(12) UK Patent Application (19) GB (11) 2 168 816 A

(43) Application published **25 Jun 1986**

(21) Application No **8432012**

(22) Date of filing **19 Dec 1984**

(51) INT CL[4]
G01B 7/03

(52) Domestic classification (Edition H):
G1N 1A3A 1A3B 1D5 3S10 3S1A 4A 4C 7N ACN
G4H KS
U1S 2283 G1N G4H

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(56) Documents cited
GB 1555249
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(58) Field of search
G1N
G4H

(54) Touch-sensitive position sensor apparatus

(57) A touch-sensitive position sensor apparatus has a transparent touch-sensitive screen adapted to overlie the display screen of a CRT. This screen comprises first and second over-lying layers each composed of a multiplicity of spaced parallel electrically conductive strips 6,8 transverse to each other. A layer of electrically insulating dots is interposed between the first and second layers, with the dots lying at the intersections formed by the two layers of strips to provide a capacitive coupling at each intersection. When the screen is touched, there is a change in the capacitive coupling at the nearest intersection which is detected by electronic means. This comprises a generator applying a pulse to each of the strips in turn in a recurrent cycle, and means for detecting a resultant pulse above a threshold on any strip 8, and output means for providing signals representing the intersection from which the resultant pulse is obtained.

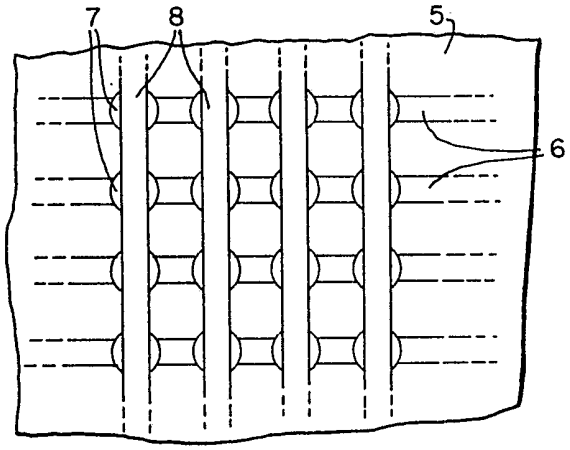

Fig.2.

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The drawing(s) originally filed was (were) informal and the print here reproduced is taken from a later filed formal copy.

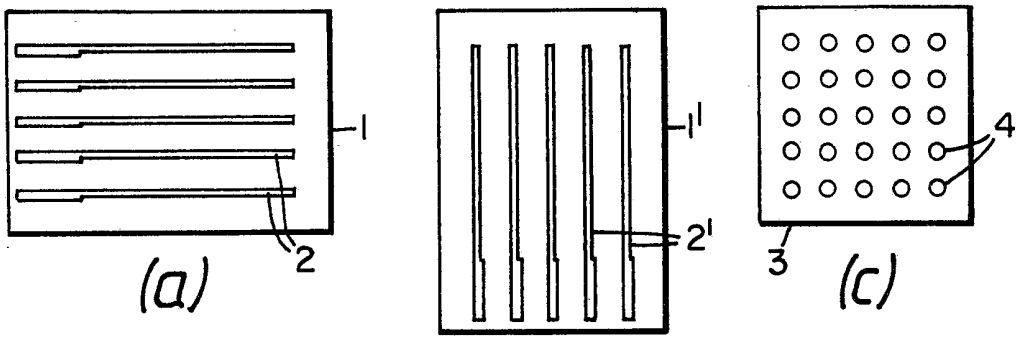

Fig. 1.

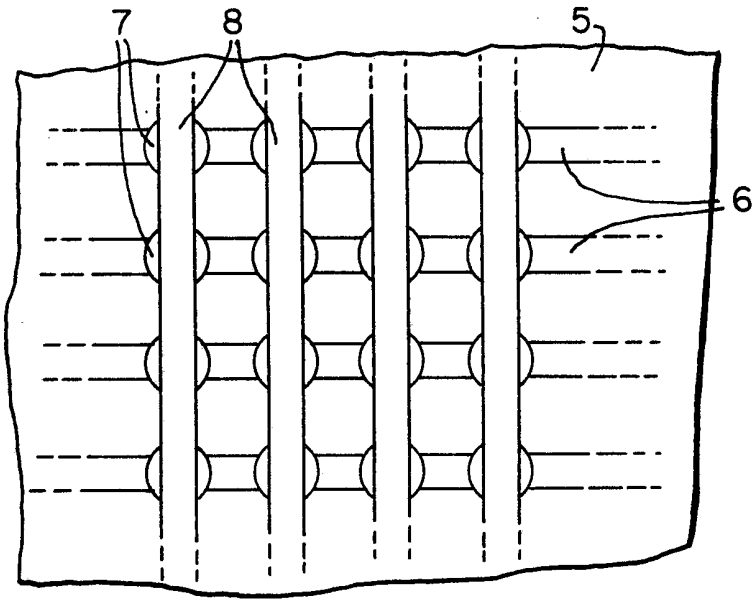

Fig. 2.

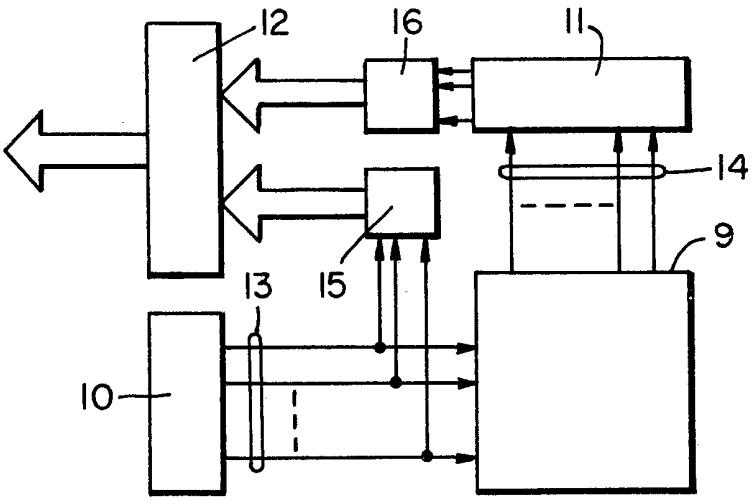

Fig. 3.

SPECIFICATION

Touch-sensitive position sensor apparatus

The invention relates to touch-sensitive position sensor apparatus for deriving signals which represent any position selected by touch in a two-dimensional area. The invention relates more particularly to such apparatus of a type having a transparent touch-sensitive screen adapted to overlie the display screen of a CRT (cathode ray tube) or other display device to enable touch selection of any portion of a display produced on the display screen.

One known form of apparatus of the above type has a touch-sensitive screen comprised by a rigid transparent plate which fits over a CRT display screen, together with an electrically conductive transparent flexible plastic film which is stretched over the plate and is held out of contact with the plate except for, and by, electrically insulating indentations formed in the plastic film. The surface of the plate facing the plastic film has a resistive film on it, and means are provided for producing a voltage gradient across this resistive film. When the plastic film is pushed into contact with the plate at any point, for instance by finger pressure, signals which represent the co-ordinates of the position of the point are determined from the voltage measured at the point.

It has been found that this known form of apparatus is fragile, in that the flexible plastic film can be damaged easily. Also, the flexible plastic film does not transmit all of the light from the CRT display screen, so that a slightly fuzzy picture results.

Another known form of apparatus of the above type is disclosed in prior UK patent specification 1 528 581. In this apparatus, the transparent touch-sensitive screen is a transparent rigid sheet which is supported over a CRT display screen by four load cells located respectively at the corners of the sheet. When the sheet is touched at any point, the resulting forces at the corners of the sheet are measured by the load cells and signals which represent the co-ordinates of the position of the touched point are determined from these measurements.

A drawback with this latter form of apparatus of the above type is its complexity, and thus cost.

It is an object of the present invention to provide a touch-sensitive position sensor apparatus of the above type, which is both more robust and less expensive than the known apparatuses outlined above.

According to the present invention a touch-sensitive position sensor apparatus of the above type is characterised in that its touch-sensitive screen comprises first and second over-lying layers each composed of a multiplicity of spaced parallel electrically conductive strips, the strips of one layer lying transverse to those of the other layer, together with a third layer interposed between said first and second layers and composed of electrically insulating dots which are located respectively at the intersections formed by the two layers of strips whereby a capacitive coupling is formed between the strips at each intersection, the apparatus being further characterised by having electronic means for detecting a change in the capacitive coupling at any intersection and thereby identify the intersection as a touched-selected position.

Said electronic means may comprise pulse generator means for applying a pulse to each of the strips of the first layer in turn, in a recurrent cycle, pulse detector means for detecting a resultant pulse, which exceeds a threshold amplitude, on any one of the strips of the second layer, and output means for providing signals which represent the intersection formed by the two strips, one in each of said first and second layers, to which a generated pulse is applied and from which a resultant pulse is obtained.

The apparatus then operates to produce a resultant pulse which exceeds the threshold amplitude only when touch-selection (by a finger) of a position on the display screen causes an increase in the capacitive coupling of the particular intersection at or adjacent that position. The capacitive coupling at each of the other intersections is insufficient for a resultant pulse which exceeds the threshold amplitude being produced on any other strip of the second layer. Thus, the intersection concerned is identified uniquely by the presence, respectively, of a generated pulse and a resultant pulse of sufficient amplitude on the two strips which form the intersection.

In carrying out the invention, the first and second layers of strips are preferably disposed normal to each other. These two layers of strips and also the layer of dots would, of course, be formed of optically transparent material.

Preferably, the two layers of strips and the layer of dots are formed by respective deposition stages onto a rigid transparent substrate, which is suitably a glass plate. This construction has the advantage of being robust, and no part of it is required to flex in operation. A first mask (e.g. of aluminium) having parallel slits formed therein may be used for the deposition of the two layers of strips, the mask being orientated through 90° for one layer of strips relative to the other, whilst a second mask (e.g. also of aluminium) having a matrix of small holes formed therein may be used for the deposition of the layer of dots between the two layers of strips. The use of a common mask for the two layers of strips reduces cost.

Known thick or thin film deposition techniques can be used for the deposition of the layers. Optically transparent electrically conductive strips can be formed by these techniques, using indium-tin compounds which have a light transmission factor greater than 85%. The layer of electrically insulating dots can be formed using quartz which has a light transmission factor greater than 85%. The use of well-established deposition techniques further contributes to reducing the cost of manufacture.

The pulse generator means can include decimal-to-binary conversion means for providing binary coded signals which identify, respectively, the strips of the first layer when generated pulses are

being applied to them and, similarly, the pulse detector means include decimal-to-binary conversion means for providing binary coded signals which identify, respectively, the strips of the second layer when resultant pulses exceeding said threshold amplitude are being detected on them. These two binary coded signals can then be latched into the output means which combines them to form a composite signal which identifies a touch-selected position.

The production of the composite signal in binary form has the advantage that it facilitates interfacing the apparatus with a digital processor or computer by which the display on the display device is controlled.

In order that the invention may more fully be understood, reference will now be made by way of example to the accompanying drawing, of which:-

Figure 1 shows diagrammatically masks which are used in a construction touch-sensitive screen of apparatus according to the invention;

Figure 2 shows diagrammatically a fragmentary portion of a touch-sensitive screen of a position sensor apparatus according to the invention; and

Figure 3 shows a block schematic diagram of a touch-sensitive position sensor apparatus according to the invention.

Referring to the drawings, diagram *a* in Figure 1 shows a mask which is made from an aluminium sheet 1 and has a multiplicity of parallel slits 2 formed therein. Diagram *b* in Figure 1 shows the same (or a similar) mask which is made from an aluminium sheet 1' and has that same number of parallel slits 2' formed therein. The slits of the mask in diagram *b* are orientated 90° relative to the slits of the mask in diagram *a*. Diagram *c* in Figure 1 shows a mask which is made from an aluminium sheet 3 and has a matrix of small holes 4 formed therein.

As will be described, the masks shown in Figure 1 are used to form a touch-sensitive screen using deposition techniques. For such a screen which is dimensioned to over-lie the display screen of a 9" CRT display device, the masks in diagram *a* and *b* in Figure 1 each have 32 slits which are each 2 mm wide and there is a 5 mm gap between adjacent slits. The slits are 160 mm long. The mask in diagram *c* in Figure 1 has a matrix of 32 × 32 holes each of which is 3 mm diameter and there is a 5 mm spacing between the centres of adjacent holes. The aluminium sheets from which the masks are made from are 1 mm thick.

The construction of a touch-sensitive screen of a position sensor apparatus according to the invention is illustrated by the fragmentary portion thereof shown in Figure 2. The screen comprises a glass plate 5 which is to over-lie the display screen of the CRT display device. The mask of diagram *a*-Figure 1 is first used to deposit onto the surface of the glass plate 5 a layer of strips 6 of electrically conducting material. The mask of diagram *c*-Figure 1 is next used to deposit on the layer of strips 6 a matrix of dots 7 of electrically insulating material. Finally, the mask 1' of diagram *b*-Figure 1 is used to deposit onto the surface of the glass plate 5 and over the dots 7 a layer of strips 8 of electrically conductive material.

The deposition of the two layers of strips and the layer of dots is effected using known thin or thick film deposition techiques. All the materials used for these deposition stages are optically transparent. For instance, indium-tin compounds can be used for the layers of strips. These compounds have a light transmission factor greater than 85%5. Quartz having a light transmission factor greater than 85% can be used for the layer of dots.

With the above construction of a touch-sensitive screen, there exists a capacitive coupling at each intersection formed by the cross-over of two strips, one from each layer, and the insulating dot which is disposed between the two strips at the intersection. Depending on the thickness of the insulating dot this capacitive coupling will have a certain value. This capacitive coupling will, however, be increased at any intersection which is at or adjacent to a position on the screen which is touched by a finger. It is this change in capacitive coupling which is used to provide selection of the touched position as will now be described with reference to Figure 3.

The touch-sensitive position sensor apparatus shown in Figure 3 has a touch-sensitive screen 9 which is constructed in the manner described above. The apparatus also comprises a pulse generator 10, a pulse detector 11 and an output circuit 12.

The pulse generator 10 applies a pulse to each of the conducting strips 7 of one layer in turn, in a recurrent cycle over a set of leads 13. When a generated pulse is applied to one of the strips 7, each of the strips 8 will have a resultant pulse produced thereon due to the capacitive couplings at the relevant intersections between the strip 7 and the strips 8. These resultant pulses are applied to the pulse detector 11 over a set of leads 14. The pulse detector 11 operates as a threshold detector to detect resultant pulses which exceed and threshold amplitude. In the quiescent condition of the screen, (i.e. when it is not being touched), the capacitive couplings at the intersections are insufficient for the amplitude of any of the resultant pulses to exceed the threshold amplitude. However, when the screen is touched, the capacitive coupling of the intersection at (or nearest to) the touched position will increase sufficiently for the amplitude of the resultant pulse on the relevant strip 8 to exceed the threshold amplitude, which resultant pulse is then detected by the pulse detector 11.

The pulse generator 10 has associated with it a decimal-to-binary converter 15 which provides binary coded signals that identify each of the strips 7 in turn during the application of generated pulses to these strips 7. Similarly, the pulse detector 11 has associated with it a decimal-to-binary converter 16 which provides binary coded signals that identify any one of the strips 8 when a resultant pulse that exceeds the threshold amplitude is detected on it.

The output circuit 12 is connected to receive the binary coded signals from the pulse generator 10

and the pulse detector 11. The former signals are applied to the output circuit 12 continually as the strips 7 are pulsed, but the latter signals are applied only in respect of a strip on which a resultant pulse of sufficient amplitude had been detected. The output circuit 12 can be arranged so as on receipt of the latter signals to latch them together with the subsisting signals from the pulse generator 10 and to produce a composite signal which identifies the particular strip 7 and the particular strip 8 that form the intersection concerned, thereby identifying the touched selected position.

Given that the touch-sensitive screen 9 has a 32 × 32 matrix of intersections, then a 5-bit binary coded signal provides the identification of the strips 7 and a 5-bit binary coded signal provides the identification of the strips 8. The composite signal is then a 10-bit binary coded signal. The provision of a binary coded output signal facilitates direct interfacing of the apparatus with a digital processor or computer by which a display device for which the apparatus is provided is controlled.

CLAIMS

1. A touch-sensitive position sensor apparatus for deriving signals which represent any position selected by touch in a two-dimensional area, which apparatus comprises a transparent touch-sensitive screen adapted to over-lie the display screen of a display device to enable touch selection of any portion of a display produced on the display screen, and which apparatus is characterised in that its touch-sensitive screen comprises first and second over-lying layers each composed of a multiplicity of spaced parallel electrically conductive strips, the strips of one layer lying transverse to those of the other layer, together with a third layer interposed between said first and second layers and composed of electrically insulating dots which are located respectively at the intersections formed by the two layers of strips whereby a capacitive coupling is formed between the strips at each intersection, the apparatus being further characterised by having electronic means for detecting a change in the capacitive coupling at any intersection and thereby identify the intersection as a touch-selected position.

2. An apparatus as claimed in Claim 1, characterised in that said electronic means comprises pulse generator means for applying a pulse to each of the strips of the first layer in turn, in a recurrent cycle, pulse detector means for detecting a resultant pulse, which exceeds a threshold amplitude, on any one of the strips of the second layer, and output means for providing signals which represent the intersection formed by the two strips, one in each of said first and second layers, to which a generated pulse is applied and from which a resultant pulse is obtained.

3. An apparatus as claimed in Claim 1 or Claim 2, characterised in that the two layers of strips and the layer of dots are formed by respective deposition stages onto a rigid transparent substrate.

4. An apparatus as claimed in Claim 3, characterised in that said substrate is a glass plate.

5. An apparatus as claimed in Claim 3 or Claim 4, characterised in that the two layers of strips are formed using a first mask having parallel slits formed therein for the deposition of the two layers of strips, the mask being orientated through 90° for one layer of strips relative to the other, and in that the layer of dots is formed using a second mask having a matrix of holes formed therein for the deposition of the layer of dots between the two layers of strips.

6. An apparatus as claimed in Claim 3, Claim 4 or Claim 5, characterised in that known thick of thin film deposition techniques are used for the deposition of the layers.

7. An apparatus as claimed in any one of Claims 3 to 6, characterised in that optically transparent electrically conductive strips are formed using indium-tin compounds for their deposition.

8. An apparatus as claimed in any one of Claims 3 to 7, characterised in that optically transparent electrically insulating dots are formed using quartz for their deposition.

9. An apparatus as claimed in Claim 2, or in any other Claim as appended directly or indirectly thereto, characterised in that the pulse generator means include decimal-to-binary coversion means for providing binary coded signals which identify, respectively, the strips of the first layer when generated pulses are being applied to them and, similarly, the pulse detector means include decimal-to-binary conversion means for providing binary coded signals which identify respectively, the strips of the second layer when resultant pulses exceeding said threshold amplitude are being detected on them, the two binary coded signals from the pulse generator means and the pulse detector means, respectively, being latched into the output means which combines them to form a composite signal which identifies a touched position.

10. A touch-sensitive position sensor apparatus for deriving signals which represent any position selected by touch in a two-dimensioned area, substantially as hereinbefore described with reference to the accompanying drawing.

Printed in the UK for HMSO, D8818935, 5/86, 7102.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.