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MAY 18, 1943. | TELEVISION METHOD AND ARRANGEMENT FOR CARRYING OUT THE SAME | **223,270**
BY A. P. C. | Filed Aug. 5, 1938 | 5 Sheets-Sheet 1

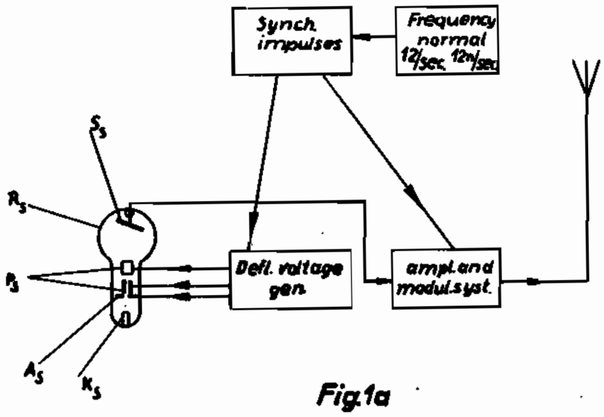

Fig. 1a

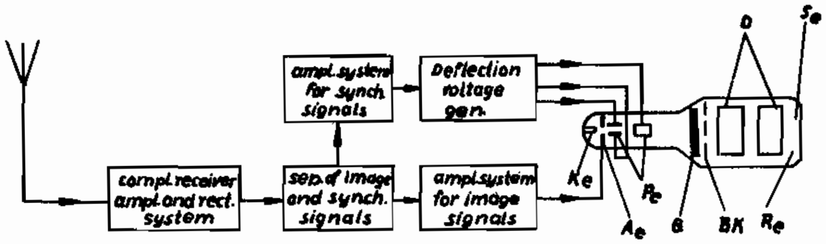

Fig. 1b

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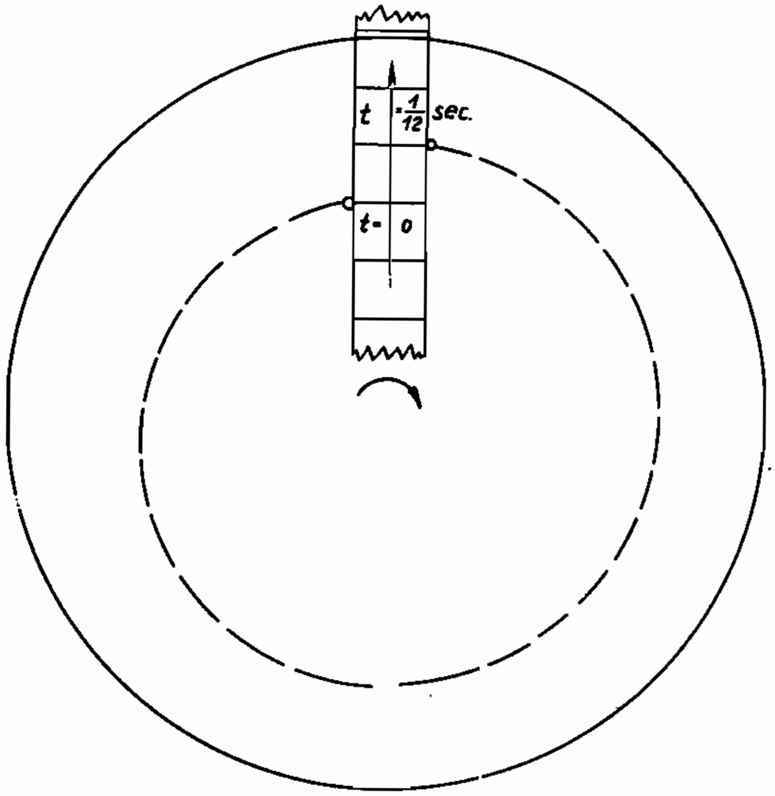

Fig.2

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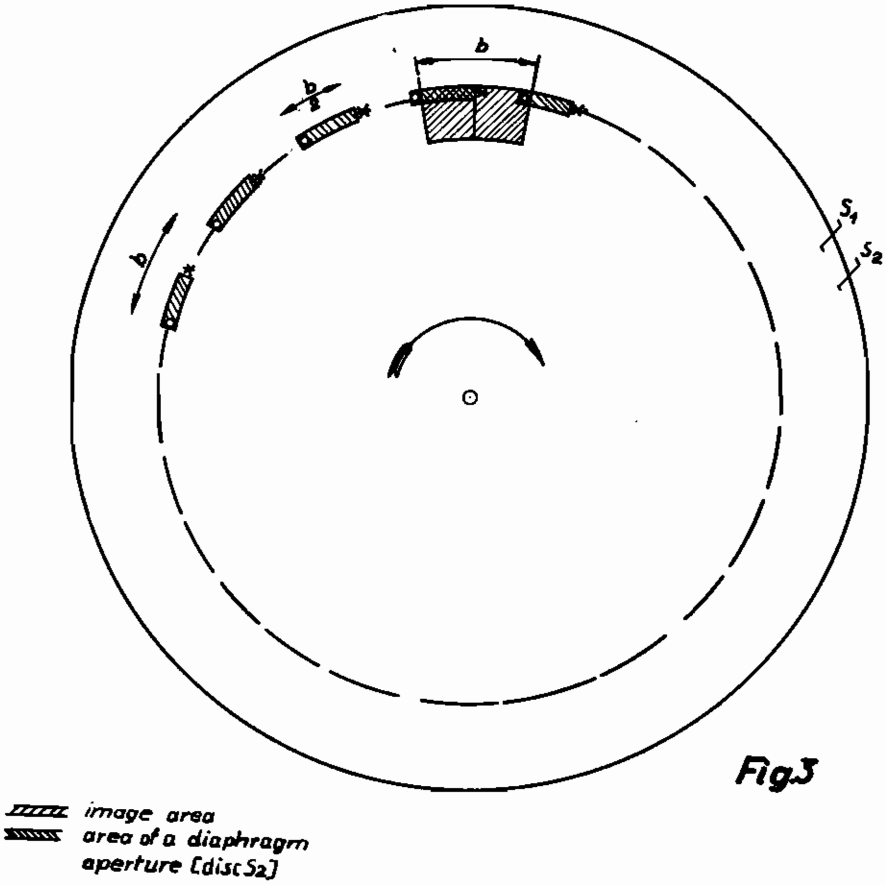

Fig.3

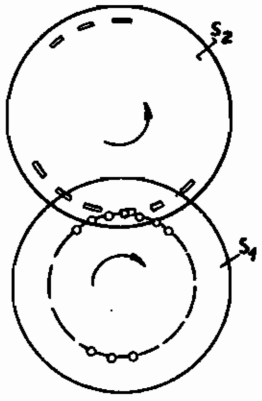

Fig.5

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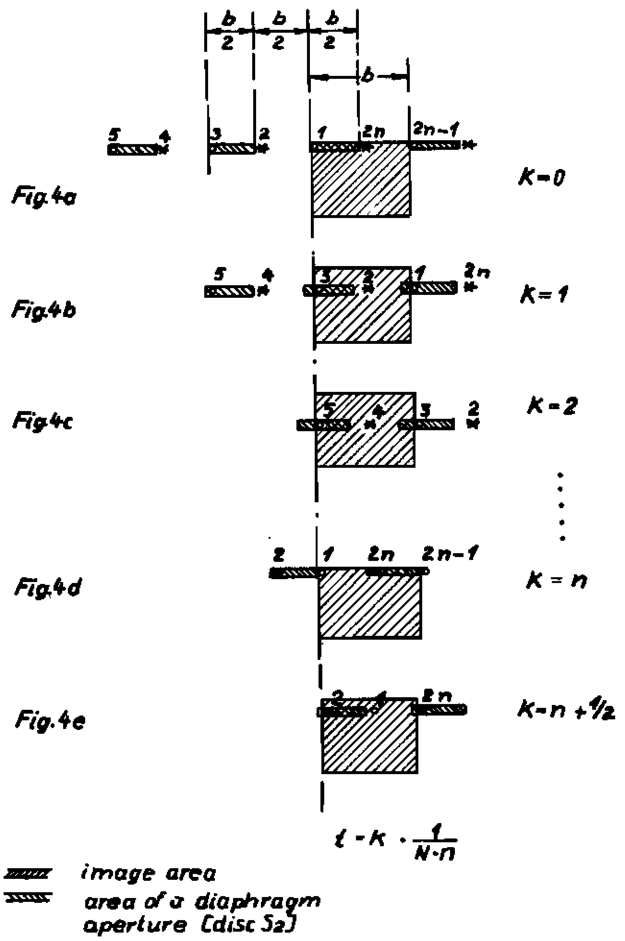

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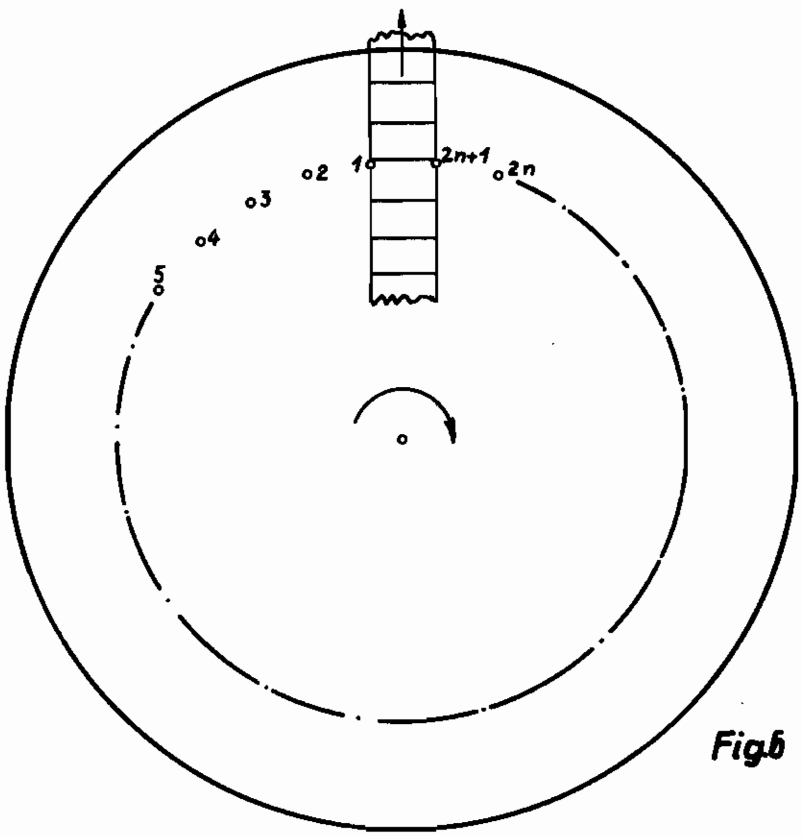

Fig.6

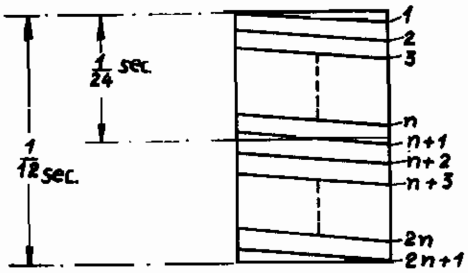

Fig.7

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ALIEN PROPERTY CUSTODIAN

TELEVISION METHOD AND ARRANGEMENT FOR CARRYING OUT THE SAME

Hanns-Heinz Wolff, Berlin, Germany; vested in the Alien Property Custodian

Application filed August 5, 1938

It has already been proposed to make use of the "storage principle", the application of which more particularly to the transmission end has recently become widely known (compare, for example, the ikonoscope), also at the receiving end, i. e. to produce received television images in such fashion that a plurality of image points, for example an entire line, or preferably even the entire image, are visible simultaneously.

The proposals made in this connection had the object of increasing the light intensity of the received television image.

The present invention relates to a television method of this nature with storage at the receiving end, and is based on the new recognition that by storage of the light impressions at the receiving end the tendency of the image to flicker is reduced. In this connection it is to be observed that in television receiving apparatus of this nature a darkening of the entire image field at times is wholly eliminated, so that television receiving means of this character, from the point of view of elimination of the flickering, possess even more favourable characteristics than a normal film. It is known that the darkening action, which is necessary in cinematograph films after $\frac{1}{24}$ sec. for the advance of the film, would lead to a flickering effect if a remedy had not been obtained by the fact that between each two unavoidable darkening actions of this kind there is included an additional darkening action, so that there are 48 darkening actions per second. It has been usual heretofore to assume that requirements of this nature require to be applied automatically to television receivers, since the characteristic properties of television receivers, from the point of view of freedom from flickering effect, have been considered fundamentally as more unfavourable than those of a cinematograph film, in which at least each single picture is projected fundamentally in its entirety. The position is different, however, in the case of television receivers operating with storage of the light impression, particularly if the storage takes place over an entire image period. In receivers of this kind the image excitation of each single element of the picture endures for such time until it has been replaced by a different image excitation. Fundamentally, a complete darkening of the image field, such as is unavoidable in a cinematograph film, does not occur in television receivers of this nature.

It has also been assumed that 24 image changes per second are necessary so that movements will not be blurred upon the reproduction. It has been found, however, that this is not the case.

It is well known that in the case of an insufficient number of image changes there is created the impression of a staccato movement. It has been found that the impression of movement acquires fluency with a number of image changes amounting to approximately 10 per second, and films with 12 image changes per second are in this respect quite faultless (the fact that they are not free from flickering has nothing to do with this). If now 12 single pictures per second are replaced by 24 pictures per second, it is true that sharper single pictures are obtained, but this greater sharpness of the single picture has subjectively no effect, as two successive pictures already appear to flow one into the other in the case of 12 single pictures per second.

The recognitions described in the above are technically utilised by the present invention. According to the invention, in a television method, the use at the receiving end of a storage principle, in which a plurality of image elements, for example a complete line and preferably an entire image, are made visible simultaneously, is combined with a transmission with a reduced number of image changes not exceeding approximately 12 per second. According to a further feature of the invention the number of image changes amounts to not less than 10 per second.

Whereas, therefore, for television purposes, image changes amounting to approximately 32 per second have been considered absolutely essential heretofore, and even with image changes in this number a satisfactory elimination of the flickering effect was not to be established, so that generally speaking there has been adopted the method of scanning in interlaced groups of lines with 48 to 50 half-scannings, it is possible in accordance with the invention when employing a storage system at the receiving end to obtain satisfactory pictures even with approximately 12 scannings of a simple kind.

A possible embodiment of the invention is described in conjunction with the diagram given in Fig. 1. In the same R_1 is an image-intercepting and signal-generating element at the transmission end, which is shown as electron camera according to the storage principle with cathode ray scanning, and possesses the cathode K_s, the anode A_s, the deflecting plates P_s and the intercepting screen S_s, whilst R_e is a receiving tube with storage of the image impression, such as the applicant has already described in a number of earlier applications, and which possesses a cathode K_e, an anode A_e, deflecting elements P_e, a grid G consisting of metallic elements insulated one against the other, a surface-like image cathode BK, an electron-optical system O for large-surface reproduction, and a luminous screen S_e. As the transmission end there is a device for producing the scanning frequencies, which according to the invention are selected to be equal to approximately 12 per second, or $12n$ per second (n being the number of lines per image), and are impressed on the synchronisation impulse generator. The synchronisation impulses produced serve, on the one hand, to synchronise the deflecting potentials produced in the scanning potential generators, and on the other hand they are conducted to the amplifying and modulating system to be impressed on the carrier wave and transmitted to the receiver. The scanning potentials are impressed on the scanning system P_s. The signal plate of the intercepting screen S_s is coupled to the amplifying and modulating system, in such a manner that the signals representing the contents of the image are also impressed on to the carrier wave. At the receiving end the received signals are amplified and rectified, the signals representing the contents of the image are separated from the synchronisation signals and amplified and modulate at the anode A_e the speed of the cathode ray, so that this charges by way of the secondary emission the grid G dependent on the image modulation. The synchronisation signals are amplified and synchronise the scanning potential generator, which supplies deflecting potentials for the system P_e. The potential-modulated cathode ray accordingly passes over the grid G synchronously with the scanning ray in the transmission tube R_s, so that the charges of the grid G correspond in their geometric distribution to the transmitted image. The emission of the image cathode BK is controlled according to the same geometric distribution, and the electron-optical reproduction of this image cathode on the luminous screen S_e accordingly provides an image corresponding to the image transmitted. The receiving tube described is designed in accordance with proposals of the applicant.

In the transmission of films, in accordance with an additional feature of the invention, the procedure may be such that only each second film picture is transmitted, so that for example in the case of a film record having **24** image changes per second there again results a transmission number of 12 per second. An arrangement having a spiral aperture disc, by means of which this idea according to the invention is capable of being realised, is illustrated diagrammatically by way of example in Fig. 2. It is assumed that the arrangement operates with continuous advance of the film. In this embodiment of the invention the direction of movement of the film is selected to be from the bottom towards the top, as indicated by the arrow. The spiral-aperture disc rotates in such fashion that apertures pass successively over the film which are always higher and higher. The rate of movement of the film, however, is selected to be so high that nevertheless a scanning takes place from the top to the bottom of the picture, i. e. the film is moved twice as quickly in the upwards direction as the location of the scanning apertures during the rotation of the disc. In the drawing there are shown the positions of a particular film picture at a time which is considered equal to "0" and one-twelfth of a second later. At the time $t=0$ the inner end point of the spiral just commences to scan the upper edge of the picture in question. At the time $t=\frac{1}{12}$ sec. the outer end point of the spiral just completes the scanning of the bottom line of the same picture. At this moment the inner end point of the spiral commences the scanning of the next picture but one. The picture situated between the two is not scanned at all, as was the intention.

According to an additional feature of the invention, an interlaced line scanning of films can be so carried out that of each two successive pictures the one is scanned in one group of lines and the other in a group of lines staggered in relation to the first group, the first picture, for example, along the lines **1**, **3**, **5** . . ., the second picture along the lines **2**, **4**, **6** . . ., the third picture again along the odd lines, and the fourth picture along the lines of even number, and so forth. An example of an arrangement for carrying out this idea is illustrated diagrammatically in Figs. 3 and 4, whilst Fig. 5 shows in relation to Fig. 3 a somewhat modified arrangement.

In the embodiment of the invention illustrated in Figs. 3 and 5 there is employed a circular-aperture discs S_1 having $2n$ apertures, assuming n to be the number of apertures for a group of lines. The distance between two adjacent apertures amounts to $b/2$, if b is the width of the picture. It is assumed that the film is turned past the disc in such fashion that two apertures, which are spaced apart to an extent equal to the entire width b of a picture scan two lines which are separated from each other by the width of a line. By means of a special diaphragm arrangement case is taken that in the interval between the scanning actions on the part of the last two apertures referred to the aperture between the same is unable to perform scanning. For this purpose there is provided a further rotary disc S_2 having a rim of n diaphragm apertures. The width of each diaphragm aperture is equal to one-half of the width of the picture, i. e. is equal to $b/2$. The distance between each two adjacent diaphragm apertures is similar. Their height is made approximately equal to but preferably greater than the height of a scanning aperture in the disc S_1.

The operation of the diaphragm S_2 will be described in conjunction with Fig. 4. As starting point there is taken the time $t=0$, when the aperture **1** commences to scan the surface of the picture. It is assumed that at this moment the diaphragm is in such a position that the aperture **1** is just situated at the left hand edge of a diaphragm aperture. Each of the remaining apertures of odd number (indicated in Fig. 4 by small circles) is also situated at the left hand edge of the appertaining diaphragm apertures. The apertures of even number (indicated in the drawing by stars) are covered at this time. N represents the number of revolutions of the disc per second. According to the invention N is selected to be approximately equal to 24, from which there then result approximately 12 complete scanning actions per second. At the phase

$$t=1\cdot\frac{1}{N.n}$$

aperture No. **3** commences to scan the image area, viz. owing to the variation in the meantime of the position of the film along the third line. In the meantime the disc S_2 has also continued to rotate, in the same direction as the disc S_1 and almost at the same speed, although somewhat more slowly, so that the left hand edges of the diaphragm apertures now lag to a slight extent behind the scanning apertures.

At the phase

$$t=k\cdot\frac{1}{N.n}$$

the aperture bearing the number $2k+1$ commences to scan. The drawing shows that as k increases the diaphragm apertures lag to an increasing extent behind the scanning apertures. The circumferential velocity of the diaphragm S_2 is so selected that after a complete revolution of the scanning aperture disc the apertures of odd number have just been shaded and those of even number uncovered. Figs. 4*d*–4*e* show the change over to the shading of the apertures of odd number in the scanning aperture disc. After a complete revolution

$$\left(k=n;\ t=\frac{1}{N}\right)$$

the aperture 1 would again just commence its scanning action. At this moment, however, it is darkened, and cannot perform scanning. Following a further half line period, however, the aperture 2 commences to move over the surface of the picture. In the meantime the film has been advanced by the width of a line in the upward direction, and the aperture 2 accordingly scans the second line of the picture, which upon the scanning by the apertures of odd number remained unscanned. This scanning by means of the apertures of even number, however, relates to a different picture to that in the scanning by the apertures of odd number, as in the meantime the film has been advanced exactly to the extent of one frame.

In viewing Figs. 4*a*–4*e* it will be seen that during a revolution of the scanning aperture disc S_1 the diaphragm S_2 must have lagged behind by the amount $b/2$ along the periphery in question. This portion is equal to the $2n$th part of the complete periphery concerned. If f_1 is the rotation frequency of the disc S_1 and f_2 the rotation frequency of the disc S_2, there results

$$\frac{f_2}{f_1}=\frac{2n-1}{2n}$$

If, for example, there is assumed a scanning operation in two groups of lines each comprising 200 lines, it is shown that the frequencies of the two discs require to differ by .25%. In the case of $f_1=24$, the example selected above, the difference in frequency accordingly amounts to

$$\Delta f=f_1-f_2=0.06$$

revolutions per second. A difference in frequency of this kind can be adjusted with extreme accuracy by stroboscopic methods.

It is now necessary to arrange the two discs S_1 and S_2 coaxially, as shown in Fig. 3. The arrangement can also be as indicated in Fig. 5.

When using the arrangement described in the above a certain difficulty arises insofar as the scanning of the second group commences, not one line period

$$\left(\frac{1}{N.n}\right)$$

but one and a half line periods after completion of the scanning of the first group (compare Figs. 4*d*–4*e*; scanning is not commenced at the time characterised by $k=n$, but at the time characterised by $k=n+\frac{1}{2}$). In the same manner scanning of the third group is delayed in relation to the second group. In a change over between two groups of lines there is always a delay of one-half of a line period, and since the movement of the film is not affected by this delay and the frames accordingly move past the scanning line at a rate equal to N frames per second, the point of location of the gap between two scanned groups is gradually shifted over the surface of the picture.

This lack of synchronism can be eliminated according to an additional feature of the invention by the use of the arrangement described in the following in conjunction with Figs. 6 and 7, which arrangement also has the advantage of greater simplicity, as in the same a special diaphragm is not required.

The scanning apertures in the disc S_1 are selected to be odd in number, equal to $2n+1$. If the film has been taken with 24 frames per second, the disc rotates with a circumferential velocity of 12 per second, whilst the film is moved at such a speed that 24 frames per second are conducted past the scanning line. In the period of time, therefore, in which all $2n+1$ apertures have been moved once past the film area two frames have passed over the scanning line. As shown in Fig. 7, this results in the fact that if the first aperture commences to scan exactly in the upper corner of a picture, the $n+1st$ aperture cuts the lower edge of the picture at the centre and it covers the second half of its scanning path in the next picture. The $n+2nd$ aperture does then not scan the first line of the picture in question, as does the first aperture, but the second line. The groups of lines in which two consecutive frames are scanned are "interlaced", which means that the lines of the one group in relation to the appertaining picture are disposed between the lines of the other group in relation to this appertaining picture.

It is to be observed that for carrying out the fundamental idea of transmitting upon the scanning of films only every second film picture, and also in carrying out the idea, upon the scanning of interlaced groups of lines, of assigning each group of lines to another picture, other arrangements would also be possible to those discussed in the above. The fundamental ideas of the present invention are not limited to the described embodiments.

The great significance of the present invention resides above all in the fact that it greatly cuts down the width of the frequency band in the transmission. From this there result inter alia the following technical advantages:

(1) Considerable simplification and cheapening of the receiver connection system (smaller demands on the band filters, etc.),

(2) Simplification of the side band problem.

(3) Possibility of a longer carrier wave, and in consequence

(*a*) relaxation of the demands on connection, aerial design, etc., at the transmission and receiving ends imposed by the shortness of the carrier wave,

(*b*) greater range of the television transmitter and less effect on the reception by elevations of the ground or the like between the transmitter and the receiver.

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