Feb. 27, 1973 E. A. BUSSE ET AL 3,718,131

VACUUM COLLAR FOR ROOFING KETTLES AND THE LIKE

Filed Feb. 7, 1972 3 Sheets-Sheet 1

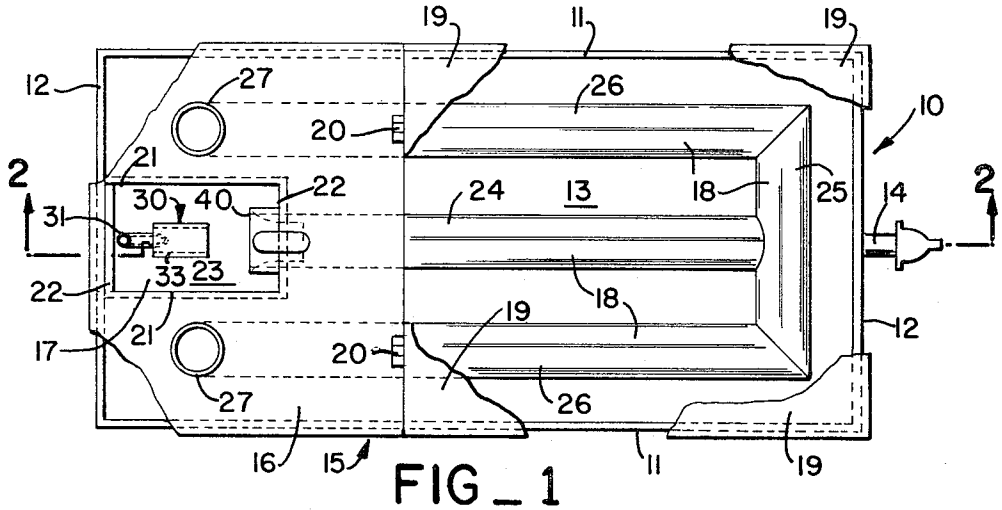


FIG_1

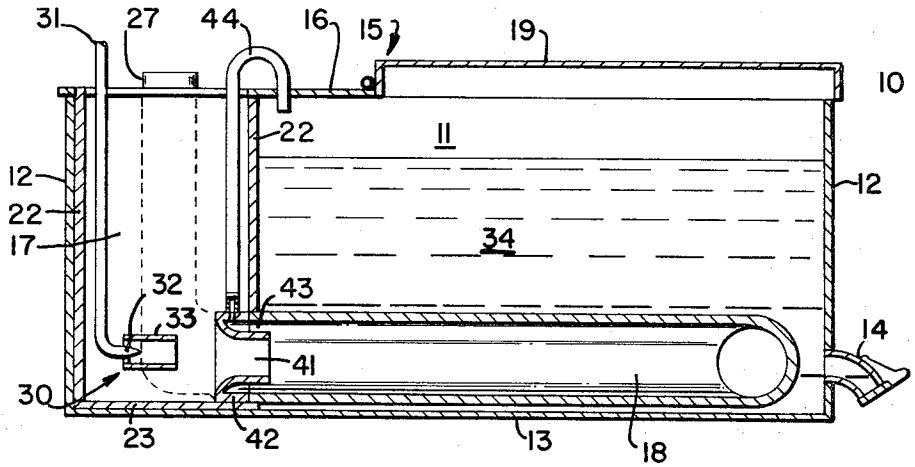


FIG_2

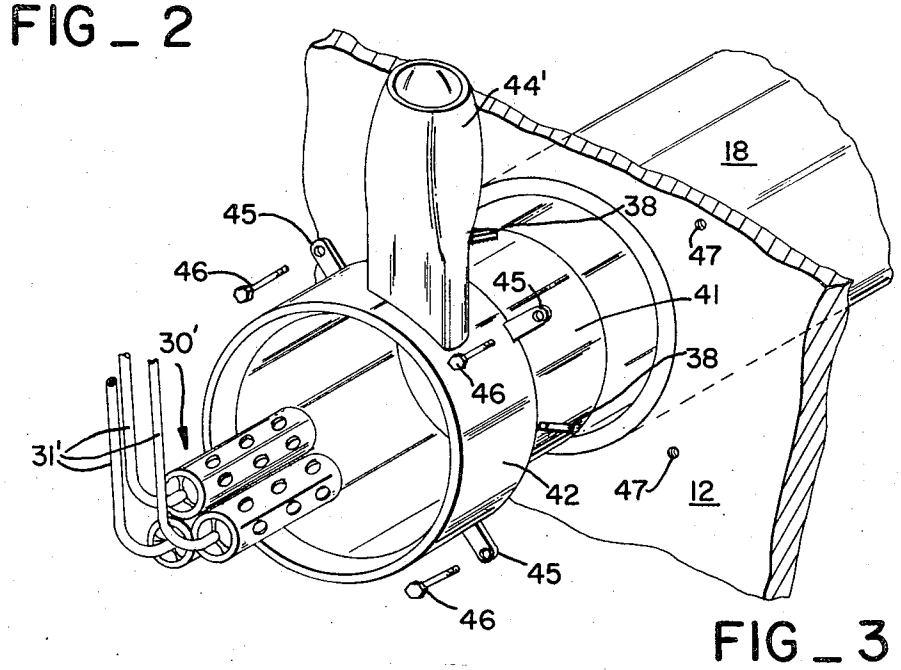
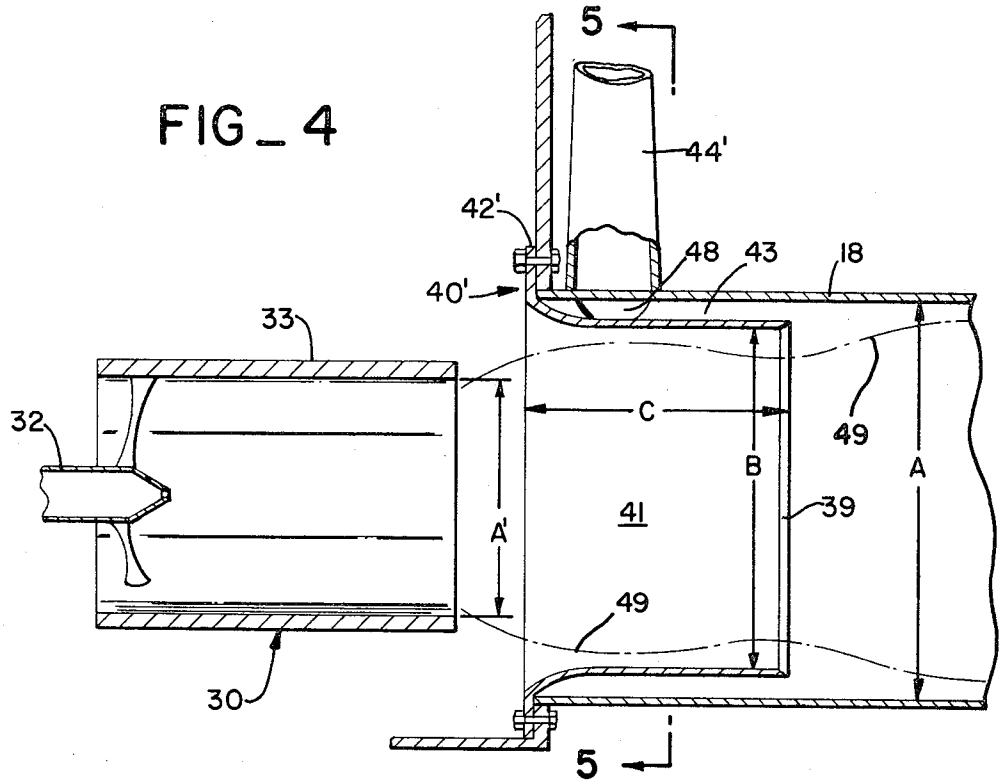


FIG_3

VACUUM COLLAR FOR ROOFING KETTLES AND THE LIKE

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FIG_4



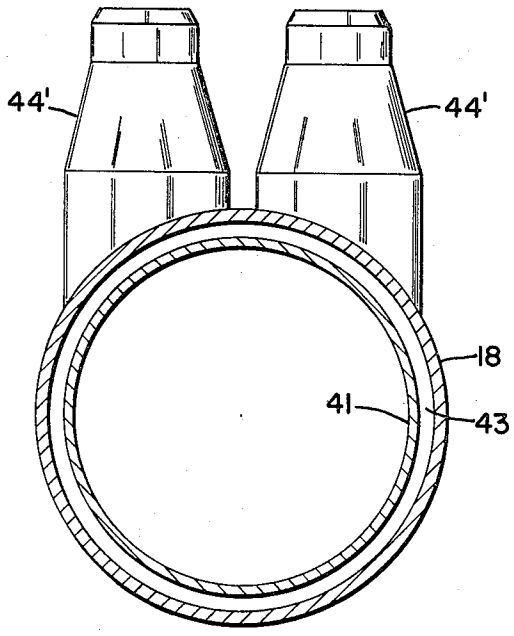


FIG_5

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VACUUM COLLAR FOR ROOFING KETTLES AND THE LIKE

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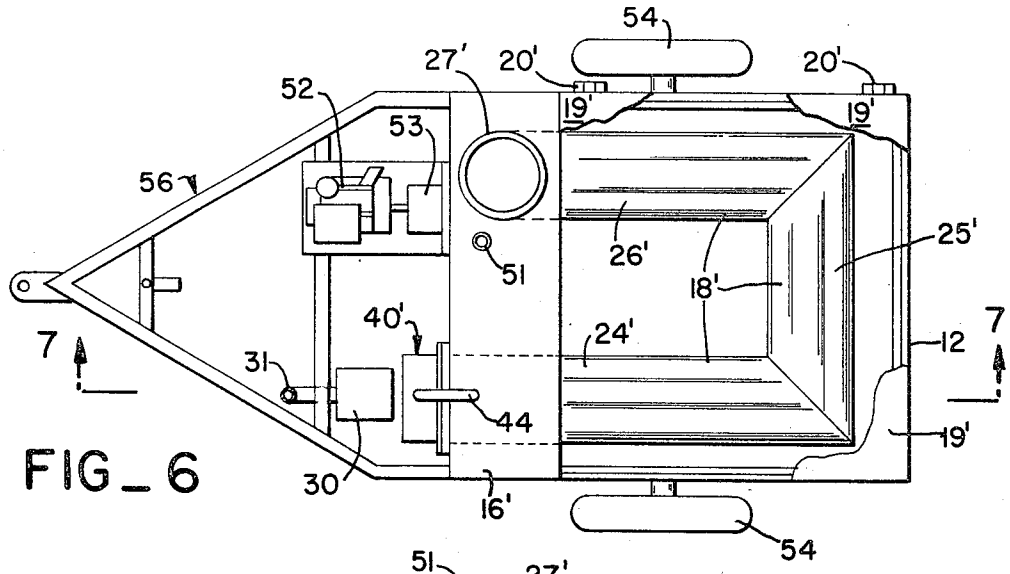


FIG_6

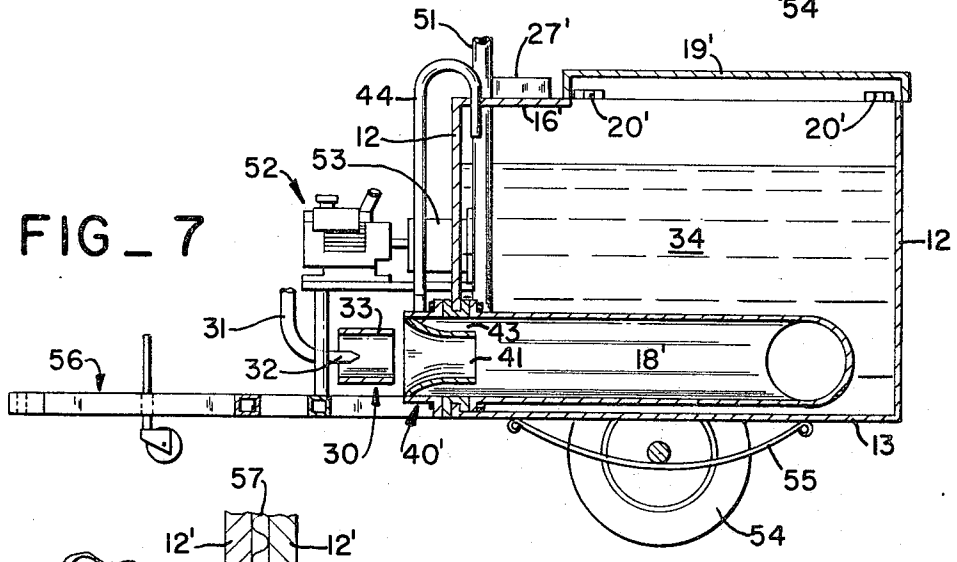


FIG_7

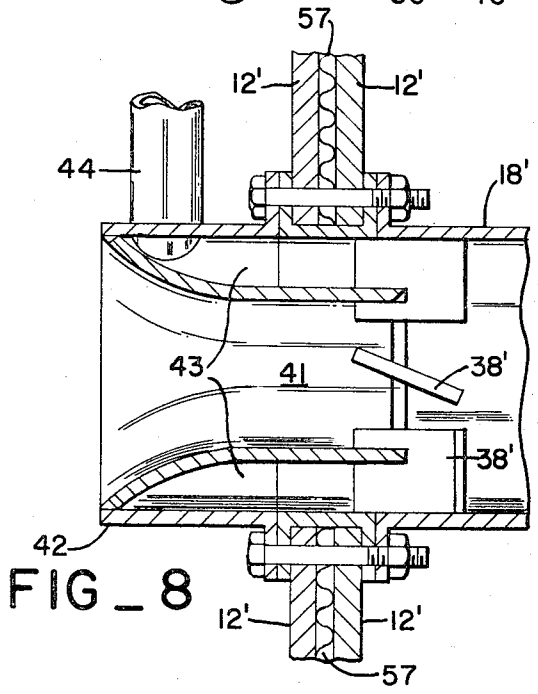


FIG_8

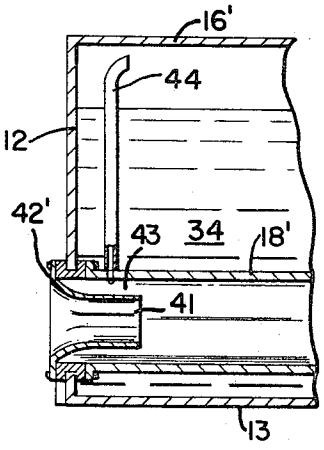


FIG_9

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3,718,131

VACUUM COLLAR FOR ROOFING KETTLES AND THE LIKE

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U.S. Cl. 126—343.5 A 10 Claims

ABSTRACT OF THE DISCLOSURE

Roofing kettles or the like, for heating masses of bituminous material, provided with means for reducing the smoke, fumes and vapors given off in operation are disclosed, which means comprise various embodiments of the invention. Embodiments of the invention suitable for retrofitting existing kettles, as well as the embodiment of the invention in kettles as originally built in various forms are described.

BACKGROUND OF THE INVENTION

This invention relates to the reduction of the smoke, vapor and fumes given off in the normal operation of kettles for heating bituminous materials and more particularly to the provision of means in such kettles for drawing off such smoke, vapor and fumes and subjecting them to substantially complete combustion within the heating means of the kettle itself.

There are a number of processes such as the roofing of buildings and the construction or repair of highways in which solid bituminous material is heated to liquify it for application and subsequent solidification over a desired area. The heating of the bituminous material is conventionally carried out in portable kettles comprising a receptacle, usually mounted on wheels, provided with a removable or hinged cover and appropriate heating tubes or pipes. The heating means usually comprises a torch supplied with liquid or gaseous fuel under pressure directed into one end of the heating tubes or pipes with the products of combustion existing from the other end of the heating tubes to the atmosphere. In a properly designed kettle, the torch and heating tubes thereof are designed to provide complete combustion of the liquid or gaseous fuel with appropriate heat transfer to the bituminous material in the kettle to liquify such bituminous material. Thus, the combustion of the gaseous fuel used in heating the kettle does not tend to produce undesirable fumes and vapors in the atmosphere.

However, bituminous materials contain a variety of volatiles which are given off as smoke and vapors when such materials are melted under the influence of heat. Such smoke and vapors are combustible, usually have an obnoxious odor and generally tend to pollute the atmosphere. A number of devices are currently in use for the purpose of reducing such atmospheric pollution, all of which comprise a vent pipe or smoke stack through the cover of the kettle and in which are located auxiliary burners supplied with liquid or gaseous fuel under pressure. Thus, the smoke and fumes given off by the bituminous material in the kettle are drawn through the vent or smoke stack where they are subjected to combustion in the flame of the auxiliary burners together with the fuel. This is obviously a wasteful means of solving the problem since the auxiliary burners must be operated at a sufficiently high level to create a draft that will prevent combustion from occurring within the kettle and at the same time insure complete combustion of the smoke and vapors drawn out of the kettle. The heat produced in

such combustion is dumped into the atmosphere without serving any other useful purpose than the combustion itself.

It has previously been suggested that the smoke and fumes given off by the bituminous material be drawn into the heating system of the kettle for combustion, either at the exhaust end of the heating system, as shown in U.S. Pat. 3,220,403 for example, or at an intermediate point in the system where the combustion of such smoke and fumes can contribute to the heating of the kettle, as shown in U.S. Pat. 3,046,977. However, these prior art devices have at least three major disadvantages. In the first place, the complete combustion of the smoke and fumes drawn from the kettle is highly unlikely at an intermediate point in the heating system of such kettle and almost an impossibility at the exhaust end of such heating system. In the second place, if combustion of such smoke and fumes does occur then the probability of such combustion propagating through the vent means and into the kettle itself (usually called a "blow-back") is quite high due to the fact that the velocity of the gases involved decreases as the gases move through the heating system becoming lowest at the exhaust end of the system. Finally, it is often necessary to reduce the level of operation of the heating system after the kettle and bituminous material therein has reached the desired temperature and no bituminous material is being taken from or added to that in the kettle. Under such conditions, usually referred to as "idling," the production of smoke and fumes from the liquified bituminous material remains relatively constant, but the possibility of combustion thereof in the heating system is reduced and the probability of a "blow-back" is increased.

It is an object of this invention to provide means for drawing off the smoke and fumes given off by bituminous material when heated and feeding such fumes directly into the heating flame for substantially complete combustion with reduced danger of a blow-back occurring.

It is a further object of this invention to provide such a means which will operate satisfactorily under idling conditions.

It is another object of this invention to provide such a means which can be readily applied either to existing kettles or in the construction of new kettles.

It is a further object of this invention to provide such a means which is inexpensive, tends to increase the efficiency of the kettle and tends to extend the life of the heating system of the kettle.

SUMMARY OF THE INVENTION

According to this invention, a roofing kettle or the like for heating masses of bituminous material comprises a receptacle for containing such material with a removable cover spaced from the surface of such material, a heating tube of given internal dimensions extending adjacent the bottom of the receptacle with both ends extending into communication with the atmosphere, a torch unit adapted to direct a flame into one end of heating tube to communicate the desired heat to the material with the products of combustion of the flame exiting the other end of the heating tube, and is provided with a tubular member received in the heating tube at such one end thereof, which tubular member has one end flared outwardly to provide internal dimensions substantially equivalent to the internal dimensions of the heating tube with the remainder of the tubular member having smaller external dimensions than the internal dimensions of the heating tube to form a substantially annular volume therebetween open to the interior of the heating tube at the free end of the tubular member and a vent pipe communicating between such annular volume and the space between the surface of the material in the receptacle and the cover of the receptacle.

BRIEF DESCRIPTION OF THE DRAWING

The foregoing and other objects and features of this invention will be more fully apparent from the following detailed description when read in conjunction with the drawing wherein:

FIG. 1 is a simplified plan view of an empty roofing kettle or the like for heating bituminous material according to one embodiment of this invention with portions broken away to show the heating tube;

FIG. 2 is a cross-sectional view taken along lines 2—2 of FIG. 1, but including a representation of liquid bituminous material in the kettle;

FIG. 3 is an exploded view in perspective of a three burner torch, a vacuum collar according to the embodiment of the invention shown in FIGS. 1 and 2, and an end portion of the heating pipe, including a fragment of an end wall of a kettle;

FIG. 4 is an enlarged cross-sectional view of a one burner torch and a vacuum collar according to another embodiment of this invention as well as a fragment of the end of the heating tube and the adjacent wall portion of a kettle;

FIG. 5 is a cross-sectional view taken along lines 5—5 of FIG. 4;

FIG. 6 is a plan view of an empty roofing kettle or the like of different design from that shown in FIG. 1, including an embodiment of this invention similar to that shown in FIG. 3;

FIG. 7 is a cross-sectional view taken along lines 7—7 in FIG. 6;

FIG. 8 is an enlarged fragmentary cross-sectional view of the vacuum collar according to the embodiment of this invention shown in FIGS. 6 and 7; and

FIG. 9 is a fragmentary cross-sectional view of a kettle, including an embodiment of this invention similar to that shown in FIG. 4.

DETAILED DESCRIPTION

Referring to FIG. 1 a simplified plan view of one type of roofing kettle **10** currently in use for heating bituminous material is shown. Such roofing kettle **10** comprises a receptacle for the bituminous material which is a simple rectangular box consisting of side walls **11**, end walls **12** and bottom wall **13** assembled in liquid tight relation. A suitable outlet is provided through one of the walls adjacent the bottom to enable the liquified bituminous material to be drawn off as needed. As shown in FIGS. 1 and 2 a simple spigot **14** communicates with an opening through one of the end walls **12** to provide an outlet for liquified bituminous material, however, it will be understood that any type of outlet may be used for drawing off the liquified bituminous material as desired.

As shown in FIGS. 1 and 2, the open top of the receptacle formed by side walls **11**, end walls **12** and bottom wall **13** is closed by a two-part removable cover **15**. One part **16** supports a burner well **17** and heating tubes **18** within the receptacle from the open top thereof as will be more fully described hereinafter. The other part **19** of the removable cover is mounted on the first part **16** by means of hinges **20** in order to facilitate the addition of solid bituminous material as the liquified bituminous material is drawn off for utilization.

As shown in FIGS. 1 and 2 the burner well **17** comprises a smaller hollow box having a shape similar to that of the receptacle and consisting of side walls **21**, end walls **22** and bottom wall **23** assembled in liquid tight relation. The open end of the burner well **17** is mounted on the part **16** of the removable cover in registry with an opening therethrough. Thus, when the removable cover is placed on the receptacle, the burner well **17** will project downwardly from the cover into the receptacle with one of its end walls **22** adjacent an end wall **12** of the receptacle.

As shown in FIGS. 1 and 2 the heating tube **18** comprises a first portion **24** mounted on the other end wall **22** of the burner well **17** and communicating with the burner well **17** through an opening in such end wall **22** adjacent the bottom wall **23**. A portion **24** of the heating tube **18** extends along the bottom wall **13** of the receptacle toward the opposite end wall **12** where it joins a transverse portion **25** of the heating tube **18**. The ends of the transverse portion **25** of the heating tube communicate with return portions **26** of the heating tube **18** which extend along the bottom wall **13** of the receptacle toward the end wall **12** of the receptacle adjacent the burner well **17** and such return portions **26** terminate in upwardly extending portions **27** which are rigidly mounted on the part **16** of the removable cover **15** and extend through openings therein into communication with the atmosphere.

As shown in FIGS. 1 and 2 a single burner torch **30** is inserted into the burner well **17** and directed into portion **24** of the heating tube **18** through the opening in the end wall **22** of the burner well **17**. The torch **30** is supplied with liquid or gaseous fuel under pressure through an appropriate feed line **31** and includes an appropriate jet **32** and burner shell **33**. It will be understood that the flame from the torch **30** enters the portion **24** of the heating tube **18** with substantial velocity due to the combustion and consequent expansion of gases in the flame. The flame and hot gases from the torch **30** proceed along the portion **24** of the heating tube to the transverse portion **25** thereof where they are conducted to the return portions **26** of the heating tube and are finally expelled into the atmosphere through the portions **27** of the heating tube. As the flame and hot gases pass through the heating tube **18**, they communicate heat to the bituminous material represeted in its liquified form **34** in FIG. 2.

It will be understood that bituminous materials having a wide variety of compositions may be heated in kettles of the type described above in order to liquify them for subsequent utilization. The composition of the bituminous material in any instance depends on the purpose for which such bituminous material is to be used, but in every case the composition of the bituminous material includes a large percentage of volatiles which are given off when the bituminous material is liquified by heating it. Such volatiles control characteristics of the bituminous material such as its melting point and physical attributes at various temperatures. Thus, such volatiles are essential to the use of bituminous materials in their various applications, however, such volatiles characteristically have an obnoxious odor and a tendency to pollute the atmosphere as given off in the process of liquifying the bituminous material by the application of heat thereto. One of the purposes of the removable cover **15** is to inhibit the escape of such volatiles to the atmosphere. However, it is impractical to make the removable cover **15** in such a way as to provide a hermetic seal with the receptacle and thus a substantial amount of such vapor continuously escapes to the atmosphere in operation. Furthermore, it is necessary to open the hinged portion **19** of the cover **15** periodically in order to add bituminous material to the receptacle thereby allowing the escape of large amounts of volatiles to the atmosphere.

It has been found that if the volatiles given off by the bituminous material in the heat liquification process are subjected to combustion, they will be converted into gaseous oxides, etc., having a reduced tendency to contaminate the atmosphere and which do not have an obnoxious odor. Thus, in the prior art, the removable cover **15** has been provided with an opening communicating with a chimney member. One or more burner devices supplied with liquid or gaseous fuel pressure have been mounted in such chimney members to provide a flame therein for the purpose of drawing off the volatiles from the receptacle and subjecting them to combustion within the chimney member prior to allowing them to escape into the atmosphere. This is obviously a wasteful solution

to the problem and it has previously been suggested that such volatiles be drawn into the heating tubes in some way for combustion, so that the heat resulting therefrom would serve a useful purpose. However, the devices heretofore proposed have been inefficient and have tended to provide a means by which combustion is propagated into the receptacle itself resulting in an explosive burning or "blow-back," which is a name given to the uncontrolled burning of the volatiles and bituminous material in the kettle itself. Such blow-back may damage the kettle or overheat the bituminous material even if it is brought under control prior to causing injury to persons and property.

According to this invention, a means is provided for drawing off the volatiles from the receptacle and subjecting them to complete combustion within the heating tubes without danger of blow-back. As shown in FIGS. 1 and 2 a device **40** according to the teaching of this invention and which is referred to herein in its various embodiments as a "vacuum collar" or "vacuum collar venturi" is applied to the end of the portion **24** of the heating tube **18** adjacent the torch **30**. It will be understood that the heating tubes **18** and torch **30** of a roofing kettle or the like for heating bituminous material are carefully designed with respect to each other to provide efficient transfer of heat from the flame of the torch to the bituminous material, complete combustion of the flame within the heating tube **18** and maximum life of the heating tube **18** under operating conditions. The vacuum collar **40** according to the teachings of this invention not only maintains such design relationship between the torch **30** and the heating tube **18**, but can improve such relationship.

As most clearly shown in FIGS. 2 and 3 a vacuum collar according to one embodiment of this invention suitable for use on existing kettles comprises a short tubular member **41** which is inserted coaxially into the heating tube **18** at the end thereof adjacent the torch **30**. The major portion of the tubular member **41** has external dimensions which are smaller than the internal dimensions of the heating tube **18**. However, the end of the tubular member **41** adjacent the torch **30** is flared outwardly to dimensions equivalent to the internal dimensions of the heating tube **18**. According to the embodiment of this invention shown in FIGS. 2 and 3 the flared end of the tubular member **41** is provided with a return flange **42** which surrounds the body of the tubular member **41** and has internal and external dimensions corresponding to those of the heating tube **18** to thereby provide a short extension of such heating tube **18**. Thus, when the free end of the flange **42** is butted against the end of the heating tube **18** the body of the tubular member **41** will project into the heating tube **18** and annular volume **43** opening into the heating tube **18** will be provided between the exterior of the tubular member **41** and the interior of the heating tube **18** and flange **42**. The flange **42** is provided with an opening through the wall thereof and a ventpipe **44** communicating with such opening is mounted to extend into the space between the upper surface of the bituminous material **34** and the removable cover **15**. As more fully described hereinafter when the flame of the torch **30** is directed into the heating tube **18** through the tubular member **14** it will be forced to constrict in passing through the tubular member **41** and subsequently expand within the heating tube **18** resulting in a zone of decreased gas pressure at the open end of the annular volume **43** between the exterior of the tubular member **41** and the interior of the heating tube **18** and flange **42**. Such zone of reduced gas pressure will tend to create a partial vacuum within the annular volume **43** drawing volatiles from the surface of the bituminous material **34** through the vent pipe **44** into such annular volume **43** and out the open end thereof into the flame of the torch **30** within the heating tube **18**. Due to the high velocity of the flame and gases at this particular point in the heating tube **18**, it has been found that the flame does not tend to propagate into the annular volume **43** thus reducing to a minimum the danger of the occurrence of a blow-back (i.e., propagation of the flame through the annular volume **43** and vent pipe **44** into the interior of the receptacle). Furthermore, it has been found that by proper dimensioning of the annular volume **43** and vent pipe **44** as well as tubuar member **41**, the escape of volatiles from the receptacle other than through the vent pipe **44** can be eliminated. Finally, it has been found that not only does complete combustion of the volatiles occur within the heating tube **18**, but that such combustion contributes significantly to the heating of the bituminous material thereby reducing the amount of fuel which must be supplied to the torch **30** in operation. An additional benefit of the vacuum collar **40** is that it tends to increase the life of the heating tube in operation as will be described more fully hereinafter.

Referring to FIG. 3 an exploded view of an embodiment of this invention suitable for use on existing kettles of the type described above is shown. It will be understood that a vacuum collar according to the teaching of this invention may be used with substantially all existing kettles regardless of their specific design. For example, as shown in FIG. 3, the torch **30'** of certain ones of existing kettles may comprise a plurality of burners joined together as a unit. As shown in FIG. 3, three burner jets together with their associated burner shells each independently supplied with liquid or gaseous fuel under pressure through lines **31'** may be combined into a single torch. However, the flame produced by such a multi-burner torch will have substantially the same characteristics insofar as this invention is concerned as a single burner torch. Thus, devices according to this invention are not limited to use with any particular kind of torch.

As also shown in FIG. 3, it has been found desirable for the vent pipe **44** to communicate with the annular volume **43** in an asymmetric fashion. To this end a vent pipe adapter **44'** may be provided on the flange **42** in order to provide a transition from a circular vent pipe to an elongated oval or slot type opening in the flange **42**. Such slot type opening in flange **42** is preferably not centered on the axis of the flange **42** in order to impart a helical swirling motion to the volatiles introduced into the annular volume **43** through vent pipe **44** and vent pipe adapter **44'**. Such helical swirling action may be further enhanced by means of three or more spacer vanes **38** which may comprise appropriate elongated metallic blocks fixed at an appropriate angle to the exterior surface of the tubular member **41** as shown in FIG. 3. In addition to enhancing the swirling motion of the gases, such spacer vanes **38** also facilitate the insertion of the tubular member **41** into the heating tube portion **24** and serve to maintain the coaxial relationship therebetween during mounting and subsequent operation.

As shown in FIG. 3, a vacuum collar in accordance with the teachings of this invention may be mounted on the kettle by means of lugs **45** provided at the free end of flange **42**, which lugs **45** are fastened to the end wall **12** of the kettle by means of screws **46**. It has been found that the joint between the free end of the flange **42** and the end of the heating tube **18** need not be hermetic since the suction created by the low pressure zone at the open end of the annular volume **43** is sufficient to draw all of the volatiles from the receptacle through the vent pipe **44** even where there is a substantial leakage of air into the annular space **43** at the joint between the flange **42** and the heating pipe **18**. It is of course desirable that the holes **47** which receive the screws **46** not penetrate the end wall **12** since this would tend to enable the leakage of liquid bituminous material from the receptacle unless appropriate gaskets are used. In many instances, the lugs **45** and screws **46** may be dispensed

with and the free end of the flange **42** simply tack-welded to the heating tube **18** or end wall **12** as indicated in FIGS. 1 and 2.

It will be understood from the above description that the removable cover **15**, burner well **17** and heating tubes **18** are fabricated as a single unit. The reason for this is two fold. In the first place the heating tubes tend to become coated with bituminous material in operation and must be removed for periodic cleaning. It will be understood that bituminous material in direct contact with the heating tubes tends to be heated to a higher temperature than the desired average temperature causing a coating of over-heated bituminous material to build up on and around the heating tube **18**. If such coating is not removed periodically, it will build up to a point at which it will interfere with the efficient transfer of heat from the heating tube **18** to the bituminous material. In the second place, the heating tube **18** will tend to be eroded by the flame from the torch **30** during operation particularly if the torch **30** is not exactly aligned with the axis of the heating tube, thereby directing the flame against the side of the heating tube **18**. It will be understood that torch **30** is adjustable within the burner well **17** so that the torch may be adjusted in its position with respect to the end of the heating tube **18** for optimum performance. However, after the kettle has been in use for a period of time, it is to be expected that maladjustments will occur from time to time and that, in any event, erosion of the heating tube **18** by the flame of the torch **30** sufficient to weaken the heating tube will eventually occur for whatever reason. It then becomes necessary to replace the heating tube **18** or at least the portion thereof which has been weakened by erosion. This is usually done by cutting out the eroded portion of the heating tube and welding in a new section in its place. As would be expected, the erosion of the heating tube tends to be most severe at the entrance to the heating tube adjacent the torch **30**. Thus, the vacuum collar according to the teaching of this invention provides the additional benefit of tending to protect the heating tube **18** from erosion by the flame of the torch **30**. The vacuum collar itself will, of course, tend to be eroded by the flame of the torch **30**, however, the vacuum collar may be replaced much more easily than a section of the heating tube. Furthermore, the tubular member **41** of the vacuum collar **40** will be cooled by the passage of gases through the annular volume **43** and thus will not tend to be eroded as quickly by the entering flame as would the end of the heating tube if no vacuum collar **40** were present.

Referring to FIG. 4, it will be seen that a vacuum collar **40'** according to the teaching of this invention may be incorporated into kettles for heating masses of bituminous material as originally constructed without sacrificing any of the advantages discussed hereinabove. Thus, an oppropriate slot or opening **48** may be provided through the side wall of the heating tube **18** and an appropriate vent pipe **44** or adaptor **44'** may be welded liquid tight to the heating tube **18** in communication with the slot or opening **48**. The vent pipe **44** of this embodiment will, of course, extend upwardly within the receptacle through the liquid bituminous material to a point above the surface of the liquid bituminous material within the receptacle. The flange **42** on the tubular member **41** may then be replaced by a simple mounting flange **42'**. Thus the tubular member **41** will tend to protect the heating tube **18** from erosion due to the flame of the torch **30** and may be easily replaced when erosion of the tubular member **41** itself occurs.

Referring to FIG. 4, it will be understood that the heating tube **18** will have a circular cross-section of given diameter designated by the letter A. For optimum operation the flame produced by the torch **30** will likewise have a given diameter, designated by the letter A', smaller than but approaching the diameter A of the heating tube **18**. Although the exact contour imparted to the flame of the torch **30** by the tubular member **41** in the heating tube **18** is not known, it is believed that it will tend to follow the dot-dash lines **49** shown in FIG. 4. As shown by such dot-dash lines **49**, the contour of the flame is believed to first expand, then constrict and then expand again as it leaves the torch **30** and passes through the tubular member **41** into the heating tube **18**. It will be seen that such supposed contour is very similar to the contour of the internal surface of the well known venturi tube and it has been found that a low pressure gas region tends to occur at the end of the annular space formed between the tubular member **41** and the interior of the heating tube **18** perhaps for the same reason that reduced pressure occurs at the throat of a conventional venturi tube. In any event, it has been found that a tubular member **41** having a diameter, indicated by the letter B, which is between 60% and 90% of the diameter A of the heating tube **18** will produce a sufficiently reduced pressure within the annular volume **43** to draw the volatiles from the receptacle through the vent pipe **44** and into the flame within the heating tube **18** without unduly reducing the efficiency of the torch and heating tube **18** in operation. If the diameter of the tubular member **41** is too small, it will, of course, interfere with the entrance of the flame of the torch **30** into the heating tube **18**. On the other hand, if the diameter of the tubular member **41** is made too large, it will tend to reduce the venture effect provided by the tubular member **41** and unduly constrict the annular volume **43** impeding the flow of volatiles therethrough. It has been found that the cross-sectional area of the annular volume **43** should be about twice the cross-sectional area of the vent pipe **44** for optimum performance. It has also been found that the length of the tubular member, indicated by the letter C, should be between about 50% and about 100% of the diameter A of the heating tube **18**. If the length C is too small than the venturi effect of the tubular member **41** is reduced and there is a greater danger of a blow-back due to combustion propagating through the annular volume **43** and vent pipe **44** into the receptacle. If, on the other hand, the length C is made too long, it will again reduce the venturi effect produced by the tubular member **41** and will also tend to interfere with the efficiency of the heat transfer from the flame of the torch **30** to the bituminous material through the heating tube **18**.

It will be understood that the maximum velocity of the gases in the heating tube **18** occurs where the most violent combustion takes place, thus producing the maximum expansion of gases. As the gases proceed through the heating tube and heat is extracted therefrom through the heating tube **18** and into the bituminous material, the volume of the gases decreases resulting in a decrease in velocity thereof. Thus, there is an optimum diameter B and length C for the tubular member **41** for any given heating tube and torch arrangement. As shown in FIG. 5, the vacuum collar venturi according to the embodiment shown in FIG. 4 or any other embodiment of this invention may be provided with a plurality of vent pipes **44** or adaptors **44'** communicating with the annular volume **43**.

As shown in FIGS. 4 and 5, the tubular member **41** may have a wall thickness substantially the same as the wall thickness of the heating tube **18**. If so, it is desirable to provide the free end of tubular member **41** with a knife-edge **39** due to the fact that volatiles in the gases drawn into the annular volume **43** may tend to deposit carbon on the exterior of the tubular member **41**. Such knife-edge **39** will tend to operate at a high temperature and thus prevent the build up of carbon deposits at the boundary between the annular volume **43** and the flame which could tend to trigger combustion in such annular volume **43**. It will be understood that the tubular member **41** could have a thinner wall thickness than the heating tube **18** due to the cooling of such tubular member **41** by gases passing through annular volume **43**, which cooling will tend to

reduce the erosion of the tubular member **41** by the flame.

Referring to FIGS. 6 through 8, it will be seen that a vacuum collar venturi according to the teaching of this invention is also applicable to the type of roofing kettle or the like which does not include a burner well **17**. In this type of kettle, the heating tube **18'** is removably mounted directly on the receptacle itself. Thus, as shown in FIG. 7, one end of the heating tube **18'** is bolted to one end wall of the receptacle in registry with an opening through such end wall and appropriate gaskets are used to prevent leakage of the liquid bituminous material **34** from the receptacle at the bolted joint. As shown in FIG. 6, the heating tube may make a single U-shaped passage within the receptacle terminating in an upwardly extending portion **27'** which may be bolted or otherwise attached to a rigid upper wall portion of the receptacle. A cover portion **19'** may be mounted on the receptacle by means of hinges **20'** to facilitate access to the interior of the receptacle. As indicated in FIGS. 6 and 7, the liquid bituminous material **34** may be pumped out of the receptacle through an outlet pipe **51** by means of a motor **52** and pump **53** arrangement. As also shown in FIGS. 6 and 7, the receptacle may be mounted on wheels **54** by an appropriate spring means **55** and may be provided with an appropriate tongue structure **56** to enable the receptacle to be towed as a trailer. The torch **30** as well as the motor **52** for the pump **53** may be mounted on the tongue structure **56** together with an appropriate source of liquid or gaseous fuel under pressure (not shown) connected to the torch **30** by means of connecting line **31**.

Referring to FIG. 8, it will be seen that an embodiment of the vacuum collar venturi according to the teaching of this invention similar to that shown in FIG. 3 may be applied to the kettle of FIGS. 6 and 7. Similarly, referring to FIG. 9, it will be seen that the kettle shown in FIGS. 6 and 7 may be modified to enable the use of an embodiment of the vacuum collar venturi according to the teaching of this invention similar to that shown in FIG. 4. As shown in FIG. 8, three or more spacer vanes **38'** similar to those **38** shown in FIG. 3 but modified to provide a helical swirling of the flame as well as the gases passing through the annular volume **43** may be provided. Such vanes **38'** may comprise metal strips slotted to fit on the free end of the tubular member **41** at an angle as shown. Such vanes **38'** extend across the annular volume **43** into contact with the interior of the heating tube **18** to position the tubular member **41** in the heating tube and enhance the swirling motion of the gases passing through the annular space **43**. Such vanes also extend into the interior of the tubular member **41** tending to impart a swirling motion to the flame which will not only enhance the mixing of gases passing through the annular space **43** with the flame, but will also tend to enhance the heat transfer from the flame and hot gases to the heating tube **18** as they proceed through the balance of the heating system. The use of vanes **38'** is particularly desirable in heating systems where the heating tube **18** is of large diameter since they will tend to prevent laminar flow of the hot gases and will contribute significantly to the efficiency of the heating system.

It will be understood that no attempt has been made herein to disclose details of construction of roofing kettles or the like which are not necessary for an understanding of this invention. For example, referring to FIG. 8, the end, side and bottom wall of the receptable of such kettles may be double walls **12'** with an insulating layer **57** therebetween in order to minimize heat loss through the walls of the kettle.

Similarly, it will be understood that various combinations may be made of the features of the different embodiments of this invention shown and described herein and that other modifications may be made in the embodiments of this invention disclosed herein without departing from the teaching of this invention. It is believed that those skilled in the art will adapt the teaching of this invention to both the retrofitting and the original construction of a wide variety of heating devices in which a flame from a torch is directed into a heating tube for the purpose of heating materials which give off pollutants at elevated temperatures than can be rendered harmless by more complete combustion thereof.

What is claimed is:

1. A roofing kettle and the like for heating masses of bituminous material and the like comprising:

(a) a receptable, having a removable cover, for containing said material with a space between the surface of said material and said removable cover;

(b) a heating tube of given internal dimensions within said receptacle and having a portion extending within said receptacle, both ends of said heating tube being adapted to extend into communication with the surrounding atmosphere;

(c) a torch unit adapted to direct a flame into one end of said heating tube, said torch unit and said heating tube being designed and arranged with respect to each other to cause said flame to communicate the desired heat to said material with the products of combustion of said flame exiting from the other end of said heating tube;

(d) a tubular member received within said heating tube at said one end thereof, one end of said tubular member being flared outwardly to external dimensions which are substantially equal to said given internal dimension of said heating tube adjacent said one end of said heating tube, the remainder of said tubular member having smaller external dimensions than said given internal dimensions of said heating tube and extending substantially co-axially within said heating tube from said flared end of said tubular member to form a substantially annular volume therebetween open to the interior of said heating tube at the free end of said tubular member;

(e) means mounting the periphery of said flared end of said tubular member at said one end of said heating tube; and

(f) a vent pipe communicating between said annular volume formed between said tubular member and said heating tube and said space between said surface of said material in said receptacle and said removable cover of said receptacle.

2. A roofing kettle and the like as claimed in claim **1** wherein said means mounting the periphery of said flared end of said tubular member comprises a tubular return flange extending from said periphery and surrounding the body of said tubular member in spaced relation thereto, the free end of said flange being mechanically mounted at said one end of said heating tube and said vent pipe communicates with said annular volume through an opening in said flange.

3. A roofing kettle and the like as claimed in claim **1** wherein said means mounting the periphery of said flared end of said tubular member comprises a planar flange extending outwardly from said periphery transversely of the axis of said tubular member, said planar flange being mechanically mounted at said one end of said heating tube and said vent pipe communicates with said annular volume through an opening in said heating tube.

4. A roofing kettle and the like as claimed in claim **1** wherein said means mounting the periphery of said tubular member at said one end of said heating tube includes a welded joint.

5. A roofing kettle and the like as claimed in claim **1**, wherein said free end of said tubular member is provided with a knife edge.

6. A roofing kettle and the like as claimed in claim **1**, wherein said vent pipe communicates with said annular volume through an opening in said heating tube and extends through said material in said receptacle into communication with said space between the surface of said material and the removable cover of said receptacle.

7. A roofing kettle and the like as claimed in claim 1 wherein said vent pipe communicates with said annular volume asymmetrically with respect to the axis of said tubular member whereby gases entering said annular volume from said vent pipe are urged to follow a helical path within said annular volume.

8. A roofing kettle and the like as claimed in claim 1 wherein more than one vent pipe communicates between said annular volume and said space.

9. A roofing kettle and the like as claimed in claim 1, wherein a spacer vane extends between the inner surface of said heating tube and the outer surface of said tubular member.

10. A roofing kettle and the like as claimed in claim 1 wherein a plurality of vanes spaced from each other about the periphery of said tubular member and each comprising a slotted metallic sheet are mounted at the end of said tubular member with a first portion thereof extending into said annular volume at an angle with respect to the axis of said tubular member and a second portion thereof extending into said tubular member at an angle with respect to the axis of said tubular member.

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