Dec. 5, 1961 C. E. PFLUG 3,011,914

DIP PAINTING APPARATUS AND METHOD

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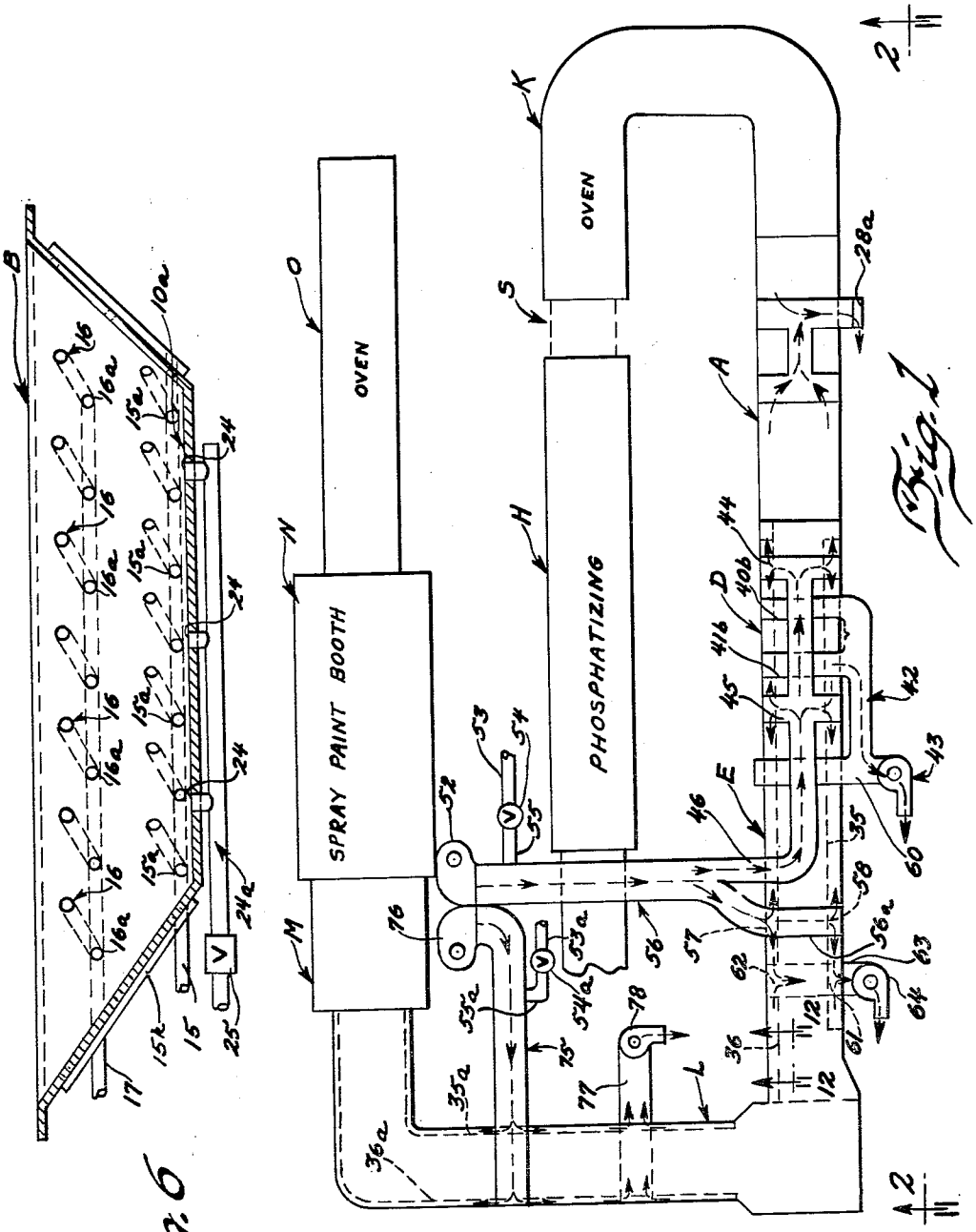


Fig. 1

Fig. 6

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DIP PAINTING APPARATUS AND METHOD

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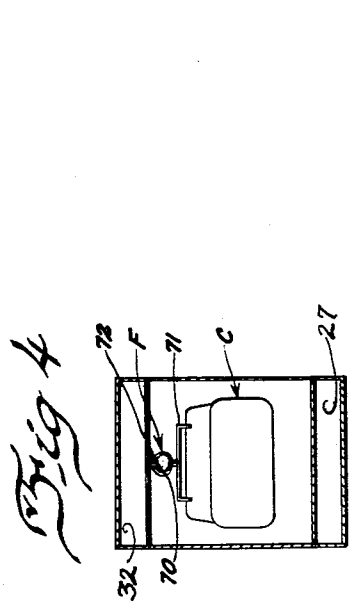


Fig. 4

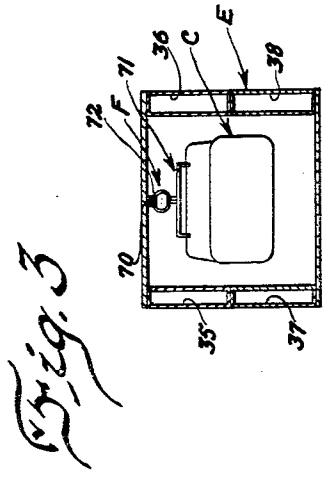


Fig. 3

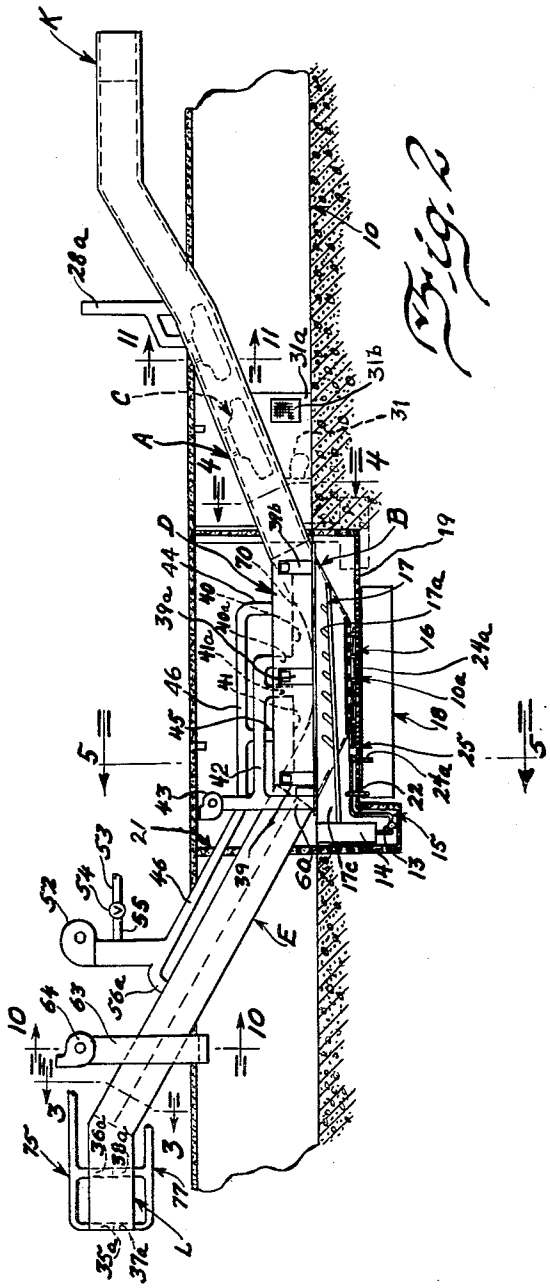


Fig. 2

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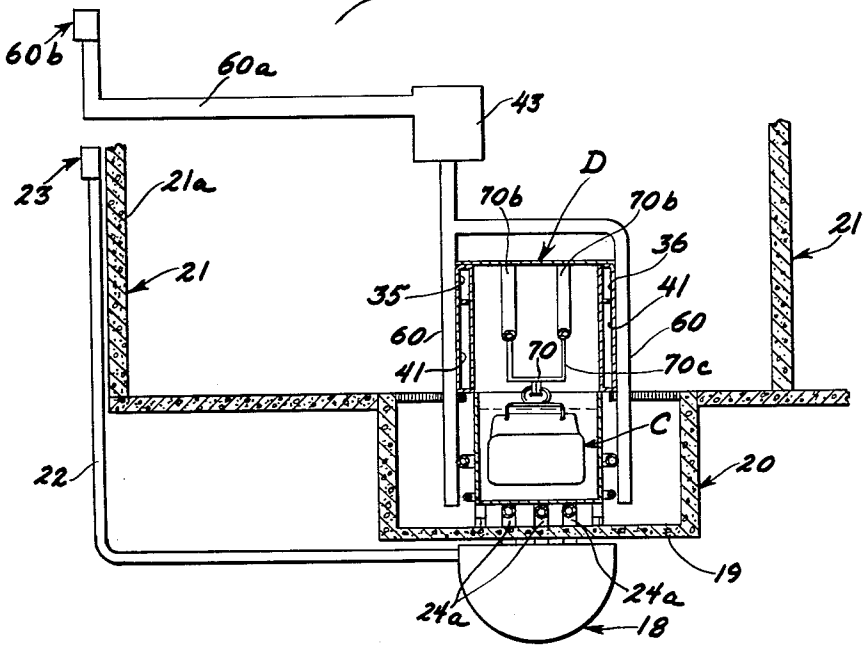
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DIP PAINTING APPARATUS AND METHOD

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Fig. 5



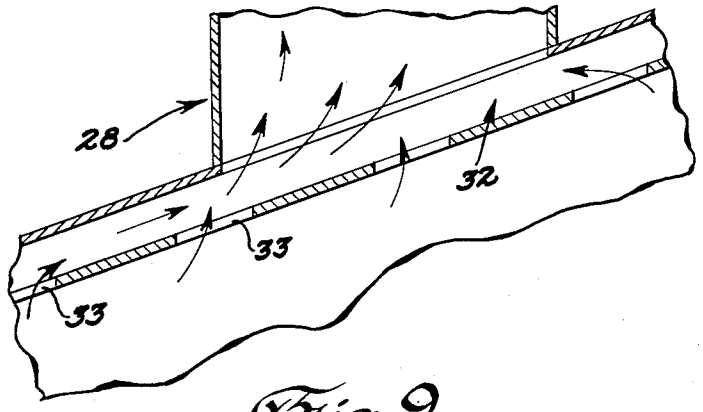


Fig. 9

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DIP PAINTING APPARATUS AND METHOD

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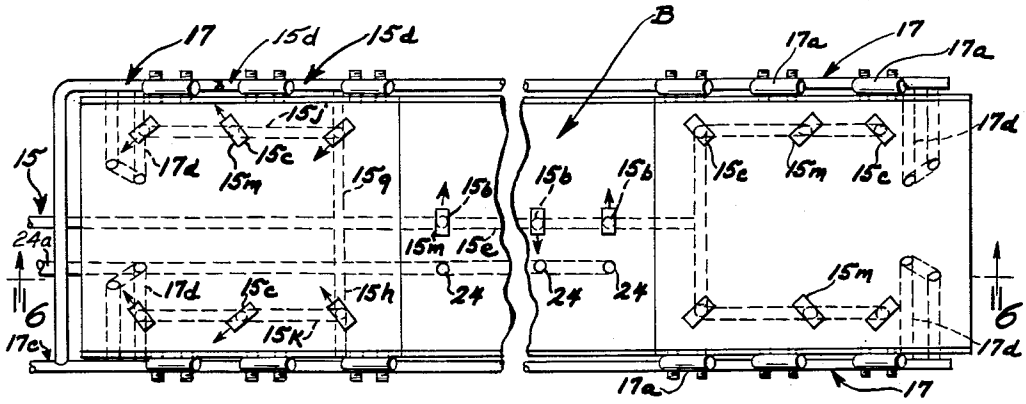


Fig. 7

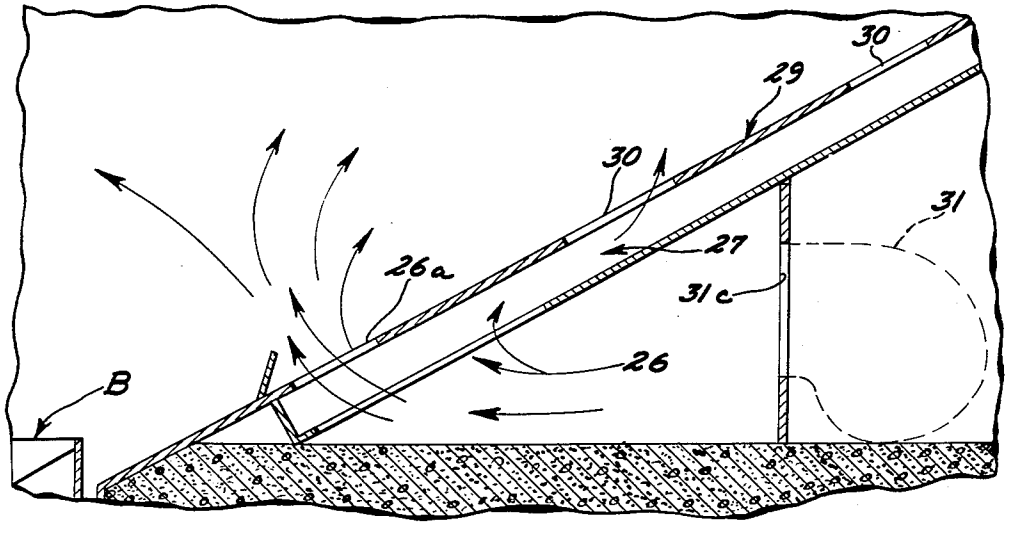


Fig. 8

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DIP PAINTING APPARATUS AND METHOD

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Fig. 10

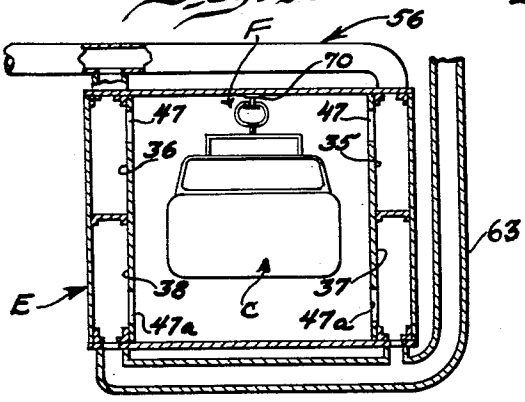
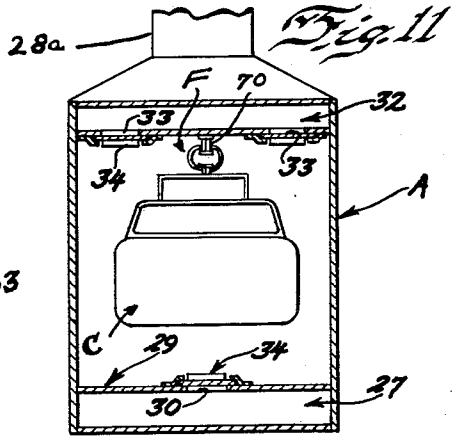


Fig. 11



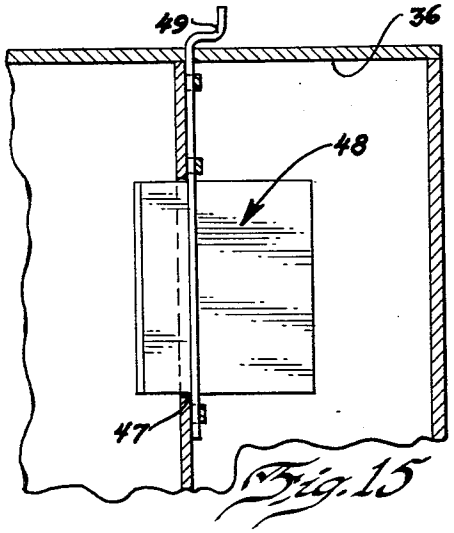
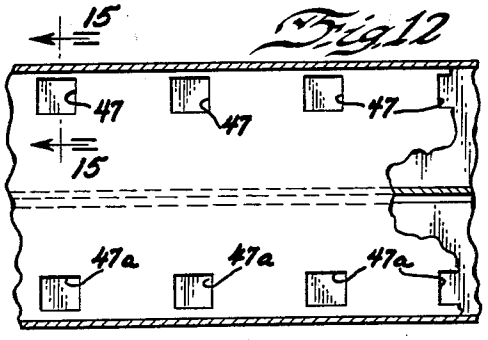


Fig. 15

Fig. 12



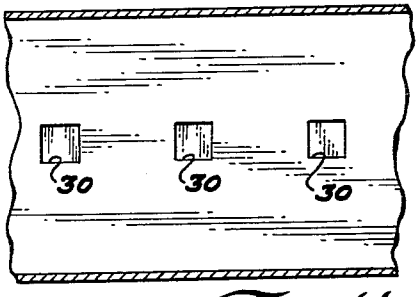


Fig. 14

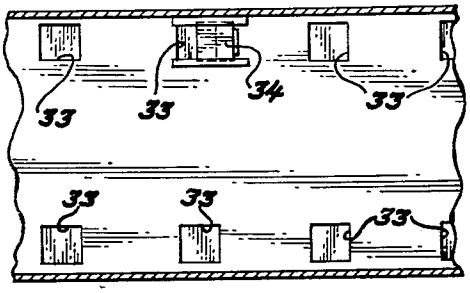


Fig. 13

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United States Patent Office 3,011,914 Patented Dec. 5, 1961

3,011,914

DIP PAINTING APPARATUS AND METHOD

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Filed Dec. 8, 1958, Ser. No. 778,916
6 Claims. (Cl. 117—113)

The invention relates to a method and apparatus for dip painting large objects such as automobile bodies.

The principal object is to control the flow characteristics of the paint on the object after same has been withdrawn from the dip tank, whereby a coating of uniform thickness and free from "sags" and "runs" is obtained.

In dip painting a large object with a type of liquid paint having as one of its ingredients a rather volatile vehicle possessing a generally high evaporation rate, surface evaporation of the vehicle from the painted object may be too rapid wherein a skin is formed and the liquid paint beneath the skin continues to flow (during the draining period) causing a build-up of excess paint beneath the skin—this build-up being referred to as a "sag."

The objective, then, is to promote the proper conditions under which the excess paint on the painted object will continue to flow during a predetermined period of time under conditions in which the surface evaporation rate is controlled to prevent sagging and to achieve a smooth coating of substantially uniform thickness throughout.

Thus, one specific object of the invention is to effect a control of the rate of surface evaporation so that all of the excess paint is permitted to flow from the painted object during the draining period.

Another object is to maintain the paint flowage in a singular direction during the draining period.

A further specific object is to provide a tunnel within which the dip tank is situated—such tunnel being of a generally minimum cross-sectional area with reference to the object to be painted. Thus the paint vehicle vapors in the area surrounding the painted object are confined within as small a cubic volume area as is practical and such vapors are concentrated so as to saturate the atmosphere thereby retarding the rate of surface evaporation of the paint vehicle from the painted object and thereby permitting the excess paint to continue flowing on the painted object a desired amount of time without incurring sags.

A further specific object is to provide a tunnel having entry and exit portions at opposite ends of the dip tank, each of which are inclined at an angle with reference to the floor line in the manner of a V, the dip tank being situated at the apex of the V. The paint vehicle is of a type which, when in a gaseous state, is heavier than the atmosphere and consequently becomes trapped largely within the apex area of the V, thus affording a heavier concentration of the vehicle vapors in the area where the painted object emerges from the dip tank. The degree of concentration of such vehicle vapors progressively decreases as the painted object proceeds up through the exit portion of the tunnel.

A further object is to provide a tunnel having means associated therewith for selectively adding ingredients to the atmosphere within the tunnel in the area surrounding the painted object and thereby aiding in controlling the flow characteristics of the excess paint on the painted object. For example, the addition of another gas which will tend to displace the air in the area surrounding the painted object, will serve to reduce the amount of vehicle evaporated from the painted object—this being accomplished by lowering the capacity of the atmosphere to absorb such vehicle vapors. Such an added gas could be CO_2, CO or other similar gases which will not support

combustion and/or which will not absorb the vehicle vapors. Or it may be desirable to add water vapor in the form of steam or high humidity air to the atmosphere within the tunnel and thereby reduce the amount of vehicle vapors which the air can absorb due to the combination of vapor pressure caused by the water vapor and the paint vehicle vapor.

A still further object is to provide means associated with the tunnel for expediting the evaporation of the paint vehicle on the painted object after the paint has been properly distributed on the surface of the object in the thickness desired—this being accomplished by substantially removing the gas or water vapor as well as the vehicle vapor from the area surrounding the painted object and thereby expediting evaporation of the paint vehicle from the painted object.

A further object is to provide means for substantially preventing escape of the vehicle vapors into that portion of the tunnel leading up to the dip tank, such means also serving for effecting cooling of the object to be painted as it approaches the dip tank.

A further object is to provide a dip painting apparatus having a paint circulation system wherein the likelihood of accumulation of surface scum and any other dirt particles in the paint is greatly lessened.

Other objects and advantages of the invention will be apparent from the ensuring specification and from the drawings in which:

FIG. 1 is a schematic plan view of a painting system incorporating the inventive subject matter with certain details omitted.

FIG. 2 is a schematic side elevational view of a portion of the system of FIG. 1 taken from the side thereof as indicated by the line **2—2**.

FIG. 3 is a schematic sectional view through the tunnel, taken on the line **3—3** of FIG. 2 and with certain details omitted.

FIG. 4 is a schematic sectional view through the tunnel, taken on the line **4—4** of FIG. 2 and with certain details omitted.

FIG. 5 is a schematic sectional view taken on the line **5—5** of FIG. 2.

FIG. 6 is a detailed schematic sectional view of the dip tank and associated plumbing taken on the line **6—6** of FIG. 7.

FIG. 7 is a schematic plan view, broken in section, of the dip tank and certain associated parts.

FIG. 8 is a schematic sectional view of the lower portion of the cooling tunnel adjacent the dip tank.

FIG. 9 is a fragmentary sectional detail view of a portion of the cooling tunnel generally remote from the dip tank.

FIG. 10 is a schematic sectional view of the tunnel taken on the line **10—10** of FIG. 2.

FIG. 11 is a schematic sectional detail view of the tunnel taken on the line **11—11** of FIG. 2.

FIG. 12 is a fragmentary sectional detail view of a typical portion of the tunnel taken on the line **12—12** of FIG. 1.

FIG. 13 is a fragmentary sectional detail view of a typical portion of the cooling tunnel and taken on the line **13—13** of FIG. 2.

FIG. 14 is a fragmentary sectional detail view of a portion of the cooling tunnel taken on the line **14—14** of FIG. 2.

FIG. 15 is an enlarged fragmentary sectional detail view taken on the line **15—15** of FIG. 12.

At the outset it should be noted that many views of the drawings are of a schematic nature—the intention being to generally illustrate the details of the inventive subject matter rather than to present a true pictorial reproduction of the commercial embodiment thereof. For ex-

ample, the commercial embodiment of the plumbing associated with the dip tank contemplates the use of various types of fittings for interconnecting various tributary pipes with main pipes and the details of such fittings are shown schematically. Also, various air ducts and fittings therefor are shown schematically for simplifying an understanding of the invention.

Additionally, no attempt has been made in the drawings to follow a given scale—for example, the wall thicknesses of the panels which make up the tunnel walls are greatly exaggerated in proportion to the actual size of the tunnel. The same is true of the wall thicknesses of the air ducts and the plumbing pipes and other parts of the inventive subject matter.

In general the apparatus for effecting the dip painting comprises a closed cooling tunnel A leading up to a paint filled dip tank B of sufficient depth to permit complete submergence of the object to be painted C (hereinafter sometimes identified as an automobile body). The dip tank is situated interiorly of the enclosed tunnel portion D which is connected to the closed exit or drip tunnel E. The automobile bodies are suspended from an endless conveyor F and move continuously through the tunnel at a predetermined rate of speed, each such body being submerged in the liquid paint contained in the dip tank B and then emerging therefrom—the excess paint draining by gravity from such bodies while they are travelling up through the exit tunnel E.

Referring to FIG. 1 there is shown a plan view of a suitable painting system incorporating the inventive subject matter and such a system includes a section of tunnel H within which the automobile body C undergoes a treatment known in the trade as "bonderizing" (an undercoating which precedes the prime paint coating)—in a complete body treatment system the body would undergo cleaning before being "bonderized." After bonderizing, the body travels through an oven K before entering the cooling tunnel A. After the body leaves the "drip" tunnel E, it passes through tunnel section L (which lies in a horizontal plane) where the painted body continues draining the excess paint to some extent from the lowermost areas of the body. The body then enters an enlarged tunnel area M where any minor "touch up" or "correcting" work is done, after which it enters a painting booth N where additional spray painting of certain critical areas is accomplished (in an automobile body it is desirable to add an extra prime coat of paint under the wheel housings). The body then passes through an oven O. Following this the body undergoes application of a finishing coat of paint—the apparatus for accomplishing this not being shown herein, since it forms no part of the inventive subject matter.

The entry or cooling portion of the tunnel A may be inclined at an angle of approximately 30°, plus or minus 5°, with reference to the horizontal floor line **10**. The tunnel section A is a continuation of the tunnel section K and the first "break" in the continuity of the tunneling occurs at S. Commencing at the location S, the tunneling is closed and continuous through the successive tunnel sections K, A, D, E, L, M, N and the oven O. The tunnel section A serves as a cooling tunnel as will be explained more fully hereinafter.

The cooling tunnel merges with the horizontal tunnel section D which is situated directly above the dip tank B. The tank is, of course, open at the top and the side walls of the tank in conjunction with the side walls of the tunnel section D form a closed tunnel above the dip tank preventing escape of vapors except within the interior of such tunnel.

The exit end of the tunnel D merges with the exit or "drip" tunnel E which is inclined at an angle of approximately 30°, plus or minus 5°, with reference to the horizontal floor line **10**. The exit tunnel merges with the closed horizontal tunnel section L as previously explained.

The paint in the dip tank is, of course, in liquid form and of a predetermined viscosity. The paint formula includes as some of its ingredients a pigment along with a liquid vehicle which carries the pigment—the vehicle including a suitable paint thinner which evaporates into the atmosphere at a rate which is dependent upon the conditions existent in the atmosphere. The paint is continuously circulated by means of a pump **13** which receives the paint from the over-flow tank **14** and pumps same through suitable pipes **15** which open into the dip tank at or just above the floor level **10***a* thereof. Thus the fresh paint enters the dip tank near the bottom thereof and leaves the dip tank at the level of the paint within such dip tank through the drain openings **16** which are cut in the side walls of the tank and which communicate with the return pipes **17** leading to the over-flow tank **14**. The drain openings are large enough to pass any material that might be floating on the surface of the paint.

FIGS. 2, 5, 6 and 7 disclose the plumbing details in a schematic manner. There are two sets of drain openings **16** and **16***a*, either set of which may be selected, depending upon the desired paint level in the dip tank. The lowermost set of openings **16***a* are closed off by any suitable means (not shown) when it is desired to raise the paint level to the uppermost set of openings **16**. Individual pipe sections **17***a* connect the openings **16** with the primary drain pipes **17**. It will be noted that a primary drain pipe is provided at each of the side walls of the dip tank since there are similar sets of drain openings on each side of the tank. Each of the drain pipes **17** may communicate with the trunk line **17***c* leading to the over-flow tank **14**. The end walls of the dip tank may be provided with sets of drain openings served by the tributary drain pipes **17***d*. A number of paint inlet openings may be provided as shown in FIGS. 6 and 7, a series of such openings **15***a* being situated in each of the side walls of the tank and additional openings **15***b* and **15***c* being situated in the floor and in the inclined end walls respectively of such tank. The openings **15***a* are served by primary feed pipes **15***d* extending alongside of the tank side walls. The openings **15***b* and **15***c* are served by the principal feed pipe **15** through tributary pipes **15***e*, **15***f*, **15***g*, **15***h*, **15***j* and **15***k*, as shown in FIG. 7. The pipes **15***d* may be served by the pipes **15***g* and **15***h*. The trunk pipe **15**, as has previously been pointed out, leads to the pump **13**. The inlet openings in the floor and in the end walls of the tank are preferably provided with housings **15***m* which are in the form of half cylinders, closed at one end, for directing the flow of the paint as it enters the tank in the desired directions as indicated by the various arrows in FIG. 7.

The over-flow tank has filters therein (not shown) which filter the paint coming from the dip tank before such paint is returned to the dip tank via the pump **13** and pipes **15**. A dump tank **18** is situated beneath the dip tank and also beneath a fire proof floor **19** which serves as the floor of the fire proof pit **20** within which the dip tank is received. The dip tank and the associated tunnel D is preferably housed within a fire proof enclosure identified generally by the numeral **21**. The dump tank **18** is provided with a vent pipe **22** which preferably exhausts at **23** outside of the enclosure **21**. The dip tank is provided with a number of emergency drain openings **24** which are situated in the tank floor and which communicate with the drain pipe **24***a* which opens into the dump tank. The drain pipe **24***a* is provided with control valves **25** which are opened in response to a predetermined temperature condition within the tunnel D by means of temperature responsive apparatus not shown herein. In the event of a fire occurring within the tunnel D, the rise of temperature within the tunnel occasioned by the flames would result in the opening of the valves **25** and the consequent draining of the paint from

the dip tank into the dump tank within the space of a few minutes.

In order to prevent, as nearly as possible, the movement of the paint vehicle vapors up through the tunnel section A, a stream of forced air is directed into the tunnel in the area adjacent to the entry end of the tunnel section D. Referring to FIGS. 8 and 9 the floor of the tunnel may be provided with a suitable opening **26**. A portion of the air passing through opening **26** travels directly into the tunnel through opening **26***a* and the remaining portion travels into the duct **27** which extends along the floor of the tunnel, terminating in the vicinity of the exhaust stack **28**. The upper wall **29** of the duct is provided with a series of discharge openings **30** throughout its length (as best viewed in FIG. 8) for discharging cooling air from the blower **31** into the interior of the tunnel to assist in cooling the automobile bodies as they pass through the tunnel section A. The blower **31** may be housed within an enclosure **31***a* which has filters **31***b* for filtering the air entering the enclosure under the inducement of the blower. The blower directs forced air through the enclosure wall opening **31***c* and thence through opening **26** as previously described.

An additional duct **32** extends along the roof of the tunnel section A communicating with the exhaust stack **28**. This exhaust duct is likewise provided with a series of openings **33** (as best viewed in FIG. 9) to receive the air within the tunnel, after it has passed over the automobile bodies, for eventual discharge through the stack **28**. Each of the duct openings **30** and each of the duct openings **33** is controlled by a damper **34** for selectively closing off as many openings as desired in effecting control of the air flow through the tunnel A. Only one of such dampers, for illustration purposes, is shown in FIG. 13—it being understood that similar dampers will be provided for each of the openings shown in FIGS. 13 and 14.

Since the air which is traveling through tunnel A toward stack **28** becomes heated when passing the automobile bodies, the normal direction of flow is upwardly into the stack **28**—the flow being enhanced by the conventional venturi effect at the outlet **28***a* of the stack. The blower **31**, of course, contributes to the air flow through the tunnel A and the stream of air which is directed into the tunnel through the opening **26** will be sufficiently turbulent as to interfere with and substantially prevent movement of the vapors from the tunnel section D into the tunnel section A. The concentration of the paint vehicle vapors is desired within the tunnel section D and within a portion of the exit tunnel E but not in tunnel A as will be more fully explained hereinafter.

The tunnel section E is provided with fresh air and exhaust ducts **35**, **36**, **37** and **38** respectively at each of its side walls—such ducts preferably extending throughout the full length of the tunnel section. The tunnel section L is likewise provided with fresh air and exhaust ducts **35***a*, **36***a*, **37***a* and **38***a* respectively of a construction similar to those in the tunnel section E (see FIG. 2)—such ducts preferably extending throughout the length of the tunnel section, as indicated in dotted lines in FIG. 1. With reference to tunnel section D, both the front and rear walls of which are provided with doors **39**, **39***a* and **39***b* (the rear wall doors not being shown), the ducts are arranged as follows. The exhaust (lower) duct in each wall is in two sections **40** and **41**—one section on either side of the center door **39***a*. On either side of the center door the exhaust duct of each section extends up at **40***a* and **41***a* to the roof of the tunnel and opens into the ducts **40***b* and **41***b* which extend across the tunnel exteriorly thereof and open into a common exhaust duct **42** leading to the blower **43**. A discharge duct **60***a* may extend from the blower **43** to atmosphere at **60***b* so that the vapors are exhausted outside of the building. Each fresh air duct in the front and rear walls is likewise in two sections, each section commencing at its respective end door and terminating short of the respective side edges of the center door. The fresh air duct sections on one side of the center doors open into the duct **44** and those on the other side open into duct **45**. The principal duct **46** supplies each of the ducts **44** and **45**.

Each of the fresh air ducts within the tunnel sections D, E and L is provided with a series of openings **47** (see FIGS. 10, 12 and 15) situated near the roof of the respective tunnel sections and being spaced apart about 30 inches, more or less. The openings are provided throughout the length of the respective ducts and each such opening is provided with a suitable damper **48** for selectively opening or closing off communication between the interior of the duct and the interior of the tunnel through that particular opening. A damper illustrative of the type employed with each opening is shown in detail in FIG. 15, such damper being operable exteriorly of the tunnel by means of a suitable handle **49**. The fresh air ducts and the openings **47** thus permit the entry of fresh air into the interior of the tunnel sections D, E and L at any of a wide range of locations within such tunnels.

Each of the exhaust ducts within the tunnel sections D, E and L are likewise provided with openings **47***a* situated near the floor level of the tunnel sections so that vapors or other gases within the interior of the tunnel sections can be exhausted therefrom at a low level. Since the paint vehicle vapors within the tunnel are heavier than air, they will be most greatly concentrated near tunnel floor level and hence will be most effectively withdrawn from the tunnel with floor level exhaust openings. Each one of the exhaust openings **47***a* is provided with a damper of the type shown in FIG. 15 for selectively closing off the opening (as has been explained hereinbefore with reference to the air inlet openings). The addition of moisturized air into the tunnel or the exhausting of vapors from the interior of the tunnel will depend upon several factors, the overall objective being to condition the atmosphere within the tunnel sections D and E in such a manner as to obtain the desired flow characteristics of the paint on the automobile body after it emerges from the dip tank.

On some days the humidity of the atmosphere will be considerably higher than on other days and the temperature of the atmosphere during the summer months will, of course, differ from the temperature during winter months. The atmospheric conditions will determine the use or non-use of the fresh air and exhaust ducts or portions thereof.

The paint mixture likewise is a factor which must be taken into consideration particularly with reference to the evaporation rate of the paint vehicle and the viscosity of the paint. Under conditions in which the atmosphere has relatively low humidity and above normal temperatures, it may be desirable to lower the rate of evaporation of the paint vehicle vapors within the tunnel sections D and E, in which case the addition of water vapor can be effected by opening several of the dampers in the fresh air ducts to permit the water vapor to enter the interior of the tunnels. A blower **52** may be situated at the entrance of the main fresh air inlet duct **46** and steam may be introduced into such duct from a suitable source (not shown) through the pipe **53**, valve **54** and pipe **55**. The steam will be carried along through the main duct **56** and enter the tunnel ducts **35** and **36** through duct **56***a* at inlet point **57** or at the inlet point **58**. If the dampers in the ducts **35** and **36** are open, then the steam will enter the tunnel E at the various inlet openings **47** throughout the length of the tunnel. If some or all of the dampers in the fresh air ducts in tunnel D are open then the steam will be carried through duct **46** to branch ducts **44** and **45** and thence into the interior of tunnel D. The exhaust ducts **37** and **38** open into the exhaust duct **60** at the lower end of the tunnel section E and also at the locations **61** and **62** with the exhaust duct **63**. A suitable blower **64** pulls the exhaust air through the duct **63**

and blower **43** pulls the exhaust air through the ducts **42** and **60** from whence they may be exhausted through a suitable stack not shown.

The addition of water vapor into the tunnel in the vicinity of the painted object will lower the evaporation rate of the paint vehicle vapors by reducing the amount of the vehicle vapors which the air within the tunnel can absorb due to the combination of vapor pressure caused by the water vapor and the paint vehicle vapors. The addition of another form of gas, which will tend to displace the air, will also reduce the amount of paint vehicle evaporated from the painted object and this type of gas may be CO_2, CO or other similar gases which will not support combustion and/or which will not absorb the paint vehicle vapors. In some instances it may be desirable to slow up the evaporation rate of the vehicle vapors near the lower end of tunnel E and as the painted object nears the upper end of such tunnel, it may be desirable to speed up the evaporation rate, in which case exhausting through ducts **37** and **38** may take place near the upper end of the tunnel while additives are being introduced through ducts **35** and **36** near the lower end of the tunnel.

By inclining the drip tunnel E, the excess paint drains in a path which is generally diagonally across the automobile body toward the rear end thereof. The length of the inclined drip tunnel is such that most of the draining of the excess paint from the automobile body is completed sufficiently to prevent the formation of "sags" and while the automobile body is traveling up through the drip tunnel at a constant angle of inclination, the excess paint flows across the body in a singular direction, thereby further preventing the possibility of "sags." The direction of flow of the excess paint across the automobile body is, of course vertical, being occasioned as the result of gravity, and when the automobile body reaches the point where it commences to enter the horizontal tunnel section L, then any further paint flowage would be in a different direction relative to the body due to changing the position of the automobile body into a horizontal path. The excess paint, however, has been sufficiently drained from the automobile body prior to its shifting from an inclined position into a horizontal position as it enters tunnel L. Any drainage that takes place within tunnel L simply involves a minor amount of excess paint which is situated at the lowermost edges of the automobile body.

The floor area of the drip tunnel E and the floor area of tunnel section L is preferably provided with coverings (not shown) for catching the excess paint drippings—such coverings being replaceable periodically as desired.

As previously mentioned herein the automobile bodies are suspended from an endless conveyor and move through the various tunnel sections at a predetermined rate of speed. Referring to FIGS. 2, 3, 4, 10 and 11 there is shown one form of conveyor apparatus which includes a stationary rail **70** which may be secured to the roofs of the various tunnel sections substantially midway between the side walls thereof. Each automobile body is removably carried by a fixture **71** which has suitable rollers **72** which ride on the rail **70** as best shown in FIGS. 3 and 4.

Viewing FIG. 2 it will be noted that only two automobile bodies C are shown (in dotted lines)—it being understood that during normal operation there will be a large number of such bodies suspended from the conveyor in successive fashion substantially equally spaced from each other as they progress through the succession of tunnels H through O.

The tunnel section L, as has been briefly explained hereinbefore, is provided with fresh air intake ducts **35***a* and **36***a* and exhaust ducts **37***a* and **38***a* of the type which have previously been described in detail in connection with tunnel section E. These fresh air intake ducts and exhaust ducts are likewise provided with a series of inlet and exhaust openings similar to the openings **47** and **47***a* respectively as shown best in FIG. 12 each of which is controlled by a damper of the type shown in FIG. 15. These inlet and exhaust openings and the dampers therefor operate in the same manner and serve the same functions as has previously been explained with reference to the corresponding components of tunnel sections D and E. The fresh air intake ducts may be served with a primary duct **75** and a blower **76** may be provided for pushing the fresh air supply through duct **75** and on into the tunnel ducts **35***a* and **36***a*. A suitable conduit **53***a*, valve **54***a* and conduit **55***a* may be utilized to serve the same functions as the corresponding components **53**, **54** and **55**. It will be understood that the conduit **53** and valve **54** could be arranged so as to additionally serve the duct **75**, if desired. The exhaust ducts **37***a* and **38***a* may communicate with a primary exhaust duct **77** and a blower **78** may be utilized for pulling the exhaust air from the interior of the tunnel section L in the same manner as has been explained with reference to the exhausting of the air from the ducts **37** and **38** in tunnel section E.

It has been previously explained that the paint within the dip tank is continuously circulated, being drained from the tank through drain pipes **17** and reentering the tank through the inlet pipes **15**. By introducing the paint into the dip tank near the floor level thereof and then draining the paint from the dip tank at the surface level of the paint, it is possible to substantially prevent the formation of any scum at the upper surface of the paint within the dip tank, thereby assuring that a minimum of foreign material will be deposited on the automobile bodies as they emerge from the dip tank. The introduction of the paint at floor level also minimizes the possibility of sludge formation on the tank floor.

Under some conditions of operation it is not necessary to utilize the inlet air ducts or the exhaust ducts—all of the dampers in tunnels D and E therefore being closed. Under such conditions it is necessary to retard the evaporation rate of the paint vehicle on the painted object after it emerges from the dip tank. This can be accomplished by restricting the cubic volume of the interior of the tunnel—particularly in the area above the dip tank and in drip tunnel E—to a relatively small area so as to adequately confine the evaporated paint vehicles. The degree of saturation of the atmosphere in the interior of tunnel sections D and E with vehicle vapors is such that the rate of evaporation of the paint vehicle from the surface of the painted object is retarded, thereby permitting the excess paint on the object to continue flowing until the desired coating free of sags and of substantially uniform thickness is obtained. The V shape presented by the combined tunnel sections A, D and E assures that the degree of saturation of the atmosphere with vehicle vapors is greatest within tunnel section D and at the lower end of tunnel section E—such vehicle vapors being heavier than air and thus concentrating more heavily at the lower levels within the tunnel. The rate of evaporation is thus slower where the painted object emerges from the dip tank than, for example, at the upper end of tunnel section E. By the time the painted object reaches the upper end of tunnel section E the rate of evaporation increases as has been previously explained herein.

In an installation for painting automobile bodies it has been found that a tunnel having inside dimensions of approximately 8 feet in heighth and 8 feet in width will provide the necessary confined area for effecting the required vehicle vapor saturation of the atmosphere within the tunnel. It will be understood that the cubic volume of a given length of object to be painted in proportion to the cubic volume of a comparable length of tunnel will vary considerably in accordance with whether the object to be painted is of a hollow nature or of solid construction. Thus in the case of an automobile body (which is of hollow construction) the cubic volume of

area displaced thereby would be several times less than the cubic volume of a section of tunnel equal in length to the length of the automobile body. It is, of course, necessary to provide a tunnel with a cross sectional area sufficient to accommodate the external dimensions of the object being painted even though the cubic volume displaced by such object might be several times less than the cubic volume of a given length of the tunnel accommodating such object. The general objective is to confine the cross sectional area of the tunnel as much as is reasonably possible.

Referring to FIGS. 2 and 5 it will be understood that the structure which supports the conveyor rail **70** must project downwardly into the interior of the tunnel section D in order that the automobile body being painted can be submerged into the paint in the dip tank. Such structure may consist of suitable beams **70***a* and **70***b* which carry the hanger structure **70***c* to which the rail **70** is secured. The path which the rail **70** follows within the tunnel section D is generally indicated in dotted lines in FIG. 2.

I claim:

1. A method of applying a coating of paint of substantially uniform thickness onto the surface areas of a comparatively large object, such paint being in a liquid form and having as one of its ingredients a vehicle in liquid form and having an evaporation rate greater than water and such paint being stored in a reservoir and the reservoir being housed in a tunnel open at its ends, such tunnel having inclined entry and exit portions emanating from opposite ends of the reservoir and the entry and exit portions of the tunnel together with that portion of the tunnel housing the reservoir establishing an enclosed and confined area of the tunnel, such method comprising the steps of: moving the object to be painted through the entry portion of the tunnel toward the reservoir; then immersing the object into the liquid paint in the reservoir; then withdrawing the object from the paint and moving it through the tunnel until the object is completely withdrawn out of the liquid paint in the reservoir; and then adding an ingredient in fluid form into the atmosphere within the tunnel to intermingle with such atmosphere for aiding in controlling the rate of surface evaporation of the vehicle of the paint on the object and simultaneously causing a concentration of the vehicle vapors which have evaporated from the vehicle in the paint in the reservoir to be trapped in the enclosed and confined area of the tunnel and continuing to move the object through the exit portion of the tunnel away from the reservoir.

2. A method of applying a coating of paint of substantially uniform thickness onto the surface areas of a comparatively large object, such paint being in a liquid form and having as one of its ingredients a vehicle in liquid form and having an evaporation rate greater than water and such paint being stored in a reservoir and the reservoir being housed in a tunnel open at its ends, such tunnel having inclined entry and exit portions emanating from opposite ends of the reservoir and the entry and exit portions of the tunnel together with that portion of the tunnel housing the reservoir establishing an enclosed and confined area of the tunnel, such method comprising the steps of: moving the object to be painted through the entry portion of the tunnel toward the reservoir; then immersing the object into the liquid paint in the reservoir; then withdrawing the object from the paint and moving it through the tunnel until the object is completely withdrawn out of the liquid paint in the reservoir; causing a heavy concentration of the vehicle vapors which have evaporated from the vehicle in the paint in the reservoir to be trapped in the enclosed and confined area of the tunnel; then adding water vapor into the interior of the tunnel for intermingling with the atmosphere and regulating the temperature conditions of the atmosphere within the tunnel, whereby the rate of surface evaporation of the vehicle of the paint on the object is controlled within predetermined limits; and continuing to move the object through the exit portion of the tunnel away from the reservoir.

3. Apparatus for dip painting a large object comprising: an elongated tunnel having a vertex area and entry and exit portions each inclined upwardly and divergently from such area at an angle between 25 and 35 degrees; a reservoir in the tunnel and situated in the vertex area thereof; a supply of liquid paint in the reservoir and having as an ingredient a vehicle having a higher evaporation rate than water and after transformation into a gaseous form having a higher specific gravity than air; means for retarding the rate of evaporation of the paint vehicle from the painted object after such object is withdrawn from the reservoir; said means including the trapping of the vehicle in a concentrated gaseous form within the vertex area of the tunnel and within the adjacent inclined entry and exit portions of the tunnel, such trapping being occasioned as a result of the gaseous vehicle being heavier than air and the interior of the tunnel in the vertex area being at a lower level than a substantial portion of the interior of the inclined entry and exit portions of the tunnel, said elongated tunnel throughout the vertex area and throughout the inclined entry and exit portions normally being substantially closed for preventing escape of gases from within the tunnel and blower means associated with the entry portion of the tunnel, the entry portion of the tunnel having an opening in one wall thereof for establishing communication between the blower means and the interior of the tunnel whereby forced air can be directed into the interior of the tunnel toward the vertex area above the reservoir and into contact with the gaseous vehicle for retarding its flow from the vertex area into the inclined entry portion of the tunnel.

4. Apparatus for dip painting as set forth in claim 3 wherein the blower means also serves to provide a supply of cooling air into the entry portion of the tunnel for assisting in lowering the temperature of the object to be painted.

5. Apparatus for dip painting a large object comprising: an elongated tunnel having entry and exit portions each inclined upwardly and divergently from a vertex area at an angle between 25 and 35 degrees; a reservoir in the tunnel and situated in the vertex area thereof; a supply of liquid paint having as an ingredient a vehicle having a higher evaporation rate than water and after transformation into a gaseous form having a higher specific gravity than air; means for regulating the rate of evaporation of the paint vehicle from the painted object after such object is withdrawn from the reservoir, said means including the trapping of the vehicle in a concentrated gaseous form within the vertex area of the tunnel and within the adjacent inclined entry and exit portions of the tunnel, such trapping being occasioned as a result of the gaseous vehicle being heavier than air and the interior of the tunnel in the vertex area being at a lower level than a substantial portion of the interior of the inclined entry and exit portions of the tunnel, said elongated tunnel throughout the vertex area and throughout the inclined entry and exit portions normally being substantially closed for preventing escape of gases from within the tunnel and said means also including inlet and exhaust ducts extending alongside of a wall of the tunnel, said tunnel wall having openings therein for establishing communication between the interior of the inlet and exhaust ducts and the interior of the tunnel, whereby an added ingredient in fluid form may be introduced into the interior of the tunnel via the inlet duct for intermingling with the atmosphere within the tunnel and whereby the atmosphere within the tunnel may be exhausted therefrom via the exhaust duct.

6. Apparatus as set forth in claim 5 wherein dampers are mounted in the ducts for selectively controlling the

establishing of communication between the interior of the ducts and the interior of the tunnel.

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