This invention relates to closure mechanisms for preventing rocks, debris and moisture from entering vertically extending exhaust pipes (sometimes termed "stacks") of vehicles such as bulldozers, tractors, etc., during periods when such vehicles are standing idle in the open, and during certain periods of use. More particularly, the present invention relates to closure mechanisms situated wholly inside either the exhaust pipe or a tubular extension thereof, both when said mechanism is in an open position or when it is closed, such arrangement preventing the closure mechanism from being struck and damaged, or removed, by overhead limbs, etc., during periods of vehicle operation, and also protecting such closure mechanism from the effects of wind, both during periods of vehicle operation and during periods of vehicle shutdown.

Reference is made to the first page of Stade et al., U.S. Patent 2,983,216, issued May 9, 1961, wherein a thorough presentation is made of the problems encountered in the utilization of vertically extending exhaust pipes with the internal combustion engines of bulldozers, tractors, etc. The exhaust pipe closure mechanisms of the present invention are in the nature of improvements over exhaust pipe closure mechanisms of the "lid" type, such as the one disclosed in the Stade et al. patent, for example. The exhaust pipe closure mechanism of the Stade et al. patent is characterized by a "lid" or "cover" pivotally mounted between laterally extending ear portions of a clamp used to secure such mechanism to the exhaust pipe. The lid or cover is provided with a balance arm or "counterweight" and is movable between a horizontal closed position to a somewhat vertical open position. The principal disadvantage of this form of closure mechanism stems from the fact that it is situated wholly outside of the exhaust pipe and hence is unprotected from being struck and damaged, or even removed, by overhead limbs and the like. Lid damage or destruction is particularly a problem where the vehicle is a bulldozer, as bulldozers are commonly employed for clearing in brushy and forest areas where overhead objects such as limbs exist in abundance. A further disadvantage of the "lid" type closure mechanism incident to their exterior location is that they are affected by wind action both during periods of vehicle operation and during periods of vehicle shutdown. A still further disadvantage of said mechanism is that they are easily opened by children playing on the vehicle when it is idle, making it easy for such children to insert such objects as sticks, rocks, sand, etc. into the exhaust pipe, and as would be expected, in most cases said objects cause serious injury to the engines.

The principal object of the present invention is to produce a closure mechanism which does not possess any of the foregoing disadvantages.

One form of closure mechanism constructed in accordance with the present invention is characterized by a cylindrical tube detachably mountable on the terminal end portion of a vertically extending exhaust pipe by a clamping ring, or the like, with such cylindrical tube housing a pair of closure members or "flaps" pivotally mounted on opposite sides of a transverse extending pin and movable between substantially horizontal closed positions and substantially vertical open positions, and with movement of said flaps from their closed to their open position being effected during engine operation by the exhaust gases flowing upwardly through said cylindrical tube, and with closure of said flaps being effected by gravitational return of the flaps to their substantially horizontal positions when the engine is turned off and the exhaust gases cease to flow through said cylindrical tube. Additional features of this form of the invention include a transverse extending gutter member situated below said pin and serving to collect and dispose of any moisture entering the generally cup-shaped zone situated above the flaps when they are closed, with such gutter member being rigidly connected at its respective ends to diametrically opposed portions of the cylindrical tube.

This first form of the invention also includes a seat forming member or members situated (at least in part) laterally of the pin and serving to limit the downward pivotal movement of said flaps, and stop means situated substantially vertically above at least a portion of said pin and serving to prevent pivotal movement of each flap from its substantially vertical open position towards the closed position of the other flap. Thus, the seat forming member or members establishes the closed positions of the flaps, and the stop means establishes the open positions of the same.

In a second form of the invention, the seat forming member is in the shape of a ring and supports both the pin onto which the flap members are pivotally mounted and the gutter member. Such ring and its associated elements (the flaps, gutter, etc.) are inserted into the open end of the exhaust pipe and once properly oriented therein is secured in place by means of a plurality of circumferentially arranged metal screws or the like. In this form of the invention a pair of metal screws or the like constitute the stop means.

Both of these forms of the present invention involve a relatively small number of easily formed components, and are thus both practical and inexpensive to manufacture. In addition, both forms of the invention present an exhaust pipe closure mechanism that is both efficient and durable, even under conditions of hard use over long periods.

These, together with other objects and advantages, which will become subsequently apparent, reside in the details of construction and operation of certain typical embodiments of the invention presently to be described, reference being had to the accompanying drawings forming a part of this application, wherein like numerals refer to like parts throughout, and in which:

FIG. 1 is a sectional view of one form of the present invention, showing in solid line the closure members in their closed positions, and in broken line such members in their opened positions, said sectional view being taken substantially on line 1—1 of FIG. 2;

FIG. 2 is a top plan view of the form of the invention shown in FIG. 1;

FIG. 3 is a view taken substantially at right angles to FIG. 1, showing the cylindrical member and the seat ring in section, and showing the gutter and the closure members in elevation, with such closure members occupying their substantially vertical positions;

FIG. 4 is a fragmentary perspective view of one form of the stop means usable to prevent pivotal travel of the closure members past a substantially vertical position;

FIG. 5 is a perspective view of a modified form of the invention wherein the closure members, the pin and the gutter are carried by the seat ring, and such ring is inserted into the vertically extending exhaust pipe of internal combustion engine and secured in position by means of a plurality of circumferentially spaced metal screws, or the like, and additional metal screws form the stop means, such view showing the attachment and screws in solid lines and the exhaust pipe in broken lines; and
3,181,451 3. F.G. 6 is a perspective view of the exhaust pipe attachment of FIGS. 1-3, showing the means used for securing such attachment to the end portion of a vertically extending exhaust pipe, and in addition showing dirt removal openings which may be optionally provided in the wall of the cylindrical member above the closure means.

The invention illustrated in FIGS. 1-4 and 6 is in the nature of a clamp-on attachment and comprises a cylindrical tube or duct member 10 detachably secured to the terminal end portion of a vertically extending exhaust pipe 12, as by a conventional clamping ring 14 (FIG. 6), for example, and forming a part of the exhaust system. The lower portion of tube 10 is preferably slotted at spaced intervals as at 16 in FIG. 6, to provide resiliency so that tube 10 can be drawn into tight engagement with exhaust pipe 12.

A pin 18 forming part of the closure mechanism laterally spans the interior of tube 10 and connects at its respective ends to the wall of tube 10 at diametrically opposed locations. A first flap or closure member 20 is pivotally connected to pin 18 by means of hinge 22. A second flap or closure member 24 is pivotally connected to pin 18 by hinges 26, 28. As most clearly shown in FIG. 2, hinges 26, 28, 20 are substantially coaxially arranged, with hinge 22 being approximately twice the length of hinges 26, 28 (or substantially equal to their combined lengths), and with hinge 22 being interposed between hinges 26, 28. Hinge 22 is an integral portion of flap 20, such portion being curved back on itself to define a substantially cylindrical bore through which pin 18 extends. Hinges 26, 28 form integral portions of flap 24, and in identical fashion to hinge 22 they cut back on themselves to define cylindrical bores for the reception of pin 18. As is apparent from FIGS. 1-3, and the foregoing description, the construction and arrangement of hinges 22, 26, 28 in pin 18 is similar to the construction and arrangement of the knuckle joint of a conventional butt hinge.

In FIG. 1 a ring-like seat member 30 is shown extending around the full circumference of the inner surface of tube 10, with its upper edge 32 forming both a seat for flap 20 on one side of pin 18 and a seat for flap 24 on the opposite side of pin 18. Rim edge 32 is preferably configured to seat flaps 20, 24 in the position shown in FIG. 1, i.e., with such flaps 20, 24 sloping downwardly slightly from the tube wall towards pin 18 for a reason hereinafter discussed. However, rim edge 32 could just as well be configured to seat flaps 20, 24 within the same horizontal plane, as such arrangement would produce no adverse results.

Flaps 20, 24 are preferably constructed from a relatively lightweight, heat resistant sheet metal. The outer edges of the flaps 20, 24 are cut so that they substantially contact the inner surface of wall 10 entirely around its circumference when closed. Thus, in embodiments wherein rim edge 32 is configured to seat flaps 20, 24 within a common horizontal plane, flaps 20, 24 are essentially semi-circular in shape. In embodiments wherein the upper edge 32 of ring 30 is of "butterfly" form, as shown, the middle ordinates of flaps 20, 24 are slightly larger than the radius of tube 10 and such flaps 20, 24 are substantially semi-elliptical in form.

Although ring 30 and its upper edge 32 are shown as extending around the entire inside circumference of tube 10, an alternative arrangement would be to provide flaps 20, 24 with relatively short seat forming members—preferably positioned below flaps 20, 24 in the vicinity of wherein portion 1—1 is taken, i.e., at the intersection of the middle ordinates of flaps 20, 24 with wall 10. Such seat forming members could take a wide variety of shapes or forms, and still fall within the scope of the present invention. For example, a three-sided cut could be made in one or more appropriate locations in the cylindrical wall of tube 10 and the tab defined between said cuts be pushed in to form the seat forming member.

A gutter member 34 is situated below the clearances existing between flap 20 and hinges 26, 28, between hinge 22 and flap 24, and between the hinges themselves. Gutter 34 extends substantially coaxially with pin 18 and connects at its respective ends to the inner surface of tube 10, as by welding, for example. Drainage openings 36, 38 are extended into tube 10 in the vicinity of the respective ends of gutter 34.

Stop means such as louver 40, 42 (most clearly illustrated in FIG. 4) are provided above pin 18 to prevent pivotal movement of flaps 20, 24 past substantially vertical positions (as shown in FIG. 1).

During periods of engine shutdown, flaps 20, 24 occupy the position shown by solid lines in FIGS. 1 and 2, such being their closed positions. Any moisture collected on top of flaps 20, 24 is drained inwardly towards the hinges and seeps through the clearances and is collected by gutter 34. The moisture then flows out of gutter 34 through drainage openings 36, 38. Thus, moisture is positively prevented from entering the exhaust pipe 12 (and in turn the engine) during periods of engine shutdown. During periods of engine operation the exhaust gases discharging from exhaust pipe 12 pivotally move flaps 20, 24 to their substantially vertical positions (shown by broken lines in FIG. 1 and by solid lines in FIG. 3). As most clearly shown in FIG. 1, the stop members 40, 42 prevent pivotal movement of each of said flaps past its open position towards the closed position of the other. The provision of at least one of said stop members is deemed essential in order to assure proper return of both flaps to their respective closed positions. If no stop member or members were provided, both of the flaps might pivotally drop on the same side of pin 18, leaving the opposite side of tube 10 open during engine shutdown. It is evident by now that as soon as the engine is turned off, flap 24 will return to its respective closed positions by the action of gravity. Small metal counterweights such as elements 44, 46 are optionally provided on the under surface of flaps 20, 24 to increase the weight of such flaps 20, 24, and in turn their tendency to drop to their closed positions.

Tube 10 is also optionally provided with a series of circumferentially spaced openings, one of which is designated 48 in FIG. 6, for facilitating removal of dirt, etc., from the cup-shaped zone existing above flaps 20, 24 when they occupy their closed positions. Dirt might accidentally lodge from an oncoming bank and fall into such cup-shaped zone, or might be placed therein by a child playing on the vehicle when it is standing idle during non-working hours. Regardless of how its gets into the cup-shaped zone, the dirt can easily be pushed out through said openings 48 by a stick, screwdriver, etc., inserted down through the open top end of tube 10.

During engine operation tail pipe 12 vibrates to some extent, with the amount of vibration varying with each piece of equipment and in some cases being quite substantial in amount. One problem experienced with clamped-type attachments is that such vibration tends to loosen the clamp and allow the attachment to "creep" downwardly on the exhaust pipe. When this occurs in the case of conventional "lid" type mechanisms, as shown in aforementioned Patent 2,963,216, the lid is prevented by the exhaust pipe from returning to its closed position. If such condition is not noticed and corrected by the operator before leaving his equipment at the end of the working day, the exhaust pipe is left uncovered during the idle hours. This is not the case with respect to the above described attachment of the present invention. If the seat forming ring 30 is employed, its lower rim edge 32 rests the upper rim edge of exhaust pipe 13 and in that way limits downward travel of tube 10 in the event clamp 14 vibrates loose. Also, if tabs or some similar seat forming means is used in place of ring 30, downward travel of tube 10 is limited or checked by gutter 34. Thus, tube 10 cannot creep downwardly on exhaust pipe.
Having thus described the invention, what I claim is:

1. In combination with a vertically extending duct member forming a part of an internal combustion engine exhaust system through which hot exhaust gases flow, and having an open upper end, closure means completely contained in duct member, said closure means comprising: a pin extending across the interior of said duct member, said pin being connected to said closure member at a substantial distance from its upper end; a first closure flaps said duct member having a free outward edge portion; first hinge means mounting said first closure flaps said pin, for free pivotal movement thereon on one side of the pin; a second closure flaps in said duct member having a free outward edge portion; second hinge means mounting said second closure flaps said pin, for free pivotal movement thereon on the opposite side of the pin; seat means for deriving and supporting the outer edge portions of said first and second closure flaps, and preventing downward pivotal movement of said closure flaps beyond a predetermined, substantially horizontal, closed position; and stop means extending radially inwardly from the wall of said duct member above at least a portion of said pin, and between said closure flaps, said stop means serving to prevent movement of either closure flap from a substantially horizontal position, said substantially horizontal closed position of the other closure flap, and with movement of said closure flaps from their closed to their open positions being effected during engine operation by the exhaust gases flowing upwardly through said duct member, and with closure of said closure flaps being effected by gravitational return of the closure flaps to their substantially horizontal closed positions whenever the exhaust gases cease to flow through said duct member.

2. The combination of claim 1, further including a heat shield member extending laterally across said duct member below said pin and said hinge means, said heat shield member having side portions meeting to form a bottom, and diverging apart as they extend upwardly from said bottom, said heat shield member serving to divert the hot exhaust gases around the pin and the hinge means.

3. In combination with a vertically extending duct member forming a part of an internal combustion engine exhaust system through which hot exhaust gases flow, duct closure means contained entirely in said duct member and comprising: a pin extending across the interior of said duct member at a substantial distance from its upper end; a first closure member in said duct member, and having a free outward edge portion; first hinge means formed integral with said first closure member, and mounting same onto said pin for free pivotal movement thereof; a second closure member in said duct member, and having a free outward edge portion; second hinge means formed integral with said second closure member, and mounting same onto said pin for free pivotal movement thereof; said second hinge means being in substantial axial alignment with said first hinge means, with slight clearances existing between the joining portions of said first and second hinge means, between the first hinge means and the second closure member, and between the second hinge means and the first closure member; baffle means extending laterally across the interior of said duct member below said pin and said closures, and being connected at its ends with said duct member, said baffle means serving to shield and in that manner protect said hinge means and said pin from exhaust gas heat during engine operation; seat means below the outward edge portions of the closure members for preventing downward pivotal movement of the closure members beyond a substantially horizontal closed position, with the outward edge portions of said closure members lying contiguous the wall of said duct member above said seat means when the closure members occupy closed positions; and stop means extending substantially radially inwardly from the wall of said duct member above at least a portion of said pin, and between said closure members, said stop
means serving to prevent movement of either closure member from a substantially vertical open position toward the substantially horizontal closed position of the other closure member, with movement of said closure members from their closed to their open positions being affected during engine operation by the exhaust gases flowing upwardly through said duct member, and with closure of said closure members being effected by gravitational return of the closure members to their substantially horizontal positions whenever the exhaust gases cease to flow through said duct member.

4. The combination of claim 3, wherein said baffle means comprises an upwardly opening trough, wherein at least one drainage opening is provided in the wall of said duct member in the vicinity of at least one end of said trough, and said trough serves, in addition to protecting said hinge means and said pin from exhaust gas heat during engine operation, to collect and dispose of moisture which leaks through said hinge clearances during engine shutdown.

5. In combination with a vertically extending, cylindrical duct member forming a part of an internal combustion engine exhaust system through which hot exhaust gases flow, closure means comprising: a pin extending across the interior of said cylindrical duct member and connecting at its respective ends with diametrically opposed wall portions of said cylindrical duct member; a first generally semi-circular closure flap having a free outboard edge portion and an inboard hinge portion curling about said pin, and serving to mount said first closure flap onto said pin for free pivotal movement thereabout; a second generally semi-cylindrical closure flap having a free outboard edge portion and an inboard hinge portion curling about said pin, and serving to mount said second closure flap onto said pin for free pivotal movement thereabout; and a generally cylindrical member fitting snugly in said cylindrical duct member, and having an upper edge surface forming a seat for said first and second closure flaps; and stop means extending substantially radially inwardly from the wall of the duct member above at least a portion of said pin, and between said closure flaps, said closure flaps being freely pivotally moveable between closed positions, wherein they rest upon said seat, and substantially vertical open positions, wherein they rest against the stop means, with said stop means serving to prevent movement of either closure flap from its open position toward the closed position of the other closure flap, with movement of said closure flaps from their closed to their open positions being effected during engine operation by the exhaust gases flowing upwardly through said duct member, and with closure of said flaps being effected by gravitational return of the flaps to their closed positions, upon said seat, whenever the exhaust gases cease to flow through said duct member.

6. The combination of claim 5, wherein the hinge portion of said first closure flap extends contiguous the hinge portion of said second closure flap, with some clearance therebetween, and said combination further includes a heat baffle and gutter member extending immediately below said pin, said member being connected at its respective ends to said duct member, and with at least one drain opening being provided in said generally duct member, in the vicinity of at least one end of said heat baffle and gutter member.

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