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[54] **TAMPER-PROOF TIME INTERVAL RECORDING SYSTEM**

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[51] **Int. Cl.** **G01m 15/00,** F16l 13/00

[58] **Field of Search** ..... 73/115, 391, 201; 137/552.7; 285/321, DIG. 22, 340, 175; 138/114

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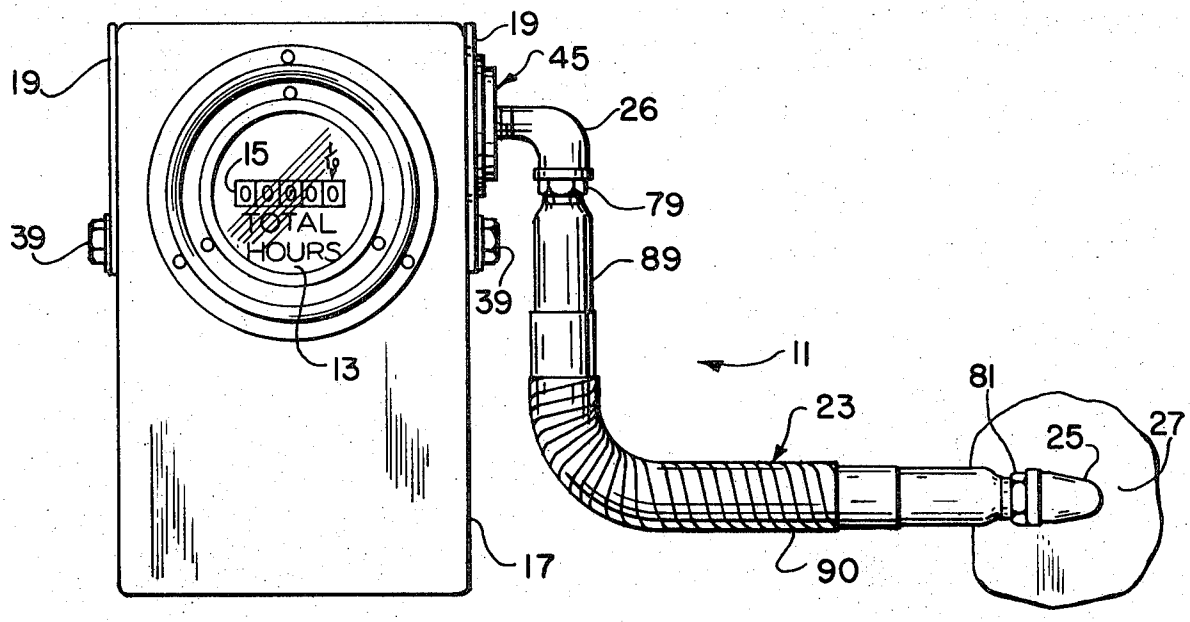
[57] **ABSTRACT**

A tamper-proof time interval (i.e., engine operating hours) recording system. An elapsed-time recorder actuated in response to engine oil pressure is enclosed and securely protected from tampering by a protective enclosure. A mounting arrangement secures the enclosure to the engine or other apparatus as to which operating time is to be recorded. The system includes an oil pressure conduit adapted to be connected between the enclosure and the apparatus for causing operation of the recorder in response to operation of the apparatus (e.g., operation of an internal combustion engine thereof). A connector arrangement connects the conduit between enclosure and apparatus so as substantially to prevent nondestructive disconnection of the conduit following connection thereof.

16 Claims, 7 Drawing Figures



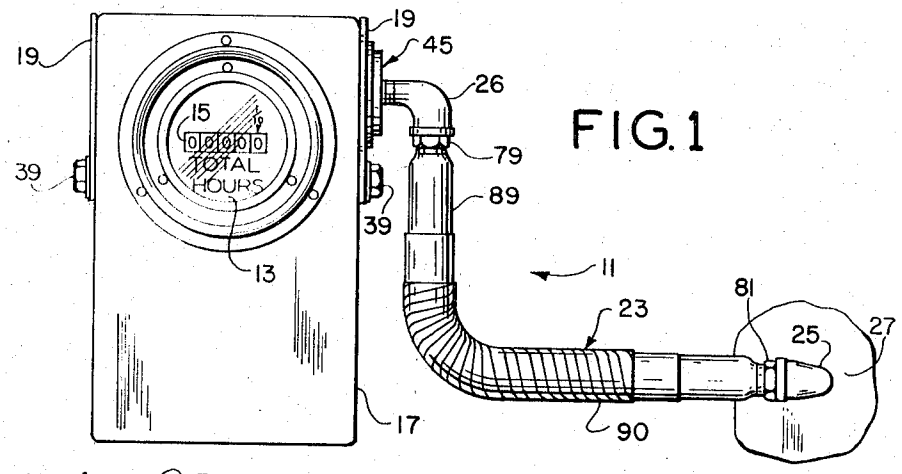


FIG. 1

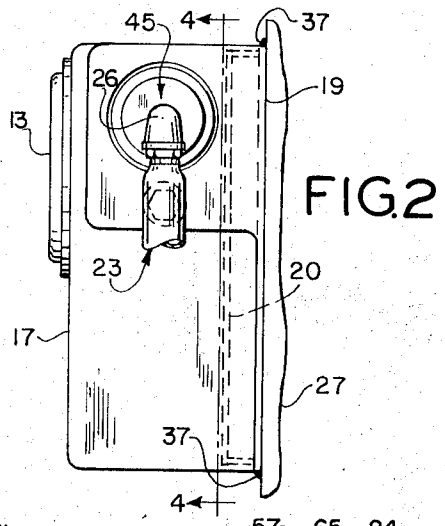


FIG. 2

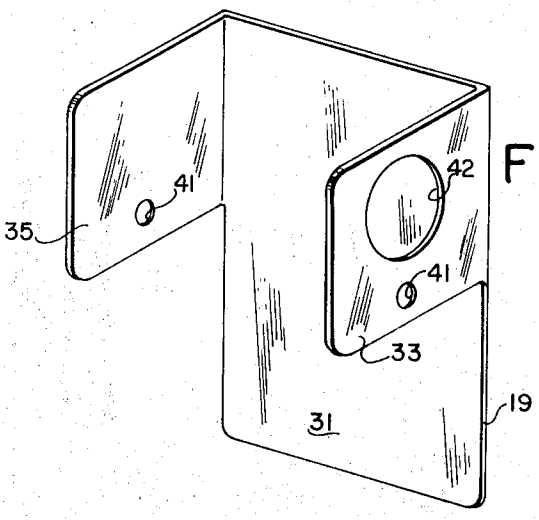


FIG. 3

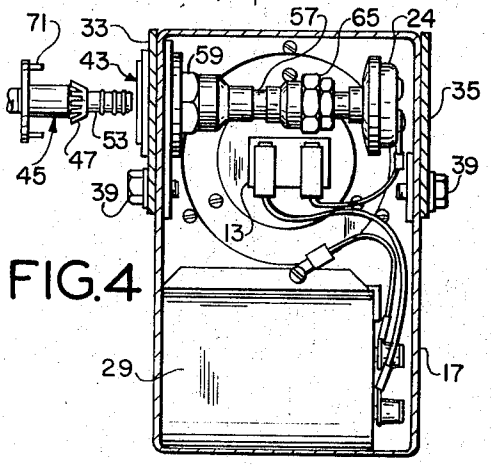


FIG. 4

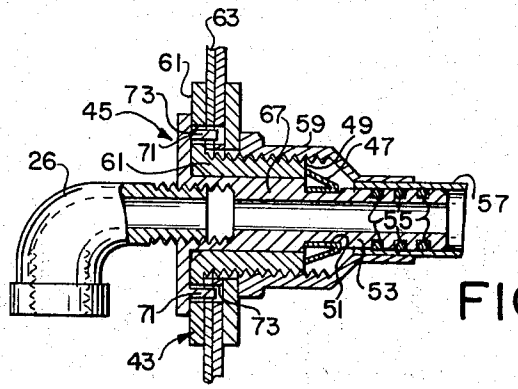


FIG. 5

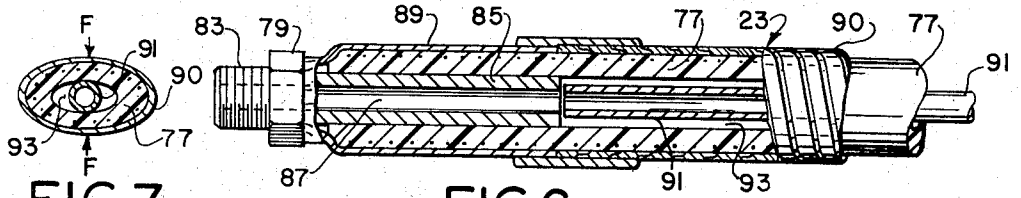


FIG. 7

FIG. 6

TAMPER-PROOF TIME INTERVAL RECORDING SYSTEM

BACKGROUND OF THE INVENTION

This invention relates to apparatus for recording operating time intervals and more particularly to tamper-resistant apparatus for recording hours of engine operations in response to engine oil pressure. In the operation of certain kinds of engine-driven machinery such as earth-moving and farm tractors, it is often essential to record the hours of operation of internal combustion engines used to power the equipment in order to be able to determine charges for the use of the equipment, to ascertain service intervals, to indicate the termination of the warranty period for the equipment, or the like. For such purposes, it has long been conventional to use engine operating hour recorders, particularly elapsed-time meters.

A serious problem in the use of elapsed-time meters on such equipment has been one of unauthorized tampering. In the use of rental equipment, for example, tampering with the meter to prevent its ordinary or full-time operation may result in lower rental charges. Similarly, there may be tampering in order to prevent lapse of a warranty period.

Such elapsed-time meters are typically electrically powered. An electrically powered meter may conventionally be actuated, for example, by energizing an engine ignition circuit. However, the external electric actuating circuit can easily be tampered with. Vibration-responsive meters have been employed where there is not excessive shock and vibration. But, while needing no external actuating circuit, vibration-responsive meters are not dependable where they are subject to severe vibration and shock as in heavy construction and farm machinery. In addition, vibration during shipment could result in erroneous indications of operating time with this kind of meter.

Another prior art arrangement involves enclosing an electrically operated hour meter in an enclosure secured to the equipment together with a battery and actuating the meter by means of a pressure switch in the enclosure and which is responsive to engine oil pressure, there being an oil pressure connection between the engine and enclosure. It has heretofore been proposed to employ a locked enclosure. However, this requires a system of locks and keys which is not satisfactory to manufacturers or owners. Moreover, there may still be the possibility that one may defeat the meter by clamping the oil pressure conduit or by simply disconnecting the conduit and temporarily plugging the oil pressure fitting.

SUMMARY OF THE INVENTION

Among the several objects of the invention may be noted the provision of a substantially tamper-proof recording system and specifically the provision of such a system for recording the operating time of apparatus with which the system is used; the provision of such a system for recording the operating time of a pressure-lubricated engine; the provision of such a system having an internal recording instrument but which does not require an external electrical actuating circuit for the instrument; the provision of such a system including a substantially tamper-proof enclosure for the recording instrument but which requires no lock-and-key arrangement; the provision of such a system which, following connection for operation, prevents nondestructive disconnection; the provision of such a system in which the recording instrument is pressure-actuated by means of a pressure connector but which precludes interruption of the pressure connection; the provision of such a system which is simply installed on equipment whose operating time is to be recorded; and the provision of such a system which is simply and economically manufactured. Other objects and features will be in part apparent and in part pointed out hereinafter.

Briefly, a tamper-proof time interval recording system includes an elapsed-time recording instrument adapted for being operated in response to fluid pressure and a protective enclosure for the recording instrument, this enclosure when intact securely protecting the instrument from tampering. The enclosure is adapted for being secured to apparatus with regard to which an operating time is to be recorded by the instrument. The enclosure is secured by a special bracket to the apparatus. A relatively flexible conduit is adapted to be connected for providing fluid pressure communication between the recording instrument and the apparatus to cause operation of the instrument in response to operation of the apparatus. The conduit resists twisting of one end thereof with respect to the other. A connector arrangement includes respective threaded fitting at the ends of the conduit for being respectively threaded to provide connections at the enclosure and at the apparatus. The fittings each have the same thread direction orientation. Thus, when both are threaded to provide the connections, neither of the fittings may be turned in a direction to cause unthreading by loosening thereof without causing tightening of the other fitting. Preferably, the conduit is specially constructed to substantially prevent clamping of the conduit from interrupting the pressure communication. Preferably, also, the conduit includes a plug-and-receptacle arrangement, the plug being receivable by the receptacle following threading of the fittings. The plug and receptacle cooperate to prevent removal of the plug from the receptacle, when received thereby, and to prevent twisting of the plug and receptacle with respect to one another.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a view in front elevation of a tamper-proof elapsed-time recording system of the invention as installed for use;

FIG. 2 is a view in side elevation of an enclosure for the apparatus of FIG. 1;

FIG. 3 is a perspective view of a bracket assembly of the invention for mounting the enclosure;

FIG. 4 is a cross-sectional view in rear elevation of the enclosure, taken along line 4—4 of FIG. 2;

FIG. 5 is a cross-sectional elevation of a plug-and-receptacle assembly of the invention;

FIG. 6 is an elevation partly in cross section of a portion of a conduit of the system, as constructed in accordance with the invention; and

FIG. 7 is a lateral cross section of the conduit illustrating the effect of clamping thereof.

Corresponding reference characters indicate corresponding parts throughout the several views of the drawings.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. **1**, a tamper-proof recording system of the invention is designated generally **11**. The system includes a conventional electrically driven elapsed-time meter **13** having a readout window **15** indicating, for example, a total number of hours and tenths of hours. Meter **13** is enclosed within a rectangular protective enclosure **17**. Enclosure **17**, which may be of welded steel, for example, must be of construction which, when intact, will securely protect meter **13** from tampering. Enclosure **17** is adapted for being relatively permanently secured by a bracket **19** to apparatus with regard to which operating time is to be recorded by meter **13**. Such apparatus may be constituted by a diesel crawler-type tractor, for example. It is contemplated that the system may be used with different types of apparatus and record a parameter (other than operating time) associated with the apparatus. Enclosure **17** includes a rear cover **20** which may be spot-welded in place, being thereby difficultly removable.

Interconnected between the engine, a portion of which is designated **27**, of the apparatus and enclosure **17** is an oil pressure conduit indicated generally **23**, this conduit being connected by means of elbow fittings **25** and **26** for providing oil pressure communication between a conventional pressure-responsive switch **24** (FIG. **4**), located within the enclosure, and the engine **27** for causing recording by meter **13** of engine operation intervals. For this purpose, elbow **25** communicates as in conventional with an oil gallery of engine **27**, it being understood that oil pressure will be present during operation of the engine, such pressure closing the pressure switch to connect meter **13** in a series circuit with a heavy-duty, long-lasting battery **29** (see FIG. **4**) within enclosure **17**, thereby causing meter **13** to accumulate and display a total number of hours at window **15** which represents the total time of operation of engine **27**.

In accordance with this invention, conduit **23** is connected between enclosure **17** and engine **27** by a special connector arrangement which substantially prevents nondestructive disconnection of conduit **23** once it has been connected and requiring a destructive disconnection, i.e., cutting of a fitting or the conduit itself, once connected, in order to permit opening (i.e., disassembly) of enclosure **17**. The arrangement is such that tampering internally of enclosure **17** and ordinary disconnection of conduit **23** for the purpose of defeating operation of meter **13** are both effectively precluded.

As installed for operation, enclosure **17** is shown in FIG. **2** as secured by bracket **19** to the apparatus or engine **27** with which the system is used. Bracket **19**, as shown in FIG. **3**, includes a flat rear portion **31** of shape corresponding generally to the plan of enclosure **17** and the two side portions **33** and **35** each adapted to extend along the opposite sides of enclosure **17**. Bracket **19** may be secured, as by welding (welds being designated **37**) to the apparatus or engine **27**. Alternatively, rear portion **31** may be bolted to the apparatus but, in either case, is thus substantially permanently attached.

Enclosure **17** is secured to bracket **19** between side portions **33** and **35** thereof as by means of bolts **39** which extend through respective apertures **41** in side portions **33** and **35**. Side portion **33** includes a relatively large additional aperture **42** which, when enclosure **17** is secured to bracket **19**, is generally aligned with a receptacle, generally indicated at **43**, at the adjacent surface of the enclosure.

A plug designated generally **45** is receivable by receptacle **43** to connect conduit **23** to enclosure **17**. Plug **45** and receptacle **43** are designed to cooperate to prevent removal of plug **45** from receptacle **43**, when received thereby, so long as enclosure **17** remains intact. For this purpose, plug **45** carries a serrated snap ring **47** which acts as a latch means preventing removal of the plug by expanding within the receptacle behind a shoulder **49** (FIG. **5**) of the receptacle.

The snap ring **47** is carried in a groove **51** of a tubular nose portion **53** of the plug. Nose portion **53** carries O-ring seals **55** which seal the nose portion within a short tube **57** which is connected at one end to the receptacle **43** by means of a sleeve **59** threaded onto a flanged collar **61** of the receptacle. Collar **61** extends through the wall **63** and is secured in position by the sleeve **59**. A fitting **65** is carried at the opposite end of tube **57**, pressure switch **24** being threaded into the latter fitting. The body of plug **45** is designated **67** and includes a flange **69** which abuts against the flanged collar **61** of the receptacle. Flange **69** includes a pair of pins **71** fitting into apertures **73** of collar **61** to prevent twisting of the plug and receptacle with respect to one another. Thus, as will be apparent, once inserted plug **45** cannot be turned with respect to receptacle **43** until sleeve **59** is unthreaded from collar **61** to provide access to snap ring **47**.

The body **67** of plug **45** includes a threaded recess **75** into which is screwed the conventional elbow fitting previously indicated at **26**. Conduit **23**, which comprises a length of conventional wire-braid hydraulic hose material **77**, includes a conventional fitting **79** adapted to the threaded into elbow **26**. A similar fitting **81** is shown in FIG. **1** threaded into elbow **25** attached at apparatus or engine **27**. Both fittings **79** and **81** have the same thread direction orientation (e.g., both having a conventional right-hand thread) for a purpose explained below. It will be understood that the hose material **77**, while being sufficiently flexible to bend, e.g., as shown in FIG. **1**, is of sufficient thickness and strength to resist and prevent any substantial twisting thereof (thus permitting only slight twisting of one end thereof with respect to the other end). Accordingly, when fittings **79** and **81** are threaded to respective elbows **26** and **25** (as in FIG. **1**) and plug **45** is plugged into (and retained by) receptacle **43**, neither of fittings **79** and **81** may be turned in a direction to cause unthreading by loosening thereof without causing tightening of the other fitting.

Referring to FIG. **6**, the construction of one end portion of conduit **23** is shown in detail, the other end being of identical construction. Fitting **79** is shown as having a threaded portion **83** (with the usual right-hand thread) and a tubular portion **85** having a bore **87** providing oil pressure communication. The wire-braid reinforced length of elastomeric material **77** is fitted over tubular portion **85** and a swaged shell **89** secures the length of material **77** in place. A so-called BX or spiral type flexible armor sheath **90** may optionally be applied to conduit **23** for protection of the conduit from abra-

sion, etc., and to discourage clamping of the conduit.

In accordance with this invention, a length of steel tubing **91** is inserted within the bore **93** of the length of hose material **77** during assembly of the conduit. Tubing **91** has an outside diameter which is preferably slightly less than the inside diameter of hose material **77**. Tubing **91** is not necessarily joined or connected to tubular portion **85** (or to the corresponding portion at the opposite end of the conduit) but instead its length preferably is just sufficient that the ends thereof are generally adjacent (or may abut) such tubular portions at the ends of the conduit.

Tubing **91** is substantially nondeformable (except when clamped with exceedingly high force) and has the purpose of substantially precluding and clamping of conduit **23**, in an attempt to prevent operation of meter **13**, from interrupting the oil pressure communication provided by the conduit between engine **27** and oil pressure-responsive switch **24**. It may be observed that tubing **91**, while of sufficient strength to preclude outright flattening by ordinary clamping thereof, is nonetheless resilient so as to permit flexing of conduit **23** as illustrated in FIG. **1**. FIG. **7** is illustrative of clamping of conduit **23** by the application of forces F from opposite sides of the conduit, causing deforming of the hose material **77** but not tubing **91** and thus leaving voids at **93** (and within the bore of tubing **91**) permitting continued pressure communication. It will be apparent that a solid length of substantially nondeformable material may be used in place of tubing **91** and which, though having no bore, nonetheless leaves voids upon clamping of the conduit through which the oil pressure may be communicated.

In installing and using the system, it is to be understood that bracket **19** may be welded or bolted to the apparatus (e.g., the frame of a crawler tractor) or to engine **27**, as during assembly of the apparatus by the manufacturer. Conduit **23**, with plug **45** attached to it, may then be connected to engine **27** by threading fitting **81** into elbow **25**. Enclosure **17** (which may first be provided with battery **29** and then have its rear cover **20** spot-welded in place to be difficultly removable) is then positioned between the side members **33** and **35** and bolts **39** then inserted to secure the enclosure in place. Plug **45** is thereafter inserted into receptacle **43** from which it cannot then be nondestructively removed. The plug is also prevented from being turned with respect to the receptacle. Hence, when so connected, the conduit **23** or its fittings cannot be disconnected without being destroyed, noting that any attempt to loosen either of fittings **79** and **81** results in tightening of the other. Moreover, since plug **45** passes through aperture **42** of bracket **19**, enclosure **17** cannot be removed from the bracket. Consequently, tampering with the system to prevent normal recording operation thereof is precluded.

To remove enclosure **17** and gain access to it (as for ultimately replacing battery **29** after thousands of hours of operation), it is necessary to saw through elbow fitting **26** (requiring a new fitting for reassembly). Enclosure **17** may then be removed from bracket **19**, the welds or other means securing rear cover **20** broken or removed, and sleeve **59** loosened to provide access to snap ring **47** so as to permit removal of plug **45**. Such steps are so substantial an impediment to tampering as to preclude it. Lead seal wires may also be used through drilled heads of bolts **39** as an added impediment to tampering.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As various changes could be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. A tamper-proof recording device comprising:

a parameter recording instrument;

a protective enclosure for said instrument, said enclosure when intact securely protecting said instrument from tampering, and adapted for being secured to apparatus with regard to which a parameter is to be recorded by said instrument;

means for securing said enclosure to said apparatus;

a conduit adapted to be connected for providing communication between said instrument and said apparatus to cause recording by said instrument of said parameter in response to operation of said apparatus; and

connector means for connecting said conduit between said enclosure and said apparatus so as substantially to prevent nondestructive disconnection of said conduit following said connecting thereof, said conduit comprising a length of tubular material, said material being relatively flexible but resisting any substantial twisting thereof, said connector means comprising respective threaded fittings at opposite ends of said material for being respectively threaded to connections at said enclosure and said apparatus, said fittings each having the same thread direction orientation whereby when both are threaded neither of said fittings may be turned in a direction to cause unthreading by loosening thereof without causing tightening of the other fitting.

2. A tamper-proof recording device as set forth in claim **1** wherein said conduit must be destructively disconnected, following connection thereof between said enclosure and said apparatus, to permit disassembly of said enclosure.

3. A tamper-proof recording device as set forth in claim **1** wherein said connector means comprises a plug and a receptacle, said plug being receivable by said receptacle to connect said conduit to said enclosure, said plug and receptacle cooperating to prevent removal of said plug from said receptacle, when received thereby, while said enclosure is intact.

4. A tamper-proof recording device set forth in claim **3** wherein said plug is carried at one end of said conduit, said receptacle being positioned at a surface of said enclosure, said plug including latch means preventing removal of said plug from said receptacle when received thereby.

5. A tamper-proof recording device as set forth in claim **4** wherein said latch means comprises a snap ring, said snap ring expanding in said receptacle to prevent removal of said plug and being releasable only from within said enclosure.

6. A tamper-proof recording device as set forth in claim **3** wherein said means for securing said enclosure

comprises a bracket element adapted for substantially permanent attachment to said apparatus and having an aperture generally in alignment with said receptacle, said conduit passing through said aperture when said plug is received by said receptacle to prevent removal of said enclosure from said apparatus.

7. A tamper-proof recording device as set forth in claim **1** wherein the instrument is an elapsed-time meter, said enclosure including means responsive to fluid pressure for causing operation of said meter, said conduit providing fluid pressure communication between said apparatus and the fluid pressure-responsive means.

8. A tamper-proof recording device as set forth in claim **1** wherein said conduit provides fluid pressure communication between said apparatus and a fluid pressure-responsive means included in said enclosure and wherein said tubular material is relatively compressible and elastic and wherein said conduit further includes a length of relatively incompressible yet flexible tubular material extending through the bore of the compressible tubular material whereby clamping of said conduit causes substantial deformation of only said compressible tubular material and said clamping is substantially precluded from interrupting said fluid pressure communication.

9. A tamper-proof recording device as set forth in claim **1** wherein said conduit provides fluid pressure communication between said apparatus and a fluid pressure-responsive means included in said enclosure and wherein said tubular material is relatively compressible and elastic and wherein said conduit further includes a length of relatively incompressible yet flexible material extending through the bore of said tubular material and having a generally circular cross section of outside diameter less than the diameter of said bore, whereby upon the application of compressive forces to said conduit the tubular material may engage both sides of the incompressible material in the plane of said compressive forces but will not completely engage the entire circumference of said incompressible material so that interruption of said fluid pressure communication is substantially precluded.

10. A tamper-proof recording device as set forth in claim **9** wherein the incompressible material comprises steel tubing.

11. A tamper-proof recording device as set forth in claim **7** wherein said elapsed-time meter is electrically powered, said enclosure including an electric power source for powering said meter, the fluid pressure-responsive means comprising a fluid pressure switch connected in a circuit with said power source and said meter.

12. A tamper-proof time interval recording device comprising:

an elapsed-time recording means adapted for being operated in response to fluid pressure;

a protective enclosure for said recording means, said enclosure when intact securely protecting said recording means from tampering, and adapted for being secured to apparatus with regard to which an operating time is to be recorded by said recording means;

means for securing said enclosure to said apparatus;

a relatively flexible conduit adapted to be connected for providing fluid pressure communication between said recording means and said apparatus to cause operation of said recording means in response to operation of said apparatus, said conduit resisting twisting of one end thereof with respect to the other; and

connector means including respective threaded fittings at the ends of said conduit for being respectively threaded to provide connections at said enclosure and at said apparatus, said fittings each having the same thread direction orientation whereby when both are threaded to provide said connections neither of said fittings may be turned in a direction to cause unthreading by loosening thereof without causing tightening of the other fitting.

13. A tamper-proof time interval recording device as set forth in claim **12** further comprising means for substantially preventing clamping of said conduit from interrupting said pressure communication.

14. A tamper-proof time interval recording device as set forth in claim **12** wherein said connector means comprises a plug and a receptacle, said plug being receivable by said receptacle following threading of said fittings, said plug and receptacle cooperating to prevent removal of said plug from said receptacle, when received thereby, and to prevent twisting of said plug and receptacle with respect to one another.

15. A tamper-proof recording device as set forth in claim **8** wherein the length of incompressible tubular material is shorter than the length of compressible tubular material with the outside diameter of the former being less than the inside diameter of the latter whereby said conduit has parallel fluid pressure communication paths through the bore of said length of incompressible tubular material and between the outside surface of the length of compressible tubular material and the inside surface of the length of incompressible tubular material.

16. A tamper-proof recording device as set forth in claim **1** wherein said conduit further comprises a flexible armor sheath surrounding said tubular material.

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