Tunnel Boring System

FIELD

[0001] The present invention relates to boring, and more particularly to utilizing plasma torches for tunnel boring.

BACKGROUND

[0002] Tunnel boring machines, also referred to as “moles,” are used to excavate tunnels with a circular cross section through various rock and soil strata. Modern tunnel boring machines typically use a rotating cutting wheel, or cutter head, followed by a main bearing, a thrust system, and trailing support mechanisms. However, existing tunnel boring machines are large, slow, labor-intensive, and expensive. They are also extremely difficult to move between locations. The cost of operations is also significant.

SUMMARY

[0002a] In one aspect, the present disclosure refers to a tunnel boring machine comprising a cutting head, a plurality of plasma torches on the cutting head, a plurality of nozzles on the cutting head to provide a stream to cool an area while the plasma torches are active, one or more vacuum tubes to vacuum up spoils generated by the cutting head, the one or more vacuum tubes are lined with a cooling sleeve circulating chilled water to cool the spoils, and a tractor providing propulsion to the cutting head, the tractor to move the cutting head to cut a tunnel.

[0002b] In another aspect, the present disclosure refers to a tunnel boring machine including a cutting head, the machine comprising, a plurality of plasma torches on the cutting head, the cutting head having a horseshoe shape, with a flat bottom and a curved top, a plurality of vacuum inlets to vacuum up spoils generated by the cutting head, a metal tube to combine vacuum streams from the vacuum inlets to create a stream of spoils from the tunnel, and a tractor providing propulsion to the cutting head, the tractor to move the cutting head to cut a tunnel.

CLAIMS

We claim:

1. A tunnel boring machine to tunnel through earth, the machine comprising:

cutting head;

plurality of plasma torches on the cutting head;

plurality of nozzles on the cutting head to provide a stream to cool an area of the earth while the plasma torches are active; and

tractor providing propulsion to the cutting head, the tractor to move the cutting head to cut a tunnel.

2. The machine of claim 1, wherein the cutting head has the plurality of plasma torches arranged in a horseshoe shape, with a flat bottom and a curved top.

3. The machine of claim 1, further comprising:

a chiller to chill the stream, to create a greater temperature delta between a heat of the plasma torches and the stream.

4. The machine of claim 1, wherein the nozzles comprise a high pressure air jet nozzle to direct a stream of air.

5. The machine of claim 1, wherein at least one of the nozzles comprises a high pressure waterjet nozzle to direct the stream.

6. The machine of claim 5, wherein the stream comprises one of: water and steam.

7. The machine of claim 1, further comprising:

a plurality of power units for the plasma torches, wherein a subset of the plasma

~~torches are powered by each of the plurality of power units.~~

~~8. The machine of claim 7, wherein the subset of the plasma torches powered by a power unit are not adjacent to each other.~~

~~9. The machine of claim 1, further comprising:~~

~~a vacuum inlet at a base of the cutting head to vacuum remove spoils.~~

~~10. The machine of claim 1, further comprising:~~

~~a plurality of vacuum inlets;~~

~~a metal tube to combine vacuum streams from the vacuum inlets to create a stream of spoils from the tunnel.~~

~~11. The machine of claim 1, further comprising:~~

~~a vacuum cart behind the tractor to remove spoils generated by the cutting head.~~

~~12. The machine of claim 11, further comprising:~~

~~one or more vacuum tubes to vacuum the spoils, wherein the one or more vacuum tubes are lined with a cooling sleeve circulating chilled water to cool the spoils.~~

~~13. The machine of claim 1, further comprising:~~

~~rapid start/stop-valves for at least a subset of the plurality of nozzles to create agitation to overcome particle inertia.~~

~~14. The machine of claim 1, further comprising:~~

~~a paving tractor pulled by the tractor, the paving tractor to apply material to one or more of: a roof of the tunnel, walls of the tunnel, and/or a bottom of the tunnel.~~

~~15. The machine of claim 1, further comprising:~~

~~an adjustable arm to connect the cutting head to the tractor, to boom and swing the cutting head, enabling the tunnel boring machine to change an angle of the tunnel being bored.~~

~~16. The machine of claim 1, wherein the cutting head further comprises:~~

~~a concave shield to reflect energy output by the plasma torches towards a cutting face, to assist a boring rate of penetration.~~

~~17. The machine of claim 1, wherein plumes of the plasma torches overlap, and the overlap creates a synergy to increase thermal and kinetic energy applied to a boring surface.~~

~~18. A tunnel boring machine including a cutting head, the machine comprising:~~

~~a plurality of plasma torches on the cutting head, the plurality of plasma torches arranged on the cutting head in a horseshoe shape, such that the tunnel is bored with a substantially flat bottom and a curved top; and~~

~~a tractor providing propulsion to the cutting head, the tractor to move the cutting head to cut a tunnel.~~

~~19. The machine of claim 18, further comprising a plurality of nozzles on the cutting head to provide a stream to cool an area while the plasma torches are active.~~

~~20. The machine of claim 19, wherein the stream comprises one or more of: cold air, cold water, and a combination of cold air and cold water.~~

1. A tunnel boring machine comprising:

a cutting head;

a plurality of plasma torches on the cutting head;

a plurality of nozzles on the cutting head to provide a stream to cool an area while the plasma torches are active;

one or more vacuum tubes to vacuum up spoils generated by the cutting head, the one or more vacuum tubes are lined with a cooling sleeve circulating chilled water to cool the spoils; and

a tractor providing propulsion to the cutting head, the tractor to move the cutting head to cut a tunnel.

2. The machine of claim 1, wherein the cutting head has a horseshoe shape, with a flat bottom and a curved top.

3. The machine of claim 1 or claim 2, further comprising:

a chiller to chill the stream, to create a greater temperature delta between a heat of the plasma torches and the stream.

4. The machine of any preceding claim, wherein the nozzles comprise a high pressure air jet nozzle to direct a stream of air.

5. The machine of any preceding claim, wherein at least one of the nozzles comprises a high pressure water jet nozzle to direct the stream, and optionally wherein the stream comprises one of: water and steam.

6. The machine of any preceding claim, further comprising:

a plurality of power units for the plasma torches, wherein a subset of torches are powered by each of the plurality of power units, and optionally wherein the subset of the plasma torches powered by a power unit are not adjacent to each other.

7. The machine of any preceding claim, further comprising:

a vacuum inlet at a base of the cutting head to vacuum remove spoils.

8. The machine of any preceding claim, wherein the cutting head further comprises:a concave shield to reflect energy output by the plasma torches towards a cutting face, to assist a boring rate of penetration.

9. The machine of any preceding claim, wherein plumes of the plasma torches overlap, and the overlap creates a synergy to increase thermal and kinetic energy applied to a boring surface.

10. The machine of any preceding claim, further comprising:

a plurality of vacuum inlets and a metal tube to combine vacuum streams from the vacuum inlets to create a stream of spoils from the tunnel, and/or

a vacuum cart behind the tractor to remove spoils generated by the cutting head, and/or

rapid start/stop-valves for at least a subset of the plurality of nozzles to create agitation to overcome the particle inertia.

11. The machine of any preceding claim, further comprising:

a paving tractor pulled by the tractor, the paving tractor to apply material to one or more of: a roof of the tunnel, walls of the tunnel and/or a bottom of the tunnel.

12. The machine of any preceding claim, further comprising:

an adjustable arm to connect the cutting head to the tractor, to boom and swing the cutting head, enabling the tunnel boring machine to change an angle of the tunnel being bored.

13. A tunnel boring machine including a cutting head, the machine comprising:

a plurality of plasma torches on the cutting head, the cutting head having a horseshoe shape, with a flat bottom and a curved top;

a plurality of vacuum inlets to vacuum up spoils generated by the cutting head;

a metal tube to combine vacuum streams from the vacuum inlets to create a stream of spoils from the tunnel; and

a tractor providing propulsion to the cutting head, the tractor to move the cutting head to cut a tunnel.

14. The machine of claim 13, further comprising a plurality of nozzles on the cutting head to provide a stream to cool an area while the plasma torches are active.

15. The machine of claim 14, wherein the stream comprises one or more of: cold air, cold water, and a combination of cold air and cold water.