

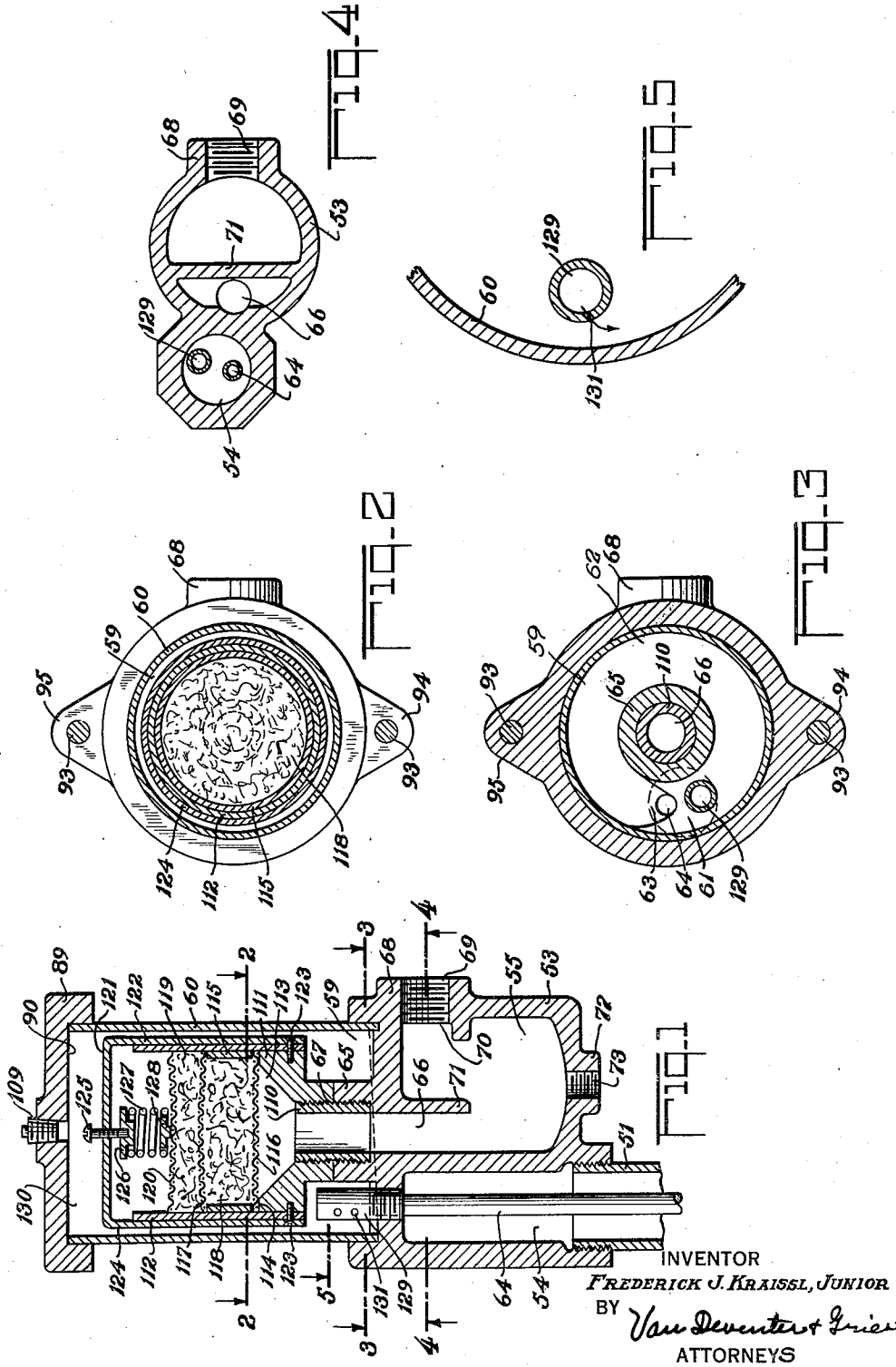
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OIL VAPOR FILTER

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OIL VAPOR FILTER

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This invention relates to improvements in oil vapor filters, and has for a main object the elimination of smoke formed by disintegration and dispersion of lubricant in the air gas discharged from such machines.

The smoke consists of oil or lubricant broken up into minute droplets having a very small specific surface and great stability. In fact, the smaller these droplets are, the greater their stability.

A further object of the invention is the provision of means, through which the discharged air or gas passes, adapted to force coalescence of these droplets or minute particles of oil. The tiny droplets or particles of oil may be electrically charged and of the same sign, therefore repellent to each other.

Another object of the invention is the provision of means for forcing said particles into coalescence in spite of said charge.

Other objects and advantages of the invention will be apparent to those skilled in the art.

In high speed compression or vacuum machines of the prior art, the discharged gas or air carries lubricant in an entrained, atomized colloidal or gaseous state. Air or gas so laden was found to be unsatisfactory and unsuitable for many purposes. According to the present invention, this finely divided lubricant is separated from the discharged air or gas and is returned to a lubricant reservoir, so that it may be used over again for lubricating purposes.

The dispersion of lubricant in the air or gas discharged from the compressor or pump is due to sudden and violent collision between the surface of the lubricant within the compressor, and the solid substance, such as the rotor and the moving parts of the pump. This is particularly true in vacuum pumps. This causes the specific surface of the lubricant to extend beyond the limits of its surface tension, with the result that it becomes unstable and breaks up into minute droplets having a smaller specific surface and greater stability. It has been found that the smaller the minute droplets become, the greater their stability becomes.

It has also been found that due to friction with the dispersing medium,—the moving parts in the compressor,—these minute particles of lubricant appear to be electrically charged.

It has also been found that the dispersion is aided by high temperatures; therefore, as the machine heats up, the dispersion increases. The electrically charged minute particles are very

stable due to the fact that they all carry light electrical charges and repel each other.

In this application, the minute particles of lubricant forming smoke in the discharge of air or gas will be termed "aerosols", which may be taken to mean smoke formed by disintegration and dispersion of liquid or solid in gas or air.

The elimination of the "aerosols" from the discharged air or gas may be effected by the following:

(1) Promoting coalescence by the presence of dust or grease at the surface of impact.

(2) Forced coalescence of the particles.

(3) Electrical precipitation.

In high speed compression and vacuum pumps, particularly in those of the rotary type employing vanes, rollers and the like, the presence of smoke in the discharged air or gas has been a problem with the manufacturers, and in order to obtain discharged air which was satisfactory (not containing sufficient smoke to interfere with the intended use), many of the manufacturers have reduced the speeds of the compressors with the following results:

(1) The compressors to operate at a lower speed and still deliver the same quantity of air, had to be increased in size.

(2) Expensive reduction gears were necessary between the motor and the compressor to obtain the necessary reduction in speed.

(3) Such gearing had to have attention and frequent oiling.

(4) The cost to the customer of the compressor system was of necessity increased.

Due to the fact that a small, compact high-speed compressor system was preferable, the herein described apparatus and method of eliminating the smoke was devised.

Referring to the drawing:

Figure 1 is a sectional elevation of one form of aerosol separator;

Figure 2 is a transverse sectional view of the device shown in Figure 1, taken along the line 2—2 thereof;

Figure 3 is a transverse sectional view of the device shown in Figure 1, taken along the line 3—3 thereof;

Figure 4 is a sectional view of the device shown in Figure 1, taken along the line 4—4; and

Figure 5 is an enlarged sectional view showing the path taken by the smoke-laden air as it is discharged into the new and improved separator.

In high speed compression and vacuum pumps, particularly those of the rotary type employing

vanes, rollers and the like, the discharged air or gas which is laden with lubricant may be passed through a chamber or the base of the compressor and impacted against a body of lubricant or the walls of the chamber and thereby separate therefrom a large percentage of the heavier particles of oil. The discharged air or gas which is still laden with minute particles of oil in the form of "smoke", may then pass into a separator such as that shown in Figure 1, via the pipe 51 of the base. A pipe 51 has its lower end secured to a flange 52 which may be welded or otherwise secured to the surface 24.

The body portion 53 of the new improved separator has formed therein a chamber 54 and a second chamber or sump 55. The pipe 51 connects to the lower end of the chamber 54. A stand pipe 129 is threaded into the body 53 and extends into the chamber 54. The upper end of the stand pipe 129 is closed and a series of small holes 131 is formed in the wall of the stand pipe communicating with the interior thereof. This may be seen in Figure 1, and the enlarged view in Figure 5 shows the preferred angular relation between the hole 131 and the surface of the inner wall of the cylinder housing 60.

Smoke laden air or gas passing via the pipe 51, the chamber 54, and the stand pipe 129, strikes the inner wall of the cylindrical housing 60 at an angle, as indicated by the arrow in Figure 11, and therefore with a rotary impact. This causes the heavier particles of oil which had not been removed from the air, prior to its entrance into the stand-pipe 129, to trickle down the walls of the cylindrical housing 60. The cylindrical housing may be made of glass so that this action may be watched.

The upper face of the body portion 53 has a recess 59 formed therein into which the cylindrical housing fits both in oil-tight and air-tight relation, as will presently be described.

The surface of the bottom of the recess 59 slants gradually down—that is, helically. The surface at the point 61 being highest, at the point 62 intermediate, and at the point 63 lowest, so that all of the oil separated by the rotary impact above described will drain down and around to the point 63. At this point a drain pipe 64 communicating with the surface in the immediate neighborhood of the point 63 extends downwardly through the chamber 54 to deliver drained oil to any desired point. It will be noted that the stand pipe 129 and the drain pipe 64 are not in line with each other. The drain pipe 64 is spaced apart from the stand pipe 56, as is clearly shown in Figure 3.

The recess 59 has an upstanding boss 65 formed in the center thereof integral with the body portion 53. A passage 66 communicating with the sump 55 terminates in the boss 65 and has a threaded hole 67 therein.

A boss 68 formed in the side wall of the body portion 53 has a threaded hole 69 formed therein, terminating in a passage 70 which also communicates with the sump 55 and forms an outlet for the air after the aerosols have been separated therefrom. A web 71 serves to extend the passage to a point below the level of the passage 70. A boss 72, formed on the lower wall of the body member 53, has a tapped end hole 73 communicating with the sump 55 at its lowest point to which a suitable drain pipe may be connected.

A top closure plate 89 having a recess 90 formed therein is fitted to the upper end of the

cylindrical housing 60 and is provided with ears, not shown in Figure 1 but lining up with ears 94 and 95 shown in Figures 2 and 3. Bolts 93 pass through holes in these ears and engage tapped holes in the ears 94 and 95 formed integral with the body portion 53 for tightly securing the cylindrical housing in air-tight and oil-tight relation to the recesses 59 and 90. To further insure proper sealing, a suitable oil resistant varnish or liquid, or a suitable gasket, may be applied to each end of the cylindrical housing member 60 and to the surfaces adjacent thereto before the body portion, the housing, and the top closure plate are assembled. If desired, the ears 94 and 95 need not be tapped, but instead the bolts 93 may be tightened up by means of nuts. A plug 109 is provided in the top closure plate.

After the heavier particles of oil in the discharged air or gas are separated, due to the helical or spiral motion given to the air entering the cylindrical housing 60 (which may be considered the first stage of the oil separation), the smoke-laden air is then subjected to a second stage in the process of separation which consists in passing it through a medium to cause the agglomeration of the lubricant particles into retainable liquid lubricant.

It has been found that by passing the smoke-laden discharged air or gas through a porous or semi-porous medium so constructed that it will effect the agglomeration of the lubricant particles, both when saturated with lubricant or when unsaturated, and do so without any impractical back pressure.

It has been found that certain fibrous materials, particularly kapok, or other cotton and vegetable fabrics may be used to cause the minute particles of oil to coalesce. Excellent results have also been obtained in the use of combinations of fibrous materials and porous mediums.

The threaded boss 65 is provided with a nipple 110, which in turn supports a flanged member 111. The flanged member has fitted thereto, in fluid-tight relation, a cylinder 112. The upper surface of the flanged member is cut by a conical hole 113, leaving a flat annular surface 114 which forms a support for the elements of the filter.

A cartridge comprised of an annular ring 115, a lower screen disk 116, and an upper screen disk 117, with a mass of steel wool 118 therebetween, forms an infiltrate.

A mass of kapok 119 rests upon the screen disk 117 after which a screen disk 120 is applied. It will be noted that the disk 120 is cupped—that is to say, concave, when viewed from the top—so that when pressure is applied thereto, as will presently be described, the material 118 will be forced against the walls of the cylinder 112 to form therewith a packing lock.

The kapok is applied in the dry state so that the small particles of oil in the first smoke-laden air passing therethrough will impregnate the fibres of the kapok and thereby impart to it the property of lending cohesive effect toward the agglomeration to the lubricant particles passing therethrough subsequently. This is in addition to the property of forcing the lubricant particles in coalescence. It has been found that if the kapok is dipped into the oil before placing it into the filter, instead of allowing it to become impregnated as above described, it will not give the desired effect; instead fissures and the like formed therein, allow the smoke-laden air to pass directly therethrough without coalescence.

After the kapok becomes impregnated, it immediately starts causing the oil to coalesce; agglomerated oil may pass from the surface of the screen disk 117 and via the steel wool 118 to the screen 116. From the latter, the oil may fall into the conical space 113 and pass via the passage 66 into the sump, 55.

I have substituted other fibrous materials, both animal and vegetable, for the kapok, but have found that of all the fibrous materials tested, many gave satisfactory results but kapok is the most efficient for the purpose. In order to prevent perforations in the screen 117 from becoming clogged, I employ a thin layer of steel wool or the like along the upper surface of the screen 117 as indicated by the numeral 118, and I have also found it desirable to apply a thin layer of steel wool or the like between the lower face of the screen 120 and the fibrous material 119.

A yoke 121 has one leg 122 extending down one side of the cylinder 112 and is secured to the flanged member 111 by means of a screw 123 passing through the wall of the cylinder. The other leg 124 of the yoke passes down along the opposite side of the cylinder and is secured to the flanged member by means of another screw 123^a. A pressure screw 125, having its end seated in an annular boss member 126, is provided for regulating the tension of a spring 127 against the spring disk 120 through the medium of the locating boss 128.

The air or gas is given a rotary or spiral motion as it enters the chamber 59, and while in said rotary motion passes into the upper portion 130 of the chamber thereby causing the heavier particles of oil to impinge upon the interior walls of the cylinder 60. This oil trickles down and is drained out via the pipe 64. The smoke-laden air then passes through the screen 120, the fibrous material 119, the screen 117, the steel wool 118, and the screen 116; and then, freed from oil, passes via the passage 66 to the oil sump 55. Due to the fact that the medium 119 is horizontally positioned in the cylinder, all of the agglomerated oil must pass therethrough and via the passage 66 into the sump 55.

The term "permeable", hereinafter used in the claims, may be taken to mean any material, whether of a fibrous nature or of a mineral nature and having such porosity and (such) arrangement of grain that, after becoming impregnated with minute particles of liquid forming a smoke in air or gas, it has the property of forcing subsequent minute particles of liquid, forming said smoke, into coalescence, upon the passage of such gas therethrough, thereby forming larger particles of liquid incapable of suspension in said air or gas without appreciable or impractical back pressure; this property being further facilitated by the cohesion between the impregnation and the subsequent particles of liquid.

Another arrangement contemplates connecting devices such as shown in Figure 1 in parallel or multiple so that the plurality would divide the quantity of air or gas into a plurality of smaller quantity paths. By this arrangement, the rate of separation for each individual device is cut down with the advantage that the liquid may drain from the semi-permeable material fast enough to prevent the latter from becoming clogged.

I do not limit myself to mounting the device on the base or oil reservoir of a compressor but instead some arrangements contemplate the mounting of the device separate and apart from

the compressor or the oil reservoir and delivering the smoke or aerosol laden air or gas to the device by piping or any other suitable means, in which case the separated liquid passing out via the drain pipes 64, or the liquid drained from the sump 55, may be collected, piped to any desired point, or allowed to go to waste in accordance with which is most desirable.

It is obvious that other modifications of the method of removing smoke or aerosols from the discharged air or gas may be made by those skilled in the art without departing from the spirit of the invention as defined in the following claims.

What is claimed is:

1. A device for removing minute particles of liquid from a gaseous medium comprising, a circular chamber, a drain pipe communicating therewith, means to deliver said medium to said chamber with a rotary motion whereby the heavier of said particles gather on the walls of the chamber by impact and drain down said walls and out through said drain pipe, a second chamber spaced apart from said first chamber, means forming a passage between said chambers, an outlet port for said gaseous medium formed in said second chamber, a flanged member secured to said boss and having formed therein a hollow portion communicating with said passage, a cylindrical member secured to said flanged member and having its upper portion in communication with said first chamber, a plurality of perforated supports mounted in said cylindrical member forming a permeable partition between said chambers, a mass of material between two adjacent perforated supports forming an infiltrate, a mass of permeable material positioned between others of said members and having such a degree of porosity and arrangement of grain that a greater percentage of said particles is separated from said gas by forced coalescence, and means for removing coalesced liquid from said second chamber.

2. In a device for separating minute particles of liquid from gases, in combination, a body member having an inlet passage and a sump formed therein, a wall between said passage and said sump, a discharge passage communicating with said sump, a boss in the upper surface of said body, a conduit leading to said sump through said boss, a closure member mounted in fluid-tight relation to the top of said body and forming a chamber, a stand-pipe in said chamber communicating with said inlet passage and having a discharge hole angular with respect to the wall of said closure member adapted to give smoke-laden air entering said chamber a rotary motion, whereby heavier particles of liquid may impinge upon the walls of the closure member and drain down to the bottom of said chamber, a drain pipe communicating with the bottom of said chamber for draining off the heavier particles of liquid as they are separated, a cylindrical member supported by said boss and having its upper end communicating with said chamber and its lower end in communication with said sump through said conduit, a pair of perforate disks mounted in said cylindrical member, a mass of permeable material positioned between said disks, adjustable means for applying tension to said material through one of said disks to maintain said material in sealing relation to the walls of said cylindrical member, said material together with said disks forming a partition between said chamber and said sump through which said smoke-laden gas must pass to leave said chamber.

whereby the particles forming said smoke are forced in coalescence and drained into said sump permitting the clean air or gas to pass out through said discharge passage, and a second drain pipe for draining said sump.

3. In a device for separating minute particles of liquid from gases, in combination, a body member having an inlet passage and a sump formed therein, a wall between said passage and said sump, a discharge passage communicating with said sump, a boss in the upper surface of said body, a conduit leading to said sump through said boss, a closure member mounted in fluid-tight relation to the top of said body and forming a chamber, a stand-pipe in said chamber communicating with said inlet passage and having a discharge hole angular with respect to the wall of said closure member adapted to give smoke-laden air entering said chamber a rotary motion, whereby heavier particles of liquid may impinge upon the walls of the closure member and drain down to the bottom of said chamber, a drain pipe communicating with the bottom of said chamber for draining off the heavier particles of liquid as they are separated, a cylindrical member supported by said boss and having its upper end communicating with said chamber and its lower end in communication with said sump through said conduit, a plurality of perforated supports mounted in said cylindrical member and forming a permeable partition between said chambers, a mass of material between two adjacent perforated supports forming an infiltrate, a mass of permeable material positioned between others of said members and having such a degree of porosity and arrangement of grain that the greater percentage of said particles is separated from said gas by forced coalescence when the latter is passed therethrough, adjustable means for applying tension to said semi-permeable material through at least one of said disks to maintain said semi-permeable material in sealing relation to the walls of said cylindrical member, said materials together with said disks forming a partition between said chamber and said sump through which said smoke-laden gas must pass to leave said chamber, and means for draining coalesced liquid from said sump.

4. A device for removing liquid particles from a gaseous medium comprising a chamber, means to deliver said medium and to impart a rotary motion thereto, whereby the heavier of said particles may impinge upon and drain down the walls of said chamber, a drain pipe communicating with said chamber at a low point therein for leading said drained liquid from said cham-

ber, means defining a sump in another portion of said chamber, an outlet port, a second drain pipe communicating with said sump, and a cartridge comprised of two adjacent perforated supports with kapok therebetween and forming a barrier between said chamber and said sump, the pores of said kapok in said cartridge after becoming impregnated with said liquid being adapted to force succeeding liquid particles into coalescence whereby the coalesced liquid may drain into said sump and out through said second drain pipe.

5. A device for removing minute particles of liquid from a gaseous medium comprising, a circular chamber, a drain pipe communicating therewith, means to deliver said medium to said chamber with a rotary motion whereby the heavier of said particles gather on the walls of the chamber by impact and drain down said walls and out through said drain pipe, a second chamber spaced apart from said first chamber, means forming a passage between said chambers, an outlet port for said gaseous medium formed in said second chamber, a flanged member secured to said boss and having formed therein a hollow portion communicating with said passage, a cylindrical member secured to said flanged member and having its upper portion in communication with said first chamber, a plurality of perforated supports mounted in said cylindrical member forming a permeable partition between said chambers, a mass of material between two adjacent perforated supports forming an infiltrate, a mass of kapok positioned between others of said members, said kapok having such a degree of porosity and arrangement of grain that a greater percentage of said particles is separated from said gas by forced coalescence, and means for removing coalesced liquid from said second chamber.

6. A device for removing liquid particles from a gaseous medium comprising a casing including a chamber, means to deliver said medium to said chamber, means defining a sump in said casing, an outlet port adjacent to said sump, means for draining said sump, and a cartridge comprised of two adjacent perforated supports with kapok therebetween and forming a barrier between said chamber and said sump, the pores of said cartridge after becoming impregnated with the liquid particles in the gaseous medium passing therethrough being adapted to force succeeding liquid particles into coalescence, whereby the coalesced liquid may settle into said sump and may pass out through said draining means.

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