IBA

ENGINEERING INFORMATION SERVICE

ENGINEERING NEWS

ORACLE

A Broadcast Information Service

Introduction

In April 1973 the Independent Broadcasting Authority in the United Kingdom first broadcast trial tranmissions of a proposed new service - ORACLE. This name was chosen as an acronym for Optional Reception of Announcements by Coded Line Electronics. The ORACLE signals were transmitted in, and together with, the normal television signal, but the system represented an entirely new technique in the field of broadcasting. By and large, it is unique in what it provides and novel in its mode of operation.

Since that time the system has been expanded and rationalized, and experimental services are now being operated in the UK.

ORACLE is a system which uses the broadcast television signal to carry written text to the viewer. The text can be - and generally is - independent of the television programme being transmitted. When displayed on a television screen it appears rather like a page of typescript and can include simple line drawings.

In essence, written information (provided by an agency either part of or separate from the programme makers) is coded to a form where it can be added to the normal television signal. The whole thing is transmitted in the normal way, but the viewer who has a television set with an ORACLE decoder unit can reconstitute the text on his screen. The text in no way interferes with reception of normal programmes.

A screen filled with written text is termed in the ORACLE system a 'page' and ORACLE gives the viewer a choice of pages to display on his screen. He has a simple extra set of controls - push buttons or thumbwheel switches - with his television receiver, and these are used to select any one of the pages available.

When a selection is made, the chosen page appears on the screen after a short interval. This interval can range from almost nothing to a few seconds. The viewer can then read the page at leisure - it's there for just as long as he decides - or he can select another 'page' - or indeed return to his normal programmes.

The pages or screens of text can contain a wide range of independent information. Some could be of indexes, listing pages of news, weather, financial reports, sports results, entertainment guides and so on. The possibilities are abundant.

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The text can be arranged to be seen either against a neutral background of black or white - or overlaid on the television pictures.

ORACLE has evoked much interest from people concerned with broadcasting in the United Kingdom, principally because of four very distinctive features.

First, ORACLE is the only medium to offer the consumer news and information precisely when he wants it. He won't have to wait for a news bulletin or any particular programme. It will be there within seconds, and that news and information can be up-to-the-minute because unlike the newspaper medium, there are absolutely no delays of printing or distribution. To quote computer parlance, it is in effect a 'real time' information service for the domestic environment.

Secondly, the service may open new avenues in so-called programme-related information - text which relates to the programme being broadcast. This includes such things as subtitles for deaf viewers or foreign nationals, educational aids, programme plot summaries and so on. In fact it may add a great deal to the television services as we now know it.

Thirdly, provision of the service will cost us nothing in terms of precious radio frequency spectrum space. The entire signal is accommodated within the existing 625-line channel allocation.

Fourthly, it will be, effectively, the first broadcast system to transmit information in digital form. Indeed it is the materialization of low-cost digital circuit blocks which makes the ORACLE decoder a potentially viable consumer product.

The Development of ORACLE

The idea of using broadcast signals to provide reconstituted written material is not new; there were thoughts in this direction as far back as 1928. A significant advance in this field came in the mid-sixties with the development of 'Homefax" (1) by RCA. This was a kind of facsimile system which transmitted lines (horizontal strips) from a scanned page in the vertical interval (a part of the television signal explained in more detail later). The lines from the scanned page were used to provide a physical copy of the original page. The system, however, was not pursued; possibly because of the cost and complexity of the necessary receiving equipment.

The principles underlying the current ORACLE system first emerged within the IBA in 1972, after our engineers had completed work on a system called SLICE (2) SLICE was a system which allowed our programme company engineers to identify which of the Independent Television programme companies made any particular programme*. Each company inserted a coded digital signal into the vertical interval. This signal was used to generate a few short words which indicated where the programme originated. These signals were, of course, not passed on to the viewer.

**Independent Television in the UK is provided by fifteen regional programme companies, each serving a particular area of the country. There is frequent, often live, interchange of programme material.*

After our engineers had brought the system into operation it was perhaps natural to realise that similar signals (digital signals in the vertical interval) could be used to provide the viewer at home with information. With the cost of digital integrated circuits falling we realised that here almost certainly could be a viable new consumer product.

As a result, our original ORACLE system was developed, and by Spring 1973 trial transmissions of the new idea were taking place in the London area. At about the same time the BBC started testing their CEEFAX system which manifested itself to the viewer in a similar (though not identical) way. Unfortunately, the technical parameters of CEEFAX were quite different from those of ORACLE, and it was clear that the prospective consumer would need decoding equipment of two different types, one for the IBA channel and one for the BBC.

Fortunately, the two sides got together, with engineers from the receiver manufacturers and the Home Office. The result of this working party was a system which most people agree is far more flexible and generally superior to either the originals. It took the best features of both systems and added some excellent features suggested by the receiver industry.

A specification (3) for this unified UK standard system was published in September 1974, although current trials may result in minor changes. Copies are available from the IBA.

The Unified System

Broadly the salient editorial features of the new system are as follows :-

1. Up to 800 pages - usually described as eight, one-hundred-page magazines.

2. Each page takes up to 24 rows with maximum of 40 characters per row.

3. Upper and lower case letters are included.

4. Six different colours plus white are available, the three primaries - red, green and blue; and the three complementaries - cyan, magenta and yellow.

5. Flashing of words - usually a one second on-and-off sequence.

6. Boxing - that is, enclosing words within a black area such that the text, when superimposed on a normal television picture, appears on a black background which masks a portion of the picture.

7. A simple graphics system with a maximum horizontal resolution defined by 80 elements, and maximum vertical resolution of 69 elements.

8. Page labelling by time code (transmission time) in hours and minutes. This is explained later.

Although there are 24 rows per page, the top row (row 0) always has a predetermined format; so, effectively, there are 23 usable text lines per page. Row 0, usually called the page header, always contains the service title ORACLE, the page number, date (for example '6 Mar') and time (for example '10:03:59').

The page holds up to about 150 words of average length. This is about the same as in 3 to 4 inches of standard newspaper column, and is roughly equivalent to, say, a 30-second radio news bulletin, a weather summary, or a daily list of television programmes.

There are three ways in which the editor of the ORACLE system can use each page. First and probably most frequently, he will use it as a straight-forward page, adding new items and changes to the text as need arises. These are called Type A pages.

Second, he can change complete page contents in a predetermined cycle. For example, with a page of football results, league division one could be broadcast for say one minute - sufficient time for it to be read - then league division two for one minute on the same page number, and so on until completion of the series. The page changes would occur automatically without any action on the part of the viewer. These are called Type B pages.

The third type of page, the Type C page, makes use of the fact that, not only can a page be labelled and selected by a number (1-800), but also by the time (in hours and minutes) that it is transmitted. For example a page might be labelled 132, 10:56. If our page selection controls are set to 132, 10:56 then only page 132 as transmitted at 10:56 will be seen. Other quite different bulletins could occur on the pages 132, 10:55 and 132, 10:57. In the normal course of events (for Type A and Type B pages) this time code selection is inoperative and the receiver displays incoming pages irrespective of the transmission time. However, if some of our pages are given over to time coding, the transmitting of different bulletins at different minutes allows us to greatly increase the number of different bulletins transmitted during the day.

The ORACLE transmission format

Let us now see how the information is conveyed. Television engineers will know that television signals are made up of a large number (625 in the United Kingdom) of horizontal lines; but in fact not all of them are used to form part of the picture. About 20 or so are arranged as to be off the top of the screen, rather like a page margin. Into this margin we put our ORACLE information. This margin is known as the field blanking period, or vertical interval. Fig. 1 shows the vertical interval for the first field of the interlace. On the left is the last half line of the first field, then comes the pattern of 'mixed syncs' which tell the receiver that the field has ended and that it is time to return to the top of the screen. Following the five broad pulses and second five equalizing pulses are 17 line-time periods with no picture information on them, up to line 22. Subjective tests have shown that lines 17 and 18 of these can be used for carrying data pulses and with no visible impairment of picture on almost all correctly adjusted receivers; and similarly on lines 330 and 331 in the even field.

The active line-times for these four are used to carry the digital data which tells the receiver what to display. One active line period in fact carries the information relating to one row on the screen.

The system is page sequential; that is - first row 0 of a page is transmitted, then row 1 of that same page, then rows 2, 3 and so on to the bottom of the page; then we start with the first line of a following page and continue through the rest of the pages. Blank rows need not be transmitted. Now, although the pages are transmitted fairly quickly (approximately one in a quarter of a second) there may still be a short delay before our selected page appears on the screen. If, for example, we select page 20 at the moment page 10 is in the process of being transmitted, our page cannot appear until the intervening nine pages have come and gone. Of course, those nine pages are not seen by us; the receiver ignores them while waiting for page 20 in the sequence, and then stores and displays it. The waiting time itself depends on where one happens to be in the transmission sequence when selecting any page and, of course, the maximum and average waiting times depend on the number of pages being transmitted. For a 100-page magazine, for example, the average waiting time is about 12 seconds. Our experience so far indicates that viewers consider these delays nominal and acceptable.

Coding of display information

The alphanumerics (letters and numbers) on the screen are formed by a matrix of dots - as in the visual display units of computers. Each character when displayed occupies a certain area. One could imagine the screen as being divided into a large number (at most 24 x 40) of small rectangles, in each of which can be displayed a character with a certain margin all round it. This same rectangle is used as the basic pattern from which ORACLE graphics are formed. In the graphics mode the character and margin rectangle is divided into six sub-rectangles, any combination of which can be illuminated to give a particular pattern. These patterns connect to give us our simple drawing.

A standard row on the screen can be considered as comprising 40 of these (imaginary) rectangles, each containing either an alphanumeric or graphics pattern; corresponding with each of these rectangles is an 8-bit word group in the digital data line for that row.

The 8-bit group can be either the code for an alphanumeric, or, in combination with a special code earlier in the line, can convey a required graphics illumination pattern. The special code earlier in the line tells the receiver that what follows on this line is in graphics rather than alphanumeric mode. There are special codes for each of the colours available for graphics. Further, codes are required to tell the receiver that ensuing alphanumerics are in a particular colour. These instruction codes each occupy one 8-bit group location in the data line, and are interpreted by the receiver as a space. Therefore, in order to change colour or mode it is generally necessary to take up a space with the instruction code. (There is one exception to this, in that upper-case (UC) letters and graphics are allowed in the same line without a mode change code between them, provided that a graphics mode code is inserted before the UC letters).

The alphanumerics are coded into digital form by use of a modified ISO-7 code. Here each character is represented by a particular combination of seven '0's or 'I's, with number eight a parity bit (an error checking bit). The graphics and colour instruction codes are a specially devised 7-bit set, also with parity bit. Details are shown in Fig. 2.

All the data lines follow the same format except for the page header (row 0). For the standard text rows (rows 1 - 23) there are 40 display-related 8-bit groups, but preceding these are some additional 8-bit groups (which are not directly related to a display). First a 16-bit clock run-in. This is a train of 8 one-nought sequences which are used to synchronize the receiver sampling system. Following these is the 'framing code'. This is a particular 8-bit word (11100100), used to ensure that the receiver samples the subsequent 8-bit words at the correct start and finish bits; that is, in the correct groups. After this is a 16-bit word, the 'control and row address group'. This gives the first digit of the three-figure page number (the hundreds digit) and the row number (1-23). After this come the 40, 8-bit, groups which define what is to be displayed on the row, a combination of alphanumerics of specified colours, or graphics etc. The page header, row nought, contains the same total number of data bits (360), but the composition is somewhat different. It starts with the clock run-in, framing code, magazine number and row address, but follows this with the final two digits of the page number. Then follow 32 bits for the time code. Also in this 32-bit group is a 'clear page' bit - a bit which tells the receiver when the incoming page contains any new information, and subtitle and newsflash bits - which instruct the receiver to ignore the page header (for subtitling use). Then there are 16 currently unused bits, the service title ORACLE, the page number, the date and time (in alphanumeric 8-bit groups) to complete the line. Details are given in Figs. 3 and 4.

Two types of error protection are used. First, the simple parity bit system for display - related groups, that is, graphics and alphanumerics. Second, for non display - related groups (apart from the clock run-in and framing code) a more elaborate system known as the Hamming code (4) is used. Here an equal number of error correcting bits are interspersed with message bits, such that by operating on the resulting binary number we are able not only to detect single errors but can also locate and correct them. The use of these two systems means that, whereas errors in display related groups possibly give rise to a missing character (which may have only a small effect on overall page intelligibility) errors in the control groups (which might mean a whole row wrongly positioned) can be corrected.

The pulse shape for all the data bits is approximately that of a raised-cosine - a shape commonly used for data transmission. The pulses are of NRZ (non-return-to-zero) format. The bit rate is just under seven Megabits/second (6.9375 Mbits/sec), and we find in practice that a bandwidth of about 4.4 MHz produces acceptable results. The maximum excursion of the pulses is 70% peak white. The parameters used give almost the maximum realizable information rate for a System I (the UK television system) channel. Studies of ORACLE reception quality with field strength have shown that a minimum field strength of about 55 dB (rel. 1μV/m) free of echoes is the limit beyond which legibility begins rapidly to deteriorate. This however, is a contour some way outside the area the IBA takes as a limit of service (65 or 70 dB (rel. 1μV/m)) corresponding to a picture of poor quality.

Receiving ORACLE information

The receiver which is capable of using the ORACLE service must have essentially five additional features (see Fig. 5). First, a selector panel. This could be a control box with a connecting lead, or a set of additional controls on the set itself. The controls can be either a set of push buttons, or thumbwheel switches, which will allow the viewer to select the numbered page he wishes to see either remotely or at the set. Switches will also be needed for setting a time-code for time coded pages. The selector unit also stores the page number which has been registered.

Second, the receiver will need to include some means of extracting the data from the incoming video signal.

Third, a comparator unit to compare the page number selected with the page number of the incoming data and output data for the chosen page.

Fourth, the data for this page must be stored, because of course it must be displayed again and again, at the correct picture rate, for as long as the viewer wants it.

Fifth, the data for the stored page must then be interrogated and used as input to a character generator. The character generator output is switched onto the beam modulation circuits to provide the visual display.

Fig. 6 shows a simplified block diagram of an ORACLE decoder system. Extraction of the data from the incoming video is effected by inspecting lines in the vertical interval for the presence of the clock run-in waveform, which starts a 6.9375MHz oscillator within the decoder. Lines which have clock run-in on them are then checked for correct sequence of the framing code. The data, once recognized by framing code coincidence, can be converted from serial to eight-wire parallel form - so that the remaining logic can work at slower and more manageable rate. The page number comparator follows, and this unit outputs only those lines which follow a page header with either the required page number or page number and time code. The data is then stored in a page store - a Random Access Memory (RAM) with capacity of about 7k bits (per page). During display the RAM is interrogated at character rate, the coded output being passed to the character generator - a Read Only Memory (ROM) programmed with a set of alphanumerics and graphics symbols. This ROM converts the coded RAM output into suitable bit patterns producing a video raster scan representation of the character.

The display itself is formed on the screen either by matrices of dots to give alphanumerics, or by combinations of the six graphics sub-rectangles. The basic arrangement for alphanumerics can be a seven-by-five dot matrix, with perhaps an additional two dots for lower-case characters with descenders, such as j and g, etc. The seven-by-five matrix means that identical information must be used on each field of the interlace. A technique which renders letters more attractive, however, is that of character rounding. Here the second field of the interlace carries information slightly different from the first, making in effect a 14 by 10 matrix. This produces smoother curvature of the letters. A further display technique might be that of providing a black outline around the alphanumerics during super-imposition of text on picture. All these require different arrangements for the Read Only Memory, with consequent reflections in the complexity and cost of the decoder.

Generating ORACLE Information

Let us now consider how the ORACLE information is generated. Essentially the source agency for the ORACLE service must perform three functions. First, it must provide the staff and information sources to generate the text for the pages. Secondly, it must have available equipment which will convert the text to the correct digital sequence. Thirdly, insertion equipment is needed, either locally (if the video signal path is local) or remotely, (if it is otherwise) to transfer the data to lines 17, 18 330 and 331 of the video signal before this proceeds to the transmitter.

Probably the most flexible method of organizing the text into the coded sequences we need is by use of a small computer. This technique was used for all the original IBA trials, and indeed is used for the Independent Television experimental service. A schematic layout giving the general idea is shown in Fig. 7.

The ORACLE editorial unit computer system provides facilities for storing completed pages and for transmitting them in the correct sequence. Part of the computer's software serves to ensure that the output sequence of lines and pages which make up our 'magazine' is maintained without interruption. Another part is designed to serve the editorial team. It allows them instant access to any of the pages and to make changes at will. We have in effect a continuously operating 'real-time' system, with an editorial 'hot line'.

Changes in the text are effected most conveniently via a visual display unit, but naturally all the usual data inputing methods are possible. Use of the visual display unit allows the text to be changed almost at normal typing speeds. For our experimental service a special visual display unit has been designed which allows the editorial team to see the page contents, layouts and colours exactly as these will be displayed to the viewer.

The computer output must of course be inserted into the normal video waveform, and this is conveniently done by equipment designed originally for the insertion of Test Line signals and SLICE (2).

The Viability of an ORACLE System

There are perhaps three questions which need be considered. One, could the consumer afford to make use of an ORACLE service? Two, will he want it? Three, the media-ecologist would ask, what might be the social effects of an ORACLE service? Until only a few years ago, any suggestion that a device as complex as an ORACLE decoder would become a viable consumer product would have seemed unrealistic; but today, with large scale integrated circuit techniques, it is a distinct possibility. Also, with larger-scale production, the cost of an ORACLE decoder circuit could fall to an almost nominal figure.

The system is based on the processing of digital signals, for which the circuit design technology is readily available. At the time of writing (mid-1975) the cost of a prototype ORACLE receiver is in the order of an additional £500 per receiver. This is obviously too expensive to attract widespread sales, but there are suggestions that the cost will fall to 1/5th or even 1/10th of that amount if public demand follows certain predicitions.

There are several approaches which could be adopted in providing ORACLE decoding receivers. These are:

1. The add-on box, giving a UHF (an rf) output, for connection to the aerial socket of a receiver.

2. The conversion kit, which could be fitted to any standard receiver, either by a local dealer or by return to the manufacturer.

3. The built-in decoder unit which could be incorporated in any new set.

The first solution, the add-on box, is very attractive; but the indications are that there would inevitably be some degradation in the quality of the display. So, the second and third approaches are probably the systems more likely to be adopted. The third approach obviously sets limits on the potential growth of ORACLE units; it is superfluous to say there are many receivers currently without decoders, and it could take some years before a substantial penetration occurs. The second opinion is being investigated by manufacturers. On the basis of option 3, the "Financial Times" commissioned an independent study of the marketing potential of ORACLE type services (5). The report suggested a growth rate (in the UK) of about half that of colour television, with retail cost starting at about £150 per unit and falling to £50 - £60 after six or seven years of mass production. A similar order of costs was also recently suggested by Texas Instruments (6), the semiconductor manufacturers.

Assuming that decoder costs can be brought to a viable level, we will still have to find some method of financing the system as a whole. We in Independent Television have a marketing committee looking into the question at the moment. There are possibilities perhaps for small spot advertisements, sponsored Type C pages and so on, but as yet no definite conclusions have been reached.

The answer to the second question - will the public want the service? - is something that needs a great deal of market research, but you may care to form your own opinions by considering the scope and depth of the information which an ORACLE service might carry. Potential topics include news, sports, weather, financial reports, travel information, local entertainment guides, consumer information (food prices etc) - in fact, most of the information one now finds in any newspaper or periodical - provided this can be arranged into the concise ORACLE format. ORACLE pages can also be used for programme related information - using subtitling and overlay to provide information about any programme going on at the time. This could be a subtitle service for deaf viewers. Some estimates put the percentage of the UK viewing population able to benefit from such a service as high as 8% - i.e. over 3,000,000; hence, a subtitling service would undoubtedly represent a true social service. The major problem is going to be the question of preparing the subtitles. Our initial work points to a ratio possibly as high as 30:1 for preparation time to programme time; so, although a desirable venture, there would remain a cost effectiveness factor which migh need public financing.

Other areas for programme-related pages include translations for foreign nationals, educational aids, summaries of previous episodes of serials, cast lists, etc.

Would a widespread ORACLE service alter in any way our current mode of living? For example, would newspaper sales be affected? Would we unwittingly accelerate the rate of price changes, assuming a feedback system were to operate? Would ORACLE affect our reading habits? Perhaps most significant of all, we are suggesting that in the home we have a device capable of interpreting binary codes - some way towards a domestic visual display unit. This could be linked to the telephone as part of a more comprehensive, even interactive service. ORACLE itself could be just the beginning of a very long and exciting road. These are perhaps questions which, not only broadcasters, but all of us must consider.

Independent Television's plans for ORACLE

Last Autumn the office of the Home Secretary gave permission for a two-year trial period of ORACLE and of the BBC's parallel system CEEFAX. During that time the technical details, markets and so on could be analysed. We in Independent Television are doing all those things. Since last Autumn, we have transmitted trial magazines of between 30 and 70 pages, and from Summer 1975 a regular experimental service. The service is operated by London Weekend Television in conjunction with Thames Television and Independent Television News.

Most of the large UK receiver manufacturers have built prototype decoder units, and are currently considering how best to manufacture such units in quantity. We now forsee a year or two of developing editorial techniques, receiver designs, assessing markets and so on. Beyond that, the development of ORACLE, while still dependent on several unknowns, would seem, if predictions are correct, very promising indeed.

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Timothy Johnson, Financial Times, Business Press.

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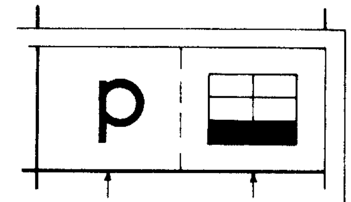
b7 b6 b5 →					0 0 0	0 0 1	0 1 0		0 1 1		1 0 0		1 0 1		1 1 0		1 1 1	
Bits b4	b3	b2	b1	Row ↓ / Column →	0	1	2		3		4		5		6		7	
0	0	0	0	0			SP		0		@(2)	@(2)(3)	P	P(3)	`(2)		p	
0	0	0	1	1		Graphics Red	!		1		A	A(3)	Q	Q(3)	a		q	
0	0	1	0	2		Graphics Green	"		2		B	B(3)	R	R(3)	b		r	
0	0	1	1	3	(1)	Graphics Yellow	£(2)		3		C	C(3)	S	S(3)	c		s	
0	1	0	0	4		Graphics Blue	$		4		D	D(3)	T	T(3)	d		t	
0	1	0	1	5		Graphics Magenta	%		5		E	E(3)	U	U(3)	e		u	
0	1	1	0	6		Graphics Cyan	&		6		F	F(3)	V	V(3)	f		v	
0	1	1	1	7		Graphics White	'		7		G	G(3)	W	W(3)	g		w	
1	0	0	0	8			(		8		H	H(3)	X	X(3)	h		x	
1	0	0	1	9		Alpha^{n} Red	)		9		I	I(3)	Y	Y(3)	i		y	
1	0	1	0	10		Alpha^{n} Green	*		:		J	J(3)	Z	Z(3)	j		z	
1	0	1	1	11		Alpha^{n} Yellow	+		;		K	K(3)	[(2)	[(2)(3)	k		{(2)	
1	1	0	0	12	Flash	Alpha^{n} Blue	,		<		L	L(3)	\(2)	\(2)(3)	l		|(2)	
1	1	0	1	13	Steady	Alpha^{n} Magenta	-		=		M	M(3)	](2)	](2)(3)	m		}(2)	
1	1	1	0	14	End Box	Alpha^{n} Cyan	.		>		N	N(3)	↑(2)	↑(2)(3)	n		—(2)	
1	1	1	1	15	Start Box	Alpha^{n} White	/		?		O	O(3)	_	_(3)	o		DEL	

control characters (4)
(columns 1 and 2)
to be displayed as spaces



character in alphanumerics mode

character in graphics mode

b_1	b_2
b_3	b_4
b_5	b_7

Graphics display rectangle showing the allocation of bit numbers to the individual cells

Notes

(1) This character code (position 0, 3) is reserved for internal use by broadcasters
(2) UK version of national use character in the ISO-7 code
(3) In the graphics mode when bit 6 = 0 the corresponding alphanumerics-mode character should be displayed
(4) All character rows start in the 'Steady', 'Alphanumeric White' and 'unboxed' condition, without control characters

FIG. 2. CHARACTER CODES FOR DATA BROADCASTING

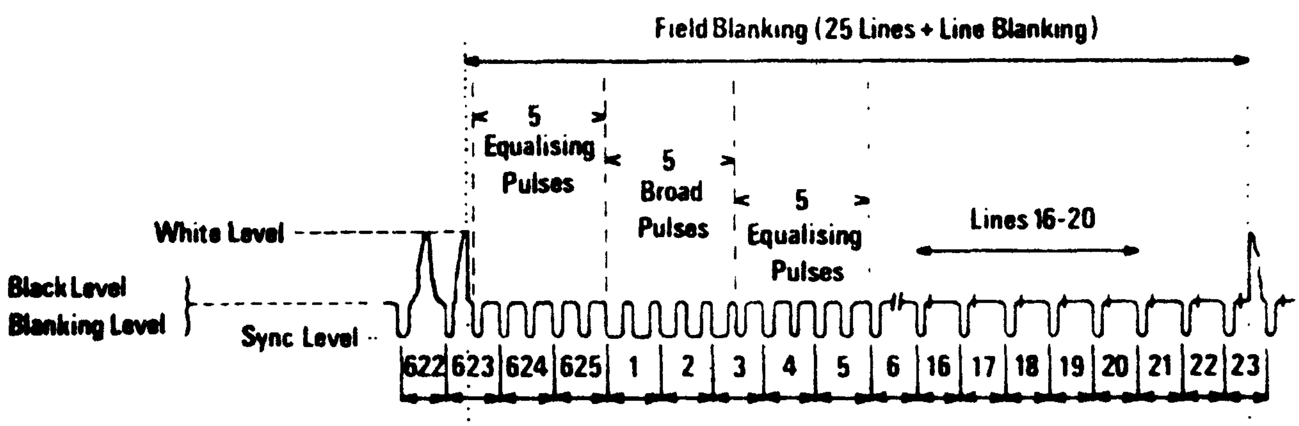


Fig. 1. A part of the television signal showing the vertical interval.

FIG. 3. PAGE HEADER (ROW 0) DATA FORMAT

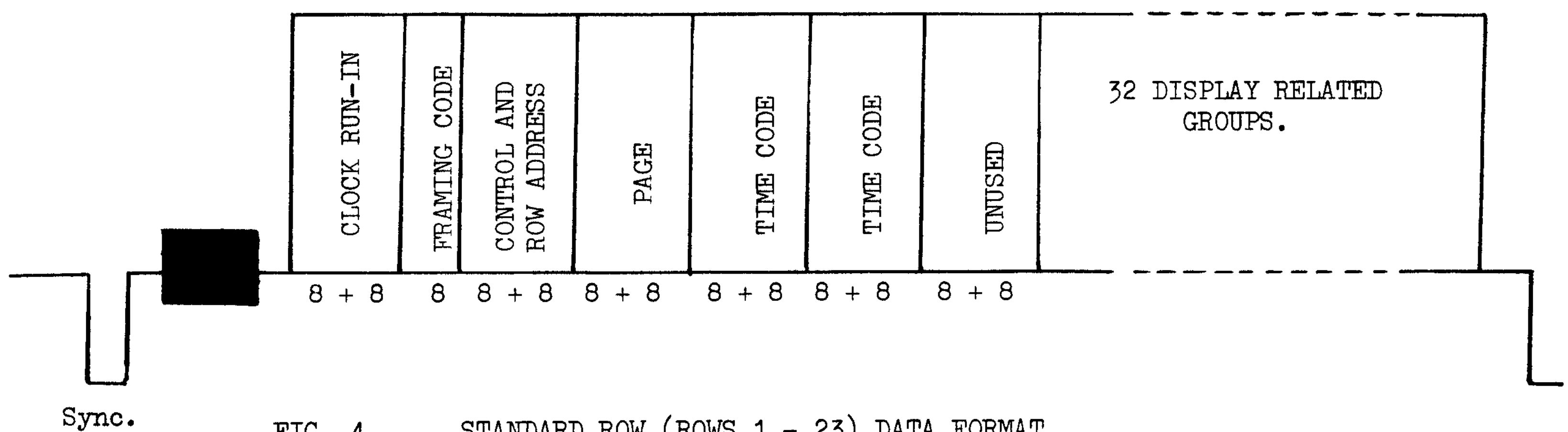


FIG. 4. STANDARD ROW (ROWS 1 - 23) DATA FORMAT

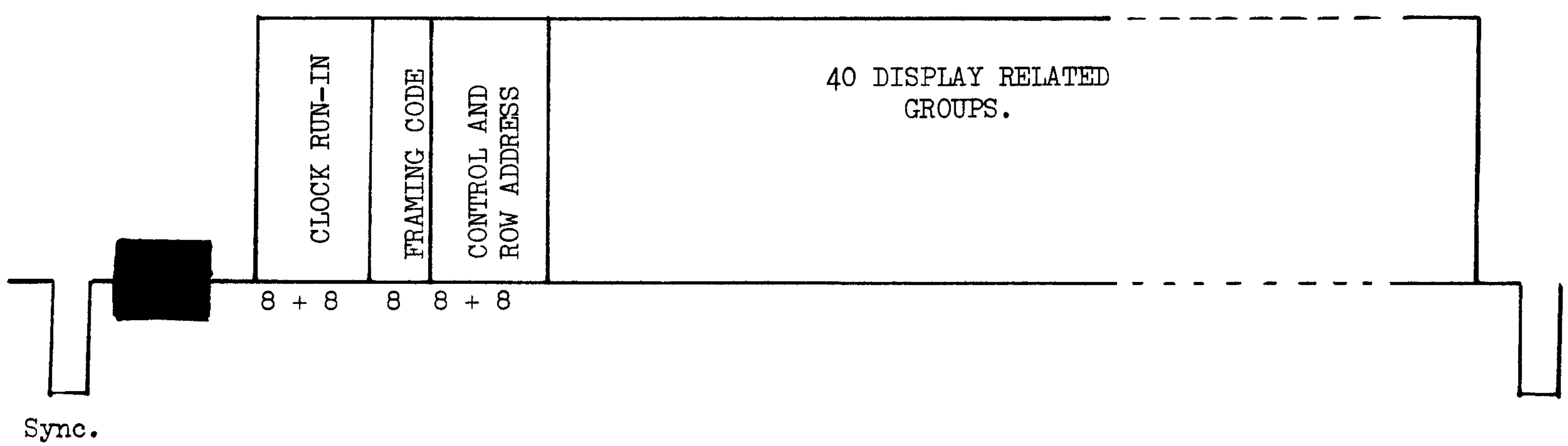


FIG. 5. ORACLE DECODER - FUNCTION SCHEMATIC

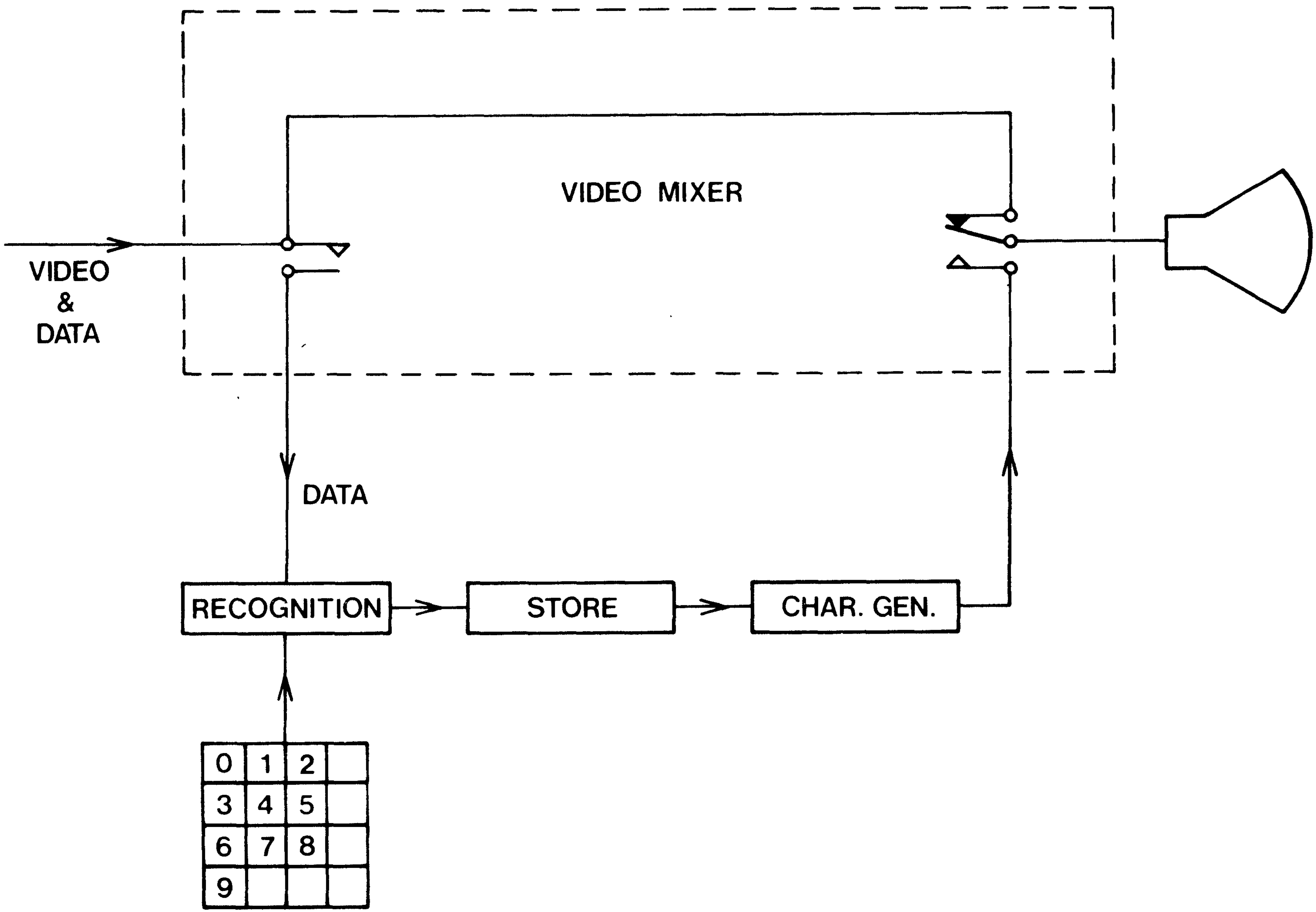
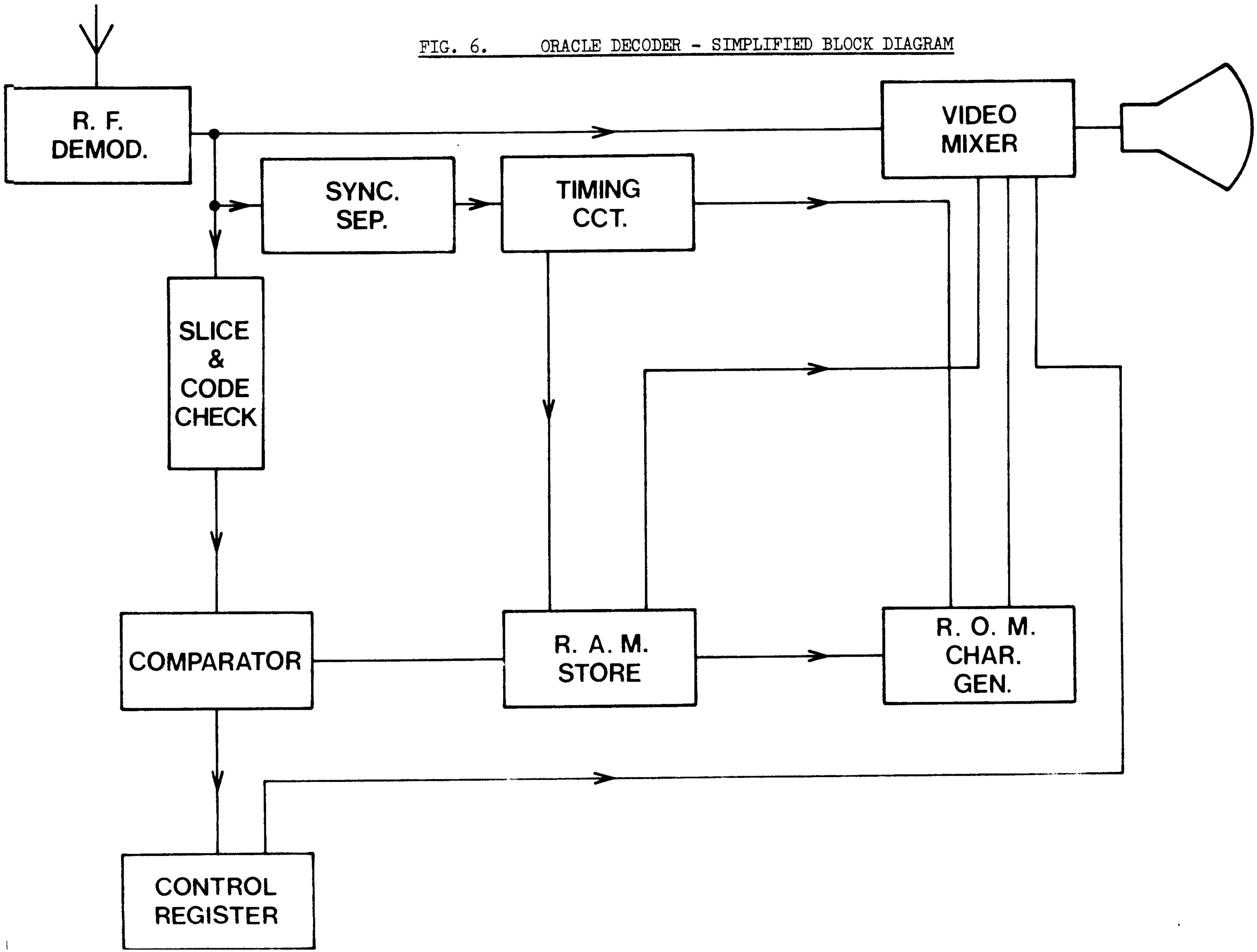
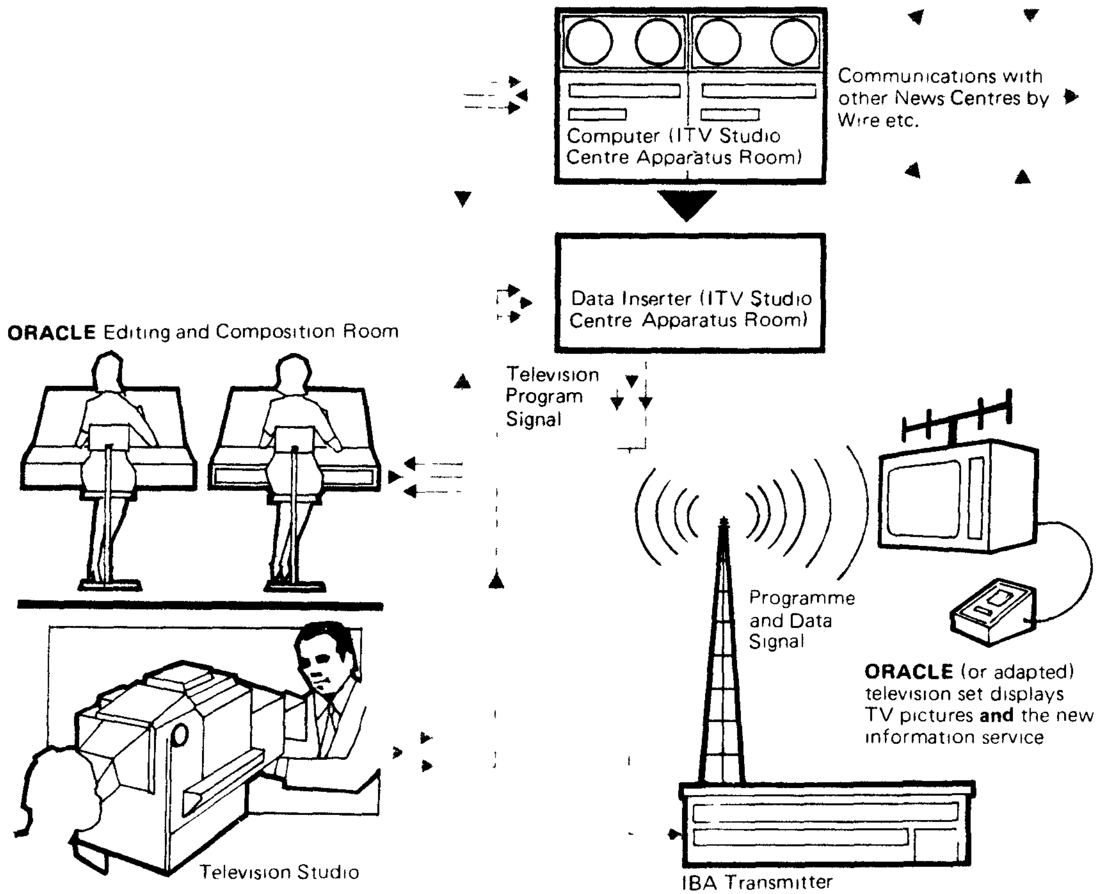


FIG. 6. ORACLE DECODER - SIMPLIFIED BLOCK DIAGRAM





Communications with other News Centres by Wire etc.
Computer (ITV Studio Centre Apparatus Room)
Data Inserter (ITV Studio Centre Apparatus Room)
ORACLE Editing and Composition Room
Television Program Signal
Programme and Data Signal
ORACLE (or adapted) television set displays TV pictures and the new information service
Television Studio
IBA Transmitter