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(54) **TEST PORT ASSEMBLY FOR ALLOWING A TEST PROBE TO BE INSERTED INTO A CONDUIT**

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G01N 1/26 (2006.01)

(52) **U.S. Cl.** **73/866.5**; 73/863.82

(58) **Field of Classification Search** 73/866.5, 73/863.85, 863.82

See application file for complete search history.

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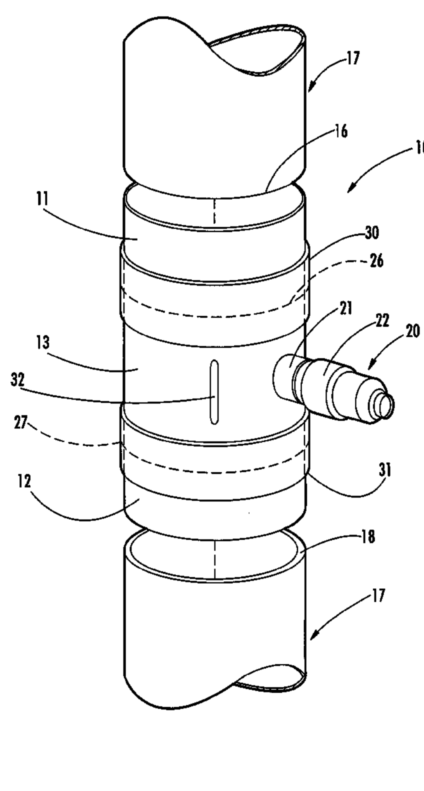
(57) **ABSTRACT**

This invention relates to a rotating test port assembly for measuring air flow and particulate matter in conduits. The test port assembly includes a first end section, a second end section, and a rotating section adapted for rotation between the first and second end sections. The assembly further includes a test port positioned on the rotating section for allowing a test probe to be inserted into a stream flowing in a conduit.

14 Claims, 7 Drawing Sheets



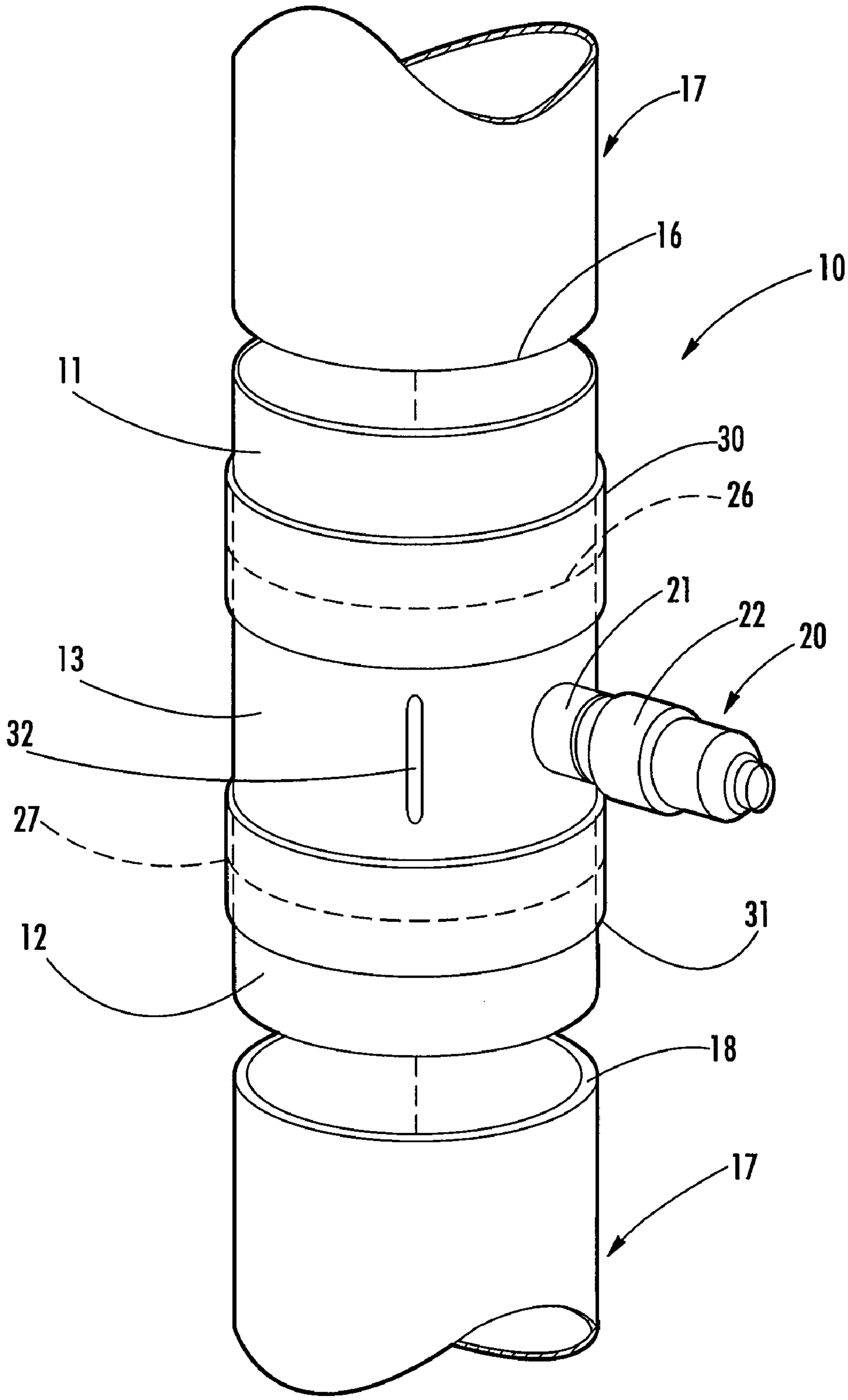


FIG. 1

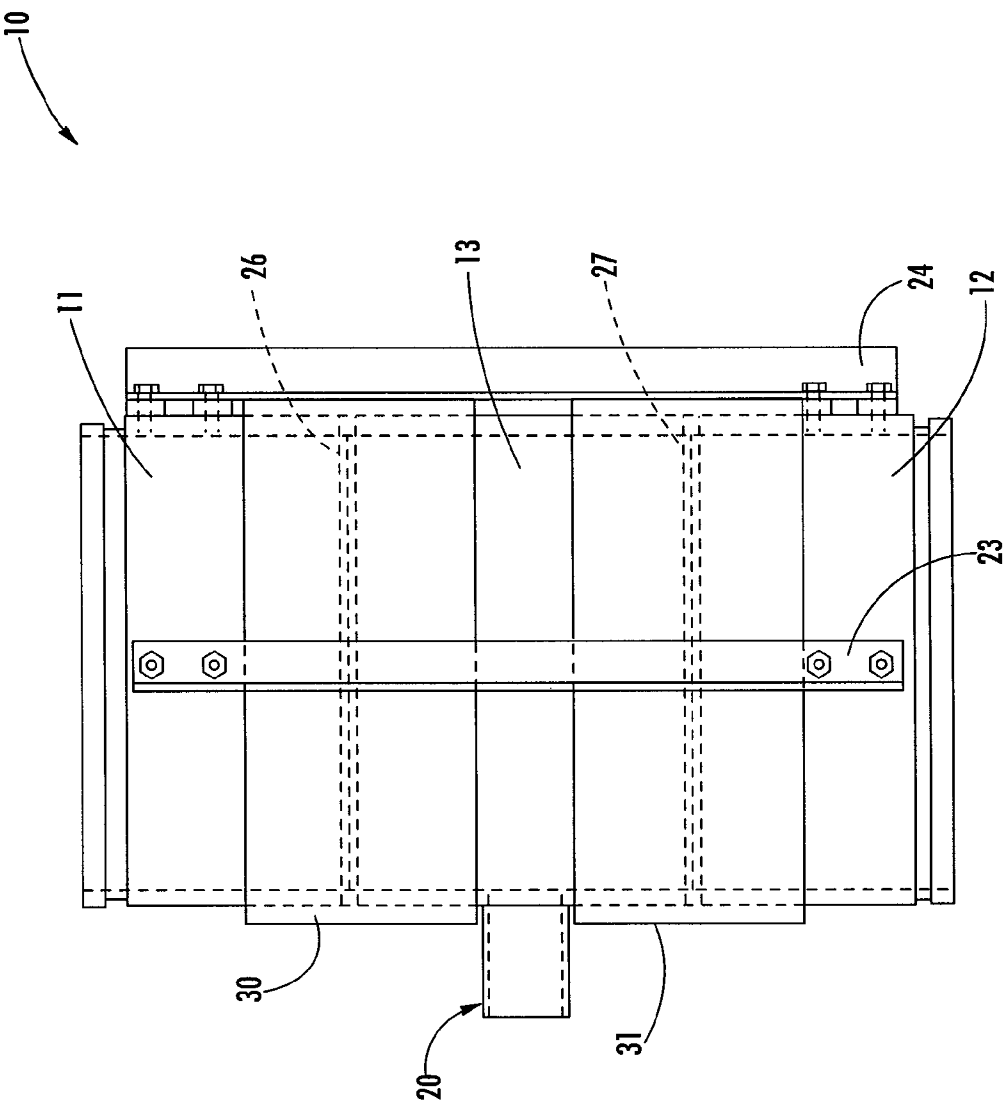


FIG. 2

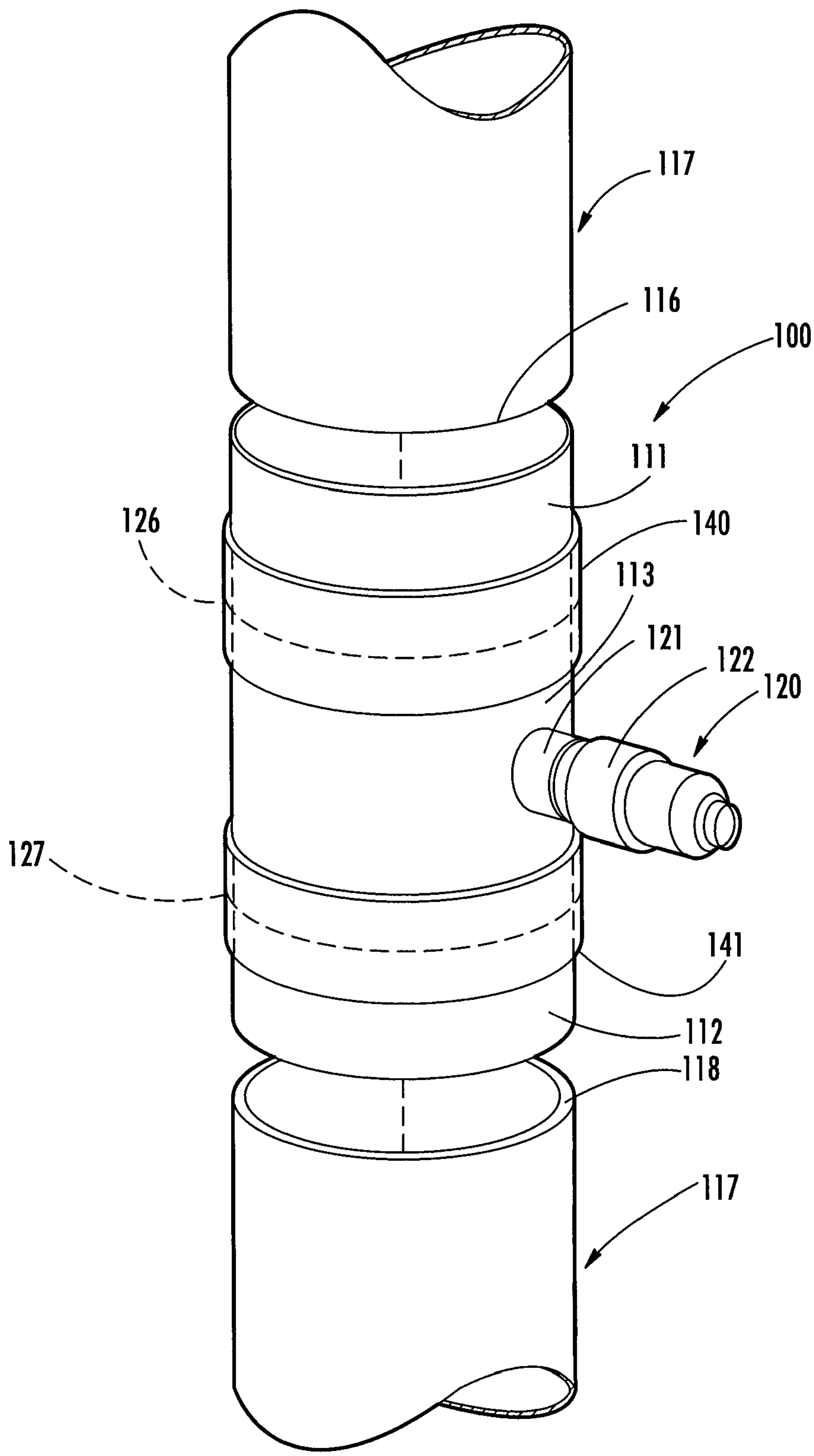


FIG. 3

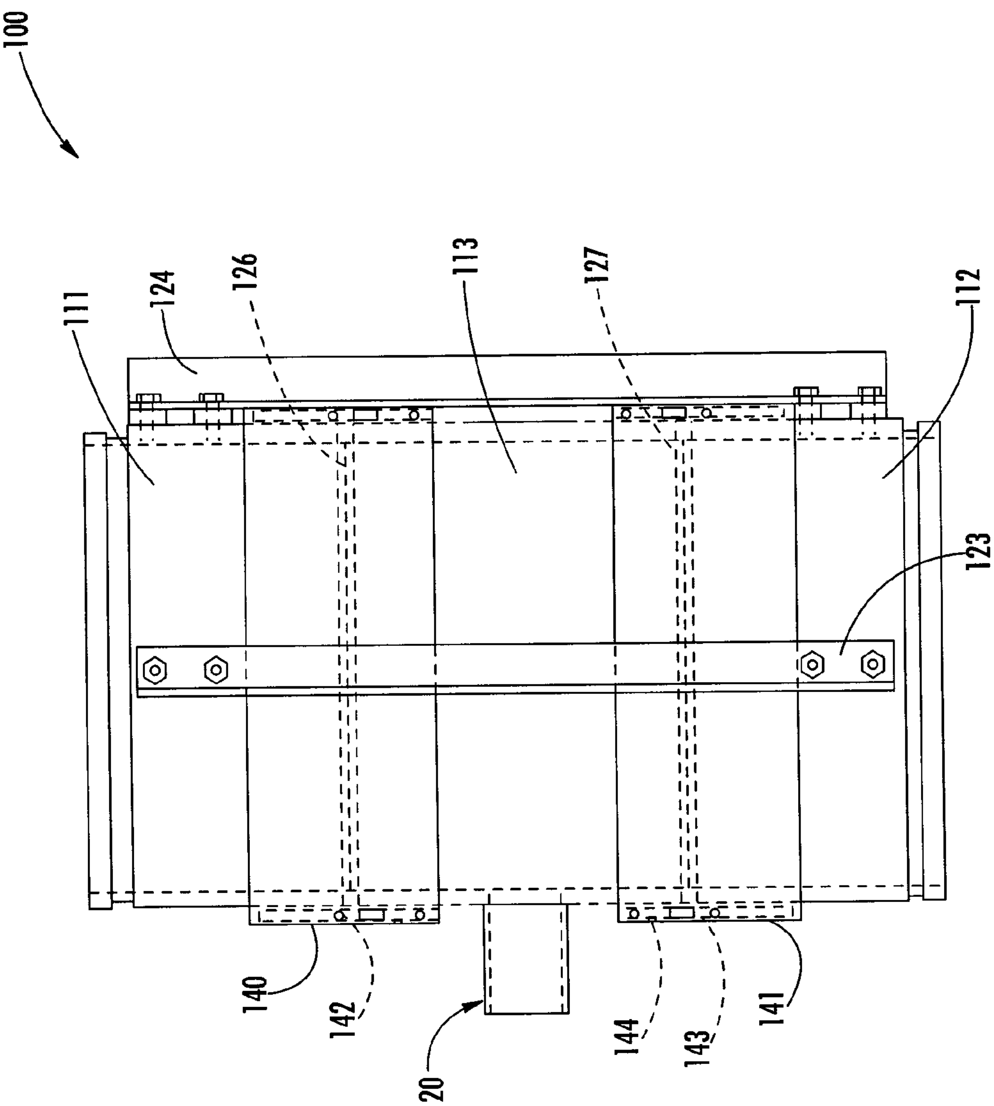
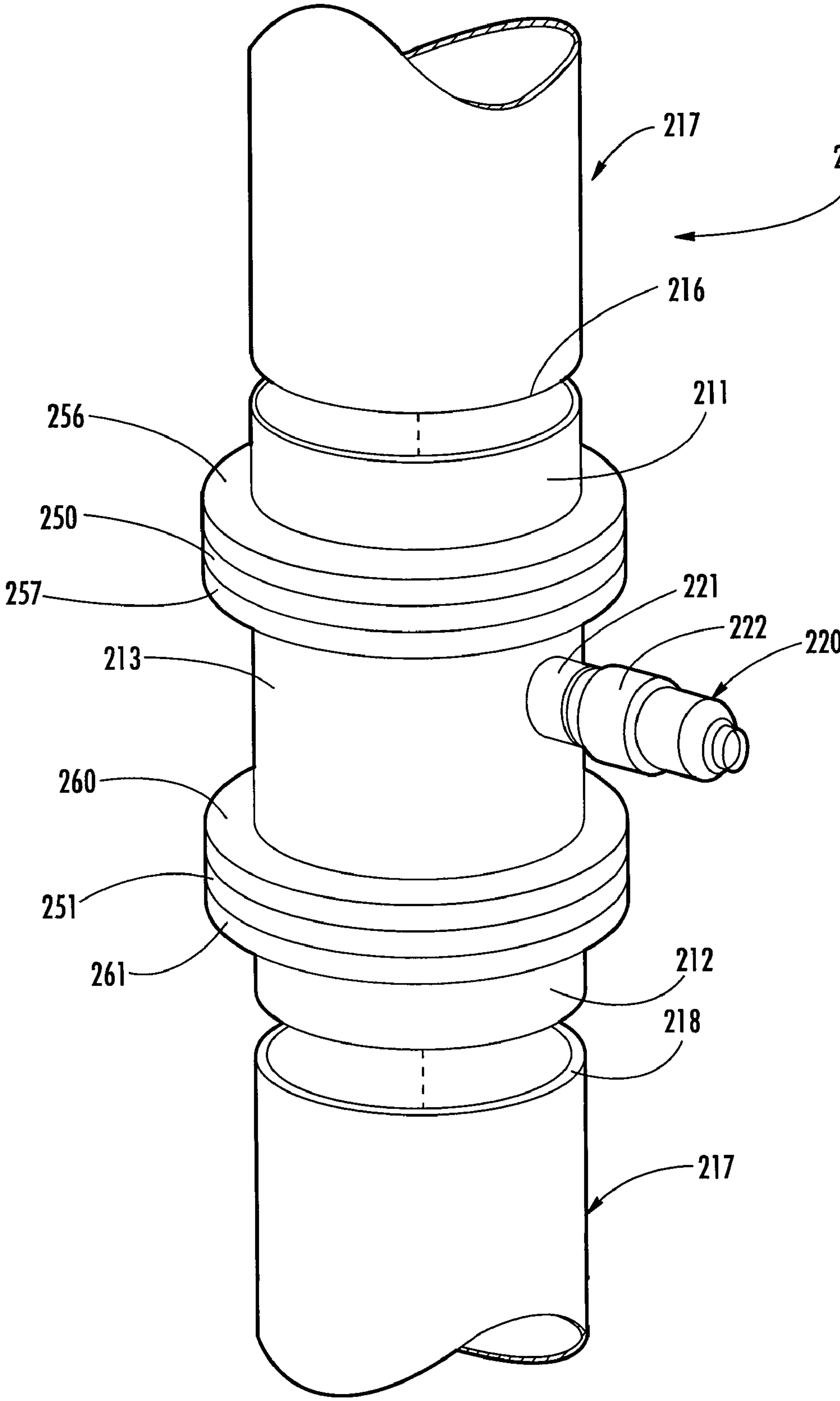


FIG. 4


217
200
216
211
256
250
257
221
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220
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FIG. 5

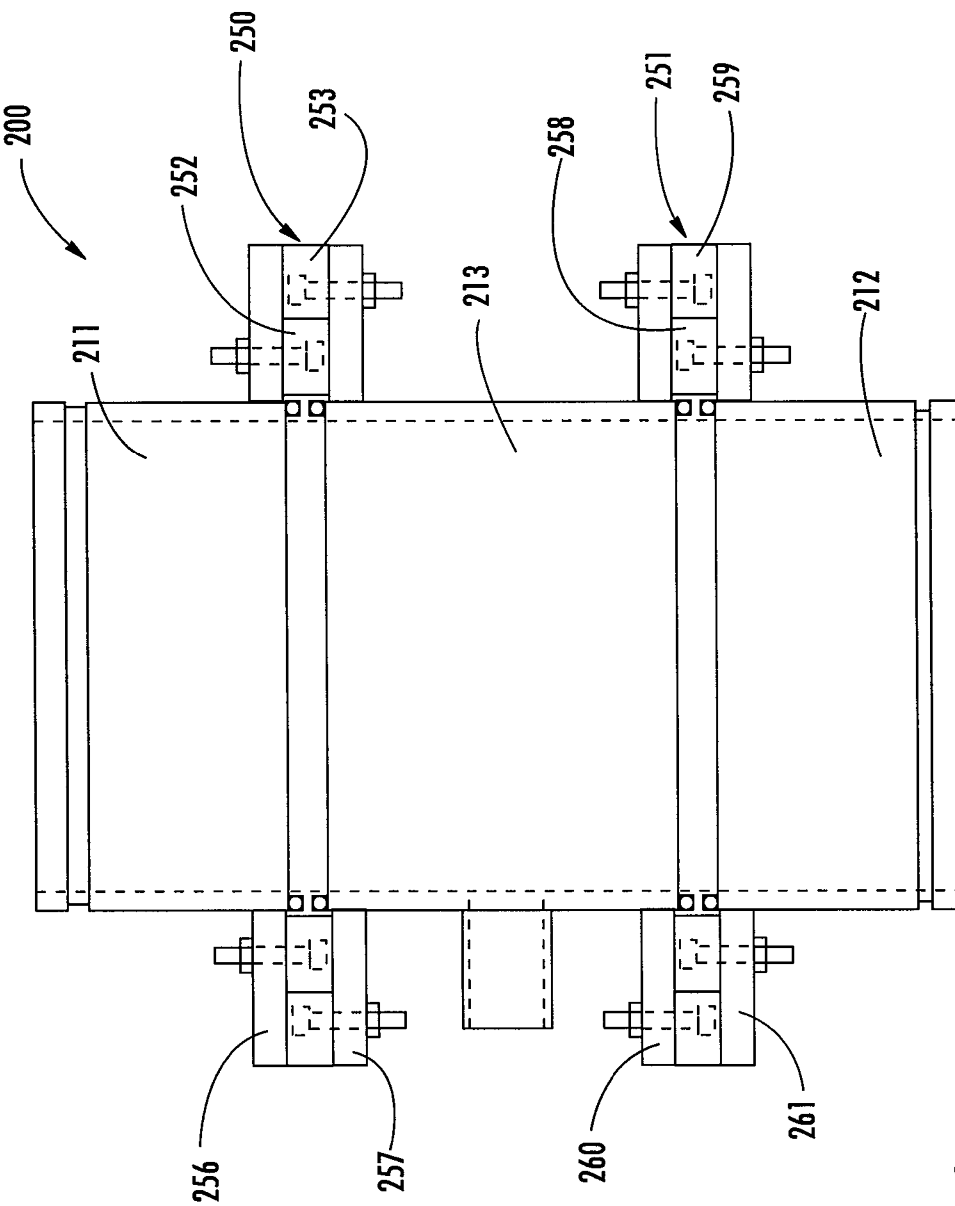

FIG. 6

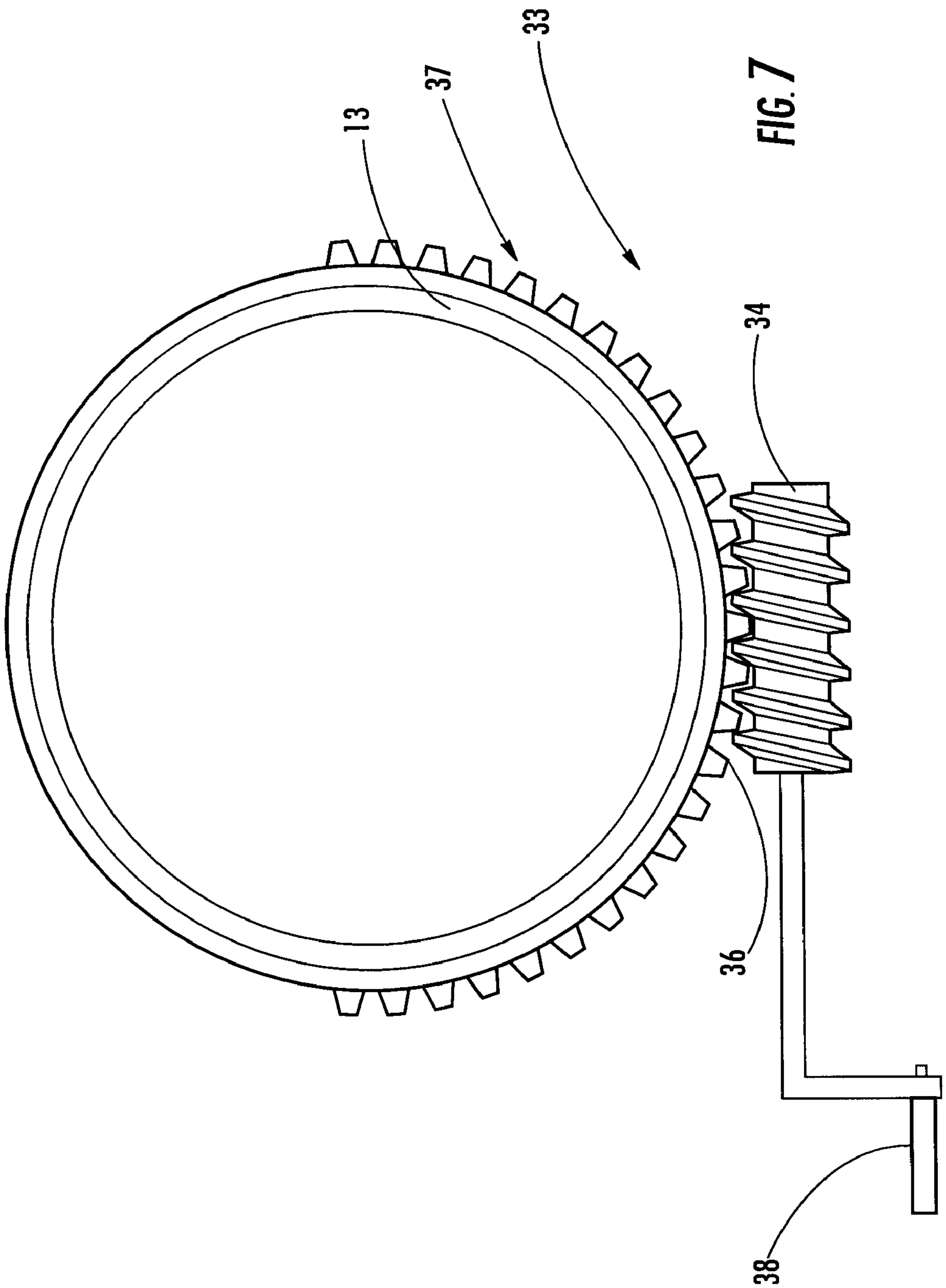

FIG. 7

TEST PORT ASSEMBLY FOR ALLOWING A TEST PROBE TO BE INSERTED INTO A CONDUIT

BACKGROUND OF THE INVENTION

The present invention relates generally to an apparatus and method for measuring airflow and particulate matter, and more particularly to a rotating test port assembly for measuring air flow and particulate matter in conduits.

The measurement of air flow and particulate matter in a conduit, such as piping, is of great importance to facilities such as power plants where environmental and operational efficiency are of concern. Currently, power plants use a manual measurement process to determine the air flow and the amount of particulate matter contained therein flowing through a conduit. This is done by inserting a test probe device through one or more test ports. The test ports, typically two to four, are welded directly to the conduit to allow the probe to be inserted into a stream of air and particulate matter flowing through the conduit. Typically, a standard ball valve is connected to each of the test ports to allow a user controlled access to the stream. When access is desired, the ball valve is opened and the test probe is inserted therethrough. When testing is finished, the test probe is removed, and the ball valve is closed to prevent the stream from exiting the conduit through the test port.

However, the current measurement process has limitations and can often result in erroneous measurements because the probe only traverses a straight line and portions of the flow area are not measured. Since portions of the flow area are not measured, these portions are assumed for calculating the true flow rate of air in the conduit, thereby resulting in errors. If a two-phase flow of air and particulate matter is being measured, both the air velocity and the particulate flow measurement are affected resulting in degradation of these assumptions and causing even greater errors. Through testing, it has been found that the error in particulate matter measurement may be as high as thirty-five percent of the true flow rate.

One way to combat these errors is to increase the number of test ports on the conduit; however, there are limitations to the number of test ports that can be installed due to the size of the conduit, the material of the conduit, and the service the conduit is being used in. For example, conduits used in corrosive environments may have ceramic linings which limit the number of test ports that can be installed.

Another solution used to reduce measurement errors is to use an articulated test probe that allows a tester to take a measurement in a pattern other than a straight line and, thus cover more of the cross sectional area of the conduit. However, these probes have limitations that affect their accuracy and that cannot easily be corrected or even determined. For example, one of the more common articulated probes has multiple extraction nozzles that draw in particulate matter simultaneously. However, in certain conduit configurations and flow conditions the multiple nozzles may not sample equally. Also, because these probes have moving parts and seals, there is potential for leakage in the sample lines that can adversely affect the measurements. In some instances, the articulated probes become jammed inside the conduit which makes their retrieval from the sampling line difficult. In other instances, the articulated probes, which have a much more complex internal flow path, may become plugged because of moisture content in the sampling stream therefore voiding the measurement.

BRIEF SUMMARY OF THE INVENTION

These and other shortcomings of the prior art are addressed by the present invention, which provides a rotating test port assembly for accurately measuring air and particulate matter flow in a conduit.

According to one aspect of the present invention, a test port assembly includes a first end section, a second end section, a rotating section, and a test port. The rotating section is adapted for rotation between the first and second end sections. The test port is positioned on the rotating section to allow a test probe to be inserted into a stream flowing in a conduit.

According to one aspect of the present invention, a test port assembly adapted for replacing a portion of a conduit includes a first end section, a second end section, a rotating section, and a test port. The first end section is connected to a first end of the conduit. The second end section is connected to a second end of the conduit. The rotating section is positioned and adapted for rotation between the first and second end sections, and the test port is positioned on the rotating section to allow a test probe to be inserted into a stream flowing in the conduit.

According to another aspect of the present invention, a method for testing a stream in a conduit includes the steps of replacing a section of the conduit with a test port assembly having a first end section, a second end section, a rotating section positioned between the first and second end sections, and a test port positioned on the rotating section. The method further includes the steps of inserting a test probe into the test port until the probe is positioned at a desired location within the stream, and rotating the rotating section to extract data from the test probe at various data points within the conduit.

BRIEF DESCRIPTION OF THE DRAWINGS

The subject matter that is regarded as the invention may be best understood by reference to the following description taken in conjunction with the accompanying drawing figures in which:

FIG. **1** shows a rotating test port assembly according to an embodiment of the invention.

FIG. **2** is a cross-sectional view of the test port assembly of FIG. **1**.

FIG. **3** shows a rotating test port assembly according to an embodiment of the invention.

FIG. **4** is a cross-sectional view of the test port assembly of FIG. **3**.

FIG. **5** shows a rotating test port assembly according to an embodiment of the invention.

FIG. **6** is a cross-sectional view of the test port assembly of FIG. **5**.

FIG. **7** shows a gear arrangement for use on the test port assemblies of FIGS. **1**, **3**, and **5**.

DETAILED DESCRIPTION OF THE INVENTION

Referring to the drawings, an exemplary rotating test port assembly according to an embodiment of the invention is illustrated in FIGS. **1** and **2** and shown generally at reference numeral **10**. The test port assembly **10** includes a first end section **11**, a second end section **12**, and a rotating section **13** positioned and adapted for rotation between the first and second end sections **11** and **12**.

As shown, the first and second end sections **11** and **12** are adapted to be attached to a first end **16** of a conduit **17** and a second end **18** of the conduit **17**, respectively. The first and second end sections **11** and **12** may be attached to the first and second ends **16** and **18** using various methods. For example, the ends could be welded (including the use of adhesive for plastic conduits) together, each of the ends could have flanges to allow the ends to be bolted together, or as shown in FIG. **2**, the ends could be grooved to allow the use of pipe couplings.

A test port **20** is positioned on the rotating section **13** to allow the insertion of a test probe (not shown). The test port **20** allows a test probe to access a stream of air, particulates, or fluid flowing within the conduit **17** to extract measurements therein. The test port **20** may be formed of a short piece of conduit **21** and a valve **22**, such as a ball valve, to allow the test probe to be inserted therethrough and to prevent the stream from exiting the test port **20** when not being used. Other configurations could also be used so long as the test port **20** is capable of allowing the test probe to be inserted therethrough and capable of closing to prevent the stream from exiting through the test port **20**.

Supports **23** and **24** are connected to the first and second end sections **11** and **12** to provide stability to the assembly **10** and assure that the rotating section **13** is secured for rotation between the first and second end sections **11** and **12**. It should be appreciated that the supports may be placed at various positions around the assembly **10** to not only provide adequate support, but also to create different degrees of rotation for the test port **20**.

Joints **26** and **27** are formed between the first end section **11** and the rotating section **13** and between the second end section **12** and the rotating section **13**. The joints **26** and **27** allow the first end section **11**, the rotating section **13**, and the second end section **12** to be properly aligned and are adapted to allow the rotating section **13** to rotate between the first and second end sections **11** and **12**. Seals **30** and **31** are wrapped around the joints **26** and **27**, respectively, to prevent the stream flowing through the assembly **10** from escaping through the joints **26** and **27**. In this example, the seals are a rubber boot type seal, but any suitable seal type and material could be used.

In use, the conduit **17** is cut to remove a section of the conduit **17** and allow the assembly **10** to be inserted in its place. As discussed above, the assembly may be attached to the conduit by welding, flanges, couplings, or any other suitable method. Once the assembly **10** is secured in the conduit **17**, measurements of the stream flowing through the conduit may be taken. The measurements are taken by inserting a test probe into the test port **20** until the test probe is positioned into the stream at a desired position within the conduit **17**. Once the test probe is inserted into the stream, tests can be performed at various test points within the conduit **17** by rotating the rotating section **13**. This can be done by using a handle **32** positioned on the rotating section **13**, as shown in FIG. **1**, or by a gear set **33**, shown in FIG. **7**. As shown, the gear set **33** uses a worm gear **34** to interact with teeth **36** of a gear **37** positioned on the rotating section **13**. It should be appreciated that any suitable type of gears for rotating the rotating section **13** could be used. As shown, the gear set **33** is operated by a hand crank **38**; however, the gear set **33** may also be actuated by an electric motor, pneumatics, or any other suitable actuator.

Referring to FIGS. **3** and **4**, a test port assembly **100** according to another embodiment of the invention is shown. The test port assembly **100** is similar to the test port assembly **10** in that it includes first and second end sections **111** and **112**, a rotating section **113**, and a test port **120** having a valve **122**. The test port assembly **100** is also installed and operated like test port assembly **10**. Unlike test port **10**, test port assembly **100** includes a sleeves **140** and **141** and o-ring seals **142** and **143**.

The sleeves **140** and **141** are connected to the first and second end sections **111** and **112**, respectively, and provide additional support to the assembly **100**, as well as aid in the alignment of the end sections **111** and **112** and the rotating section **113**. The sleeves **140** and **141** may be integrally formed with the end sections **111** and **112** or may be attached to the end sections **111** and **112** by welding, or any other suitable method to provide a sealed and secure attachment. The o-rings **142** and **143** provide a seal between the rotating section **113** and the sleeves **140** and **141**, respectively, to prevent leakage of the stream flowing through the assembly **100**.

A seal air port **144** may also be used in the assembly **100** to provide additional sealing capabilities and to prevent particles from entering between the sleeves **140** and **141** and the rotating section **113**, thereby preventing particulate matter from interfering with rotation of the rotating section **113**.

Referring to FIGS. **5** and **6**, a test port assembly **200** according to another embodiment of the invention is shown. Like test port assemblies **10** and **100**, test port assembly **200** includes first and second end sections **211** and **212**, a rotating section **213**, and a test port **220** having a valve **221**. The test port assembly **200** is also installed and operated like test port assemblies **10** and **100**. Unlike test port assemblies **10** and **100**, test port assembly **200** uses bearings **250** and **251** instead of supports and seals.

Bearing **250** is positioned between the first end section **211** and the rotating section **213**, and includes an inner ring **252** and an outer ring **253** to allow rotation of the rotating section **213**. As illustrated in FIG. **6**, the bearing **250** is sandwiched between flanges **256** and **257**. Flange **256** is connected to the first end section **211** and flange **257** is connected to the rotating section **213**. The inner ring **252** is bolted to flange **256** and the outer ring is bolted to flange **257**. Bearing **251** is sandwiched between the second end section **212** and the rotating section **213**, and also includes an inner ring **258** bolted to a flange **261** connected to the second end section **212** and an outer ring **259** bolted to a flange **260** connected to the rotating section **213**.

The bearings **250** and **251** allow the rotating section **213** to rotate easily between the first and second end sections **211** and **213**. Because the bearings **250** and **251** are bolted to flanges, the bearings **250** and **251** support and align the assembly **200**, thereby eliminating the need for supports like those used in assemblies **10** and **100**. Because the bearings **250** and **251** support the assembly **200**, they provide the ability to rotate the test port **220** three hundred and sixty degrees, thereby allowing a test probe to provide measurements around the entire conduit **217**.

The foregoing has described a test port assembly. While specific embodiments of the present invention have been described, it will be apparent to those skilled in the art that various modifications thereto can be made without departing from the spirit and scope of the invention. Accordingly, the foregoing description of the preferred embodiment of the invention and the best mode for practicing the invention are provided for the purpose of illustration only and not for the purpose of limitation.

What is claimed is:

1. A test port assembly, comprising:

(a) a first end section;

(b) a second end section;

(c) a rotating section adapted for rotation about the central axis of a conduit and positioned between the first and second end sections; and

(d) a test port positioned on the rotating section for allowing a test probe to be inserted into a stream flowing in said conduit.

2. The test port assembly according to claim **1**, wherein the test port includes a valve to prevent the stream from exiting the conduit through the test port.

3. The test port assembly according to claim **1**, wherein the first end section is connected to a first end of the conduit and the second end section is connected to a second end of the conduit such that the test port assembly is aligned with the conduit.

4. The test port assembly according to claim **1**, wherein at least one support is connected to the first and second end sections to support and align the test port assembly.

5. The test port assembly according to claim **1**, further including at least one seal to prevent the stream from exiting the conduit through joints formed between the first end section and the rotating section and the second end section and the rotating section.

6. The test port assembly according to claim **1**, further including a gear for rotating the rotating section.

7. The test port assembly according to claim **1**, further including a handle positioned on the rotating section to aid in the rotation of the rotating section.

8. The test port assembly according to claim **1**, further including a first sleeve extending from the first end section and a second sleeve extending from the second end section, such that a portion of the rotating section is positioned within the first and second sleeves.

9. The test port assembly according to claim **8**, further including at least one seal positioned between the first sleeve and the rotating section and at least one seal positioned between the second sleeve and the rotating section to prevent the stream from exiting between the sleeves and the rotating section.

10. The test port assembly according to claim **1**, further including a first bearing positioned between the first end section and the rotating section and a second bearing positioned between the second end section and the rotating section to permit the rotating section to rotate.

11. The test port assembly according to claim **10**, wherein the first and second bearings each include an outer ring and an inner ring, the outer and inner rings being connected to flanges positioned on the first end section, the second end section, and the rotating section by fasteners.

12. A method for testing a stream in a conduit, comprising the steps of:

(a) replacing a section of the conduit with a test port assembly, having:

(i) a first end section;

(ii) a second end section;

(iii) a rotating section adapted for rotation about the central axis of the conduit and positioned between the first and second end sections; and

(iv) a test port positioned on the rotating section;

(b) inserting a test probe into the test port until the probe is positioned at a desired location within the stream; and

(c) rotating the rotating section to extract data from the test probe at various data points within the conduit.

13. The method according to claim **12**, further including the step of opening a valve of the test port to allow access to the stream.

14. The method according to claim **12**, further including the step of closing a valve of the test port to prevent the stream from exiting the conduit through the test port.

* * * * *