



APPARATUS FOR INNER SURFACE CLEANING AND OBJECTS MOUNTING ON THE INNER SURFACE

5 **Field of the Invention**

The invention relates to an apparatus for cleaning the inner surface of small hollow bodies and for mounting an object onto the inner surface. More particularly, the invention relates to an apparatus for cleaning the inner surface of small hollow bodies and
10 mounting strain gauges accurately on the cleaned inner surface where the hollow space is narrow and inaccessible to human hands.

Background of the Invention

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In structural testing, very often there is a need to measure applied loads on the structures of interests. Strain gauges are commonly attached to certain surfaces of the structure of interest to measure these applied loads. The mounting of strain gauges at precise locations on the structure of interest is of great importance in order to ensure that
20 the data obtained from the strain gauges is accurate.

In general, a conventional standard procedure for mounting strain gauges includes the following steps:

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1. Cleaning the surface where the strain gauge is to be mounted on.
 2. Mounting the strain gauge. This usually involves mounting the strain gauge onto the surface by means of an adhesive.
 3. Connecting wires to the strain gauge.

30 In strain gauge mounting, surface cleaning is a critical process as the surface will directly affect the quality of the bonding between the strain gauge and the surface. The next important step is how to mount the strain gauge onto the planned location precisely.

It is obvious that accessibility to the surfaces for mounting strain gauges is one of the
35 important factors when deciding how to carry out instrumentation work.



A lot of time and effort is spent to study where are the suitable mounting locations for strain gauges such that the data collected from the strain gauges are accurate and useful. Often there will be situations whereby there is a need to mount strain gauges on the inner surfaces of hollow bodies, especially in circumstances when the external profile of the hollow bodies cannot be changed, such as by attaching strain gauges to the external surface, the external profile will be affected.

When the planned locations for mounting strain gauges are on the inner surface of a narrow hollow body with open ends, as the inner surface is inaccessible to human hands due to the narrow space, it is not possible to clean the planned location effectively and mount the strain gauge at the precise location without an effective tool.

US Patent No. 4, 329, 754 issued to Ray Wilson on 18 May 1982 discloses an apparatus for cleaning and clearing of engine cylinder exhaust ports, wherein access is gained through the spark plug receiving bore. The apparatus comprises a rod implement and template means affixable to the engine cylinder adjacent to the plug receiving hole. The apparatus is specifically adapted for use with certain two-cycle engines.

US Patent No. 5,619,925 issued to Karl-Heinz Seefried on 15 April 1997 discloses a cleaning device for a cylinder of a printing press. The cleaning device has a beam-type cleaning tool extending over the length of the cylinder gap open at the cylinder circumferential and extending in the direction of the cylinder axis.

US Patent No. 6,390,105 issued to Donald Ramsey on 21 May 2002 discloses an apparatus for cleaning the interior of small diameter pipes. The apparatus has high-pressure rotary fluid distribution nozzles on a rotating bracket carried on a movable platform.

US Patent No. 5,829,461 discloses an interior tank cleaning apparatus for tanks and large pipes having multiple nozzle heads on a rotating support bracket.

Whilst the above prior references disclose numerous forms of cleaning apparatus, there does not appear to be any prior disclosure which is directed to apparatus for inner surface cleaning and objects mounting on the inner surface.

Accordingly, it is an aim to provide an apparatus that can overcome the inaccessibility problem to achieve the accurate mounting of strain gauges with good bonding quality.

Summary of the Invention

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According to one aspect of the invention, an apparatus is provided for surface cleaning and strain gauge mounting on inner surface of hollow bodies with narrow space inside. The apparatus comprises a positioning support and an operable lever. The lever passes through an opening at the center of the support and is operable to be pivotally mounted
10 onto the support. The support has contacting walls, which are profiled to match with the inner surface profile where the support is to be mounted. The support has at least one operable threaded member having a lengthwise axis, such as a hollow cylinder with threads on its inner surface or a nut. By operating the threaded member, the support is caused to be extended or contacted in the direction parallel to the lengthwise axis of the
15 threaded member. The lever has two groups of pivot holes and an operation end, which can be fitted with cleaning agent or strain gauge, and reach the target locations.

Still another aspect of the present invention is to provide an apparatus for inner surface cleaning and objects mounting on the inner surface, wherein said at least one threaded
20 member is a cylindrical element having two opposite direction threads at the two ends on its inner surface.

A further object of the present invention is to provide an apparatus for inner surface cleaning and objects mounting on the inner surface, wherein the lever is provided with a
25 plurality of guiding openings along the length thereof for defining a path for movement of the lever, which can provide one degree of freedom (purely rotation) and two degrees of freedom (rotation and sliding).

Brief Description of the Drawings

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The invention will now be further described by way of non-limiting examples, with reference to the accompanying drawings, in which: -

Figure 1 is a perspective view of an apparatus for inner surface cleaning and objects
35 mounting on the inner surface of a preferred embodiment of the present invention.

Figure 2 is a simplified sectional side view of Figure 1 of the present invention.

Figure 3 is a sectional view along line A-A of Figure 2.

Figure 4 is a front view of a support of the embodiment of Figure 1.

Figure 5 is a front view of the support body of the support of Figure 1.

Figure 6 is a front view of an extendible member of the support of Figure 1.

5 Figure 7 is a front view of a connector of the support of Figure 1.

Figure 8 is a side view of a lever of the embodiment of Figure 1.

Figure 9 is a sectional view along line B-B of Figure 8.

Figure 10 is a sectional view along line B-B of Figure 8, wherein a piece of sand paper is attached to the support.

10 Figure 11 is a sectional view along line B-B of Figure 8, wherein a strain gauge is attached to the support.

Detailed Description

15 Figure 1 shows a perspective view of an exemplary apparatus for surface cleaning and strain gauge mounting of the invention when the apparatus is placed into a hollow body 200. In accordance with the present invention, the apparatus comprises a support 10 and a lever 80. The support 10 has at least one extendible member 40 joined to a threaded member 50 which is connected to the support 10 at the other end and an opening 20 is formed at the center of the support. The lever has a cleaning end 88. The lever 80 is inserted through the opening 20 in the central body 15 of the support 10 such that the lever 80 extends into the hollow body 200. Figure 2 shows a simplified side view of an exemplary apparatus when the apparatus is placed in a hollow body. Figure 3 shows the support 10 mounted within the hollow cylinder 200 when viewed from the accessible end of hollow cylinder 200. When in use, by turning threaded member 50, which has threads on its inner surface, the support 10 extends across the cross section of hollow body 200 with the contact walls 42 abutting the inner surface of the hollow body 200 such that the support 10 is firmly held in place inside hollow body 200. The support 10 is used to provide firm positioning support for the lever 80 during surface cleaning and strain gauge mounting. The support 10 is held firmly inside the hollow body 200 due to reaction forces as well as frictional forces between the inner surface of hollow body 200 and the contact walls 42.

Figure 4 is a front view of an exemplary support 10. The support 10 includes a central body 15, two extendible members 40 and two threaded members 50. Figure 5 shows the central body 15 of the support 10.

5 In the present preferred embodiment, the central body 15 is elongated and generally rectangular in form, tapering at both ends, when viewed from the front. Each tapered end 12 has a threaded portion 18 that is generally cylindrical in shape and has a threaded outer surface. The opening 20 is generally elongate in shape and extends through the central body 15. In use, the lever 80 is inserted through the opening 20 and into the
10 hollow cylinder 200. The shape of the opening 20 must be configured to accommodate the shape of lever 80 and provide clearance to allow for the movement of the lever 80 during surface cleaning and strain gauge mounting operations. Side hole 30 extends through the side of the central body 15 with its axis perpendicular to the longitudinal axis of the opening 20. In use, a pin 400 is inserted through the side hole 30 and a
15 corresponding pivot hole 75 or elongated slot 70 in the body of the lever 80 such that the lever 80 can be pivoted and reach the target.

Figure 6 shows an extendible member 40 of the support 10. The extendible member 40 has a contact wall 42 at one end and a connecting portion 48 at the opposite end. The
20 connecting portion 48 is threaded on its outer surface. The contact wall 42 has a external profile that matches with the profile of the inner surface of hollow body 200. Figure 7 shows a threaded member 50 of the support 10. The threaded member 50 is a hollow cylinder with two threaded segments at the two ends of its threaded inner surface 52, which have opposite directions and interface with the extendible member 40 and the
25 central body 15 respectively.

The connector 10 connects the threaded portion 18 of the central body 15 and the connecting portion 48 of the extendible member 40 to form the support 10. The threaded portion 18 of the central body 15 engages with the threaded inner surface 52 at one end
30 of the threaded member 50 and the connecting portion 48 of the extendible member 40 at the other end of the threaded member 50. The threaded member 50 also act as a means to adjust the external dimension of the support 10 by enabling the extendible members 40 to move away from the central body 15 such that the contact walls 42 abut the inner surface of the hollow body 200 and to move back to their original position. The
35 threaded member 50 are turned to decrease the length of the support 10 until there is

enough clearance between the inner surface of the hollow body 200 and the contact walls 42 such that the support 10 can be inserted into the hollow body 200. The support 10 is then inserted via the accessible end of the hollow cylinder 200 up to a convenient depth as shown in Figures 1 and 3.

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When the threaded member 50 is turned in one direction, the threads on the threaded inner surface 52 engage with the threads on the connecting portion 48 of the extendible member 40 such that extendible member 40 moves away from the central body 15. The same is done for the threaded member 50 on the other side of the central body 15. This results in an overall increase in the external dimension of the support 10 due to the relative horizontal movement between the connecting portion 48 and the threaded portion 18. The threaded member 50 is rotated until the contact wall 42 abuts the inner surface of the hollow body 200. Turning the threaded member 50 further causes the contact wall 42 to exert a greater force on the inner surface of the hollow body 200. The threaded member 50 is turned until the support 10 is firmly mounted onto the inner surface of the hollow body 200.

Turning the threaded member 50 in the opposite direction causes extendible member 40 to move towards the central body 15. Consequently, the contact wall 42 moves away from the inner surface of the hollow body 200 and the external dimension of the support 10 is decreased.

As the external dimension of the support 10 can be varied, the support 10 can be used for hollow bodies of various cross-sectional dimensions, not just the hollow body used as the example in the figure above, as long as the maximum external dimension of the support 10 enables the support 10 to be firmly mounted onto the inner surface of the hollow body.

Figure 8 is a side view of the lever 80 of the preferred embodiment of the present invention. The lever 80 is elongated, with a head portion 60 at the cleaning end 88 of the lever 80 that is inserted into the hollow body 200. The lever 80 is generally an elongated arm, having a operation end 89 and a head portion 60 when viewed from the side. The head portion 60 serves as a means for attaching an abrasive material for surface cleaning and provides for attaching a strain gauge for mounting. The pivot holes 75 and the elongated slots 70 extend through the sides along the length of the lever 80.

The positions of elongated slots 70 and the pivot holes 75 are alternated along the length of lever 80.

The pivot holes 75 enable the lever 80 to be pivotally mounted onto the support 10. The location of the pivot holes 75 will depend on the distance of the planned location(s) for strain gauge mounting. The multiple pivot holes 75 along the length of the lever 80 enable strain gauges to be mounted at various locations along the inner surface of the hollow body 200. A suitable pivot hole 75 is chosen such that when the lever 80 is pivotally mounted to the support 10 at the pivot hole 75, a strain gauge 500 can be mounted at the exact planned location on the inner surface of the hollow body 200. The lever 80 is operable to be inserted into the hollow body 200 through the opening 20 until the chosen pivot hole 75 coincides with the side hole 30 of the central body 10. The pin 400 is inserted through the side hole 30 of the support 10 and the chosen pivot hole 75 on the lever 80. The lever 80 is now pivotally mounted onto the support 10 via the pin 400. In this configuration, the lever 80 is operable to be tilted such that the head portion 60 of the lever 80 is able to come into positive contact with the inner surface of hollow body 200 and is used for the mounting of the strain gauge 500.

In another configuration, the lever 80 is operable to be inserted into the hollow body 200 until a chosen elongated slot 70 coincides with the side hole 30 of the central body 10. The pin 400 is inserted through the side hole 30 of the central body 10. Similarly, the lever 80 is now pivotally mounted onto the support 10. This configuration enables the lever 80 to be operable to move forwards and backwards along the inner surface of hollow body 200. The path of the forwards and backwards movement of lever 80 is guided by the profile of the elongated slot. This ensures that surface cleaning is done at a precise planned location on the inner surface of the hollow body 200. The support 10 stabilizes the movement of the lever 80 by preventing sideways movement and slipping of the lever 80 during the surface cleaning and strain gauge mounting operations.

Figure 9 shows the head portion 60 of the lever 80 when viewed from B-B direction of Figure 8. The head portion 60 includes a holder 90, an attachment support 95 and head attachment portion 85 assembled together. The holder 90 is a rectangular block with a slot 97 at its top surface and a slot 92 at its bottom surface, resulting in the holder 60 having a "H" shaped cross-section as shown in Figure 9. The depth of the slots 97, 92 end about four ninth into the depth of the holder 90 from each side. The bottom edge of

the head attachment portion 85 of the lever 80 is disposed into the slot 97 on the top surface of the holder 90 and held together by fasteners 600. The attachment support 95 has an enlarged surface on one side and is used as a support means for attaching sand paper 700 or strain gauge 500 while the other side of the attachment support 95 has a cross-sectional shape that is configured to fit into the bottom slot 92 of the holder 90. The attachment support 95 and the holder 90 are held together by the fasteners 600 after the attachment support 95 disposed into the bottom slot 92 of the holder 90. In the present invention, screws may be used as the fasteners 600 to hold the parts together.

Figure 10 shows the cross-sectional view of the head portion 60 of the lever 80 with sand paper 700 attached to the attachment support 95. A piece of abrasive material, for example a piece of sand paper 700 is wrapped around the attachment support 95 such that the enlarged surface of the attachment support 95 is covered with the sand paper and the edges of the sand paper 700 fit into the bottom slot 92 of the holder 90. The fasteners 600 are then used to hold the attachment support 95 that is wrapped with the sand paper 700 to the holder 90. This ensures that the sand paper is held tightly against the support holder 90 to enable effective cleaning of the surface for strain gauge mounting.

In an alternative embodiment, the central body 15 and one of the extendible members 40 may be made as a single piece rather than being separate pieces mounted together. In this case, only one threaded member 50 is required to connect the extendible member 40 to the opposite side of the central body 15. This alternative embodiment is suitable for cases where the hollow cylinder 200 is very narrow.

It will be understood that most of the structure of the above example can be changed without departing from the scope of the invention. For example, the number and position of the pivot holes and the elongated slots can vary according to the planned location for surface cleaning and strain gauge mounting.

The profile of the contact wall 42 may be changed to match the profile of the inner surface of any hollow body. For example, if a hollow body has a square cross section, the contact wall 42 may be a square disc instead of a curved one.

The threaded member 50 described in the above embodiment is generally cylindrical in shape and has a threaded inner surface. The external profile of threaded member 50 may be changed such that it can be turned with a tool, for example, by using a nut with a hexagonal external profile such that it can be turned using a spanner.

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The shape of the support 10 and the number and configuration of the extendible members 40 can also be changed as required by different circumstances. The above described embodiment is intended for support at both ends where the two contact walls 42 abut the inner surface of the hollow body 200. Other multiple support possibilities exist, for example, a triangularly shaped support having three extendible members 40, each extending from one apex of the triangular support body.

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The configuration of the head portion 60 of the lever 80 may be changed as well. In the above described embodiment, the head portion 60 has a holder 90 and an attachment support 95. The head portion 60 and the lever 80 may be formed as a single piece, as long as there is a surface at the head portion 60 to serve as a cleaning end for the attachment of sand paper and a strain gauge.

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Many other variations are possible within the scope of the present invention which is only limited as defined in the claims or elsewhere as indicated.

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CLAIMS:

1. A surface cleaning apparatus for hollow body comprising:
 - (a) at least one extendible member urging the inner contact wall of the hollow body;
 - (b) a support having at least one extendible member joined to a threaded member at one end of the support and an opening at the center thereof; and
 - (c) an elongated lever having a cleaning end; wherein the elongated lever passes through the opening on the support and slidably held by the support; whereby a rotational movement of the threaded member causes the extendible member to move in a direction parallel to the lengthwise axis of the threaded member so that the support is extendably fitted to the internal surface of the hollow body.
2. The apparatus according to claim 1 wherein said at least one threaded member is a cylindrical element having two opposite direction threads at the two ends on the inner surface thereof.
3. The apparatus according to claim 1 or 2, wherein said at least one threaded member is a threaded nut.
4. The apparatus according to claim 1 wherein the lever is provided with a plurality of guiding openings along the length thereof for defining a path for movement of the lever, which can provide one degree of freedom (purely rotation) and two degree of freedom (rotation and sliding).
5. The apparatus according to claim 4 wherein the guiding openings include circular holes and elongated slots.
6. The apparatus according to claim 1 wherein said at least one extendible member includes a wall positioned at an end thereof, and the wall has a profile that is to match the profile at the mounting position of an inner surface of the hollow body.

7. The apparatus according to claim 1 wherein a strain gauge is removably attached to the cleaning end of the lever.
8. The apparatus according to claim 1 wherein an abrasive material is attachable to the cleaning end for cleaning the internal surface of the hollow body.
9. A surface cleaning and strain gauge mounting apparatus on the inner hollow body having an internal narrow space, comprising:
 - (a) at least one extendible member urging the inner contact wall of the hollow body;
 - (b) a support having at least one extendible member joined to a threaded member at one end of the support and an opening at the center thereof; and
 - (c) an elongated lever having a cleaning end; wherein the elongated lever passes through the opening on the support and slidably held by the support; whereby a rotational movement of the threaded member causes the extendible member to move in a direction parallel to the lengthwise axis of the threaded member so that the support is extendably fitted to the internal surface of the hollow body, and the lever is operable in rotational movement or rotational and slidable movement.
10. The apparatus according to claim 1 or 9 wherein an end of the extendible member is operable to abut an inner surface of the hollow body.
11. The apparatus according to claim 1 or 9 wherein the support is removably mounted onto the inner surface of the hollow body and the lever extends into the hollow body such that the cleaning end of the lever contacts the surface of the inner surface of the hollow body.
12. The apparatus according to claim 1, or 4 or 9, wherein the lever provides a serial of connecting points with a rotating or rotating and sliding movement.
13. The apparatus according to claim 1 or 5 or 9, wherein the edge of the opening at the center of the support is able to provide firm guide to the lever to operate only with rotating or rotating and sliding movement.