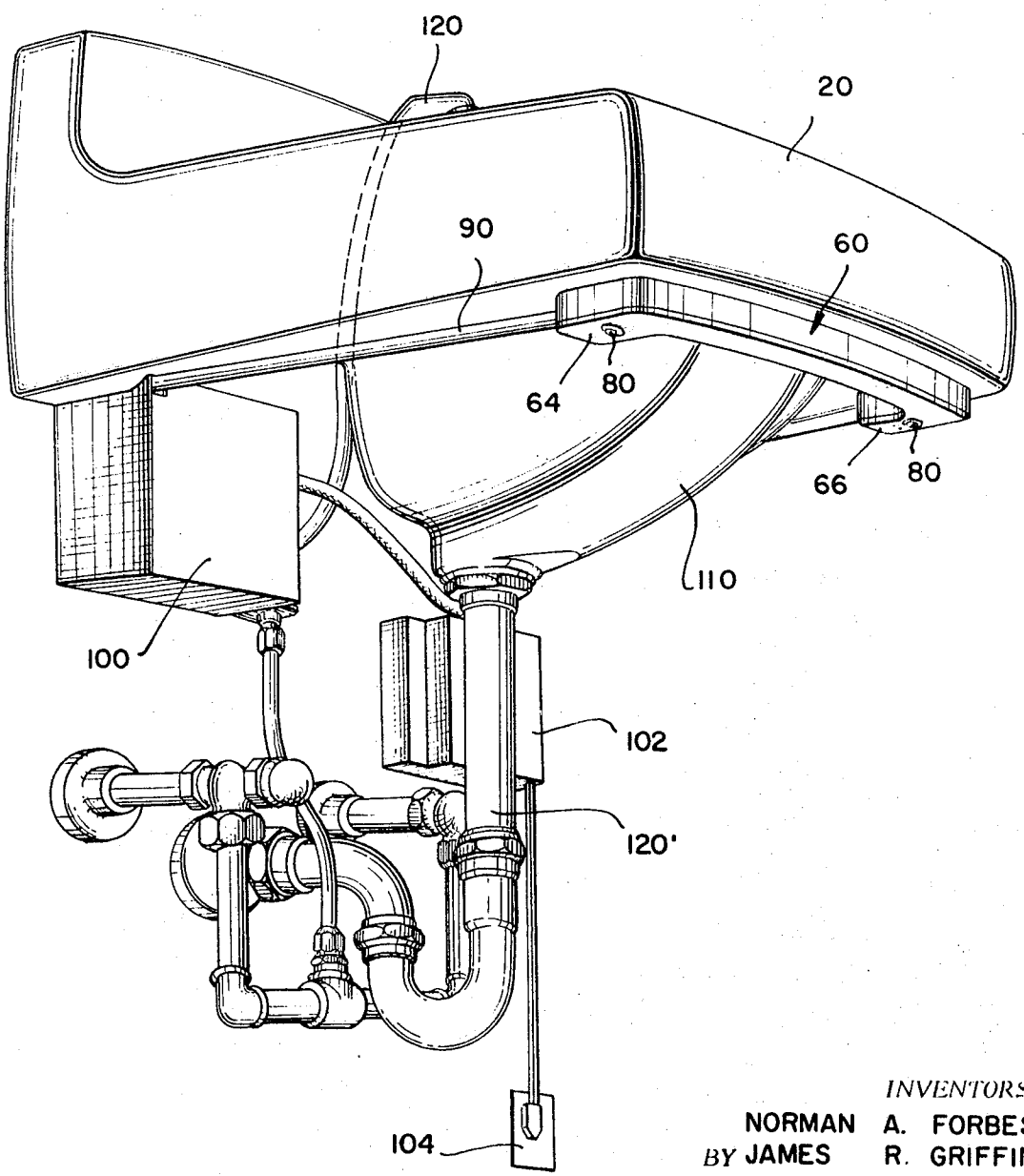
June 22, 1971 N. A. FORBES ET AL 3,585,653

PROXIMITY ANTENNA STRUCTURE FOR A LAVATORY OR PLUMBING FIXTURE

Filed Sept. 10, 1969 4 Sheets-Sheet 1

FIG. 1



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PROXIMITY ANTENNA STRUCTURE FOR A LAVATORY OR PLUMBING FIXTURE

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FIG. 2

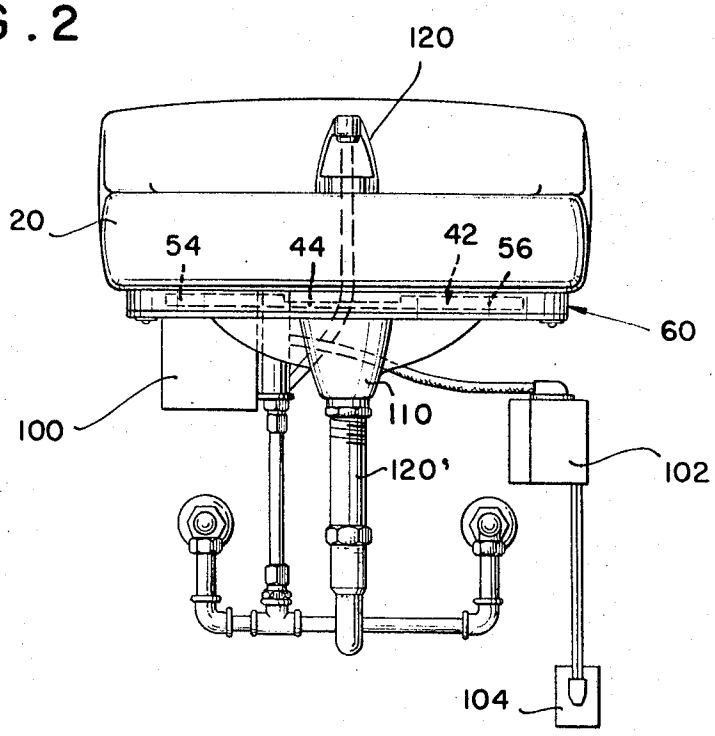
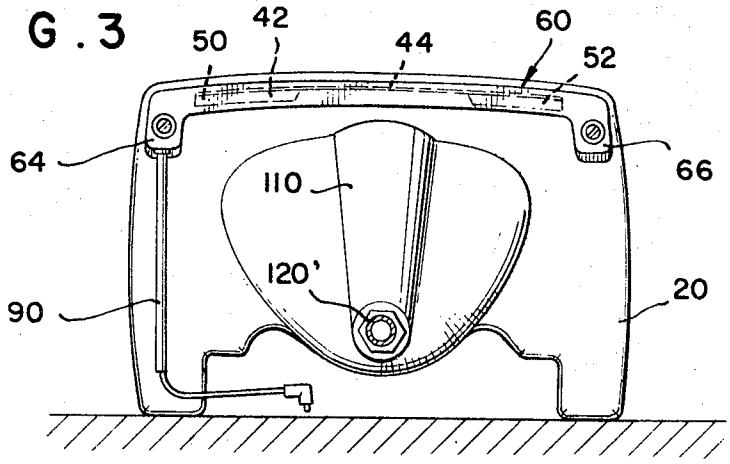


FIG. 3



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PROXIMITY ANTENNA STRUCTURE FOR A LAVATORY OR PLUMBING FIXTURE

Filed Sept. 10, 1969 4 Sheets-Sheet 3

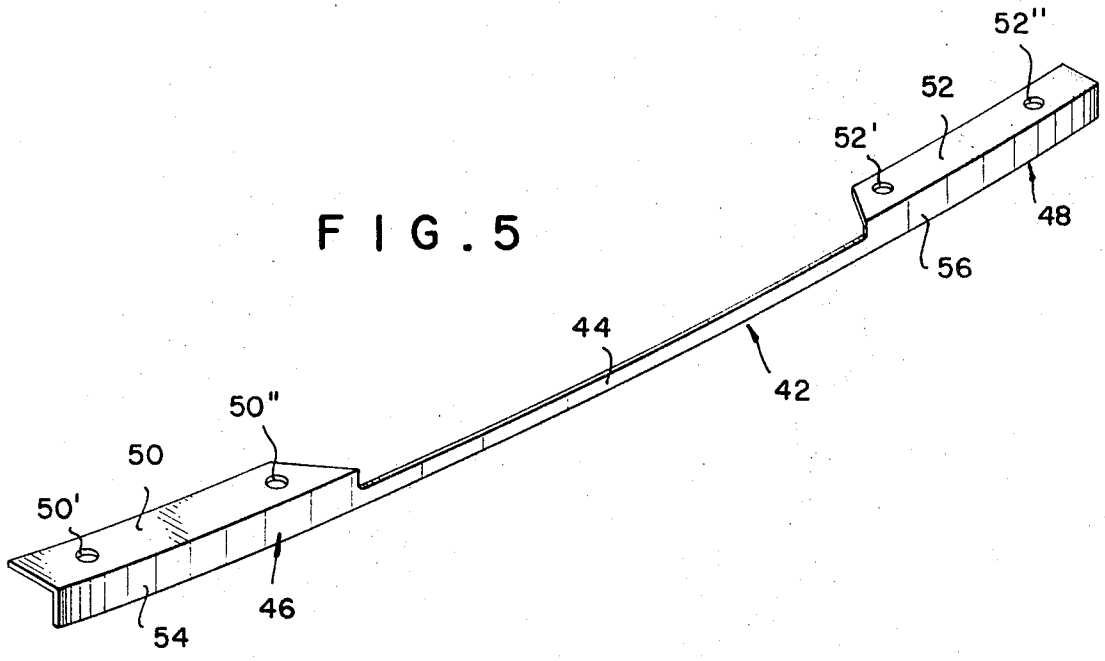


FIG. 5

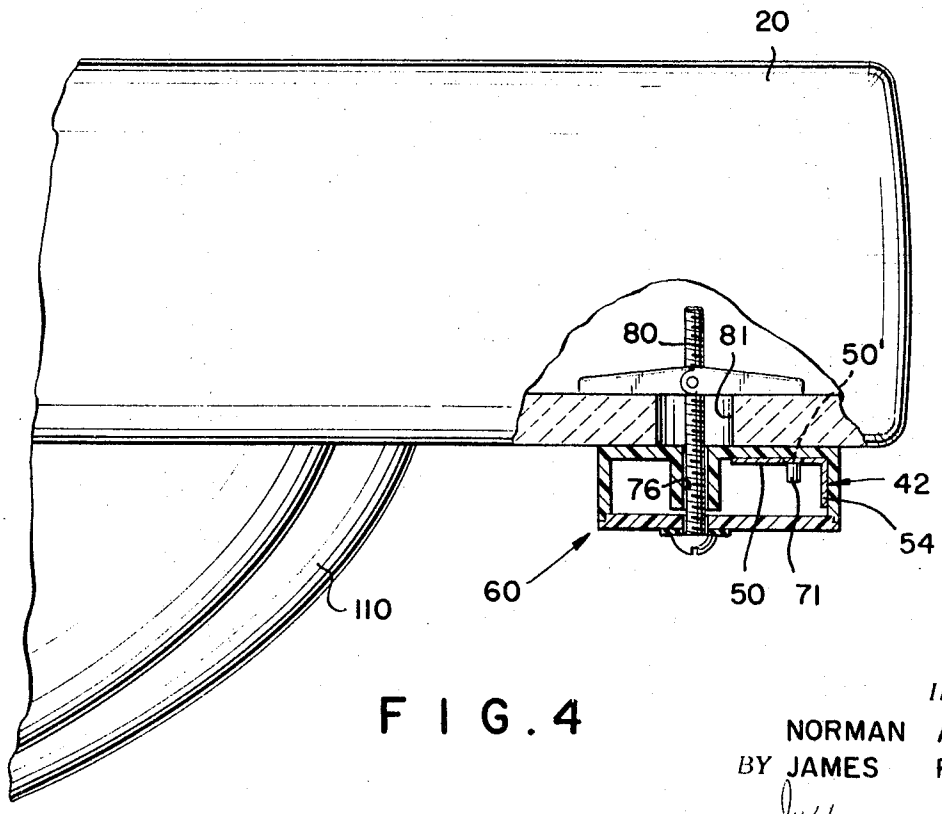


FIG. 4

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PROXIMITY ANTENNA STRUCTURE FOR A LAVATORY OR PLUMBING FIXTURE

Filed Sept. 10, 1969 4 Sheets-Sheet 4

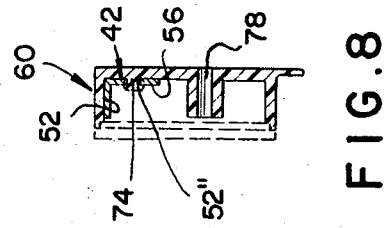


FIG. 8

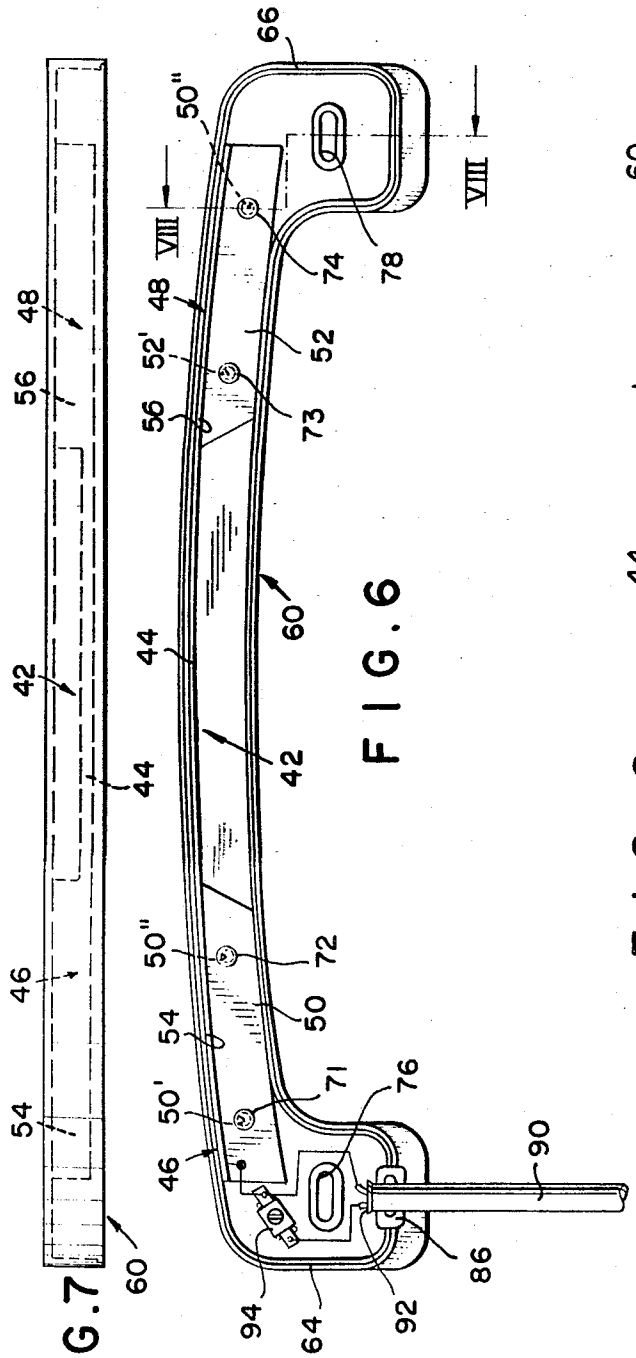


FIG. 6

FIG. 7

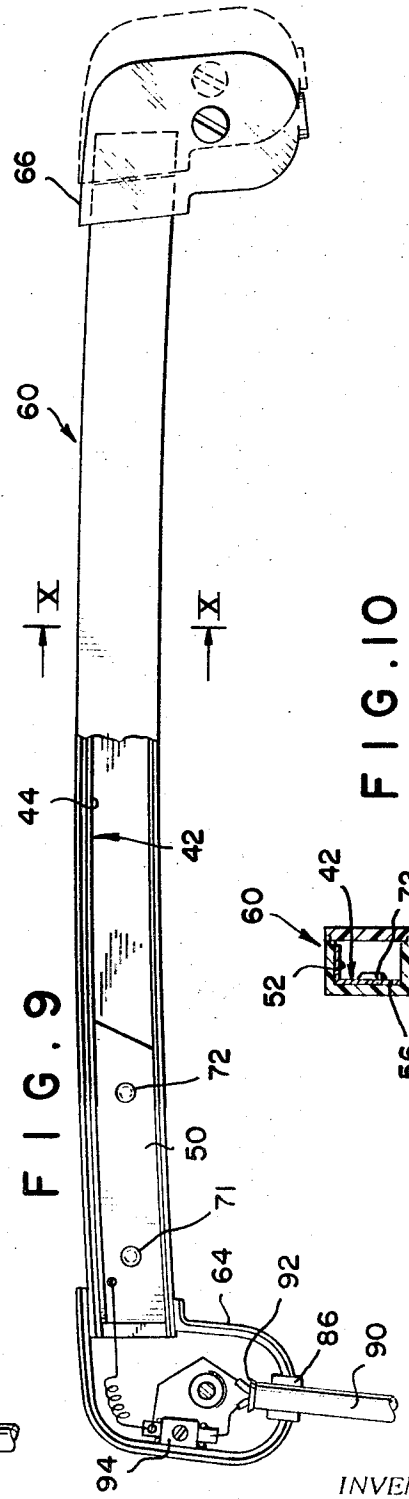


FIG. 9

FIG. 10

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United States Patent Office 3,585,653
Patented June 22, 1971

3,585,653

PROXIMITY ANTENNA STRUCTURE FOR A LAVATORY OR PLUMBING FIXTURE

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Filed Sept. 10, 1969, Ser. No. 856,731
Int. Cl. A47k 1/04
U.S. Cl. 4—166 16 Claims

ABSTRACT OF THE DISCLOSURE

A sensing device, often called an "antenna," employed with a capacitance-operated proximity control circuit to detect and respond to the presence or absence of a user in front of a lavatory or any other plumbing fixture. The antenna develops an increase in capacitance upon the arrival of the user at the front of the lavatory. The increase of capacitance activates an electronic control circuit which turns on the faucet of the lavatory and keeps it turned on while the user sways his body in washing his hands. When the user departs from the lavatory, the faucet will be turned off upon the resulting decrease in the capacitance.

This invention relates to sensing devices and apparatus suitable for detecting the presence or absence of a person or an object at a particular location, such as a plumbing fixture. More particularly, this invention relates to sensing devices, often called "antennas," for sensing or detecting the presence of a user in front of a plumbing fixture, such as a lavatory, and, in response to the arrival of the user, to operate the plumbing fixture by turning on the water if the plumbing fixture is a lavatory and maintaining a continuous flow of water even if the user's body sways while washing his hands, and later, in response to the departure of the user, to de-activate the plumbing fixture.

Stated differently, this invention relates to antenna structures for fixtures, such as lavatories, in which the antennas will undergo desired or predetermined electrical changes in response to the arrival of the user to initiate the operation of the fixture and will continue to maintain the desired or predetermined changes even when the user sways or bends his body away from the fixture while washing his hands. In response to the departure of the user, the structure will respond to corresponding desired or predetermined changes to de-activate the fixture.

Stated in still another way, this invention relates to an antenna structure for a lavatory or other fixture which will undergo a substantial positive change in capacitance or reactance upon the approach of the user, and maintain substantially the same reactance change even though the body of the user sways or moves while his hands remain in the bowl of the lavatory, and which will undergo another substantially equal change—say a negative change in capacitance or reactance—upon the departure of the user. The positive change in capacitance or reactance will activate a solenoid valve or, if it has already been operated and the antenna has undergone a negative change, the negative change will interrupt its operation.

The antenna structure of the present invention is especially suitable for and applicable to a lavatory which may be used at airports, public rest rooms, kitchens, etc., or in any places where it is desired to have the lavatory controlled by the approach and departure of the user. The antenna structure embodies, in its basic form, an elongated metallic structure as the essential

capacity changing component, and the structure includes a correspondingly elongated casing which may be made of a material such as plastic. The combination preferably is small in size and hence readily concealed beneath the plumbing fixture to protect it against vandalism and theft. The antenna structure is essentially made up of a specially contoured metallic element, to be subsequently described, and its operating characteristics depend upon its shape and upon the adjacent ceramic, plastic or wood-top material of which the lavatory or its deck is made.

The antenna or sensing device of a so-called proximity control system for a plumbing system, such as a lavatory, is of importance because it serves to trigger the operation of the proximity equipment and initiate the flow or stoppage of water. The antenna must be arranged to promptly bring on the flow of water upon the approach of the user and to maintain it operated even while the body of the user sways away from the lavatory while his hands remain within the lavatory basin. Thus, the antenna must be effective to maintain control of the solenoid even while the user is washing has hand or hands. Furthermore, the antenna structure is equally important in deactivating the flow of water into the bowl of the lavatory just as soon as the user has fully departed from the lavatory. Thus, the antenna must undergo a predetermined electrical reactive change upon the arrival of the user so that the control circuits connected to the antenna structure will be operated properly and promptly. Furthermore, it must supply the electrical property required to overcome those changes brought about by the shifting body movements while the hands of the user are positioned adjacent to or within the bowl of the lavatory and thereby maintain the continuity of the water flow. Also, the antenna structure must undergo a substantially equal but opposite change in its reactive property upon the departure of the user from the lavatory so that the spigot of the lavatory will be turned off promptly when this occurs. This requirement implies that the positive capacitive change caused by the flow of the water should be small compared to the change caused by the presence of the user. The prompt and correct starting and stopping of the water control mechanism not only will satisfy the user, but also it will limit the wastage of water.

The most common variety of antenna structure suggested for proximity controlled plumbing fixtures consists of a simple vertical metallic plate which is located at the front of the fixture and is connected to appropriate control circuitry and to a controlled solenoid valve of the fixture. Such a simple vertical metallic plate member is sensitive only in a direction normal to the plane of the metallic plate member. Such a vertical plate member, however, suffers from the difficulty that, as the user advances far enough toward the antenna to turn the water on, the water will be turned off just as soon as the user leans forward to wash his hands. This is due to the fact that the mid-section of the user naturally sways away from the plate antenna while the user's hands are being positioned within the bowl of the lavatory, thereby necessarily reducing the capacitance of the antenna structure and deactivating the mechanism. The stoppage of the water at this time not only is undesirable but it is baffling to the user. The mechanism turns the water off just when it may be needed most, sometimes startling the user. Such erratic and defective action, introduced by the limitations of a vertical plate member serving as an antenna arrangement, has constituted an operating defect and has retarded the use and growth of proximity structures for lavatories.

Another antenna structure suggested for proximity-controlled plumbing fixtures consists of a simple vertical

metallic plate which is located near the spout or spigot. Such an antenna is sensitive to the position of hands under the spout, in the normal washing position; however, such an antenna suffers from the difficulty that the water itself is grounded via the supply and drain pipes, and therefore the presence of water tends to create a positive change in capacitance that is sufficiently large to maintain the flow of water. In other words, the antenna turns the water on readily, but cannot turn it off nearly as readily.

One of the principal objects of the present invention is to provide an antenna structure which will be substantially free of the difficulties above mentioned. According to this invention, the antenna structure will be shaped not alone to trigger the operation of the solenoid mechanism upon the adequate approach of the user, but also to maintain it in full and continuous operation even as the body of the user sways or bends during any intervals when he is washing his hands and also will be relatively free from capacitive effects due to the normal flow of water. The antenna structure will, therefore, embody a particularized shape, including a segment or member which will be effective essentially to respond to the approach of the body of the user and, moreover, other segments or members to respond to the washing position of the hands and the incidental movement of the mid-section of the user with respect to the lavatory to maintain the solenoid valve continuously operated while the hands of the user remain in the locality of the bowl of the lavatory.

It should be pointed out that the mere enlargement of the prior suggested single vertical plate antenna in front of the fixture, in an effort to overcome the defects noted, will be insufficient to meet the normal requirements of good operation under the conditions encountered. A large single plate will have increased sensitivity to the rear as well as to the front, so that it will have too large a sensitivity to the presence of water flowing. Even if a shield is interposed between the plate antenna and the water to minimize this effect, the resulting structure will be large, and will be a tempting target for vandals. These undesired effects are overcome by a multisegment antenna structure of the kind which will be more fully described hereinafter in connection with the disclosure of this invention.

The multi-segment antenna structure of this invention will be relatively small in size and shaped so that it may be easily concealed from the view of vandals and thieves and yet its shape will provide the necessary plural sensitivities to respond fully and properly to the varying physical conditions that occur in the normal and expected use of lavatories. By embodying the multi-segment antenna structure as a component of the lavatory by mounting it so that its physical location will be on the underside of the lavatory, the ceramic or other material of the lavatory proper will form a part of the antenna system, and will increase the change in capacitance created by the presence of the user in front of the lavatory. The antenna structure will be shaped so that it effectively and continuously "looks" at the body of the user as he approaches or arrives at the lavatory, and also continuously "looks up" to his arm position or positions as the user's body sways or bends away from the lavatory during the hand washing period, and so maintains a desired continuity of the service.

This invention will be better understood from the more detailed description and explanation hereinafter following, when read in connection with the accompanying drawing, in which FIG. 1 illustrates a perspective view of a proximity lavatory made of ceramic material to which the invention may be applied; FIG. 2 represents a front elevational view of the proximity lavatory; FIG. 3 illustrates a view of the underside of the lavatory per se to show the antenna housing as a part of the combination; FIG. 4 shows a portion of the lavatory and a partial cross-sectional view of the mechanism for mounting the antenna structure and affixing it to the lavatory; FIG. 5

shows the metallic antenna element of this invention; FIG. 6 shows a plan view of the assembled antenna structure; FIG. 7 shows a front elevational view thereof; FIG. 8 shows a cross-sectional view taken on line VIII—VIII of FIG. 7; FIG. 9 illustrates a plan view of a modified form of antenna structure, partly cut away; and FIG. 10 is a cross-sectional view taken on line X—X of FIG. 9.

Throughout the drawing, the same reference characters will be employed to designate the same or similar parts.

The antenna construction embodied in this invention is arranged for physical connection to the underside of a lavatory **20**, as already suggested and as shown in FIGS. 1, 2 and 3 of the drawing. The lavatory **20** is preferably made of vitreous china and is preferably of the wall-hung type or of the countertop or "drop-in" type. That is, the lavatory preferably may be mounted on the wall in embodying this invention. The antenna structure **42** includes a specially shaped, elongated metallic member, as shown in FIG. 5 and the metallic antenna member **42** is encased in a housing **60**, preferably made of plastic, the combination being shown in FIG. 6, for example. The combination of the antenna member **42** and its casing **60** and additional structural components are together illustrated generally in the assembly shown, for example, in FIG. 6.

The metallic antenna structure **42** of this invention is essentially made of a flat elongated piece of metal, such as steel, copper or aluminum, a clear perspective view of which is shown in FIG. 5. As will be apparent from FIG. 5, the flat piece of metal **42** is right-angular in cross-section and is cut away at its center to provide a central segment **44** and two winged segments **46** and **48** which are on the two opposite, or left and right, sides of the central segment **44**. The winged segments **46** and **48** are intended to be positioned adjacent to the front central portion of the lavatory **20** so that, in the normal use of the lavatory **20** by the user who is standing in front of the lavatory **20**, the body of the user normally will be adjacent to the vertical sections **54** and **56** of the winged segments **46** and **48** of the structure. As shown in FIG. 5, for example, the central section **44** consists of a narrow vertical strip of metal which will be fairly close to the body of the user as he approaches adjacent to the lavatory **20**. Such a narrow strip of material **44** is relatively insensitive by itself, but in conjunction with wings **46** and **48** the antenna will be sufficiently sensitive to develop the required increase in capacitance when the body of the user is closely adjacent to the lavatory **20** and thereby develops the necessary reactance to initiate the operation of the mechanism.

The winged segments **46** and **48** comprise two flat horizontal metallic portions **50** and **52** and two vertical metallic portions **54** and **56**, respectively. The horizontal portions **50** and **52** are located facing upward to the normal positions of the arms of the user when he is washing his hands in the bowl of lavatory **20**. Thus, the two horizontal portions **50** and **52** continuously "look up" at the arms of the user and introduce an appreciable increased capacitance as the arms of the user are positioned within or adjacent to the bowl of the lavatory **20**. This capacitance is sufficient, as will be outlined hereinafter, to maintain the faucet mechanism in full and proper operation even while the body of the user sways or bends from the front of the lavatory during the hand-washing interval.

The casing **60**, as shown in FIGS. 6 and 7, is elongated and houses the elongated metallic member **42**, and the casing **60** is curved or shaped, not only to conform to the contour of the front of the lavatory **20** as shown in FIGS. 1 and 3, but it also conforms to the similarly curved metallic member **42**. The casing **60** is preferably made of any suitable plastic material, either transparent or non-transparent plastic material, and the thickness of walls of the casing member **60** may be, for example, about ⅛" thick. The casing **60** also embodies two lateral plastic winged sections **64** and **66**, as shown. The plastic casing

60 may also include a plurality of studs, four of which are shown in FIG. 6 and are designated 71, 72, 73 and 74. These studs are passed through corresponding apertures 50', 50", 52' and 52" in the metallic member 42 and are employed to hold the metallic antenna member 42 permanently positioned and affixed against the top horizontal side of the plastic casing 60. As will be further noted later, a minimum spacing is therefore provided between the upper horizontal surfaces of the metallic antenna member 42 and the upper horizontal segments of the winged sections 64 and 66 of casing 60. This minimal spacing may be accomplished, for example, by hammering or flattening the heads of the several studs 71 and 74 so as to depress or flatten them out and thereby insure a permanent grip between the metallic member 42 and the casing 60.

It will also be observed from FIG. 6 that the casing 60 includes two substantially equal openings or slots 76 and 78 in the respective winged segments 64 and 66. These slots 76 and 78 are intended to receive conventional toggle or expansion bolts 80 which are inserted into the openings 76 and 78. One such bolt 80 is shown in FIG. 4 in its mounted position. The toggle bolts are inserted into appropriate openings 81 on the underside of the lavatory 20, which openings 81 would normally receive the legs of a lavatory if it were not wall mounted. These toggle bolts 80 may be manually adjusted by the installer so as to hold the assembled antenna casing 60 permanently affixed against the underside of the lavatory 20 as shown in FIGS. 1 to 3. The plastic casing 60 also embodies an additional opening or slot 86, which may be located, for example, on one side of the casing 60, for receiving appropriate tubing 90 bearing and enclosing the usual wiring extending between the metallic antenna member 42 and the electrical control equipment within a housing 100 for automatically controlling the flow and stoppage of water, as may be desired, via the faucet 120 of the lavatory 20. The electrical equipment of housing 100 may be connected through other electrical circuitry, such as a transformer within a housing 102, to a conventional power outlet 104. The electrical equipment within housing 100 is wired to a solenoid (not shown but preferably positioned on the underside of lavatory 20) which controls the faucet 120. Moreover, the tubing 90 preferably embodies a tapered or enlarged head 92 which would be retained within the slot 86 and would bar the removal of the tubing 90.

The casing 60 preferably will also include a small variable or adjustable capacitor 94 which, as shown in FIG. 6, serves to connect one end of the metallic antenna member 42 to the ground conductor of the cable extending through the tubing 90. This capacitor 94 introduces a desired or predetermined capacitance into the control circuitry. For example, capacitor 94 may have a capacitance which would bring the total capacitance between the antenna structure 42 and ground (including the applicable adjacent ceramic or other material) to a value which may be adjusted to about 60 pf.±1.5 pf.

As already noted, the metallic antenna element 42 includes a narrow segment 44 in the central region thereof as shown in FIG. 5. This narrow segment 44 may extend horizontally over a distance of, say, six inches. This narrow segment 44 need not be a flat plate member or segment; alternatively it may be any piece of conductive wire of any cross-sectional shape, whether round or square or whatever. This central segment 44 serves to substantially eliminate or diminish the reactive effect of the flow of water through the usual drain pipe 120 and also through the overflow path 100 within the lavatory 20 to the drain pipe 120 in its travel to and through the usually grounded drain pipe 120 and into the sewer system. Thus, this small central segment 44 will render the change in electrostatic capacity of the antenna structure 42 substantially insensitive to the flow of water through the drain pipe 120 or through the overflow path 110 of the lavatory 20 to the drain pipe 120. This insensitivity to the presence of water in the lavatory occurs because the antenna is not closely coupled to the overflow. As can be seen in FIG. 1, the china surrounding the overflow represents a relatively short path of relatively large cross-sectional area between the antenna and the water near the drain. To prevent coupling via this path, the central segment 44 of the antenna is deliberately made with a small projected area. By comparison, the winged segments 46 and 48 are coupled to the water through the china via relatively long paths of relatively small cross-sectional area. Therefore, the capacitance effect of water on the antenna is kept to an acceptably low value.

The extended or widened winged segments 46 and 48 of the antenna structure 42 provide a special and unique purpose in supplying necessary capacitance for initiating the operation of the solenoid and its controlled faucet 120, or for maintaining the solenoid and the faucet 120 in operation if they had previously been initiated, when either or both of the hands of the user are in their usual or appropriate positions within or near the bowl of the lavatory 20. The substantially vertical portions 54 and 56 of the antenna structure 42 are capacitively sensitive primarily to the presence of the user as he approaches the lavatory. The substantially horizontal portions 50 and 52 of the antenna structure 42, though positioned on the underside of the lavatory 20, provide added capacitance as the arms of the user reach toward or into the bowl of the lavatory 20. Thus, the winged sections 50 and 52 insure the operation of the faucet mechanism when either or both of the arms of the user are within the bowl area even though the body of the user may have swayed considerably away from the front of the lavatory 20. This compensating factor is an important feature of the present invention.

The unitary metallic antenna member 42 may be regarded as composed of three individual components, two separated components, 46 and 48, having vertical areas 54 and 56 for sensing the presence of a body and horizontal areas 50 and 52 for sensing the position of the areas of the user as the arms are lowered into the lavatory bowl, and a central segment 44 which serves to decouple the antenna from the water and to connect the end segments.

The metallic antenna structure 42 and the casing 60 are shown as arcuate and similarly shaped longitudinal components, but obviously they may be linear or of any other shape to conform to the shape of the understructure of the lavatory 20. The smallness of the principal components, i.e., the metallic structure 42 and casing 60, render them especially suitable for easy installation on the underside of any lavatory, the installation to be made either at the factory where the lavatory is manufactured or at the location where the lavatory is installed. The absence of large metallic structures, especially large flat structures, is especially desirable for the avoidance of vandalism and thievery.

FIGS. 9 and 10 show a modified arrangement in which the casing 60 is composed of a central portion, similar to that shown in FIG. 6, and two separate segments 64 and 66 which are arranged to be separately adjustable for different lavatories.

The apertures 76 and 78 within the casing 60 of FIG. 6 and the winged segments 64 and 66 of FIG. 9 are suitable to provide adjustability of the casing to accommodate the casing and its enclosures to lavatories of different widths.

While this invention has been shown and described in certain particular arrangements merely for illustration and explanation, it will be clearly understood that this invention may be applied to many other and widely varied organizations all designed for carrying out the features and objects of the present invention.

A modified form of unitary antenna structure is disclosed in our copending application, filed of even date and assigned to the assignee of the present application.

What is claimed is:

1. An antenna structure for an electronically operated lavatory or other plumbing fixture consisting of an elongated metallic element including a narrow vertical central segment and two winged segments electrically connected to, and positioned on opposite sides of, the central segment and substantially horizontal, the three segments changing in capacitance in a substantial amount in response to the approach to, or departure from, the plumbing fixture of different sections with respect to a person's body, not withstanding the swaying of said body.

2. An antenna structure according to claim 1, including an elongated housing of dielectric material enclosing the central segment and the two winged segments of the antenna structure.

3. An antenna structure according to claim 2, in which the housing is substantially rectangular in cross section and includes means for affixing the horizontal segments of the metallic element to the adjacent side of the housing.

4. An elongated antenna structure for an electronically operated plumbing fixture comprising a unitary structure having two substantially equal flat metallic segments and a narrow metallic interconnecting segment, the interconnecting segment having small cross-sectional area and the two winged segments being partially vertically disposed and partially horizontally disposed, whereby the three segments will undergo capacitive changes in substantial amount in response to the approach of a persons's body or his arms and opposite capacitive changes in response to the departure of such person's body or arms, not withstanding small changes in the position of said body or arms.

5. An elongated antenna structure according to claim 4, including also an elongated housing which is substantially rectangular in cross section and made of plastic material and encasing the unitary structure, and means for fastening the housing to the underside of the plumbing fixture.

6. An antenna structure for an electronically operated plumbing fixture which is to be operated and released when a user approaches or departs therefrom, consisting of an elongated rectangular metallic plate member which is cut away in the central region of said plate member so that the plate member consists essentially of a central segment having a small dimension in a direction perpendicular to the length of the metallic member, said metallic member being bent so that the two outer segments are partly vertical and partly horizontal.

7. An antenna structure according to claim 6, including an elongated housing having a rectangular cross section and made of non-conductive material, in which the elongated metallic member is enclosed, and means whereby said metallic member may be affixed to a wall of said housing, said housing being affixable to the underside of said plumbing fixture.

8. An antenna structure for an electronically operated lavatory comprising a unitary longitudinal metallic plate member shaped so that it includes two partly vertical and partly horizontal winged segments and an intermediate segment interconnecting the two winged segments, a longitudinal housing of non-metallic material having a rectangular cross section and enclosing said unitary member, and means for affixing said housing to the underside of the lavatory, the two winged sections being adjacent to the ends of the front of said lavatory.

9. An antenna structure according to claim 8, including also an adjustable capacitor which is located within said housing and is connected to an end of one of the winged sections of the unitary member.

10. An antenna structure for an automatically operated lavatory for responding capacitively to the mid-position of a user approaching the lavatory and for responding capacitively also to the arms of the user as they are moved into the bowl of the lavatory, said antenna structure comprising an elongated unitary metallic member including two outer segments interconnected by a slender central segment, each outer segment having a substantially vertical area and a substantially horizontal area, and arranged so that the antenna structure is adjacent to the front section of the lavatory and so that the two outer segments are positioned symmetrically about the central segment but adjacent to the outer sections of the front of the lavatory, whereby the two vertical areas of the outer segment will respond capacitively to the proximity of the mid-section of the user and the two horizontal areas of the outer segments will respond capacitively to the proximity of the arms of the user within the bowl of the lavatory.

11. An antenna structure according to claim 10, including also an elongated housing within which said unitary metallic member is enclosed and including also means for affixing the housing to the underside of the lavatory.

12. An antenna structure according to claim 11, in which the housing also encloses an adjustable capacitor connected to an end of one of the outer segments.

13. An automatically operated plumbing apparatus comprising a lavatory which has a spout, a solenoid valve mechanism to control the operation of said spout, and a bowl for receiving water emitted by said spout; an antenna structure for controlling the operation of said solenoid valve mechanism, said antenna structure having a unitary metallic element which includes two outer plate segments having vertical and horizontal areas and an interconnecting narrow segment therebetween; and a plastic casing enclosing said antenna structure, said plastic casing being affixed to the underside of said lavatory so that the two plate segments of the antenna structure are positioned near the respective ends of the front of the lavatory and are symmetrically arranged with respect to the interconnecting segment.

14. An automatically operated plumbing apparatus according to claim 13, in which the solenoid valve mechanism includes a solenoid valve and electrical circuitry connected between the antenna structure and the solenoid valve so that the solenoid valve will respond to the approach or departure of a user of the lavatory.

15. An automatically operated plumbing apparatus according to claim 14, including also an adjustable capacitor physically enclosed within the casing and interconnecting the antenna structure to the electrical circuitry.

16. An automatically operated plumbing apparatus according to claim 15, including clamping means for affixing the casing to the underside of the lavatory to maintain the plate segments horizontal.

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U.S. Cl. X.R.

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