

SPECIFICATION

Touch panel and operating system

Background of the Invention

Touch-controlled panel or display devices and systems are known in the art, and U.S. Patents 3,757,322; 3,482,241; and 3,696,409 are examples of such devices and systems. However, the touch panel described herein is different in construction than those in the prior art, and a novel drive system is provided for use therewith.

Description of the Drawings

Fig. 1 is a sectional view of a cathode ray tube face plate and electrode assembly or touch embodying the invention;

Fig. 2 is a plan view of the electrodes of the touch panel of Fig. 1;

Fig. 3 is a schematic representation, in block form, of the system of the invention; and

Figs. 4A and 4B are a more detailed schematic representation of the system of the invention.

Description of the Preferred Embodiments

Apparatus 10 embodying the invention comprises a display device, for example, a cathode ray tube 20 having a phosphor-coated face plate 30, with an electronic assembly or touch panel 40 embodying the invention secured to, or removably coupled to, the face plate but shaped to match the curvature of the face plate. The touch panel 40 includes a sheet of glass 32 having, on its inner surface, a transparent conductive layer 36 of tin oxide or the like which acts as a Radio Frequency Interference (RFI) shield. The assembly or touch panel 40 also includes a sheet 50 of insulating material, for example, glass, which carries on its inner surface 52 an array of transparent conductive film areas or electrodes 60 disposed in rows and columns. Each row of electrodes 60 is electrically connected by a conductor 70 (Fig. 2) to a contact pad 80 at an edge of the glass plate. The outer surface 54 of the glass plate is similarly provided with an array of rows and columns of transparent conductive film areas or electrodes 90, each area of key 90 overlying and aligned with one of the areas 60 on the inner surface. A column conductor 100, or strobe line, is provided for each column of conductive film areas and is capacitively coupled by means of conductive fingers 102 which are closely interleaved with, but are spaced from, conductive fingers 104 which extend from each of the outer areas as illustrated in Fig. 2. Each column conductor 100 extends to a conductive contact pad 110 at the lower edge of the glass plate.

The interleaving of the conductive fingers 102 and 104 provides efficient coupling between the column conductors 100 and the electrodes 90. A layer 42 of a clear dielectric is provided over the outer surface of plate 50 for insulating purposes.

The touch panel assembly 40 is prepared by coating both surfaces of a flat glass plate with a layer of indium-tin-oxide, screening photo-resist patterns on the inner and outer surfaces, exposing

said patterns and then etching to provide the electrodes 60 and 90 described above. The layer 42 is provided, and the flat plate thus treated is placed in a suitably shaped mold, and it is heated sufficiently to cause it to sag to conform to the shape of the cathode ray tube face plate 30. In the past, such curved assemblies had to be formed by first curving the glass plate and then forming electrodes thereon; the art did not permit forming the electrodes on a flat plate and then curving the plate.

If desired, an anti-reflection coating 44 may be provided on the outer surface of the assembly 40.

The optimum relationship of the electrodes according to the invention, as illustrated in Fig. 2, shows the vertical or column conductors 100 and their horizontally projecting fingers 102, and the adjacent relatively large-area electrodes or keys 90 and their horizontally projecting fingers 104 which lie between the fingers 102. Also seen is a horizontal sense line 70 which lies beneath the area 90. In operation of the invention and with this arrangement of the electrode areas and conductors, maximum coupling of signal from the vertical conductor 100 to area 90, and minimum coupling from conductor 100 to the underlying sense conductors 70 are achieved. This permits an optimum amount of signal to be removed by the operator's finger and prevented from being coupled through to the sense line when a key 90 is touched.

The system 120 of the invention is shown in block diagram in Fig. 3 and includes a microprocessor 130 having output leads 140 which are coupled to a driver 150 having an output lead 152 coupled to each vertical conductor 100. The driver 150 is adapted to apply a strobe signal to each of the columns 100 in turn. As each column receives an energizing pulse, the previous column is driven in the opposite direction. In the system, each sense line or row conductor 70 is also coupled by leads 154 to a sense line multiplexer 160 which is adapted to select the line associated with the conductive area or key 90 which has been selected by an operator. The output of the multiplexer 160 is coupled to the microprocessor 130 which is adapted to couple the line and column information to an output latch 170 and thence to the CRT display system 172 which stores the information selected for display on the cathode ray tube 173.

The system of the invention, shown in greater detail in Figs. 4A and 4B, includes touch panel 40 and its row sense lines 154 connected to sense line multiplexer 160. The multiplexer 160 comprises two F4512 chips. The system also includes microprocessor unit 130 which has leads 182 to the driver 150 and leads 184 to the output of the multiplexer 160. The microprocessor 130 has connections 188 to an 8708 memory 190 and to latch 170. The memory 190 also has connections 192 through a latch 186 to the leads 188 to latch 170. The output latch 170 has 8-line data bus 174 which is coupled to the display system 172 shown in Fig. 3.

Under the control of the microprocessor 130, generally positive pulses of about 40 volts are applied sequentially and continuously to the leads 182 and the column conductors 100 in the touch panel 40. If none of the keys or conductive areas 90 is touched by an operator, no output is seen on any of the row conductors. However, if a key is touched, it unbalances the panel so that, by way of capacitive coupling, a pulse appears on the selected row conductor 70. This produces an analog signal on the selected lead 154, and this, when applied to the digital multiplexers 160, produces a digital output at terminal 194. This output signal is passed through a noise rejection circuit 196 and is coupled by lead 198 to the input of the microprocessor 130. When the microprocessor receives such a signal, it interrupts the routine of scanning the column conductors and changes this routine of scanning the conductors surrounding the selected key 90 to verify that the key has been touched. Once this has been verified, the microprocessor 130 puts out two bytes of information, one for the X or row position and one for the Y or column position of the selected key, and this information is applied to the latch 170. The latch then provides an output signal on leads 174 to the display system 172 which couples the requested information from its memory and displays it on the display screen of the cathode ray tube 173.

CLAIMS

1. A touch panel assembly comprising an insulating plate having an outer surface and an inner surface,

a plurality of narrow column conductors on said outer surface and a column of first relatively large-area transparent conductors disposed adjacent to each of said column conductors, said first conductors also being aligned to rows,

interleaved means intimately coupling each column conductor to the column of first conductors adjacent to it,

a plurality of rows of second large-area transparent conductors on the inner surface of said plate, each second conductor lying beneath a first conductor on the outer surface and capacitively coupled thereto, and

a narrow row conductor extending along and coupling together the second conductors in each row on said inner surface.

2. A touch panel assembly comprising an insulating plate having an outer surface and an inner surface,

a plurality of narrow column conductors on said outer surface and a column of first relatively large-area transparent conductors disposed adjacent to each of said column conductors, said first conductors also being aligned in rows,

a plurality of first conductive fingers extending from each column conductor to a first conductor adjacent to it, and a plurality of second conductive fingers extending from each first conductor toward the column conductor adjacent to it, said first and second fingers being interleaved with each other

and disposed in good capacitive coupling relationship while spaced apart a small distance,

a plurality of rows of second large-area transparent conductors on the inner surface of said plate, each second conductor lying beneath a first conductor on the outer surface and capacitively coupled thereto, and

a narrow row conductor extending along and coupling together the second conductors in each row on said inner surface.

3. A touch panel display system comprising a display device for displaying information, a touch panel assembly as claimed in Claim 1 or Claim 2, in operative relation with said display device, electronic circuit means coupled to said touch panel assembly including first means coupled to said column conductors for applying a strobe signal to each in turn and continuously, second means coupled to each row conductor for receiving an output signal when one of said second conductive areas is touched by an operator, third means for generating coordinate information from said output signal, and fourth means for coupling said coordinate information to a display system wherein information is stored for display on said display device.

4. A touch panel display system comprising a touch panel assembly as claimed in Claim 1 or Claim 2, a microprocessor, first means in said microprocessor coupled to said column conductors for applying a signal to each in turn and continuously for strobing said columns of first conductors sequentially, second means in said microprocessor for receiving an output signal when one of said first conductors is touched by an operator, a multiplexer coupled between all of said row conductors and second means in said microprocessor for providing said output signal for said second means, third means in said microprocessor for generating coordinate information from said output signal and identifying said one touched first conductor, and fourth means for coupling said coordinate information to a display system wherein information is stored for display on the viewing screen of a display device and the selected stored information is coupled to and displayed on said display device.

5. A system as claimed in Claim 4 and including a latch circuit between said microprocessor and said display system.

6. A touch panel assembly as claimed in Claim 1 or Claim 2, manufactured by a process including the following steps:

forming electrodes of indium-tin-oxide on one of said surfaces, molding said plate to a desired curvature, and coupling the curved plate to a support member.

7. A touch panel assembly as claimed in Claim 1 or Claim 2 manufactured by a process including the following steps:

forming electrodes of indium-tin-oxide on one of said surfaces, heating said plate on a mold to form said plate to a desired curvature, and coupling the curved plate to a support member.

8. A touch panel assembly as claimed in Claim



Under the control of the microprocessor 130, generally positive pulses of about 40 volts are applied sequentially and continuously to the leads 182 and the column conductors 100 in the touch panel 40. If none of the keys or conductive areas 90 is touched by an operator, no output is seen on any of the row conductors. However, if a key is touched, it unbalances the panel so that, by way of capacitive coupling, a pulse appears on the selected row conductor 70. This produces an analog signal on the selected lead 154, and this, when applied to the digital multiplexers 160, produces a digital output at terminal 194. This output signal is passed through a noise rejection circuit 196 and is coupled by lead 198 to the input of the microprocessor 130. When the microprocessor receives such a signal, it interrupts the routine of scanning the column conductors and changes this routine of scanning the conductors surrounding the selected key 90 to verify that the key has been touched. Once this has been verified, the microprocessor 130 puts out two bytes of information, one for the X or row position and one for the Y or column position of the selected key, and this information is applied to the latch 170. The latch then provides an output signal on leads 174 to the display system 172 which couples the requested information from its memory and displays it on the display screen of the cathode ray tube 173.

CLAIMS

1. A touch panel assembly comprising an insulating plate having an outer surface and an inner surface,

a plurality of narrow column conductors on said outer surface and a column of first relatively large-area transparent conductors disposed adjacent to each of said column conductors, said first conductors also being aligned to rows,

interleaved means intimately coupling each column conductor to the column of first conductors adjacent to it,

a plurality of rows of second large-area transparent conductors on the inner surface of said plate, each second conductor lying beneath a first conductor on the outer surface and capacitively coupled thereto, and

a narrow row conductor extending along and coupling together the second conductors in each row on said inner surface.

2. A touch panel assembly comprising an insulating plate having an outer surface and an inner surface,

a plurality of narrow column conductors on said outer surface and a column of first relatively large-area transparent conductors disposed adjacent to each of said column conductors, said first conductors also being aligned in rows,

a plurality of first conductive fingers extending from each column conductor to a first conductor adjacent to it, and a plurality of second conductive fingers extending from each first conductor toward the column conductor adjacent to it, said first and second fingers being interleaved with each other

and disposed in good capacitive coupling relationship while spaced apart a small distance,

a plurality of rows of second large-area transparent conductors on the inner surface of said plate, each second conductor lying beneath a first conductor on the outer surface and capacitively coupled thereto, and

a narrow row conductor extending along and coupling together the second conductors in each row on said inner surface.

3. A touch panel display system comprising a display device for displaying information, a touch panel assembly as claimed in Claim 1 or Claim 2, in operative relation with said display device, electronic circuit means coupled to said touch panel assembly including first means coupled to said column conductors for applying a strobe signal to each in turn and continuously, second means coupled to each row conductor for receiving an output signal when one of said second conductive areas is touched by an operator, third means for generating coordinate information from said output signal, and fourth means for coupling said coordinate information to a display system wherein information is stored for display on said display device.

4. A touch panel display system comprising a touch panel assembly as claimed in Claim 1 or Claim 2, a microprocessor, first means in said microprocessor coupled to said column conductors for applying a signal to each in turn and continuously for strobing said columns of first conductors sequentially, second means in said microprocessor for receiving an output signal when one of said first conductors is touched by an operator, a multiplexer coupled between all of said row conductors and second means in said microprocessor for providing said output signal for said second means, third means in said microprocessor for generating coordinate information from said output signal and identifying said one touched first conductor, and fourth means for coupling said coordinate information to a display system wherein information is stored for display on the viewing screen of a display device and the selected stored information is coupled to and displayed on said display device.

5. A system as claimed in Claim 4 and including a latch circuit between said microprocessor and said display system.

6. A touch panel assembly as claimed in Claim 1 or Claim 2, manufactured by a process including the following steps:

forming electrodes of indium-tin-oxide on one of said surfaces, molding said plate to a desired curvature, and coupling the curved plate to a support member.

7. A touch panel assembly as claimed in Claim 1 or Claim 2 manufactured by a process including the following steps:

forming electrodes of indium-tin-oxide on one of said surfaces, heating said plate on a mold to form said plate to a desired curvature, and coupling the curved plate to a support member.

8. A touch panel assembly as claimed in Claim



(18)

1 or Claim 2, manufactured by a process including the following steps:

- 5 providing a layer of indium-tin-oxide on each of said surfaces, screening a layer of photo-resist material on said layers of indium-tin-oxide, exposing and removing portions of said layers to leave patterns of indium-tin-oxide electrodes on said surfaces, molding said plate to a desired curvature, and coupling the curved plate to a

10 support member.

9. A touch panel display system substantially as hereinbefore described with reference to, and as illustrated in, the accompanying drawings.

- 15 10. A touch panel assembly substantially as hereinbefore described with reference to, and as illustrated in, the accompanying diagrammatic drawings.

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THE PATENT OFFICE
12th July, 1982