

# **New Aspects and Experiences in Stereoscopic Television**

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## **INTRODUCTION**

During the conference you have had the opportunity to see our 3D-television demonstration program "An evening magazine in 3D", in true stereoscopy, in color and with stereophonic sound, produced for the International Audio and Video Fair 1983 in Berlin. In addition we displayed some sequences of a conventional TV program in "quasi-stereoscopic" mode. The following paper gives supplementary background information to our presentation.

In 1982, in Germany and in some other European countries a series of stereoscopic TV programs in simple anaglyphic technology were transmitted. The broadcasts found an unexpected public response: Fourty millions of red/green filter glasses were sold. Similar experiences are known from USA. In 1983, the Thomson-Brandt group introduced color television sets equipped with a circuitry which, by wearing color filter glasses, adds spatial impression to normal TV broadcasts. Worldwide there is an apparent renaissance of interest for three dimensional imaging in other media too, as in cinematography, photography and printing.

This indicates that the old idea of perfecting pictorial presentation by spatial depth has not yet lost its attractiveness. But up to now the success of all 3D efforts always was of short duration. One of the crucial reasons was unsatisfactory quality, especially in TV. Most viewers obviously are not willing to accept different colorfilters for either eye, lack or reduction of natural color as well as reduction of picture sharpness or of other quality parameters as a trade-off for the 3D impression.

Our institute, the IRT in Munich, the research and development centre of the broadcasting organizations in the Federal Republic of Germany, had started investigations on 3DTV fifteen years ago already, after color TV had been introduced in Germany. Meanwhile the technical prerequisites have increased and it seems that now, or at least in the near future, the technical basis will be available to achieve an attractive high quality 3DTV as a real improvement of today's picture quality. Especially in combination with research and standardization of new TV systems - providing enhanced quality and sense of realism - we believe that 3DTV should be taken into consideration.

## **3D STUDIO EQUIPMENT**

The basis of 3D reproduction is to copy human binocular vision as perfectly as possible. Today, some ENG-cameras even of high quality are sufficiently slim to be mounted side by side closely within the interaxial distance of the human eyes, which is 65 mm in average. Fig. 1 shows a 3D-camera we used for our 3DTV production, consisting of two Hitachi SK 81. The interaxial distance, however, is 100 mm and this causes a somewhat exaggerated perspective perceptible in some scenes of our demonstration program. Nevertheless, it is a very handy equipment for outdoor shooting. In more complex arrangements (Fig. 2) by means of semi-transparent mirrors, as known from 3D-cinematography, one can obtain interaxial

distances down to zero for close-up shootings. Fig. 3 presents a camera of this kind developed by Philips, Netherlands. Further necessary or desirable features are devices for converging the optical axis to position the so-called "stereo window", as well as for simultaneous operation of the lenses and camera controls. This can be achieved by means of servos and micro-processors. A much simpler construction we used in our 3D-camera: the zoom lenses were controlled by cords, wrapped around both lenses. Sufficient mechanical and electrical stability to avoid misregistration between both cameras - especially in vertical direction, which causes eye strain to the viewer - can be achieved by modern technology. Altogether it can be summarized that today 3D-productions are only a matter of cost.

Slide and film scanning presents no fundamental problems either. Fig. 4 shows the scheme of a 3D slide scanner in flying spot technology which we developed in the beginning of our 3D-investigations. It is still in operation and was used for the still pictures in our demonstration program. For film scanning in separate-reel technique it is recommendable to scan both reels with the same film scanner storing one reel on a VTR in order to avoid geometrical differences.

### **3D RECORDING AND TRANSMISSION**

For high quality 3DTV two channel recording and transmission is a practicable method and up to now the most efficient one.

Our demonstration program was recorded on two B-format VTRs from Bosch-Fernseh, using time code for synchronisation (Fig. 5). 3D editing can be accomplished by most of the modern editing systems. We used the MOSAIC system developed in the IRT. As we did not have enough machines for simultaneous editing of the "left" and the "right" recordings, we edited both in sequence. This was carried out automatically, under the control of the stored data. For synchronous play back, with the necessary accuracy of one field, normal editing systems can be used, but it is also possible to synchronize both machines manually by means of a suitable synchron-leader and the tape-speed-override mode, as done for our demonstration at this conference.

For home application twin-track VTRs seem to be possible, e.g. using the Video 2000 format manufactured by Grundig and Philips. This format uses a reversing cassette on which only one half of the tape is recorded per run. Sony presented a prototype of a twin-track VTR recently. A 3D demonstration system consisting of two locked video disc players was shown by Philips. Experiments with a single-disc two-track player are carried out in the laboratories of the same manufacturer.

For 3D transmissions, now and in the near future, a two-channel system by cable and satellites could be an imaginable and practicable solution. It would be advantageous that both channels are evidently compatible with conventional TV. Recently, a range of HDTV systems using two-channel technology have been proposed, considering that there are no transmission channels offering the adequate high bandwidth for one-channel HDTV. It seems to be obvious to combine a two-channel HDTV system with a two-channel 3DTV system allowing alternative services.

If compatibility with conventional TV can be ignored, sequential one-channel 3D systems could be conceived by means of frame stores, which are becoming cheaper and are expected to appear in home receivers in the near future. It is impossible to discuss all the various methods in this paper in detail, but it is obvious that also in the field of transmission today or in the near future the technical basis is available for high quality 3DTV.

### 3D DISPLAY DEVICES

For 3D display the polarization technology, using the almost neutral-grey polarizing glasses, is the favourite method. A simple and well-known arrangement consisting of two picture tubes, polarizing filters in front of the screens and a semi-transparent mirror is illustrated in Fig. 6. The viewer wears corresponding filter glasses. Plane polarizers ( $90^\circ$ -V) are commonly used, but bicircularly polarized systems allowing more freedom for head movement are possible too. In the future, it is imaginable to build a combined 3D-tube or a flat-panel-display offering a screen with alternately polarized pixels. Instead of polarizing filters, technology may allow the use of an arrangement of lenticular lenses (Fig. 7) for glassless viewing. At a conference of the International Society for Optical Engineering in Geneva, Switzerland, last year, excellent lenticular sheets in large dimensions for photographic purposes were presented.

The most convincing 3D-display device today is TV projection. The larger screen size in TV projection supports the 3D impression considerably. Fig. 8 shows the 3D-projector, which we use for our demonstration, consisting of two Barco "Data"-Projectors with polarizing filters in front of the projection lenses. The customary metallized screen causes no depolarization. By means of an additional convergence circuit the registration of the two pictures for left and right is quite well all over the screen. The reversed color sequence in the second row compensates in the resultant picture the typical color shading to be found in that kind of projectors. This principle also can be applied in rear projection. On the International Audio and Video Fair in Berlin last year, the German manufacturer Grundig presented a prototype of a 3DTV rear-projector.

### QUASI STEREOCOPY

At the end of our survey on true stereoscopic devices I would like to mention a method which adds a 3D impression to any conventional TV program, shot two-dimensionally. It has been developed at the IRT and we call it "Quasi stereoscopy". In 3D displays as described, the picture for one eye only needs to be shifted somewhat horizontally (up to 9 percent picture height) (Fig. 9). Viewed by the polarizing glasses, this displacement creates the impression that the picture is in some distance behind the screen, but moreover, the two-dimensional picture itself appears three-dimensional. This astonishing phenomenon can be explained by stimulation of spatial vision and by visual experience. Of course, it can not offer real depth information or typical 3D effects like objects protruding out of the screen, but nevertheless the spatial impression is surprising. We feel that this could be an interim solution prior to true stereoscopy.

The principle of "Quasi stereoscopy" is also the basis for the 3D television sets by the Thomson-Brandt group mentioned before. With conventional color TV sets, only the red picture component is shifted by means of a 600 nsec delay line. The viewer has to wear color filter glasses. This method also creates the three-dimensional impression, but with the drawbacks of the anaglyphic technology.

In our 3D-demonstration we present "Quasi stereoscopy" in polarizing technology, thus providing natural color. The demonstration program is a conventional TV program music show.

### CONCLUSION

The purpose of our 3D demonstration and of this paper is to stimulate a discussion. We have seen the great public interest in the 3DTV broadcasts in the simple and hardly satisfying anaglyph technology. At the presentation of our 3D demonstration

program in full color and full sharpness at the International Audio and Video Fair 1983 in Berlin, people were nearly enthusiastic: 12 000 visitors have taken the opportunity to attend the presentation and many people had to be sent away because of shortage of space.

Not only the feeling of spatial depth is the advantage of a stereoscopic system, but also the impression of a generally increased picture quality. The reasons for this phenomenon are not yet fully explicable and should be further investigated. It could be compared with stereophony, where not mainly true sound location, but the over-all transparency of sound adds the attractiveness to monophonic sound. In 3D display, the impression of resolution increases remarkably; the picture looks more crisp. Distortions as jitter, noise (especially color noise), conspicuous in a one-channel picture, appear to be significantly reduced in 3D.

The demonstration may have shown that high quality 3DTV can be achieved with conventional studio equipment. However, we are aware of the technical, economical and last but not least psychological problems which have to be solved prior to a public introduction of 3DTV. An important question would be, whether people will accept to wear glasses - shurely not in primitive cardboard mounts - or whether technologies dispensing with glasses have to be found. On the economical side it has to be taken into account that up to now for 3DTV only a limited number of 3D films are available.

Nevertheless, we believe that high quality 3D television is attractive enough and worth to think about it. Let me end with an optimistic quotation from Charles W. Smith, a well-known British expert in 3DTV: "Future generations will be astonished that for a few decades in the 20th century we were happy to accept these small flat images as a representation of the real three-dimensional world".

#### **ACKNOWLEDGEMENTS**

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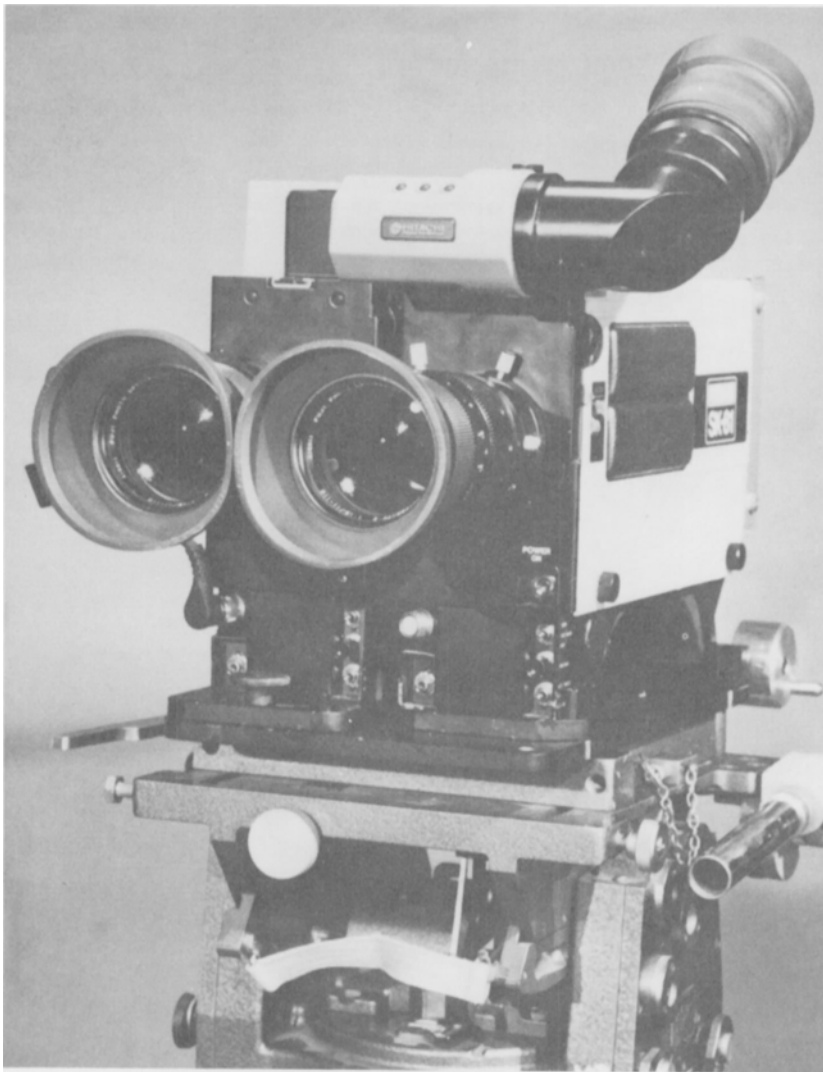


Fig. 1. 3D camera consisting of two Hitachi "SK 81" cameras (IRT).

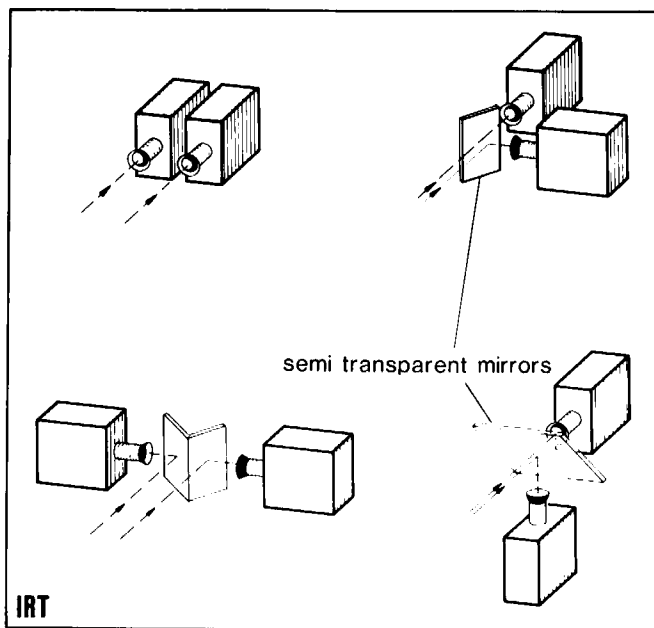


Fig. 2. Design principles of 3D cameras.

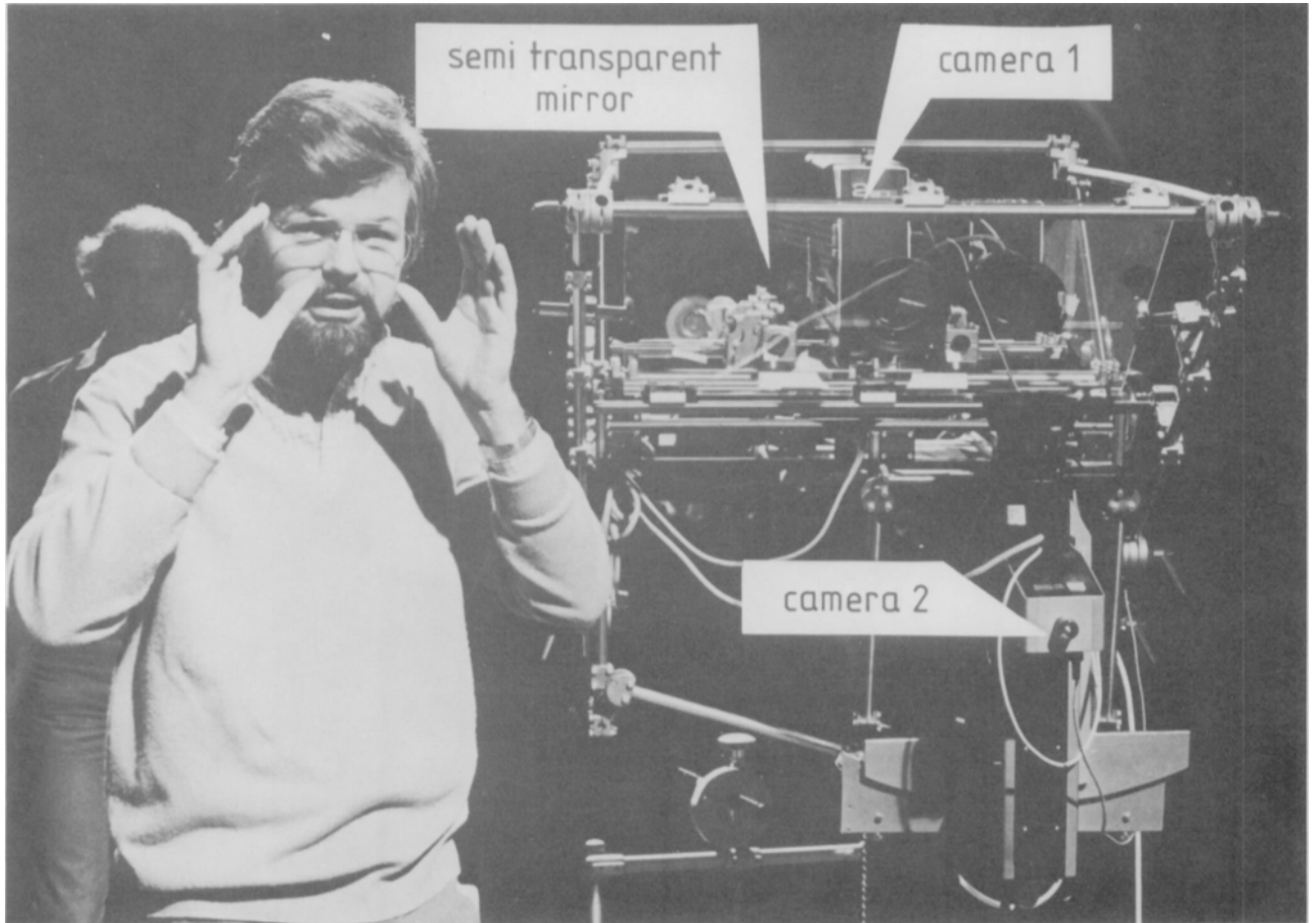


Fig. 3. 3D camera using a semi-transparent mirror for reduced interaxis distances (Philips).

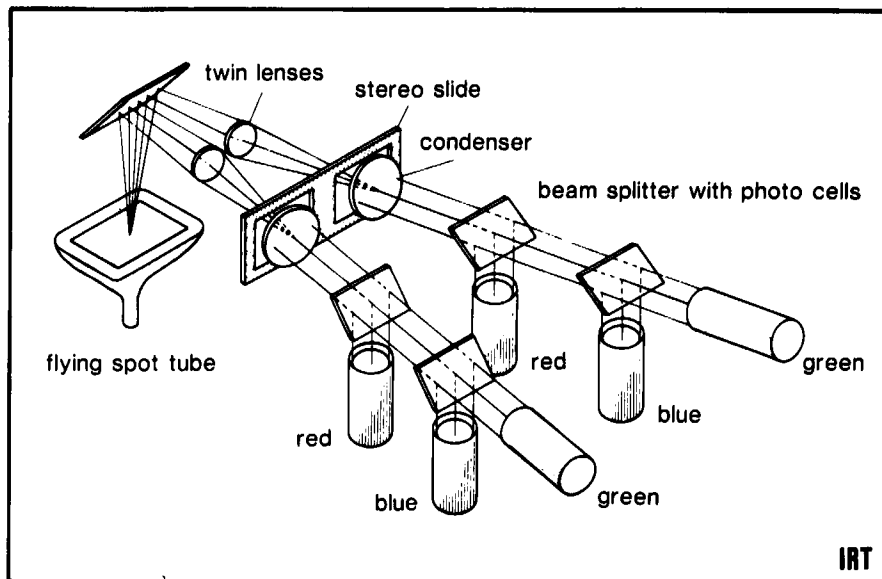


Fig. 4. Scheme of a flying-spot 3D slide scanner (IRT).



**Fig. 5.** 3D recording and display equipment consisting of two B-format VTRs (Bosch-Fernseh) and the MOSAIC editing system (IRT).



**Fig. 6.** 3D display device with two 26-in. monitors, polarizing filters and a semi-transparent mirror (IRT).

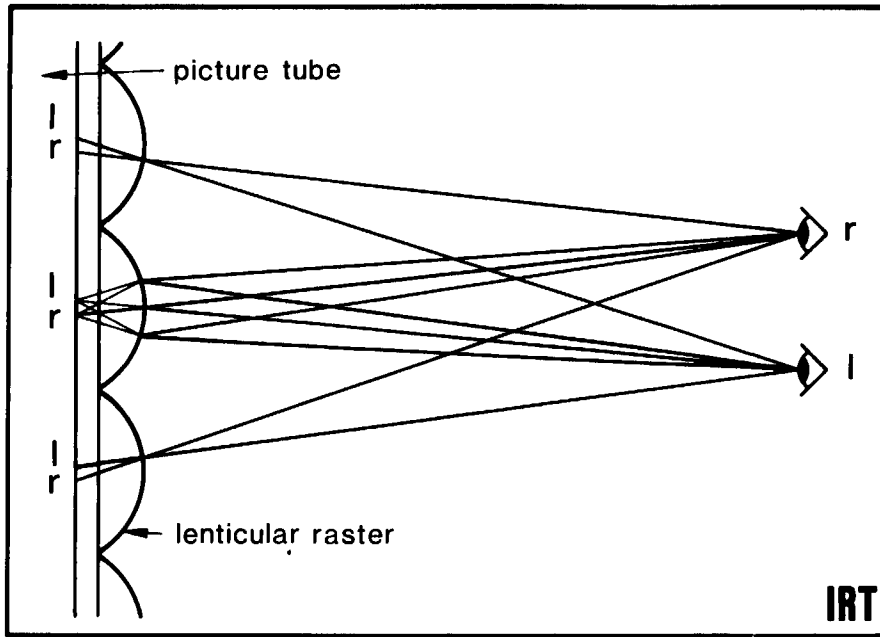


Fig. 7. Principle of a lenticular screen.

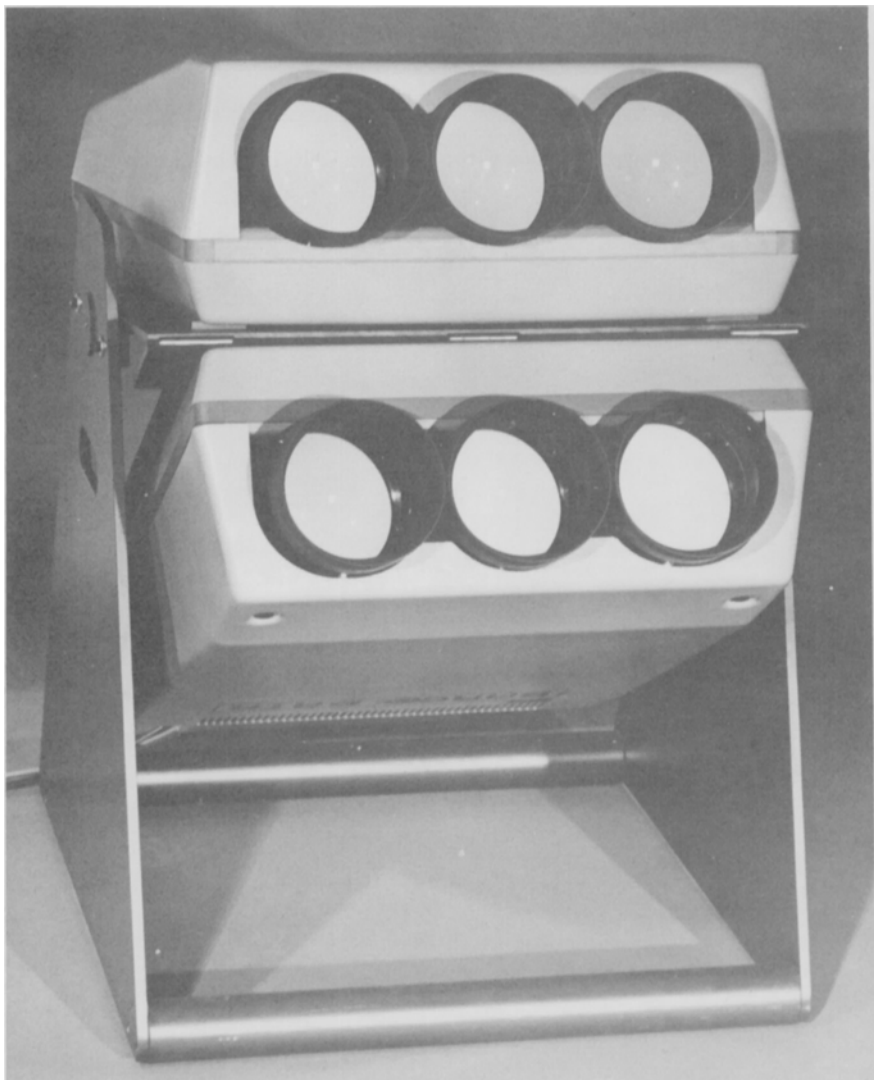


Fig. 8. 3D projector consisting of two TV Barco "DATA" projectors with polarizing filters (IRT).

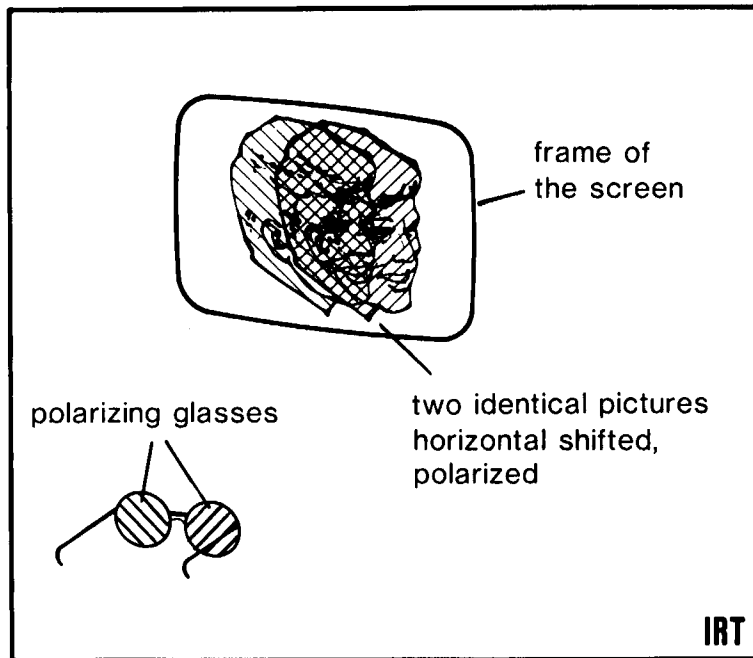


Fig. 9. Principle of "Quasi stereoscopy".



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