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Feb. 9, 1971 B. W. WISEMAN, JR 3,561,210

METHOD AND APPARATUS FOR COOLING ENGINE EXHAUST PIPES

Filed Jan. 24, 1969

2 Sheets-Sheet 1

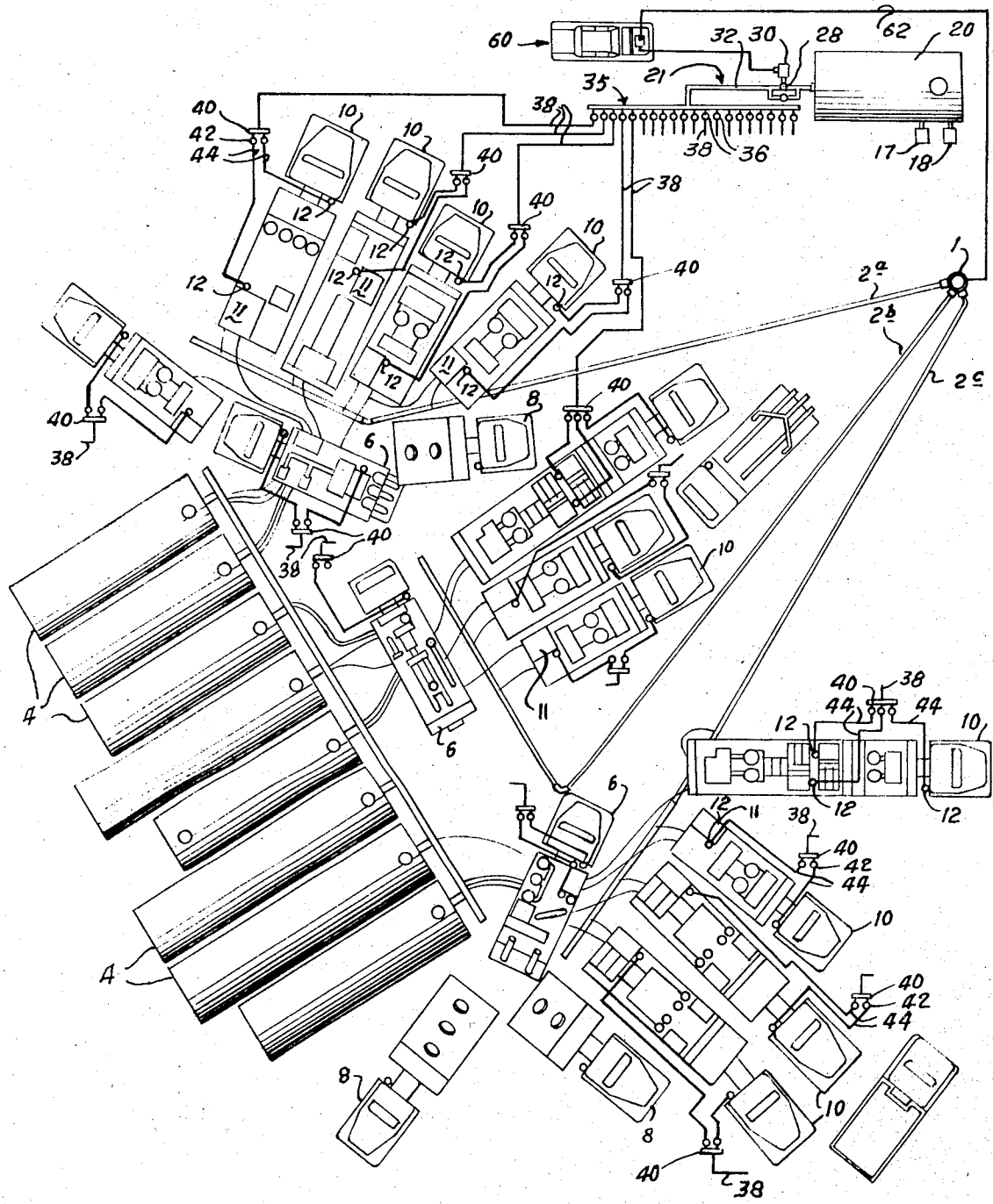


Fig. I

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METHOD AND APPARATUS FOR COOLING ENGINE EXHAUST PIPES

Filed Jan. 24, 1969 2 Sheets-Sheet 2

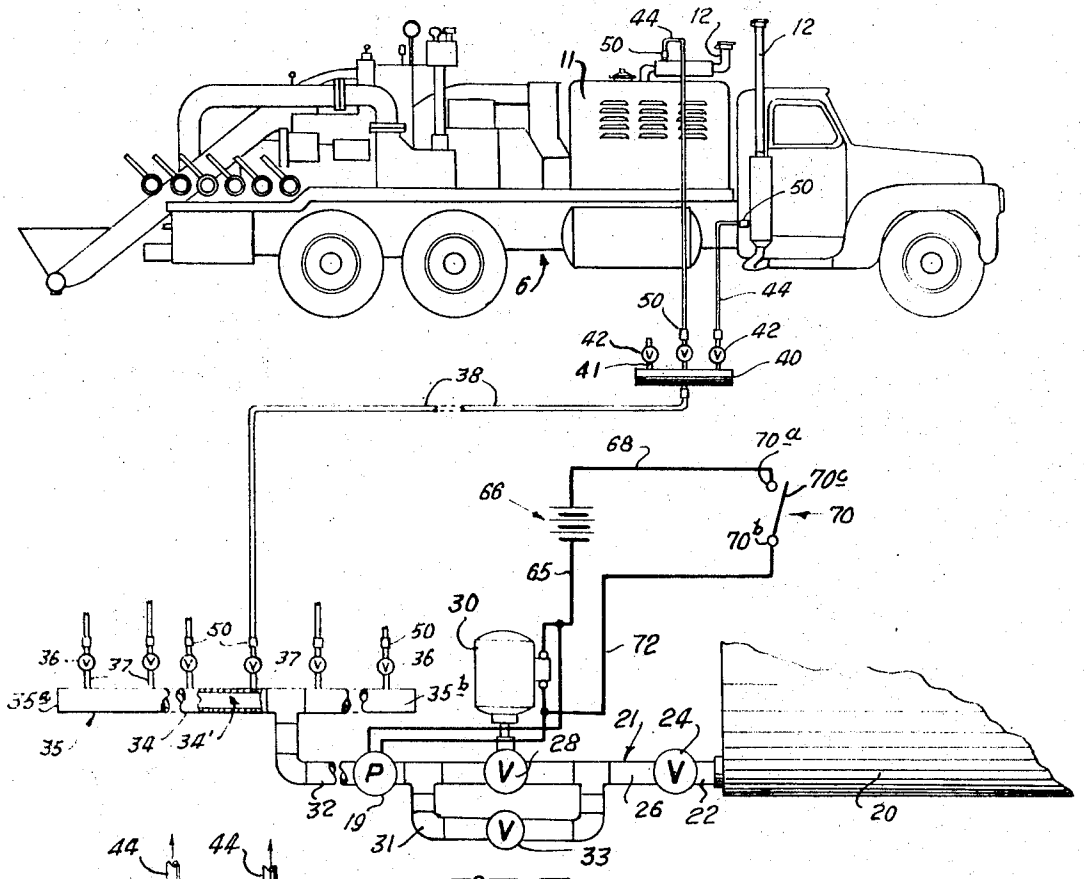


Fig. II

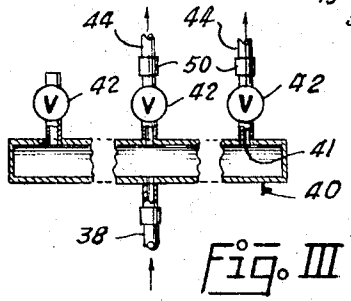


Fig. III

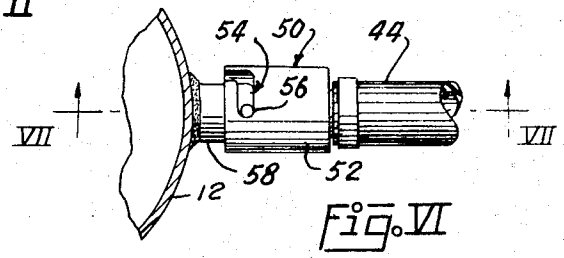


Fig. VI

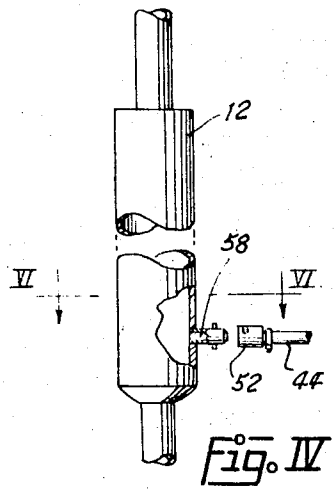


Fig. IV

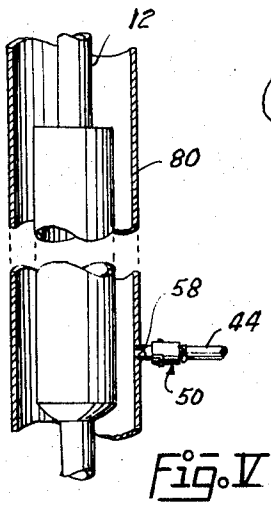


Fig. V

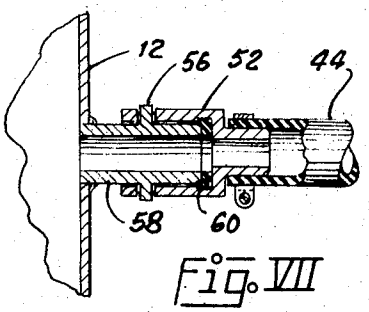


Fig. VII

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United States Patent Office 3,561,210 Patented Feb. 9, 1971

3,561,210

METHOD AND APPARATUS FOR COOLING ENGINE EXHAUST PIPES

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Filed Jan. 24, 1969, Ser. No. 793,695
Int. Cl. A62c 3/00, 35/40
U.S. Cl. 60—31 17 Claims

ABSTRACT OF THE DISCLOSURE

A method and apparatus for cooling exhaust pipes of internal combustion engines wherein carbon dioxide, stored in liquid state, is dispensed through a network of conduits and released in or around each exhaust pipe to cool the pipe preventing fire when combustible fluid comes into contact therewith.

BACKGROUND OF INVENTION

The production of oil and gas wells is reduced by flow restrictions, caused by an accumulation of matter in the bearing formation and by closure of a fracture through which oil and gas normally flow into the well. The production of the well is increased by removing flow restrictions, reopening closed fractures, and by enlarging drainage patterns.

Numerous techniques are employed to stimulate production. However, a method commonly used consists of pumping fracturing fluid, usually oil, mixed with various chemicals and propping agents down the well and into the formation. The high pressure fracturing fluid is forced through the formation in a direction opposite to that of normal flow of oil and the propping agent, which is normally silica sand, is forced into the fracture and holds the fracture open thereby increasing the normal flow rate of oil and gas from the formation to the well.

Several trucks having large engines, pumps and mixing devices mounted thereon are employed for forcing the fracturing fluid into the well to fracture a formation. Engines are normally run "wide open" to deliver maximum horsepower to pump the fracturing fluid at very high pressure into the well. Since the engines are running at maximum power, exhaust pipes become very hot and sparks are often blown from the end thereof.

When a line between the pumps and the well breaks, hydraulic forces cause the pipe to swing violently spraying the combustible liquids therein over a large area. When the combustible fluid strikes the hot exhaust pipes of engines used for driving the pumps, a fire is started which will often result in the destruction of equipment costing in excess of one million dollars and greatly endangers the lives of workmen.

A break in the high pressure line usually begins with a small leak which is visibly detectable and then a larger rupture begins to form which ultimately causes the oil to be sprayed upon the engines causing a fire.

Heretofore, no suitable device has been developed to prevent the eventuality of a fire when a line breaks while fracturing operations are being conducted on oil and gas wells.

SUMMARY OF INVENTION

I have developed a method and apparatus for cooling the exhaust pipes of internal combustion engines instantaneously when the danger of a leak is first detected, to prevent the ignition of oil and other combustible liquids when it is sprayed thereon.

The method which I have discovered comprises releasing carbon dioxide or other suitable coolant into the exhaust pipe of an engine, or into a manifold around the exhaust pipe, causing the pipe to be chilled to a temperature below that required to ignite oil.

The apparatus which I employ to carry out the method consists of a container in which carbon dioxide or other coolant is stored and a network of conduits connecting the container to each exhaust pipe on each engine which is being utilized in the fracturing operation. A valve is positioned to allow the carbon dioxide to be released into the conduits when a leak is first detected in the high pressure oil line and the exhaust pipes are cooled before a major break has time to form in the oil line.

It is therefore a primary object of the invention to provide a method of cooling the exhaust pipe of an engine in a very short period of time.

Another object of the invention is to provide apparatus capable of delivering coolant to the exhaust pipe of the engine in a very short period of time in sufficient quantities to cool the exhaust pipe.

A further object of the invention is to provide apparatus which is versatile and readily adaptable to cooling any number of exhaust pipes of any number of engines positioned at varying locations at a work site.

A further object of the invention is to provide apparatus for cooling the exhaust pipe of an engine wherein the apparatus may be connected quickly and easily to an exhaust pipe without interfering with the work to be done by the engine.

A still further object of the invention is to provide apparatus for cooling the exhaust pipe of an engine which is of simple construction requiring minimum maintenance and inspection.

A still further object of the invention is to provide apparatus for cooling the exhaust pipe of an engine adapted to be readily connectable to the exhaust pipe of an engine regardless of varied designs of different manufacturers of engines.

A still further object of the invention is to provide apparatus for cooling the exhaust pipe of an engine having a high degree of dependability.

A still further object of the invention is to provide apparatus for cooling the exhaust pipe of an engine which may be manufactured and installed at a reasonable cost making the use thereof economically feasible for use in mobile operations lasting a few hours or a few days and then moved to a different site.

Other and further objects of the invention will become apparent upon reading the detailed specification hereinafter following and by referring to the drawing annexed hereto.

DESCRIPTION OF THE DRAWINGS

The enclosed drawings of two embodiments of the invention are provided so that the invention may be better and more fully understood, in which:

FIG. I is a plan view showing a schematic layout of apparatus employed in a typical fracturing operation illustrating the relationship of my invention associated therewith;

FIG. II is a simplified diagrammatic view of the network of conduits connected to the exhaust pipes of engines on a typical pump truck;

FIG. III is a partially sectionalized view of a distribution manifold;

FIG. IV is a side elevational view of a conventional exhaust pipe showing a conduit connected thereto for cooling same;

FIG. V is a side elevational view of a conventional exhaust pipe similar to that illustrated in FIG. IV with a modified means for connecting a conduit thereto;

FIG. VI is a cross sectional view taken substantially along line VI—VI of FIG. IV; and

FIG. VII is a cross sectional view taken along lines VII—VII of FIG. VI.

Numeral references are employed to indicate the various parts shown in the drawings and like numerals indicate like parts throughout the various figures of the drawings.

DESCRIPTION OF A PREFERRED EMBODIMENT

The general layout of a conventional well fracturing operation will first be briefly described as a framework for the description of my invention.

Referring to FIG. I of the drawing, numeral **1** designates a well bore having a suitable control head mounted thereon connected to lines **2***a*, **2***b* and **2***c* through which fracturing fluid is pumped at very high pressures for servicing the well to increase the productivity thereof.

Fracturing fluid, such as oil, is pumped from containers **4** to proportioning units **6** where sand, delivered by dump trucks **8**, and other additives are accurately measured and mixed with the fracturing fluid and delivered to pumping units **10**. Pumping units **10** are equipped with pumps which discharge fracturing fluid into lines **2***a*, **2***b* and **2***c*. Pumping units **10** may deliver from 40 to 50 barrels per minute and pressures may exceed 20,000 p.s.i. in lines **2***a*, **2***b* and **2***c*.

It should be apparent that the number of proportioning units **6** and pumping units **10** will vary depending upon specific requirements at a particular well. The primary consideration dictating the number of units necessary for a given job is the horsepower of engines needed to achieve the required pressure and flow rate.

Each proportioning unit **6** and pump unit **10** has one or more engines **11** mounted therein for providing the needed horsepower. The engines and pumps are usually mounted upon a truck or trailer making them easily movable from one well side to another. It should be readily apparent that other or additional equipment may be utilized.

As best illustrated in FIGS. I and II of the drawings, my invention embodies apparatus for cooling the exhaust pipes **12** of engines **11**.

Container **20** is used as a storage vessel for carbon dioxide or other suitable coolant. Carbon dioxide is sometimes used as a refrigerant because it is readily obtainable, has a low boiling point, and has a high latent heat of vaporization.

The critical temperature (the temperature above which no pressure, no matter how great, can liquefy the gas) of carbon dioxide is 88° Fahrenheit. The critical pressure (the pressure which just suffices to liquefy the gas at the critical temperature) of carbon dioxide is 1,073 p.s.i. As temperature is reduced the pressure required to maintain the carbon dioxide in the liquid phase is decreased.

Carbon dioxide is in the liquid state when maintained at 0° Fahrenheit under 300 p.s.i. pressure, limits which may be readily achieved in the field. Therefore, under normal operating conditions container **4** should be refrigerated and pressurized to assure that the carbon dioxide is maintained in the liquid phase to facilitate pumping at high velocity, using a conventional pump **19**, through conduits or to allow the carbon dioxide to be simply released into the atmosphere adjacent to the exhaust pipes **12** on each engine employed in the fracturing operation.

Conventional refrigeration means **17** and pressurization means **18** are therefore operably connected to container **20** in a manner well known to persons having ordinary skill in the art.

A trunk line **21** consists of conduits **22**, **26** and **32**.

One end of conduit **22** communicates with the inside of container **20** and the other end thereof is connected to shutoff valve **24**.

Shutoff valve **24** is of conventional construction having a passageway extending therethrough which may be opened or closed as desired by manipulating suitable closure means therein.

Valve **24** is connected by a conduit **26** to valve **28** which may be opened and closed by suitable actuating means such as solenoid or motor **30**. Actuating means **30** is controlled by suitable electrical circuit as will be hereinafter more fully explained.

Valve **28** is connected through line **32** to a distributing manifold **35** which has a plurality of valved outlets **36** communicating with the inside thereof being connectable through branch line **38** to individual unit manifolds **40**.

Individual unit manifolds **40** may be positioned adjacent each proportioning unit **6** and each pump unit **10** and has valved outlets **42** communicating with the inside thereof connectable through unit lines **44** to each exhaust pipe **12** of each engine.

Conduits **38** and **44** are preferably flexible tubes capable of carrying a sufficient quantity of coolant to chill exhaust pipes **12** when valve **28** is opened.

In the particular embodiment of the invention illustrated in FIG. II of the drawing, distributing manifold **35** is a tubular member **34** having opposite ends **35***a* and **35***b* thereof closed defining a closed chamber **34'**. Valves **36** are positioned in spaced apart relation along the length of the tubular member and may be manually operated individually to open or close outlets **37** communicating with the inside of chamber **34'**. A conduit **38** extends between one of the valves **36** and one of the vehicles on the site and is connected to an individual unit manifold **40**. Each individual unit manifold **40** and distribution manifold **35** is of similar construction. Unit manifold **40** has outlets **41** having valves **42** mounted therein.

Preferably each flexible conduit **38** and **44** has a conventional quick connect coupling **50**, see FIGS. IV, VI and VII, whereby a suitable number of conduits may be connected to manifolds **35** and **40** for supplying coolant to each exhaust pipe **12**. Couplings **50** may consist of a female member **52** having a J-slot **54** formed therein and being adapted to receive pin **56** on male tubular member **58** when the male member is inserted into female member **52** and rotated. Seals **60** are provided in female member **52** to prevent leakage when pressurized fluid is pumped therethrough.

Couplings **50** may be of the type which automatically opens and closes a valve in outlets **37** and **41** if the use of such is deemed expedient.

In a preferred embodiment of the invention illustrated in FIG. IV, each exhaust pipe **12** has a male tubular member **58** extending through the wall thereof and welded or otherwise secured thereto connectable through a coupling **52** to flexible conduit **44**.

From the foregoing, it should be readily apparent that any number of flexible conduits **38** may be connected to the valved outlets **36** on distribution manifold **35** to accommodate any number of vehicles or power units on the well site. Valved outlets **36** which are not to be used may be closed. For example, if manifold **35** has twenty-five valved outlets **36** and ten vehicles are on the site, fifteen valves would not be used and may therefore be closed.

Any number of flexible conduits **44** may be connected to valves **42** on individual unit manifold **40** depending upon the number of exhaust pipes on a given vehicle. It should be noted the use of manifolds **35** and **40** facilitates connecting container **20** to each exhaust pipe of a varying number of vehicles by merely attaching conduits **38**, manifolds **40** and conduits **44** to accommodate each exhaust pipe **12**.

From the foregoing, it should be readily apparent that shutoff valve **24** is normally in the open position. When valve **28** is opened liquid carbon dioxide will be forced through conduits **22**, **26**, **32**, **38** and **44** and will be released into each exhaust pipe **12**, causing immediate cooling thereof.

In a normal operation a vehicle **60** has pressure gauges and other instruments mounted therein for providing instrumentation of the fracturing operation. The instruments are connected through a conduit **62** to the well **1**. A supervisor directs his attention to the instruments at all times. It is desirable that actuating device **30** for controlling valve **28** be operable from vehicle **60** adjacent the instruments mounted therein.

Motor **30** is energized by a circuit consisting of a line **65** connected to one side of the windings of motor **30** and the other end thereof connected to the negative terminal of battery **66**. The positive terminal of battery **66** is connected through line **68** to a contact **70***a* of switch **70** and the other contact **70***b* is connected through line **72** to the opposite side of the windings of motor **30**. It should be readily apparent that when moveable pole **70***c* of switch **70** engages contact **70***a* a circuit is completed, energizing the coil of motor **30**, causing valve **28** to be opened to release carbon dioxide into each exhaust pipe **12** of each engine on the site.

In some applications it may be desirable that more than one means be provided for releasing the carbon dioxide from container **20**. As best illustrated in FIG. II, a bypass conduit **31** connects conduit **26** with conduit **32** for routing carbon dioxide around valve **28**. A manually operated valve **33** is disposed in line **31** and is normally in the closed position. Carbon dioxide may be released into line **32** by opening either valve **28** or valve **33**.

DESCRIPTION OF A SECOND EMBODIMENT

Referring to FIG. V, if it is not desirable to insert tubular member **58** directly into exhaust pipe **12** of an engine, the tubular member **58** may be secured in a pipe **80** which may be positioned around exhaust pipe **12** whereby the carbon dioxide will be released to the inside of pipe **80** for cooling the exhaust pipe without puncturing the said exhaust pipe.

From the foregoing, it should be readily apparent that I have developed a method and apparatus for cooling the exhaust pipe of an engine which is simple and inexpensive to manufacture and use and which may be manipulated in a minimum of time.

As soon as a leak is detected in pressure lines **2***a*, **2***b* or **2***c*, switch **70** may be closed causing valve **28** to be opened, releasing carbon dioxide upon each exhaust pipe **12** to cool same below the temperature required to ignite the combustible fracturing fluid if it is sprayed thereon.

Having described my invention, I claim:

1. In apparatus for cooling the exhaust pipes of engines, a container; carbon dioxide in the container; means communicating with the container to maintain the carbon dioxide under pressure; means communicating with the container to maintain the carbon dioxide under refrigeration; dispensing means for the carbon dioxide adjacent each of said exhaust pipes arranged to release carbon dioxide to ambient atmosphere on the surface of the exhaust pipe; a conduit extending between the container and the dispensing means; and means for controlling the flow of carbon dioxide through the conduit.

2. The combination called for in claim **1** wherein there are a plurality of dispensing means, at least one of said dispensing means being connected to each exhaust pipe; and a plurality of conduits extending between the container and the dispensing means.

3. The combination called for in claim **1** wherein the conduit includes a trunk line having one end thereof communicating with the inside of the container; distributing means on the other end of the trunk line; a plurality of outlets in the distributing means; a plurality of branch lines each being connectable between an outlet in the distributing means and one of the dispensing means.

4. The combination called for in claim **3** with the addition of a plurality of individual unit manifolds; an inlet in each individual unit manifold connectable to the end of one of the branch lines; a plurality of outlets in each individual unit manifold; a plurality of unit lines, each being connectable between an outlet in the individual unit manifold and one of the dispensing means.

5. The combination called for in claim **1** wherein the dispensing means comprises an aperture in the wall of the exhaust pipe and means to attach the end of the conduit in communication with the aperture.

6. The combination called for in claim **1** wherein the dispensing means comprises a tubular body arranged about the exhaust pipe having an aperture in the wall thereof and means for attaching the end of the conduit in communication with the aperture.

7. In apparatus for cooling exhaust pipes of engines, a pressurized container; carbon dioxide in the conainer; a trunk line having one end thereof communicating with the inside of the container; a control valve in the trunk line; actuating means operably connected to the valve; a distributing manifold connected to the other end of the trunk line; distributing outlets in the distributing manifold; a valve in each distributing outlet; branch lines, each having an end connectable to the distributing outlets in the distributing manifold; individual unit manifolds connectable to the other end of each branch line; unit outlets in each individual unit manifold; a valve in each unit outlet of each individual unit manifold; unit lines having ends connectable to each unit outlet of each individual unit manifold; dispensing means connectable to the other end of each unit line, said dispensing means being connectable adjacent to and communicating with an exhaust pipe of an engine whereby opening the control valve causes carbon dioxide to be dispensed on the surface of the exhaust pipe for cooling same.

8. The combination called for in claim **7** wherein the actuating means operably connected to the control valve is electrically operated; and with the addition of an electrical circuit connected to the actuating means; a source of electricity in the circuit; and a switch in the ciruit whereby the switch may be manipulated to close the circuit to energize the actuating means to open the control valve.

9. A method of cooling exhaust pipes of engines comprising maintaining a supply of liquid carbon dioxide refrigerating and pressurizing said carbon dioxide; and conveying and dispensing the carbon dioxide to ambient atmosphere adjacent each of said exhaust pipes, whereby expansion of the carbon dioxide absorbs heat to cool the exhaust pipe.

10. The method called for in claim **9** wherein the carbon dioxide is released into each exhaust pipe.

11. The method called for in claim **9** wherein the carbon dioxide is released around the outside of each exhaust pipe.

12. In apparatus for cooling the exhaust pipes of engines; a container; coolant in the container; a trunk line having one end thereof communicating with the inside of the container; distributing means on the other end of the trunk line; a plurality of outlets in the distributing means; a valve in each outlet in the distributing means; a plurality of branch lines each being connectable to an outlet in the distributing means; a plurality of individual unit manifolds, each of said manifolds having an inlet connectable to an end of one of the branch lines, each of said manifolds having a plurality of outlets; a valve in each outlet in the manifolds; a plurality of unit lines, each line being connectable to an outlet in an individual unit manifold; dispensing means for coolant adjacent each exhaust pipe arranged to dispense coolant on the surface of the exhaust pipe, each of said dispensing means being connectable with a unit line; and means for controlling the flow of coolant to the trunk line.

13. In apparatus for cooling exhaust pipes of engines, a source of coolant; means for refrigerating and pressurizing said coolant; a dishtributing manifold connectable to the source of coolant, said manifold having a plurality of outlets; valve means in each of said outlets; means for controlling flow of coolant to the manifold; dispensing means connectable to the valve in the outlet

of the manifold, said dispensing means being arranged to dispense coolant adjacent each of the exhaust pipes for cooling the exhaust pipes.

14. The combination called for in claim 13 wherein the coolant is carbon dioxide.

15. The combination called for in claim 14 with the addition of means to cool the carbon dioxide to maintain same in liquid state until dispensed from the dispensing means.

16. In apparatus for cooling heated exhaust pipes of engines used in well servicing operations, a source of coolant; means for refrigerating and pressurizing said coolant; an individual coolant dispenser adjacent each of said exhaust pipes equipment in the vicinity of the well being serviced; conduit means connecting each coolant dispenser with the source of coolant; and means to circulate coolant through the conduit means to release coolant onto the exhaust pipes for reducing the temperature thereof to a temperature lower than the temperature of combustion of fluids used in the well servicing operation.

17. The combination called for in claim 16 wherein the coolant is carbon dioxide.

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DOUGLAS HART, Primary Examiner

U.S. Cl. X.R.

60—20; 169—2, 11

PO-1050
(5/69)

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,561,210 Dated February 9, 1971

Inventor(s) Ben W. Wiseman, Jr.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Claim 7, line 2, change "conainer" to read -- container -- .

Claim 9, line 2, after "carbon dioxide" insert a semicolon.

Claim 13, line 3, change "dishtributing" to -- distributing -- .

Claim 16, line 5, cancel "equipment".

Signed and sealed this 8th day of June 1971.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

WILLIAM E. SCHUYLER, JR
Commissioner of Patents