May 18, 1965 W. E. LEVINE 3,184,622

BELL STRIKER ASSEMBLY

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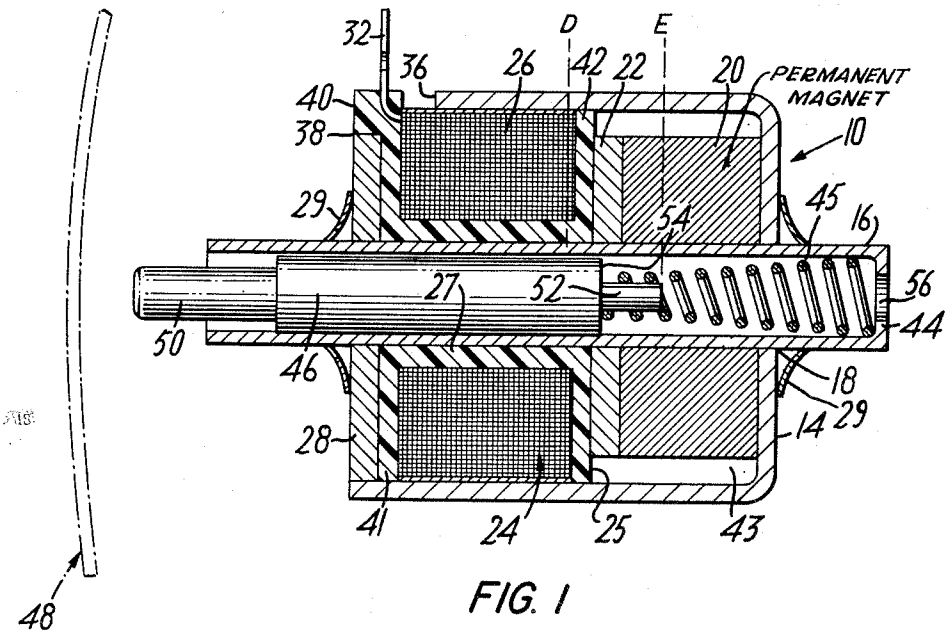


FIG. 1

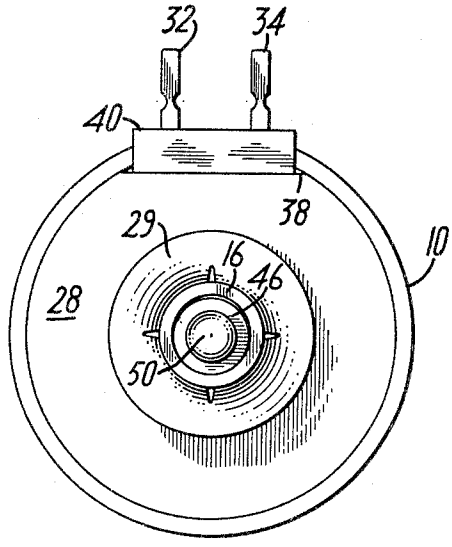


FIG. 2

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BELL STRIKER ASSEMBLY

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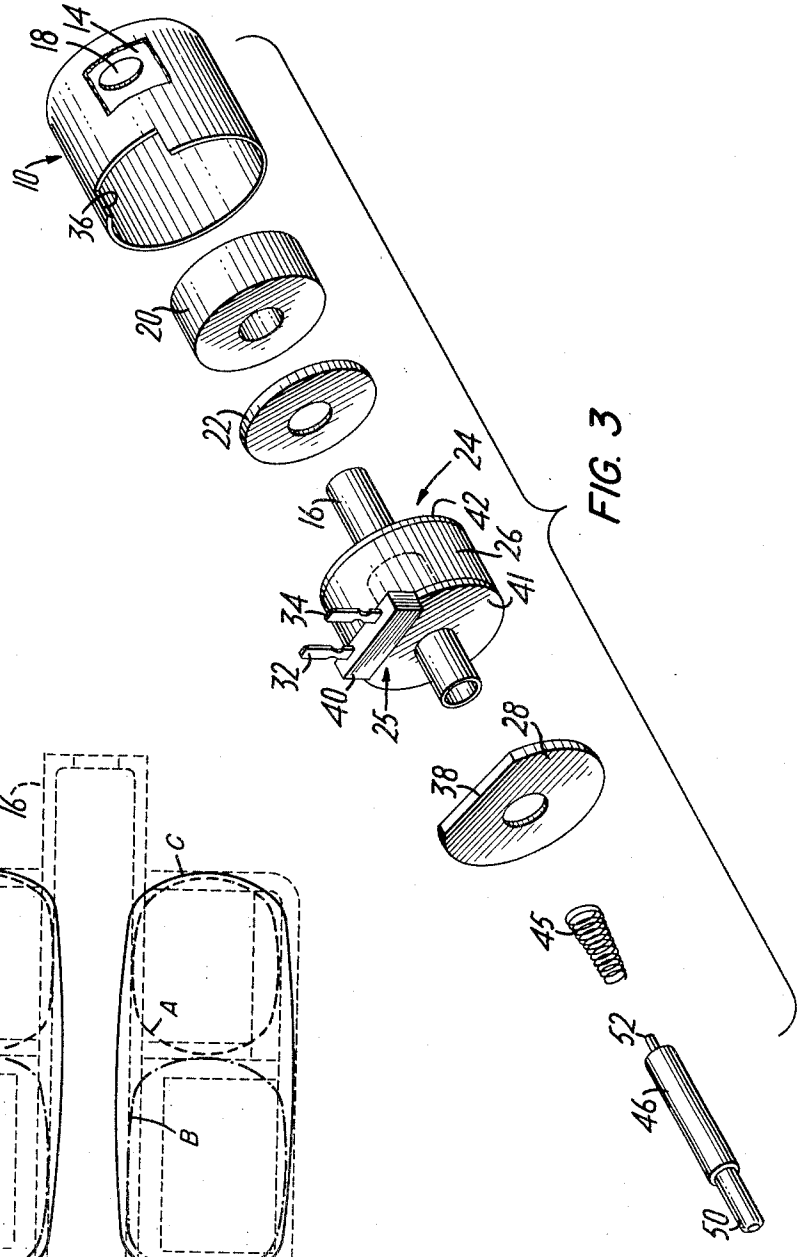


FIG. 3

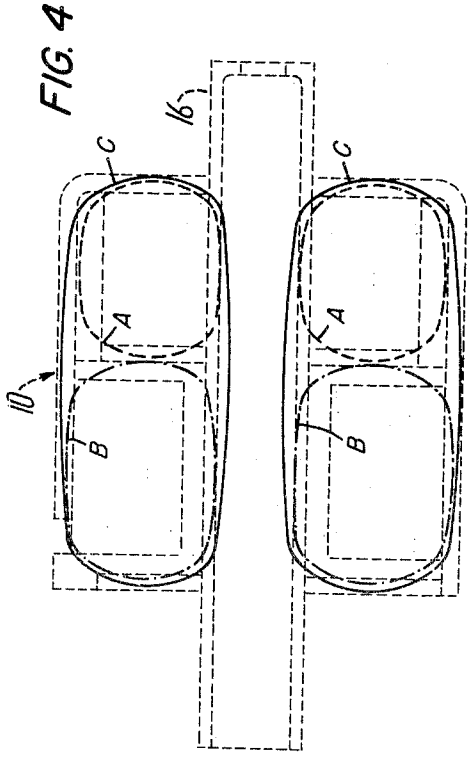


FIG. 4

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BELL STRIKER ASSEMBLY

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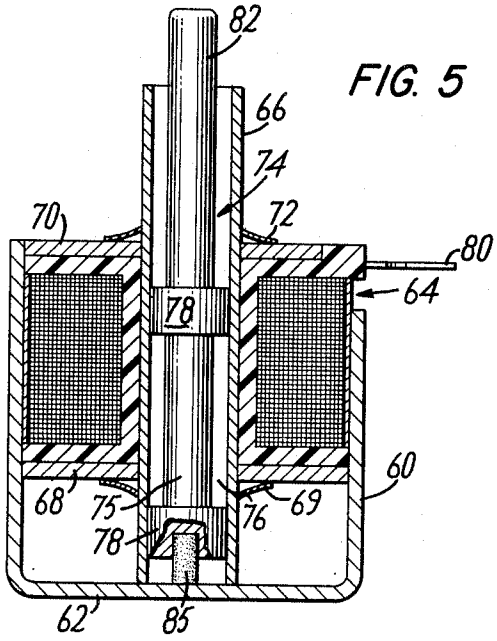


FIG. 5

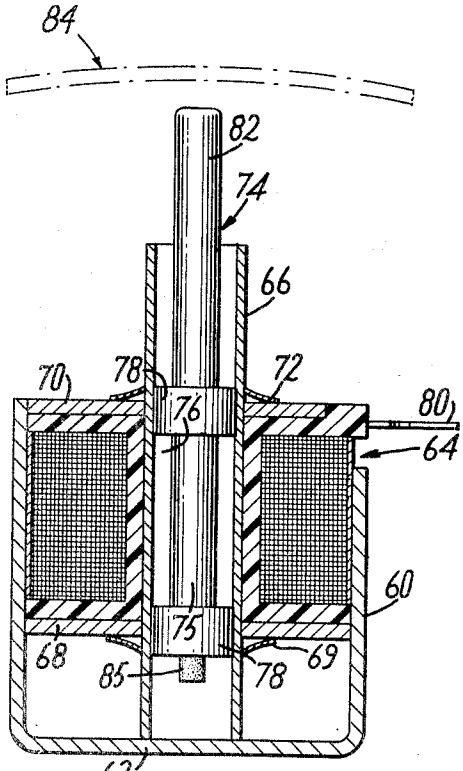


FIG. 6

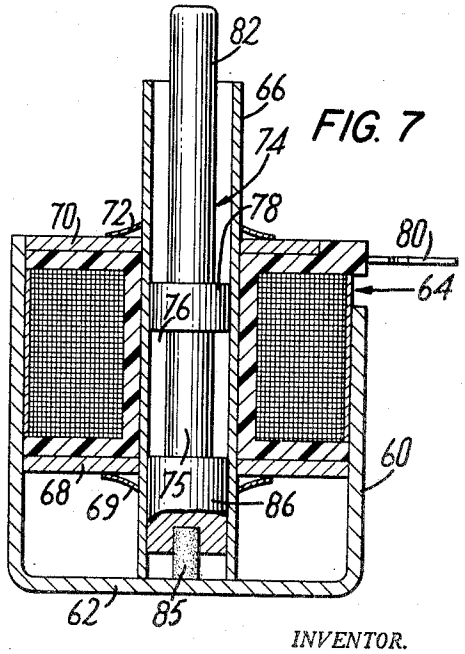


FIG. 7

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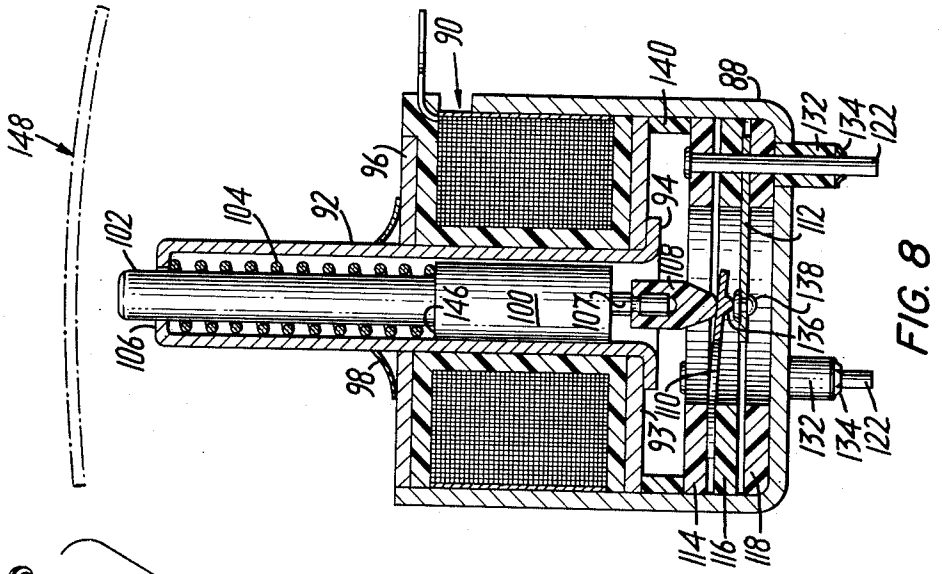


FIG. 8

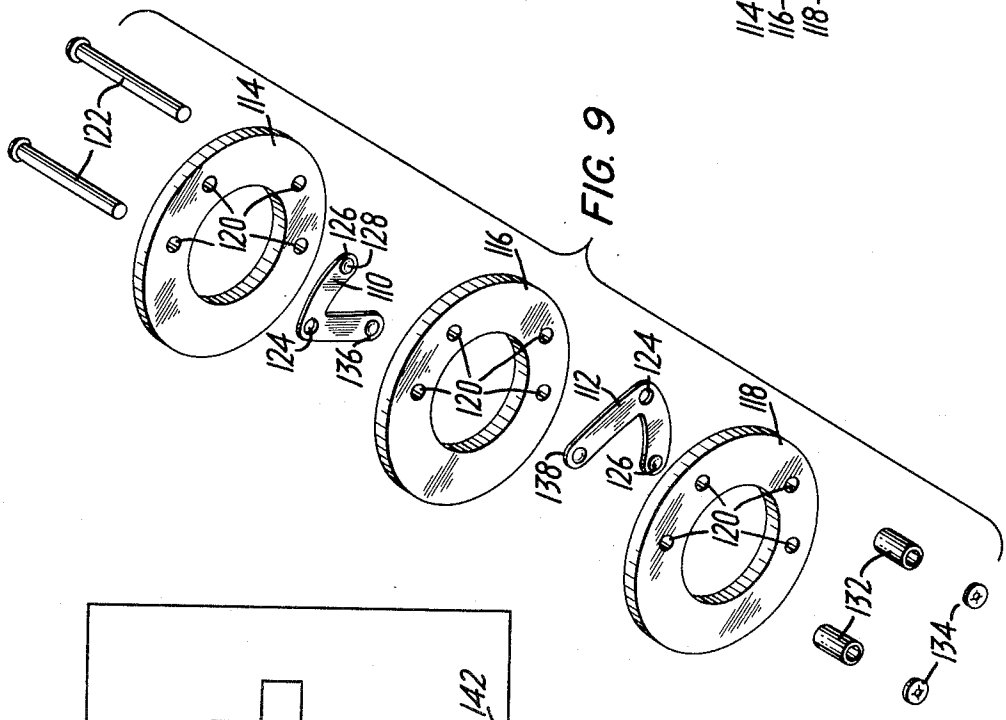


FIG. 9

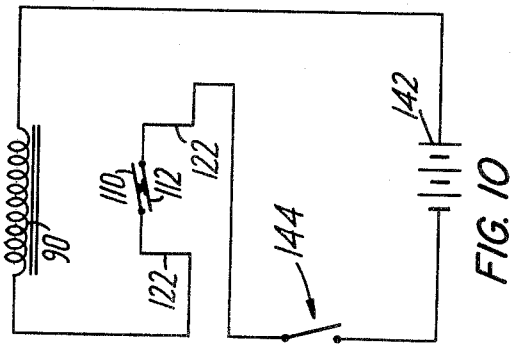


FIG. 10

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BELL STRIKER ASSEMBLY

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Filed Aug. 1, 1960, Ser. No. 46,451
9 Claims. (Cl. 310—30)

This invention relates to a bell striker assembly of the type in which a paramagnetic plunger is caused to reciprocate in a tube of nonmagnetic material and strike a gong by means of one or more units that generate magnetic flux.

In accordance with the present invention magnetic flux generated in the assembly is controlled and guided along certain paths by means of a paramagnetic casing and one or more paramagnetic pole pieces which are so arranged in proximity to flux generating and receiving units that the length of the path of the flux is materially reduced and thereby strengthened to provide extremely positive and precise action.

Reduction of the paths of magnetic flux makes the unit extremely compact which is of advantage in certain applications where space is a factor and by concentrating the magnetic flux in the shell of the casing it is possible to use the same casing in bell striker assemblies employing different parts and different operating characteristics. Another advantage of the casing of the present invention is that it protects the operating parts from the elements and if desired the casing may be made waterproof.

These and other advantages of the structure of the present invention as well as details of construction may be readily understood by reference to the accompanying drawings which disclose preferred forms of structure for the purpose of illustration. In the Drawings:

FIG. 1 is a plan view of one form of bell striker assembly which is in section to better illustrate the structure;

FIG. 2 is an end view of the assembly of FIG. 1;

FIG. 3 is an exploded view of the parts of the assembly of FIG. 1;

FIG. 4 illustrates a portion of the paths of the magnetic flux in the structure of FIG. 1;

FIGS. 5 through 7 illustrate modified forms of the bell striker assembly; and

FIGS. 8 through 10 illustrate another form of bell striker assembly.

In the preferred form of invention shown in FIGS. 1 through 4, 10 is a paramagnetic cylindrical casing preferably made of a single piece of steel which is open at one end and closed at the second end thereof by means of end wall **14**. End wall **14** supports one end portion of a nonmagnetic tube **16**, made of any suitable material such as stainless steel, brass, or plastic such as phenolic, nylon or so-called fiber glass plastic. In the drawings tube **16** is made of brass. The tube is inserted through a hole **18** in the end wall of the casing. A cylindrical permanent magnet **20** and a paramagnetic circular steel washer or pole piece **22** are slidably mounted on the tube followed by a conventional electromagnet **24** which comprises the usual spool piece **25** of suitable electrical insulating material and windings **26**. Tube **16** passes through the bore **27** of the spool piece. The electromagnet is followed by a second paramagnetic circular steel washer or pole piece **28** which fits into the casing to form an end wall which closes the open end of the casing. Brass tube **16** readily fits into each of the mounting holes of the elements and the elements are held in position against each other within casing **10** by means of spring steel locking washers **29** which are pressed into fixed position on the tube to exert spring tension against end wall **14** and pole piece **28**.

The electromagnet has the usual terminals **32** and **34** which project out of the casing through a slot **36** in the mouth of casing **10**. Terminals **32** and **34** are connected to separate outside conductors (not shown) which provide alternating electric current for generating a magnetic flux.

In the preferred form of structure shown one end portion of the circular pole piece **28** is cut off along the line of a "cord" **38** (FIG. 2) to provide an opening in the end wall of the casing which is arranged to receive a rectangular projection **40** positioned on one of the circular end pieces **41** of the spool. The projection is arranged to bear against the edges of the casing in the slot **36** and against the edge of pole piece **28** along the line of the cord and as a result the spool piece is prevented from rotating within the casing. The periphery of the circular pole piece **28** and the periphery of the circular end pieces **41** and **42** of spool **25** are positioned in close proximity to the interior wall of casing **10** and preferably in contact with the casing as shown in the drawing. The diameter of pole piece **22** and the diameter of the cylindrical permanent magnet however, are such that an annular space **43** is provided between these two elements and the interior wall of the casing. In the structure shown, the inside diameter of the casing is about 1¼ inch and the outside diameter of pole piece **22** and permanent magnet **20** is about 1⅛ inch. For the purpose of the present invention the distance between the interior wall of the casing and periphery of the permanent magnet and pole piece **22** may range from between about 1/16 to 3/16 inch and preferably between about 1/16 to ⅛ inch for a casing having an inside diameter of about 1¼ inch. As the size of the elements of the assembly is increased the distance between the interior wall of the casing and the periphery of the magnet and pole piece **22** is increased proportionally.

Tube **16** is provided with an annular flange **44** at one end thereof which closes off a part of the opening at the end of the tube. A paramagnetic steel spring **45** in the tube bears against the annular flange and against a paramagnetic cylindrical plunger **46** the body portion of which has an outside diameter a few thousandths less than the inside diameter of the tube so that the plunger will slide freely in the tube.

The assembly is small and compact and it may be mounted under the cup of a bell or gong **48** so that the nose **50** of plunger **46** will strike the gong when the assembly is in operation. Conventional mounting means (not shown) are employed and best results are achieved with nonmagnetic mounting means which will not dissipate the magnetic flux generated in the paramagnetic casing.

As shown in FIG. 1 the parts are at rest and no current is being supplied to the electromagnet. The path of the unidirectional magnetic flux of the permanent magnet passes through pole piece **22** and then across the gap of the nonmagnetic tube **16**, through the body portion of the paramagnetic plunger **46** and to the right through the reduced end portion **52** of the plunger. It then travels to the right within the tube mostly through spring **45**, and then across the gap of the nonmagnetic tube and through the shell of the casing back to the other face of the magnet. The face **54** at the end of the body of the plunger seeks to close the gap between it and the permanent magnet and as a result the plunger is drawn to the right against the spring which is compressed so that the spring exerts positive pressure against the plunger when the parts are at rest as shown in FIG. 1. At this time the verticle plane of the surface at one end of the enlarged body portion of the plunger passes through pole piece **22**.

When alternating electric current is supplied to the winding of the electromagnet two additional magnetic flux paths are established. The first flux path of the electromagnet passes through pole piece **28** across the gap of the nonmagnetic tube through the plunger **46** and then across the gap of the nonmagnetic tube through pole piece **22** and then back to the electromagnet. The second

flux path passes through pole piece 28 across the gap of the nonmagnetic tube 16, through plunger 46 and then through the reduced end portion 52 of the plunger. The flux then proceeds to the right within the tube mostly through spring 45, and then across the gap of the nonmagnetic tube through the shell of the casing and back to the electromagnet.

The three magnetic flux paths are illustrated diagrammatically in FIG. 4. As there shown the flux path of the permanent magnet is marked A, the first path of the flux of the electromagnet is marked B and the second path of the electromagnet is marked C. When alternating current is supplied to the electromagnet an alternating magnetic flux is generated in the paths B and C and in alternating the flux will first aid and then oppose the magnetic flux of the permanent magnet. When the magnetic flux of the electromagnet aids the flux of the permanent magnet plunger 46 is moved inwardly to the right in tube 16 beyond the position shown in FIG. 1 to further compress spring 45 and then on the next half cycle of current the flux of the electromagnet will oppose that of the permanent magnet and the compressed spring will drive the plunger against the gong. Upon rebound the plunger will again be drawn to the right to compress the spring and repeat the cycle. The approximate extent of movement of face 54 of plunger 46 is indicated by means of the dotted lines D and E in FIG. 1. When the nose 50 of plunger 46 strikes the gong, face 54 is aligned approximately with dotted line D and the magnetic flux urges the plunger to the right to close the gap between face 54 and pole piece 22. Thereafter the flux urges the plunger to close the gap between face 54 and permanent magnet 20 and finally face 54 is urged to close the gap between it and the end wall 14 of the casing. The exposed face at the end of the reduced end portion 52 of the plunger is positioned approximately in line with the left wall (FIG. 1) of permanent magnet 20 when the striker hits the gong and on rebound the exposed face on extension 52 is urged to close the gap between it and end wall 14 of casing 10. The reduced end portion 52 of plunger 46 cooperates with spring 45 to assist in guiding the plunger in the center of tube 16 during reciprocation.

The importance of the annular space 43 between the interior wall of the casing and pole piece 22 and permanent magnet 20 is readily apparent from a consideration of the three paths of magnetic flux (FIG. 4) and the gaps which the plunger is urged to close. Without annular space 43 the flux path C of the electromagnet would pass through pole piece 22 or permanent magnet 20 and then into the shell of the casing to return to the winding. However, the annular space 43 tends to interrupt the path of magnetic flux so that most of the flux is caused to travel the length of the tube until it reaches end wall 14 of the casing. As a result the flux in the gap which urges the plunger to compress the spring is materially strengthened. Strengthening the flux in this way makes it possible to use an inexpensive ceramic type permanent magnet as compared to the expensive alnico permanent magnets employed in conventional devices. While a ceramic type permanent magnet reduces cost of construction it will be understood that an alnico permanent magnet may be employed to provide an especially strong magnetic flux.

For the purpose of description the term "gap" as used herein is intended to describe the distance between the paramagnetic plunger and any of the other magnetic flux generating or conducting elements. The magnetic flux jumps across the gap to the plunger which at all times is urged by the magnetic flux to close the gap. The term "space" is intended to describe the distance between any two elements in the assembly which tends to interrupt the path of magnetic flux so that the strength of the flux is materially reduced or made negligible in the space.

In many installations, as in marine use, it may prove desirable to have a waterproof casing. This is readily achieved in the structure of my invention, it being only

necessary to close the opening for the terminals 32 and 34 in known manner by means of a conventional potting compound such as an epoxy resin. In such case potting compound is also applied to the junction between casing 10 and pole piece 28 and at the junction between pole piece 28 and tube 16 and tube 16 and end wall 14 of the casing so that fluid will not enter the casing at these points. In the event that the assembly is mounted with tube 16 in vertical position any liquid that enters the tube will readily drain out through the opening 56 in the end of the tube. Hole 56 is also of advantage in that it insures equal air pressure on both sides of plunger 46 which contributes to uniform reciprocation of the plunger. As shown in the drawings spring 45 is a tapered nonlinear spring and while this is preferred satisfactory operation may be achieved with a linear spring having turns of uniform diameter. The tapered spring is of advantage in that only a portion of the spring contacts the wall of the casing which reduces friction so that less power is required for driving the plunger.

Another great advantage of the structure of the present invention is that the casing may be used to house parts which employ different operating characteristics. For example FIG. 5 shows a plunger assembly which operates on alternating current as well as direct current. In this case the striker is adapted for single stroke operation such as is used in broadcasting a bell code. In this case casing 60 is identical with casing 10 with the exception that one end of the casing is completely closed by end wall 62 which does not have a hole in the center thereof as in the case of wall 14. The electromagnet 64 is of the same construction as electromagnet 24 and as in the case of electromagnet 24 the electromagnet 64 is mounted on a nonmagnetic tube 66. A paramagnetic circular steel washer 68 which serves as a pole piece is mounted on tube 66 with one face of the washer in contact with one end face of the spool piece of the electromagnet. There is a space between the second face of the washer and end wall 62 of the casing and the pole piece 68 and electromagnet 64 are held in position on the nonmagnetic tube 66 by means of a spring steel locking washer 69 which is the same as locking washer 29. If desired pole piece 68 and electromagnet 64 may be mounted in fixed position on tube 66 by means of a tight interference fit between these members. The periphery of the circular pole piece 68 is in contact with the side wall of casing 60. The casing is closed by means of a paramagnetic circular steel washer or pole piece 70 which is of identical construction with pole piece 28 and pole piece 70 is held in position to form the end wall of casing 60 by means of a spring steel locking washer 72 which is of identical construction with locking washer 29. A paramagnetic cylindrical plunger 74 is slidably mounted in tube 66. The diameter of the body portion 75 of plunger 74 is substantially less than the inside diameter of tube 66 in order to provide an annular "space" 76 between the exterior of the body of the plunger and the interior wall of tube 66. In the preferred form of structure shown the diameter of the body portion 75 is about 3/16 inch and the inside diameter of the tube is about 0.300 inch. For the purpose of the present invention the distance between the inside wall of the tube and body portion 75 of plunger 74 may range between about .056 and .087 inch and preferably between about .050 and .072 for a tube having an inside diameter of .300 inch. For larger tubes and plungers the distance is increased proportionately. A cylindrical collar 78 is positioned at each end of the body portion 75 of plunger 74 and the diameter of the collar members 78 is just a few thousandths less than the inside diameter of tube 66 so that the plunger will readily reciprocate within the tube.

It will be noted that the plane of the exposed surface of the interior faces of each collar are positioned at an angle of approximately ninety degrees with the longitudinal axis through plunger 74 and this is an important feature of the structure shown in FIG. 5. With this con-

struction the plunger may be moved upwardly in tube 66 to strike a gong and thereafter held suspended in locked position in the tube to provide a single bell tone without tendency for echo tapping as hereinafter more fully described.

Separate conductors (not shown) from a suitable source of either A.C. or D.C. current are connected to the terminals 80 of electromagnet 64. In FIG. 5 the plunger is at rest and no current is being supplied. When current is supplied to the electromagnet a magnetic flux is generated which passes through the pole piece 70 across the gap of the nonmagnetic tube 66 and into plunger 74 and the top collar thereof. Thereafter the flux travels downwardly in the plunger across the gap from the body of the plunger (FIG. 5) to the paramagnetic wall of casing 60 to complete the cycle. When the magnetic flux is generated the top and bottom collars 78 close the gap between the collar and the pole pieces 70 and 68 respectively. This causes the plunger to move up slightly beyond the position shown in FIG. 6 whereupon striker rod 82 strikes the gong indicated at 84 and the plunger is locked in the position shown in FIG. 6. As long as the supply of current to the electromagnet 64 is not cut off plunger 74 will remain in the locked position shown in FIG. 6 and this is true regardless of whether alternating or direct current is employed. When the current is interrupted the plunger falls under the influence of gravity back down into the position shown in FIG. 5. A rubber pin 85 mounted in the bottom of the plunger prevents the metal from contacting the wall of casing 60 which eliminates audible sound and it assists in preventing residual magnetic flux in the casing from interfering with the desired movement of the plunger.

One of the problems experienced with this type of single stroke operation is that the striker in conventional devices tends to give a double tap. This drawback is overcome in the structure of the present invention by means of the inner exposed faces of collars 78 which are positioned substantially at right angles with the longitudinal axis of plunger 74. As a result of the sharp angle which these surfaces make with the body of the plunger the collars 78 are positively locked in position as shown in FIG. 6 where each collar is held adjacent to one of the paramagnetic pole pieces 68 and 70 which prevents drifting that might result in an echo tap. As a matter of fact in actual practice we have operated the plunger shown in the drawings without any gong in position to restrict the travel of the plunger and quite unexpectedly found that the plunger remained in the tube even though the plunger was rapidly accelerated as it moved slightly beyond and then into the locked position of FIG. 6. There was no appreciable drift.

If desired casing 60 may be sealed against moisture by use of suitable potting compounds as previously described in connection with casing 10. In such case a small hole (not shown) similar to hole 56 can be drilled through the end wall 62 so that any water that collects in the tube will drain out. The bell striker assembly shown in FIG. 5 may be mounted in proximity to a gong as previously described for the structure of FIG. 1.

FIG. 7 shows another form of the structure shown in FIGS. 5 and 6. Referring now to FIG. 7 the structure shown therein is identical with that shown in FIG. 5 with the exception that the bottom cylindrical collar 86 of plunger 74 is elongated so that when the plunger is in the at rest position shown in FIG. 7 the exposed top face of the collar is positioned approximately in line with the top surface of the paramagnetic pole piece 68. With the exception of the gap of tube 66 there is no magnetic gap between pole piece 68 and collar 86. Otherwise the construction and operation of the form of structure shown in FIG. 7 is identical with that described in connection with the structure shown in FIGS. 5 and 6.

Another form of bell striker assembly which employs the casing of the present invention is shown in FIGS. 8, 9 and 10. As there shown casing 88 is of identical construction as casing 60. An electromagnet 90 of the same construction as that of electromagnet 64 is mounted on a nonmagnetic brass tube 92. The tube preferably makes a tight interference fit with the bore of the electromagnet which assists in locking the electromagnet in place on the tube. A circular steel washer which serves as pole piece 93 is also mounted in the tube with one face of the pole piece in contact with the face at one end of the spool piece of the electromagnet and as in the case of the structure of FIG. 5 there is a "space" between the second face of the pole piece and end wall of the casing. In the preferred form of structure shown the rim at one end of the tube is swedged over the rim of the back of the pole piece to form a lip 94 which locks the washer and electromagnet on the tube.

A paramagnetic circular steel washer or pole piece 96 of identical construction with pole piece 70 forms a wall which closes the open mouth of the casing. A spring steel locking washer 98 of identical construction as washer 72 locks pole piece 96 in place against the electromagnet. The subassembly of the electromagnet, pole pieces and tube are locked in place in casing 88 by means of swedging over at least a portion of the mouth of the casing on top of the pole piece 96.

A paramagnetic cylindrical steel plunger 100 is slidably mounted in tube 92 and the diameter of the body of the plunger is a few thousandths less than the interior of the tube. Plunger 100 carries a striker rod 102 at one end thereof which in the preferred form of structure shown extends out slightly beyond the rim of the tube. A nonmagnetic spring 104 is positioned in the striker end of tube 92 to surround the striker rod and the spring is held within the confines of the tube by means of the annular flange 106 at the rim of the tube. Non-magnetic spring 104 may for example be made of phosphorous bronze or stainless steel. The spring 104 is made of stainless steel. In the preferred form of structure shown, spring 104 is not compressed when the assembly is in the "at rest" position shown in FIG. 8 so that the plunger will start to accelerate and move before any appreciable spring pressure is applied to the plunger. A pin 107 is mounted at the second end of plunger 100 and pin 107 is provided with a coating of electrical insulating material such as nylon which, as shown, is in the form of a cone 108 which is adapted to open and close a pair of spring contacts 110 and 112 respectively. The details of the construction of the contact assembly is best shown in FIG. 9.

Referring to FIG. 9, the contact assembly comprises three circular washers 114, 116 and 118 respectively each of which is made of a suitable electrical insulating material such as phenolic resin and the like. The diameter of the washers is such that they will readily fit into casing 88. Each of the washers is provided with a plurality of holes 120 which are so arranged that the holes in the respective washers may be a ligned to receive one of a pair of identical locking pins 122 which are made of an electric conducting material such as steel or brass. In the drawings pins 122 are made of brass. The diameter of the locking pins 122 is such that they make a tight interference fit with a mounting hole 124 positioned at the base of each of the generally U-shaped contact members 110 and 112 respectively to provide electrical contact between the contact member and the pins. One of the spring contacts 110 is mounted on one side of washer 116 and the second spring contact 112 is mounted on the second side of the washer by means of the locking pins. One of the legs of each of the spring contacts is provided with a second mounting hole 126 which has an embossed lip in the form of an annular flange 128 that fits snugly into a mounting hole 120 of washer 116 to prevent the spring contact from rotating on its mounting pin.

The contact assembly is formed by positioning one of the contacts on each side of washer 116 with the lip 128 assembled in a mounting hole 120 of the washer. After this is done washers 114 and 118 are assembled against opposite faces of washer 116. The brass locking pins 122 are then inserted through holes 120 and through the holes 124 at the base of the U of spring contacts 110 and 112 as shown in the drawings. An electrical insulating sleeve 132 made of phenolic resin is then inserted on the exposed end of the locking pins and a conventional spring steel washer 134 is inserted at the end of each pin to lock sleeves 132 in place on the pins.

When assembled one leg of each of the generally U shaped contacts extends into the opening at the center of washer 116 and these legs are positioned with the contact buttons 136 and 138 in line so that when the leg of the spring contact 110 is moved toward the leg of contact 112 by the weight of the plunger the two contacts will be closed. When the plunger moves upwardly away from the contact assembly the contact buttons are spaced apart.

The contact assembly is positioned in the casing with the locking pins 122 and sleeves 132 projecting through holes provided in the wall of the casing. The sleeves 132 provide electrical insulation between pins 122 and wall of the casing. A spacer 140 is positioned in the casing between the contact assembly and face of pole piece 93. The spacer is made of electrical insulating material such as a phenolic resin.

The contact assembly is connected in series with the terminals (not shown) of electromagnet 90. This may be done in any convenient manner. As shown in FIG. 10 locking pin 122 of spring contact 110 is connected to one of the terminals of the electromagnet 90 and the second terminal of the electromagnet is connected to a suitable source of electrical energy as indicated at 142. The locking pin 122 of the second spring contact 112 is connected to one terminal of a switch 144 and the second terminal of the switch is connected to the other side of the power supply 142. The bell striker assembly is mounted with the longitudinal axis of the plunger in vertical position and as a result the weight of the plunger and spring 104 will close contacts 110 and 112 as shown in FIG. 8.

At this time no current is being supplied to the electromagnet and switch 144 is open. In order to actuate the plunger switch 144 is closed. Since contacts 110 and 112 are closed current is supplied to the electromagnet 90 which generates a magnetic flux. The magnetic flux of the electromagnet passes through pole piece 96, across the gap of the non-magnetic tube 92, over to the exposed face 146 of plunger 100 and then down through the body of the plunger 100. The magnetic flux then leaves plunger 100 to cross the gap of the nonmagnetic tube 92 and then it enters pole piece 93 and returns to the electromagnet to complete the path. As a result the exposed face 146 of plunger 100 is urged to close the gap between it and the pole piece 96 and the plunger is thereby forced to move up in the tube until striker 102 strikes the gong as indicated at 148. As soon as the plunger moves upwardly in the tube spring contacts 110 and 112 open to interrupt the supply of current to electromagnet 90 and the electromagnet no longer generates a magnetic flux. The striker rebounds from the gong and starts to move downwardly in the tube and its motion is accelerated by the compressed spring 104. Plunger 100 continues to move downwardly in tube 92 until the insulated tip 103 of the plunger closes the spring contacts whereupon current is again supplied to solenoid 90 to generate a magnetic flux and drive the plunger upwardly in the tube so that striker 102 again contacts the gong and the cycle is repeated.

The bell striker assembly shown in FIGS. 8 through 10 may be operated with either alternating or direct current and the assembly is mounted in proximity to the gong 148 in conventional manner as described hereinabove for the structure of FIG. 1.

It will be understood that it is intended to cover all changes and modifications of the preferred embodiment of the invention herein chosen for the purpose of illustration which do not constitute a departure from the spirit and scope of the invention.

What is claimed is:

1. A bell striker assembly comprising a cylindrical paramagnetic casing having an opening in one end thereof, a cylindrical electromagnet with an open circular bore positioned within said casing, a nonmagnetic tube extending through the bore of the electromagnet, a paramagnetic plunger slidably mounted in said tube, a first circular paramagnetic pole piece mounted on the tube in position against the face at one end of the electromagnet, a second circular paramagnetic pole piece mounted on the tube in position against the face at the second end of the electromagnet to close the open end of the casing, a slot positioned in the rim at the mouth of the casing which slot is constructed and arranged to receive the terminals of the winding of said electromagnet for connection to separate exterior conductors, whereby when electrical current is supplied to said electromagnet the magnetic flux generated by the electromagnet will pass through the casing and plunger within the tube to cause the plunger to reciprocate in the tube and whereby during operation a face at one end of the said plunger will be brought into proximity with the face of a pole piece at one end of the electromagnet to establish a magnetic gap between the two members.

2. A structure as specified in claim 1 in which the plunger is provided with a resilient pin of electrical insulating material which projects out from the face at one end of the plunger to contact the wall of the casing when the plunger is at rest in the casing.

3. A structure as specified in claim 1 in which the body of the plunger is provided with a pair of spaced cylindrical collars with the surface of the interior faces of each of said collars being positioned at an angle of approximately ninety degrees with the longitudinal axis through the body of the plunger, said collars having a diameter approximately equal to the inside diameter of the tube, and said cylindrical body of the plunger having a diameter substantially less than the inside diameter of the tube to provide an annular space between the body of the plunger and interior wall of the tube, the surface at the end of one of said collar members being positioned in spaced relationship to one of the said pole pieces to establish a magnetic gap between the pole piece and face of the collar.

4. A structure as specified in claim 1 in which the plunger is provided with an insulated tip which bears against one of a pair of spring contacts in the casing to hold the contacts closed and whereby when magnetic flux is generated in the electromagnet it will cause the plunger to slide in the tube away from the contacts which thereby open to interrupt the supply of current to the electromagnet.

5. A structure as specified in claim 4 in which one face at the end of said plunger is positioned in proximity to the face of one of said pole pieces to provide a magnetic gap between the pole piece and face of the plunger.

6. A structure as specified in claim 5 in which the tube is provided with a spring member adapted to cooperate with the plunger and aid in the reciprocating movement thereof.

7. A structure as specified in claim 1 in which the diameter of the first of said pole pieces is less than the inside diameter of the interior of the casing to provide a space between the pole piece and wall of the casing and in which a permanent magnet is mounted within the casing on said tube with one end face of said magnet being in contact with the face of said first pole piece and the second end face of the permanent magnet being held against the

end wall of said casing, the diameter of said permanent magnet being less than the diameter of the interior of the casing to provide a space between the magnet and the interior wall of the casing.

8. A structure as specified in claim 1 in which a projection is positioned on one end face of the electromagnet and in which the casing is provided with a slot positioned in the rim of the cylindrical wall thereof and in which the circular pole piece which forms the end wall of said casing is cut off along the line of a cord to provide an opening in such wall of the casing which in cooperation with the slot in the rim of said casing provides an opening constructed and arranged to receive said projection which bears against the wall of the casing to prevent rotation of the electromagnet therein.

9. A bell striker assembly which comprises a nonmagnetic tube having an opening in one end, a substantially cylindrical paramagnetic casing coaxially surrounding the body of said tube, said casing having a substantially circular opening in one end thereof which is coaxially arranged with respect to said tube, an electromagnet surrounding said tube; a permanent magnet, a paramagnet pole piece with an opening therein which is axially aligned with said tube, said electromagnet, permanent magnet and pole piece being positioned in tandem within said casing between the ends of said casing with the pole piece positioned between one end of the electromagnet and one end of the permanent magnet and with the other end of the permanent magnet and the electromagnet positioned adjacent opposite interior end walls of the casing and with said permanent magnetic and paramagnetic pole piece being spaced away from the interior of the side wall of the casing, a substantially cylindrical paramagnetic plunger slidably mounted in said tube, one end of said plunger extending through the opening in the

casing so that a portion of cylindrical side wall of the plunger is in a closely spaced relationship with the side wall of the circular opening in said casing and the other end of said plunger is positioned in the casing in the proximity of the pole piece so that it is attracted towards said pole piece by the force due to magnetic flux of the permanent magnet, and a spring positioned within the casing and exerting a force on the second mentioned end of the plunger which opposes the force on the pole piece due to the magnetic flux of the permanent magnet to hold the paramagnet plunger in position against the force of the permanent magnet attracting the plunger to the pole piece whereby when alternating current is supplied to the electromagnet flux will be generated by said electromagnet that will alternately aid and oppose the magnet flux attracting the second mentioned end of the plunger to the pole piece and thereby cause the plunger to reciprocate in the tube.

References Cited by the Examiner

UNITED STATES PATENTS

1,596,468	8/26	Wallace	310—34
2,444,134	6/48	Hittson	310—30
2,447,230	8/48	Brown	310—34
2,458,692	1/49	Downer	310—34
2,468,343	4/49	Parker	310—34
2,708,245	5/55	Werner	310—30
2,726,342	12/55	Cavetto	310—30
2,985,802	5/61	Drenning	310—30
2,994,792	8/61	Parker	310—34
3,024,374	3/62	Stauder	310—30

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