Dec. 6, 1966 R. P. SONNEVILLE 3,289,941

RAILWAY TRACK WITHOUT BALLAST

Filed Dec. 7, 1964

Fig. 1

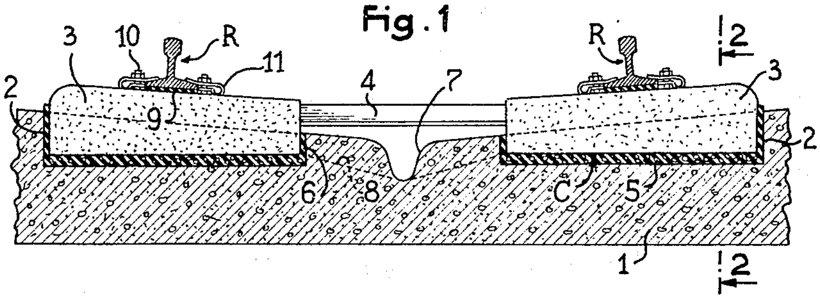
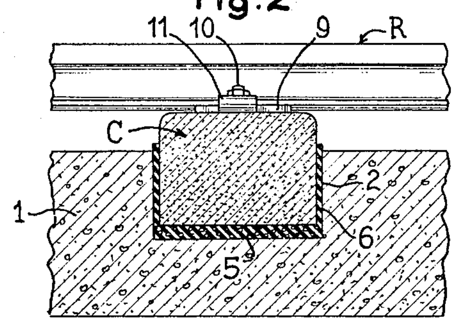


Fig. 2



United States Patent Office

3,289,941

Patented Dec. 6, 1966

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3,289,941

RAILWAY TRACK WITHOUT BALLAST

Roger Paul Sonneville, Saint-Cloud, France, assignor to Societe d'Etudes Ferroriaires, a French body corporate, Paris, Seine, France

Filed Dec. 7, 1964, Ser. No. 416,206
Claims priority, application France, Dec. 12, 1963, 956,997
11 Claims. (Cl. 238—116)

The present invention relates to railway tracks and the object of the invention is to arrange the track in such manner as to avoid use of ballast without this affecting the resilience of the railway track.

A conventional railway track composed of rails resting on ties or sleepers which are supported on a bed of ballast of broken stones, has a certain resilience. This resilience is not only due to the ballast but also to the ground or platform on which it is supported.

The resilience of the assembly of the ballast and the platform is characterized by the Müller-Breslau coefficient K which is defined by the mean pressure in kg./sq. cm. that the lower plane face of each tie would develop to result in the resilient sinking of the tie to a depth of 1 cm. In a good track, which is well maintained and suitable for high speeds, this coefficient K varies from 10 to 20. As the effective area of half a tie of a normal track is of the order of 2,000 sq. cm., each rail would have to transmit to each support on each half tie a force between 20 and 40 tons in order to cause the tie to sink to a depth of 1 cm. In other words, under vehicles loaded to 20 tons per axle, namely 10 tons per wheel—the force of the "chair reaction" of the rail on each tie being on average about 6 tons owing to the stiffness of the rail which distributes the loads over a plurality of ties—the resilient sinking or springiness of each tie would be between 1.5 and 3 mm.

This resilience is considered sufficient in current tracks and is obtained easily with a suitable depth of ballast, bearing in mind the nature, the resistance and resilience of the ground constituting the substructure.

But it is sometimes necessary to lay the railway track on a much less resilient bed without ballast and even without the resilience of the ground. This is the case, for example, when the rails must be laid on the girders or flooring of concrete of a permanent structure, or directly on the stone floor of tunnels so as to lower the level of the rails as far as possible.

Elimination of the ballast obviously results in considerable economy and permits decreasing the opening of tunnels by several decimetres. It also avoids the necessity of cutting into the arch or lowering the floor of the tunnel in order to increase the available space over the vehicles for cantenaries when electrifying an existing railway line.

Although the ballast plays an important part in a conventional track it has serious drawbacks, owing to its very nature. As it has no cohesion other than frictional cohesion, it tends to gradually subside under the hammering of the loads and it also becomes clogged up and gradually looses its resilience as it becomes more and more soiled. If it were possible to eliminate the ballast and replace it by a coherent bed, such as a foundation of cement concrete or black concrete (tar-macadam, stones stabilized by the injection of bituminous products, etc.), there would result a considerable economy as concerns maintenance costs.

However, such arrangements are only possible if the loss of the natural resilience of the ballast and of the ground are remedied by special means. Such means exist. They consist, for example, in placing under the

2

rail rubber pads or sole-plates. The most efficient devices at the present time are constructed in the following manner.

The rails are secured to wide metal sole-plates or packing pieces. These metal sole-plates rest on the concrete foundation through the medium of thick rubber pads whose resilience is increased by shaping, grooves or cavities which are formed when moulding the pad. These metal sole-plates are fixed to the floor by bolts which are sealed, screwed or bonded in the concrete, there being interposed between the nut and sole-plate resiliently yieldable element, such as washers having multiple spring steel coils.

Unfortunately, these devices have the following drawbacks.

. Their construction is difficult and costly. For example, high precision in the sealing of the bolts is required and in the levelling or alignment of the support surfaces, and this precision is often incompatible with the construction of the foundations. As the rails must be firmly held so as to maintain the geometry of the track (as concerns track alignment, track width and inclination of the rails) and prevent the longitudinal creep thereof, this requires highly tightening the bolts that hold down the sole-plates and leaving no clearance between the bolts sealed in the foundation and the walls of the apertures in the sole-plates.

Consequently, this restricts the resilient give of the pads which are necessarily precompressed by the bolts fixing the sole-plates to the floor. Further, the bolts transmit to the foundation a part of the vibrations of the rails and the sole-plates, above all at certain critical frequencies.

Apart from their complicated structure and price, these known devices do not perform their function correctly; the track thus constructed is much harder and noisier than a conventional track laid on ballast. In tunnels, it shakes the foundation and neighbouring constructions to an unacceptable degree.

It is obvious that a track laid in a tunnel must have a much higher resilience than a conventional track laid in open country. Investigations carried out by the applicant have shown that it is necessary to provide a resilience equal to at least 0.5 mm. per ton of load transmitted by the rail to each of its supports, so as to absorb the impacts and shaking due to defects in the surface of the rails and of the wheel rims, flat faces on the wheels and geometric and dynamic eccentricity thereof. If it is attempted to obtain such springiness or compressibility of the support with presently-known devices, the rails would tilt and produce an unacceptable increase in the rail track width owing to the transverse forces applied to the rails at the level of the rail heads by the flanges of the wheels, since the length of the sole-plates, measured in the direction perpendicular to the longitudinal axis of the track, is necessarily restricted by the modulus of elasticity of the existing pads and by considerations of cost.

The object of the present invention is to provide a railway track system without ballast which remedies the aforementioned drawbacks while possessing the two apparently irreconcilable features namely: a resilience very greatly exceeding that of a conventional track, such as that required for a track laid in urban tunnels, and a precise geometry even in the case of the passage of rapid trains or in sharp bends in which the rails are subjected to high transverse forces.

The invention provides a railway track comprising a continuous platform overlying the substructure and provided with aligned cavities in each of which is inserted the lower part of a rail support block the upper surface of which is secured to a rail by means of rail fasteners, a sheath of elastomer material being fitted on said lower part and being interposed between the walls of the block and the walls of the cavity, the bottom of said sheath, which is incontact with the base of the cavity, having a closed cellular structure.

Owing to this arrangement, the track maintains a correct geometry, while the resiliently yieldable sheaths, whose resilience is greatly enhanced by the occluded gas in the closed cellular structure of their base, compensate, and even more than compensate, the loss of resilience due to the elimination of the ballast.

The continuous platform in which the blocks are inserted can be a floor, a foundation or a concrete flooring, whether the latter contains cement or other binder, such as asphalt.

The blocks supporting the rail are advantageously those making up known composite sleepers or ties, namely two concrete blocks each of which is placed under one of the rails and which are interconnected by a section steel strut or spacer member, the platform comprising two rows of cavities corresponding to the two rows of the blocks of the composite ties and to the two rows of rails. However, blocks of other types could be employed.

Further, the fasteners employed for fastening the rails to the blocks are preferably fasteners of the type having a double resilience generally employed with composite ties.

Further features and advantages of the invention will be apparent from the ensuing description with reference to the accompanying drawings to which the invention is in no way limited.

In the drawings:

FIG. 1 is a cross-sectional view of a preferred embodiment of a railway track according to the invention, this section being through a pair of rail support blocks, and

FIG. 2 is a sectional view taken along line **2—2** of FIG. 1.

In the illustrated embodiment, the railway track according to the invention comprises a continuous platform **1** consisting of a floor, a foundation or flooring of concrete (cement concrete or black concrete) which overlies the substructure of the tunnel of the permanent structure or any other support for the track. Formed in this platform are two rows of cavities **2** in which are inserted concrete blocks **3** for supporting the rails R, each row of cavities corresponding to a row of rails. Each cavity of one row is intransverse alignment with the cavity of the other row and the two blocks in these cavities are braced or held spaced apart by a rolled steel section or strut **4** the ends of which are embedded in the two blocks. These blocks and their strut constitute a composite tie or sleeper of known type.

The lower part of the blocks **3** inserted in the platform **1** has a rectangular-sided configuration, but it can have some other shape, such as that of a truncated right prism. This lower part is inclosed in a sheath C. This sheath has a base **5** of elastomer material having a closed cellular structure, such as neoprene foam, and four vertical walls corresponding to the four sides of the block **3**. The walls **6** are composed of an elastomer material which can also have a cellular structure, if the sheath C is moulded in one piece, or they can have a non-cellular structure if the walls **6** are assembled with, and welded or bonded to, the base **5**. Regardless of its construction, the liner C must be fluid-tight. It is interposed between the lower part of each block **3** and the corresponding cavity. The walls **6** have a height of at least **5** cm., except possibly that wall which is nearest to the axis of the track, since this wall can be notched in order to take into account the slope of the platform insuring the flow of water running down to a central channel **7** with which draining passages **8**, formed in the platform **1** between the cavities **2**, can communicate. The platform **1** is leveled off at its upper part at a level substantially corresponding to that of the upper edges of the walls **6** of the sheaths C so that the blocks **3** with their sheaths are inserted in the platform **1** to a depth of at least 5 cm., with the possible exception of the side adjacent the axis of the track.

The rails R are preferably secured to the upper face of the blocks **3** in the manner generally adopted at the present time for modern railway tracks on composite ties. Thus, between the rail R and the upper face of each block **3** there is interposed a grooved rubber pad **9**, the rail being secured by bolts **10** and double elastic fasteners **11**, such as those described in French Patent No. 1,004,331, filed on April 5, 1947.

The railway track according to the invention is very easily constructed and this is in itself a very important advantage. The rails R of the track are first secured to the concrete blocks **3** by the fasteners **11**, then adjusted to their precise geometric position as concerns level and alignment. The rails or the ties are then temporarily held in position and the blocks **3** are provided with their sheath, which, by construction, exactly fits round the outer shape of the blocks without clearance. For this it is sufficient that the inside dimensions of the sheath be slightly less than the outside dimensions of the block **3** so that the sheath is elastically streached when fitted onto the block. The concrete of the platform **1** is then poured and carefully packed under and around the sheaths so that they are closely embedded in the concrete. The fact that the sheaths (which are moulded or composed of assembled elements) are absolutely fluidtight, in particular at the edges, the concrete of thte platform **1** surrounding the sheaths, which act as framing, has no contact with, and absolutely no adherence to, the block supporting the rails.

The track according to the invention satisfies the requirements of a track without ballast. The heavy blocks **3** and their doubly elastic fasteners **11** effectively damp the high-frequency vibrations of the rail and they also insure a correct track geometry.

Further, the sheaths C benefit from the exceptional characteristics of the elasticity of elastomers having a closed cellular structure, which associates the elasticity of the bubbles of gas (such as nitrogen) trapped in the perfectly fluidtight elastic enclosure (Mariotte's law) and the damping power of the elastomer itself, which is selected not only for its hysteresis but also for its non-aging properties. With a relatively thin wall, for example a few centimetres thick, and in providing a suitable amount of gaseous bubbles, it is easy to impart to the track thus constructed a vertical resilience which is as great as desired, for example if the track must be laid in an urban tunnel. Owing to their freedom in the cavities and to the resilience of the vertical faces of the sheaths, the concrete blocks supporting the rails can move upon passage of the wheels while remaining perfectly insulated from the foundation both mechanically and electrically. The sheaths having a base composed of an elastomer having a closed cellular structure thus constitute a pneumatic suspension of the track on its foundation. A rubber pad—even if it is thick and moulded to be deeply recessed so as to provide hollow spaces—is far from possessing the compressibility and resilience without creep that the pad of the sheath according to the invention possesses, above all if it is placed under a concrete block having a large surface area and a low unit pressure, of the order of a few killograms per square centimetre. Now, it is essential that the concrete blocks placed between the rail and foundation have a large surface area and in particular great length in a direction perpendicular to longitudinal axis of the rail so as to diminish the tendency of the assembly to incline excessively outwardly of the track under the effect of the transverse forces applied on the top of the rail by the flanges of wheels. This length of the blocks must be at least equal to three times the height of the section of the rail.

The fact that each block **3** and its sheath C is inserted to a depth of at least 5 cm. in the supporting concrete permits, bearing in mind the weight of the concrete blocks of the tie, opposing the longitudinal expansion forces and creep of the rails without this lifting the assembly of the rail and the blocks fastened thereto. Further, the resilient support or abutment of the vertical outer face of each block, with respect to the longitudinal axis of the track, against the support of the cavity in which the assembly is embedded, through the medium of the corresponding wall of the sheath surrounding the block, affords a perfect transverse track stability. These arrangements permit dispensing with the bolts which, in presently-known constructions, restrict the movements of the metal sole-plates in all directions relative to the concrete foundation.

In the absence of rolling loads on the track, it is the weight of the rails and of the embedded concrete blocks having vertical faces which insure the stability. Thus, advantage is taken of practically the entire resilience of the resiliently yieldable sheath. As opposed to this, in known constructions the bolts employed for securing the sole-plates to the foundation develop, if they are to be at all effective, a permanent force precompressing the pads which thus lose a large part of their available resilience under the rolling loads.

Although a specific embodiment of the invention has been described, many modifications and changes may be made therein without departing from the scope of the invention as defined in the appended claims.

Thus, when the track is employed in such a layout and conditions of use that the transverse forces supported by the rails remain moderate, the track according to the invention can be constructed at lower cost price with independent concrete blocks without a strut or spacer member, or with a composite assembly of pairs of blocks and struts, depending on the requirements of maintenance and correct track geometry.

Further, if the preferred embodiment of the invention as described employs concrete blocks, it is owing to the fact that they are non-responsive to the dampness usually prevailing in tunnels and owing to their great weight, which is essential, on the one hand, to impart to the doubly elastic fasteners their maximum efficiency in the damping of high-frequency rail vibrations (sonic frequencies) and, on the other, to impart to this track maximum stability without risk of these blocks and the sheaths surrounding the blocks being lifted out of the cavities of the foundation in which they are embedded.

However, the described arrangements can also be obtained in replacing the concrete blocks by wooden blocks, on condition that the latter are cut to precise dimensions corresponding to those of the commercially moulded sheaths and that the lateral faces of the sheaths have an increased height so as to permit a deeper insertion of the block in the foundation and thus avoid the danger of the track being lifted and coming out of alignment, since this track is much lighter with wooden blocks than with concrete blocks. Materials other than concrete and wood, such as steel, cast iron and plastic materials, could of course also be employed.

Although in the foregoing description the two rows of rails are supported by two rows of separate blocks, it is possible to employ a single row of blocks which have such dimensions that each block receives both rails of the track. In this case, only a single row of cavities would be provided.

Having now described my invention what I claim as new and desire to secure by Letters Patent is:

1. Railway track without ballast comprising a continuous platform overlying the substructure of the track, blocks supporting rails which are fastened to the top face of the blocks by rail fasteners, a sheath of elastomer material covering the lower part of each block, and cavities in the platform in which the blocks are respectively inserted, and sheaths being interposed between the faces of the blocks and the faces of the cavities, the sheaths having a bottom wall which is in contact with the base of the cavity and has a closed cellular structure, each sheath having lateral walls which are fixed to the bottom wall in a fluidtight manner, the dimensions of the sheath being such that the walls of the sheath mounted on the block are in an elastically stretched condition.

2. Railway track as claimed in claim **1**, wherein the lateral walls have a height of at least about 5 cm. and the platform has an upper face substantially flush with the upper edges of the lateral walls.

3. Railway track as claimed in claim **1**, wherein the platform has a top face which slopes downwardly toward the centre axis of the track to facilitate the drainage of rain water, and the top edges of the lateral walls are substantially flush with said top face.

4. Railway track without ballast comprising a continuous platform overlying the substructure of the track, rails, blocks supporting the rails, each of the blocks having a top face, a bottom face and lateral faces, rail fasteners mounted on said blocks and fastening the rails to the top faces of the blocks, and means maintaining the blocks in position relative to the platform, said means consisting of cavities in the platform in which cavities the blocks are respectively inserted, each of the cavities being defined by a base and lateral faces, and sheath means of elastomer material covering the lower portion of each block and interposed between and in adjoining relation to said lateral faces of each of the blocks and the lateral faces of each of the cavities and having a bottom wall which is in contact with the base of the cavity and with the bottom face of the block and has a closed cellular structure, whereby a resilient mounting of the blocks is achieved and transmission of vibrations from the rails to the platform through rigid metal elements is avoided.

5. Railway track as claimed in claim **4**, wherein the platform is composed of concrete having a cement binder.

6. Railway track as claimed in claim **4**, wherein the platform is composed of concrete having an asphalt binder.

7. Railway track as claimed in claim **4**, wherein the blocks are composed of concrete.

8. Railway track without ballast comprising a continuous platform overlying the substructure of the track, two rails, a row of composite ties under the rails, each tie having two rail support blocks and a metal strut interconnecting the two blocks and extending tranversely of the rails, each block having a top face, a bottom face and lateral faces, rail fasteners fastening the two rails respectively to the top faces of the blocks, means maintaining the blocks in position relative to the platform, said means consisting of two rows of cavities in the platform in which the blocks are respectively inserted, each of the cavities being defined by a base and lateral faces, and sheath means of elastomer material covering the lower portion of each block interposed between and in adjoining relation to said lateral faces of each of the blocks and said lateral faces of each of the cavities and having a bottom wall which is in contact with the base of the cavity and with the bottom face of the block and has a closed cellular structure, whereby a resilient mounting of the tie on the platform is achieved and transmission of vibration from the rails to the platform through rigid metal elements is avoided.

9. Railway track without ballast comprising a continuous platform overlying the substructure of the track, two rails, a row of composite ties under the rails, each tie having two rail support blocks and a metal strut interconnecting the two blocks and extending transversely of the rails, each block having a top face, a bottom face and lateral faces, rail fasteners fastening the two rails respectively to the top faces of the blocks, means maintaining the blocks in position relative to the platform, said means consisting of two rows of cavities in the platform in which the blocks are respectively inserted, each of the cavities being defined by a base and lateral faces, and sheath means of elastically yieldable neoprene covering the lower portion of each block interposed between and in adjoining relation to said lateral faces of each of the blocks and said lateral faces of each of the cavities and having a bottom wall which is in contact with the base of the cavity and with the bottom face of the block and is of foam neoprene, whereby a resilient mounting of the tie on the platform is achieved and transmission of vibration from the rails to the platform through rigid metal elements is avoided.

10. Railway track as claimed in claim **9**, wherein the sheath means have lateral walls of foam neoprene.

11. In a railway track comprising composite ties each having two blocks which are interconnected by a strut and are disposed in cavities in a platform underlying the ties; a sheath of elastomer material fitted on the lower portion of each block and interposed between the block and the faces of said cavity, said sheath comprising a bottom wall portion and lateral wall portions extending upwardly from and connected to said bottom wall portion.

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