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An agency of Industry Canada

CA 2699059 C 2013/05/28

(11)(21) 2 699 059

(12) BREVET CANADIEN
CANADIAN PATENT

(13) C

(22) Date de dépôt/Filing Date: 2010/04/06

(41) Mise à la disp. pub./Open to Public Insp.: 2010/10/02

(45) Date de délivrance/Issue Date: 2013/05/28

(30) Priorités/Priorities: 2009/04/02 (US61/166,079);
2010/04/01 (US12/752,582)

(51) Cl.Int./Int.Cl. *B60K 28/10* (2006.01),
B60P 3/22 (2006.01)

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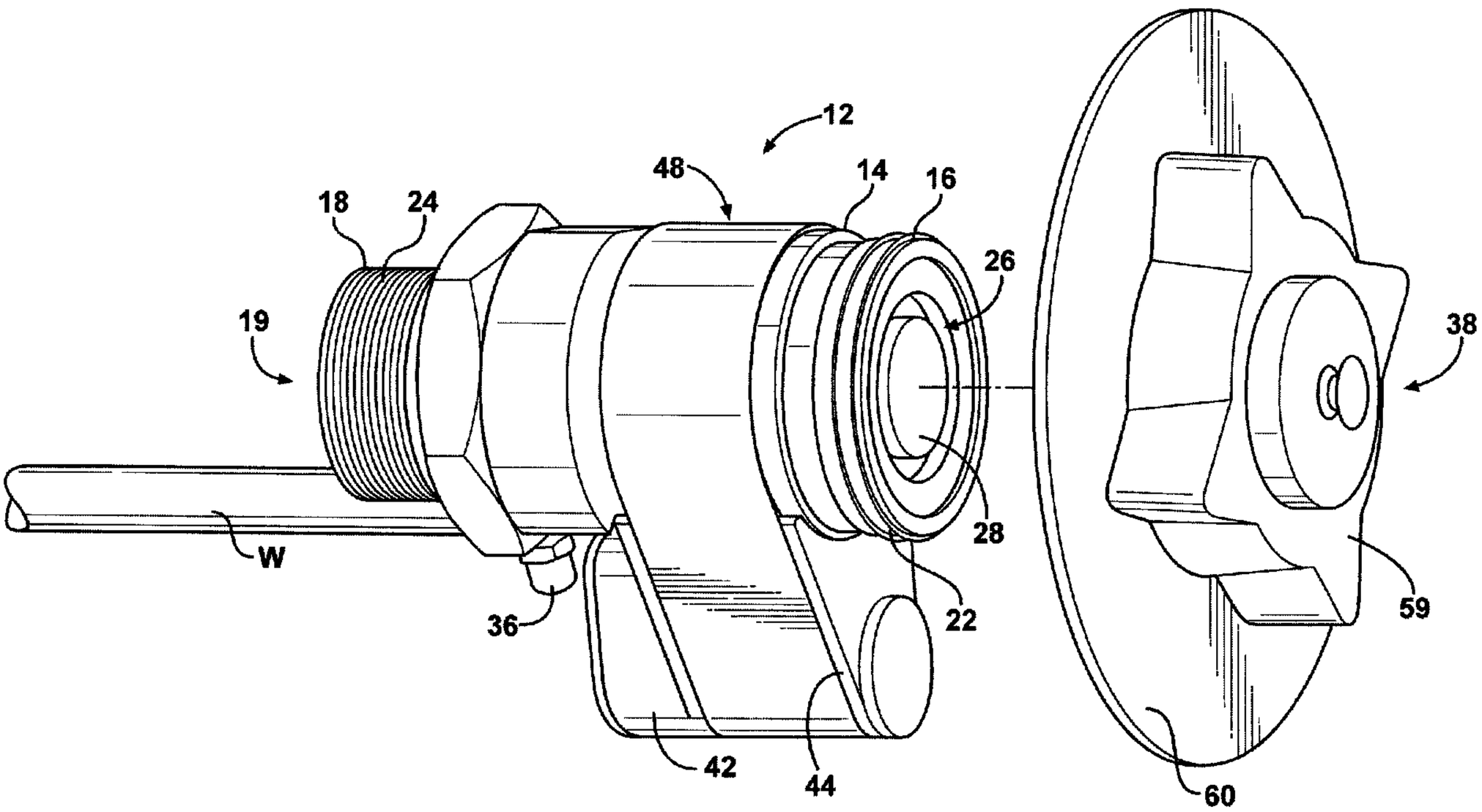
(54) Titre : SYSTEME ET METHODE PERMETTANT D'IMMOBILISER UN VEHICULE
(54) Title: SYSTEM AND METHOD FOR DISABLING A VEHICLE



(57) Abrégé/Abstract:
A system for disabling a vehicle carrying a storage tank includes a coupler component supported by the vehicle for receiving a connection from a delivery line. A cap is attachable to an end of the coupler component for preventing connection of the delivery line when the cap is attached. A proximity sensor is disposed outside of the coupler component and senses whether the cap is attached without making contact with the cap. A switch is in electrically connected to the sensor and disables at least one drive element of the vehicle, e.g., the transmission, when the cap is not attached to the coupler component.

SYSTEM AND METHOD FOR DISABLING A VEHICLE

ABSTRACT OF THE DISCLOSURE

A system for disabling a vehicle carrying a storage tank includes a coupler component supported by the vehicle for receiving a connection from a delivery line. A cap is attachable to an end of the coupler component for preventing connection of the delivery line when the cap is attached. A proximity sensor is disposed outside of the coupler component and senses whether the cap is attached without making contact with the cap. A switch is in electrically connected to the sensor and disables at least one drive element of the vehicle, e.g., the transmission, when the cap is not attached to the coupler component.

SYSTEM AND METHOD FOR DISABLING A VEHICLE

[0001]

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0002] The subject invention relates to a system and method for disabling a vehicle. More specifically, the subject invention relates to a system and method for disabling movement of a vehicle when a cap of a coupler component is not disposed on the coupler component.

2. Description of the Related Art

[0003] Motorized vehicles often carry storage tanks for holding a substance. The substance is typically delivered to or extracted from the storage tank via a hose. The hose is often attached to a coupling component to ensure that spillage of the substance is kept to a minimum. Unfortunately, often due to human error, the hose is left attached to the vehicle as the driver operates the vehicle. This invariably results in damage to the hose, the coupling component, or other equipment. Furthermore, spillage of the substance invariably occurs, which can have negative environmental, financial, and safety implications.

[0004] The prior art identifies some systems and methods for disabling a vehicle. Unfortunately, these systems often use moving mechanical parts to sense

whether or not a hose is attached to a vehicle. These moving mechanical parts are prone to failure over time. Furthermore, implementation of these prior art systems and methods typically require specialized coupler components and/or modification of existing coupler components.

[0005] The present invention solves these and other shortcomings of the prior art.

BRIEF SUMMARY AND ADVANTAGES

[0006] The subject invention includes a system for disabling a vehicle carrying a storage tank capable of holding a substance. The system includes a coupler component supportable by the vehicle for receiving a connection from a delivery line. The coupler component including a peripheral housing having a first end and a second end. The coupler component defines an inner passage for accommodating the flow of the substance therethrough and separating the inner passage from an outer region. A cap is attachable to the first end of the coupler component for preventing connection of the delivery line when the cap is attached to the coupler component. A sensor senses whether the cap is attached to the coupler component without making contact with the cap. The system also includes a switch in communication with the sensor and connectable to at least one drive element of the vehicle to disable the at least one drive element of the vehicle when the cap is not attached to the coupler component.

[0007] The subject invention also includes a method for disabling the vehicle carrying a storage tank, where the vehicle has a coupler component with at least a first end for receiving connection to a delivery line and accommodating the flow of a

substance therethrough. The method includes the step of electronically sensing whether a cap is attached to the coupler component without making contact with the cap. The method also includes the step of disabling at least one drive element of the vehicle when the cap is not attached to the coupler component.

[0008] By sensing the presence of the cap, the system and method prevent the accidental drive-off of the vehicle while the delivery line is still attached to the vehicle. Furthermore, the vehicle is prevented from moving due to accidental or malicious removal of the cap. As such, the system prevents damage to equipment as well as preventing environmentally hazardous spills in the case where the substance may be hazardous.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] Other advantages of the present invention will be readily appreciated, as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

[0010] Figure 1A is a perspective view a vehicle carrying a storage tank with a coupler component having a cap attached;

[0011] Figure 1B is a perspective view of the vehicle with the cap removed from the coupler component and a supply line attached to the coupler component;

[0012] Figure 2 is side perspective view of the coupler component with a sensor housing attached thereto and showing the cap removed from the coupler component; and

[0013] Figure 3 is front perspective view of the coupler component showing a valve face of a valve;

[0014] Figure 4 is a rear perspective view of the coupler component;

[0015] Figure 5 is a cross sectional interior view of the coupler component and the sensor housing showing a sensor embedded within the sensor housing;

[0016] Figure 6 is a bottom view of the coupler component and a bottom cross-sectional view of the sensor housing; and

[0017] Figure 7 is a electrical schematic of a system for disabling the vehicle showing the sensor sensing the proximity of the cap and engaging a relay to prevent vehicle movement when the cap is removed.

DETAILED DESCRIPTION OF THE INVENTION

[0018] Referring to the Figures, a system **10** and method for disabling a vehicle **V** carrying a storage tank **S** is shown herein.

[0019] The storage tank **S** is utilized for holding a substance. The substance may be a flammable liquid or gas, such as, but not limited to, propane, liquefied petroleum gas, gasoline (petrol), petroleum, ethanol, methanol, diesel, hydrogen, kerosene, and jet fuel. The substance may also be a non-flammable liquid or gas, such as, but not limited to, water, compressed air, milk, and vegetable oil. Furthermore, the substance may be a solid, especially a solid in granular form, such as, but not limited to, grains. Moreover, those skilled in the art realize other substances that may be held in the storage tank **S** in accordance with the subject invention. In the illustrated embodiment,

the substance held in the storage tank **S** is not used to propel the vehicle **V**, but is instead being merely transported by the vehicle **V**.

[0020] Referring to Figure 1, the system **10** includes a coupler component **12** for coupling the storage tank **S** to an external tank **E** to transfer the substance therebetween. The coupler component may be implemented as the "dry break coupler" disclosed in U.S. Patent Application No. 12/184,752, filed on August 1, 2008, issued as U.S. Patent 8,113,240. Of course, other implementations of the coupler component **12** are realized by those skilled in the art within the scope of the claimed invention.

[0021] The coupler component **12** is supportable by the vehicle V for receiving a connection from a delivery line **L**. The delivery line **L**, as shown in Figure 1, is in fluidic communication with the external tank **E**. The delivery line **L** may be a hose or similar device. In the illustrated embodiment, the coupler component **12** is supported by, i.e., attached to, the vehicle **V**. The coupler component **12** may be fluidically connected to the storage tank **S** by one or more pipes (not numbered). However, those skilled in the art realize that the coupler component **12** may be connected directly to the storage tank **S**. Furthermore, one or more valves (not shown) may be disposed between the coupler component **12** and the external tank **E** and between the coupler component **12** and the storage tank S.

[0022] Referring to Figure 2, the coupler component **12** includes a peripheral housing **14** having a first end **16** and a second end **18**. The peripheral housing **14** also defines an inner passage **19** for accommodating the flow of the substance therethrough. The peripheral housing **14** separates the inner passage **19** from an outer

region **20** outside of the peripheral housing **14**. The first end **16** is connectable to the delivery line **L** while the second end **18** is connectable to the pipes.

[0023] In the illustrated embodiment, the peripheral housing **14** has a generally cylindrical shape and is formed of a metal. An outer surface **21** of the peripheral housing **14** defines first threads **22** disposed adjacent the first end **16** for mating with the delivery line **L**. The outer surface of the peripheral housing **14** also defines second threads **24** disposed adjacent the second end **18** for mating with the pipes.

[0024] The illustrated embodiment of the coupler component also includes a coupler valve **26** disposed in the inner passage **18**. The coupler valve **26** is moveable between an open-coupler valve position and a closed-coupler valve position. The coupler valve **26** includes a valve face **28** of a circular shape. A coupler spring **30** (see Figure 5) continuously biases the coupler valve **26** in the closed-coupler valve position. The coupler valve **26** includes a guide rod **32**. A guide mount **34** is fixed to the peripheral housing **14** and slidably receives the guide rod **32** as the coupler valve **26** moves between its open and closed positions. The coupler component **12** further includes a pressure relief valve **36** for relieving the substance in instances where the pressure inside the inner passage 19 exceeds a predefined limit.

[0025] Referring to figures 1A and 2, a cap **38** is attachable to the first end **16** of the coupler component **12** for preventing connection of the delivery line **L** when the cap **38** is attached to the coupler component **12**. In the illustrated embodiment, the cap **38** is generally circular in shape and includes internal threads (not shown) for mating with the first threads **22** of the peripheral housing **14**.

[0026] Referring specifically to Figure 5, the system **10** includes a sensor **40** for sensing whether or not the cap **38** is attached to the coupler component **12**. Furthermore, the system **10** disables at least one drive element **E** of the vehicle **V** when the cap is **38** not attached to said coupler component **12**, as described in greater detail below.

[0027] In the illustrated embodiment, the sensor **40** senses whether or not the cap **38** is attached to the coupler component **12** without making contact with the cap **38**. That is, no mechanical connection is made between the sensor **40** and the cap **38**. Those skilled in the art realize that this type of non-contact sensor **40** is typically referred to as a proximity sensor. The sensor **40** may be implemented as any of the proximity sensors known in the art, such as, but not limited to, inductive sensors emitting an electromagnetic field, capacitive sensors emitting an electrostatic field, optical sensors emitting a beam of electromagnetic radiation, or Hall-effect sensors detecting changes in a magnetic field.

[0028] In the illustrated embodiment, the sensor **40** is implemented as an inductive proximity sensor. One suitable sensor **40** is Part No. Bi8U-M18-AP6X-H1141, manufactured by Hans Turck GmbH & Co. KG headquartered in Mülheim an der Ruhr, Germany. Of course, those skilled in the art realize other suitable sensors **40** that may be implemented within the scope of the claims of the subject invention. The sensor **40** of the illustrated embodiment includes a sensor head **41** which emits the electromagnetic field.

[0029] The sensor **40** is preferably disposed in the outer region **20**. That is, the sensor **40** is preferably not disposed within the inner passage 19 of the coupler

component. Furthermore, the sensor **40** preferably does not penetrate the peripheral housing **14** of the coupler component **12**. As such, there is no need for additional machining and sealing of the coupler component **12** in order for the sensor **40** to sense whether or not the cap **38** is attached.

[0030] The sensor **40** of the illustrated embodiment is encased within a sensor housing **42**. More specifically, the sensor housing **42** includes an external surface **44** and defines an inner cavity **46** for accommodating the sensor **40**. The sensor housing **42** also defines a passageway **47** coupled with the inner cavity **46**. The passageway accommodates wires and/or cables (not numbered) for electrically connecting the sensor **40** to other electrical devices. The sensor housing **42** is preferably formed of a non-conductive material, such as, but not limited to, rubber or plastic. As such, the sensor housing **42** does not interfere with the inductive proximity sensor **40** of the illustrated embodiment. However, in other embodiments, the sensor housing may be formed of a conductive material, such as metal.

[0031] Preferably, the sensor housing **42** is formed to mate with at least a portion of the outer surface **21** of the peripheral housing **14** of the coupler component **12**. As can be seen in Figure 4, the sensor housing **42** includes an arcuate base **43** defining a semi-circular surface (not numbered) which abuts the outer surface **21**. In other words, the arcuate base **43** is shaped to correspond in shape to a generally cylindrical surface, such as on the coupler component **12**. A strap assembly **48** is used for securing the sensor housing **42** to the coupler component **12**. More specifically, the strap assembly **48** is disposed about the outer surface **21** of the peripheral housing **14** and the external surface **44** of the sensor housing **42**. One advantage of the strap assembly **48** is that no

modification to the coupler component **12** is necessary to secure the sensor housing **42** thereto. That is, the strap assembly **48** may be used to retrofit existing coupler components **12** with the sensor **40** without replacement or modification of the coupler component **12**. However, it is to be appreciated that the sensor housing **42** can be secured to the coupler component **12** using other methods without departing from the nature of the subject invention.

[0032] The strap assembly **48** of the illustrated embodiment has an inner strap **50** and an outer strap **52** such that the inner strap **50** and outer strap **52** cooperate to secure the sensor housing **42** to the coupler component **12**. The inner strap **50** is disposed about the outer surface **21** of the peripheral housing **14** for preventing the sensor housing **42** from freely rotating about the outer surface **21** of the peripheral housing **14**. It is to be appreciated that the inner strap **50** and the outer strap **52** each may comprise a material such as, but not limited to, a polymer such as an elastomer, a thermoplastic, and blends thereof; a metal and a metal alloy; or any other material known to one skilled in the art suitable for securing the sensor housing **42** to the peripheral housing **14**. Preferably, the inner strap **50** comprises an elastomer for providing a friction between the inner strap **50** and the outer surface **21** of the peripheral housing **14**, and the outer strap **52** comprises a metal or metal alloy for supporting a weight of the sensor housing **42**. The inner strap **50** is partially disposed within a strap passage (not numbered) defined through the sensor housing **42**, as best seen in Figure 5. The outer strap **52** is disposed about the outer surface **21** of the peripheral housing **14** and the external surface **44** of the sensor housing **42**. The sensor housing **42** defines a strap groove (not numbered) for cooperating with

the outer strap **52**. Preferably, the outer strap **52** defines an opening **54**, as shown in Figure 4, having a rectangular configuration for allowing access to the passageway **47**.

[0033] The outer strap **52** and the inner strap **50** each have a pair of flanged ends **56** spaced apart from each other with at least one bolt **58**, preferably two, disposed there between for moving the flanged ends **56** of the outer strap **52** and the inner strap **50** together to prevent the sensor housing **42** from freely rotating about the outer surface **21** of the peripheral housing **14**. In another embodiment of the present invention (not shown), the outer strap **52** extends through a portion of the sensor housing **42**.

[0034] The sensor housing **42** in the illustrated embodiment holds the sensor **40** generally parallel to the coupler component **12**. More specifically, the sensor **40** is held generally parallel to a longitudinal axis (not shown) of the peripheral housing **14**. As such, the sensor head **41** is generally perpendicular to the longitudinal axis of the peripheral housing **14**.

[0035] The sensor **40** distinguishes between connection of the cap **38** to the coupler component **12** and connection of the delivery line **L** to the coupler component **12**. That is, the sensor **40** does not mistake connection of the delivery line **L** to connection of the cap **38**.

[0036] In the illustrated embodiment, the cap **38** includes a handle portion **59** and a sensing portion **60**. The handle portion **59** is generally circularly shaped and includes protrusions and/or indentations (not numbered) to allow the cap **38** to be grasped, thus allowing installation and/or removal from the coupler component **12**. The handle portion **59** may also at least partially block the flow of the substance through the inner passage **19** when attached to the coupler component **12**. The handle portion **59** defines

the internal threads of the cap **38** which mate with the threads of the coupler component **12**.

[0037] The sensing portion **60** of the cap **38** serves to be detected by the sensor **40** while distinguishing the cap **38** from the delivery line L. The sensing portion **60** is disposed in the outer region when attached to the coupler component **10** such that the sensor **40** senses the sensing portion **60** of the cap **38**. In the illustrated embodiment, the sensing portion **60** extends outward from the handle portion **59** and is generally perpendicular to the peripheral housing **14**. Furthermore, the sensing portion **60** is disposed in the outer region **20** and preferably extends into an area that is not in-line with or is offset relative to the peripheral housing **14** of the coupler component **10**.

[0038] The sensing portion **60** of the illustrated embodiment is ring shaped and extends completely around the handle portion **59**. As such, the sensing portion **60** can be sensed by the sensor **40** regardless of the rotational position of the cap **38**. However, in other embodiments, the sensing portion **60** may be implemented as one or more tabs (not shown) extending from the handle portion **59** of the cap **38**.

[0039] To aid in distinguishing the cap **38** from the delivery line **L**, a diameter of the sensing portion **60** of the cap **38** is preferably longer than a diameter of the first end of the peripheral housing. That is, the sensing portion 60 is radially outwardly spaced from the outer surface **21** of the coupler component **12**. More preferably, the diameter of the sensing portion **60** is at least 1.25 times longer than the diameter of the peripheral housing at the first end. In the illustrated embodiment, the diameter of the peripheral housing at the first end measures from about 3-4 inches, most preferably about 3.25 inches. An inner diameter of the sensing portion **60** measures

about 4-5 inches, most preferably 4 inches, while an outer diameter of the sensing portion **60** measures preferably greater than 4 inches to about 10 inches and most preferably about 8 inches.

[0040] The system **10** also includes a switch **62** in communication with the sensor **40**, as shown in Figure 6. The switch **62** is connectable to at least one drive element **E** of the vehicle **V** to disable at least one drive element **E** of the vehicle **V** when the **38** cap is not attached to the coupler component **12**.

[0041] In the illustrated embodiment, the switch **62** is implemented as an electromechanical relay **64** electrically connected to the sensor **40**. Of course, solid state relays, transistors, or other devices may alternatively be utilized to implement the switch **62** as are well known to those skilled in the art. The electromechanical relay **64** of the illustrated embodiment includes a coil **66** and at least one normally open contact **68**. When the coil **66** is energized, the normally open contact **68** closes to allow electric current to flow, i.e., provides a logical "1" signal. When the coil **66** is not energized, the contact **68** is open and prevents electric current from flowing, i.e., provides a logical "0" signal. The sensor **40** is electrically connected to the coil **66** to energize the coil when the cap **38** is properly attached to the coupler component **12**.

[0042] The drive element **E** of the vehicle **V** may be any of the mechanisms used to propel the vehicle, including, but not limited to, an engine, a transmission, brakes, a transmission shifting device, an engine controller, and a vehicle controller. In the illustrated embodiment, a normally open contact of the switch **62** is electrically connected to the transmission shifting device. When the switch is open, i.e., when the cap **38** is not properly attached to the coupler component **12**, the transmission

switching device maintains the transmission in a "park" position in response to the logical "0" signal, and will not allow transfer to any other position or gear (e.g., "drive" or "neutral"). When the switch is closed, i.e., when the cap **38** is properly attached to the coupler component **12**, the transmission switching device allows the transmission to be switched to any position in a normal operating fashion in response to the logical "1" signal.

[0043] In the illustrated embodiment, the switch **62** is disposed remote from the coupler component **12** and the sensor **40**. For instance, the switch **62** may be disposed in an engine compartment (not labeled) of the vehicle **V**. However, those skilled in the art realize that the switch **62** may alternatively be disposed adjacent to or within the sensor housing **42**.

[0044] The passageway **47** of the sensor housing **42** extends through the external surface **44** to define an opening (not numbered). A connector **66** is located at this opening. The connector **66** includes one or more seals (not numbered) such that passageway **47** and the inner cavity **46** are sealed to prevent entry of solids, liquids, or gasses into the passageway **47** and inner cavity **46**.

[0045] The sensor housing **42** also includes a door **68** to allow access to the inner cavity **46**. This permits routing of the wire **W** and connection to the sensor **40** as well as replacement of the sensor **40**. The door **68** in the illustrated embodiment is attached to the sensor housing with a retaining leash **70**.

[0046] In an alternative embodiment, an enclosure (not shown) may be disposed around at least part of the coupler component **12** to enclose and thereby protect the coupler component **12** from the elements. The enclosure includes a door (not shown)

which is openable to provide access to the coupler component **12**. A door sensor (not shown) senses whether the door is open or not. In one implementation, the door sensor is in communication with the drive element **E** of the vehicle **V** to disable the drive element **E**, in conjunction with the sensor **40** and switch **62**. That is, the drive element **E** is disabled when either the cap **38** is not connected to the coupler component **12** or when the door is open. In another implementation, the door sensor is utilized instead of the sensor **40** such that the drive element **E** is disabled when the door is open.

[0047] The present invention has been described herein in an illustrative manner, and it is to be understood that the terminology which has been used is intended to be in the nature of words of description rather than of limitation. Obviously, many modifications and variations of the invention are possible in light of the above teachings.

We claim:

1. A system for disabling a vehicle carrying a storage tank for holding a substance, said system comprising:

a coupler component supportable by the vehicle for receiving a connection from a delivery line;

said coupler component including a peripheral housing having a first end and a second end and defining an inner passage for accommodating the flow of the substance therethrough and separating said inner passage from an outer region;

a cap attachable to said first end of said coupler component for preventing connection of the delivery line when said cap is attached to said coupler component;

a sensor for sensing whether said cap is attached to said coupler component without making contact with said cap; and

a switch in communication with said sensor and connectable to at least one drive element of the vehicle to disable the at least one drive element of the vehicle when said cap is not attached to said coupler component,

wherein said sensor is configured to distinguish between connection of said cap to said coupler component and connection of the delivery line to said coupler component such that the at least one drive element remains disabled by said switch when the delivery line is connected to said coupler component.

2. A system as set forth in claim 1 wherein said sensor is disposed in said outer region.

3. A system as set forth in claim 2 wherein said cap includes a handle portion for blocking the flow of the substance through said inner passage when attached to said coupler component and a sensing portion disposed in said outer region when attached to said coupler component such that said sensor senses said sensing portion of said cap.

4. A system as set forth in claim 3 wherein said sensing portion of said cap extends from and completely around said handle portion of said cap such that said sensing portion can be sensed by said sensor regardless of a rotational position of said cap.

5. A system as set forth in claim 4 wherein said peripheral housing has a cylindrical shape and said cap has a generally circular shape.

6. A system as set forth in claim 5 wherein said sensing portion is radially outwardly spaced from an outer surface of said coupler component.

7. A system as set forth in claim 3 wherein said sensing portion is generally perpendicular to said peripheral housing.

8. A system as set forth in claim 1 wherein said sensor is encased within a sensor housing.

9. A system as set forth in claim 8 wherein said sensor housing is formed of a non-conductive material.

10. A system as set forth in claim 8 wherein said sensor housing is formed to mate with at least a portion of said peripheral housing of said coupler component.

11. A system as set forth in claim 8 further comprising a strap assembly for securing said sensor housing to said coupler component.

12. A system as set forth in claim 11 wherein said strap assembly includes a first strap and a second strap wherein said first strap extends around said sensor housing and said second strap extends through said sensor housing.

13. A system as set forth in claim 8 wherein said sensor housing defines an inner cavity for accommodating said sensor.

14. A system as set forth in claim 13 wherein said sensor housing defines a door for accessing said inner cavity of said sensor housing.

15. A system for disabling a vehicle carrying a storage tank for holding a substance, said system comprising:

a coupler component supportable by the vehicle for receiving a connection from a delivery line;

said coupler component including a peripheral housing having a first end and a second end and defining an inner passage for accommodating the flow of the substance therethrough and separating said inner passage from an outer region;

said first end of said coupler component configured to receive a cap for preventing connection of the delivery line when the cap is attached to said coupler component;

a proximity sensor supported by said peripheral housing for sensing whether the cap is attached to said coupler component without making contact with the cap; and

a switch in communication with said sensor and connectable to at least one drive element of the vehicle to disable the at least one drive element of the vehicle when the cap is not attached to said coupler component,

wherein said sensor is configured to distinguish between connection of the cap to said coupler component and connection of the delivery line to said coupler component such that the at least one drive element remains disabled by said switch when the delivery line is connected to said coupler component.

16. A method for disabling a vehicle carrying a storage tank for holding a substance, the vehicle having a sensor and a coupler component with at least a first end

for receiving connection to a delivery line and accommodating the flow of a substance therethrough, said method comprising the steps of:

electronically sensing whether a cap is attached to the coupler component without the sensor making contact with the cap; and

disabling at least one drive element of the vehicle when the cap is not attached to the coupler component,

wherein said sensing distinguishes between connection of the cap to the coupler component and connection of the delivery line to the coupler component such that the at least one drive element remains disabled when the delivery line is connected to the coupler component.

17. A method as set forth in claim 16 wherein the cap includes a handle portion for blocking the flow of the substance through the coupler component and a sensing portion extending from the handle portion and said sensing whether the cap is attached to the coupler component is further defined as sensing the sensing portion of the cap to determine whether the cap is attached to the coupler component without the sensor making contact with the cap.

18. A system for disabling a vehicle carrying a storage tank for holding a substance, said system comprising:

a coupler component supportable by the vehicle for receiving a connection from a delivery line;

said coupler component including a peripheral housing having a first end and a second end and defining an inner passage for accommodating the flow of the substance therethrough and separating said inner passage from an outer region;

a cap attachable to said first end of said coupler component for preventing connection of the delivery line when said cap is attached to said coupler component;

a sensor housing and a sensor encased within said sensor housing for sensing whether said cap is attached to said coupler component without making contact with said cap;

a strap assembly for securing said sensor housing to said coupler component; and

a switch in communication with said sensor and connectable to at least one drive element of the vehicle to disable the at least one drive element of the vehicle when said cap is not attached to said coupler component.

19. A system as set forth in claim 18 wherein said strap assembly includes a first strap and a second strap wherein said first strap extends around said sensor housing and said second strap extends through said sensor housing.

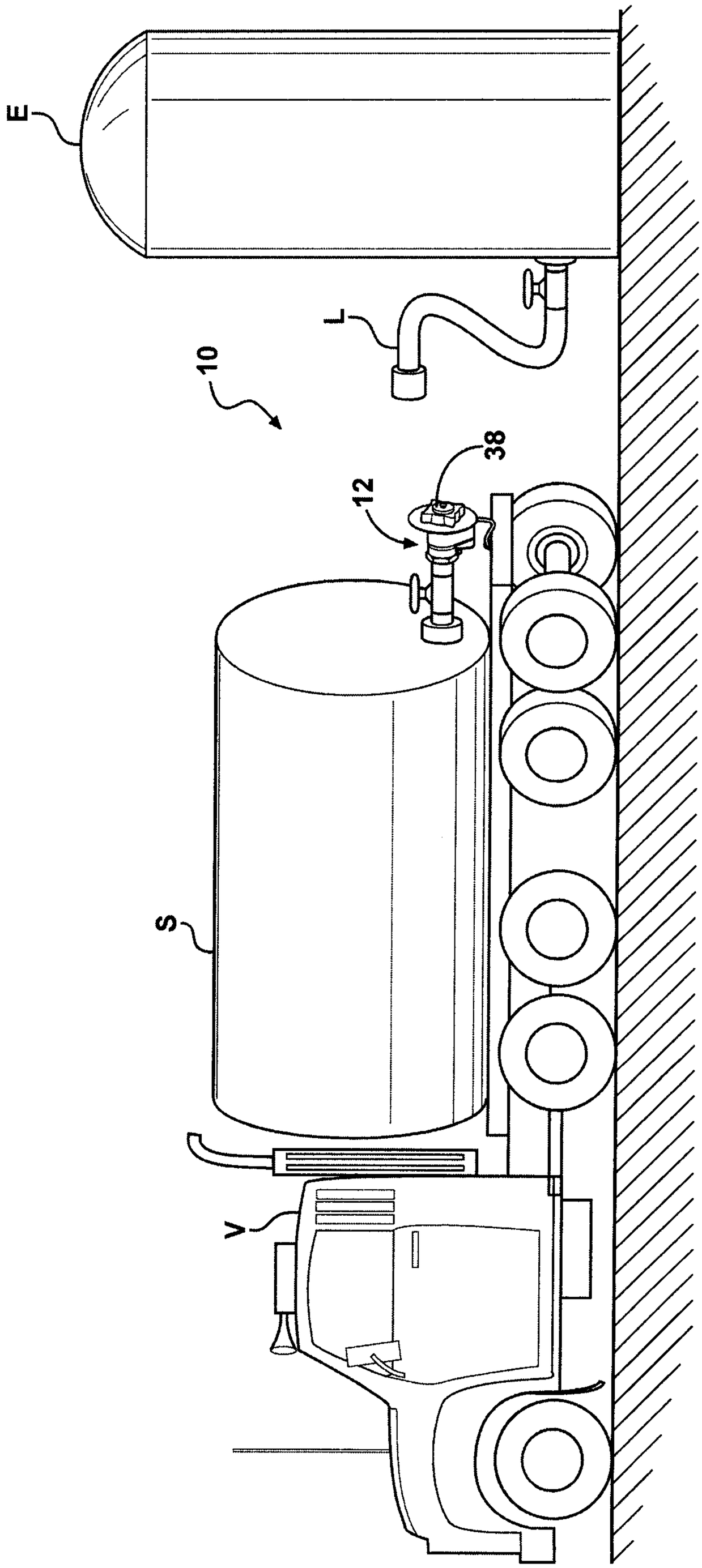


FIG. 1A

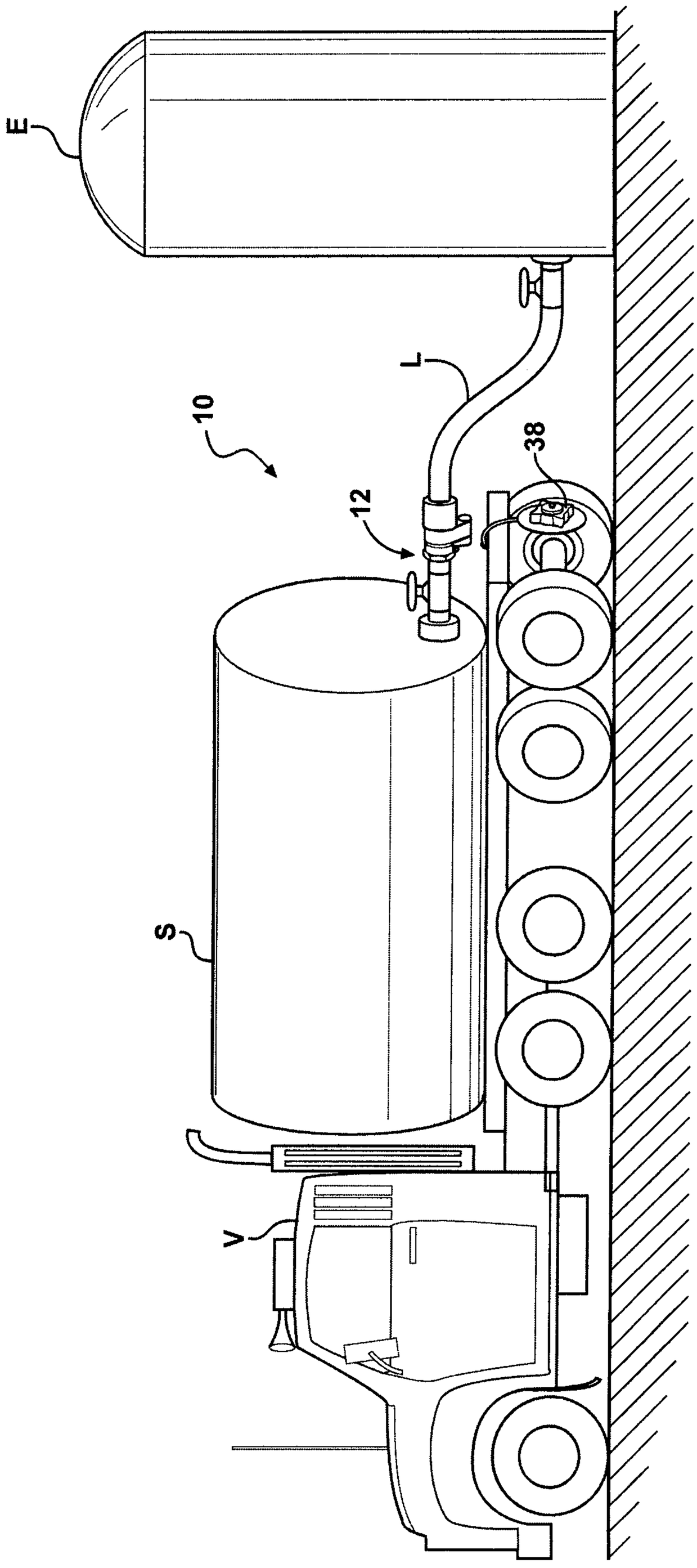


FIG. 1B

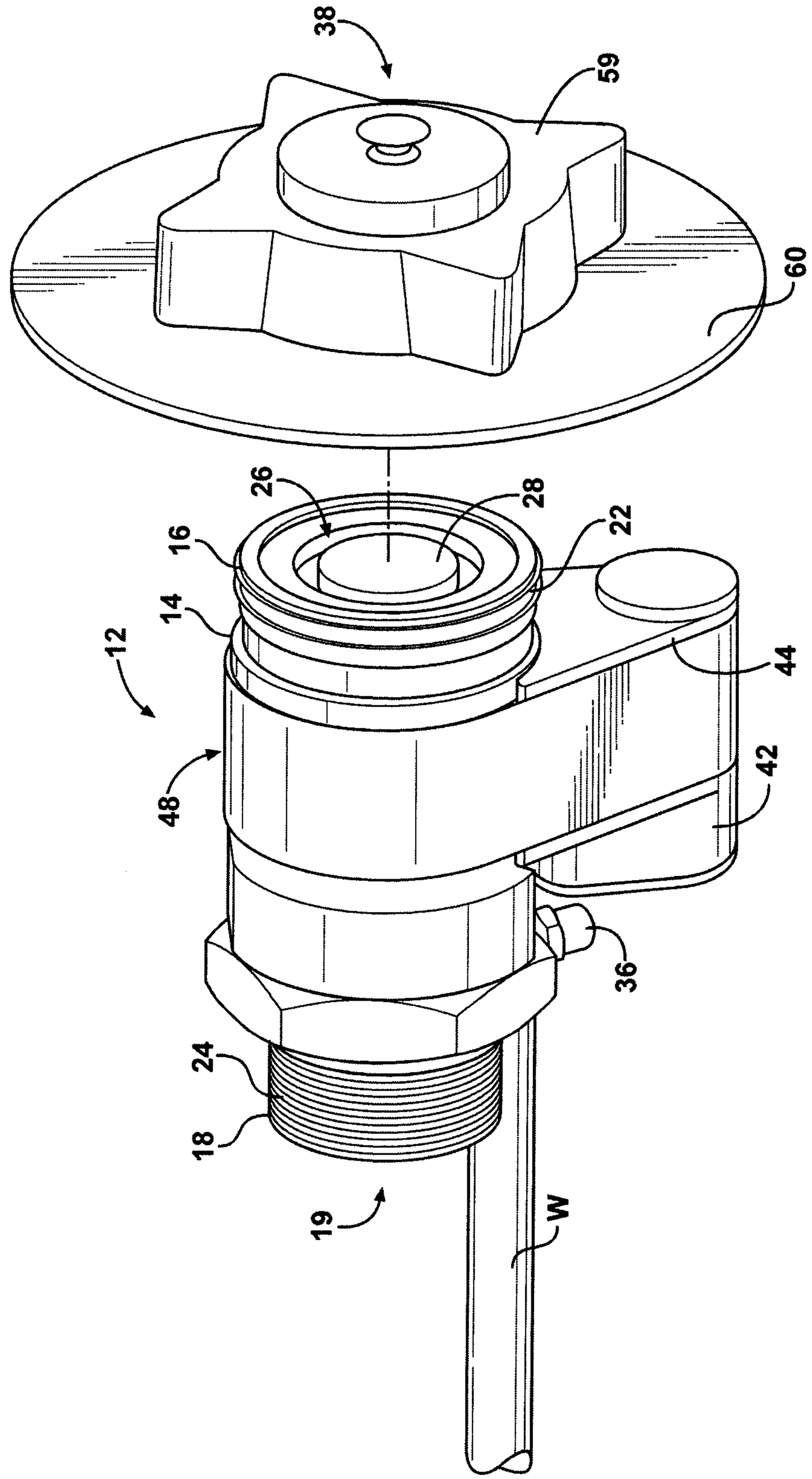


FIG. 2

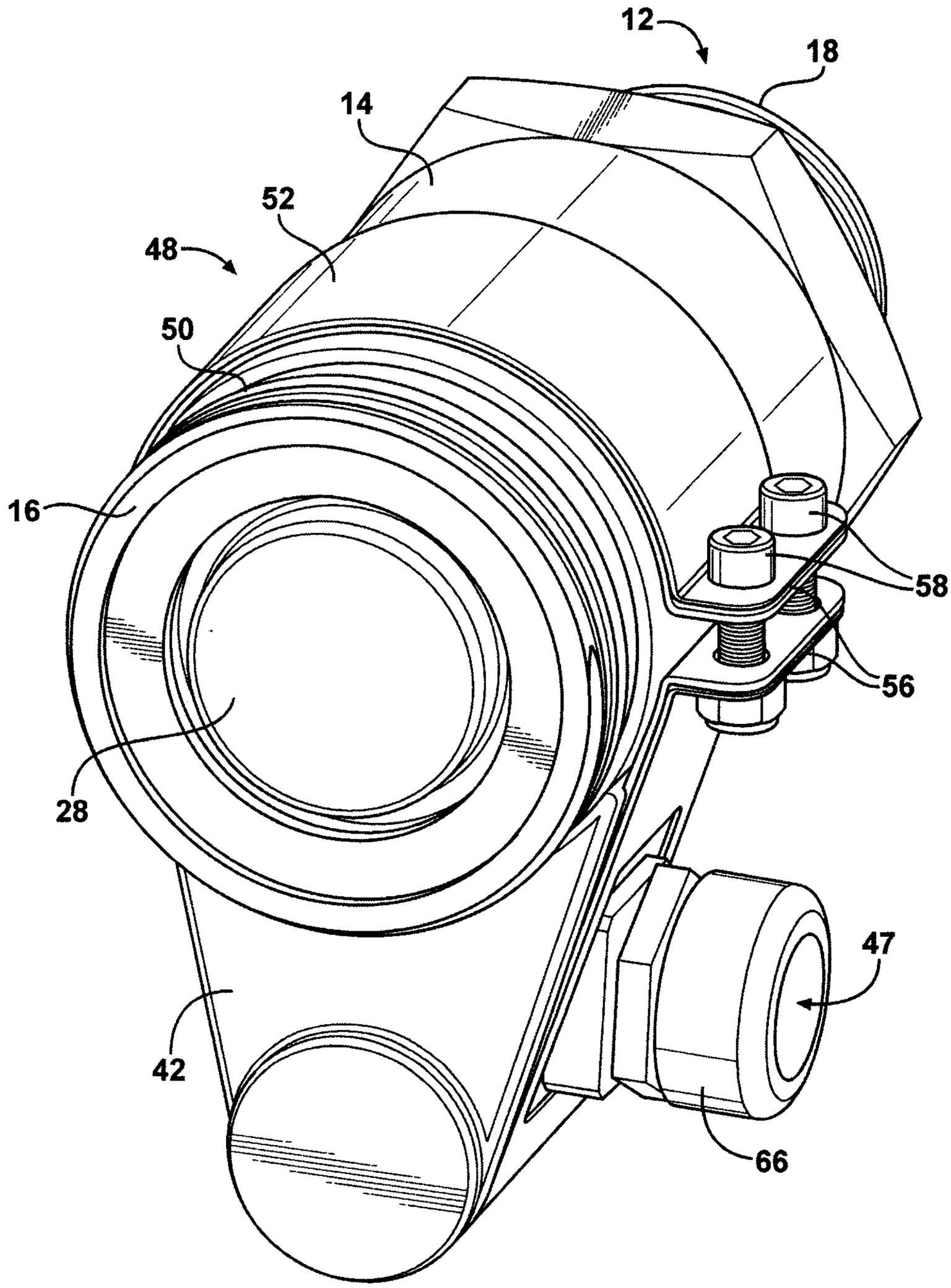


FIG. 3

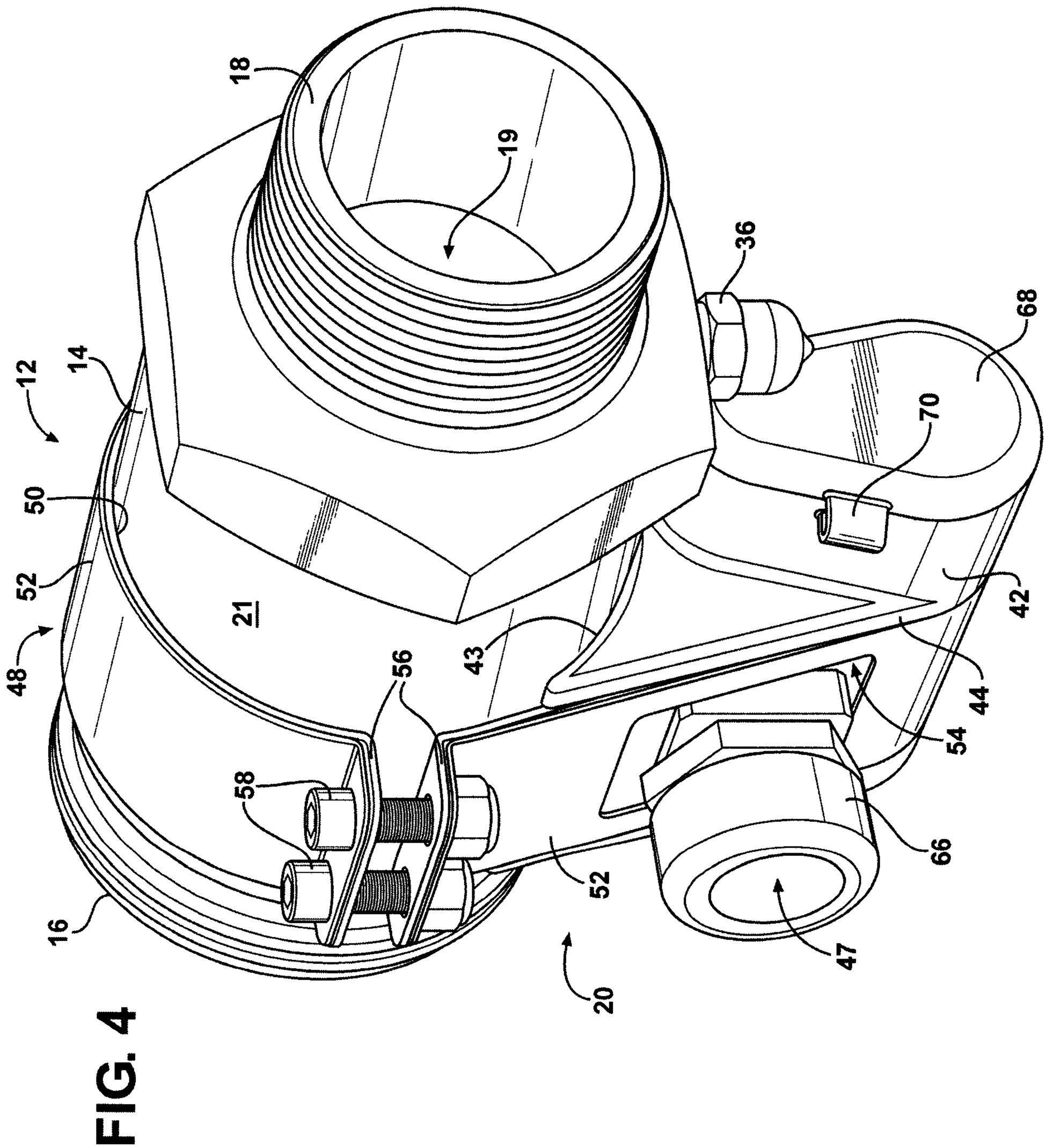
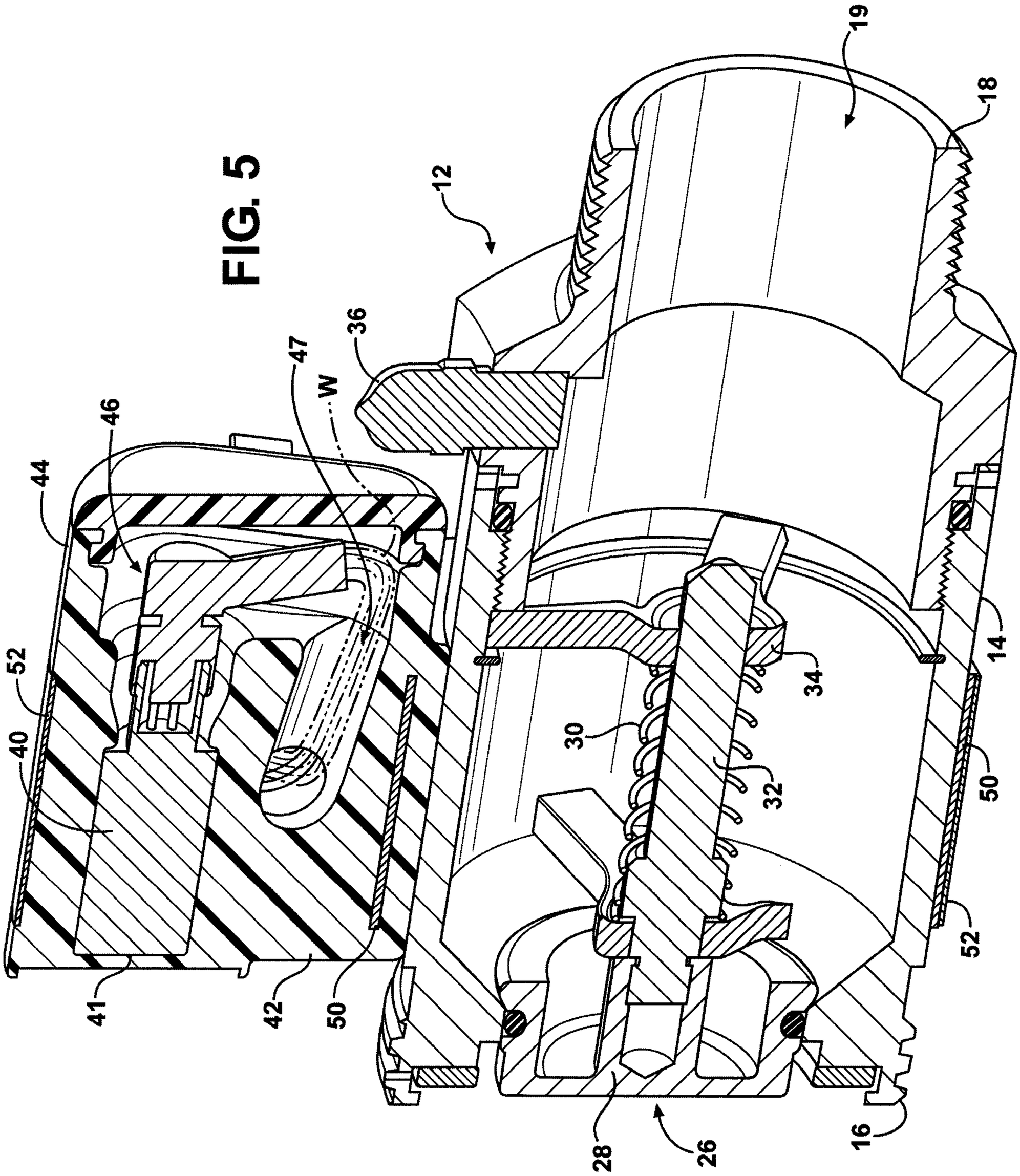


FIG. 4

FIG. 5



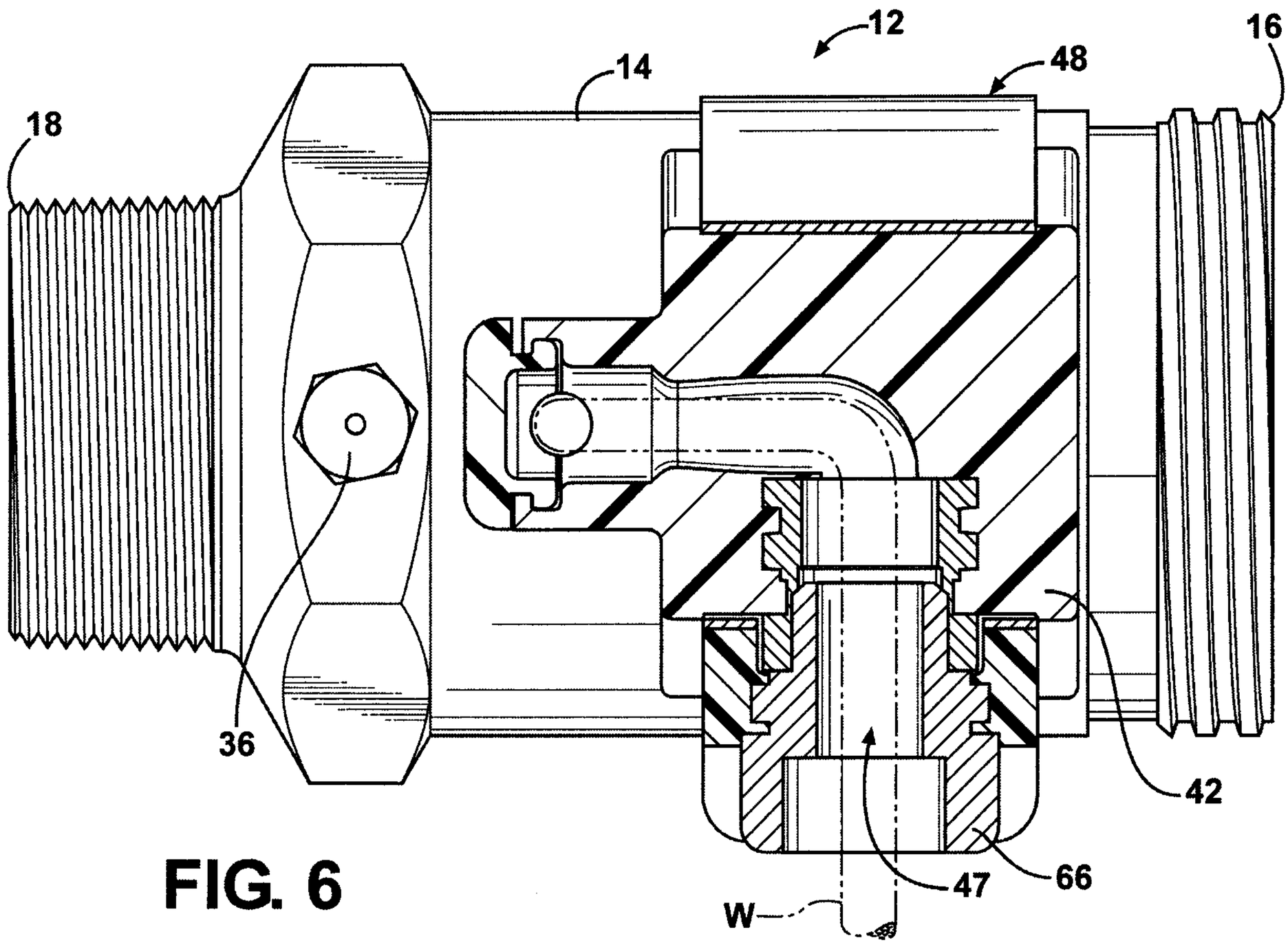
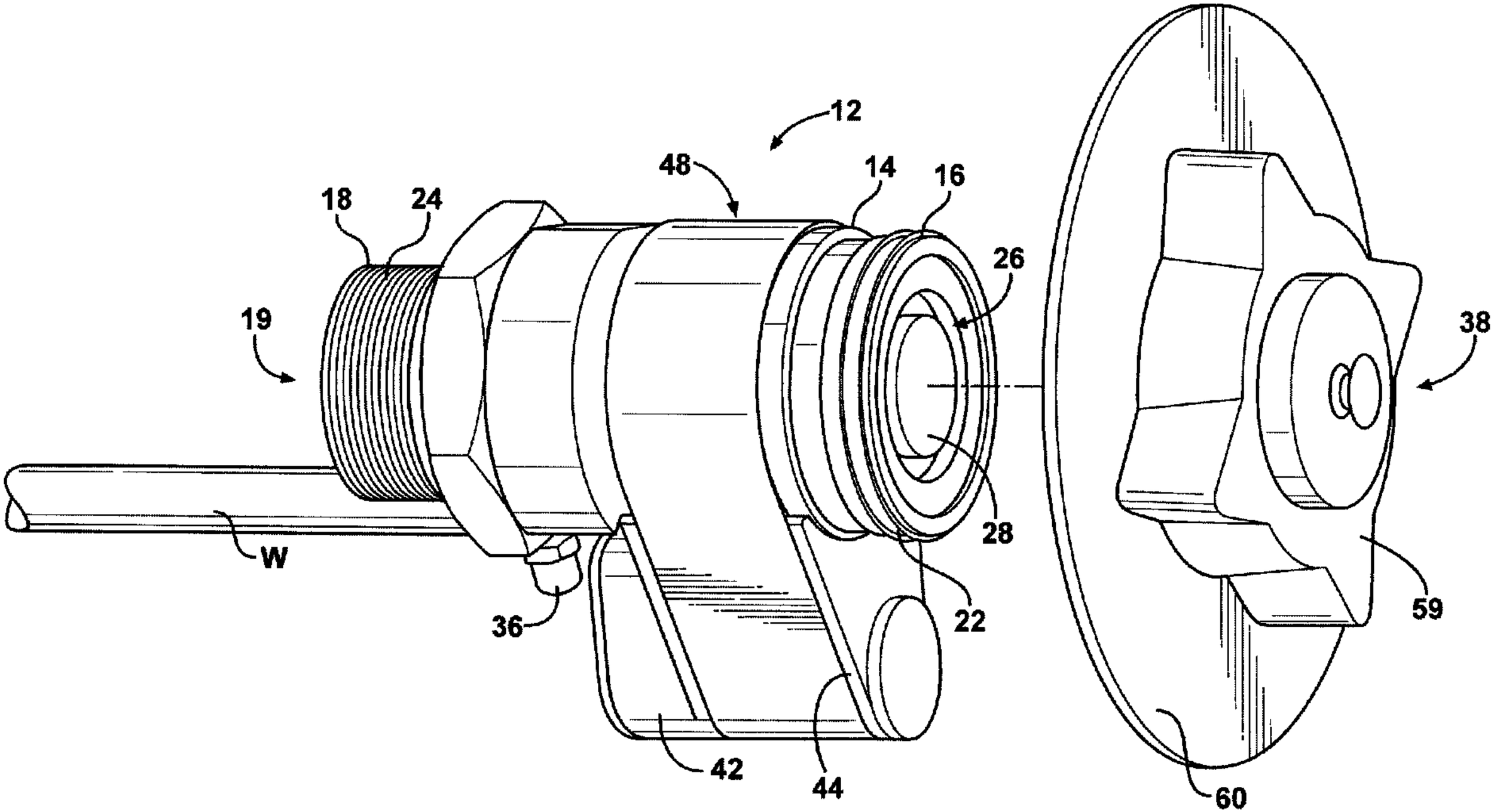


FIG. 6

FIG. 7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