; and power means for actuating the operative parts of the machine.

5. In a machine of the class described, the combination with a transporter, of a cylindrical casing carried by the transporter; a boring head rotatably carried by the casing and arranged to excavate the soil and deliver it through the head coaxially of the casing; means to elevate the excavated soil to the surface of the ground as it is delivered by the boring head; means for supplying material to make a lining for the tunnel formed thereby, comprising a mixer fixed upon the transporter, an agitator within the mixer fixed to a vertical shaft projecting upwardly therefrom, a horizontal shaft driving the vertical mixer shaft through bevel gearing, said horizontal shaft being

driven through miter gears by a vertical shaft; an engine; and worm gearing to operatively connect said latter vertical shaft with the engine shaft.

6. In a machine of the class specified, the combination with a transporter, of a cylindrical casing arranged with means operable to excavate and displace soil for the casing; a receptacle having an outlet in which to mix material to line the wall of the excavation; a passageway leading from the receptacle outlet to the casing; rotatable means to mix material in the receptacle; a helical screw rotatable with said mixing means; a spiral conveyer in the casing formed around a hollow shaft concentrically mounted in the casing; and a hollow die fixed at the rear of the casing and arranged to form the material delivered by the screw around the wall of and line the excavation.

7. In a machine of the class specified, the combination with a transporter, of a cylindrical casing arranged with means operable to excavate and displace soil for the casing; a receptacle in which to mix material with which to line the wall of the excavation; means to deliver the mixed material from said receptacle arranged to form the material around the wall of and line the excavation; and means for supplying solid fuel to the interior of the lined excavation to dry and bake the lining of the excavation.

8. In a machine of the class specified, the combination with a transporter, of a cylindrical casing arranged with means operable to excavate and displace soil for the casing; a receptacle in which to mix material with which to line the wall of the excavation; means to deliver the mixed material from said receptacle arranged to form the material around the wall of and line the excavation; and means for supplying solid fuel to the interior of the lined excavation to dry and bake the lining of the excavation, comprising a hopper, a tubular casing leading from the hopper to the cylindrical casing; a helical feed screw in the tubular casing, and a fixed spiral conveyer in the cylindrical casing.

9. In a machine of the class specified, the combination with a transporter, of a cylindrical casing arranged with means operable to excavate and displace soil for the casing; a receptacle having an outlet in which to mix material to line the wall of the excavation; a passageway leading from the receptacle outlet to the casing; means to mix the material in the receptacle including a helical screw to force the material from the receptacle into the passageway; a spiral conveyer in the casing formed around a hollow shaft concentrically mounted in the cylindrical casing; a die fixed at the rear of the casing and arranged to form the material delivered by the screw around the wall of

and line the excavation; a hopper for a solid fuel; a tubular casing leading from the hopper to the hollow shaft of the lining material delivery screw; a helical feed screw in said latter tubular casing to feed the fuel therethrough to the hollow shaft; and a fixed spiral conveyer in the hollow shaft of the lining material delivering screw.

10. In a machine of the class specified, the combination with a transporter, of a cylindrical casing arranged with means operable to excavate and displace soil for the casing; a receptacle in which to mix material with which to line the wall of the excavation; a hollow shaft rotatable in and spaced from the wall of the casing and arranged with a spiral screw on the periphery; means to deliver material from the mixer to the screw in the space between the hollow shaft and casing; and means for supplying fuel for drying and baking the lining of the excavation through the hollow shaft.

11. In a machine of the class specified, the combination with a transporter, of a cylindrical casing arranged with means operable to excavate and displace soil for the casing; a receptacle in which to mix material with which to line the wall of the excavation; a hollow shaft rotatable in and spaced from the wall of the casing and arranged with a spiral screw on the periphery; means to deliver material from the receptacle to the screw in the space between the hollow shaft and casing; means for supplying solid fuel through the hollow shaft to the lined tunnel to dry and bake the lining; and means for supplying air and gas to the fuel in the tunnel to insure ignition and combustion thereof.

12. In a machine of the class specified, the combination with a transporter, of a cylindrical casing arranged with means operable to excavate and displace soil for the casing; a receptacle in which to mix material with which to line the wall of the excavation; a hollow shaft rotatable in and spaced from the wall of the casing and arranged with a spiral screw on the periphery; means to deliver material from the receptacle to the screw in the space between the hollow shaft and casing; and means for supplying solid fuel through the hollow shaft to the lined tunnel to dry and bake the lining material and to supply air and gas to the fuel in the tunnel to insure ignition and combustion thereof, comprising a vertical shaft communicating with the hollow shaft in the cylindrical casing, a screw in said vertical shaft, a screw fixed in the hollow shaft in the casing, a valve casing surrounding the upper end of the vertical shaft, a pair of annular chambers in the valve casing, a fan to supply air to the one chamber, a container delivering inflammable gas to the other chamber, slots in the vertical shaft, a valve

casing surrounding the lower end of said shaft, an annular chamber in the lower valve casing, slots in the vertical shaft opening into the annular chambers, and a hollow shaft leading to the rear of the cylindrical casing substantially as described.

13. In a machine of the class specified, the combination with a transporter, of a frame mounted thereon to have adjustment in a vertical direction; means carried by said frame to excavate the soil to form a subterranean tunnel, means to deliver material in a green state to and line the tunnel therewith, means to deliver combustible material to the lined tunnel and promote combustion thereof; and means to raise and lower the adjustable frame with the means carried thereby.

14. In a machine of the class specified, the combination with a transporter, of a frame mounted thereon to have adjustment in a vertical direction; means carried by the frame to excavate the soil to form a subterranean tunnel, to deliver material in a green state to line the tunnel therewith, and means to deliver combustible material to the lined tunnel and promote combustion thereof; and means to raise and lower the adjustable frame, comprising a frame fixed upon the transporter, bearings at the upper end of the frame, vertical screw threaded shafts depending therefrom and passing through fixed lugs on the adjustable frame, bevel gears fitted to the upper ends of the vertical threaded shafts, a horizontal shaft mounted rotatably in bearings supported on top of the frame, bevel gears on the horizontal shaft meshing with the bevel gears fitted to the vertical threaded shafts, and an operating handle on the end of the horizontal shaft, substantially as described.

15. In apparatus of the class specified, the combination with a transporter, of a frame carried thereby; means carried by the frame operable to excavate a subterranean tunnel and deliver the excavated material to the surface of the ground; means for excavating a slot in the soil from the surface of the ground to the tunnel excavating means in advance of the frame carrying the latter to permit of the passage of the frame; means to line the walls of the tunnel with a material in a green state; means to dry and bake the lining material; and a mold board carried at the rear of the transporter operable to divert the excavated material delivered to the surface of the ground to fill the vertical slot for the purpose specified.

16. In a machine of the class specified, the combination with a transporter, of a frame carried thereby; a tubular casing carried by said frame arranged with means to excavate the soil to form a subterranean tunnel and deliver the excavated soil to the surface of the ground; means carried by the

casing to which material in a green state is delivered to line the wall of the tunnel with said material; and means to force air through the tubular casing into the lined tunnel.

17. In apparatus of the class specified, the combination with a transporter, of a frame to depend therefrom; a cylindrical casing carried at the lower end of said frame; a rotatable head carried at the forward end of said casing arranged to excavate the soil and deliver it through the head into the casing; a spiral conveyer to deliver the soil delivered by the head to the surface of the ground; a hollow shaft journaled in the casing carrying a helical screw in the space between the shaft and casing; means to deliver material with which to line the excavated tunnel to said spiral screw; said screw being operable to deliver said material from the casing and line the tunnel therewith; and means to deliver air through the hollow screw carrying shaft to the lined tunnel.

18. In apparatus of the class specified, the combination with a transporter, of a frame depending therefrom; a cylindrical casing carried at the lower end of said frame; a rotatable head carried at the forward end of said casing arranged to excavate the soil and deliver it through the head; a spiral conveyer to which the soil excavated by the head is delivered operable to deliver said excavated soil to the surface of the ground; a hollow shaft journaled in the casing carrying a helical screw in the space between the shaft and casing; means to deliver material with which to line the excavated tunnel to said helical screw; said screw being operable to deliver said material from the casing

and line the tunnel therewith; a spiral screw supported in fixed position in the hollow shaft; and means to deliver solid fuel to said fixed screw and through the rotation of the hollow shaft by the screw into the lined tunnel.

19. In apparatus of the class specified, the combination with a transporter, of a frame to depend therefrom; a cylindrical casing carried at the lower end of said frame; a rotatable head carried at the forward end of said casing arranged to excavate the soil and deliver it through the head into the casing; a spiral conveyer to deliver the soil delivered by the head to the surface of the ground; a hollow shaft journaled in the casing carrying a helical screw in the space between the shaft and casing; means to deliver material with which to line the excavated tunnel to said helical screw; said screw being operable to deliver said material from the casing and line the tunnel therewith; a hollow shaft fixed in the first hollow shaft; a spiral screw carried by said shaft; means to deliver solid fuel to the interior of the first hollow shaft and which fuel is delivered by the screw on the fixed shaft as the first hollow shaft surrounding said screw is rotated; and means to deliver an inflammable gas and air through the fixed hollow shaft to the lined tunnel to promote combustion of the solid fuel in the tunnel.

In testimony whereof I affix my signature in presence of two witnesses.

NETA MURIEL RYAN.

Witnesses:

B. RYAN,

JAMES H. ANDERSON.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."