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Gelhard et al.

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[54] **SELF-PROGRESSING CONSTRUCTION SYSTEM**

[76] Inventors: **Egon Gelhard,** Mehlemer Strasse 28, 5, 51, Cologne; **H. Rudolf Gunkel,** E. Gerlander Strasse 5A, 6390 Usingen, both of Germany

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[51] **Int. Cl.** **E01d 19/02**

[58] **Field of Search** 14/77, 19, 1, 3

[56] **References Cited**

UNITED STATES PATENTS

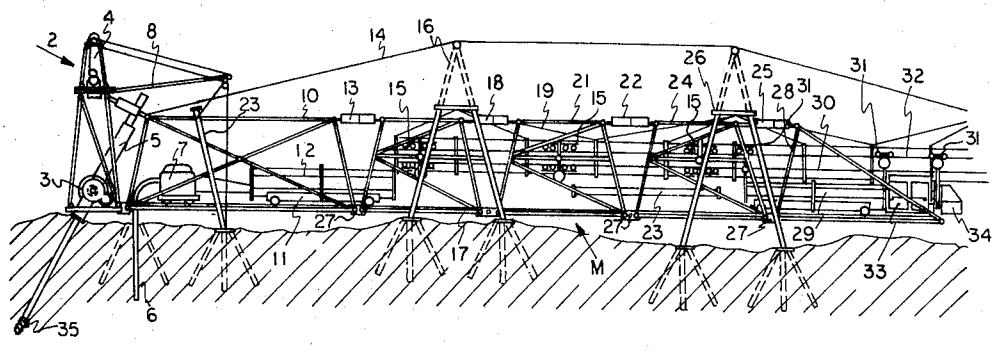
718,237	1/1903	Zimmerman	14/19 X
1,868,630	7/1932	DeVou	14/3
3,299,191	1/1967	Mantscheff	14/1 X
3,448,511	6/1969	Suter	14/1 X
3,490,605	1/1970	Koss	14/1 X
3,571,835	3/1971	Buechler	14/1
3,677,189	7/1972	Appelt	14/19 X
3,706,125	12/1972	Hopkins	14/1 X

Primary Examiner—Nile C. Byers, Jr.
Attorney, Agent, or Firm—Finnegan, Henderson, Farabow and Garrett

[57] **ABSTRACT**

A system for the self-advancing construction of a conduit line, preferably one to receive a vehicular transportation. Construction proceeds without damage to the peripheral environs and without the necessity for additional trackway, roads or the like for material support. Materials are transported along an existing line to a self-driven assembly structure adjacent the forward end of the line. The assembly structure erects further line and then moves along to the new forward end for still further erection.

5 Claims, 5 Drawing Figures



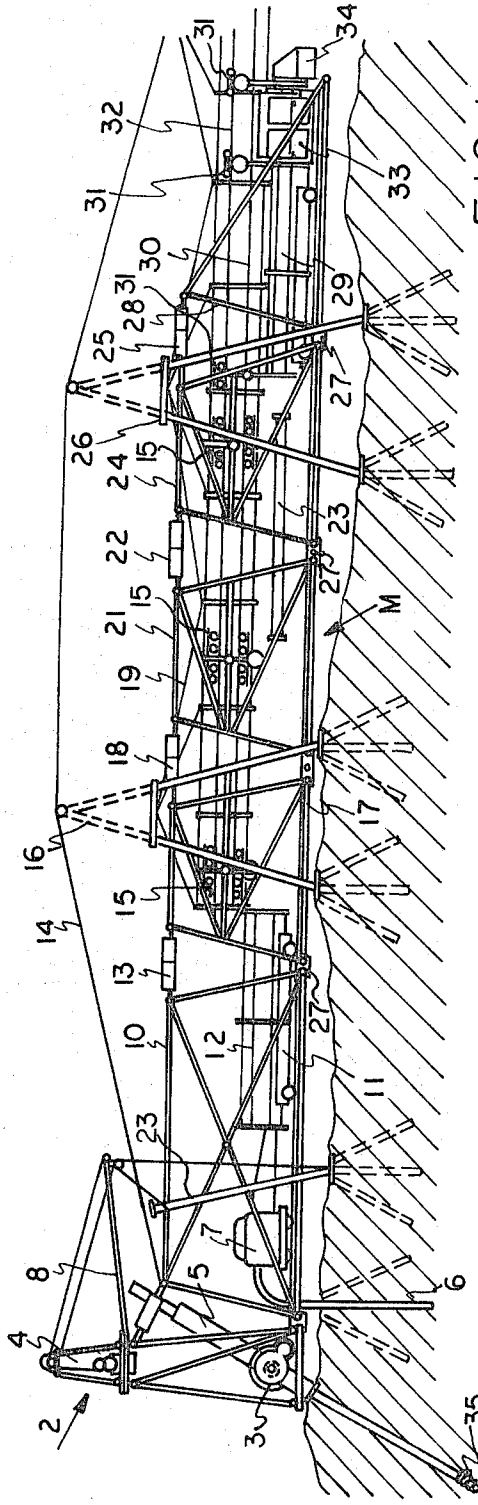


FIG. 1

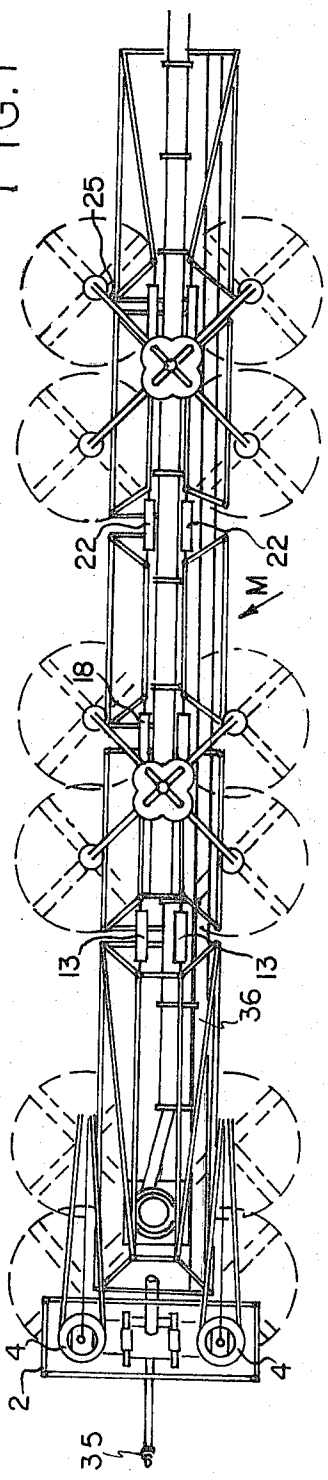


FIG. 2

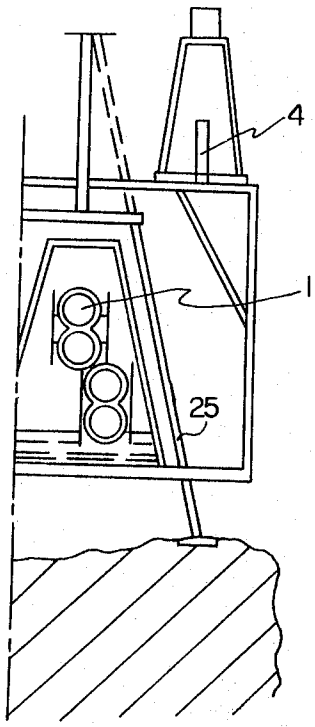


FIG. 3

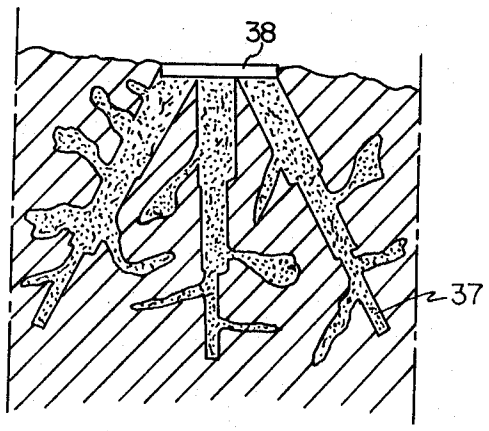


FIG. 4

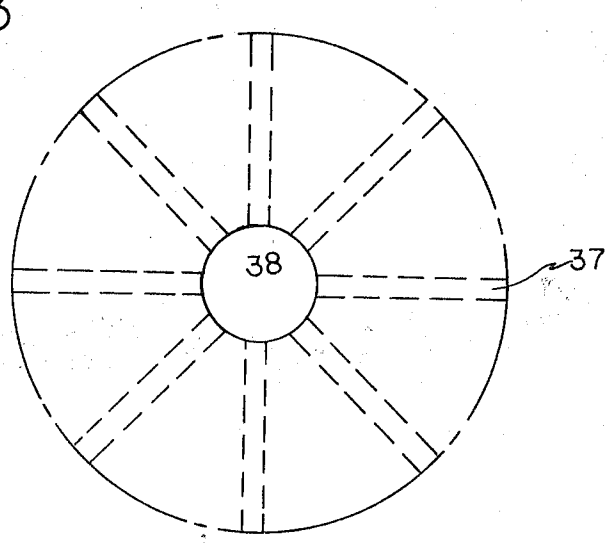


FIG. 5

SELF-PROGRESSING CONSTRUCTION SYSTEM

BACKGROUND OF THE INVENTION

The present invention concerns a self-progressing assembly system for the construction of a conduit line and especially a pipe railroad. The pipe railroad may, for example, comprise a support tube of interconnected pipe sections, the support tube being suspended above ground from supports. Preferably two conduit lines will be utilized, one secured atop the other, each of which is made of conduit sections. Reference is made to our copending patent applications, Ser. No. 227,856, now U.S. Pat. No. 3,776,141 filed Feb. 22, 1972, entitled A TRANSPORTATION SYSTEM PARTICULARLY USEFUL IN HOSTILE ENVIRONMENTS; and Ser. No. 279,769, filed Aug. 8, 1972 entitled A TRANSPORTATION SYSTEM FOR HOSTILE ENVIRONMENTS for further details concerning suitable transportation systems movable through said line and also further details as to the line per se that may be constructed.

The pipe railroad systems are intended for the transportation of liquid, granular and bulk goods, but particularly for oil and other earth treasures, across regions having extreme climatic and topographical conditions. The pipe or conduit railroad systems comprise series-arranged pipe sections lying essentially along a common axis and assembled into one conduit through which freight, etc. carrying vehicles may be driven. The assembled pipe is suspended above ground from supports spaced along its length.

Appreciable difficulties arise during the construction of such a pipe railroad when conventional construction apparatus and techniques are employed. One must take into account that the construction of such an installation will be carried out partly in unexplored terrain and also on soil that is impassable on foot or by vehicle. The soil or perma frost in Alaska is often incapable of sustaining loading, thus obviating the available use of conventional apparatus since no roads, etc. are available. The hitherto unsolved problems of material transportation in a region without roads, rail lines, navigable streams and possibly even beyond reach of air supply are solved by utilization of the method according to the present invention.

Further, a self-advancing means per se is a most desirable operation of construction of a conventional railroad or pipe line. A self-advancing mechanism in general allows the most economical and most rapid erection of a non-mobile transportation system such as tracks. Transportation of the required materials, personnel, and the like, by other means is nearly inconceivable across terrain and in climates such as are found in an arctic region. This is especially true considering that construction of roads, railroads, or the like, purely for the purpose of transporting supplies will produce an undesirable and irrevocable change to the area adjacent the pipe line system, not to mention the cost and time required to construct same. All means of transportation required for carrying construction materials such as iron, concrete, and the like, in special vehicles such as wagons, containers, tenders, and the like, are undesirable also since the payload factor of such vehicles amounts to an average of only fifty percent (50%). A conventional ground-bound construction system further requires enormous machines, tractors, bull-

dozers, ramming machinery, compactors, graders, and auxiliary construction materials such as supports, revetments, pumps, compressors, and the like, to be carried along as progress is made.

The present invention overcomes the problems of the conventional technqiues and deals with the task of construction of a pipe railroad in a simple, rational manner and in a reasonably short time. The present self-progressing construction method may be carried out without prior exploration of the itinerary of construction, and without requirement of revetments and the like, thus permitting the transportation of materials without entailing the construction of additional roads or railway tracks. Further, no special vehicles are necessary to meet the transportation requirements of moving the materials along the pipe railroad as it is being constructed.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a method for the self-progressing construction of a pipeline.

A further object of the present invention is to provide a method for the self-progressing construction of a pipe railroad.

Still further another object of the present invention is to provide a method of progressively constructing a conduit railroad through an area without prior exploration of the itinerary.

Still another object of the present invention is to provide a method for progressively constructing a conduit railroad through an arctic region.

Generally speaking, the method of the present invention includes the steps of conveying construction materials to a forward end of an initial section of pipe railroad, said materials being transported on said railroad; providing a self-driven assembly structure adjacent a forward end of said initial section of said railroad; and utilizing said assembly structure and materials conveyed thereto and constructing a further section of railroad, said further construction being completely self-contained by said assembly structure.

More specifically, the present invention involves the mounting of an exposed railway on each side of the conduit, the rails being opposite each other for two-way travel. An assembly scaffolding capable of motion is suspended from the rails, and is provided with a progressing erection component cantilevered to overhang the most forward assembled conduit section. The scaffolding accepts construction components and progressively erects same along the intended itinerary. Further, a movable transportation means is located on at least one rail behind the assembly scaffold for the purpose of supplying construction components required for the progressive erection of the system.

Preferably, the assembly scaffold or structure consists of several connected, mutually supported and series-arrayed assembly sections. As such, the self-advancing mechanism may easily follow a rolling terrain, curves, and the like, without necessitating special measures. For such purposes the front section of the assembly structure is developed into a cantilevered erecting section, while the most rearward assembly section is developed into a cantilevered material receiving section. Sections in between the front and rear cantilever sections, on the other hand, are provided with controlled suspensions. An assembly scaffold consisting of

several assembly sections is thus suspended from its middle sections on travel rails of the previously erected pipe railroad section, and may be supplied with construction materials from the rear. The materials are then transported to the front progressing sections of the structure where they are used by the cantilevered erection equipment to construct a further forward section of the pipe railroad. When construction of that section is completed, the entire assembly scaffold may move forward by the corresponding new itinerary segment, and a new section may be begun.

It is proposed to carry construction materials within conduit through the assembly scaffold by means of assembly scaffold cars, preferably lift trucks with hydraulic lift gear. Hence, after the materials are removed from the conduit the conduit may be lifted by the car into position for securement to the end of conduit that is already in place.

Since the self-progressing assembly structure, according to the invention, remains in advance of the erected supports of the pipe railroad with at least those parts overhanging the most advance erected pipe section, it is an advantage to provide the progressing segment with a head piece wider than the clear support passage of the pipe railroad. The head piece accepts assembly equipment such as a drilling unit and hoisting gear or cranes. All the required equipment for anchoring, foundation laying and supporting of the pipe railroad is thus located in the front part of the self-progressing equipment, according to the present invention, and does not interfere with inflow of construction materials from the rear. The drilling unit in the head piece is preferably movable in transverse directions and is adjustable whereby bore holes may be drilled at any angle within the range of the planned itinerary. The head piece may be constructed of pipe and rigidly connected to the progressing element. The head piece is, however, developed into a separate progressing component, hingeably connected to the progressing element and preferably is provided with a crane on each side thereof.

The transportation means fur supplying the progressing unit with construction materials is preferably a crane carriage system that supports the materials being stored within the conduit that is to ultimately become a length of the pipe railroad. As such, dead weight during transportation of materials is at a minimum. The assembly structure may further be provided with a transporting facility for transferring the trolley system or the like from one lateral rail to the other, so that the rail on one side may be used for bringing the materials forward and the rail on the opposite side for return of the empty trolleys to a materials depot.

It should be made clear that the self-progressing assembly equipment of the present invention rests upon rails outside of the previously erected sections of the pipe railroad. The structure thus is self-sustaining for conveyance of construction materials and the like and no superfluous mode of transportation is required. A further embodiment of the present invention improves the bearing strength, carrying capacity, and stability of the system by providing additional bracing of the assembly scaffold. Intermediary supports are provided for this purpose. This supplemental bracing is easily erected and dismantled and increases the loading capacity of the assembly scaffold or structure appreciably.

The assembly scaffold is preferably made up of five assembly sections of rigidly interconnected pipes, preferably titanium pipes. Upper hinged tie bars of the pipes are interconnected on each side of the pipe railroad by hydraulic cylinders located between the individual assembly sections. The three middle assembly sections are further provided with driven wheel sets to supply motive power to the assembly structure per se. A continuous track is to be laid on the lower hinged tie rods of the assembly structures.

Another feature of the self-progressing assembly scheme of the present invention is a system for producing foundations. Preferably, the self-driven assembly structure is provided with a means for producing support foundations, which will support the pipe railroad. This foundation system generally includes a mixer for the preparation of a hardenable composition such as a polyester concrete, for example; a pressure generator; and a conduit connected to the mixer, preferably a flexible pipe. The pipe conduit may further be provided with a spray nozzle at its terminal end. The aforementioned equipment facilitates the capability of producing foundations, according to the present method. According to the invention, foundations are produced by sinking bore holes into the ground during the self-progressing construction of the pipe railroad. The hardenable composition, such as polyester concrete, is forced into the bore holes under great pressure, whereby the composition branches off the predrilled hole to provide a branch network of the rapidly setting composition. A pedestal is then poured onto the substratum to be connected to the polyester concrete branch network. Vast branching of the rapidly setting mass of composition results over a large soil area, solidifying to become load bearing. The foundation will meet the requirements of load-bearing capacity and has the further advantage of being unusually easy to construct.

To further improve the load-bearing capacity of the foundations, the bore holes may be step like and have downward decreasing diameters. This is achieved by proceeding first with the deepest, smallest diameter, drilling followed by subsequent drillings of lesser depth, but larger diameters along the same drilling axis. The number of drillings may be varied in accordance with the subsoil conditions, a larger number of drillings being required for soft terrain. The drillings are generally quite deep, and radiate from a point on the surface that corresponds to the center of gravity of the pedestal to which the pipe railroad supports will be fastened.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic side elevation of a self-progressing assembly scheme according to the teachings of the present invention.

FIG. 2 is a top view of the scheme as illustrated in FIG. 1.

FIG. 3 is a partial vertical cross section of the scheme of the present invention.

FIG. 4 is a vertical section of an illustration of a foundation produced according to the present invention.

FI. 5 is a top view of a foundation showing radial bore holes.

DESCRIPTION OF THE SPECIFIC EMBODIMENTS

The pipe or conduit railroad according to the present

invention is illustrated in FIG. 1 to include two support tubes 1, located one above the other and assembled from individual pipe sections 12. The support tubes 1 are secured about four (4) meters above ground from four-legged supports 25 by means of a polygonal suspension rope system 19. The ground is illustrated by shaded lines, and support tubes 1 are moved forward to a certain stage of completion.

Electrically driven vehicles are designed to travel in both directions through the erected support tubes 1 and carry liquids, stone, ores, sand, powder-like substances, gases, and bulk goods along the itinerary. A lower and an upper pair of rails 30 and 32 are fastened outside and laterally from the support tubes 1, permitting the conveyance of goods, personnel, and inspection crews after operation of the pipe railroad has begun. The outer rails 30 and 32 are also usable for the suspension of a self-driven assembly structure, according to the scope of the self-progressing assembly scheme of the present invention.

Outside rails 30 and 32 are of such cross section, dimensions, and so secured to support pipes 1, that they can bear appreciable loads. An assembly scaffold or structure M of the self-progressing assembly scheme is preferably made up of a five-part titanium assembly structure, as exemplified by three (3) identical drive-and-support roller sections 17, 21 and 24; a front progressing section 10; a separately shown head piece 2 that is associated with progressing section 10 and a trailing section 28.

The five (5) sections, 10, 17, 21, 24 and 28, are hingeably interconnected by joints 27 to the conduit supporting girders so that the self-progressing assembly structure is capable of negotiating curves, ascents and descents along the itinerary. Further, hydraulic cylinder pairs 13, 18 and 22, respectively, keep sections 17, 21 and 24 in the required position and together with hinges 27 represent the connections between the individual assembly sections 10, 17, 21, 24 and 28. Front part 2 is also connected in the same manner to progressing section 10 by means of a hinge 27 and a pair of hydraulic cylinders.

Four-legged supports 25 from which the pipe railroad is suspended are raised in the forward construction area by two or three temporary supports 16 to which is secured a strong rope or cable 14 to provide additional bracing between the assembly scaffold M and front part 2 on one hand, and the previously erected pipe railroad sections. The temporary supports 16 are secured by any conventional removable means to the cross beams 26 of four-legged supports 25. They are shown in dotted lines in the drawing.

Front part 2 is provided with a deep-drilling unit 3 which may be moved, pivoted and/or rotated within front part 2 from the left series of support legs to the right (See FIG. 2). Drilling unit 3 is associated with a drilling installation 5. A drill 35 of drilling installations 5 may thus be moved to all required drill locations and directions. Front part 2 is also equipped with a crane installation 4 on both outer sides in alignment with the support legs. Cranes 4 have an overhanging beam 8 that is dimensioned and rotatable such that individual supports 23 may be handled thereby to be mounted on the previously laid pedestals of the foundations and then assembled into four-legged supports 25.

Laying of the foundations may be carried out in a conventional manner, according to terrain conditions. It is intended, however, as mentioned above to provide the progressing section 10 of the assembly scaffold M with a foundation pouring means 7 which preferably will both provide the quick hardenable mixture, and force same under high pressure into the drilled bore holes. A flexible hose or pipe conduit 6 having a spray nozzle is preferably used to pump the mixture into the bore holes prepared by the drilling installation 5 in such a manner that a supporting foundation may be built for the pedestals. Particular advantages are obtained with the above method of foundation laying, according to the invention, by using a polyester concrete composition.

The assembly scaffold M consisting of the five (5) individual assembly sections 10, 17, 21, 24 and 28 is borne by means of multiple rolls, electrically driven wheel sets 15 which ride on the outside of the pair of rails 30 and 32 attached to support pipes 1 of the pipe railroad. The wheel sets 15 are rigidly interconnected to the intermediate three (3) assembly sections 17, 21 and 24 and provide motive power thereto.

Support tubes 1 to be erected may be used, together with the outside rails 30 and 32, as track bodies for conveying materials for construction of the pipe railroad. Suitable trolleys 31 serve as drive means and conveniently transport two double support pipe pieces coupled together (See FIG. 1). Likewise, a cabin 33, a hydraulic energy generating plant 34, or the like, may be conveyed by trolley 31.

The material required for the foundations as well as the smaller parts needed for the supports also may be carried forward in the sealed support tubes 1. The loaded support pipes 1 are thus carried by trolleys 31 to the receiving section 28 of assembly structure M. Tubes 1 are then transferred to a car 11 provided with a hydraulic lifting gear. After delivered support pipes 1 are deposited upon car 11, trolley suspensions 31 are transferred within the receiving section 28 by means of a transposing installation (not shown), to the opposite side outer rail for return to the supply depot.

Cars 11 move along a track 36 built on the lower hinged tie bars of the assembly scaffold M, thus enabling support pipes 1 to be carried forward as far as the progressing section 10. Pipes 1 are then emptied and are lifted up to the proper assembly height be means of the lifting gear of car 11. Pipe 1 can then be secured onto the last pipe section without requiring recourse to a crane installation.

The transportation scheme making use of trolley suspensions 31 for bringing forward construction materials represents an efficient circulatory transportation system. Power supply for the system may be obtained from the previously emplaced and electrically connected current rails inside the support pipes 1. The electrical rails also are used to drive the freight containers of the pipe railroad. The speeds of progression attainable with this system are appreciable, since the individual construction phases may be carried out at some distance from the assembly scaffold M.

The construction phases for producing a pipe railroad according to the present invention are: predrilling for laying of foundations, unloading and preparation of the foundation material, preferably a polyester concrete composition, pumping of the foundation material into the bore holes under high pressure, anchoring a support ground plate in the pedestal, erection of the support, assembly of the support cross beams,

bolting of the pairs of support tubes, tensioning of the suspension rope system, connection of the electrical power supply, transportation of the trolley car suspensions, and moving the assembly scaffold or structure forward for further erection. An itinerary progress of **100** meters per hour is feasible.

A loaded double length of support tube **1**, twelve (12) meters in length, can carry fifty percent (50%) more freight than the material demand of a 12 meter length of pipe railroad. The transportation system is thus capable of efficiently operating continuously at a relatively low speed and, therefore, economically, safely, and adaptably. In harmony with the materials transportation efficiency, the assembly scaffold allows simultaneous processing of applicable construction components.

FIGS. **4** and **5** illustrate further certain preferred embodiments of foundations for the system. It is necessary, within the scope of the self-progressing aspect of construction of the pipe railroad, to lay foundations in the subsoil for the anchoring of the four-legged supports **25.** The foundations are prepared according to the present invention by first sinking bore holes **37** star like or radially into the subsoil, as visualized from a point above the surface which essentially is the center of gravity of the pedestal to be formed. Preferably, the bore holes have step-like diameters as discussed above. Mixed and prepared polyester concrete or other quick hardenable composition is compressed under high pressure into these bore holes **37,** so that the fluid mass of composition may penetrate every crevice and empty space of the subsoil in the vicinity of the bore holes **37** and thereby generate branching. This branching is shown diagrammatically in FIG. **4** of the drawing. The concrete sets rapidly and thus solidifies the subsoil. A pedestal **38** is then poured on top of the subsoil in connection with the polyester concrete branch network and the filled bore holes **37.** Each pedestal **38** carries a single support **23** as shown in the drawing of FIG. **1.**

Having described the present invention in detail, it is obvious that one skilled in the art will be able to make variations and modifications thereto without departing from the scope of the invention. Accordingly, the scope of the present invention should be determined only by the claims appended hereto.

What is claimed is:

1. A method for the self-progressing construction of a pipe railroad comprising the steps of:

a. providing an initial section of the pipe railroad, said railroad having a plurality of interconnected supports with pipe suspended therefrom, said pipe containing a vehicle trackway therein to form the pipe railroad and exterior vehicle trackways along opposite sides thereof;

b. transporting forward new pipe sections having construction supplies loaded therein from a supply depot by a rail vehicle movable along one of said exterior trackways;

c. providing a self-advancing assembly structure movable along and adjacent the forward end of said initial section of the railroad, said assembly structure having a rear receiving section and a forward erecting section;

d. transferring said loaded pipe from the rail vehicle to the receiving section of said assembly structure and unloading said construction materials therefrom;

e. utilizing said assembly structure and supplies to erect supports in advance of the initial section;

f. suspending said now empty pipe from said erected supports and securing the pipe end to end to the initial section of the pipe railroad; and

g. returning the rail vehicle along the other of said exterior trackways to the supply depot.

2. The method as defined in claim **1,** comprising further:

h. moving said assembly structure adjacent the forward end of said further section of railroad; and

i. continuing to erect said further railroad section along an intended itinerary.

3. The method as defined in claim **1,** wherein said supports are erected by drilling bore holes, filling said bore holes with a hardenable composition to produce foundations, placing members on said foundations, connecting said members to form said supports, and interconnecting said supports with a cable system.

4. The method as defined in claim **1,** wherein all materials and services required for self-progressing construction are supplied along the previously constructed length of said railroad.

5. The method as defined in claim **1,** wherein at least two lengths of pipe are suspended at each section, one length of pipe being secured atop said other length.

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