United States Patent

[11] **3,570,628**

[72] Inventor **Charles H. Rodgers**
Sykesville, Md.

[21] Appl. No. **820,591**
[22] Filed **Apr. 30, 1969**
[45] Patented **Mar. 16, 1971**
[73] Assignee **Koppers Company, Inc.**

[54] **APPARATUS FOR LUBRICATING PNEUMATIC RAPPERS**
7 Claims, 2 Drawing Figs.

[52] **U.S. Cl.** **184/24,** 55/112, 92/155, 92/249, 308/238
[51] **Int. Cl.** **F16n 15/02**
[50] **Field of Search** 308/238; 55/112; 184/6, 24, (1E); 92/153, 155, 248, 249, 170

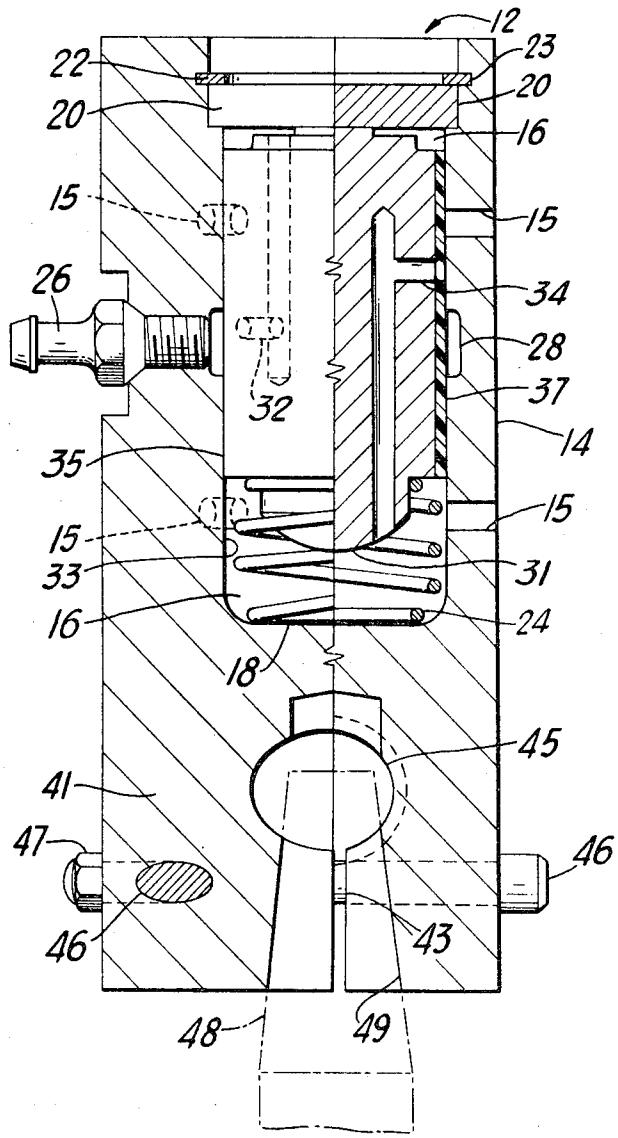
[56] **References Cited**

UNITED STATES PATENTS

2,854,089	9/1958	White et al.	55/112
2,985,802	5/1961	Drenning	55/112
3,030,753	4/1962	Pennington	55/112
3,149,543	9/1964	Naab	92/155
3,298,753	1/1967	Eaton, Jr.	308/238
3,464,845	9/1969	Osborn et al.	308/238X
3,479,007	11/1969	Buell	308/238X

Primary Examiner—Manuel A. Antonakas
Attorneys—Oscar B. Brumback, Boyce C. Dent and Olin E. Williams

ABSTRACT: A pneumatically operated rapper including a piston reciprocable within a cylinder adapted to strike an anvil within said cylinder thereby imparting vibrations to a structure connected to said rapper, wherein the improvement comprises providing said piston and said cylinder of dissimilar materials of which one material possesses dry lubricating properties and one of said dissimilar materials is covered with a thin film of low friction material which is erodable by abrasion between said piston and said cylinder to form microscopic particles for coaction with said dry-lubricating material, thereby conditioning the coacting surfaces of the piston and cylinder for reduced friction and continuous dry-lubrication thereof.



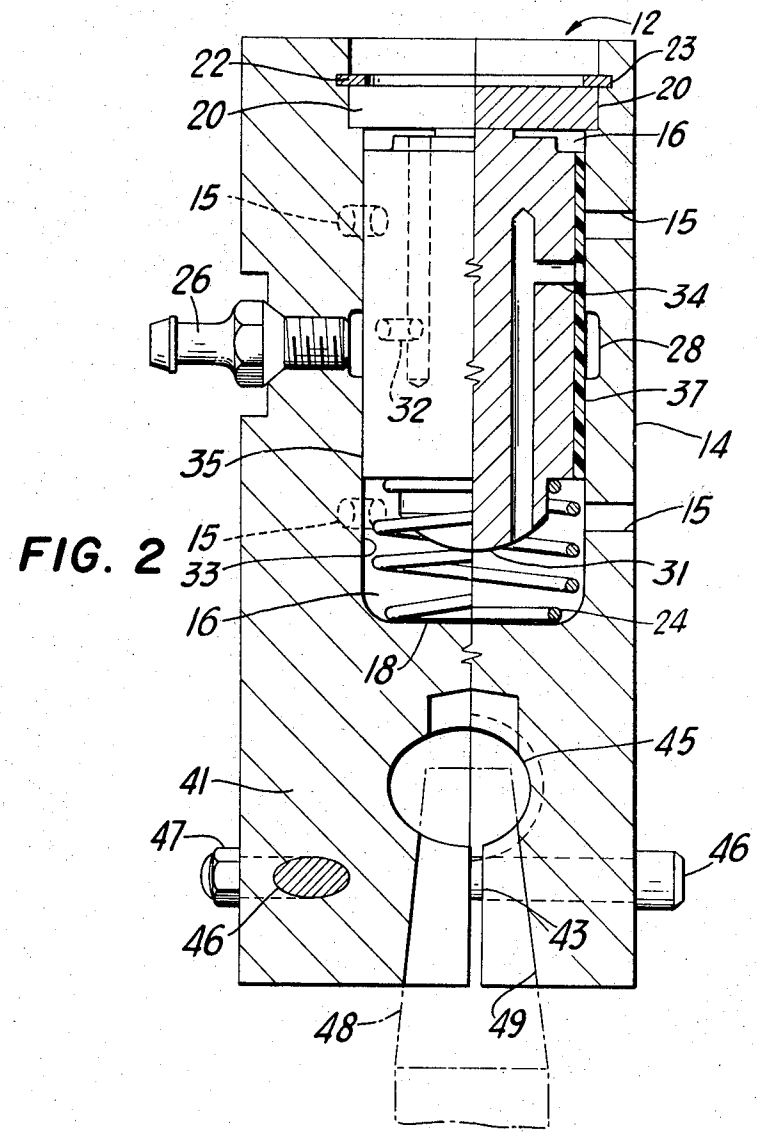


FIG. 2

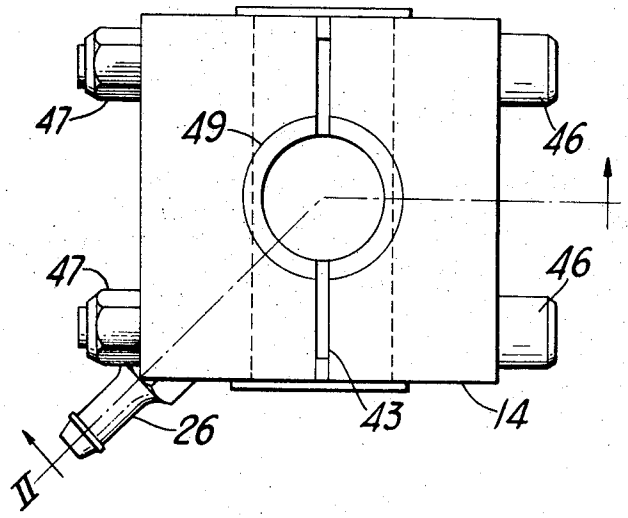


FIG. 1

INVENTOR.
CHARLES H. RODGERS
BY Boyce C. Dent
HIS ATTORNEY

APPARATUS FOR LUBRICATING PNEUMATIC RAPPERS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to gas separation devices and more particularly to vibrating, jarring, or rapping means for the collector and discharge electrodes of an electrostatic precipitator.

2. Description of the Prior Art

Conventionally, in electrostatic precipitators, a particle laden gas stream is directed through banks of large vertically suspended sheet metal collector electrode plates. Between these collector plates are vertically suspended discharge electrode wires. High voltage applied to the electrode wires ionizes the gas. Dust particles in the gas become charged and are thus attracted to the collector electrode plates. The plates and wires must be kept free of accumulated dust to function properly. Pneumatic rappers are often used to transmit vibrations to the electrodes thus causing the deposited dust particles to break loose and fall into a hopper at the bottom of the precipitator. Rappers of both the single impulse type and the rapidly reciprocating type are used. The precipitation operation described in connection with the present invention is best accomplished by the use of a rapper of the rapidly reciprocating type.

One recurring problem in such rappers is the lack of an adequate lubricating means between the coacting annular surfaces of the piston and the rapper housing. Improved lubrication means would greatly increase the life of the rapper assembly, require a minimum of servicing and maintenance, provide the necessary durability to withstand the rapid reciprocations, and be produced economically.

One solution to the problem as shown in Pennington's U.S. Pat. No. 3,030,753 is to apply a polytetrafluoroethylene (hereinafter referred to as PTFE) tape to the wall of the piston thus reducing friction between coacting annular surfaces of the piston and the rapper housing. While such use of the PTFE tape has improved the life of the rapper assembly, it has presented production problems because of the need to achieve a firm bond when applying the PTFE tape to the piston wall. Pennington threads the outer surface of the bearing lands and then applies an epoxy resin thereto to bond the tape to the lands, clamps the tape in place and cures it in an oven. This method of production has proved to be expensive. Also, it has been found that the tape must be at least three thirty-seconds of an inch in thickness to wear properly and if it is greater than one-fourth of an inch thick the leading edge tends to flow or stretch in operation. Such flowing or stretching sometimes causes the tape to be severed from the piston.

An improvement was provided by Rodgers et al. as disclosed in their aforementioned application wherein it is disclosed, among other things, that a ductile iron piston disperses a sufficient amount of nodular graphite to adequately lubricate the coacting annular surfaces of a piston and cylinder provided the piston reciprocates slowly. Thus, this improvement works best for single impulse rappers. It does not improve the operation of rapidly reciprocating rappers as much as desired.

SUMMARY OF THE INVENTION

It has been discovered according to the present invention that a lubricating means can be provided which performs satisfactorily in a rapidly reciprocating rapper by cooperating with the materials comprising the piston and the rapper housing to achieve the desired results. This means includes a housing made of a first material and a piston made of a dry lubricating material having PTFE sprayed on the annular surface of the piston.

Surprisingly, it was found that a synergistic action occurs between the PTFE and the coacting annular surfaces of the piston and the housing, that is, some of the PTFE erodes by abrasion of the coacting annular surfaces thus producing microscopic particles of PTFE which then cooperate with the dry lubricating material also eroded from the piston after portions of the PTFE film have worn away. The particles condition the coacting annular surfaces thereby providing a continuous dry lubricant between them for reducing friction and increasing wear life.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings wherein like parts are marked alike:

FIG. 1 is an end view of the rapper assembly;

FIG. 2 is a cross-sectional elevation of the rapper assembly taken along line II–II of FIG. 1 including a partial cross-sectional elevation of the piston.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 2, rapper assembly 12 comprises a rapper housing 14 having a cylindrical cavity 16 therein in which piston 30 reciprocates. Air supplied from a suitable source (not shown) enters rapper 14 through air inlet fitting 26 which directs the air to annular groove 28 and subsequently through ducts 32 and 34 provided in piston 30 thus causing piston 30 to reciprocate in the conventional manner. During reciprocation, the spherical striking end 31 of piston 30 strikes anvil 18 very rapidly to produce vibrations which are transmitted to a supporting structure (not shown) by a rod 48.

Spring 24 urges piston 30 toward the upper portion of cavity 16 at the end of each rapping cycle to prevent piston 30 from stopping in the center of the cavity 16 in a null position. The upper end of cavity 16 is closed with end cap 20 by an interference fit between it and enlarged cavity 21. A snap ring 22 seated in a groove 23 provides a fail-safe connection for the end cap 20.

Due to the rapid reciprocation of piston 30, usually between 3000 and 4000 cycles per minute, rapper assembly 12 tends to be driven downward into tighter engagement with rod 48; however, since rapper 12 may be used in the horizontal position, bolts 46 and nuts 47 are provided to clamp the flanges 41 formed by slot 43 and stress relieving hole 45 tightly against the tapered rod 48 seated in a corresponding tapered hole 49 in housing 14.

When a piston reciprocates within a cylinder at between 3000 and 4000 c.p.m., a serious lubrication problem is developed. A satisfactory means of lubricating the coacting annular surfaces of the piston and the cylinder is needed to enable the rapper to function properly as it would not be feasible to use a rapper which had to be continuously serviced and often replaced.

The use of oil as a lubricant is unsatisfactory since an elaborate means of evenly distributing oil throughout the cylinder must be used and the supply of oil must be constantly replenished.

It has been found that if the annular surface 33 of cavity 16 is made of a first material having no particular lubricating properties and the coacting annular surface 35 of piston 30 is made of a dry lubricating material such as ductile iron and a film of PTFE 37 is provided on one of the annular surfaces, some of the PTFE 37 erodes from abrasion between the annular surfaces during reciprocation of the piston to condition the surfaces for reduced friction operation and continuous dry lubrication.

Although several material combinations fall within the preferred boundary conditions hereinbefore stated it has been discovered that certain materials perform to a higher degree of proficiency than others.

Accordingly, the preferred material for the annular surface 33 of cavity 16 is steel roll finished at least as smooth as 400 R.M.S. or ground or turned to a finish at least as 200 R.M.S. and then roll finished to substantially 30 R.M.S. The annular surface 35 of piston 30 is a dry lubricating material, preferable ductile iron which contains dispersed nodules of graphite.

The PTFE film or coating 37 is preferably applied to the outer surface 35 of the piston 30 rather than surface 33 of

cavity 16. The outer surface of the piston rubs against the inner wall 33 of the cylinder during reciprocation causing erosion of the PTFE coating. This erosion causes microscopic particles of PTFE to form and causes the surface of the ductile iron to become gradually exposed. Upon exposure of the ductile iron, nodules of graphite break free and form into microscopic particles. These particles combine with the particles of PTFE to form a conditioning mixture of particles which tend to become imbedded in the rubbing surfaces of the piston and cylinder.

It is believed that the use of ductile iron as the piston material enhances the tendency of the powder mixture to become imbedded since the ductile iron is inherently more porous than the steel surface 33. Nevertheless, some of the mixture becomes imbedded in surface 33 so that the end result is that the rubbing surfaces between the piston and cylinder are both coated with a low friction material. Of course, the surface 33 can also be made of ductile iron but since the preferred combination works well, there is no special need to do this.

The PTFE coating may be applied to either the annular surface of the piston or cylinder and reach substantially the same results.

However, it is usually easier to coat the PTFE 37 onto the annular surface 35 of the piston 30 than to the surface 33. As illustrated herein, coating 37 is sprayed on the annular surface 35 of piston 30 in layers of between .0006 inches and .0012 inches thick. Additional layers are applied until the coating 37 is between .0006 and .0020 inches thick. Advantageously, the thickness of coating 37 does not exceed a maximum of .0030 inches thick because the coating is expensive and a coating of greater thickness than .0030 inches does not erode at a desirable rate or expose a sufficient surface area of piston 30. Coatings of a thickness less than .0006 inches on the other hand do not provide enough PTFE particles upon erosion to create a sufficient mixture with the nodules of graphite to provide the desired lubricating properties. Coating 37 may be applied to piston 30 by conventional methods. However, spraying of the PTFE to the surface is convenient and provides a uniform coating of PTFE.

In operation, air under pressure is supplied from a suitable source (not shown) and enters housing 14 through fitting 26 and is directed into annular groove 28. Piston 30 is thereby activated due to the air in groove 28 passing alternately to opposite ends of cavity 16 through ducts 32 and 34 provided in piston 30. The network of ducts 32 and 34 in piston 30 and vents 15 in housing 14 cause air to be supplied to opposite ends of cavity 16 thus changing air pressure therein and causing piston 30 to reciprocate rapidly in the conventional manner.

As piston 30 reciprocates, the coating 37 acts to reduce friction between annular surfaces 33 and 35; however, after many reciprocation cycles, the particles of PTFE coating 37 slowly erode by abrasion between surfaces 33 and 35 thereby producing microscopic particles of PTFE. Gradually, portions of annular surface 35 of piston 30 become exposed thus causing nodules of graphite to be dispersed within cavity 16.

When the nodules of graphite are dispersed, they mix with the microscopic particles of PTFE already eroded and form a dry lubricating mixture within cavity 16. This mixture becomes imbedded in surfaces 33 and 35 due to the rubbing of the surfaces thus creating a conditioning of the surfaces and greatly reducing friction between them. In addition, the mixture provides a continuous dry lubricant to further enhance the coaction of the annular surfaces 33 and 35.

Tests indicate that the present invention provides continuous lubrication for pistons reciprocating rapidly within a rapper housing which requires no servicing or replacement for long periods of time.

Having thus described the invention in its best embodiment and mode of operation, that which is desired to be claimed by Letters Patent is:

I claim:

1. In pneumatically operated apparatus including a piston rapidly reciprocable within a cylindrical housing to impart vibrations to a structure connected to said housing and wherein an outer annular surface of said piston is in rubbing engagement with an inner annular surface of said cylindrical housing, the improvement comprising:

one of said annular surfaces comprising a first material having dry-lubricating particles therein and the other of said annular surfaces comprising a second material different from said first material; and

a substantially thin coating of PTFE provided on one of said annular surfaces whereby the rubbing engagement resulting from reciprocation of said piston forms microscopic particles of said PTFE from said coating and releases microscopic particles of dry-lubricating particles from said first material for the mixing with said particles of PTFE for conditioning said annular surfaces for reduced friction.

2. The apparatus of claim 1 wherein said first material is ductile iron having nodules of graphite therein.

3. The apparatus of claim 2 wherein said second material is steel.

4. The apparatus of claim 3 wherein said PTFE coating comprises a coating of PTFE having a thickness of between .0006 inches and .0030 inches.

5. The apparatus of claim 4 wherein said inner annular surface has a rolled finish no coarser than 400 R.M.S.

6. The apparatus of claim 4 wherein said inner annular surface has a rolled finish at substantially 30 R.M.S.

7. The apparatus of claim 3 wherein said coating of PTFE is applied to said steel surface.