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(54) **METHOD AND DEVICE FOR NAVIGATING EXCAVATION TOWARDS A BURIED TARGET**

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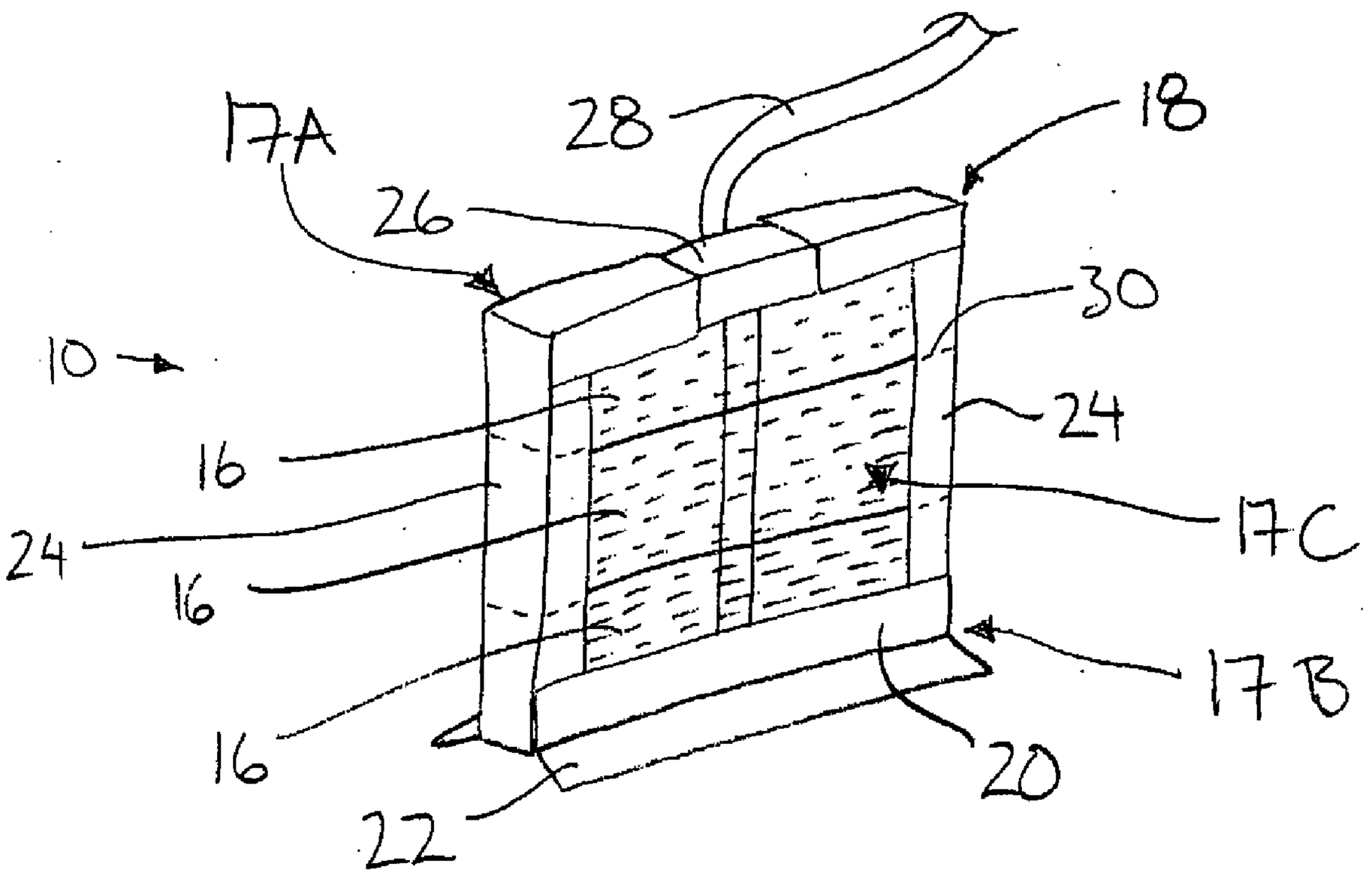
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(57) **ABSTRACT**

A method and device to navigate excavation towards a target buried in an excavatable material, for example excavation near an underground pipeline by excavation equipment. The device generally comprises indicating material arranged to be buried in the ground in proximity to the target. The indicating material is arranged to be frangible for permitting a portion of the indicating material to be removed from a remainder either by tearing, separation at separated sections or separation at perforated lines of severance. Different visual proximity indicators on the indicating material cause different sections of the indicating material to be visually distinct from one another corresponding to different degrees of proximity to the target. In use, the indicating material is placed in the ground and excavation towards the target results in portions of the material being removed. Proximity is indicated by associating which section a removed portion of the indicating material corresponds with. The proximity indicators may comprise use of varying colour, scaled indicia or other suitable notation.



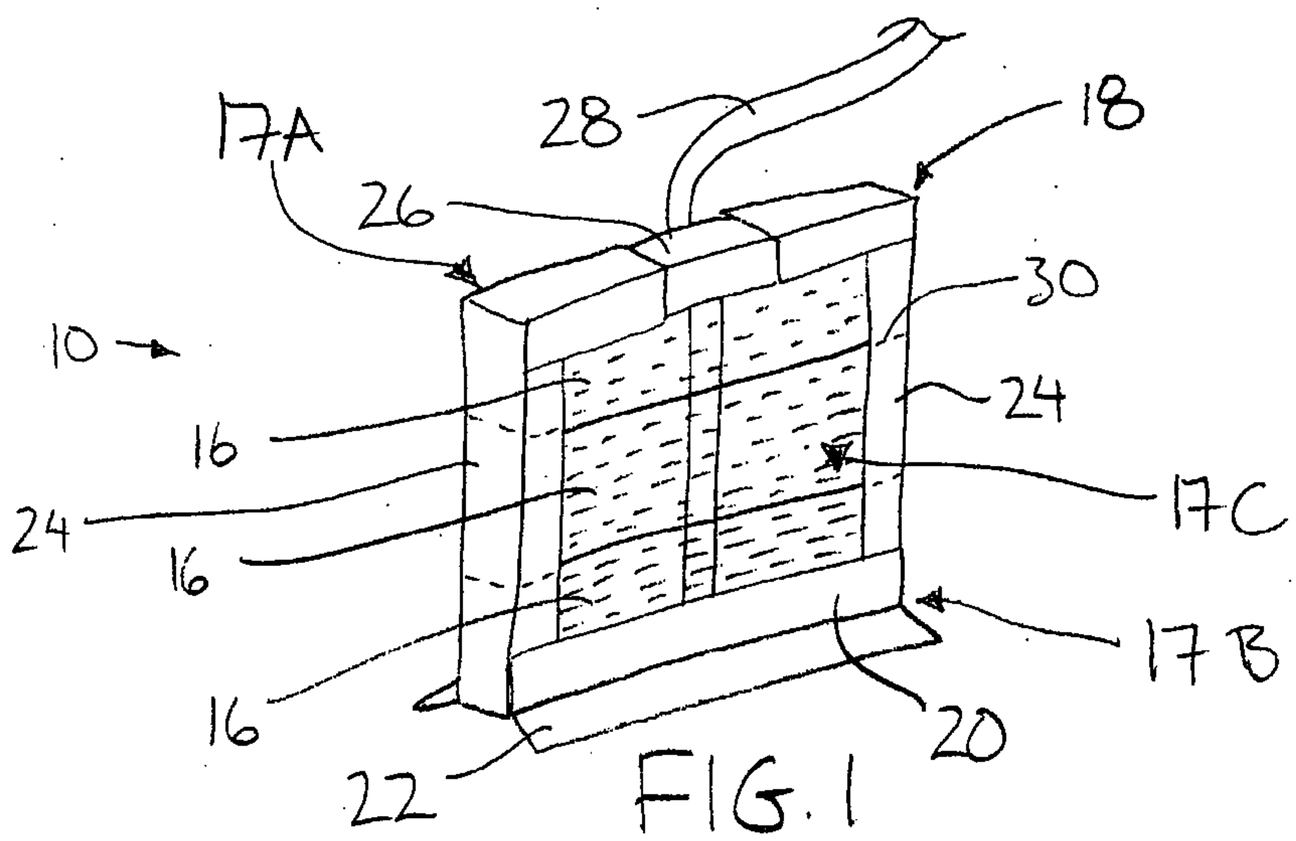

17A
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17C
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17B
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FIG. 1

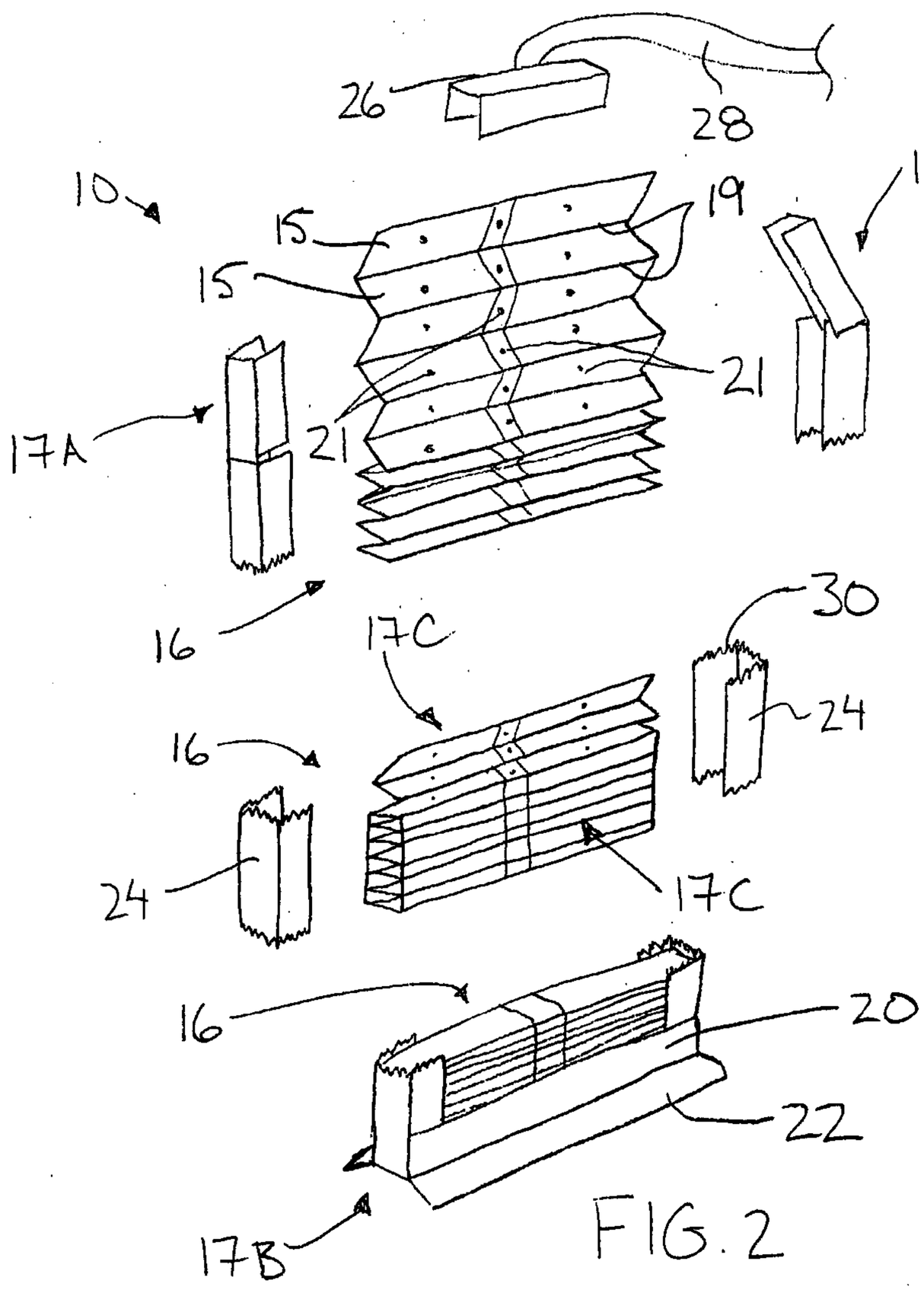

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17A
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FIG. 2

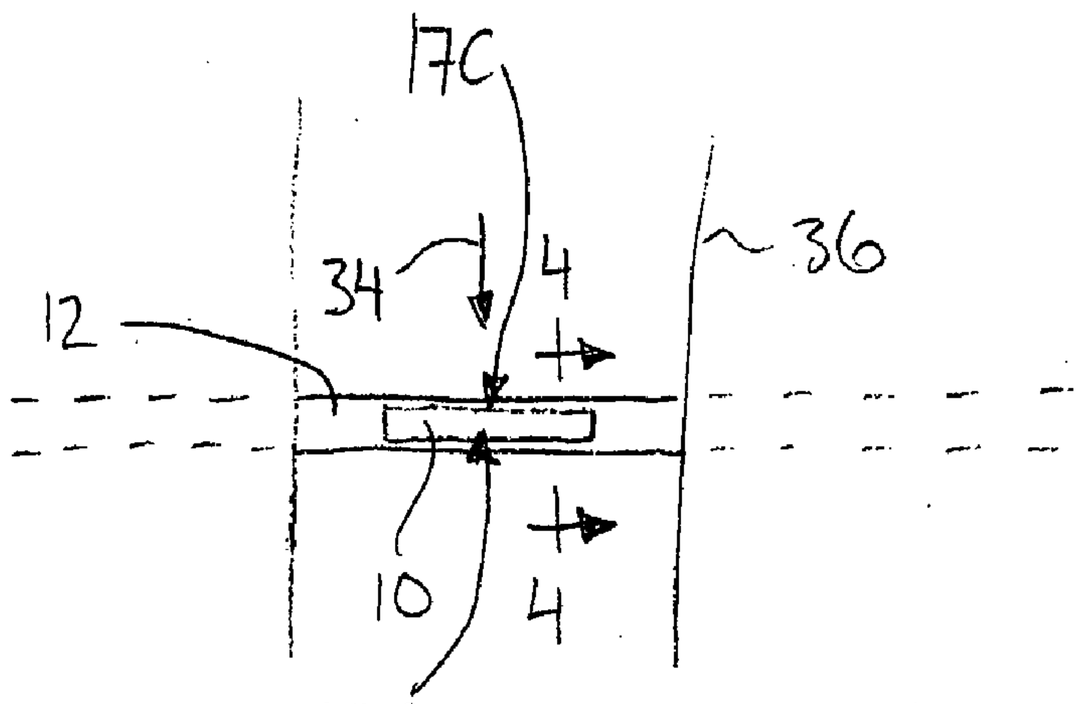


FIG. 3

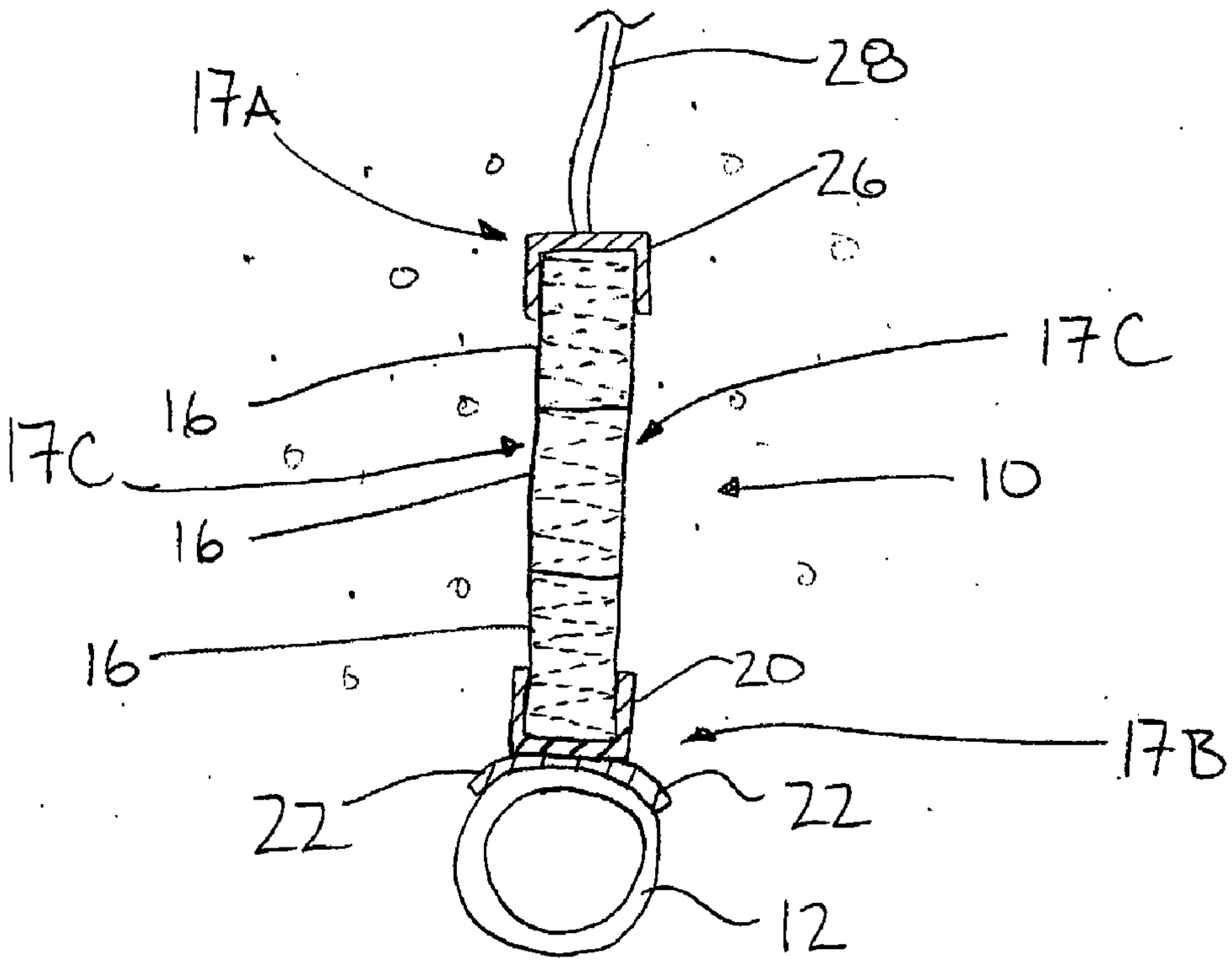


FIG. 4

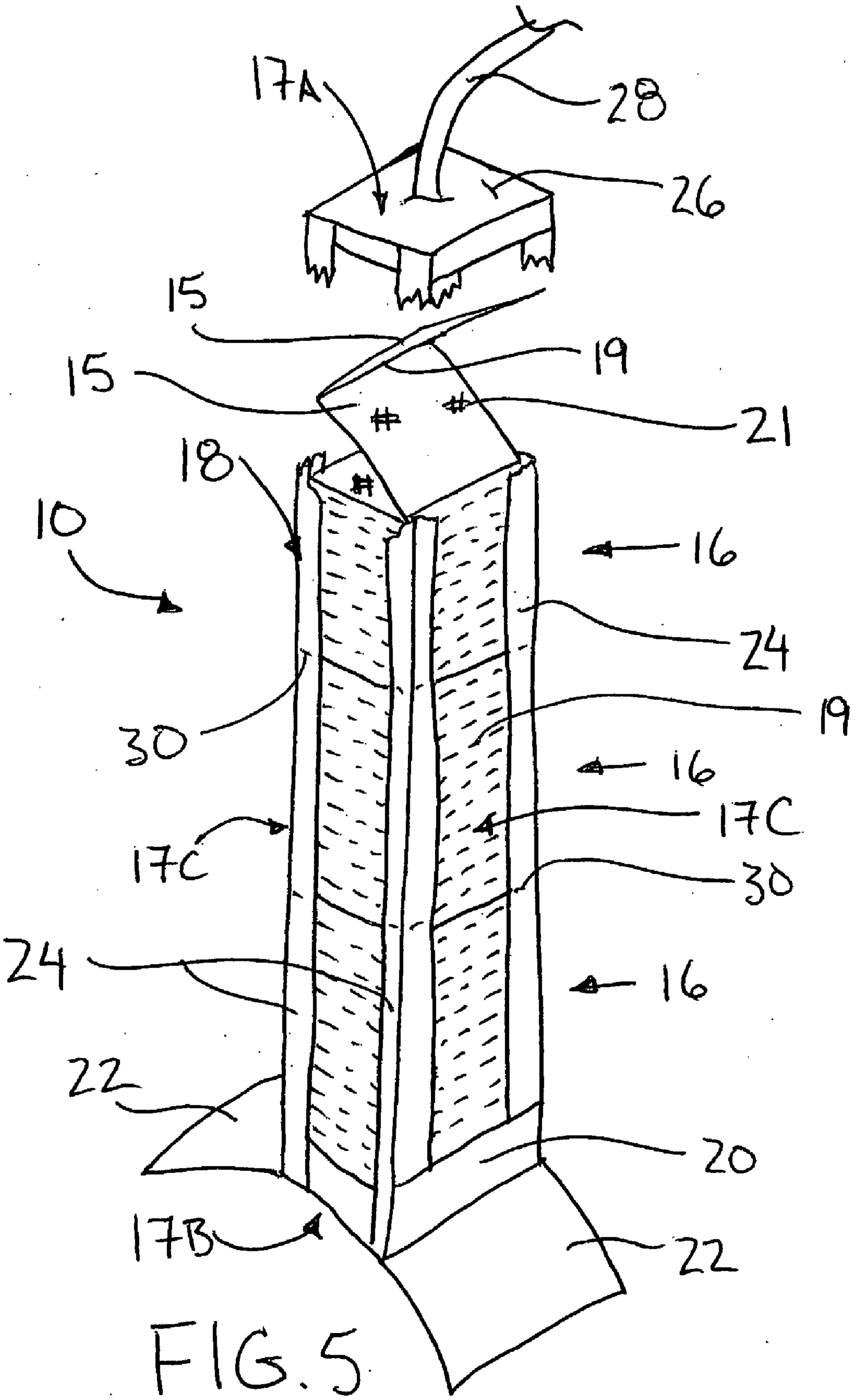

17A
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17C
17C
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17B
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FIG. 5

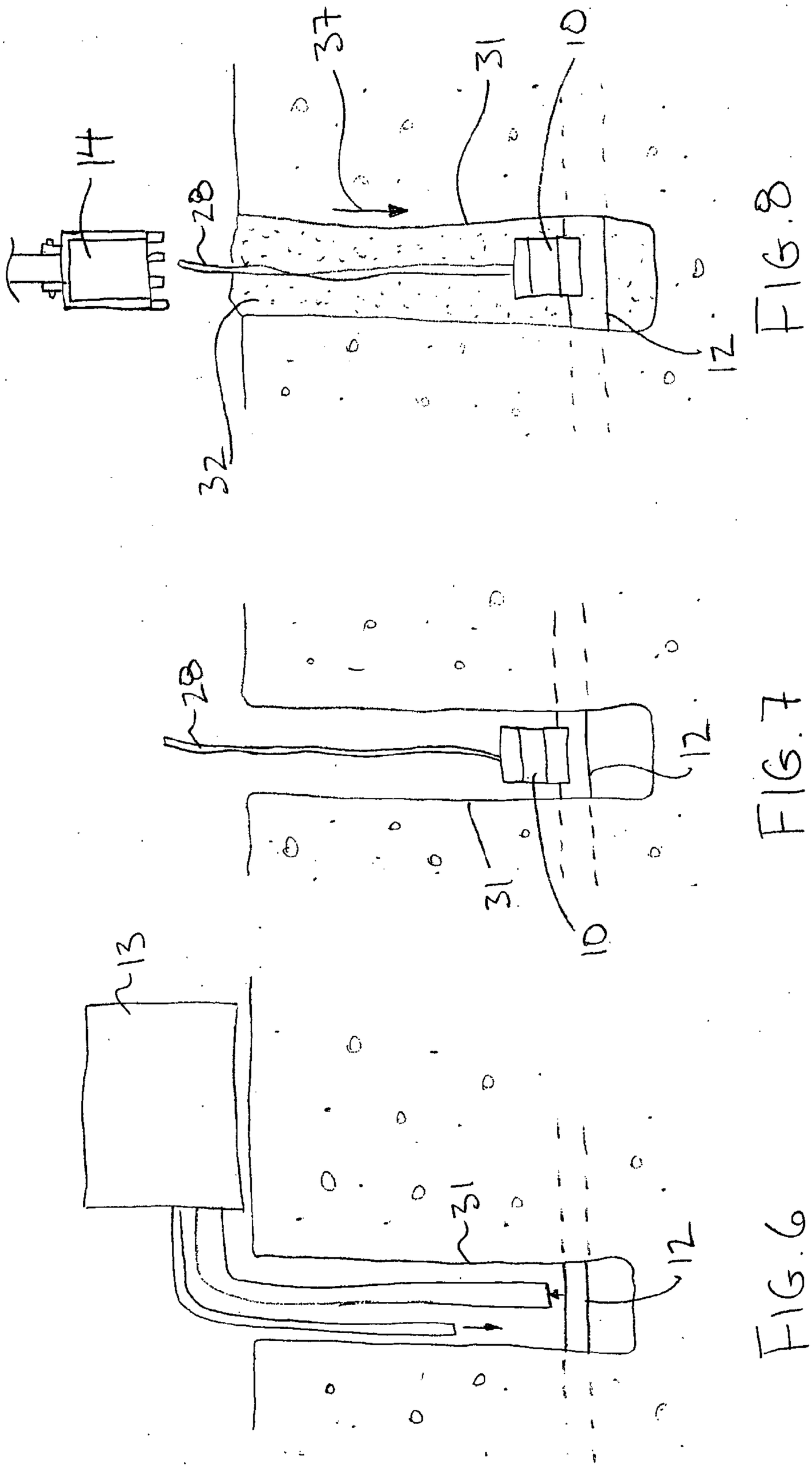


FIG. 8

FIG. 7

FIG. 6

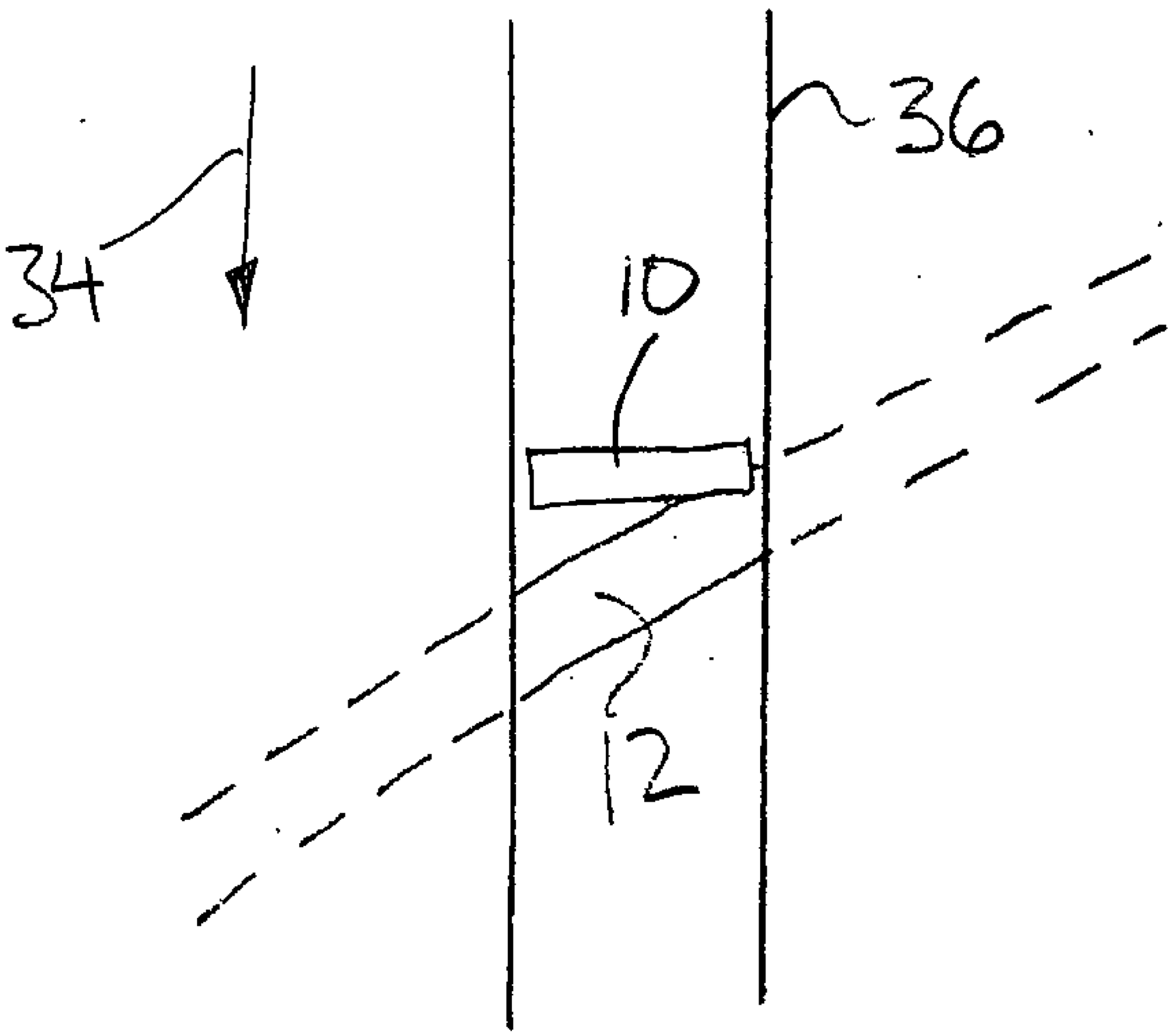


FIG. 9

METHOD AND DEVICE FOR NAVIGATING EXCAVATION TOWARDS A BURIED TARGET

FIELD OF THE INVENTION

[0001] The present invention relates to a device and a method of use thereof for navigating excavation towards a target which is buried in an excavatable material, for example when using excavating equipment to excavate the ground near an underground pipeline.

BACKGROUND

[0002] Trenches for underground cables and ditches and the like are commonly dug using hydraulically actuated excavating equipment having a bucket at a free end of an arm. When such a trench is being dug across an existing pipeline, special care must be taken to avoid damaging the pipeline in anyway due to contact from the excavating equipment. It is common practice to initially visually locate the pipeline by providing a vacuum type excavator which uses an injector to inject liquid into the ground. The liquid forms a slurry with the earth and a vacuum mechanism on the excavator then withdraws the slurry. A small hole from the surface to the underground pipeline in the order of a few feet in diameter is thus formed. Once the pipeline is visually located, the depth of the pipeline to the surface can be measured so that operators of excavating equipment can proceed with a better degree of assurance as to where the pipeline is located. Presently, operators use excavating equipment to dig the trench within a prescribed safe distance of the pipeline by measuring the depth of the trench relative to the surface. While digging, it is common for backfill to cover the pipeline so the operator of the excavating equipment loses visual contact with the pipeline while digging with the bucket. Slight measurement errors when measuring the depth of the pipeline or the depth of the trench being formed by the excavating equipment, or other errors of which many involve human error, can result in extremely costly and dangerous accidents. These accidents may involve damage to equipment, damage to the environment, personal injury or even possible loss of life due to the extremely high pressures commonly found in pipelines.

SUMMARY

[0003] According to one aspect of the present invention there is provided a method of navigating excavation towards a target buried in excavatable material, the method comprising:

[0004] placing indicating material in the excavatable material in proximity to the target;

[0005] excavating the excavatable material towards the target to remove a portion of the indicating material leaving a remainder of the indicating material; and

[0006] indicating a degree of proximity to the target by arranging the portion of the indicating material to be visually distinct from another portion of the remainder.

[0007] According to a second aspect of the present invention there is provided a device for navigating excavation towards a target buried in excavatable material, the device comprising:

[0008] indicating material arranged to be placed in the excavatable material in proximity to the target;

[0009] frangible means for permitting a portion of the indicating material to be removed from a remainder of the indicating material to be left in the excavatable material; and

[0010] proximity indicating means on the indicating material corresponding to a degree of proximity to the target for permitting a removed portion of the indicating material to be visually distinguished from a remaining portion of the indicating material.

[0011] Location of the indicating material adjacent or in proximity to a buried object or other target assists in navigating in relation to the target. For example, when the target is a pipeline, the device assists in navigating in relation to the pipeline while digging with excavating equipment even when backfilling occurs and visual sight of the pipeline is lost. Permitting sections of the indicating material to be separated and removed from a remainder ensures that the entire indicating material is not removed upon initial contact by the excavating equipment. Instead a remainder portion of indicator material remains buried in the ground or buried in other excavatable material, to continue indicating proximity to a target location. Proximity indication on the indicating material, in the form of color coding and/or scaled indicia for example, readily indicates a degree of proximity to the bottom of the indicating material, and accordingly distance to the target when the material is in proximity to the target. Proximity is continued to be indicated as sections of the indicating material are torn or separated and removed from the trench with the excavated material by visually comparing the removed portions to the buried remainder.

[0012] The method preferably includes removing a plurality of portions from the indicating material while excavating towards the target and indicating a degree of proximity to the target as each portion is removed by visually comparing each portion to the remainder.

[0013] The indicating material is preferably arranged into a plurality of sections which are visually distinct from another in which each section corresponds to a different degree of proximity to the target so that proximity can be indicated by determining which section that a removed portion of the indicating material corresponds with.

[0014] The sections may be visually distinct from one another by providing scaled indicia on the sections respectively, by associating a different colour with each section, by providing various notations on the sections, by varying shape of the sections, or any combination thereof.

[0015] The indicating material is preferably arranged to be frangible so that as excavation proceeds, portions of the indicating material may be separated and removed by tearing the portion from the remainder, by forming lines of severance defining sections of the indicating material and breaking apart at least one section from a remainder of the sections at one of the lines of severance, by forming the indicating material into a plurality of separated sections and removing at least one section from a remainder of the sections, or any combination thereof.

[0016] The sections which permit portions to be visually distinct from one another corresponding to a different degree of proximity to the target may also correspond with the sections which cause the indicating material to be frangible.

[0017] The indicating material is preferably elongate in a longitudinal direction corresponding to the direction of proximity indication on the indicating material. The indicating material is preferably oriented in relation to the target so that the longitudinal direction and the direction of proximity indication are parallel to a direction of excavation of the excavatable material towards the target. The direction of excavation comprises the direction which the excavated area approaches

the target with which the indicating material is associated. The navigation provided by the indicating material of the device is simply an indication of proximity in a direction towards the target whether it is desirable for the excavated area to approach the target or not.

[0018] The portion of the indicating material may be extendable in length in a direction of proximity indication as the portion is removed for increased visibility. This is accomplished in the illustrated embodiment by forming the indicating material of elongate sheeted material, placing the indicating material in proximity to the target in a folded condition and extending the portion of the indicating material in length as the portion is removed by unfolding the material.

[0019] The elongate sheeted material may be folded into segments laying one against another, in alternating directions in a zig-zag pattern. When the segments are rectangular and of similar dimension, the segments may be folded such that each segment spans a full thickness of the indicating material in a folded condition. The folded segments are preferably perpendicular to a direction of proximity indication of the proximity indicating means.

[0020] A housing may surround the indicating material for maintaining the sheeted material in a folded condition. The indicating material is preferably readily separable from the housing.

[0021] The housing may comprise channels spanning in a direction of proximity indication of the proximity indicating means for receiving opposing edges of the segments in the channels in the folded condition.

[0022] When the segments are rectangular, the housing preferably spans across the corners of the segments to protect the indicating material during installation when the indicating material is placed in the ground by simply positioning the housing which contains the indicating material. Preferably the housing also spans in the direction of proximity indication.

[0023] The housing may also be arranged to be frangible by forming the housing in frangible sections defined by lines of severance and separating at least one frangible section of the housing from a remainder of the housing when the portion of the indicating material is removed from the remainder of the indicating material. Alternatively or in addition to the frangible sections, the housing may be formed of tearable material.

[0024] The indicating material may be anchored in the excavatable material by coupling the indicating material to an anchor and burying the anchor in the excavatable material. The anchor is preferably formed of flexible material which conforms about the target.

[0025] Excavating towards the target using power-assisted excavation equipment is typically discontinued while a portion of the indicating material remains in the excavatable material in proximity to the target.

[0026] In one embodiment which is particularly suited for when the target comprises an elongate pipe, the indicating material is preferably formed into a panel structure and orienting the panel structure substantially parallel to the pipe. Preferably the panel spans in the direction of proximity indication.

[0027] Alternatively, the indicating material may be formed as a column which is elongate in a direction of proximity indication of the proximity indicating means. The embodiment of the device as a column is particularly advantageous when the device is to be approached above ground with excavating equipment from any one of various lateral directions. The column may also be suited for locating narrower or more precise targets.

[0028] The target may be located at the surface of the excavatable material by extending an elongate flexible marker from the indicating material to a location at or above the surface of the excavatable material during installation of the indicating material into the ground.

[0029] The indicating material and surrounding housing are preferably formed of a material which is non-metallic and which will not support an electrical charge or a static charge.

[0030] According to another aspect of the present invention there is provided a method of navigating excavation towards a target, the method comprising:

[0031] burying indicating material in proximity to the target;

[0032] arranging sections of the indicating material to be visually distinguished from one another corresponding to a degree of proximity to the target;

[0033] excavating towards the target to remove a portion of the indicating material leaving a remainder of the indicating material; and

[0034] indicating a degree of proximity of excavation towards the target by visually determining which section of the indicating material said portion of the indicating material corresponds with.

[0035] According to yet another aspect of the present invention there is provided a device for navigating excavation towards a buried object, the indicator device comprising:

[0036] indicating material for being buried in proximity to the object, the indicating material being supported to extend in a longitudinal direction from an outer end to an inner end;

[0037] visually graduated means on the indicating material representative of a distance in the longitudinal direction of the device relative to the inner end of the device; and

[0038] frangible means for permitting at least one portion of the indicating material adjacent the outer end of the device to be readily separable from at least one portion of the indicating material adjacent the inner end of the device.

[0039] According to a further aspect of the present invention there is provided a method of locating an elongate buried object, for example a pipeline, a conduit or a duct, prior to surrounding excavation by excavating equipment, the method comprising:

[0040] providing a vacuum type excavator having an injector which injects liquid into the ground to form a slurry therewith and a vacuum mechanism for withdrawing the slurry;

[0041] forming a hole from a surface of the ground to the object using the vacuum type excavator;

[0042] providing a device comprising indicating material in the shape of a panel having proximity indicating means thereon indicating distance or a degree of proximity to a bottom end of the device and having frangible means permitting portions of the device to be separated from a remainder of the device;

[0043] placing the device in an upright orientation directly above the object;

[0044] and backfilling the hole about the device.

BRIEF DESCRIPTION OF THE DRAWINGS

[0045] In the accompanying drawings, which illustrate exemplary embodiments of the present invention:

[0046] FIG. **1** is a perspective view of the assembled device according to a first embodiment of the present invention.

[0047] FIG. **2** is an exploded perspective view of the device according to FIG. **1**.

[0048] FIG. **3** is a top plan view of the device according to FIG. **1** above a pipeline across which a trench is being dug.

[0049] FIG. **4** is a sectional view along the line **4-4** of FIG. **3**.

[0050] FIG. **5** is a perspective view of a second embodiment of the device.

[0051] FIGS. **6**, **7** and **8** are partly sectional elevational views illustrating the steps of forming an initial hole from the surface to a buried target, placing the device according to FIG. **1** directly above the target and backfilling the hole prior to excavation with power assisted excavating equipment.

[0052] FIG. **9** is a schematic plan view of the location of the indicator device when a pipeline intersects a trench being dug.

DETAILED DESCRIPTION

[0053] Referring to the accompanying figures, there is illustrated an excavation navigating device generally indicated by reference numeral **10**. The device **10** is particularly useful for navigating towards a buried or excavatable material encased target, for example a buried object **12** such as a pipeline, while excavating through the surrounding excavatable material. In certain applications, the target may merely comprise an area within a surrounding excavatable material to which excavation is desired. More particularly, the invention relates to a method of indicating proximity to the target or object **12** when digging or excavating, for example with hydraulically power-assisted excavating equipment **14**. The device **10** is intended to be placed or buried in a surrounding excavatable material in proximity to the object **12** to indicate a degree of proximity to the object once a bucket of the excavating equipment contacts the device and removes a portion of the device along with the surrounding excavatable material being removed.

[0054] Usable excavating equipment may comprise any variety of equipment used for excavating soil or aggregate for example. Examples of excavating equipment include a track hoe excavator, a back hoe or any other type of implement including a bucket like tool for excavating an excavatable material. Excavatable materials which may be used for burying or placing the device underground include various types of soil, for example, topsoil, subsoil, earth or clay; various types of aggregate, for example crushed stone, sand or gravel of various particle sizes; various manmade substances, for example fillcrete or soil cement; or any combination thereof.

[0055] Though various embodiments are shown in the accompanying figures, the features common to all the illustrated embodiments will first be described herein. The device **10** generally comprises indicating material which is suitably arranged for being placed in proximity to a target buried in an excavatable material. The material may be formed of various types of paper, cardboard, plastic, or other material which can be coated with water resistant or water proof coatings as desired in some applications. In a more permanent installation, the indicating material may be arranged to remain functional for a period of several years, in which case the material is typically waterproof and resistant to decomposition such as various types of plastic and the like. Alternatively where the indicating material is not required to remain functional for nearly as long in a semi-permanent installation, a lighter gauge of material including paper and the like is preferred, possibly with only an aqueous resistant coating which is not fully waterproof. The indicating material can also be formed of a biodegradable material to prevent any environmental pollution if left buried in the ground indefinitely.

[0056] The device is elongate in a longitudinal direction between a top or outer end **17**A and a bottom or inner end **17**B. The material is suitably arranged so as to be frangible in nature so that when struck by excavating equipment **14**, one or more portions of the indicating material at the outer end **17**A can be separated from one or more portions of a remainder of the material at the inner end **17**B which remains buried in the surrounding excavatable material in proximity to the object.

[0057] The device is firstly frangible by forming the indicating material in a plurality of primary sections **16** which are separated from one another and vertically stacked one on top of the other in the longitudinal direction of the device. In this manner the sections readily come apart when upper sections are struck by a bucket excavator so that the remaining sections stay intact adjacent the object **12** for continued indication of a degree of proximity to or a distance to the bottom of the device and accordingly distance to the object **12** which is buried.

[0058] Each section **16** is formed of sheeted material which can be in the order of 14 or 15 meters long and has a selected width depending upon the application when laying flat. The sheeted material is folded in alternating directions in rectangular segments **15** which define secondary sections of the indicating material having dimensions defined by the distance between adjacent fold lines and the selected width of the sheet. When folded, the segments lay flat against one another resulting in a zig-zag pattern permitting the sheet to be compacted in an accordion like manner to the desired height of approximately one foot in the folded condition.

[0059] The spacing between the fold lines defining each segment determines the thickness of the assembled indicating material in the folded condition. The selected width of the unfolded sheet remains constant when the sheet is folded into the folded condition and thus determines the overall width of the device. In the folded condition, each segment thus spans a full thickness between opposing flat sides **17**C of the device and a full width of the device between opposed vertical edges while lying perpendicular to the longitudinal direction of the indicating material. The segments have identical dimensions throughout in the illustrated embodiment so that a cross sectional shape and area of the indicating material remains constant at various positions spaced along the longitudinal direction.

[0060] The indicating material is also frangible by forming perforated lines of severance **19** along the fold lines between each adjacent pair of folded segments. Each of the segments **15** thus defines the smaller secondary sections of the indicating material which can also be readily separated from adjacent segments or sections by breaking apart the indicating material at the lines of severance.

[0061] Furthermore, the indicating material is frangible by being formed of a material which is readily tearable when impacted by excavator equipment. The material remains sufficiently durable to permit portions to be pulled free without

falling apart when only partially buried by small amounts of excavatable material, but when shearing forces from excavator equipment are applied, the material easily tears.

[0062] While excavating towards the target, numerous portions of the indicating material are separated from a remainder at various stages of the excavation, either by tearing, separation at the primary sections or breaking apart between segments/secondary sections at lines of severance. As each portion is separated, distance to the inner end of the device, and in turn a degree of proximity to the target, can be gauged by use of various visual proximity indicators. The visual proximity indicators serve to visually distinguish each of the removed or excavated portions of the indicating material from remainder portions in the ground in proximity to the target. By having portions which are visually distinct from one another, an operator can determine which section of the indicating material a portion was excavated from to thereby indicate the degree of proximity to the target by association.

[0063] A first visual proximity indicator is provided by arranging each primary section **16** to be of a different colour which corresponds to a prescribed degree of proximity to or a depth to the inner end of the indicating material and the target. In the illustrated embodiments, three primary sections **16** are provided which are one foot in height each and accordingly three different colours of indicating material result. When more sections are desired, more colours can be provided or more colours can be provided within a given primary section and thereby define further secondary sections of the indicating material which are visually distinct from one another. It is desirable for the colours to be graduated to correspond with varying proximity to the target. Proximity to the inner end of the device adjacent the target can be thus indicated by determining which section an excavated portion of the indicating material is associated with by matching the colour.

[0064] The colours are selected to indicate increasing danger with increasing proximity to the buried target. The colours are selected so as to be identical to the familiar order of traffic stop lights in which the uppermost section is green for indicating that the device has been reached and that a particular condition of a company's digging policy should then be followed. The middle section is yellow to indicate a more immediate proximity to the object as compared to the uppermost green section, with the result that there is increased caution in relation to any additional digging. The lowermost section of the device is red to indicate an immediate proximity to the object. Red is the most desirable colour for the lowermost section when it is intended for the lowermost section to indicate to the operator to stop digging with the power-assisted excavation equipment while a portion of the indicating material remains buried in the excavatable material because the prescribed distance to the target where digging should discontinue has been reached. Further excavation can then proceed with manual digging tools or other similarly less aggressive excavating equipment.

[0065] As an additional visual proximity indicator to the varying colour for identifying proximity, a vertical band is provided along the center of each section with notations thereon or other suitable indicia which indicates various degrees of severity of warning that the underground object is being approached by the excavator bucket. Scaled indicia **21**, for example lettering indicating distance measurements, are also provided at various locations across the indicating material. Each segment **15** or secondary section is preferably marked at several locations with the scaled indicia in addition to being coloured for association with one of the sections **16**.

[0066] In each instance, the visual proximity indicators are arranged for indicating proximity in the longitudinal direction of the indicating material between the inner end and the outer end of the device. Accordingly, in the folded condition each segment lays perpendicular to the direction of proximity indication towards the target.

[0067] A suitable housing **18** surrounds the sections **16** of the indicating material to support the indicating material to be elongate in the longitudinal direction while being arranged to permit the indicating material to be readily separable therefrom. The housing maintains the sections in a longitudinally stacked orientation one adjacent the other in the folded condition of the segments. The housing **18** includes a base portion **20** which is generally U-shaped in cross section for extending along a bottom edge of the lower most section **16** of the indicating material.

[0068] Anchors **22** are bonded to and extend longitudinally along the base **20** to extend outwardly from the opposing sides **17**C of the device. Each anchor **22** comprises a sheet of flexible material which can be folded against the side of the device during shipping or oriented to project laterally outward during installation into the surrounding excavatable material. When extending laterally outward during installation, backfill of excavatable material, which surrounds and buries the device, applies weight onto the anchors **22** to provide some resistance to the device from being pulled out of the excavatable material in a single piece. The anchors **22** instead serve to anchor the inner end of the device in abutment against the target. The flexible nature of the sheets forming the anchors **22** permit the anchors **22** to conform about the target and maintain alignment of the device with the target. Lines of severance can be provided on the anchors **22** so that the anchors **22** are also frangible.

[0069] The housing **18** further includes opposed channels **24** which confront one another for receiving opposing ends of the sections **16** spanning therebetween. The channels **24** receive opposing ends of all of the plurality of sections **16** by spanning the corners of all of the segments and extending longitudinally a full height of the stacked sections in the direction of proximity detection of the proximity indicators to maintain the segments in the folded condition. A suitable cap **26** extends between the opposing channels **24** across the top end of the assembled indicating material of the device to hold the sections **16** vertically aligned within the channels.

[0070] An elongate marker **28**, in the form of a flexible ribbon, is anchored to the cap **26** and has sufficient length to extend from the buried indicating material to which it is coupled to an area above the surface of the ground or surrounding excavatable material for later locating by an operator of a bucket excavator.

[0071] The housing **18** is formed of material similar to the indicating material so as to remain tearable when contacted by the bucket of the excavator so that the housing is similarly frangible. Perforations **30** are formed in the channels **24**, defining lines of severance, in alignment with an intersection between adjacent pairs of the primary sections **16** of the indicating material so that the channels **24** are frangible into sections similarly to the sections **16** of the indicating material.

[0072] When the device is buried and then subsequently contacted by excavating equipment, portions of the indicating material are separated from the remainder by either tearing segments of one of these sections from remaining segments,

removing an entire section possibly by tearing the side channels **24** at the perorations, or any combination noted above. When the excavating equipment contacts one of the sections **16** of the indicating material, the individual segments of that section may remain in proximity to the device but can become unfolded resulting in a clearly visible elongate banner extending from the excavated material once removed.

[0073] Turning now to the first embodiment illustrated in FIGS. **1** through **4** and **6** through **9**, the indicating material is shaped to form a panel member which is particularly suited for navigating towards elongate objects **12** including pipelines and the like. The panel member is elongate and spans in the longitudinal direction and in the direction of proximity indication of the proximity indicators between the inner and outer ends of the device. When in the assembled position illustrated in FIG. **1**, typical dimensions are approximately 3 feet tall in the longitudinal direction, 2 feet wide and 1 inch thick. Many other sizes may still function adequately, for example a height in the range of 1 to 5 feet would remain desirable. The width and thickness can similarly be varied over a broad range without significantly affecting the function of the device.

[0074] The housing in this instance includes two of the channels **24** extending in the longitudinal direction between the base and the cap. The channels are generally U-shaped and receive the narrow dimension of the folded segments therein at opposing edges of the segments.

[0075] Turning now to the installation of the first embodiment as shown in FIGS. **6** through **8**, the device can be installed above a pipeline which has already been buried by exposing the pipeline. Alternatively, the device may be simply placed on the pipeline when the pipeline is initially laid in the ground. In either instance, the indicating material is placed in proximity to the target by simply positioning the housing to extend in the longitudinal direction radially outward from the target from the inner end to the outer end of the device.

[0076] When the pipeline has already been buried or otherwise encased in surrounding excavatable material, the usual practice of visually locating the pipeline with a vacuum type excavator **13** prior to use of a bucket excavator remains in practice as illustrated in FIG. **6**. Once a hole **31** is formed by the vacuum type excavator from the pipeline to the surface, the pipeline is no longer buried and is considered to have been daylighted as it is exposed to daylight. The indicating material of the device **10** is placed directly above the pipeline in an upright orientation and the ribbon **28** is extended to the surface of the ground as shown in FIG. **7** prior to back filling with sand **32** as shown in FIG. **8**. Any other suitable excavatable material may be used to bury the device in the ground in proximity to the target prior to subsequent excavation.

[0077] Excavating equipment can then be safely used to excavate the material surrounding or in proximity to the target without fear of contacting the pipeline until after the device **10** has already been made visible. While digging with the excavator equipment having a bucket, contact of the bucket with the device ensures either that a portion of the indicating material will be torn away, one of the sections **16** will be removed or an upper most remaining section **16** is extended by the lifting motion of the bucket to unfold the segments of the section and produce an elongate visible banner.

[0078] Turning now to FIG. **9**, an alternative installation of the device according to the first embodiment is illustrated for use when the buried object or target comprises a pipeline extending at an inclination relative to the elongate direction of a trench **36** being dug. The device **10** remains perpendicular to the longitudinal direction **34** in which the trench being dug extends, however the device is additionally positioned so that one end contacts the pipeline with the remainder of the panel member spanning across the trench ahead of the pipeline in relation to the direction **34** which the bucket of the excavating equipment moves while digging the trench. This ensures that the panel member is contacted before the pipeline in the direction of bucket passes of the excavator equipment while excavating.

[0079] Turning now to FIG. **5**, a second embodiment of the device is illustrated in which the indicating material is substantially square in cross section to define an elongate column. In this instance the folded segments which define width and thickness of the indicating material are approximately 6 inches by 6 inches square while being similar in length to the previous embodiment in the folded condition. Four of the channels **24** are provided in this instance and the channels are L-shaped in cross section for only spanning a single corner of all of the segments. The four channels **24** together span in the longitudinal direction of proximity detection of the proximity indicators on all four corners of the device. The column shape of the second embodiment is well suited for indicating proximity in a variety of environments as the device can be approached by excavating equipment equally effectively from all directions. The column shape of the second embodiment is also useful with a variety of targets as the narrow cross sectional dimensions can more precisely locate a smaller target when compared to the first embodiment.

[0080] The second embodiment of the device **10** can similarly be inserted into excavatable material surrounding a target either at the time the target is first buried, or subsequently by exposing the target and then placing the inner end of the indicating material in proximity to the target. The anchors **22** conform to the target and are then covered with backfill of excavatable material. The backfill provides weight onto the anchors **22** to anchor the indicating material in relation to the target as the indicating material is buried.

[0081] In each instance of installation, in either embodiment, it is desirable for the indicating material to be oriented so that the longitudinal direction of the device and the direction of proximity indication of the device are both parallel to the direction of excavation **37** towards the target, as shown in FIG. **8**. The direction of excavation **37** is understood to comprise the direction which the excavated area approaches towards the target as excavatable material is removed by the excavating equipment. This direction of excavation **37** is not necessarily the intended direction of movement of the excavating equipment while digging or the longitudinal direction which the excavated area extends.

[0082] In a variation of the second embodiment, each segment **15** may be joined to an adjacent segment **15** by a fold line which is offset in a common direction of rotation by 90 degrees from a fold line immediately thereabove so that the resulting folding pattern is spiral in shape. In this arrangement, the column is multi-directional for responding to passes from excavator equipment equally in all directions.

[0083] While various embodiments of the present invention have been described in the foregoing, it is to be understood that other embodiments are possible within the scope of the invention. The invention is to be considered limited solely by the scope of the appended claims.

1. A method of navigating excavation towards a target buried in excavatable material, the method comprising:

placing indicating material in the excavatable material in proximity to the target;

excavating the excavatable material towards the target to remove a portion of the indicating material leaving a remainder of the indicating material; and

indicating a degree of proximity to the target by arranging the portion of the indicating material to be visually distinct from another portion of the remainder.

2. The method according to claim **1** including removing a plurality of portions from the indicating material while excavating towards the target and indicating a degree of proximity to the target as each portion is removed by visually comparing each portion to the remainder.

3. The method according to claim **1** including indicating a degree of proximity to the target by arranging a plurality of sections of the indicating material to be visually distinct from another in which each section corresponds to a different degree of proximity to the target and determining which section that a portion of the indicating material removed from the remainder corresponds with.

4. The method according to claim **1** including arranging the sections to be visually distinct from one another by providing scaled indicia on the sections respectively.

5. The method according to claim **1** including arranging the sections to be visually distinct from one another by associating a different colour with each section.

6. The method according to claim **5** including providing scaled indicia on the sections.

7. The method according to claim **1** including removing the portion of the indicating material and leaving the remainder of the indicating material by tearing the portion from the remainder.

8. The method according to claim **1** including removing the portion of the indicating material and leaving the remainder of the indicating material by forming lines of severance defining sections of the indicating material and breaking apart at least one section from a remainder of the sections at one of the lines of severance.

9. The method according to claim **8** including arranging the sections to be visually distinct from one another in which each section corresponds to a different degree of proximity to the target.

10. The method according to claim **1** including removing the portion of the indicating material and leaving the remainder of the indicating material by forming the indicating material into a plurality of separated sections and removing at least one section from a remainder of the sections.

11. The method according to claim **10** including arranging the sections to be visually distinct from one another in which each section corresponds to a different degree of proximity to the target.

12. The method according to claim **1** including forming the indicating material to be elongate in a longitudinal direction and orienting the longitudinal direction of the indicating material in a direction of excavation of the excavatable material towards the target.

13. The method according to claim **1** including extending the portion of the indicating material in length as the portion is removed.

14. The method according to claim **13** including forming the indicating material of elongate sheeted material, placing the indicating material in proximity to the target in a folded condition and extending the portion of the indicating material in length as the portion is removed by unfolding the material.

15. The method according to claim **14** including folding the elongate sheeted material into segments laying one against another.

16. The method according to claim **14** including folding the segments in alternating directions in a zig-zag pattern.

17. The method according to claim **14** wherein the segments are rectangular and of similar dimension, the method including folding the segments such that each segment spans a full thickness of the indicating material in a folded condition.

18. The method according to claim **14** including maintaining the sheeted material in a folded condition by surrounding the indicating material with a housing from which the indicating material is readily separable.

19. The method according to claim **18** including forming the housing as channels spanning in a direction of proximity indication of the proximity indicating means and receiving opposing edges of the segments in the channels in the folded condition.

20. The method according to claim **18** wherein the segments are rectangular, the method including arranging the housing to span across the corners of the segments.

21. The method according to claim **14** including orienting the segments in the folded condition to be perpendicular to a direction of proximity indication of the proximity indicating means.

22. The method according to claim **14** including providing a housing which spans in the direction of proximity indication and maintains the segments in the folded condition and arranging the indicating material to be readily separable from the housing.

23. The method according to claim **14** including supporting the indicating material within a housing and placing the indicating material in proximity to the target by placing the housing in the excavatable material.

24. The method according to claim **18** including forming the housing in frangible sections and separating at least one frangible section of the housing from a remainder of the housing when the portion of the indicating material is removed from the remainder of the indicating material.

25. The method according to claim **18** including forming the housing of tearable material and tearing a portion of the housing from a remainder of the housing when the portion of indicating material is removed from the remainder of the indicating material.

26. The method according to claim **1** including anchoring the indicating material in the excavatable material by coupling the indicating material to an anchor and burying the anchor in the excavatable material.

27. The method according to claim **1** including abutting the indicating material against the target.

28. The method according to any claim **1** including discontinuing excavating towards the target using power-assisted excavation equipment while a portion of the indicating material remains in the excavatable material in proximity to the target.

29. The method according to claim **1** for a target comprising an elongate pipe, the method including forming the indicating material into a panel structure and orienting the panel structure substantially parallel to the pipe.

30. The method according to claim **1** including locating the target at the surface of the excavating material by extending a marker from the indicating material to the surface.

31. A device for navigating excavation towards a target buried in excavatable material, the device comprising:

indicating material arranged to be placed in the excavatable material in proximity to the target;

frangible means for permitting a portion of the indicating material to be removed from a remainder of the indicating material to be left in the excavatable material; and

proximity indicating means on the indicating material corresponding to a degree of proximity to the target for permitting a removed portion of the indicating material to be visually distinguished from a remaining portion of the indicating material.

32. The device according to claim **31** wherein the proximity indicating means comprises a plurality of sections formed in the indicating material which are visually distinct from one another in which each section indicates a different degree of proximity to the target.

33. The device according to claim **31** wherein a different colour is associated with each section.

34. The device according to claim **31** wherein there is provided scaled indicia on the sections respectively.

35. The device according to claim **31** wherein a different colour is associated with each section and wherein there is provided scaled indicia on the sections respectively.

36. The device according to claim **31** wherein the frangible means comprises tearable material forming the indicating material.

37. The device according to claim **31** wherein the frangible means comprises lines of severance defining sections of the indicating material which are readily separable from one another at the lines of severance.

38. The device according to claim **37** wherein the proximity indicating means comprises forming the sections to be visually distinct from one another in which each section indicates a different degree of proximity to the target.

39. The device according to claim **31** wherein the frangible means comprises the indicating material being formed in a plurality of separated sections.

40. The device according to claim **39** wherein the proximity indicating means comprises forming the sections to be visually distinct from one another in which each section indicates a different degree of proximity to the target.

41. The device according to claim **31** wherein the indicating material is elongate in a direction of proximity indication of the proximity indicating means.

42. The device according to claim **31** wherein the indicating material is extendable in length in a direction of proximity indication of the proximity indicating means.

43. The device according to claim **31** wherein the indicating material is formed of elongate sheeted material folded into segments against one another so as to be extendable in length by unfolding the segments.

44. The device according to claim **43** wherein the segments are folded in alternating directions in a zig-zag pattern.

45. The device according to claim **43** wherein the segments are rectangular and of similar dimension such that each segment spans a thickness of the device in a folded condition.

46. The device according to claim **43** wherein the sheeted material is maintained in a folded condition by a surrounding housing, the indicating material being readily separable from the housing.

47. The device according to claim **43** wherein the housing comprises channels spanning in the direction of proximity indication of the proximity indicating means, the channels receiving opposing edges of the segments therein in the folded condition.

48. The device according to claim **43** wherein the segments are rectangular and the housing spans across the corners of the segments.

49. The device according to claim **43** wherein the segments in the folded condition are oriented perpendicular to the direction of proximity indication of the proximity indicating means.

50. The device according to claim **43** wherein there is provided a housing spanning in the direction of proximity indication which maintains the segments in the folded condition, the indicating material being readily separable from the housing.

51. The device according to claim **31** wherein there is provided a housing surrounding and supporting the indicating material.

52. The device according to claim **51** wherein the frangible means includes the housing being formed in frangible sections which are readily separable from one another.

53. The device according to claim **51** wherein the frangible means includes the housing being formed of tearable material permitting sections of the housing to be readily separable from one another.

54. The device according to claim **31** wherein there is provided an anchor coupled to the indicating material for spanning outwardly into surrounding excavatable material.

55. The device according to claim **54** wherein the anchor is formed of flexible material for conforming about the target.

56. The device according to claim **31** wherein the indicating material comprises a panel which spans in a direction of proximity indication of the proximity indicating means.

57. The device according to claim **31** wherein the indicating material comprises a column which is elongate in a direction of proximity indication of the proximity indicating means.

58. The device according to claim **31** wherein there is provided an elongate flexible marker coupled to the indicating material for extending to a surface of the excavatable material.

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