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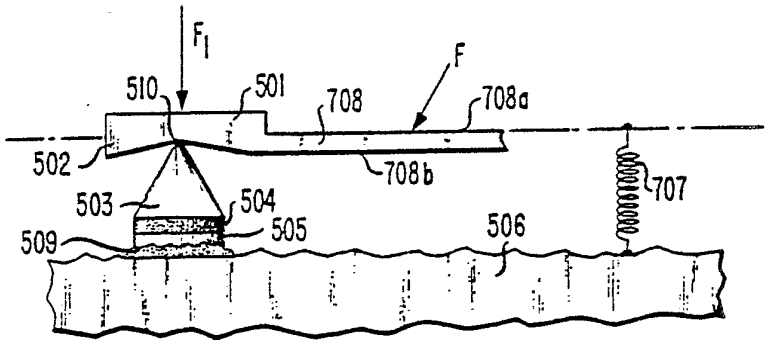
(54) Title: TOUCH POSITION LOCATING ARRANGEMENT

(57) Abstract

In a touch position locating system comprising a member (501) to be touched and a touch sensing device (504), a mounting arrangement is provided for transferring the touching force through a point of action, e.g., the tip (510) of a conical member (503) disposed between the sensing device and the touched member. The mounting arrangement provides a precise location of the transmitted force with respect to the sensing device, thereby improving accuracy of the touch position locating process, and avoids the application of distorting stresses against the touch member.



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TOUCH POSITION LOCATING ARRANGEMENT

Background of the Invention

1. Technical Field

This invention relates to apparatus for locating the position of a localized force applied to the surface of a visual display.

2. Description of the Prior Art

In the use of interactive computers, a computer terminal having a visual display presents a plurality of alternative choices on the display. The user selects one desired alternative by simply touching the display at a location corresponding to the desired alternative. The computer terminal identifies the position of the touch and reacts accordingly.

Peronneau et al., U.S. Patent 3,657,475, disclose a position indicating system comprising (FIG. 1 herein) a rigid plate, a plurality of force sensing devices, and a processing unit. The user applies a localized force F from above the exposed surface of a touch plate P, the force having a potentially non-perpendicular direction. When the localized force F is applied to the surface of the plate P, the piezoelectric sensors, C_1-C_4, provide the processing unit S with electrical signals, G_1-G_4, which are proportional to the distance of the applied force F to each sensor.

A considerable amount of error in this system arises from the arrangement for mounting the plate between a force sensing device C and a rigid block D as shown in FIG. 2. Because the planar surfaces of the force sensing devices C_1-C_4 are rigidly clamped against the surface of touch plate P by horseshoe spring E, any dimensional or clamping pressure variations from device to device tends to distort or twist the plate P thereby introducing errors into the measurements. Also, because the applied force is sensed over the entire planar area of each force sensing

device, the length of the moment arm from point M to each force sensing device is not definite but runs to an undetermined point on the surface of the force sensing devices.

Another problem is that the surfaces of the force measurement devices are perpendicularly displaced from the plane of the exposed surface of the plate by a distance equal to the thickness of the plate P. Tangential (non-perpendicular) components of the force F applied against the exposed surface of plate P produce moments which tend to act on the force sensing devices C_1-C_4 causing errors in the coordinate calculations.

Herot et al., in their publication "One-Point Touch Input of Vector Information for Computer Displays," Computer Graphics, v. 12, n. 3, pp. 210-216, describe an arrangement, shown in FIG. 3 herein, which comprises octagonally shaped spring members 301 which are used to mount a touch surface 302 on a display surface 303. Strain gauge sensors 304 are affixed to the spring members 301 to detect the magnitude and direction of the forces sensed when the members 301 are compressed and twisted.

A problem with the Herot mounting arrangement is that visual parallax error is introduced into the system because of the spacing, determined by the diameter of the octagonal members 301, between the touch and display surfaces. A further problem is that the system is susceptible to mechanical vibration caused by the flexible octagonal support members 301.

Roeber, U. S. Patent No. 4,121,049, discloses a position and force measurement system whose mounting arrangement is shown in FIG. 4. The mounting arrangement comprises two similar rectangular rigid surfaces 401 and 404 whose edges are joined by semi-circular springs 402 upon which are mounted strain gauge sensors 403. The Roeber system minimizes tangential displacement by confining the movement of the upper touch surface 401 to a perpendicular direction. However, the touch surface 401

must be displaced from the second surface 404 by the diameter of the semi-circular springs 402. Accordingly, visual parallax error can result. Also, the accuracy of the system is limited by the variability of the spring constants of the semi-circular springs 402.

The present invention avoids these problems of the prior art arrangements.

Summary of the Invention

In a touch position location system comprising a member to be touched and a touch sensing device, a mounting arrangement is provided for transferring the touching force to the sensing device through a point of action providing precise location of the transmitted force with respect to the sensing element as well as avoiding stressing of the touched member. In one embodiment, the mounting arrangement includes a pointed conical member, the point thereof providing the sole touch force transmitting contact between the touched element and the sensing device, and the base of the conical member being clamped against a surface of the sensing device.

Brief Description of the Drawing's

FIG. 1 is a view of a prior art position indicating system.

FIG. 2 shows certain details of the FIG. 1 arrangement.

FIGS. 3 and 4 show two further prior art arrangements.

FIGS. 5 and 6 show two embodiments of the present invention.

FIG. 7 shows the embodiment of FIG. 5 mounted on a rigid body.

FIGS. 8 and 9 show additional embodiments of the invention.

FIG. 10 shows the electrical connections to the arrangement of FIG. 5.

FIG. 11 is a partially exploded side view showing a touch plate mounted on a cathode ray tube.

FIG. 12 is an exploded perspective view of the apparatus of FIG. 11.

FIG. 13 is a view of a portable touch sensitive system.

FIG. 14 shows an alternate arrangement for use with a cathode ray tube.

Detailed Description

With reference to FIG. 5, a mounting arrangement is shown for transmitting a touching force from a touched member 501 to a force sensing device 504. The force sensing device 504 comprises a piezoelectric transducer in the form of a disc. In one embodiment, the sensing device 504 comprises a body of the piezoelectric material lead zirconate titanate which is poled in a direction perpendicular to the flat surfaces of the disc 504. Other force sensing devices which do not distort so greatly as to alter the geometry of the arrangement can be used, e.g., strain gauge sensors and variable capacitance transducers. The device 504 is mounted on a metal disc 505 secured, in turn, as by a solder joint 509, to a rigid member 506. The member 506 can comprise a display device, e.g., the face plate of a cathode ray tube.

A solid, conical member 503 of, e.g., metal, is mounted with its base flush with a surface of the disc-like sensing device 504 and with its point received at the apex of a conical recess within a receiving member 502 mounted on the touched member 501. As shown in FIG. 10, electrical signals from the sensing device 504 are extracted by means of leads 1001 and 1002 soldered to metal members 503 and 505. These members are conductively bonded to the disc 504 using, for example, a conductive epoxy cement.

The point contact 510 between the two members 503 and 502 is referred to as the "point of action" because it is through this point that the touching force is transmitted to the sensing device 504. Because of the point contact, an exactly located point of reference is created for the calculation of the length of the moment arm

between the point of application of the touching force and the force sensing device 504. Further, because of the point contact between the two members 501 and 506, the mounting of the one on the other gives rise to no undesirable twisting or distortion of either. This avoids the first described problem with the Peronneau et al. system.

The use of the sensor 504 mounting arrangement in a touch position locating system is described hereinafter. Also, it can be used in place of the sensor mounting arrangements of the touch position locating apparatus of the aforedescribed prior art as well as in a system described in a concurrently filed patent application entitled Touch Position Locating System, by DeCosta et al.

In the embodiment shown in FIG. 6, the receiving member 502 shown in FIG. 5 is replaced with a small recess 602 within rigid body 501. Alternatively, but not illustrated, if the sensing device 504 is mounted on the rigid member 501, e.g., between it and the receiving member 502 (FIG. 5), a pointed bump mounted directly on the surface of body 506 can be used.

With reference to FIG. 7, there is illustrated how a touch force impinging on a touch surface is reduced to its perpendicular component at a point of action and the torque it causes eliminated. A touch plate 708 is used having an outer touch surface 708a exposed to the application of a force F which may impinge on the surface 708a at any angle. A biasing spring 707 is used to hold the receiving member 502 in engagement with pointed member 503. As shown, the touch plate is so indented as to dispose the point of action 510 in the plane of the touch surface 708a. When a tangential force F is exerted on surface 708a, no moment or torque can be exerted about point 510 because the moment arm between the tangential force and the point of action 510 has zero length. Thus, the only force sensed by the sensing device 504 corresponds to the perpendicular component of the applied force F.

Referring now to FIG. 8, the biasing spring 707 is eliminated by employing mounting apparatus comprising a ball member 503a and a socket member 502. The ball and socket joint is lubricated so as to be practically frictionless. The lubrication should provide a continuum of contact between points on the surface of the ball 503a and points on the surface of the socket 502. The point of action 510 is the center of ball member 503a.

Referring to FIG. 9, two conic members 903 and 904 are shown flexibly joined at their points. The point of action 510 of this embodiment is the point of juncture of the conic members 903 and 904. Again, no biasing spring is used.

FIGS. 11 and 12 show the mounting of a touch plate 708 on the display screen of a cathode ray tube 506. In this arrangement, the force sensing member 504 is mounted on the touched body rather than, as in FIG. 5, the rigid supporting member. Some amount of visual parallax error is possible in this arrangement because of the spacing between the touch surface 708a and the viewing surface 506a.

As shown in FIG. 12, the sensor structures S_1, S_2, and S_3 are disposed at the corners of an isosceles triangle. Other arrangements of the sensor structures, e.g., at the four corners of a rectangular touch plate, can be used.

Referring to FIG. 13, a portable touch plate system is shown having rectangularly placed sensor structures. Since the touch plate surface 708a must remain free of visual impairment, the biasing springs 707 are mounted outside of the viewing area. Also, since the viewing surface is located adjacent to rigid body 506, rigid body 506 must be transparent.

The structure of FIG. 13 has the disadvantage that visual parallax error may result because the touch surface 708a is displaced from the viewing surface of the visual display.

Referring to FIG. 14, the visual parallax errors that are possible in the mounting arrangements depicted in FIGS. 11, 12 and 13 are eliminated. In the FIG. 14 arrangement, the face plate 708b of the cathode ray tube 708 is the touch surface.

Bias springs 707 serve to maintain contact between the sensor structures and the tube 708, the application of the touching force (F) being detected as a reduction of pressure against the force sensing detectors.

Claims

1. A touch position locating arrangement comprising a member (501) to be touched and a touch sensing device (504)

CHARACTERIZED IN THAT

the mechanical coupling means for transmitting the applied touching force to the sensing device comprises a point of action (510) for providing a precise location of the transmitted force with respect to the sensing device.

2. An arrangement according to claim 1 CHARACTERIZED IN THAT

the mechanical coupling means comprises a pointed member (503), the point (510) of which lies in the path of transmission of the applied touch to said sensing member and provides said point of action.

3. An arrangement according to claim 1 CHARACTERIZED IN THAT

the mechanical coupling means comprises a bell-shaped element (503a) and a socket (502) for receipt of the element, the center of the element comprising said point of action.

4. An arrangement according to claim 1 CHARACTERIZED IN THAT

the mechanical coupling arrangement comprises two cone-shaped elements (903, 904) joined at their points to form a flexible, point of action hinge.

5. An arrangement according to claim 1 CHARACTERIZED IN THAT

the point of action lies in the plane of the surface of the touched member against which the touch is applied.

FIG. 1

(PRIOR ART)

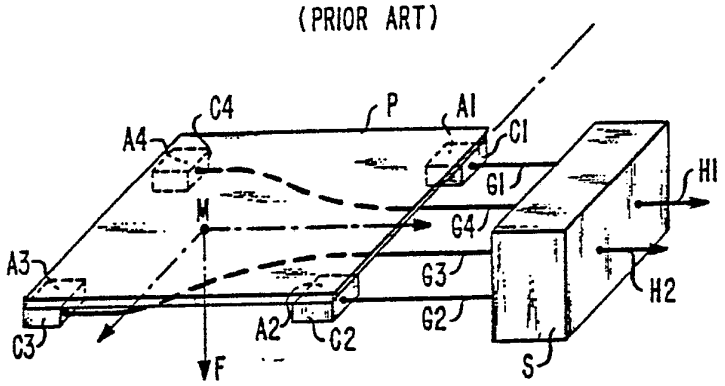


FIG. 2

(PRIOR ART)

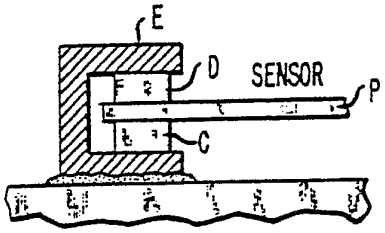


FIG. 3

(PRIOR ART)

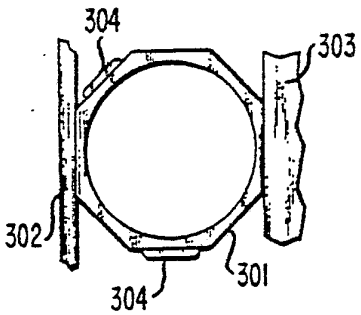


FIG. 4

(PRIOR ART)

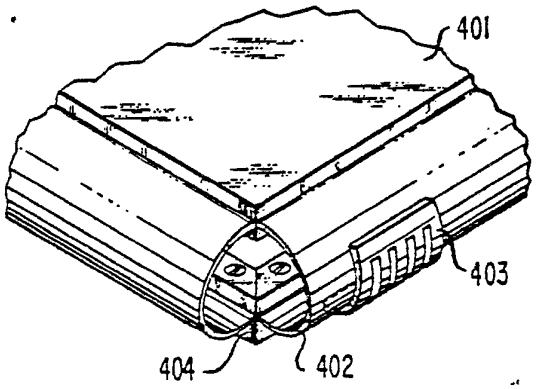


FIG. 5

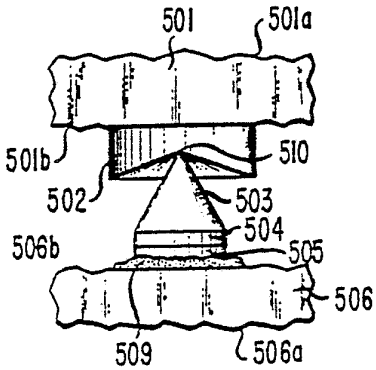


FIG. 6

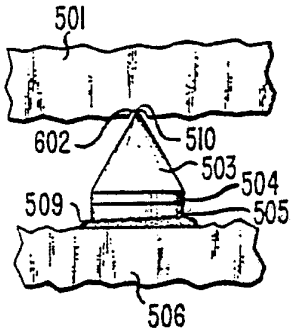


FIG. 10

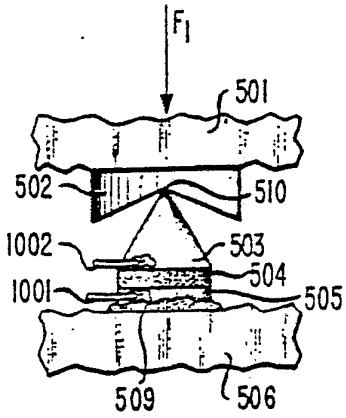


FIG. 7

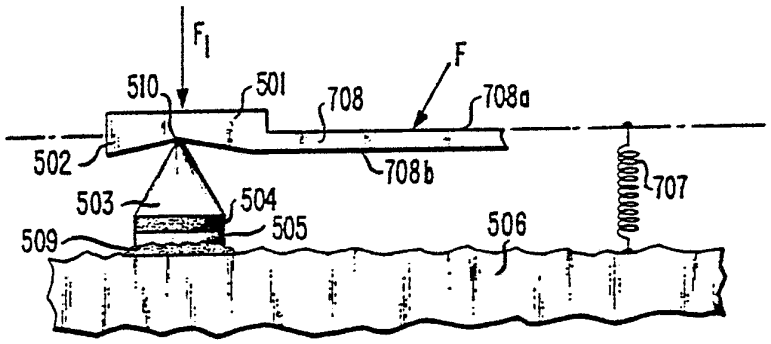


FIG. 8

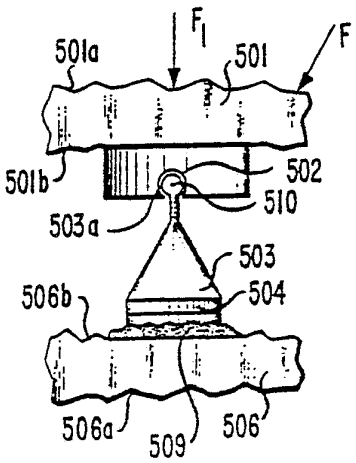


FIG. 9

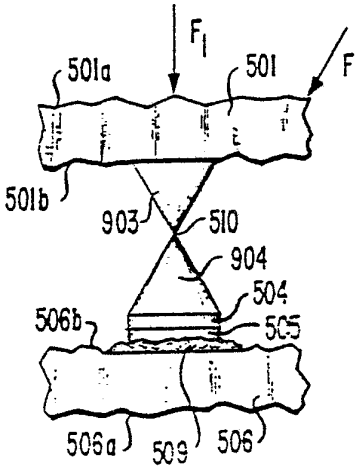


FIG. 11

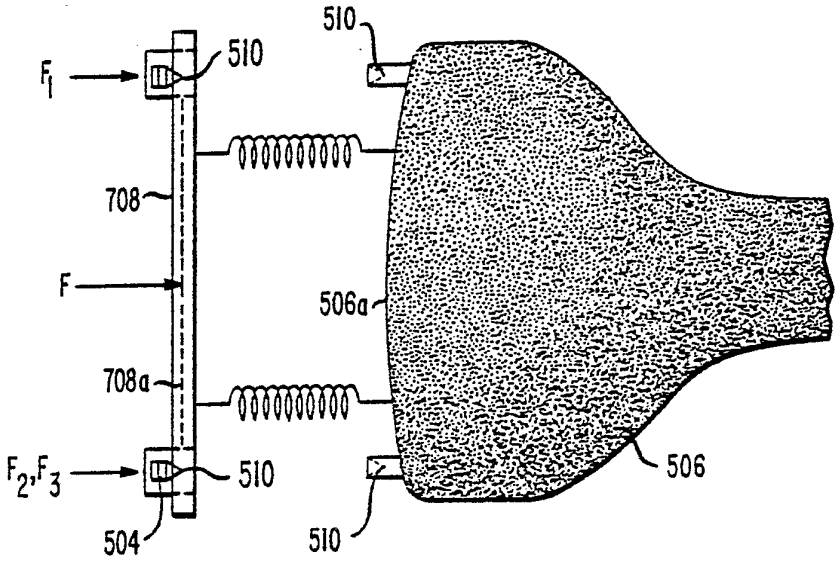


FIG. 12

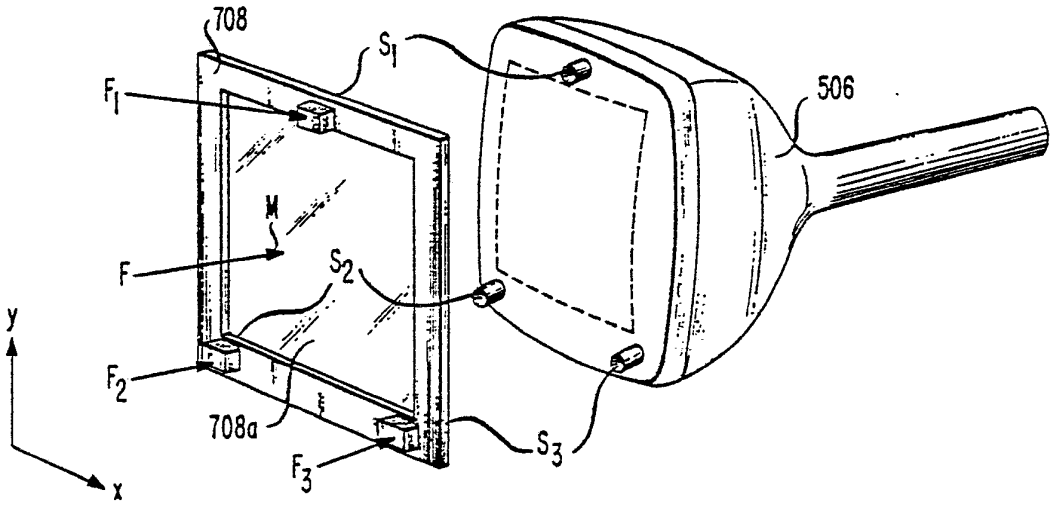


FIG. 13

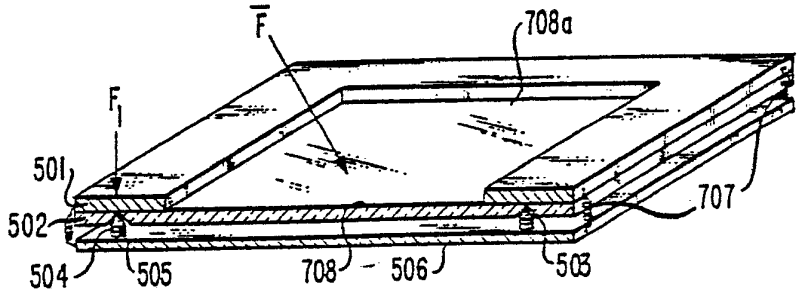
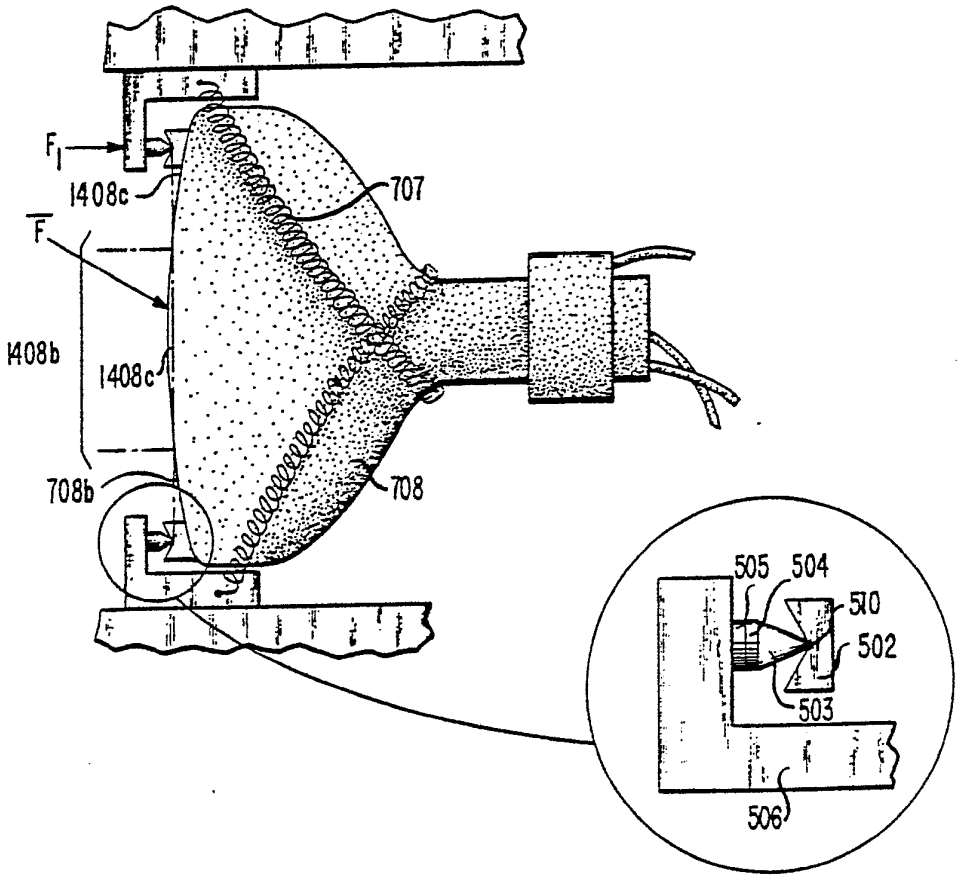


FIG. 14



INTERNATIONAL SEARCH REPORT

International Application No PCT/US81/01582

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

INT.CL.[3] G08C 21/00
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II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
U.S.	178/18,19,20;177/210R,C,EM,FP,211,212,3,185,Dig.3; 73/141R,A,172,763,765,767,769,770,772,777,781,Dig.4; 340/709,712,146.3Sy;33/1M

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
A	U.S.,A, 3,657,475, Published 18 April 1972, Perroneau et al	
A	U.S.,A, 4,121,049, Published 17 October 1978, Roeber	
A	"One-Point Touch Input of Vector Information Computer Displays", Herot, COMPUTER GRAPHICS (US.), August 1978, pages 210-216	

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"X" document of particular relevance

IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
5 January 1982	21 JAN 1982
International Searching Authority [1]	Signature of Authorized Officer [10]
ISA/US	Thomas A. Robinson