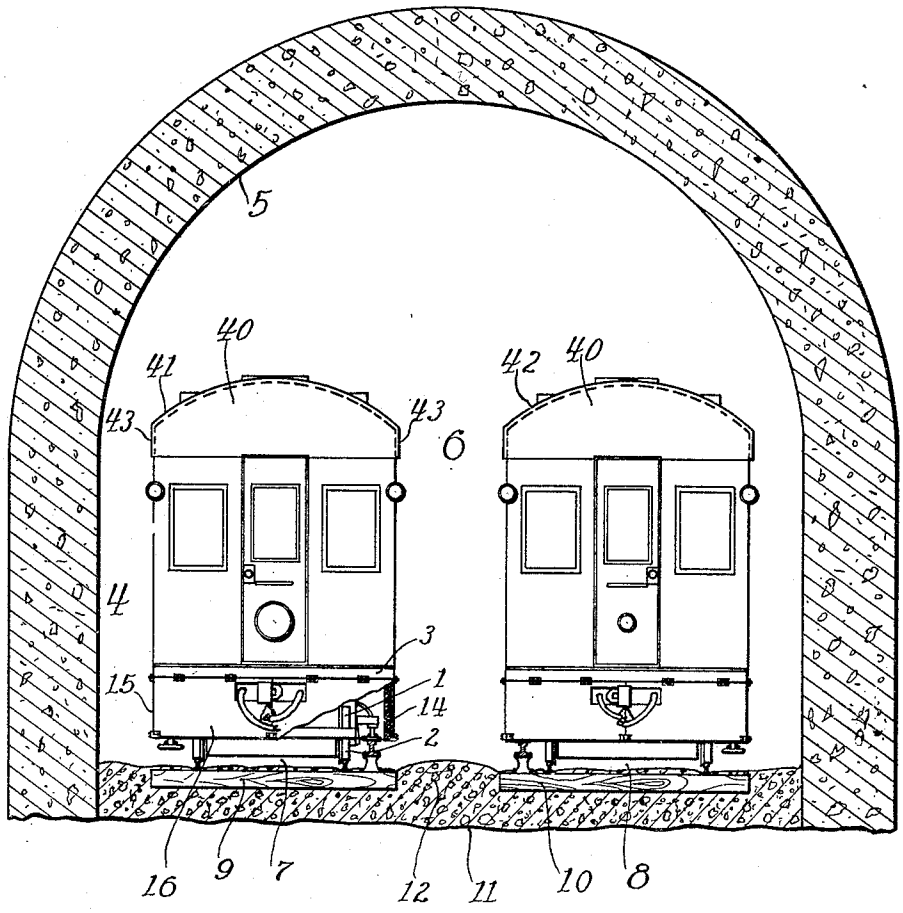
Aug. 25, 1931. J. M. WHITE 1,820,874

METHOD OF REDUCING SOUND IN SUBWAYS

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Fig. 1.



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Fig. 2.

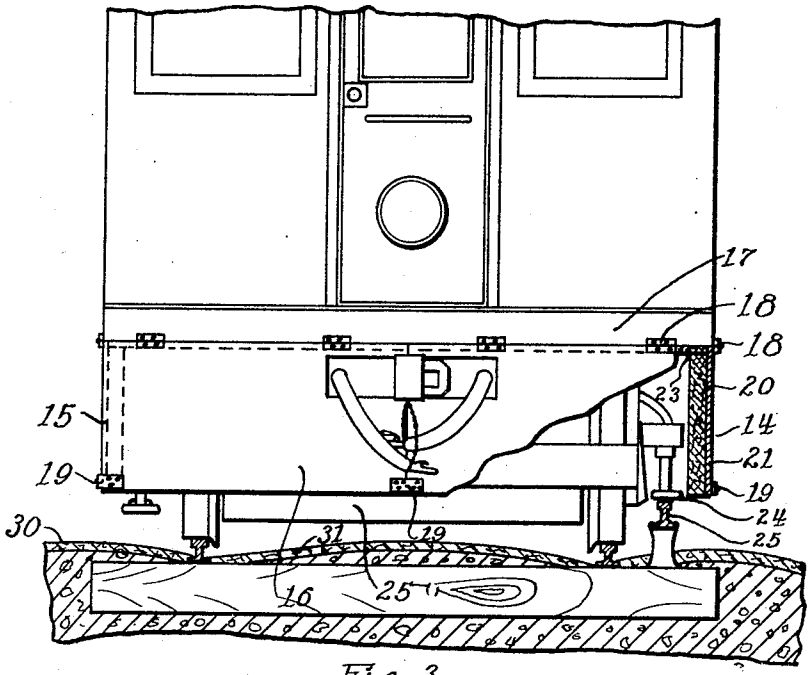
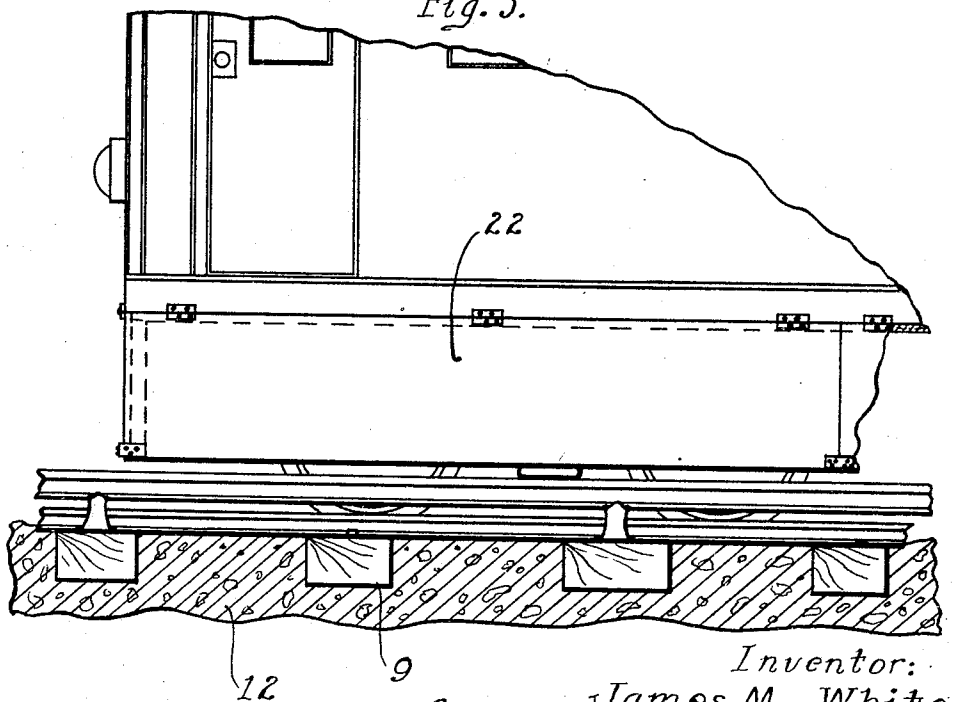


Fig. 3.



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UNITED STATES PATENT OFFICE

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METHOD OF REDUCING SOUND IN SUBWAYS

Application filed August 4, 1930. Serial No. 472,775.

This invention relates to a method of and means for reducing sounds in subways.

In the operation of passenger carrying cars in a subway tube difficulty has been experienced, heretofore, in keeping the noise level in the subway down to a point at which the cars are tenantable by a person. The ordinary methods of reducing noise such as are commonly employed in buildings, auditoriums and the like, cannot well be employed in subway construction. In the first place most of these methods contemplate lining the walls and ceiling of the chamber in which the sound is to be deadened with a porous sound absorbing material. In a subway, this practice is objectionable first from the standpoint of health because of the contact of this absorbent material with germ laden air from which germs could lodge in the material and reproduce rapidly. Then too, dust, dirt and other objectionable particles in the air would then lodge in the porous linings of a subway and render the subway unfit for use as a passenger carrying medium.

The source of the greatest noise in a subway is located under the floor of the cars of the subway trains, that noise being caused by the impact of the wheels upon the rail joints and of the rails on the tie plates, by the action of the gears connecting the driving motor to the wheels of the car, and from the action of the air compressor, brakes and other miscellaneous moving parts usually located under a car of this type.

Previous attempts to reduce the sound in a subway have resulted in the employment of a sound deadening road bed on which the track is mounted in a resilient manner such as by wooden ties supported by a suitable resilient ballast, with the ballast carried well up over the surface of the ties and into the space between the rails. This has eliminated a part of the noise, however, since a good share of the noise generated under the car escapes laterally from the car and is reflected by the walls of the subway until it eventually enters the car, the employment of a sound deadening ballast on the track is not alone sufficient to render the subway as quiet as it is desired that it should be rendered.

Because of the arched ceiling commonly employed in subway construction, the focal point of the sound generated under the car is at a point near the top of the cars and midway between the two cars of a two-track subway. This concentration of sound at this point is particularly disadvantageous since it renders the interior of the cars extremely noisy.

My improved method of reducing the sound in subways and similar structures contemplates confining the sound at its source in so far as it is possible to do so. This may be accomplished in a number of ways, for example, the edges of the floor of the car may be skirted by an apron depending downwardly and terminating at the lowest possible point consistent with satisfactory clearance between the rails and other devices commonly encountered along side the track of a subway system. These aprons are constructed of a sound absorbing material disposed on the car side of the apron and for the sake of appearance and mechanical strength this material may be backed up by a harder plate disposed outwardly of the apron, for example, by a sheet metal plate.

By an arrangement of this kind, a majority of the sound generated underneath the car of a subway train is confined to the space thereunder, where it is absorbed partly by the absorbent material on the interior faces of the aprons and partly by the ballast of the trackway. I also contemplate lining the underside of the car floor with a similar sound absorbing material so that the sound generated under the car encounters sound absorbing material in any direction in which it may travel.

In most instances the employment of sound absorbent aprons of this kind will reduce the noise in the subway sufficiently to render its cars tenantable. In certain instances, the sound deadening ballast material used heretofore may not sufficiently deaden the sound and I therefore contemplate covering the usual ballast of a subway track with a sound absorbing material which may be either placed in there in the form of sheets or may be cast from sound absorbing concrete to be

laid over the ties and adjacent to the rails of the trackway. If desired, the ballast of the trackway may consist of sound absorbing concrete broken up into suitable size blocks which are installed in the same manner as ordinary ballast materials are installed on a trackway.

In case the rolling stock used in the subway is particularly noisy, or in case it is desired to render the subway extremely quiet, I may also employ a sound absorbing roof on the cars of the subway train. For example, a blanket like structure of sound absorbing material may be placed on the outside and over the regular roof of a subway car, this material absorbing the sound waves that are deflected downward from the ceiling of the subway onto the top side of the car. In ordinary circumstances however this expedient may not be necessary since the skirting of the floor of the car to confine the noise that is beneath it will sufficiently deaden the sound to render the subway satisfactorily tenantable.

In carrying out the method of my invention, I contemplate attaching the apron skirts to the car in such a manner that they may be either readily removed to permit inspection maintenance and repair of the various devices located beneath the car floor or may be swung up out of the way to permit similar work upon those devices. In either event, the aprons are securely fastened in place and anchored at their bottom edges by suitable braces depending downwardly from the car floor so that they are rigidly and securely attached thereto.

The roof of the car is covered with a sound absorbing and deadening material; this too must be securely fastened thereto by fastening means which presents a minimum hard surface on the outside so that the maximum possible area of the roof will be covered with a sound absorbing and deadening material. Since subway cars are not exposed to wind and weather to the same extent that surface lines, elevated lines or railroad cars are exposed, the use of a more or less porous material over and above the ordinary weather proof roof of the car is not seriously objectionable.

Now to acquaint those skilled in the art with the teachings of my invention, reference is made to the accompanying drawings in which a preferred embodiment of it is shown by way of example and in which;

Figure 1 is a cross sectional view of a two-track subway showing the relative position of the train therein;

Figure 2 is a partial elevational view of the end of a subway car showing the application of the sound deadening skirt thereto; and

Figure 3 is a partial elevational view of the side of the car showing the application of the sound deadening aprons thereto.

Referring now to the drawings in more detail, customary subway construction employs a circular or semi-circular roof, the center point of which is located between the cars operating therein and approximately coinciding with the roof of these cars. The cars spaced in such a subway in such a manner that the amount of clearance space on the sides of the car is about equal to one-half of the space between the cars.

Such cars are usually motor driven and the motors 1 thereof are located on the truck 2 beneath the floor 3 of the car. Sound generated by these devices under the car is reflected in all directions, part traveling laterally outward against the side wall 4 of the subway where it is reflected upward against the curved ceiling 5 of the subway and is again reflected, eventually striking the focal point 6 located adjacent the roof of the car. The tracks of the subway 7 and 8 are customary steel rails supported upon ties 9 and 10 which are preferably wooden ties supported upon the floor 11 of the subway with a suitable ballast material 12 interposed therebetween.

In practicing the method of my invention I have provided the sides of the cars with sound absorbing skirts 14 and 15 and the ends of the car with similar sound absorbing skirts 16, these skirts being made in convenient size sections which are hinged to the sills 17 of the car in any convenient manner such as by the hinges 18. The hinges 18 are of the type which permit the aprons 14, 15 and 16 to be swung upward to thereby permit inspection of the devices beneath the car and also to permit the aprons 14, 15 and 16 to be completely removed from the car in a convenient manner when it is necessary to perform a major operation thereunder. The bottom edges of the aprons are joined together in any preferred manner such as by the clamps 19, which are bolted to the framework of the aprons to securely hold the bottom sides thereof against vibration and movement as the car travels through the subway.

Preferably these aprons consists of rectangular members supported upon a suitable framework of metal, not shown, and consisting of an interior face 20 consisting of a sound absorbent material. There are a number of such sound absorbent materials on the market, some being composed of vegetable fibers suitably treated and pressed together in the form of rigid sheets which are impregnated to make them moisture proof, vermin proof, and fire resistant. The resultant sheet is a porous structure which possesses certain qualities for absorbing sound. Other forms of sound absorbing materials suitable for use in these aprons consist of sheets made up of wood fibers shaved in the form of excelsior or the like and bound together with a suitable cementitious material which also is

chemically treated to render the sheets moisture proof, vermin proof and fire resistant. Still other forms of sound absorbing material which might be used as an interior face for these aprons consist of a composition composed of clay and cement, which forms a very porous concrete which absorbs an appreciable percentage of the sound waves that are directed against it. The particular type of sound absorbing material is of course capable of being varied within the teachings of my invention, it being sufficient that a suitable material be securely fastened to the framework of the apron in such a manner that it cannot be readily dislodged during the normal operation of the subway car. If the sound absorbing concrete is employed it will preferably be cast on to the frame in such a manner that the frame members themselves form a reinforcement for the concrete structure to thereby give it rigidity and strength and to guard it against the possibility of damage in service.

In order to protect the sound absorbing material from injury due to mechanical blows struck from the outside, I contemplate covering the sound absorbing layer 20 of the apron 14 with a thinner hard layer 21, this layer preferably being of sheet metal although if desired wood or other similar relatively hard material might be substituted therefor. This exterior surface 21 is painted and finished in the same manner as the outside walls of the car so that the addition of the apron 14 to the car does not detract from its appearance.

The aprons 15 and 16 are constructed in the foregoing manner, each being built in as many individual sections as is necessary to form convenient entrances in to the various devices in each car which must be regularly inspected and maintained. For example, the end apron 16 may be conveniently composed of two or more individual panels which may readily be swung up out of the way or completely removed from the car to permit inspection of it.

Preferably the end apron 16 is stream lined to reduce air resistance against it when the car is in motion, and the straight end apron shown in the drawings is shown by way of example only and I am not to be limited to its use.

The side aprons 14 and 15 are preferably composed of a larger number of panels of varying lengths so that any such a panel length forms a door which exposes a device when it is swung out of the way or removed. The end section 22 of the side panel 14 or 15 may be sufficiently long to completely cover the truck of the car so that when it is elevated or removed from the car those trucks are completely available for maintenance and repair.

In many instances, particularly for long cars, it may be advantageous to apply aprons to the car floor in such a manner that they surround only the trucks of the car, leaving the central portion clear and open. A majority of the noise generated under a car is generated in or at the trucks and this plan of skirting is therefor effective to confine the greater part of the noise. Preferably the truck aprons are stream lined at both ends to reduce their air resistance when the car is in motion in either direction.

The sound generated by the hammer of the wheels upon the rail joints and by the action of the gears, motors, pumps, brakes, etc., beneath the car is thus arrested by the sound absorbent wall 20 disposed below the surface of the car. I also, within the teachings of my invention, contemplate covering the undersurface of the floor of the car with a similar sound absorbing material 23 which is suitably attached thereto and serves to absorb sound waves rising directly from the roadbed to the bottom of the car. In certain instances, particularly when the car is being equipped with sound deadening material when it is being built, this sound absorbing material 23 may be in the form of sound absorbing concrete which itself forms the floor of a car, being, of course, protected with a suitable surface coating of hardened concrete upon the interior of the car where the maximum wear occurs. In adding the sound absorbing material 23 to an existing car it may be in any one of the above mentioned forms and may be suitably attached to the under side of the car, either in a permanent or semi-permanent manner which renders it removable should it be necessary to do so when making repairs or adjustments on the car.

The bottom edges of these aprons are disposed in such a manner that they clear obstructions located in their path, such for example, as the third rail 25 of the subway system. It is desirable that the lower edges of these aprons be maintained as close to the ballast of the roadbed as it is possible to do so consistent with safe operation of the train, and since subways are not subjected to snow and sleet as are the more exposed types of railways, this clearance can be made very small with a high degree of safety.

The roadbed upon which ties 9 are laid may consist either of the customary sand and gravel ballast or a cast sound absorbing concrete, or sound absorbing concrete broken up into suitable sized lumps, or to a combination of such arrangement. If it is desired, in addition to this usual form of ballast, suitable sheets 30 and 31 of efficient sound absorbing material may be laid above the customary roadbed between the rails and between the tracks of the subway. If it is desired to render the subway extremely quiet this extra sound absorbing material may be applied, either in the form of a sheet suitably attached

to the ties or the ballast of the roadbed or it may be composed of sound absorbing concrete cast therein.

With a car and roadbed so equipped the sound generated under the car is deflected from wall to wall thereunder and down against the ballast of the roadbed, being partially absorbed each time it encounters a wall of absorbent material, with the result that the noises generated under the car are quite completely damped out and do not reverberate through the arched walls of the subway to cause an undesirable roar inside of the subway cars.

In certain instances, to quiet the noise caused by the movement of the train in the subway, such noises as are generated elsewhere than beneath the car, I also contemplate equipping the roof 40 of the cars with a coating of sound absorbing material 41 which is securely attached thereto and permitted to drop for a short distance over the sides of the car as shown at 43. Noises escaping to the arched ceiling 5 of the subway and deflected downward thereby against the roof of the car are absorbed by this sound-deadening material 41, and the interior of the car is thereby more tenantable. Since the subway car is seldom, if ever, exposed to rain, sleet, snow and the like, the presence of this sound-absorbing material, securely fastened to the roof of the car, is not disadvantageous, nor is its maintenance a serious problem.

The car in this way carries the sound absorbent along with it to deaden the zone through which the car is moving thereby resulting in great economy over the plan of deadening the tunnel surfaces throughout their entire length.

Thus it will be seen that I have provided a method of and means for deadening the sound in a subway or other similar structure without lining the walls of the structure with a sound absorbent material. The sound absorbent material used beneath the cars and on top of the same can be more conveniently disinfected and cleansed periodically than can such material rigidly attached to the interior walls of the subway itself and the method therefore fully complies with the health requirements imposed upon subway operators.

While I have chosen to illustrate my invention in connection with a subway, I have done so by way of example only, as it is applicable in many other instances such as, for example, street railways, elevated railways and the like. The method is capable of practical and economical application to existing railway cars, and such application results in a deadening of the sound to a very satisfactory degree, especially is this true with cars moving over a pavement from which sound waves will be reflected upward and absorbed within the enclosure formed by the aprons. The application of the invention is broad and therefore I am not to be limited to the specific details shown by way of example only.

Having thus complied with the statutes and having shown and described a preferred embodiment of my invention, what I consider new and desire to have protected by Letters Patent is set out in the appended claims.

What is claimed is:

1. The method of deadening the noise in a subway which comprises, confining the noises generated beneath a car to the space beneath that car, and ballasting the road bed between the rails with a sound absorbing material which absorbs such sounds and exposing said material to such sounds.

2. The method of deadening the noise generated by a railway car which comprises, confining the noises generated beneath the car in the space beneath the car, lining the bottom of the car with a sound absorbing material which absorbs a part of that noise and ballasting the road bed on both sides of the rails with a sound absorbing ballast which absorbs another part of said noise.

3. The method of deadening the noise in a subway which comprises, confining the noises generated beneath a car to the space beneath that car, ballasting the road bed on both sides of and between the rails with a sound absorbing material which absorbs such sounds, and covering the roof of such cars with a sound absorbing material which absorbs the sounds reflected to the car roof from the subway ceiling.

4. The method of deadening the noises generated by the operation of trains in a subway which comprises confining the running gear noises in the space between the floor of the cars and the road bed, absorbing a majority of that noise by absorbents placed in that space and on the road bed between the rails and ties thereof, and absorbing noises generated elsewhere on the train by absorbents placed on the roofs of the cars.

5. The combination with a railway car having driving and controlling devices located beneath the floor of the car of a pluralty of aprons skirting the entire floor of the car and depending downward therefrom, each apron comprising a framework, a thick sound absorbing face exposed inwardly therefrom and a protecting face disposed outwardly therefrom, and means for hinging and removably attaching said aprons to the car, said means permitting easy access to the devices below the car for maintenance and inspection.

6. The combination with a railway car having driving and controlling devices located beneath the floor of the car of a plurality of aprons skirting the entire floor of the car and depending downward therefrom, each apron comprising a framework, a thick

sheet of porous sound absorbing material exposed on the car side of said framework, and a thin metallic face disposed on the outside of the framework, and hinges for attaching the aprons to the car.

7. The combination with sound absorbents placed on the roof and as aprons beneath the floor of a car, of sound absorbent ballast sheets for the tracks upon which the car is to be operated, said sheets being adapted to be placed between the rails and ties of the tracks.

8. In combination with a subway car, an apron, comprising a plurality of removable sheets of sound absorbing material hanging downwardly from the frame into juxtaposition to the rails on which the car runs to absorb and deflect the sound waves generated by the mechanisms of the car to the road bed, and a sound absorbing ballast on said road bed said ballast extending in sheets between the ties and between the rails of the road bed.

9. In combination with a subway car, an apron, comprising a plurality of removable sheets each comprising a thick sheet of porous material next to the car and a thin sheet of non-porous material outside thereof and disposed beneath the car to absorb sounds generated thereunder, said thick sheet being exposed next to the car.

10. In combination with a subway car, an apron, comprising a plurality of removable sheets each comprising a thick sheet of sound absorbing material next to the car and a thin sheet of non-porous material outside thereof and disposed beneath the car to absorb sounds generated thereunder, said thick sheet being exposed to sounds under the car.

11. In combination with a subway car having wheel trucks, an apron, comprising a plurality of removable sheets each comprising a thick sheet of sound absorbing material next to the car and a thin sheet of metal outside thereof, disposed beneath and attached to the floor of the car to absorb sounds generated thereunder, said thick sheet being open and exposed on the side opposite the thin sheet for absorbing sounds, the apron being mounted independently of the wheel trucks and extending the entire length of the car.

12. The method of deadening the noise in a subway which comprises ballasting the road bed between the ties and rails thereof with sheets of sound absorbing material.

13. The method of deadening the noises generated by the running gear of a railway coach which comprises insulating the road bed above the ballast thereof and between the ties and on both sides of the rails thereof with sheets of sound absorbent material.

In witness whereof, I hereunto subscribe my name this 31st day of July, 1930.

JAMES M. WHITE.