

A New Principle for an X-Y
Touch Screen

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1. Introduction

A touch screen device with 16 touch sensitive areas and its appropriate touch detecting circuitry has already been described in the CERN report "Two devices for operator interaction in the central control of the new CERN accelerator " (Ref. 1).

This system has now proved its value and is one of the major control devices for operating the CERN SPS Accelerator.

The experience with the first system has led to some thoughts whether it would be possible to build a new touch system which would not only be able to replace the old one, but at the same time give several advantages such as screen design not related to any special type of display or character format used, many additional operating modes and maybe smaller construction costs. The purpose of this paper is therefore to describe some possible methods for these new x-y touch systems, to suggest a way in which a system could be built and finally to suggest some new applications.

2. Basic differences between the old and the new system

The old system consists of 16 fixed positions and fixed size one plane touch areas connected up to 16 detector circuits using the principle of a phase-locked loop, as described in Ref. 1.

The new system is a complete x-y co-ordinate system where each co-ordinate represents a touch sensitive narrow line area going from one side of the screen to the other. The x and y plane being electrically isolated from each other, see Fig. 1.

3. Physical principle employed

The new system as well as the old system both use change of electrical capacity, but where the old system used only 16 capacitors the new system uses a much higher number depending on the size of the screen and the resolution wanted.

4. The screen

Ideally a touch screen used in front of any display should be a thin and transparent device not having any visible structure nor limitations to a touch of any area which can be visualized by the display under it.

The following will describe some suggestions for the construction of such a screen.

Fig. 2 shows the principle of a single plane composed by equidistant lines combined to give three lines for the ref. 3 oscillator lines not connected and three lines which are touch sensitive. The x and y plane design is identical.

Fig. 3 shows the combined x-y plane where, for simplicity, the three wires are combined and shown as one wire.

4.1 Physical construction

The suggested physical dimensions are shown in Fig. 4. As it can be seen here the whole construction is a sandwich type made up by the following main operations :

- 4.1.1 Deposit of the x plane on a glass base
- .2 Insulation of the x plane by a transparent insulator
- .3 Deposit of the y plane on the transparent insulator
- .4 Insulation of the y plane by a transparent insulator

4.2 Why this construction ?

An x-y grid of wires being 80 μ mm wide and 80 μ mm apart from each other placed in front of a display is sufficiently fine to give no disturbance of the information seen through it. However, 80 μ mm equidistant wires on glass are wide enough and have a spacing big enough to be manufactured by different techniques without too great difficulties.

As the operating tool for the screen consists of a human fingertip it is believed that the needed x-y resolution of the screen would not be higher than ~ 2 mm. With the structure suggested the distance between two sensitive wires in the same plane would be 1,92 mm.

The combination of wires shown in Fig. 2 gives several advantages. When three wires are in parallel then small random holes in the lines can be tolerated without spoiling the screen. The non-connected wires fill up the gap between the touch wires and the wires connected to the ref. oscillator and isolated shorts between two adjacent lines can be tolerated.

Other types of patterns can be used as shown in figs. 5, 6 and 7. The principle in fig. 7 is very interesting as the capacitors in the x plane are identical to those in the y plane and the sensitivity for both planes is identical. However this screen is thought to be more difficult to produce.

The pattern construction selected should be the one which gives the best compromise between resolution required, easiest screen manufacturing and sensitivity needed for a given screen size.

4.3 How does the screen work ?

All the x-y touch capacitors are part of their own resonant circuit. When the screen is touched by a finger a certain number of x and y "touch lines" will have their capacity changed as the finger changes the dielectric for the area which is touched. While it is rather clear to understand that the upper plane will work (screen type 1 and 2) it is less obvious to see that the lower plane will work also, as the upper plane could act as a screen for the lower one.

In Fig. 4 it can be seen that the distance from a finger pressed on the surface of the screen and down to the lower layer is only 11 μ m where the distance between wires is 80 μ m. It is therefore believed that the upper layer wires will not be an effective screen. The non connected wires will also reduce the screening effect of the upper plane.

As mentioned before the old touch button system now in use has 16 (fixed positions) touch areas in one plane only. The use of only 16 touch detector circuits makes it possible to use a rather sophisticated and expensive technique for the detection of a touch (phase locked loops) without the price for the whole system becoming too expensive.

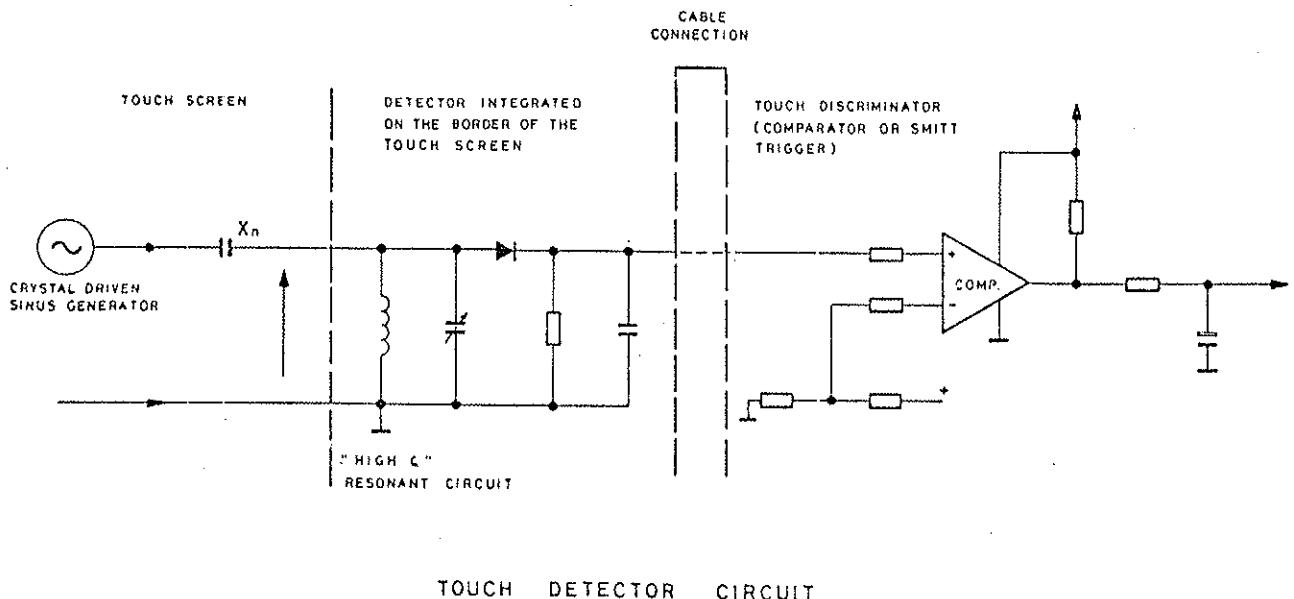
For the x-y screen proposed the price for the detector attached to each touch wire must be very low as the total number for each plane could be as high as 100.

The design of such a detector must therefore be extremely simple for cost reasons but still be reliable in operation.

The practical work on the construction of such a detector has successfully been done at CERN and is described in detail in a report (see ref. 2), therefore only the principle should be repeated here.

5. The touch detector for the x-y screen

The detector for one line of an x or y line looks as follows :



The touch capacitor is given by the capacity between the wires connected to the crystal driven sinus generator and the wires X1, X2, Xn and Y1, Y2 and Yn.

Using the construction technique described in chapter 4.1 all capacitors in the x plane will be approximately identical to each other and so will be the capacitors for the y plane. However, the x and y capacitors will not be identical.

When the screen is touched by a finger all the x-y capacitors under the finger will change capacity as the dielectric in front of these is modified by the presence of the finger.

The change of capacity detunes the resonant circuit and the rectified voltage to the voltage comparator will drop, causing the output from the comparator to change state.

As it can be seen the detector itself is very simple and it could be built on the border of the same glass base as the touch screen itself using various techniques as for example thick film. The biggest component is the coil but using a relatively high frequency as 0.5 MHz, the size is only 10 mm long and 2 mm in diameter.

6. The interface

It is clear that for the x-y screen described a touch by a finger will activate several x and y lines at the same time according to the size of the finger and the pressure applied. A perfect device to find out the gravity point for a touch would be a μ processor scanning the status of the x-y lines. The μ processor will also allow for a more precise indication of a touch than the absolute resolution given by the distance of the x-y wires and it will permit a serializing of the input/output information.

Depending on the type of display used for the touch screen the μ processor will also be able to generate the actual display.

7. Advantages of the new system

The advantages of the new system only becomes true when one has a need for the additional operation facilities which it offers. Therefore what will be called advantages here, must be taken with care. It may apply much more to future users and new systems and applications than to users of the present touch screen systems.

The advantages of the new system can be divided into two groups.

- 7.1 The advantage of having a high resolution x/y screen compared to a 16 button fixed format system.
- 7.2 The advantages of the proposed x/y system compared to other principles in use today.

The first advantage is very obvious as the user is free to use any type of display under the touch screen, these being TV monitors x-y scopes solid state LED, liquid crystal and others. The user is also free to program at any given time the size and number of areas or points he wants to be sensitive.

Other known principles for interactive display systems are :

- 7.3 Crossing light beams with photocells
- 7.4 Crossing wires which are pressed together
- 7.5 Light pen
- 7.6 Sound transducers in the x-y plane where the touch is detected by modifying the reflection on the surface of the screen.

Compared to the proposed system these all have at least one of these disadvantages :

- 7.7 Ambient light dependent
- 7.8 Mechanical contacts
- 7.9 Additional tool for operation needed
- 7.10 Mechanical arrangement around the screen is very space demanding
- 7.11 Poor resolution
- 7.12 Expensive to produce

The proposed system should not have any of these disadvantages. It is particularly suited for a development where the parts are more or less integrated, and can therefore be produced in large quantities at low costs.

8. Suggested applications

Apart from allowing a more flexible use of the touch screen for the applications working today, some new ones should be suggested :

8.1 Ticket automates

Various kinds of ticket issuing automates for railways, busses, etc. are in use today. The most sophisticated of these allows the traveller to select between a rather high number of mechanical buttons, his destination and the price of the ticket. The text of all these buttons will have to be changed manually if tariff modifications occur.

The mechanical buttons could be replaced by the touch system connected through a modem to the central computer. This will allow all changes to be done centrally and open up the possibility for a user service never seen before. In fact, the user or traveller would be able to request any relevant information concerning his present or future travel. The display could even show maps of selected route networks with touch points for interaction.

8.2 News information through your TV receiver

Serious experiments are at present done on how you can use your TV receiver for other purposes than what you are using it for today. One of the things which might be common in the future is to add information of various kinds which is useful to the normal user and allows him (by some tool for selection) to make a choice. A touch screen system either integrated onto the TV itself or as a separate unit interfaced to the TV might be the answer.

9. Conclusion

A very intensive research is done on new display devices which will take over a part of what the CRT is used for today. The successful development of an x-y touch screen of the kind proposed will allow us to use it in front of any display device which may come up in the future.

A report which is being prepared will discuss the suggestion on how to build a "touch control unit" for universal use (both scientific and domestic) where the display (not a CRT), the touch screen and the interface and control (a μ processor) are all integrated into one small and "handy" unit. This device could be the first pocket size mini-terminal for use with any computer system.

10. References

- 1) Two devices for operator interaction in the central control of the new CERN accelerator, F. Beck and B. Stumpe, CERN 73-6, Laboratory II, Control Group, 24 May 1973.
- 2) Un nouveau circuit détecteur pour l'écran sensitif digital (Touch Screen), C. Pignard, PS/LIN/Note 77-1, 6 janvier 1977.

X-Y TOUCH SCREEN

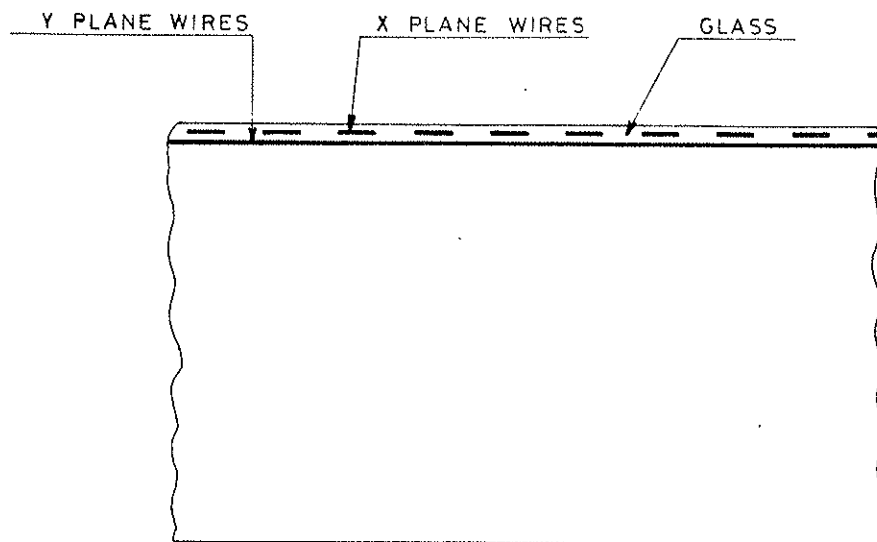
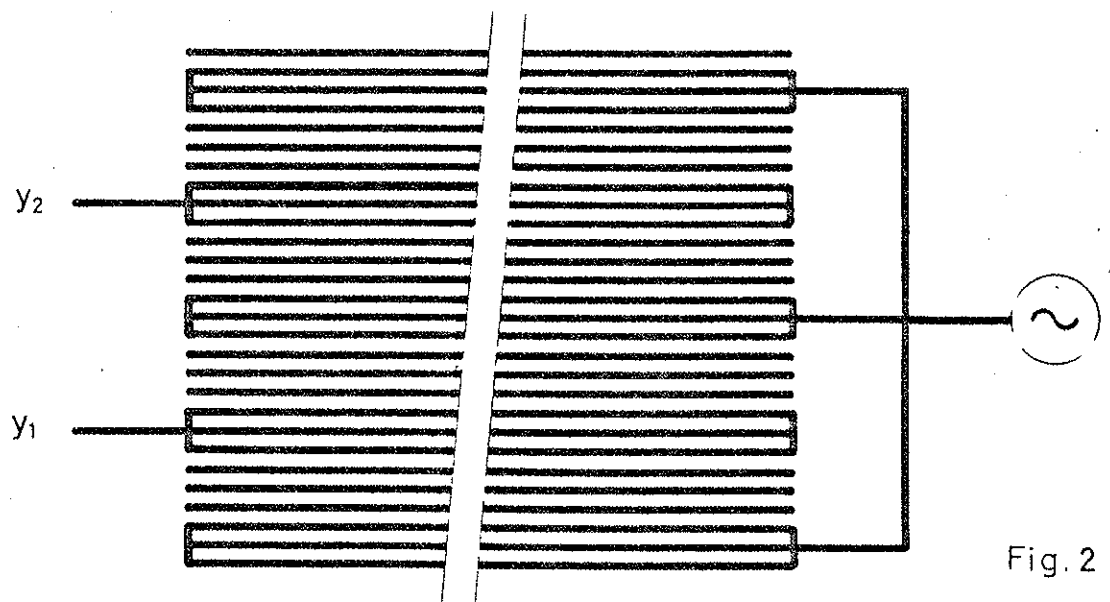


Fig. 1

SCREEN TYPE 1

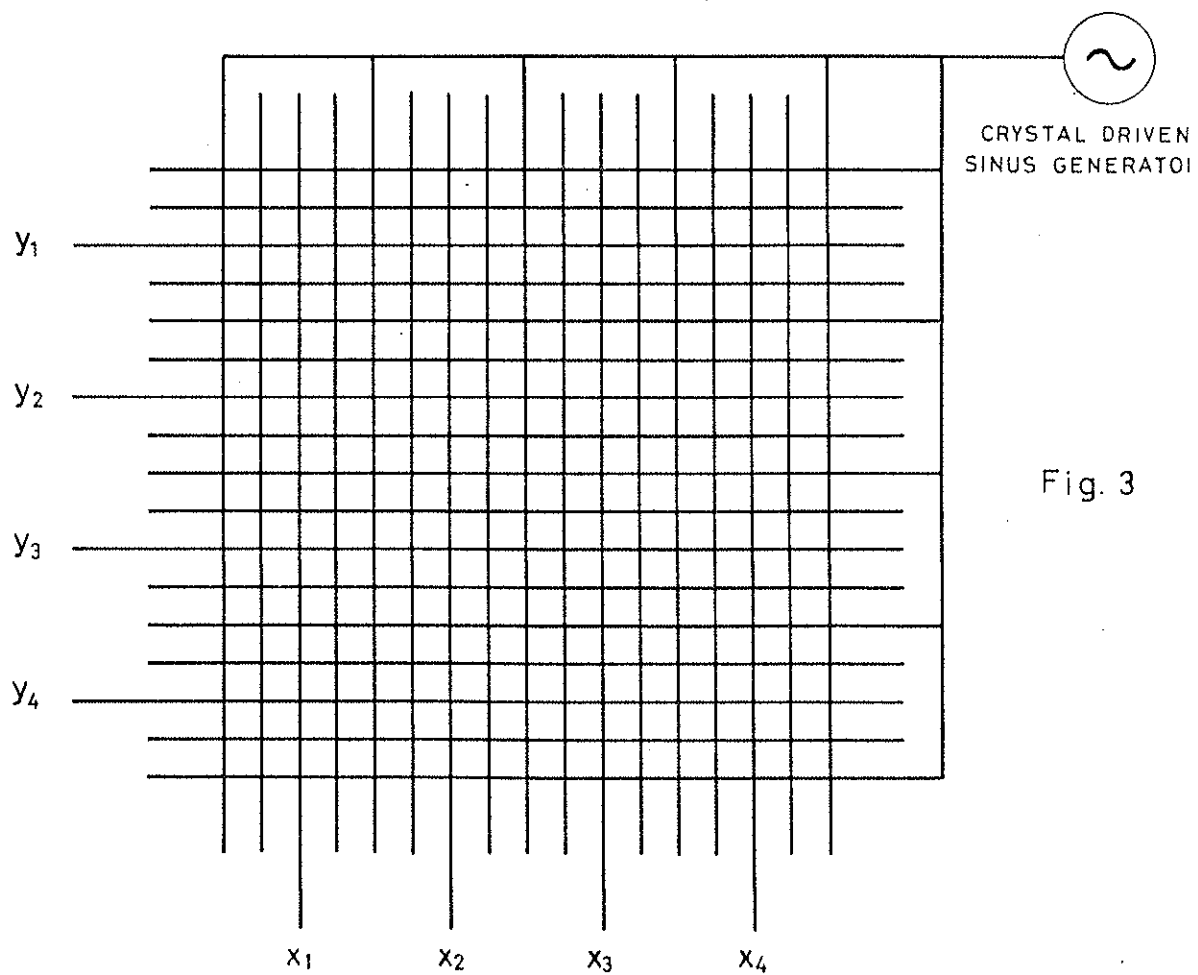
SINGLE PLANE OF THE X-Y SCREEN
(Not to scale)



SCREEN TYPE 1

X-Y PLANE COMBINED AND SIMPLIFIED

(Not to scale)



X-Y SCREEN END VIEW

PHYSICAL DIMENSIONS

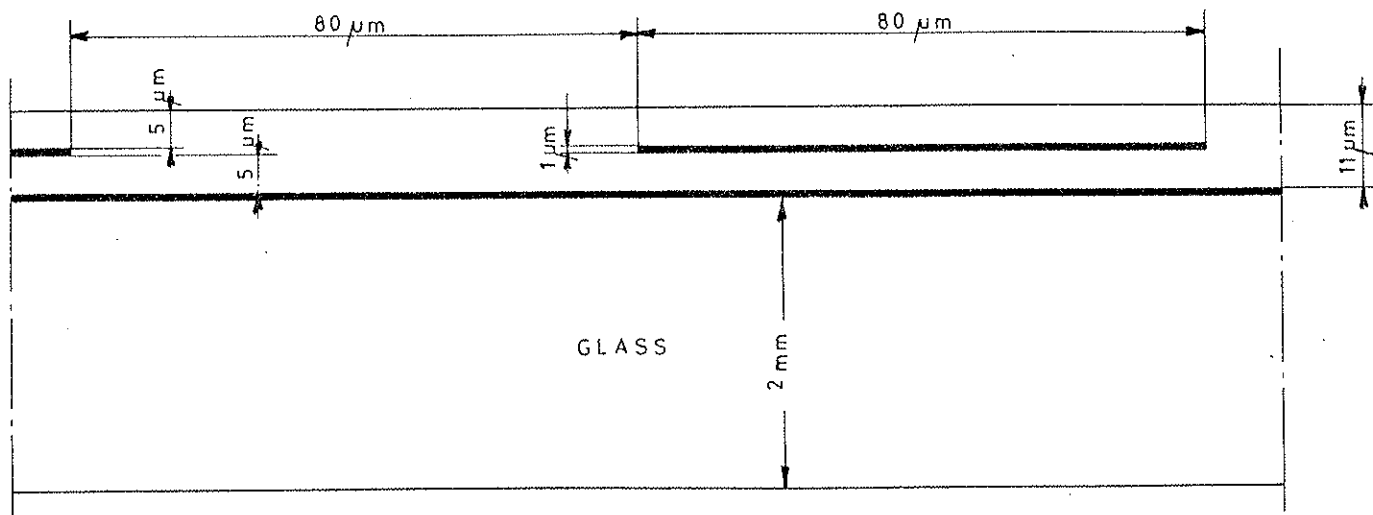


Fig. 4

SCREEN TYPE 2

SINGLE PLANE OF THE X-Y SCREEN
(Not to scale)

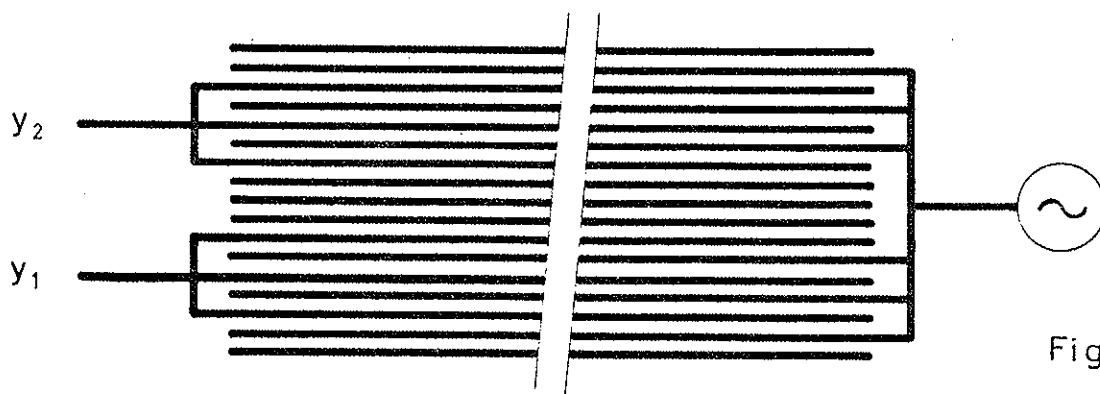
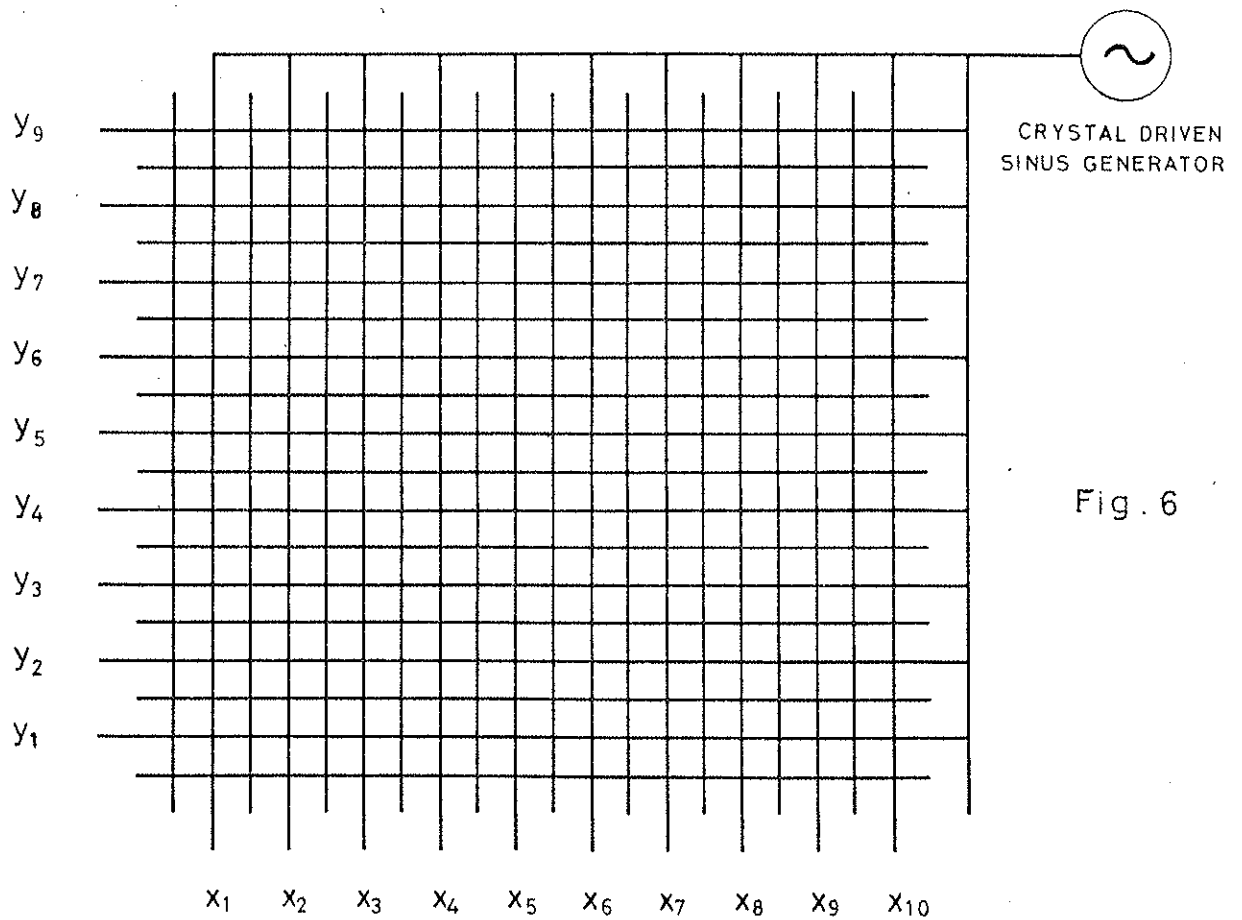


Fig. 5

SCREEN TYPE 2

X-Y PLANE COMBINED AND SIMPLIFIED
(Not to scale)



SCREEN TYPE 3

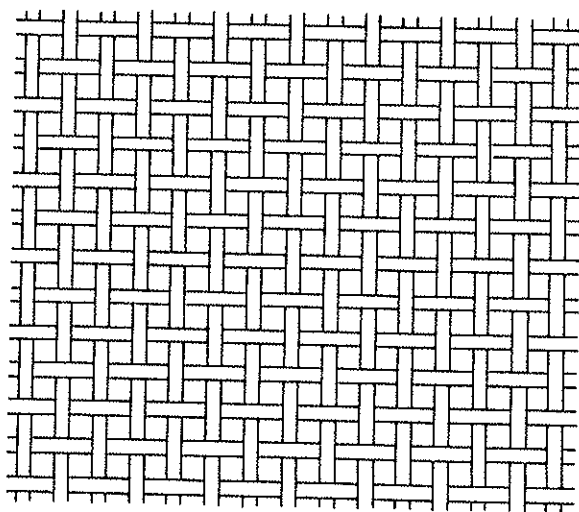
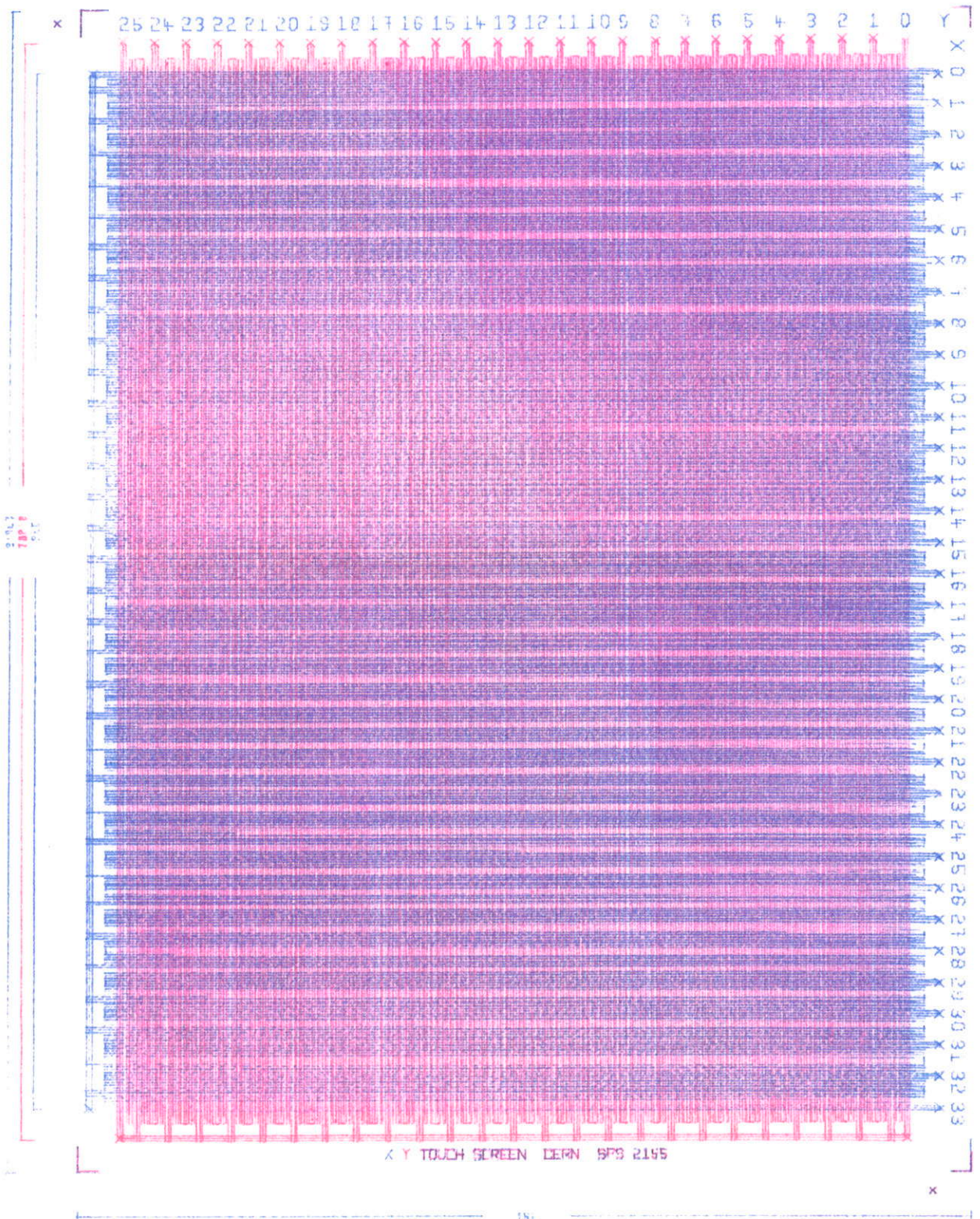
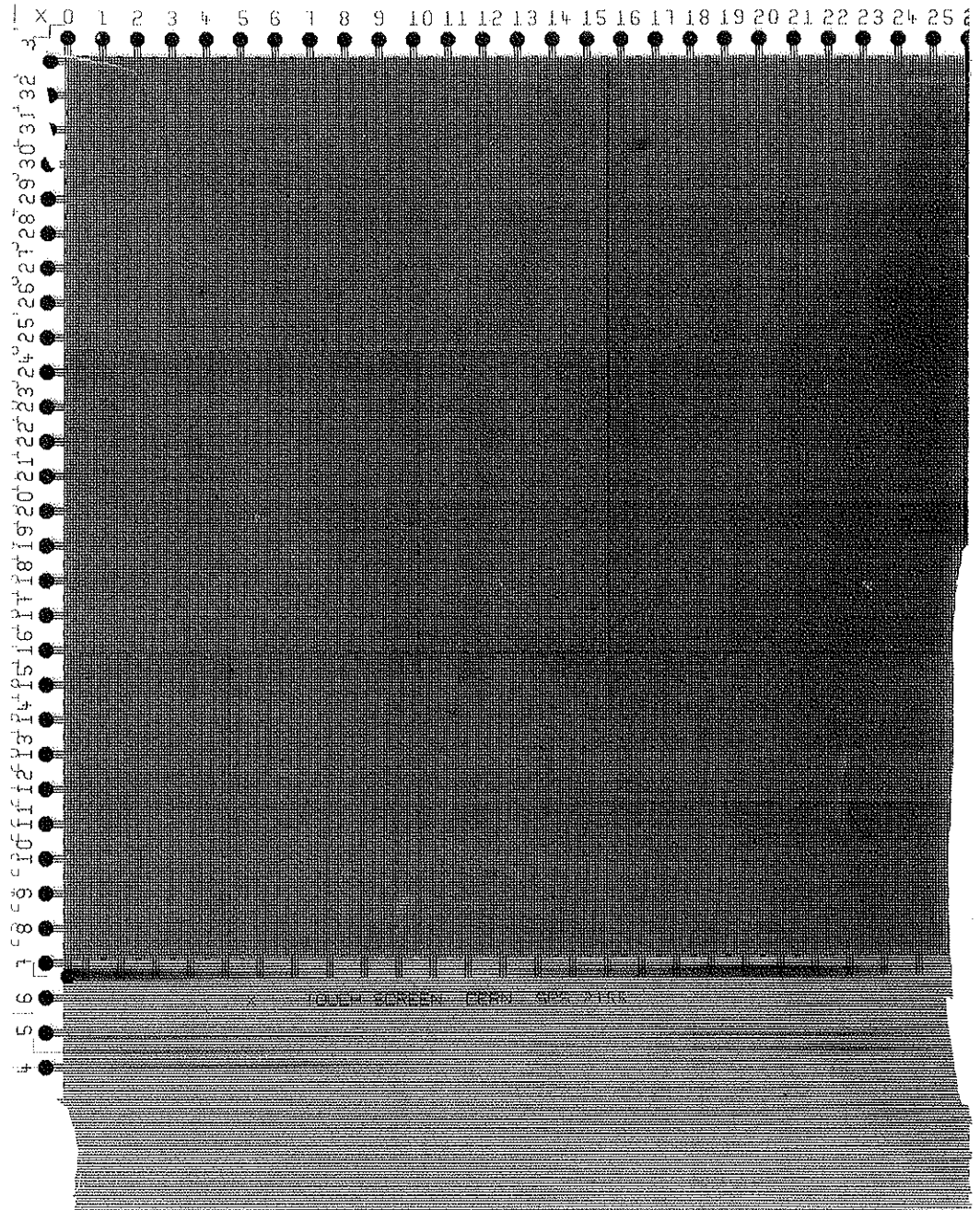


Fig. 7





25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0