Title: METHOD AND APPARATUS FOR TESTING PLUMBING INSTALLATIONS

Abstract: A method and apparatus for testing plumbing installation including a tool (100) for making an opening through a test cap (70) or other blockage in a fluid conduit (36).
For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.
Description

Method and Apparatus for Testing Plumbing Installations

Technical Field

The present invention pertains to a method and apparatus for testing plumbing installations and more particularly to a tool for making an opening through a test cap or other blockage in a fluid-carrying line of a plumbing system and to an improved method for testing a plumbing installation wherein the tool and cap make the testing method possible.

Background

In residential house construction and as is well known, the plumbing is basically installed in three stages, namely, the rough-in plumbing, top-out plumbing and finish plumbing. The rough-in plumbing occurs prior to pouring of concrete. Top-out plumbing follows framing the building and involves installing the pipes in the walls and vent pipes that extend up through the roof of the structure. Finish plumbing relates to setting toilets, sinks, and the like.

The rough plumbing includes laying a drain or waste pipe which leads from building to the city sewer main normally in the access street or road adjacent to the building. It is, thus, common practice to insert a clean-out in the drain pipe between the pipes in the building and the section of the drain pipe that leads to the sewer line. This clean-out may be located in a basement or, in a building without a basement, outside the building and underground. If underground, the clean-out has a branch extending to the surface of the ground for providing access to the drain pipe both during construction and during use of the building.

As is well known, in order to pass the rigid inspection normally imposed by building codes, it is necessary to test the drainage part of the plumbing system after the rough-in and top-out stages are finished. For this purpose, common procedures and devices are in use. The devices include test caps and inflatable test plugs, so-called water-weenies. In use, the test caps are sealed at the ends of all open and exposed branch pipes, and the inflatable test plugs are used in the clean-out where the passageway plugged is not as accessible. After the tests, the exposed test caps are
punched out with a hammer, and the inflatable plugs are deflated and pulled out of the
clean-out. Thus, the test plugs and the inflatable plugs can be removed without
disassembling and disturbing the tested system.

As indicated, the test caps in above-ground, accessible locations are usually
knocked out with a hammer, whereupon the fragments are pried out with a screwdriver
or pliers. If a test cap were sealed in a clean-out, however, whether the clean-out is
relatively accessible in a basement or whether it is underground, it cannot be punched
out with a hammer and screwdriver without disassembling part of the system and
thereby disturbing the tested system. Thus, test caps have not been used to block the
test pressure in the drain pipe.

Instead, during the rough-in plumbing stage, the inflatable weenie-shaped, test
plugs have been inserted in the clean-out, used for the tests, and subsequently removed
with a pull chain attached to the plug and extending out of the clean-out. More
specifically, to test the rough-in plumbing, the plug is inserted and inflated thereby
sealing the drain pipe. The plumbing on the building side of the plug is then pressurized
to check for leaks. After the top-out phase is completed, the plumbing is again tested
by again inflating the plug, and pressurizing the system, usually by feeding water into
the system through the vent pipes in the roof.

Use of such inflatable weenie plugs for the described testing has proved
unsatisfactory for several reasons. The essential problem is that the plugs often leak
although the plumbing may be entirely sound. Either the plug does not seal perfectly
circumferentially within the pipe or the plug is punctured as it is being slid in or out of
the clean-out and against the rough surfaces thereof. As a result, the test fails, not
because of faulty plumbing, but because of a faulty plug. The plumbing crew will then
need to be called back to the job to attend to the problem, causing aggravation and extra expense to the contractors and owners involved. Not only is there extra labor cost
involved, but the failed inflatable test plugs must be replaced at considerable expense.

Summary

A method and apparatus for testing plumbing installations is provided including
a tool for making an opening through a test cap or other blockage in a fluid-carrying
line of a plumbing system and to an improved method for testing a plumbing installation
wherein the tool and cap make the testing method possible. During the rough-in
plumbing phase of construction, a test cap welded in the drain pipe seals the drain line
from the sewer line at the location of the clean-out. Thereafter, the rough-in plumbing
system is tested by pressurizing the system through the clean-out on the building side of
the cap. Following successful completion of this test, the top-out plumbing is
completed, leaving the test cap welded in place. After the roof vents are in, the top-out
test of the plumbing system is made, also through the clean-out. After final test and
inspection, a special tool constructed in accordance with the present invention is
inserted down the clean-out to penetrate and ream-out the test cap. The test cap used is
specially constructed to facilitate use of the tool, and the tool has an operating head
especially adapted to access the test cap and to penetrate and ream out the cap.
Thereafter, the tool including the head is readily withdrawn from the clean-out.
Moreover, the tool is easily lengthened or shortened to suit particular applications and
users. The tool may also be useful in opening a passage through other blockages in a
fluid-carrying line.

An object of this invention is to be able to open a passage through a test cap or
other blockage in a fluid-carrying line.

Another object is to provide a tool that can be extended into a clean-out and
can penetrate through and ream out a test cap or other blockage that is secured or
stuck in a fluid-tight manner in a drain pipe to which the clean-out is connected.

Still another object is to be able from a remote position to maneuver and guide
the operating head of a tool inside a clean-out and into a position therein to penetrate
and ream out a test cap welded in the clean-out or other blockage in the line.

An additional object is to be able to do the rough-in and final pressure tests of a
plumbing system in a building under construction through a clean-out instead of
through a roof vent or other internal pipe of the building.

A further object is to provide a tool for penetrating and reaming out a test cap
or other blockage in a drain line wherein the tool is adapted to flex more easily around
corners or other transitions between a clean-out and the drain line and thereby make an
opening through the test cap or other blockage.
An additional object is to provide a test cap for blocking a drain line that can be more easily removed by a tool especially adapted to penetrate and ream out the cap through a clean-out.

Another object is to provide an operating head on a plumbing tool that is especially adapted to penetrate through and ream out a test cap in a drain line.

Yet another object is to provide a test cap- or other blockage-removing tool that can be adjusted in length depending on the distance between the test cap-to-be-removed and the location of the operator of the tool.

A further object to provide a test cap-removing tool that cooperates with a clean-out to leverage the operating head into an operating position and then allows the operating head to penetrate and ream out the test cap or other blockage.

A still further object is to enable a test plug or other blockage that has been welded or otherwise fixed in fluid-tight relation in a drain pipe to be removed so that nearly the full diameter of the drain pipe is available for conducting material therethrough after the plug or other blockage has been removed.

These and other objects and advantages of the invention will become apparent upon reference to the accompanying drawings and the following detailed description.

Brief Description to Drawings

Fig. 1 is an isometric view showing a schematic representation of a plumbing installation in a residential building construction that is intended to represent the plumbing installation after the rough-in plumbing or first stage of the plumbing installation has been completed and during which a clean-out is installed in a drain pipe leading from the building to a public sewer line.

Fig. 2 is an enlarged exploded isometric view of a part of Fig. 1, showing fragments of upper and lower sections of the drain pipe, showing the clean-out with a branch thereof partially broken away to be connected to the lower section of the drain pipe, and showing a test cap to be connected to the lower section between the section and the branch of the clean-out.

Fig. 3 is a still further enlarged view similar to Fig. 2 but with the parts assembled, thereby showing the clean-out connected between the upper and lower sections of the drain pipe and showing the test cap connected to the lower section
between that section and the clean-out so as to block flow through the clean-out from
the upper section of the drain pipe to the lower section thereof.

Fig. 4 is a still further enlarged face view of the test cap shown in Figs. 2 and 3
as seen from the downstream side of the cap.

Fig. 5 is an exploded longitudinal diametrical section of the test cap taken on a
plane indicated by line 5-5 of Fig. 4 and showing the test cap between the drain pipe
and the clean-out and illustrating how these three parts will interfit when assembled.

Fig. 6 is a view similar to Fig. 1 but on a reduced scale and intended to
represent the plumbing system after the second or top-out stage thereof has been
completed.

Fig. 7a is an isometric view of a tool used in carrying out the method of the
present invention and including an operating head, a flexible shaft, and handles and with
the tool in its fully extended position.

Fig. 7b is an isometric view similar to Fig. 7a but with the tool in its fully
retracted position.

Fig. 8 is an enlarged end view of the operating head of the tool shown in Figs.
7a and 7b.

Fig. 9 is an enlarged, exploded, isometric primarily of the operating head of
Figs. 7a and 7b with the shaft being shown fragmentarily and showing how the
operating head is releasably pivotally connected to the shaft.

Fig. 10 is an enlarged isometric view of the shaft showing the turns of the coil
spring construction of the shaft.

Fig. 11 is an enlarged exploded isometric view of the handle of the tool of Figs.
7a and 7b and showing how the handle is connected to the shaft.

Fig. 12 is an isometric view similar to and on the same scale as Fig. 3 with an
extension pipe connected to the clean-out, with the tool of Figs. 7a and 7b extended
into the clean-out, and with part of the clean-out broken away to show the operating
head of the tool pivots in order to move into operating engagement with the center
plate of the test cap.

Fig. 13 is an enlarged fragmentary, vertical longitudinal section of the clean-out
and part of the lower section of the drain pipe and showing the tool with its operating
head in pivoted engagement with the center plate of the cap.
Fig. 14 is a view similar to Fig. 12 but with the tool removed and with the clean-out broken away to show how the operating head has completely removed the center plate of the test cap thereby to open the drain pipe for movement of drain materials therethrough.

Detailed Description

Prior to describing the method and apparatus of the present invention, reference will be briefly made to the environment in which the invention is used. Thus, in Fig. 1, a plumbing system is schematically shown and generally indicated by the numeral 20 in a residential building construction 22, with the plumbing system being represented at the rough plumbing stage. Only the foundation area 24 and a few of the interior pipes 26 of the plumbing system are shown, thereby indicating that only the basic pipes have been installed and that none of the finish plumbing is in nor are the appliances installed.

During the rough-in plumbing stage (Fig. 1), a drain pipe 36 is connected between the interior plumbing 26 and a city sewer main or public sewer line 38 which usually runs underneath the street or road in front of the construction 22. The drain pipe is typically made of a plastic such as ABS or PVC, but it may be cast iron or copper or other suitable material. For drainage purposes, the pipe usually has a three- or four-inch diameter and is laid with enough slope to enable drainage. As is well known, the ground 42 around the construction is excavated to provide a large trench or open area 44 below normal ground level so the drain pipe can be connected to the sewer line. The drain pipe has an upper section 46 connected to the interior plumbing and a lower section 48 connected to the sewer line.

A three-way clean-out 56 (Figs 1, 2 and 3), usually of the same material as the drain pipe 36, has inlet, outlet and clean-out branches 58, 60 and 62, each having a collar 64 and an annular shoulder 66. The collars of the inlet and outlet branches are respectively slid over and cemented to the upper and lower sections 46 and 48 of the drain pipe with the shoulders of the clean-out normally abutting the ends of the pipe sections. A riser 68 is connected to the clean-out branch and extends above the surface of the ground 42, and a clean-out cover 69 is releasably connected to the riser for sealing and closing this branch when necessary. Note also that the clean-out may be a
wye as shown, but also a sanitary tee or a combination, that is, a two way, clean-out,
the latter two types not being shown.

An important feature of the present invention is the use of an inlet nipple 69a in
the cover 69 that is closed by a removable cap 69b. When opened by removing the cap,
the nipple provides fluid communication into the riser 68 and thus to the clean-out 56
for a purpose to be described. This nipple may be offset from the wrench lug, as shown,
or it may be coaxial with the cover. The important characteristic is that the nipple
provides a way of feeding water into the plumbing system 20 through the clean-out at
the appropriate time, as will be seen.

As is well-known, building codes typically require plumbing installations for
new construction to be tested for leaks twice: after the rough-in plumbing is in and after
the top-out plumbing is completed. It has been standard practice to insert an inflatable
plug, not shown, down the clean-out branch 62 and into the outlet branch 60; to inflate
the plug; and thus to block the drain pipe 36 so the plumbing system can be pressurized
for leaks. Since such plugs have not been satisfactory as discussed above, the principles
of the present invention involve conducting the tests differently.

In accordance with the method of the present invention, as part of the rough-in
plumbing phase (Figs. 1-5) and before installing the clean-out 56, a test cap or plug 70
of special construction and also known as a "knock-out disc," is fitted in and glued to
the lower section 48 of the drain pipe 36. Thereafter, the clean-out is connected
between and joins the upper and lower sections 46 and 48 of the drain pipe. The test
cap has an annular body 72, an annular flange 74 extending radially outwardly from the
body, and a flat, circular center plate 76 filling the body. The center plate is divided into
several pie-shaped or triangular segments 80 with adjacent segments being divided by
straight weakened break lines or grooves 82 that meet in the center 84 of the plate.
Although not shown, the plate may also have one or more circular, weakened break
lines or grooves concentric with the annular body and flange; if singular, such a circular
break line would preferably have a radius from about 1/3 to 1/2 of the radius of the
annular body and flange or if multiple, the break lines would be preferably about
equally spaced between the center 84 and the flange. Alternatively and also not shown,
the plate may have only circular break lines in which case, the center plate may be
concavo-convex, instead of flat, with the concave side facing upstream.
Test caps, or knock-out plugs as they are commonly called, for a similar purpose are sold by the PASCO Company of 11156 Wright Road, Lynwood, CA 90262, as part Nos. 4844 and 4845. Since the weakened break lines 82 in the cap 70 facilitate penetration by the subject tool 100, the caps 70 are preferred over the identified PASCO caps. The caps 70 are made of the same plastic material as the PASCO caps and are thus capable of being solvent-welded to ABS or PVC pipe. The caps 70 are also made in various sizes so that their annular bodies 72 can be fitted in three- or four-inch diameter drain pipes 36.

As above stated and during the rough-in plumbing stage, the test cap 70 (Figs. 2 and 5) is fitted in the lower section 48 of the drain pipe 36 with the body 72 received within the pipe, the flange 74 engaging the end of the pipe, and the center plate 76 disposed transversely of and within the pipe. Prior to making this assembly, layers of a suitable bonding cement are applied as at 78 to the mating surfaces so as to solvent-weld the parts together in the described assembly. After the test cap is welded in place (Fig. 13), the collar 64 of the outlet branch 60 of the clean-out is slipped over and solvent-welded to the lower section of the drain pipe with the shoulder 66 of the outlet branch abutting the radial flange 74 of the test cap. The resulting connection (Fig. 3) of the test cap in the drain pipe effects a fluid-tight seal that will block flow through the pipe. Either before or after this connection, the inlet branch 58 of the clean-out is connected to the upper section 46 of the drain pipe.

Following the described assembly (Figs. 1 and 3) of the test cap 70, the clean-out 56, and the upper and lower sections 46 and 48 of the drain pipe 36, the rough-in plumbing is subjected to a first pressure test. In accordance with the present invention, such pressurization is accomplished by removing the cap 69b and connecting a hose, not shown, to the nipple 69a. The hose is connected to a source of water under pressure, and water is introduced under pressure into the plumbing system 20 through the clean-out 56. It is, of course, understood and well known that all open ends of the pipes in the system 20 are plugged and, of course, the cover 69 closes the riser 68 of the clean-out branch 62, except for the nipple. Pressurization through the clean-out is made possible by bonding the test cap in place as described above, in contrast with using water-weenies as described above and pressurizing the system through a pipe in
the building 22. The presence of a water weenie in the clean-out and drain line would of course make pressurizing the system through the clean-out impossible.

Such pressurization imposes fluid pressure on the upstream side of the test cap 70 (Figs. 1 and 3) on the side thereof opposite from the sewer line 38. Since the test cap is securely bonded in fluid-tight relation within the drain pipe 36, no leaks will occur through or around the test cap. As a result, if there is any loss of pressure during the test, it will clearly be in the plumbing system 20 itself and not in the failure of the test cap, as contrasted with the frequent leaks of inflatable test plugs, as described above.

After the plumbing system 20 has passed the initial test at the rough-in plumbing stage, the cap 69b is replaced on the nipple 69a and the construction of the building 88 continues (Fig. 6) including completion of the top-out plumbing job. As part of finishing the construction, the ground 42 around the building is filled and graded, leaving the riser 68 exposed above ground level to allow access to the clean-out 56 and the nipple 69a.

During the completion of the building 88 (Fig. 6), the test cap 70, the clean-out 56 and the drain pipe 36 are not disturbed and thus remain connected in the described relationship (Fig. 3). After the top-out stage is completed, a second test of the plumbing system 20 is conducted by again pressurizing the system 20 through the nipple 69a, as above described. Once more, the test cap absolutely blocks flow through the drain pipe so that if there are any leaks, they will be in the system 20 and not in the test cap plugging the drain pipe. If the system is sound, only one additional test is needed, but of course if there are leaks, they must be repaired and the test repeated until all problems are corrected.

Following successful passage of the second or final test or tests, however, it is of course necessary to remove the blockage caused by the test cap 70. In accordance with the principles of the present invention, the blockage is removed by a special plumbing tool 100 (Figs. 7a-11). This tool includes an elongated telescopic shaft 102 including a rigid, upper or rear cylindrical sleeve 104 and a flexible, lower or forward cylindrical shaft member 106 mounted for telescopic movement within the sleeve, as will be described. The sleeve is preferably made of steel or other strong, durable metals. The flexible shaft member is made of coiled wire and is thus tubular having
open upper and lower ends. Adjacent turns 108 of the coil spring flexible member are in
very close engagement whether the shaft member is flexed or unflexed, thereby
imparting a measure of rigidity to the shaft member notwithstanding its considerable
flexibility in the length used. It is noted that the shaft member even in its fully retracted
telescopic position can be manually flexed into a full 360° bend and yet resiliently return
to its perfectly straight unstressed condition. Moreover, even with the shaft in its fully
extended teleoscopic position and supported horizontally like a fishing pole in use, the
flexible shaft member is rigid enough to flex downwardly only about 45° from the
horizontal. Coil springs suitable for the flexible shaft member are sold as part No. 9504
by the Marco Products Company of Sylmar, CA. Alternatively, other types of flexible
shafts or cables with the measure of rigidity described can be employed for the flexible
shaft member.

As stated, the shaft 102 (Figs. 7a, 7b, 9 and 11) is telescopic in that the flexible
shaft member 106 is slidably mounted within the sleeve 104 for movement between
extended positions, one of which is shown in Fig. 7a and retracted positions, one of
which is shown in Fig. 7b. More specifically, the sleeve has open upper and lower ends
109 and 110 (Fig. 11), respectively, and a plurality of adjustment holes 111
longitudinally spaced (preferably equally) therealong and aligned lengthwise of the
sleeve. A crank 112 includes an arm 150 connected to and projecting radially from the
upper end of the shaft and a tubular crankhandle 154 mounted on the arm for free
rotatable movement about the longitudinal axis of the crankhandle. The crankhandle
extends rearwardly from the arm in offset, parallel relation to the shaft.

A tubular supporting handle 155 (Figs. 7a, 7b, 9 and 11) is rotatably, coaxially
mounted on the upper end 109 of the sleeve and is thus parallel to the crankhandle. The
sleeve has an annular groove 156a (Fig. 11) spaced from the arm 150 by approximately
the length of the supporting handle so that with the supporting handle on the sleeve, the
groove is visible just outside the lower end of the supporting handle. A yieldably
expandable split, retainer ring 156b is snap-fitted into the groove thereby retaining the
supporting handle in its upper position on the sleeve but permitting rotation of the
supporting handle relative to the sleeve. The supporting handle also has a U-shaped slot
157 opening out of its upper end and alignable with the uppermost adjustment hole
upon rotation of the supporting handle to bring the uppermost hole and the slot into registry.

The flexible shaft member 106 is slidably mounted within the sleeve 104 by a cylindrical mounting block 114 having an outside diameter that will slidably fit within the sleeve. The mounting block also has a threaded end 115 that is threaded into the open upper end of the flexible shaft member 106. An outwardly spring-urged detent 116 is fitted in the mounting block and is of a size to fit into any of the adjustment holes 111 or the slot 157. The detent may be manually pressed into a retracted position in the block so as to not to project from its periphery or released into an extended position wherein it projects out from the periphery, as shown in Fig. 11.

With the mounting block 114 attached to the flexible shaft member 106 (Figs 7a, 7b and 11) and with the detent 116 compressed into its retracted position, the block and the upper end of the flexible shaft member are slipped into the lower open end of the sleeve 104 and then slid upwardly therein. With the detent aligned with the adjustment holes 111 circumferentially of the sleeve, the detent will be spring-urged outwardly into its locking position in any hole that is selected and with which it becomes aligned, thereby releasably locking the flexible shaft member in selected positions within the sleeve and enabling the overall length of the shaft 102 to be adjusted. Normally, when the flexible shaft member 106 is fully retracted within the sleeve so that the detent is in the uppermost hole 111, the tool is in its storing condition, although it can be used in this position if the circumstances warrant such a short length. In normal use to remove a test cap as 70, however, the detent is retracted, and the flexible shaft member is pulled outwardly into one of its extended positions wherein the detent projects and locks into one of the lower holes. Locking in any of the holes other than the uppermost hole also frees the supporting handle 155 for rotation on the sleeve (or stated otherwise, frees the sleeve rotation in the handle), thus preventing rotation of this handle in the operator's grasping hand and making the tool more comfortable to use. In its uppermost locked storing position, the detent not only projects into the uppermost hole 116, but it also projects into the slot 157 of the supporting handle 155 thereby locking this handle against rotation on the sleeve. Note that such locking of the supporting handle facilitates carrying of the tool since rotation of the handle on the sleeve may make carrying and handling the long shaft 102 with its
flexible, springy shaft member 106 somewhat unwieldy when not in use. Note also that
the U-shaped slot 157 allows the supporting handle 155 to be slid downwardly on the
sleeve past the detent in its uppermost locking position assuming that the retaining ring
156bis removed.

The plumbing tool 100 (Figs. 7a-9 and 13) also includes an operating head 120
which may have various configurations depending on the application of the tool,
including the head configuration of my prior copending application and my issued
patent, both cited above; a head similar to the configuration of these prior documents
but with another set of triangular blades on the back side of the mounting ring as well
as on the front as disclosed; or a head 120 as shown in Figs. 7a, 7b, 9 and 13 herein.
The present head has a cruciform configuration (see Fig. 8) and is pivotally attached to
the lower end of the flexible shaft member 106. This operating head has a pair of rigid,
tear-drop or paddle-shaped operating elements providing a plurality of rigid blades 122
rigidly connected in the shape of a cross or plus sign. Alternatively, the head may be
considered to be four semi-tear-shaped blades 122 joined in a cross configuration. The
head also has a mounting stub 126 provided with an aperture 128.

For attaching the operating head 120 to the shaft 102, a coupling ring 134
(Figs. 7a, 7b, 9 and 13) has a threaded upper end 135 that threads into the lower open
end of the flexible shaft member 106. The coupling ring also has a lower recess that
loosely receives the hub 126, and a pin 132 extends through the ring and into the
aperture of the stub thereby pivotally connecting the operating head to the shaft 102. It
will be understood that there may be different configurations and sizes of operating
heads 120, depending on the diameter of the drain pipe involved, the particular
blockage, the type of clean-out used, and other well-known factors. All of these may be
pivotally connected to the shaft by the specific pivoted connection shown and described
or by other pivoted connections as will be understood by those skilled in the art.

The blades 122 are rigidly joined to each other and are positioned in the four
quadrants of the operating head 120. The blades have a tear-drop shape so as to
provide smoothly curved reaming edges 138 that converge rearwardly to the mounting
stub 126 and blend smoothly forwardly into curved forwardly convex penetrating edges
140. The maximum transverse dimension of the head at the reaming edges 138 of each
coplanar pair of blades is approximately equal to the inside diameter of the annular
body 72 of the test cap 70. The axial length of the head is such that when the head is in
a drain pipe 36, the maximum transverse dimension of the head will be within the
annular body 72 while the pivot axis at the pin 132 is still in line with the clean-out
branch 62.

Description of Use and Method

The plumbing tool 100 (Fig. 7a and 7b) is first adjusted to the desired length by
depressing the detent 116 and adjusting the position of the flexible shaft member 106 to
the desired extended or retracted position in the sleeve 104 and then allowing the
detent to spring out into an aligned adjustment hole 111 in order to fix the overall
length of the tool shaft 102 for the particular application. The tool is then held by
grasping the supporting handle 155 in one hand and the crankhandle 154 in the other
hand. The tool shaft and thus the operating head 120 are rotated by turning the
crankhandle while holding the supporting handle, the shaft turning in the handle 155.
Also, the tool shaft has sufficient rigidity to allow force to be transmitted through and
axially of the shaft to the penetrating edges 140 by grasping the supporting handle in
one hand and the crankhandle in the other and thrusting the tool axially of the tool
shaft. Such rotation and axial thrusting can be accomplished at the same time whether
the tool shaft is straight or flexed.

Before further describing the operation of the plumbing tool 100, brief reference
is made here to the subject method described above for pressurizing the plumbing
system 20 through the clean-out 56. The ability to use this method will be better
understood after describing use of the plumbing tool 100. Moreover, the tool is used
to carry out other method aspects of the present invention after all necessary pressure
tests have been successfully completed. To this end, the cover 69 (Fig. 2) is removed,
and the operating head 120 of the tool is inserted into the riser 68 and lowered down
into the clean-out 56. The flexible shaft member 106 slidably engages the interior of
the riser and the clean-out branch 62 and guides the operating head 120 down the
clean-out until it exits the clean-out branch 62 and strikes the base of the outlet branch
60 of the clean-out (Fig. 13) whereupon the operating head 120 pivots over into the
generally horizontal attitude shown in Fig. 13, with one or two of the blades 122
engaging the base of the outlet branch 60 of the clean-out 56 and the penetrating edges
140 pointing toward the test cap 70. Such generally horizontal positioning is facilitated not only by the pivotal connection of the head to the shaft and by also the flexibility of
the flexible shaft member and the engagement of this shaft member with the clean-out branch along area 170, but also by the downward slope of the drain pipe 36.

When in this generally horizontal position (Figs. 12 and 13), further axial pressure on the tool shaft 102 causes the operating head 120 to move axially downwardly of the drain pipe 36 toward the test cap 70. Because of the combined flexibility and rigidity of the tool shaft and the leveraging effect of the shaft bearing against the clean-out branch 62 and/or the riser 68 at region 170, this axial pressure on the tool shaft causes the penetrating edges 140 of the operating head to move into engagement with the center plate 76 of the test cap 70. Then, the shaft is thrust sharply downwardly to force the penetrating edges to break through the plate by causing the plate to rupture along the break lines 82, creating an initial hole 174 (Fig. 12) in the plate.

Thereafter, while continuing to apply axial downward pressure on the tool shaft 102 (Fig. 13), the tool shaft and the operating head 120 are rotated with the crankhandle 154 to begin reaming away the center plate with the reaming edges 138 of the operating head. Within seconds the reaming blades will have substantially completely reamed out or cut away the center plate 76 from within the annular body 72 of the test cap to provide a large opening 180 (Fig. 14) in the test cap. This opening 180 is the about the same diameter as the inside diameter of the body since the maximum diameter of the operating head at the reaming edges 137 is about the same diameter as the inside diameter of the body. In turn, the inside diameter of the body is just slightly less than the inside diameter of the drain pipe, so that creating the opening 180 will allow waste material to move essentially unimpeded through the pipe.

After the opening 180 has been created, the tool 100 is pulled back out of the outlet branch 60 and thence out of the clean-out branch 62 and riser 68. Because of the smooth curvature of the tear-drop-shaped blades 122, the operating head 120 slides right back out of the test cap 70, drain pipe 36, and the clean-out and does not hang-up or become locked in the test cap, drain pipe or clean-out. It is also to be noted that the cut fragments, not shown, of the center plate are subsequently flushed down the lower section 48 of the drain pipe to the sewer line 38.
Having understood how the subject test cap 70 and tool 100 are used, it will be understood how the method of pressurizing the plumbing system 20 through the clean-out 56 is made possible. Since there is no inflatable test plugs or so-called water-weenie to block the clean-out, pressurization is most conveniently carried out through the clean-out, thereby avoiding having to pressurize the system through a roof vent.

From the foregoing it will be understood that an improved method for testing a newly installed plumbing system has been provided including a tool 100 used in carrying out the method. The method is more cost-effective because it avoids having to re-test a plumbing system 20 that would have passed the test but did not only because the test plug failed. Since the method does not use inflatable test plugs to seal off the drain pipe 36 while doing the testing, the common failure of the inflatable plug does not cause a failed test. Instead, the method involves use of a test cap which positively seals the drain pipe and allows an accurate test of the plumbing system. The test cap and its positive seal can be employed because the method also uses the tool 100 that can be extended into the clean-out and operated from a remote position to cut an opening 180 in the cap and remove the blockage from the pipe. It will be recognized that although the method and tool have been described and shown with an underground clean-out, they can be used equally as well when the clean-out is in a basement or otherwise above ground.

It will also be more generally recognized that since, as stated above, the test cap 70 is a blockage in the line, the tool is useful not only for removing test caps but also any such blockage that is so fixed or secured in the line that it prevents, either partially or completely, fluid flow therethrough.

Although a preferred embodiment of the present invention has been shown and described, various modifications and substitutions may be made thereto without departing from the spirit and scope of the invention. Accordingly, it is to be understood that the present invention has been described by way of illustration and not limitation.
What is claimed is:

1. A plumbing tool, comprising an operating head having reaming blades; a telescopic shaft having a lower flexible portion connected to the operating head and an upper rigid portion; a tubular handle rotatably receiving the rigid portion of the shaft; and a crankhandle connected to the rigid portion of the shaft.

2. The tool of claim 1, wherein the rigid portion is tubular; and wherein the flexible portion is slidably received in the rigid portion.

3. The tool of Claim 1, wherein the operating head is pivotally connected to the lower flexible portion of the shaft.

4. The tool of Claim 1, wherein the lower flexible portion is a coil spring.

5. The tool of Claim 1, wherein the lower flexible portion is slideable relative to the upper rigid portion between longer extended positions and shorter retracted positions; and wherein there is a locking mechanism locking the flexible portion and the upper rigid portion in selected extended or retracted positions.

6. The tool of claim 1, wherein the operating head has an axis of rotation and includes a plurality of blades radially extending from the axis in circumferentially spaced relation to each other; and wherein the blades have arcuate outer edges.

7. The tool of claim 6, wherein the blades have a semi-tear-shape projecting outwardly from the axis of the head.

8. The tool of claim 6, wherein the outer edges of the blades have lateral reaming edge portions and forward penetrating portions.

9. A tool for making an opening through a blockage in a fluid-carrying line that is blocking flow therethrough and wherein a branch laterally connected to and extending
from the fluid-carrying line provides access to the blockage, comprising an operating
head having semi-tear-shaped reaming blades projecting radially outwardly from an axis
of rotation of the head, the blades having lateral arcuate edges and forward arcuate
edges; a telescopic shaft having a lower flexible coil spring portion and a tubular upper
rigid sleeve portion having an internal diameter larger than the outside diameter of the
spring, the sleeve portion slidably receiving the spring portion for movement upwardly
and downwardly in the sleeve portion into various relative positions, a locking
mechanism locking the portions in selected positions; a pivotal connection between the
coil spring portion and the head; a crankhandle connected to the sleeve portion; and a
tubular handle rotatably receiving the sleeve portion adjacent to the crankhandle.

10. The tool of Claim 9, wherein the locking mechanism is a detent on one of the
portions and holes in the other portion releasably receiving the detent and locking the
two portions in selected positions of extension relative to each other.

11. A plumbing tool, comprising an operating head having reaming blades thereon; a
shaft having a lower flexible portion and an upper portion; a pivot connection between
the head and the flexible portion with the blades extending endwardly of the shaft; a
tubular handle rotatable receiving the upper portion of the shaft; and a crankhandle
connected to the rigid portion of the shaft.

12. A tool for making an opening through a blockage in a fluid-carrying line that is
blocking flow therethrough and wherein a lateral branch connected to the line provides
access to the blockage, comprising an operating head having a teardrop configuration
capable of penetrating and reaming an opening through the blockage; an elongated
shaft having a longitudinal axis and having an upper rigid sleeve and a lower tightly
wound coil spring pivotally connected to the operating head for extending the head into
the branch and into engagement with the blockage, the shaft being thereby relatively
rigid lengthwise of the axis when the coil spring is unstressed but being resiliently
flexible and bendable along the coil spring when the latter is subjected to force imposed
transversely of said axis so that when the head is in the line adjacent to the test cap, the
spring is capable of flexing in the transition from the branch to the fluid-carrying line
and the head is pivotal relative to the shaft to enable the engagement of the operating head with the blockage but because of said rigidity, the shaft is also capable of exerting force axially on the operating head and against the blockage to penetrate through the blockage; and a handle connected to the shaft for rotating the shaft while in its flexed condition and for axially forcing the operating head against the blockage thereby to cause the operating head first to penetrate and then to ream out an opening in the blockage so that the line is open and provides a passageway permitting flow therethrough.

13. A test cap for blocking a fluid-carrying line wherein a branch laterally extends from the line, provides access to the cap, and through which a tool can be inserted to break an opening through the cap, comprising an annular body, and a center plate within the body, the plate having a weakened break line therein dividing the center plate into segments that are breakable out of the body along the break line upon application of force to the center plate.

14. The tool of Claim 13, wherein the break line extends radially outwardly from the center of the plate to the annular body.

15. The tool of Claim 13, wherein the break line is circular and concentric with the plate.

16. An operating head for a plumbing tool capable of removing a test cap from a drain line through a clean-out, comprising a plurality of blades projecting radially outwardly from an axis of rotation of the head and having forward and rearward ends, each of the blades having a semi-teardrop shape with arcuate outer edges; and a mounting stub projecting rearwardly from the blades along said axis.

17. The head of Claim 16, wherein the arcuate edge of each blade curves smoothly outwardly and longitudinally of said axis from the mounting stub along a lateral reaming segment of the edge and thence curves smoothly transversely inwardly of the axis along a penetrating segment of the edge, and the penetrating segments of all of the
edges meeting forwardly of the head at said axis and at the opposite end thereof from
the mounting stub.

18. A cover for a clean-out of a plumbing system that facilitates testing of the system
during installation of the system, the clean-out enabling access to a drain line through a
branch projecting outwardly from the drain line, comprising an annular body adapted to
be fitted onto the branch of the clean-out, a top wall extending across the annular
body, a nipple mounted in one of the body and the wall and providing fluid
communication through the wall to enable fluid to be introduced into the plumbing
system through the clean-out from exteriorly of the plumbing system, and a cap
removably closing the nipple.

19. A method for testing a plumbing installation wherein a clean-out extends from a
drain line of the installation and wherein the clean-out has a branch extending from the
drain line, comprising the steps of bonding a test cap in the drain line on the
downstream side of the clean-out; inserting into the branch a tool having an upper
handle, an elongated shaft projecting from the handle, and an operating head with
penetrating and reaming blades thereon, the shaft having a lower resiliently flexible
portion pivotally connected to the head; positioning the head opposite to the test cap
with the lower flexible portion against the branch of the clean-out; moving the head into
engagement with the test cap by leveraging the flexible portion against the branch and
pivoting the head on the flexible portion; axially downwardly thrusting the tool thereby
causing the blades to penetrate the test cap; and rotating the shaft with the handle
thereby reaming out the test cap.

20. The method of Claim 19 wherein the shaft is telescopically adjustable in length,
including the further steps of adjusting the length of the shaft prior to inserting the tool
in the branch.

21. The method of Claim 19, including the further steps of pressurizing the system
through the clean-out before the tool is inserted in the branch to test if the system has
leaks.
22. A method of testing a plumbing installation having a clean-out that includes a branch providing access to fluid-carrying line of the installation that is otherwise inaccessible without disturbing the installation, comprising the steps of bonding a test cap in fluid-tight relation in the drain line on the downstream side of the clean-out prior to making the line inaccessible; covering the line and the clean-out except for the branch so that the only access to the test cap is through the branch without disturbing the covering; pressurizing the installation through the branch of the clean-out to test for leaks; and removing the test cap through the branch of the clean-out.

23. The method of Claim 19, wherein the removing step is carried out with a tool that is inserted down the branch of the clean-out and reams out the cap.

24. The method of Claim 19, wherein the bonding step is carried out with a test cap that has penetrable weakened areas.

25. The method of Claim 24, wherein the tool is rotatable, wherein the removing step is carried out with a tool that is inserted down the branch of the clean-out, the tool having penetrating and reaming edges; penetrating through the weakened areas with the penetrating edges by axially thrusting the tool against the cap; and reaming out the cap with the reaming edges by rotating the tool.

26. The method of Claim 19, wherein the removing step is carried out with a tool having an operating head with smoothly curving penetrating and reaming edges, inserting the tool down the branch of the clean-out to position the penetrating and reaming edges into engagement with the test cap; penetrating the test cap with the penetrating edges of the tool; reaming out the test cap with the reaming edges of the tool; and withdrawing the tool from the branch with the smooth edges sliding back out without hanging up on the line or clean-out.
AMENDED CLAIMS

[received by the International Bureau on 18 March 2001 (18.03.01);
new claims 27-37 added; original claims 1, 9 11, 12, 19, 21-26 amended;
remaining claims unchanged (8 pages)]

1. A plumbing tool for creating an opening through a blockage in a line, comprising
an operating head having blades capable of penetrating and reaming out such a
blockage that is sealed in a line; a telescopic shaft having a lower transversely flexible
portion connected to the operating head and an upper rigid portion, the shaft having
axial rigidity from its upper rigid portion to the head and being characterized in its
ability to apply axial force from the upper rigid portion to the lower flexible portion to
the head with a force sufficient to penetrate such a blockage with the head and further
being characterized in its ability to apply rotary force to the shaft and thus the head
with a force sufficient to ream out the blockage and provide an opening therethrough; a
tubular handle rotatably receiving the rigid portion of the shaft; and a crankhandle
connected to the rigid portion of the shaft.

2. The tool of claim 1, wherein the rigid portion is tubular; and wherein the flexible
portion is slidably received in the rigid portion.

3. The tool of Claim 1, wherein the operating head is pivotally connected to the lower
flexible portion of the shaft.

4. The tool of Claim 1, wherein the lower flexible portion is a coil spring.

5. The tool of Claim 1, wherein the lower flexible portion is slidable relative to the
upper rigid portion between longer extended positions and shorter retracted positions;
and wherein there is a locking mechanism locking the flexible portion and the upper
rigid portion in selected extended or retracted positions.

6. The tool of claim 1, wherein the operating head has an axis of rotation and includes
a plurality of blades radially extending from the axis in circumferentially spaced
relation to each other; and wherein the blades have arcuate outer edges.

7. The tool of claim 6, wherein the blades have a semi-tear-shape projecting outwardly
from the axis of the head.
8. The tool of claim 6, wherein the outer edges of the blades have lateral reaming edge
portions and forward penetrating portions.

9. A tool for making an opening through a blockage in a flow line that is blocking flow
therethrough and wherein a branch laterally connected to and extending from the line
provides access to the blockage, comprising: an operating head having semi-tear-
shaped reaming blades projecting radially outwardly from an axis of rotation of the
head, the blades having lateral arcuate edges and forward arcuate edges; a telescopic
shaft having a lower transversely flexible coil spring portion and a tubular upper rigid
sleeve portion having an internal diameter larger than the outside diameter of the
spring, the sleeve portion slidably receiving the spring portion for movement upwardly
and downwardly in the sleeve portion into various relative positions, the coil spring
portion having a longitudinal axis; a locking mechanism locking the portions in
selected positions; a joint between the coil spring portion and the head allowing the
head to move relative to the coil spring portion so that the axis of rotation of the head
can be angled relative to the axis of the coil spring portion, the shaft having axial
rigidity between the upper rigid portion and the joint, the shaft being characterized in
its ability to apply axial force from the upper rigid portion to the lower flexible portion
to the joint with a force sufficient to penetrate such a blockage with the head and
further being characterized in its ability to apply rotary force to the shaft and thus the
head with a force sufficient to ream out the blockage; a crankhandle connected to the
sleeve portion; and a tubular handle rotatably receiving the sleeve portion adjacent to
the crankhandle.

10. The tool of Claim 9, wherein the locking mechanism is a detent on one of the
portions and holes in the other portion releasably receiving the detent and locking the
two portions in selected positions of extension relative to each other.

11. A plumbing tool, comprising: an operating head having an axis of rotation and
reaming blades thereon projecting outwardly from the axis; a shaft having a lower
transversely flexible portion and an upper portion, the lower portion having a
longitudinal axis; a joint connecting the head and the flexible portion of the shaft with
the blades extending endwardly of the shaft, the joint allowing movement of the head
relative to the flexible portion into various angulated positions of said axis of rotation
relative to said longitudinal axis; a tubular handle rotatably receiving the upper portion
of the shaft; and a crank handle connected to the rigid portion of the shaft.

12. A tool for making an opening through a blockage in a fluid-carrying line that is
blocking flow therethrough and wherein a lateral branch connected to the line provides
access to the blockage, comprising: an operating head having a teardrop configuration
capable of penetrating and reaming an opening through the blockage; an elongated
shaft having a longitudinal axis and having an upper rigid sleeve and a lower tightly
wound coil spring pivotally connected to the operating head for extending the head
into the branch and into engagement with the blockage, the shaft being resiliently
flexible and bendable transversely of the axis along the coil spring from a straight
condition into a flexed condition when the spring is subjected to force imposed
transversely of said axis so that when the head is in the line adjacent to the blockage,
the spring is capable of flexing in the transition from the branch to the fluid-carrying
line and the head is pivotal relative to the shaft to enable the engagement of the
operating head with the blockage, the shaft having axial rigidity whether straight or
flexed so that, the shaft is also capable of exerting force axially on the operating head
and against the blockage to penetrate through the blockage; and a handle connected to
the shaft for manually rotating the shaft while in its flexed condition and for manually
axially forcing the operating head against the blockage thereby to cause the operating
head first to penetrate and then to ream out an opening in the blockage so that the line
is open and provides a passageway permitting flow therethrough.

13. A test cap for blocking a fluid-carrying line wherein a branch laterally extends
from the line, provides access to the cap, and through which a tool can be inserted to
break an opening through the cap, comprising: an annular body, and a center plate
within the body, the plate having a weakened break line therein dividing the center
plate into segments that are breakable out of the body along the break line upon
application of force to the center plate.
14. The tool of Claim 13, wherein the break line extends radially outwardly from the center of the plate to the annular body.

15. The tool of Claim 13, wherein the break line is circular and concentric with the plate.

16. An operating head for a plumbing tool capable of removing a test cap from a drain line through a clean-out, comprising: a plurality of blades projecting radially outwardly from an axis of rotation of the head and having forward and rearward ends, each of the blades having a semi-teardrop shape with arcuate outer edges; and a mounting stub projecting rearwardly from the blades along said axis.

17. The head of Claim 16, wherein the arcuate edge of each blade curves smoothly outwardly and longitudinally of said axis from the mounting stub along a lateral reaming segment of the edge and thence curves smoothly transversely inwardly of the axis along a penetrating segment of the edge, and the penetrating segments of all of the edges meeting forwardly of the head at said axis and at the opposite end thereof from the mounting stub.

18. A cover for a clean-out of a plumbing system that facilitates testing of the system during installation of the system, the clean-out enabling access to a drain line through a branch projecting outwardly from the drain line, comprising: an annular body adapted to be fitted onto the branch of the clean-out, a top wall extending across the annular body, a nipple mounted in one of the body and the wall and providing fluid communication through the wall to enable fluid to be introduced into the plumbing system through the clean-out from exteriorly of the plumbing system, and a cap removably closing the nipple.

19. A method for testing a plumbing installation wherein a clean-out extends from a drain line of the installation and wherein the clean-out has a branch extending from the drain line, comprising the steps of: bonding a disc in fluid-tight relation in the drain line on the downstream side of the clean-out, the disc having at least one weakened
break line therein dividing the disc into segments; testing the installation under
pressure against the disc; after said testing step, inserting into the branch a tool having
an upper handle, an elongated shaft projecting from the handle, and an operating head
with penetrating and reaming blades thereon, the shaft having a lower resiliently
transversely flexible portion angularly movably connected to the head and having axial
rigidity when flexed or straight; positioning the head opposite to the disc with the
lower flexible portion against the branch of the clean-out; moving the head into
engagement with the disc by leveraging the flexible portion against the branch and
angulating the head on the flexible portion; axially downwardly thrusting the tool
thereby causing the blades to separate the segments along the break line and thereby to
penetrate the disc; and rotating the shaft and thus the head against the disc or
remaining portions thereof with the handle.

20. The method of Claim 19 wherein the shaft is telescopically adjustable in length,
including the further steps of: adjusting the length of the shaft prior to inserting the
tool in the branch.

21. The method of Claim 19, where the testing step includes the step of: pressurizing
the system through the clean-out before the tool is inserted in the branch to test if the
system has leaks.

22. A method of testing a plumbing installation having a lateral branch providing
access to a fluid-carrying line of the installation, comprising the steps of: providing a
fluid-tight blockage in the line on the downstream side of the branch; pressurizing the
line on the upstream side of the blockage to test for leaks; after the pressurizing step,
accessing the blockage through the branch and separating the blockage into fragments;
and flushing the fragments down the line.

23. The method of Claim 22, wherein the blockage has break lines dividing the
blockage into fragmentable segments; and wherein the accessing and separating step is
carried out with a tool that is inserted down the branch and that impacts the blockage
and separates it into such segments leaving a remaining portion, and then reams out
said remaining portion of the blockage.

24. The method of Claim 22, wherein the blockage is a test disc that has a plurality of
radial weakened break lines thereby creating pie-shaped segments in the disc; and
wherein the separating step breaks the disc into said segments.

25. The method of Claim 24, wherein the removing step is carried out with a tool that
is inserted down the branch of the clean-out, the tool having a rotary head with
penetrating and reaming edges; including the further steps of: penetrating through the
weakened break line with the penetrating edges by axially downwardly thrusting the
shaft and thereby thrusting the head against the cap; and reaming out the cap with the
reaming edges by rotating the shaft.

26. The method of Claim 19, wherein the blades have smoothly curving penetrating
and reaming edges, including the additional steps of inserting the tool down the branch
of the clean-out to position the penetrating and reaming edges into engagement with
the disc; penetrating the disc with the penetrating edges of the tool; reaming out the
disc with the reaming edges of the tool; and withdrawing the tool from the branch with
the smooth edges sliding back out along the drain line or clean-out.

27. The method of Claim 24, wherein the break lines radiate outwardly from the center
of the cap, wherein the pressure is applied centrally of the cap.

28. A method of testing a plumbing system wherein the system is connected to a
sewer line by a drain line, comprising the steps of: installing a disc having
separable break-apart segments in the drain line thereby to prevent flow through the
line past the disc; testing the plumbing system by applying fluid pressure in the
plumbing system on the opposite side of the disc from the sewer line and against the
disc thereby to test the plumbing system for leaks; creating an opening through the
disc by causing the segments of the disc to separate by applying force against the disc
while allowing the separated segments to remain in the drain line; and flushing the
separated segments down the drain line.

29. A method of using a manually operated tool to provide an opening through a test
plug that prevents flow through a flow passage of a pipe of a plumbing system while
the system on one side of the plug is tested for leaks, the test plug having separable
segments that are adjacent to each other, and a weakened break line joining adjacent
segments; wherein the plumbing system has a clean-out extending from the pipe,
communicating with the flow passage, and providing access to the test plug; and
wherein the tool includes an elongated flexible, rotatable shaft and a test-plug-
penetrating and reaming head connected to the shaft and axially movable and rotatable
therewith, comprising the steps of manually grasping the tool and inserting the head
and the shaft into the clean-out until the head is in the flow passage in opposed relation
to the test plug; manually axially pressing on the shaft to force the head against the test
plug and to cause the segments to be separated along the break line; and manually
rotating the shaft while in engagement with the test plug to ream out an opening
through the test plug, so that the flow passage is at substantially its normal inside
diameter.

30. A plumbing tool for creating an opening in a blockage in a line, comprising: an
operating head having penetrating and reaming blades; a telescopic shaft having a
lower transversely flexible portion connected to the operating head and an upper rigid
portion, the shaft having axial rigidity in both its upper rigid portion and its lower
flexible portion to the head and constituting means acting through the upper rigid
portion and the lower flexible portion to the head for applying an axial force sufficient
to penetrate such a blockage with the head and for also applying a rotary force to the
head with a force sufficient to ream out the blockage and provide an opening
therethrough; a tubular handle rotatably receiving the rigid portion of the shaft; and a
crankhandle connected to the rigid portion of the shaft.

31. A fragmentable disc for temporarily sealing a fluid-carrying line, comprising: a
central portion having a center and an annular portion circumscribing the central
portion and the center, the annular portion being connectable in fluid-tight relation in a fluid-carrying line, the central and annular portions being imperious to the passage of fluid therethrough, the central portion having a plurality of break lines therein along which the central portion may be fractured thereby dividing the central portion into a plurality of segments, and the plurality of break lines including an annular first break line positioned relatively adjacent to the annular portion and at least one second break line intersecting the first break line and extending to said center.

32. A breakable disc for temporarily sealing a fluid-carrying line, comprising: a fluid-impervious central portion having a center and a plurality of break lines, an annular mounting flange integral with and circumscribing the central portion and terminating in a peripheral edge, and one of the break lines circumscribing the center and being located intermediate the center and the peripheral edge.

33. The disc of claim 32, wherein said one break line is located closer to the peripheral edge than to the center.

34. The disc of claim 32, wherein another break line radiates outwardly from the center.

35. The disc of claim 34, wherein there are a plurality of break lines radiating outwardly from the center and intersecting said one break line.

36. The disc of claim 32, wherein there are a plurality of radially spaced, break lines circumscribing the center.

37. The disc of claim 32, wherein there are a plurality of radially spaced, annular break lines circumscribing the center; and wherein there are a plurality of radial break lines projecting outwardly from the center and intersecting the annular break lines.
INTERNATIONAL SEARCH REPORT

International application No. PCT/US00/29137

A. CLASSIFICATION OF SUBJECT MATTER
IPC(7) : F16K 43/00; G01M 3/04; F16L 55/11
US CL : Please See Extra Sheet.
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>US 4,364,140 A (IRWIN) 21 December 1982, see entire patent.</td>
<td>1-26</td>
</tr>
<tr>
<td>Y</td>
<td>US 5,056,176 A (BELCHER) 15 October 1991, see entire patent.</td>
<td>1-26</td>
</tr>
</tbody>
</table>

Further documents are listed in the continuation of Box C.
See patent family annex.

Date of the actual completion of the international search: 27 DECEMBER 2000
Date of mailing of the international search report: 17 JAN 2001

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Form PCT/ISA/210 (second sheet) (July 1998)
A. CLASSIFICATION OF SUBJECT MATTER:
US CL. :
4/679, 680, 681; 15/104.095, 104.3, 104.31, 104.33; 73/40.5R, 49.1, 49.5, 49.6, 49.8; 137/15.11, 15.13, 15.14,
247.47, 247.51, 318; 138/89, 90, 94

B. FIELDS SEARCHED
Minimum documentation searched
Classification System: U.S.
4/679, 680, 681; 15/104.095, 104.3, 104.31, 104.33; 73/40.5R, 49.1, 49.5, 49.6, 49.8; 137/15.11, 15.13, 15.14,
247.47, 247.51, 318; 138/89, 90, 94