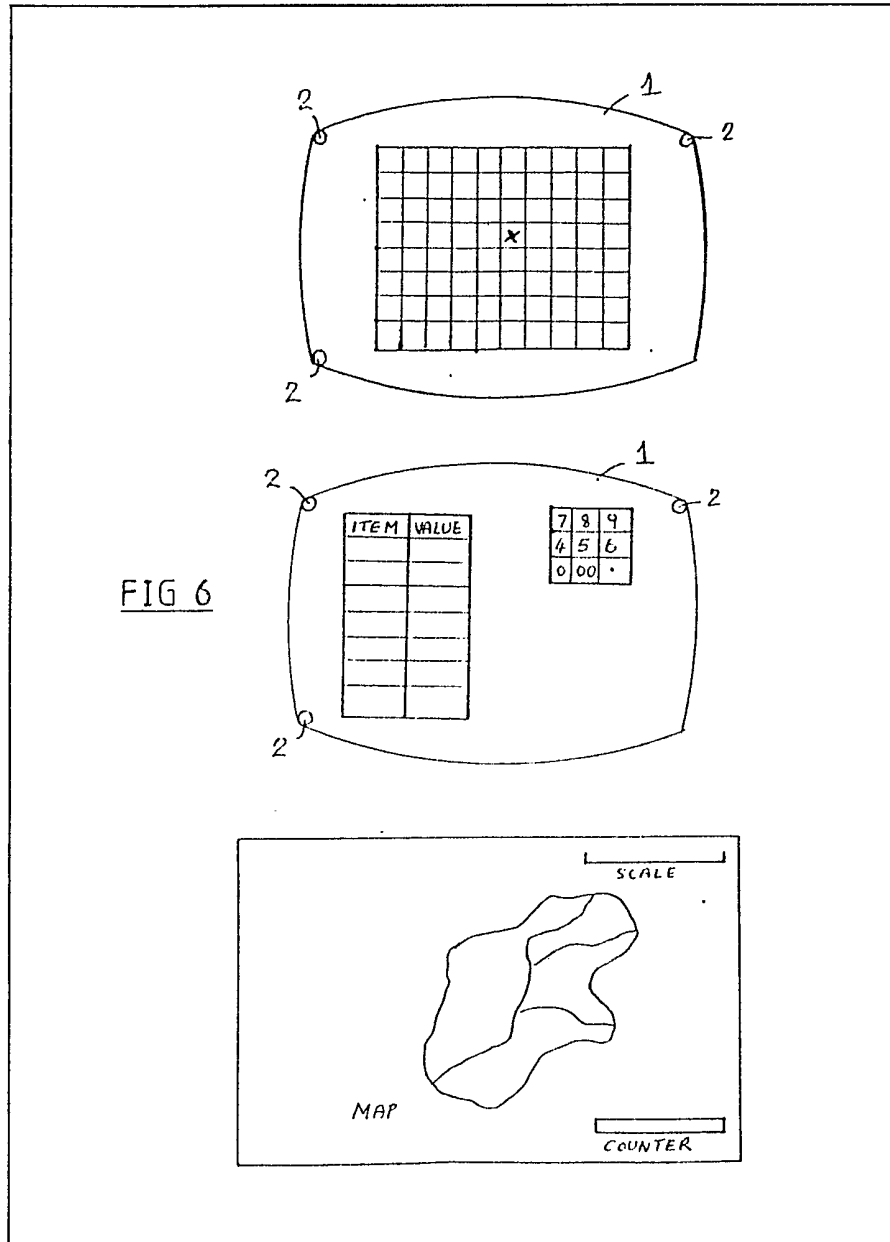


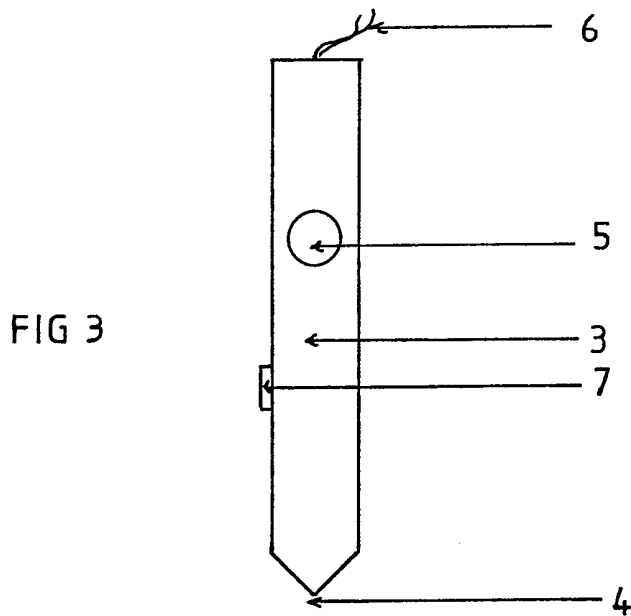
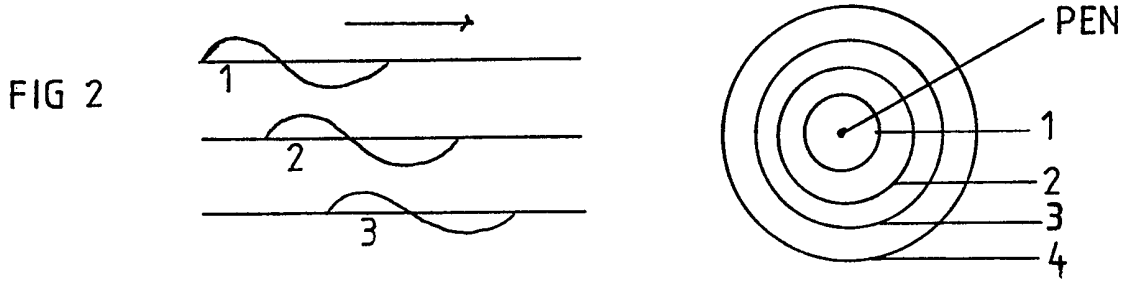
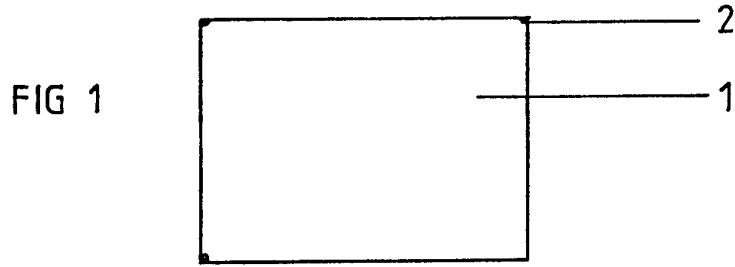
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(54) **Positional determination**

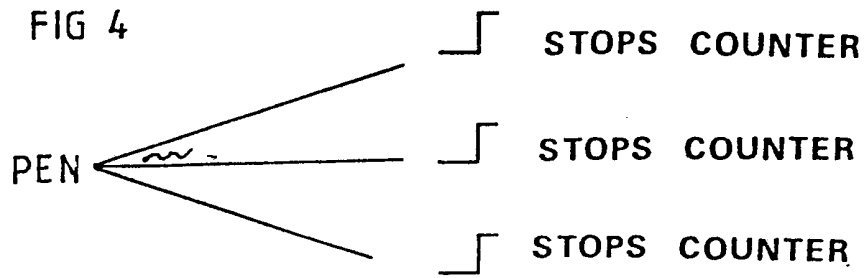
(57) Apparatus suitable for determining the position of index means relative to a stratum (1), comprising:  
generator means for generating mechanical pulses for transmission via said index means to at least one selected point of the stratum;  
at least two transducer means (2) at respective detection points of said

stratum and spaced apart from said point, each transducer means being adapted to convert into a signal a said pulse that arrives at that transducer means;  
means (e.g. counters) for measuring an interval of time for a said pulse to arrive at any transducer means from said generator means. The stratum may overlie a CRT display. The apparatus is useful in interactive computer applications.

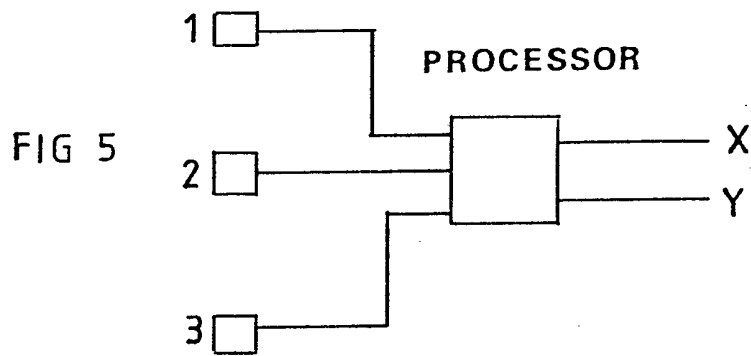




LEVEL\_DETECTOR



COUNTERS



3/3

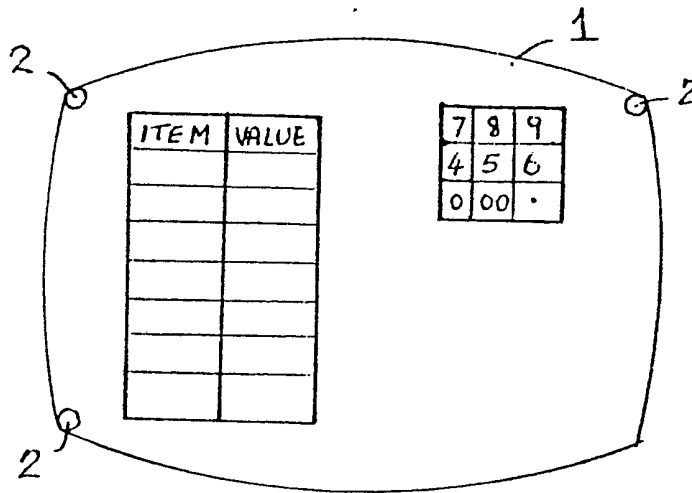
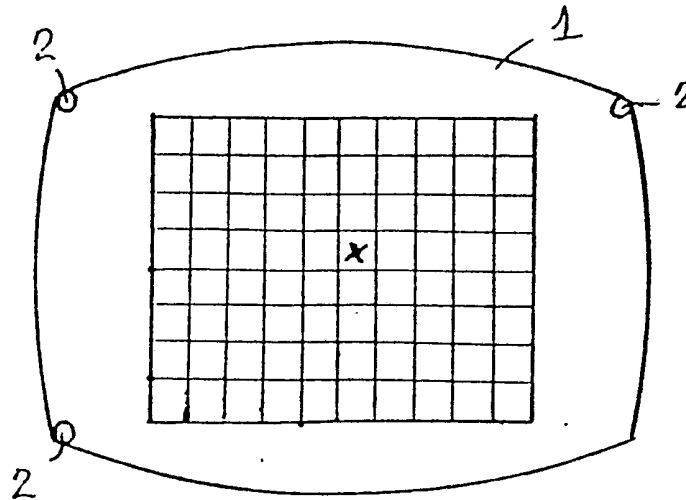
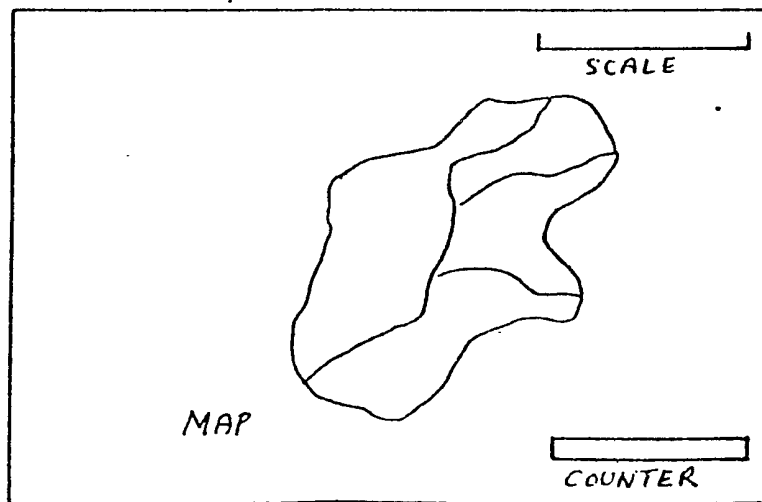


FIG 6



## SPECIFICATION

**Positional determination**

This invention relates to the determination of the position of an index relative to a field of use within which the index is movable.

By way of illustration, and without any restriction to such use, it is useful, for cartographic work, computer-aided design or computer interaction of any sort which involves graphical pictorial or in general non-alpha-numeric information, to be able to identify accurately the position of a "pen" on a "drawing board" in such a way that the positional co-ordinates may be input into a computer in digital form to be processed. In the prior art this has been achieved in various ways, such as a light-emitting pen and a T.V. screen or inductive coupling between a pen and a drawing board. However, the known method and apparatus are restricted by the accuracy and expense of digital electronics to (a) limited resolution and (b) a limited size of drawing board, i.e. "field".

A first object of the invention is to provide a method, for the production of digital information from which the instantaneous position of an index relative to a field of use may be calculated, and apparatus for carrying out that method, with which the resolution obtainable is considerably greater than was hitherto available with economically practicable electronic circuitry, and with which the performance is substantially unaffected, within wide limits, by the size of the field of use.

A second object is to provide a "pen" and "drawing board" structure in which said method and apparatus are embodied.

According to the present invention a method of providing digital information from which to calculate the instantaneous position of an index relative to a field of use comprises steps of:—

- (i) causing transference of a mechanical pulse from the index to a stratum of hard elastic material extending over the field of use, at that point of the field of use where the index is currently situated,
- (ii) detecting the arrival of that pulse, transmitted through the medium of the stratum, at at least two points of the field of use remote from the current situation of the index, and
- (iii) converting into digital information the respective periods taken for that pulse to arrive at the points of detection.

Where the field of use is a simple geometric shape, a minimum of two detection points may suffice, and where the field of use in any convex planar region a minimum of three detection points will suffice. For more complicated fields of use, more detection points may be necessary.

The mechanical pulse may be transferred from the index to the stratum by contacting the stratum with the index, and the pulse may be generated within the index or received by it from a remote generator.

Successive pulses may be generated such that the method may be applied manifold at very short

intervals to give information which will permit substantially continuous tracking of the index as it moves relative to the field of use.

Ascertaining of the respective period for arrival of the pulse at the detection points is preferably carried out by causing the generation of the pulse to trigger a respective time measuring means for each detection point, and the time measuring means may conveniently be an electronic counter, both or all of the counters being preferably clocked by the same clock to ensure synchronisation. The time-measuring means is stopped by arrival of the pulse, through the stratum, at the respective detection point, and preferably the pulse is provided with a relatively steep front, i.e. very fast rise time, so that no spurious data ensues through mishandling of the index and field of use.

When both or all of the detection points have detected the arrival of the pulse through the stratum, it is a simple matter to calculate the position of the index in the field of use because the ratios of the respective periods of arrival time will be proportional to the ratios of the respective distances of each detection point from the current disposition of the index in the field of use.

Apparatus for use in carrying out the method of the invention comprises:—

- (a) a stratum of hard elastic material extending over the field of use,
- (b) an index for positioning in contact at a selected point of the stratum
- (c) means for the generation of a mechanical pulse at the point of contact of the index with the stratum
- (d) at least two transducers situated at detection points of the stratum remote from the selected point and adapted to convert an arriving pulse into a signal
- (e) means for measuring an interval of time, for each detection point, between generation of the pulse and arrival of the pulse at the respective detection point.

The time measuring means may be a respective digital counter for each detection point, both or all of the counters being preferably clocked by the same clock, and the counters being preferably both re-set and started by the pulse generator.

The stratum of the field of use may be, for example, a sheet of glass or "PERSPEX" (Registered Trade Mark) which may then serve as a "drawing board".

The detection transducers may conveniently be piezo-electric transducers situated at the two or more respective detection points of the board, the number used depending upon the shape of the board.

The index may be in the form of a "pen" which incorporates a piezo-electric transducer which is arranged to transmit its mechanical pulse to a tip which is placed in contact with the board. The tip may serve merely for mechanical transference of the pulse to the board, or may have a writing function also, e.g. may be a pencil lead, ball-point, or other item of suitably hard material.

In a convenient arrangement, the pen

incorporates a switch with which to commence the operation which identifies its position relative to the board. In the preferred embodiment, upon closing the switch in the pen, a sharp pulse is sent via the surface of the board to the piezo-electric transducers of the board, and at the same time re-sets and starts the counters for each transducer of the board. The counters are all clocked by the same clock to ensure synchronisation.

For applications such as a screen to put in front of a television tube, as an alternative to the conventional method of use of a light pen, there may equally well be used, for avoidance of the problems of non parallax, a well defined three dimensional surface for which the geodesics may be calculated by interpolation.

In order that the nature of the invention may be readily ascertained, an embodiment of "pen" and "drawing board" combination operable in accordance therewith is hereinafter particularly described with reference to the figures of the accompanying drawings, wherein:

Fig. 1 is a plan view of a "drawing board";

Fig. 2 is a diagram and graph to show

propagation of the mechanical pulse from a point of contact of the "pen" with the "drawing board";

Fig. 3 is a side elevation of a "pen";

Fig. 4 is a schematic representation of the electrical connections and functions of the various items;

Fig. 5 is a block diagram to show provision of signals corresponding to "X" and "Y" co-ordinates;

Fig. 6 is an illustration of some methods of use of the apparatus.

Referring to Fig. 1, the drawing board is a rectangular sheet 1 of glass or "PERSPEX" having a detection transducer 2 mounted at two corners. More than two may be provided, as may be necessary to uniquely identify a location on the surface of the board. Leads from the transducer go to the processor.

Referring to Fig. 2, the circles represent time isopleths on the board surface, for a pulse generated at the centre where the pen (pulse-generator) touches the surface.

Referring to Fig. 3, the pen comprises a body 3 which has a smooth rounded tip (or writing tip) 4 for contacting the board. Within the body, and mechanically connected to the tip, is a piezo-electric generator 5, the input leads 6 of which lead to the signal processor. Also on the pen is a switch 7 for placing the apparatus in operation.

In Fig. 4, the pen 3 generates a pulse signal which travels, through the medium of the board, to each of the detectors which are here three in number and identified as "1", "2" and "3". Arrival of the pulse detector "1" stops a counter No. 1, and arrival of the pulse at detector "2" stops a counter No. 2, and so on.

Fig. 5 shows the respective counters "1", "2", and "3" connected to a processor from which there is derived an output providing "X" and "Y" co-ordinates.

In Fig. 6, the upper illustration is of a

"PERSPEX" board which is fitted closely over a T.V. monitor. The pen locates a unique spot on the display, an allows unique mapping onto other information.

The centre illustration shows a discrete mode of operation, as follows:

1. Poke number display with pen, to encode the respective value;

2. Poke the location with the pen, and

3. The value appears in the location.

The lower illustration shows a continuous mode of operation, and assuming that a map is placed over or under a flat "PERSPEX" board, the operation is:—

1. "Pen" traces outline

2. The information is stored digitally, and

3. The display shows the distance travelled incrementally.

#### CLAIMS

1. Apparatus suitable for determining position of index means relative to a stratum, comprising: a stratum in which mechanical pulses can propagate;

index means for positioning in correspondence with any one of at least one selected point of said stratum;

generator means for generating said mechanical pulses for transmission via said index means to at least one said selected point;

at least two detector transducer means at respective detection points of said stratum and spaced apart from said at least one selected point, each said detector transducer means being adapted to convert into a signal a said pulse that arrives at that transducer means;

measurement means for measuring an interval of time for a said pulse to arrive at any said detector transducer means from said generator means.

2. Apparatus as claimed in claim 1, wherein said stratum will transmit light therethrough.

3. Apparatus as claimed in claim 1 or 2, wherein said stratum comprises a glass sheet.

4. Apparatus as claimed in claim 1 or 2, wherein said stratum comprises an organic polymeric sheet.

5. Apparatus as claimed in any one of claims 1 to 4, wherein said index means comprises tip means for transferring at least one said pulse to any said selected point.

6. Apparatus as claimed in claim 5, wherein said tip means is adapted to write on said stratum.

7. Apparatus as claimed in any one of claims 1 to 6, wherein said generator means is adapted to trigger said measurement means.

8. Apparatus as claimed in any one of claims 1 to 7, wherein said generator means is adapted such that said pulses will have substantially steep fronts.

9. Apparatus as claimed in any one of claims 1 to 8, wherein said generator means comprises piezo-electric means.

10. Apparatus as claimed in any one of claims

1 to 9, comprising switch means for having operational modes that will respectively enable or disable said transmission.

11. Apparatus as claimed in claim 10, wherein said switch means and said generator are portions of an assembly.

12. Apparatus as claimed in any one of claims 1 to 11, wherein said measurement means comprises respective said measurement means for each said detector transducer means.

13. Apparatus as claimed in claim 12, wherein each said respective measurement means is adapted to be started by said generator means and stopped by arrival of a said pulse at the detector transducer means corresponding to said respective measurement means.

14. Apparatus as claimed in claim 12 or 13, wherein each said respective measurement means is adapted to be operated in synchronisation with each other.

15. Apparatus as claimed in claim 14, wherein each said respective measurement means comprises respective digital counter means.

16. Apparatus as claimed in any one of claims 1 to 15, comprising signal processor means for providing signals defining X and Y coordinates of any said selected point, said signal processor means being responsive to said measured interval(s) of time.

17. Apparatus as claimed in claim 1, substantially as hereinbefore described with reference to and as shown in Figs. 1 to 5 of the accompanying drawings.

18. Apparatus as claimed in claim 1, substantially as hereinbefore described with reference to and as shown in any one of the illustrations contained in Fig. 6 of the

accompanying drawings.

19. Apparatus as claimed in claim 18, substantially as hereinbefore described with reference to and as shown in Figs. 1 to 5 of the accompanying drawings.

20. A method of indexing, comprising: in said indexing, using apparatus as claimed in any one of claims 1 to 19.

21. A method as claimed in claim 20, wherein said at least one selected index point corresponds to a display.

22. A method as claimed in claim 21, wherein said display is a cathode ray tube display.

23. A method as claimed in claim 21 or 22, wherein said display comprises non-alpha-numeric information.

24. A method as claimed in claim 20, substantially as hereinbefore described with reference to and as shown in Figs. 1 to 5 of the accompanying drawings.

25. A method as claimed in claim 20, substantially as hereinbefore described with reference to and as shown in any one of the illustrations contained in Fig. 6 of the accompanying drawings.

26. A method as claimed in claim 20, substantially as hereinbefore described with reference to and as shown in Figs. 1 to 5 of the accompanying drawings.

New claims or amendments to claims filed on 1/4/82.

New claim:—

27. A method as claimed in claim 25, substantially as hereinbefore described with reference to and as shown in Figs. 1 to 5 of the accompanying drawings.