United States Patent [19]

Tabor

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[54] **METHOD FOR CONSTRUCTING AN UNDERGROUND RAILWAY**

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[21] Appl. No.: **144,888**

[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** **61/44,** 61/42

[51] **Int. Cl.** **E01g 3/04**

[58] **Field of Search** ..... 61/43, 44, 42, 45 R, 84, 61/85

[56] **References Cited**

UNITED STATES PATENTS

804,437	11/1905	See	61/42
899,735	9/1908	Jackson	61/44
922,768	5/1909	Jackson	61/44
977,306	11/1910	Hess	61/44
1,138,603	5/1915	Hallinger	61/42
1,899,474	2/1933	Ono	61/44
1,981,361	11/1934	Jones	404/1
3,319,385	5/1967	Szpytman	404/1 X
3,386,351	6/1968	Shusaku Hara	404/1
3,410,098	11/1968	Winberg	61/85

OTHER PUBLICATIONS

"Engineering News Record" June 17, 1926, Vol. 96, No. 24, Facing P. 974.

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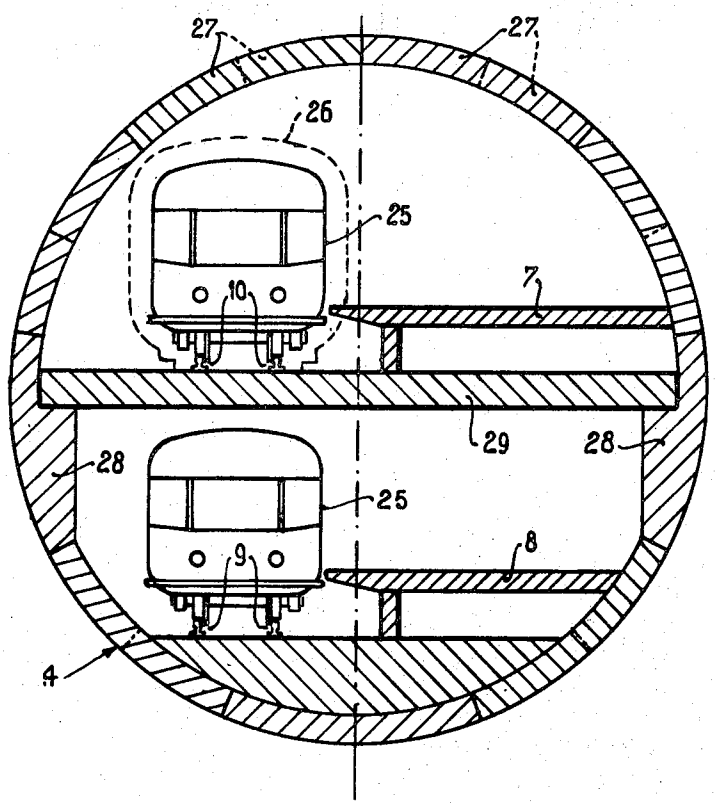
[57] **ABSTRACT**

Method and apparatus for constructing an underground railway which includes platform station tunnels and interconnecting carrier tunnels, both the platform station tunnels and carrier tunnels being constructed as a gradually formed subsurface gallery, without excavating through the overburden. All the tunnels are formed with the aid of an underground tunneling machine housed in a shield. All tunnels have substantially the same profile.

5 Claims, 7 Drawing Figures



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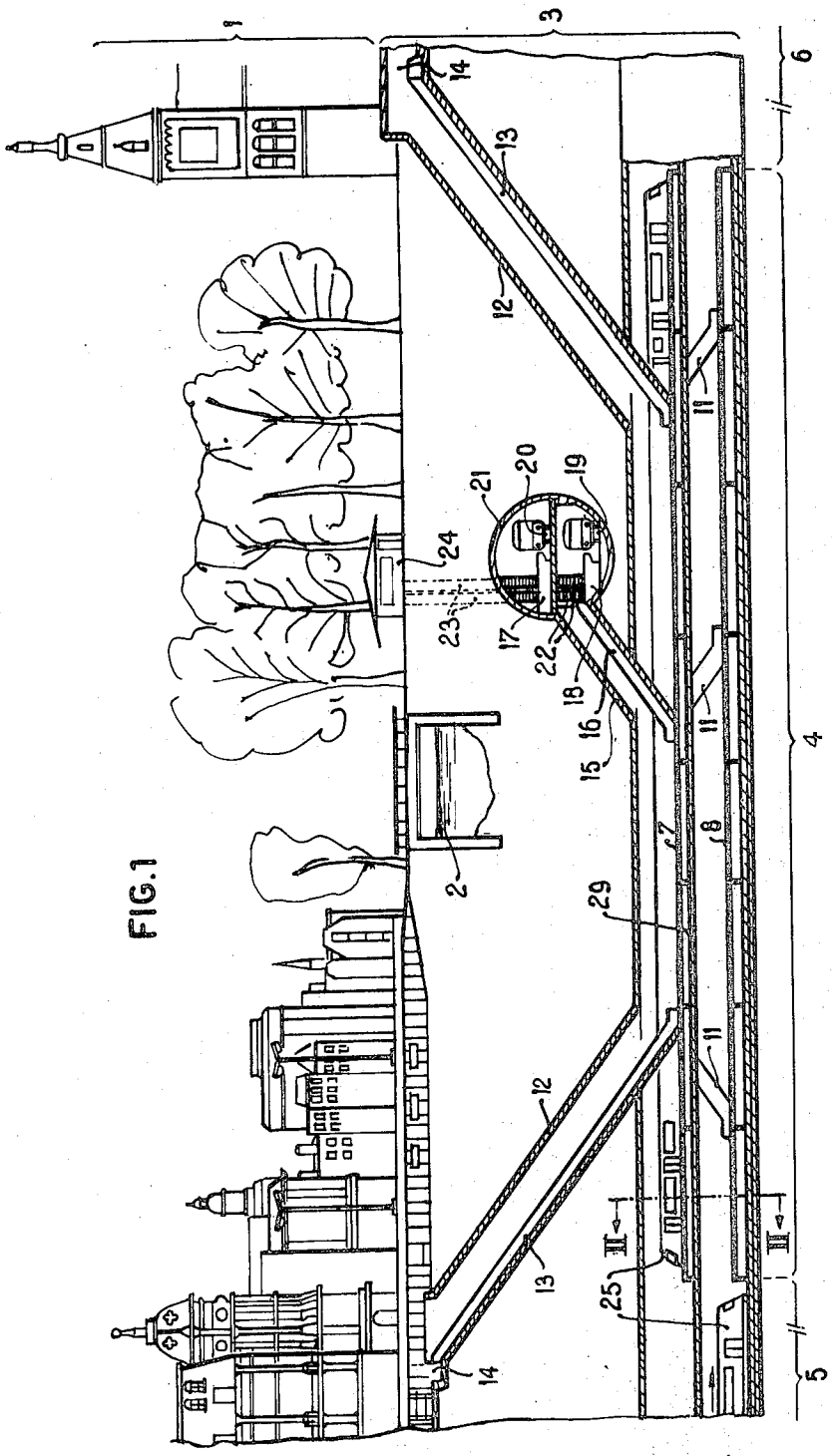

FIG. 1

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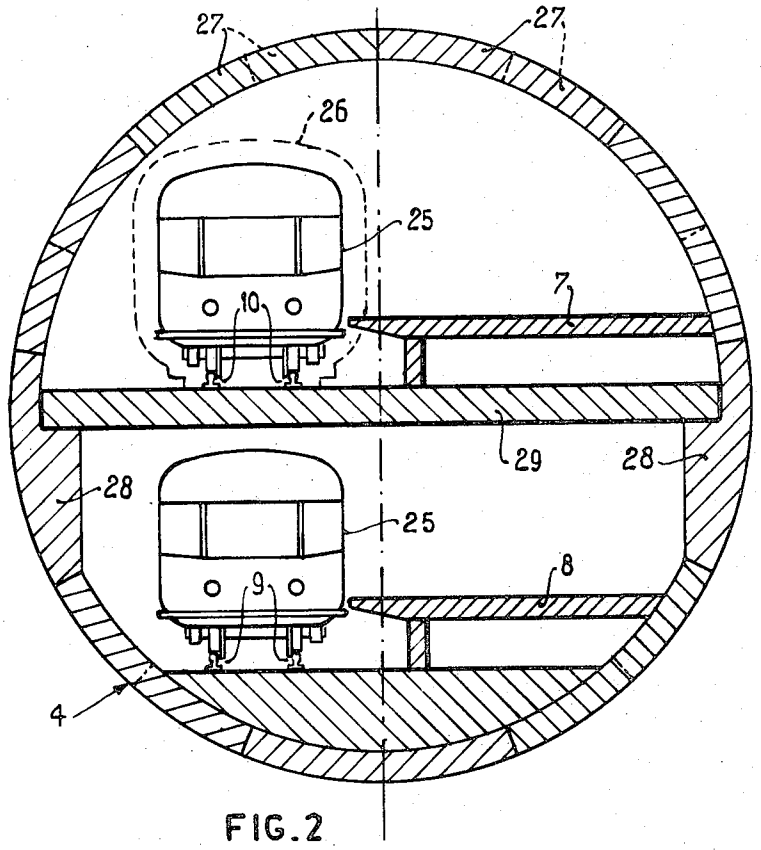

FIG. 2

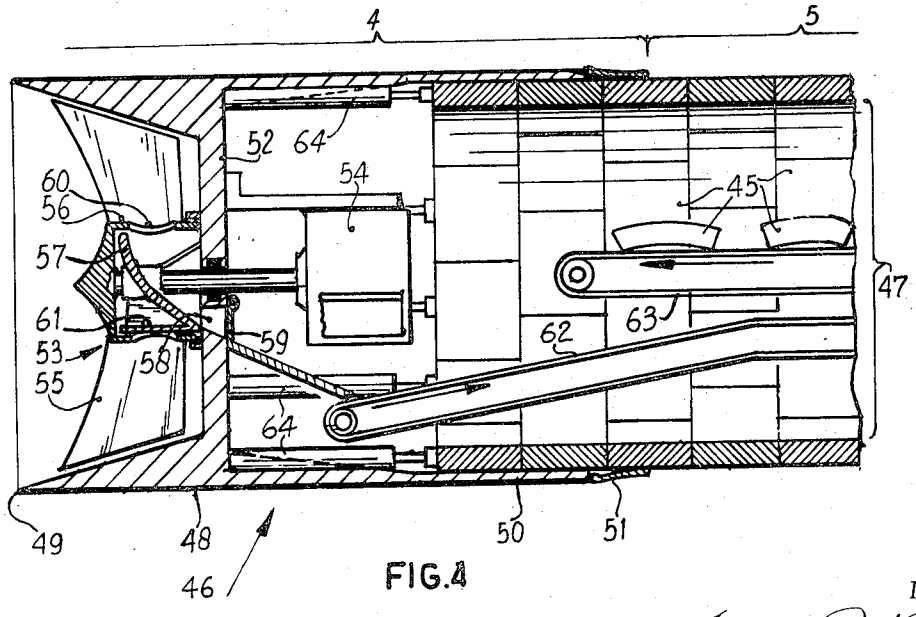

FIG. 4

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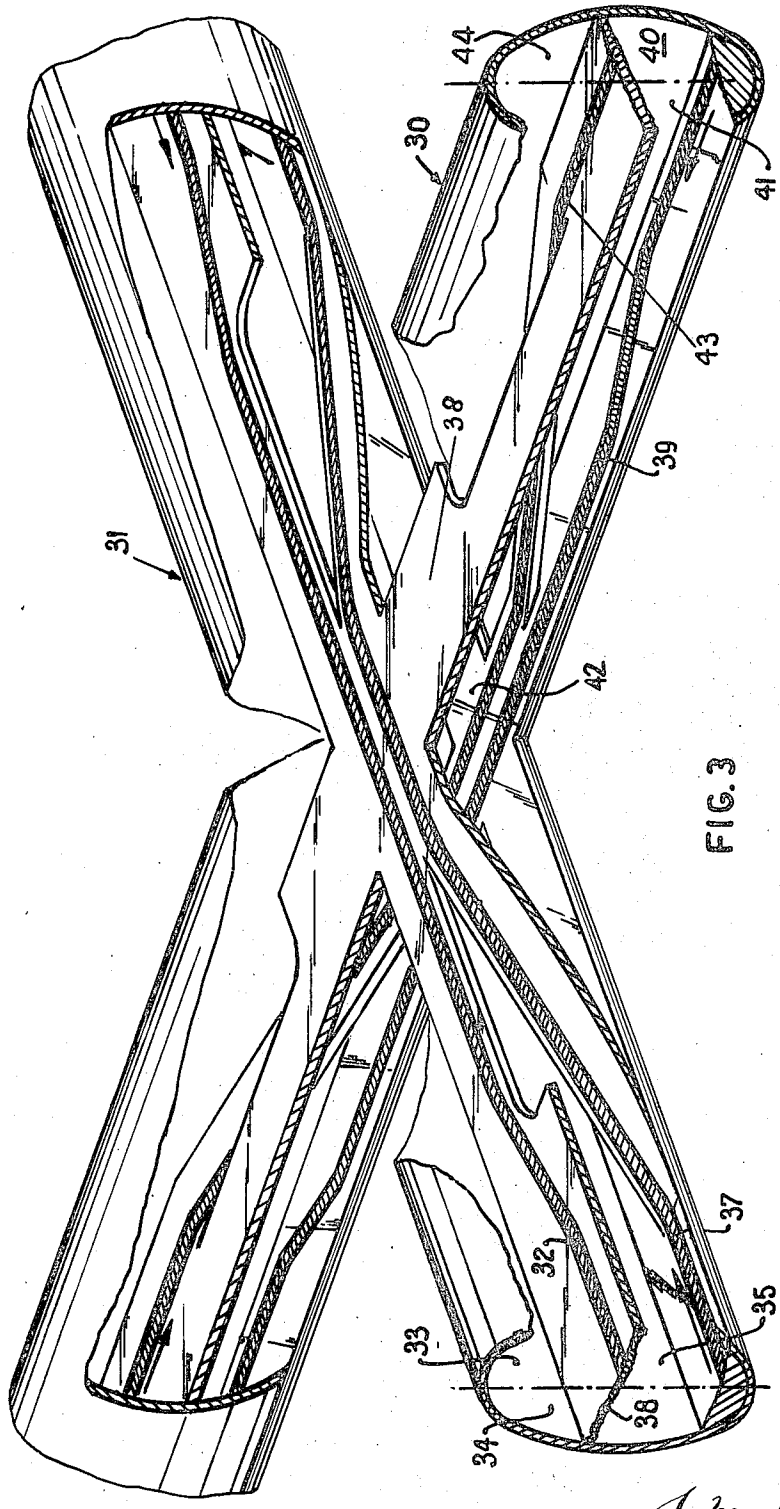

FIG. 3

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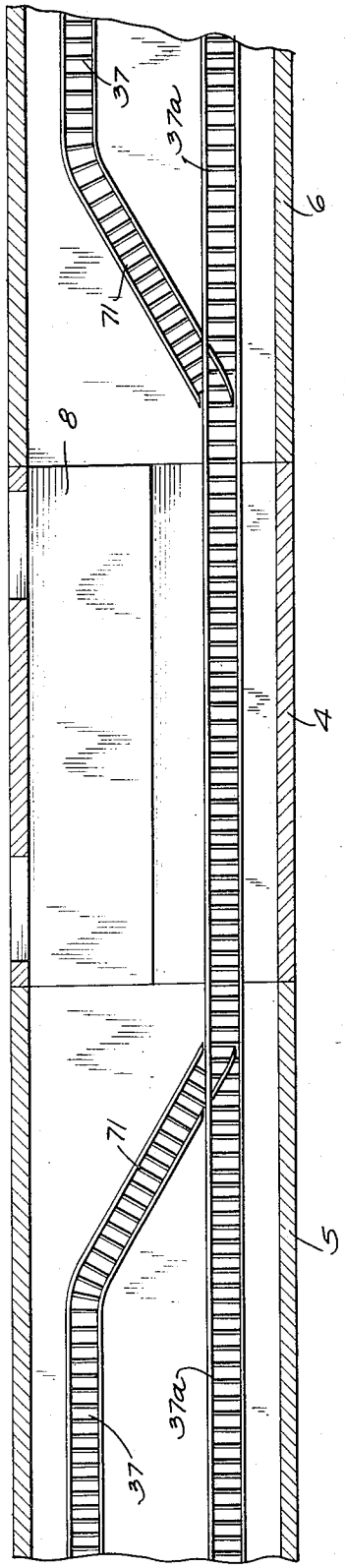

Fig. 5

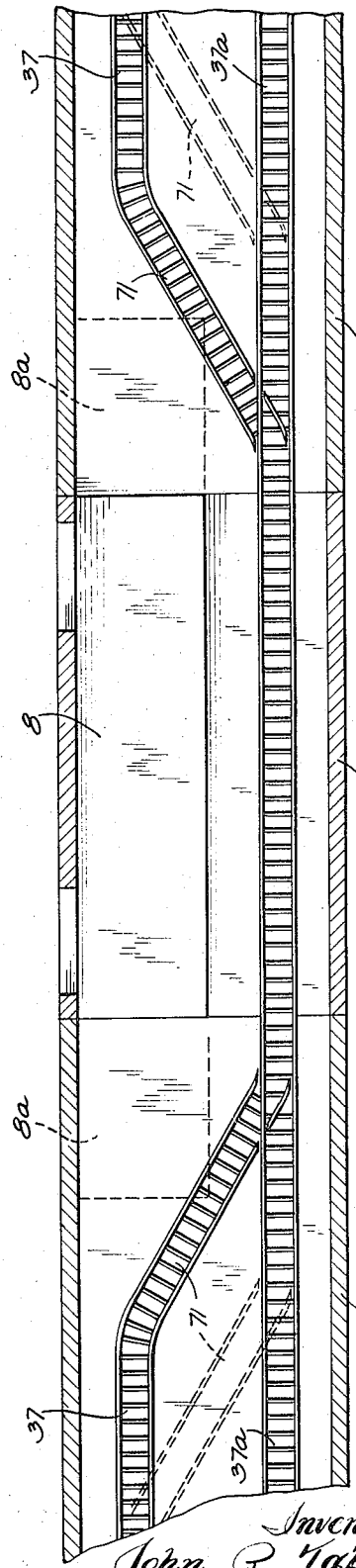

Fig. 6

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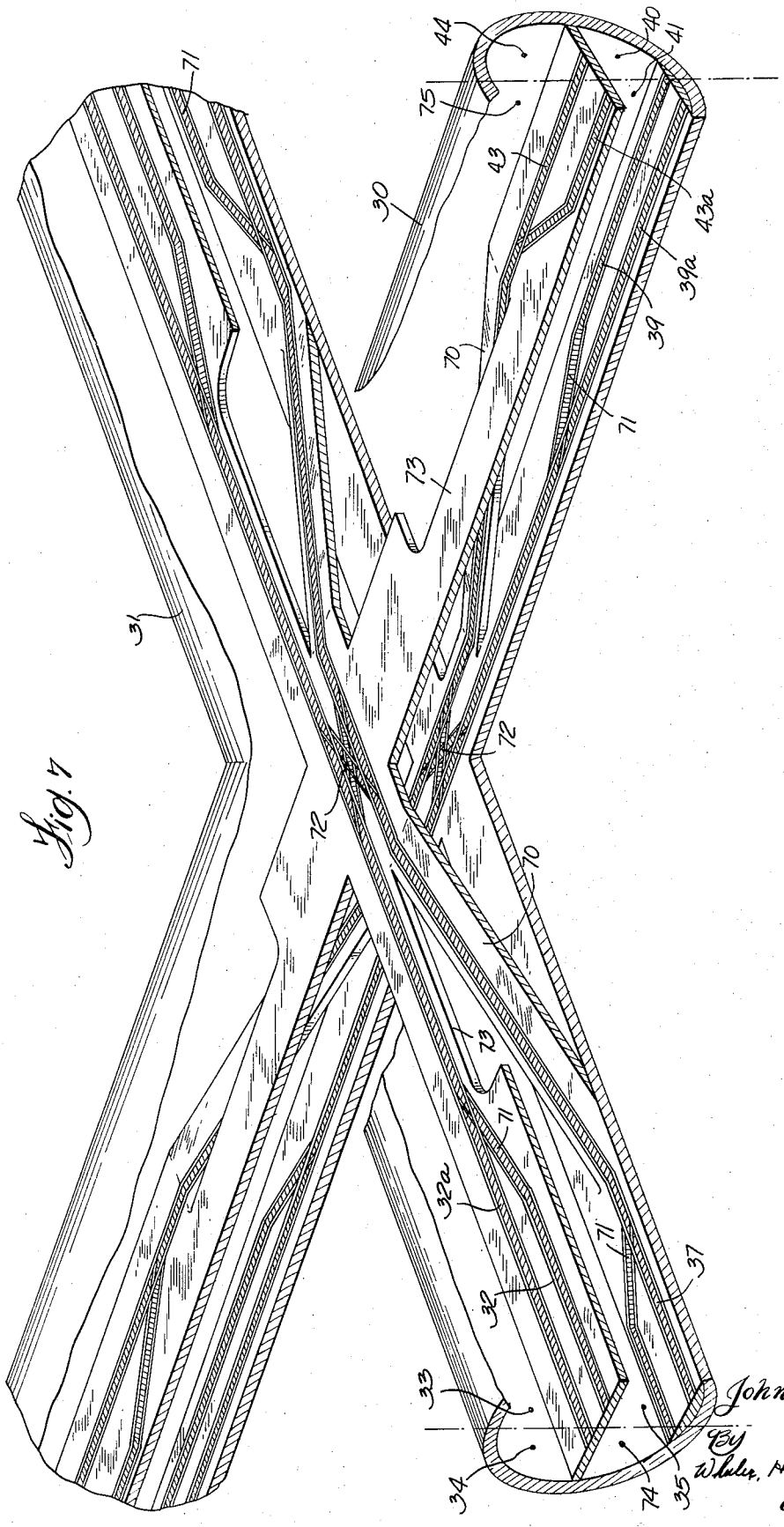

Fig. 7

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METHOD FOR CONSTRUCTING AN UNDERGROUND RAILWAY

BACKGROUND OF THE INVENTION

Present day underground railway or subway construction technique involves construction of the platform station by massive excavation through the surface to form an underground station space, enclosing the station space with walls, back-filling against the enclosure walls, and restoring the surface site. This technique disrupts surface traffic and other activity for a prolonged period of time and introduces many problems of transporting materials and equipment to the site as well as removing spoil from the site. Moreover, the excavating equipment housed in tunneling shields which excavate the carrier tunnels cannot travel under their own power in the space excavated for the platform station. The tunneling machine must be dismantled, transported across said space and reassembled at the other side of the space to resume excavation of the carrier tunnel. Special equipment and handling procedures are required during this movement. This requirement causes considerable lost time and disruption in tunneling momentum.

SUMMARY OF THE INVENTION

According to the present invention both the carrier tunnels and the platform stations are formed as a consecutive and gradually formed continuous gallery. No massive excavation through the overburden is required and the same tunneling machine which forms the carrier tunnels also forms the platform stations as tunnels with the same profile as the carrier tunnels. Accordingly, the problems encountered and created in massive excavation through the overburden are completely eliminated and tunneling momentum is maintained. Structural tunnel elements are installed within the tunnel area in a repetitive building block fashion. Structural elements are prefabricated off-site with proper manufacturing procedures and quality control, thus reducing on-site labor and equipment congestion. The structural elements are fabricated to support the tunnel wall as well as the platforms and associated equipment.

Thus all tunnels are constructed completely subterraneously in the continuous advance of the tunneling machine, except for escalator and transfer ramps which connect between platform tunnels and between platform tunnels and surface halls.

Underground railways constructed according to the present invention have the added advantages that modifications in the platform station, such as extending the platforms to accommodate longer trains and heavier traffic loads, can be accomplished in a short time with no work exterior of the existing tunnel walls, at low expense and with minimum disruption of continued operation of the subway system.

Tunnels embodying the present invention desirably have vertically stacked upper and lower traffic levels. Where tunnels intersect at the same grade level, means are provided to switch the traffic in one tunnel entirely into one level and traffic in the other tunnel to the other level, thus to avoid a grade crossing at the intersection. In some embodiments there are two parallel tracks on each level. In other embodiments there is one track on each level.

Other objects, features and advantages of the invention will appear from the disclosure.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagrammatic view, partly in elevation and partly in vertical cross section through a subway system embodying the present invention at the location of a platform station and showing a townsite schematically at the surface level.

FIG. 2 is a vertical cross section taken along the line II—II of FIG. 1.

FIG. 3 is a perspective view of a crossing or intersection between two carrier tunnels at equal level, portions of the tunnel walls being broken away to expose the interior.

FIG. 4 is a longitudinal section of a tunnel in the course of forming it with a shield mounted excavator.

FIG. 5 is a horizontal cross section through a platform and carrier tunnel gallery in which there are two traffic tracks in each level of the gallery.

FIG. 6 is a view similar to FIG. 5 but illustrating the technique used for adding additional length of platform to the platform in the platform tunnel.

FIG. 7 is a view similar to FIG. 3 but illustrating two tracks at each level of each of the intersecting carrier tunnels.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Although the disclosure hereof is detailed and exact to enable those skilled in the art to practice the invention, the physical embodiments herein disclosed merely exemplify the invention which may be embodied in other specific structure. The scope of the invention is defined in the claims appended hereto.

FIG. 1 schematically illustrates a portion 1 of a town over a subway system embodying the present invention. The town may include a canal 2 and has various buildings, etc., above the level of the ground surface. The subway or underground railway includes a station zone 3 which is underground. Station zone 3 includes platform tunnels 4, 21 and carrier tunnels 5, 6. In accordance with the invention the platform tunnel 4 is formed consecutively with the carrier tunnels 5, 6. Both the carrier tunnels 5, 6 and platform tunnel 4 have the same profile and are formed as one continuous gallery, for example by the tunneling mechanism shown in FIG. 4, and without requiring massive excavation through the overburden.

Each tunnel desirably has a horizontal partition 29 between upper and lower levels in the interconnecting tunnels, thus to form a floor for an upper track 10 at the top tunnel level. The lower tunnel level has a floor for a track 9. In the platform tunnel 4 there are respectively top and bottom loading platforms 7, 8 each of which extends for approximately one-half of the width of the tunnel, the other half being occupied by the tracks 10, 9.

The lower platform 8 communicates with the upper platform 7 by means of escalators 11. Top platform 7 communicates with surface halls 14 of the station 3 by means of escalators 13 arranged in inclined tubes 12. The top platform 7 may also communicate with the lower platform 18 of a crossing platform tunnel 21 which is at a higher non-intersecting level but which is substantially identical with platform tunnel 4, by means

of escalators 16 arranged in inclined tube 15. The lower platform 18 is positioned along lower track 19 in tube 21 and communicates by means of escalators 22 with the top platform 17 positioned along the top track 20 in tube 21. Top platform 17 in tube 21 communicates with a surface hall 24 of station 3 by means of escalators 23.

In the embodiment of the invention shown in FIGS. 1 through 3 each of the tracks 9, 10, 19, 20 and each of the platforms 8, 7, 18, 17 is positioned in a quadrant of its respective platform tunnel 4, 21. Each quadrant offers a sufficient space for the clearance zone 26 of the rolling stock 25, as indicated in FIG. 2.

All tunnels are desirably built up of concrete liner blocks 27 as disclosed in my Canadian Patent 816,998 of July 8, 1969. This construction includes shoulder sections 28 for supporting the partition or floor 29. Partition 29 supports the upper tracks and platform and also stiffens and re-enforces the tunnel structure.

As shown in FIG. 3, two carrier tunnels 30, 31 typically may intersect at the same level. The tunnels have sufficient carrier space for providing an undisturbed or separated crossing for the tracks in the respective tunnel levels. In this embodiment there is a single track at each level of each tunnel. At the intersection the floor partitions 38 in each tunnel intersect at the same level. The top track 32 in quadrant 33 in tunnel 31 is diverted to one side to quadrant 34 and the bottom track 37 of the same tunnel 31 is brought upwardly on ramp 70 through an opening 73 in floor 38 onto floor 38, but in quadrant 33. Lower track 39 in tunnel 30 is also diverted to one side of the lower tunnel 40, from quadrant 40, to quadrant 41, and the top track 43 in quadrant 44 descends on ramp 70 into quadrant 40 at the lower floor level 42 of tunnel 30. Accordingly, the tracks will cross at different levels, thus avoiding conflict between traffic at the intersection of the two tunnels.

After passing through the intersection, the tracks return to their original levels and their original quadrants.

FIG. 7 illustrates an intersection similar to that shown in FIG. 3 but in which each of the carrier tunnels 30, 31 carry two tracks at each level, for a total of four tracks in each tunnel. In this view the elements which correspond to those in FIG. 3 are given the same reference characters.

In tunnel 31 track 37*a* at the lower level is located in quadrant 74 and parallels track 37 in quadrant 35. Track 32a is provided in quadrant 34 at the upper level and parallels track 32 in quadrant 33. In tunnel 30 track 39a at the lower level is located in quadrant 41 and parallels track 39 in quadrant 40. Track 43a is provided in quadrant 75 at the upper level and parallels track 43 in quadrant 44.

In order to transfer trains running on the additional tracks various switches 71 are provided whereby trains running on parallel tracks on one level of a tunnel can be transferred to a single track which passes through the zone of intersection of two tunnels as hereinbefore described in connection with FIG. 3. Operation of the switches may be automatically controlled to avoid conflict between trains.

Further flexibility in train operation can be provided by crossing switches 72 which are disposed between parallel runs of the upper and lower tracks where they merge at the same level at the intersections of the tunnels.

FIG. 4 illustrates the manner of use of a shield-tunneling-drill 46 to construct tunnels suitable for use in the present invention. In this figure a carrier tunnel 5 has previously been constructed. Its lining consists of arced liner blocks 45. A few of the liner blocks of platform tunnel 4 have already been positioned on an extension of carrier tunnel 5 in the gradually formed continuous gallery 47.

The shield-tunneling-drill 46 consists of a profiled hollow shield 48 provided with a cutting edge 49 and a skirt 50 sealed by means of a trailing annular sealing strip 51 at the outside of the liner blocks 45 which have already been positioned. The shield 48 is closed by means of a transverse partition or bulkhead 52 immediately behind the digging wheel 53 which is mounted for rotation in the bulkhead. Digging wheel 53 is driven by a motor 54 and has digging implements 55 and a hollow hub 56 provided with openings 60 through which the digging implements 55 discharge spoil. A hopper 57 is positioned within the hub 56 and is mounted on the partition 52 and has an outlet 58 which can be closed by gate valve 59. The parts 60 are sealed at the lower side of the hollow hub 56 by a stationary baffle or sealing plate 61. Spoil delivered through outlet 58 is deposited down a ramp onto a spoil discharge conveying belt 62.

The liner blocks 45 are supplied by a conveyor belt 63 and are positioned in the tunnel wall by lifting and setting apparatus not shown. Jacks 64 press against positioned liner blocks 45 to force the shield 48 forwardly. The shield 48 is thus advanced and spoil removed from the tunnel face by the cutting wheel 53, thus gradually elongating the gallery 47 from one carrier tunnel 5 or 6 through the platform tunnel 4 and therebeyond into the next carrier tunnel 5 or 6, and so on, without requiring any excavation from the surface.

After the platform tunnels 4 are thus formed they are connected to the surface halls 14 by means of the inclined tube 12.

FIG. 5 illustrates a platform tunnel 4 to which carrier tunnels 5 are connected and in which the platform 8 occupies substantially the entire length of the platform section 4. In this embodiment each level of each carrier tunnel is provided with two parallel tracks, such as tracks 37 and 37*a*, as in FIG. 7. Switches 71 are utilized to divert traffic from track 37 to track 37*a* within the platform tunnel 4, for loading purposes.

FIG. 6 illustrates an arrangement similar to that in FIG. 5, and also illustrates the technique for enlarging the platform tunnel section 4 from its extent indicated by the showing of platform 8 in full lines to its enlarged zone indicated by the platform extensions 8*a* shown in broken lines. All that is required is to move switches 71 longitudinally along the continuous tunnel gallery away from the platform 8 and to add the platform extensions 8*a*. No work exterior of the existing tunnel walls is required and these remain intact. The switches 71 can be installed during periods of light traffic, thus clearing the platform area for construction of the extensions 8*a*. Moreover, while construction work is being performed on one level of the platform tunnel 4 it is possible to transfer traffic to the other level temporarily, as by the techniques illustrated in FIGS. 3 and 7 in which ramps 70 are provided between two tunnel levels. Thus con-

struction work can continue with minimum disruption of traffic.

FIG. 4 is illustrative of one form of shield mounted excavating machine useful for forming the tunnels. My U.S. Pat. Nos. 3,382,002 and 3,404,920 show other forms. In its broad aspects the invention is not limited to any particular form of tunneling machine.

I claim:

1. A method for constructing an underground railway which includes spaced platform stations and interconnecting carrier tunnels, said method comprising the construction of both the platform stations and carrier tunnels as a substantially uniform profile continuous subsurface gallery formed by continuously tunneling longitudinally of said gallery to form successively a carrier tunnel, a platform station, and another carrier tunnel at the other side of the platform station, installing laterally adjacent loading platforms and track in the platform station portions of said continuous gallery to define said platform stations and installing track in the carrier tunnel portions of said continuous gallery, and installing passenger ramps laterally into the platform stations portions of said continuous gallery.

2. The method of claim 1 in which the platform stations comprise tunnels communicating with the carrier tunnels, all said tunnels being formed with the aid of an underground tunneling machine housed in a shield which defines the cross sectional profile of all said tunnels.

3. The method of claim 1 plus the step of providing said gallery with upper and lower levels separated by a horizontal partition, two of said carrier tunnels intersecting at the same level, and the step of installing ramps through said partition to transfer all traffic in one tunnel to the other level at said intersection, whereby to avoid grade crossings at said intersections.

4. The method of claim 1 in which the capacity of the platform station is increased while the existing tunnel walls remain intact and including the step of extending the loading platforms along said tunnel walls to increase their length.

5. The method of claim 4 plus the further step in which any track in the path of extension of said loading platform is also removed and replaced at points beyond the extended loading platform.

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