

Dec. 28, 1948.

L. E. FLORY

2,457,456

READING AID FOR THE BLIND

Filed May 14, 1946

Fig. 1

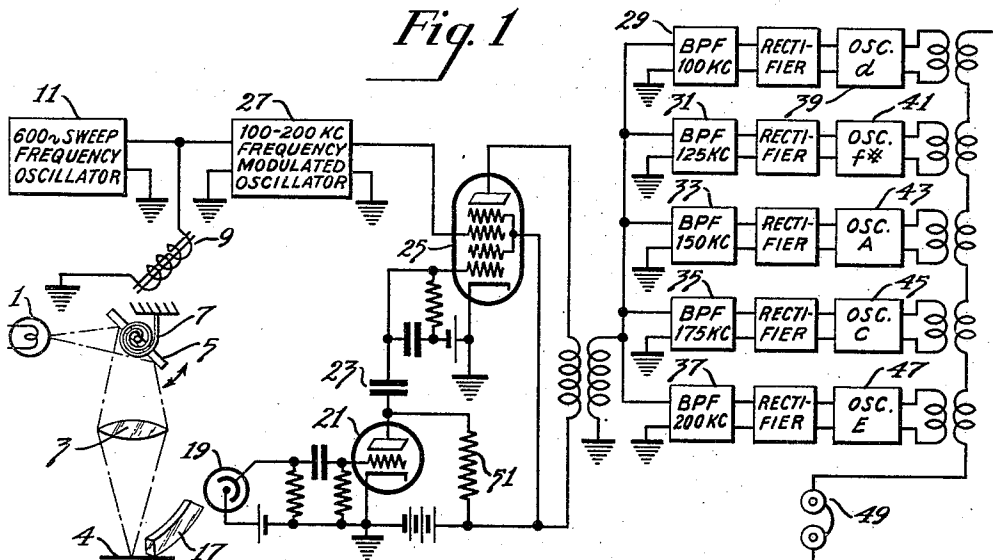
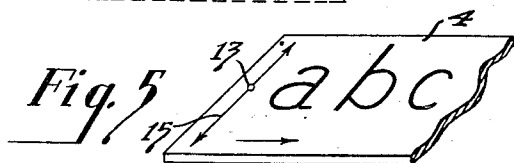
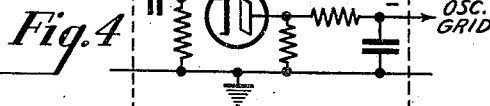
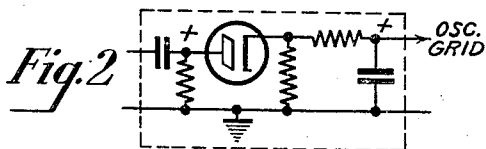
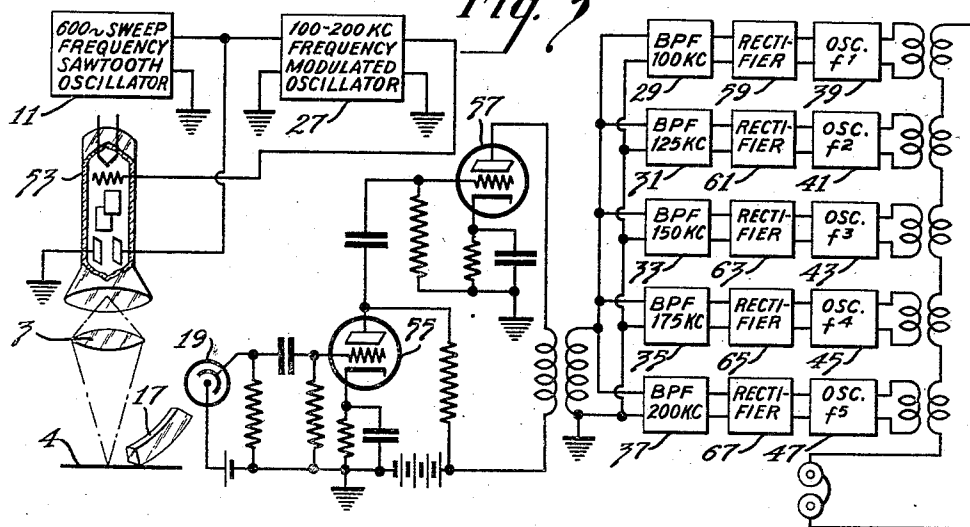


Fig. 3



INVENTOR.
Leslie E. Flory
BY *CD Huska*
ATTORNEY.

UNITED STATES PATENT OFFICE

2,457,456

READING AID FOR THE BLIND

Leslie E. Flory, Princeton, N. J., assignor to Radio Corporation of America, a corporation of Delaware

Application May 14, 1946; Serial No. 669,542

17 Claims. (Cl. 250—41.5)

1

This invention relates to the art of converting light energy into sound energy and has for its principal object the provision of an improved method of and apparatus for enabling a blind person to locate and distinguish between different degrees of light through the ear and thus to read printed matter.

In a copending application of V. K. Zworykin, Serial No. 560,472, filed October 26, 1944, now Patent No. 2,451,014, a device of the same general type is described and claimed. In the aforementioned device a light beam is caused to scan each letter or other elementary area of the printed surface being examined and the reflected light is employed to control the amplitude of an oscillator whose frequency is caused to vary synchronously with the movement of the scanning beam. The resultant output is an audible tone which is interrupted at the scanning frequency as the beam passes from white to black areas. Reading is accomplished by identifying the black area in terms of the frequency of the tones produced during the scanning cycle. Some difficulty has been experienced heretofore in identifying the position of the black areas due to the presence of these scanning frequency interruptions, because they introduce a constant tone and a large number of harmonic frequencies into the output circuit, thus tending to confuse the tones and to make them partially indistinguishable. It is therefore the primary object of this invention to provide an improved reading aid which is free from these disadvantages.

In accordance with the present invention, an improved apparatus is provided in which a plurality of separate oscillators for producing currents of distinguishable audible frequencies are controlled by direct current voltages produced by the frequency-modulated signal whose instantaneous frequency corresponds to the beam position, so that a pure tone is produced representative of the instantaneous position of the beam. This tone is not interrupted at the scanning frequency and therefore it is more easily identified.

The novel features that are considered characteristic of this invention are set forth with particularity in the appended claims. The invention both as to its organization and method of operation, as well as additional objects and advantages thereof, will best be understood from the following description when read in connection with the accompanying drawings, in which

Figure 1 is a schematic diagram of a reading aid in accordance with this invention;

2

Figure 2 is a circuit diagram of a rectifier used in connection with Fig. 1;

Figure 3 is an alternative embodiment employing a cathode ray tube;

Figure 4 is a schematic diagram of a rectifier used in connection with Figure 3; and

Figure 5 is a perspective view illustrating the movement of a scanning beam across the printed line.

Similar reference numerals are used to identify similar elements throughout the several figures of the drawing.

Referring now to Fig. 1, a single line of a printed page 4 is scanned in a vertical direction by a light beam produced, for example, by a lamp 1 reflected from a vibratory mirror 5 focused on the page in a small spot by a lens 3. The mirror is mounted for limited rotation about an axis perpendicular to the drawing and is held in a normal position by a hairspring 7. An electromagnet 9 is positioned so as to react to the desired degree on the mirror when actuated by sweep frequency currents produced by an oscillator 11. The mirror 5 may be a metal mirror so as to respond to the magnetic field produced by the electromagnet 9 or it may be a small glass mirror having attached thereto a small piece of iron or other magnetic material. The vibration of the mirror is adjusted so as to cause the spot of light 13 to scan successive elemental areas along a line 15 perpendicular to the printed matter, as illustrated in Fig. 5. It will be understood that the light source, vibratory mirror and pickup device, and such other apparatus as may be desired are mounted in a small container adapted to be moved by the user along the line of print in a direction perpendicular to the direction of scanning so as to cause the spot to scan successively adjacent areas and ultimately to cover the entire line. The sweep frequency has such a value that it is substantially above any frequency generated by moving the scanner along the line of letters, as for example, 600 cycles.

Light reflected from the surface of the page being scanned is picked up by a Lucite rod 17 and fed to a phototube 19, the output of which is coupled through a resistance-capacitance network to the grid of an amplifier tube 21. In actual practice the Lucite rod would be located approximately 90° from the position illustrated so that the light spot moves substantially parallel to its face. The output of amplifier 21 is coupled through a capacitor 23 to the first grid of a second amplifier 25 of the multigrid type. The second grid of this amplifier is energized by

3

the output of a frequency modulated oscillator 27 which sweeps between two frequencies, from 100 to 200 kilocycles, for example, in synchronism with the scanning frequency, by means of a control circuit derived from the sweep frequency oscillator 11 in accordance with well-known practice. The output of amplifier 25 is coupled to the input circuits of each of a plurality of band pass filters. Although this invention has been illustrated with five band pass filters it will be understood that more or less may be used, depending upon the degree of definition which is desired. Each band pass filter is tuned to pass a different band of frequencies within the range covered by the frequency modulated oscillator 27. Thus, filter 29 passes currents having a frequency of 100 kc.; filter 31 is tuned to 125 kc.; filter 33 is tuned to 150 kc.; filter 35 is tuned to 175 kc.; and filter 37 is tuned to 200 kc. The output of each band pass filter feeds into a diode rectifier which produces a positive rectified voltage as illustrated in Fig. 2. Each rectifier in turn is connected to one of the five audio oscillators, 39, 41, 43, 45, 47, which are adjusted to produce the audible tones to be heard by the user. The frequencies employed are preferably those harmonically related in accordance with a portion of a musical scale, and may be tuned to produce, for example, the musical notes *d*, *f*#, *a*, *c* and *e*. The output circuits of the five oscillators are connected in series with a reproducing device such as a pair of headphones 49.

Amplifier 21 is operated at zero grid bias and thus a normal plate current flows through the plate resistor 51 producing a substantial I. R. drop in this resistor. The grid is capacitively coupled to the cathode of the phototube 19. It is a well known characteristic of phototubes that the cathode potential approaches the potential of the anode when the cathode is illuminated. Because of the differentiating action of the grid coupling capacitor, a positive pulse is applied to the grid of amplifier 21 when the cathode receives more light, and a negative pulse when the light is reduced. Thus when the spot moves from a white marginal area to a black area, a negative pulse is applied to the grid of amplifier 21 which causes a positive pulse to be applied to the first grid of amplifier 25. As the spot passes from the black area to a white area again, a positive pulse is applied to the grid of amplifier 21, which restores the original condition.

The second amplifier 25 is normally biased to cut off and thus, in the absence of the positive pulse produced by the movement of the spot from a white to a black area, produces no signal in its output circuit. The above mentioned positive pulse, however, overcomes the cut-off bias and the tube then becomes conductive and passes the radio frequency currents from the oscillator 27 which are applied to all of the band pass filters. Since the frequency of the frequency modulated oscillator 27 is changing in synchronism with the scanning movement of the beam, its frequency will be determined by the position of the beam when it strikes a black area. If, for example, its frequency was of the order of 125 kc. when the spot first struck a black area, this frequency would be rejected by all except band pass filter 31, and a positive D. C. voltage would be developed by the associated rectifier, the circuit of which is shown in Fig. 2. This positive voltage is utilized to put oscillator 41 in operation, it being understood that all the audio frequency oscillators, 39 to 47, inclusive, are normally biased off and operate only

4

when a positive potential is applied by their respective rectifiers. As a result the tone *f*# will be heard by the user, thus permitting him to visualize the position of the spot and thus the position of the black area.

The time constant of the resistance-capacitance networks utilized in the various rectifiers is made sufficiently long to prevent the scanning frequency from coming through. Otherwise stated, the rectified voltage will hold throughout one cycle of the sweep frequency oscillator. As a result, as the beam passes from one elemental area to the other accomplishing the vertical scanning of the line, the various oscillators will be turned on each time the spot passes into a black area in a position corresponding to the frequency of the oscillator concerned, and will be turned off when the spot passes from a black area to the white area. If, however, the spot is scanning the letter L, having a substantial length throughout several adjacent areas in a vertical direction, all the oscillators corresponding to the regions covered by the letter will simultaneously be in operation. Since audio oscillators 39 to 47 are merely keyed on and off in accordance with changes in light reflected from the pages, substantially pure tones are produced which do not contain sweep frequency components. This gives a highly pleasing tone to the user and identification is more easily accomplished.

An alternative embodiment is illustrated in Fig. 3 in which the mechanical system for scanning the line is replaced by a cathode ray tube 53 in which the beam is focused on the luminescent screen and deflected in the vertical direction by connecting the output of the sweep frequency oscillator 11 across the appropriate deflecting electrodes of the cathode ray tube. The moving spot is focused on the page 4 by a lens 3 as in the previous case. The output of the frequency modulated oscillator 27 is applied to the control grid of the cathode ray tube so as to modulate the intensity of the cathode ray beam in accordance with the output frequency, which is synchronized with the sweep frequency as in the preceding illustration. The luminescent screen must be of a material such as zinc oxide which will respond to frequencies of hundreds of kilocycles. In the present case, however, it may be preferable to utilize a sawtooth wave to deflect the light spot so that the return path of the spot is substantially instantaneous and the alternate scanning cycles progress in the same direction in each case.

The light reflected from the surface of the page 4 is picked up by the Lucite rod 17 and applied to phototube 19 as in the previous case. For reasons which will appear subsequently, the two amplifier tubes 55 and 57 may be biased for class A operation. The output is applied to the five band pass filters 29 to 37 which in turn feed into five rectifiers 59, 61, 63, 65 and 67 respectively, which develop negative rectified potentials, and which are connected as shown in Fig. 4. Each rectifier controls one of the five audio oscillators as in the previous illustration.

The operation of the embodiment illustrated in Fig. 3 differs somewhat from that previously described for the reason that the audio oscillators must be made to operate by the absence of a signal. This is because it is desirable to indicate the black areas, and when the spot is on a black area no signal from the frequency-modulated oscillator is applied to the frequency selective circuits. Considering first, therefore, the situation when the beam is scanning an entirely white

5

area, it will be appreciated that the reflected light applied to the phototube will contain the frequency modulated currents corresponding at any instant to the position of the spot. These currents will be amplified by amplifiers 55 and 57 and will therefore energize in turn all of the band pass filters and the rectifiers will then, in each case, apply a constant negative voltage to the grid of its associated audio oscillator. This negative voltage is sufficient to prevent oscillations and no audio signal is therefore applied to the output circuit. If the spot strikes a black area corresponding to the instant when the output of the frequency-modulated oscillator is passing through 125 kc., for example, no signal will be applied to rectifier 61, no negative voltage will be developed and consequently oscillator 71 will go into operation and will produce an audio frequency in the output circuit. If the extent of the black area is sufficient to cover the region which corresponds to the radio frequency bands represented by two or more band pass filters, the additional oscillators will be brought into operation as before and a musical tone will be produced representative of the location of the black area along the vertical scanning line.

A reading aid for the blind has thus been described which includes a spot of light for scanning an area in one direction while advancing the spot across the area in a direction at right angles thereto and for producing a plurality of currents of distinctive frequencies characteristic of the position of the spot and which are controlled in amplitude in accordance with the amount of light reflected from the area being scanned.

What I claim is:

1. The combination which includes means for producing a spot of light, means for moving said spot cyclically across an area in one direction while advancing said spot along said area in a direction at an angle to said one direction, means for producing a plurality of separate currents of distinctive frequencies, and means for controlling the amplitudes of said separate currents in accordance with the amount of light reflected from said area.

2. A device of the character described in claim 1 in which each of said currents is controlled by the light reflected from a different portion of said scanned area.

3. A device of the character described in claim 1 in which each of said currents is controlled by the light reflected from a different portion of said scanned area and maximum reflected light corresponds to minimum current amplitude.

4. The combination which includes means for scanning an area in one direction with a spot of light while advancing said spot across said area in a direction at an angle to the scanning direction; a source of oscillations; means for modulating the frequency of said oscillations in synchronism with the scanning movement of said spot; a plurality of frequency selective filter networks each responsive to a different frequency; means for applying said frequency modulated oscillations to said networks; means for varying the amplitude of said applied oscillations in accordance with the amount of light reflected from said area at any instant, means for producing currents of distinctive frequencies characteristic of each of said networks; and means for controlling individually the amplitudes of said currents in accordance with the variations of amplitude of said applied oscillations.

6

5. A device of the character described in claim 4 in which said currents have harmonically related frequencies corresponding to notes of a musical scale.

6. A device of the character described in claim 4 in which said means for applying said frequency modulated oscillations to said networks includes a thermionic tube whose gain is varied in accordance with the amount of light reflected from said area.

7. A device of the character described in claim 4 in which said currents have a maximum amplitude when the light reflected from said area is a minimum.

8. A device of the character described in claim 4 in which said means for varying the amplitude of said applied oscillations includes a phototube responsive to the amount of light reflected from said area.

9. A device of the character described in claim 4 in which said means for scanning an area in one direction with a beam of light includes a cathode ray tube for producing a moving spot of light, and means for focusing said spot on said area.

10. The combination which includes means for scanning an area with a spot of light moving up and down at a fixed frequency while advancing said spot across said area in a direction perpendicular to the scanning direction; a source of oscillations having a nominal frequency substantially higher than said fixed frequency; means for modulating the frequency of said oscillations between predetermined limits synchronously with the scanning movement of said spot, a plurality of frequency selective filter networks each responsive to a different frequency between said predetermined limits; means for applying said frequency modulated oscillations to said networks to induce currents of distinctive frequencies in said networks; means for varying the amplitude of said applied oscillations in accordance with the amount of light reflected from said area at any instant; means for generating separate currents of distinctive frequencies characteristic of each of said networks; and means for controlling the amplitudes of said separate currents in accordance with the amplitude of said induced currents, respectively.

11. A device of the character described in claim 10 in which said nominal frequency is above the range of audibility, said fixed frequency is within the audible frequency; and the frequencies of said separate currents are harmonically related audible frequencies.

12. A device of the character described in claim 10 in which said means for controlling the amplitudes of said separate currents includes a means in circuit with each of said networks for rectifying said induced currents to produce D. C. voltages which control the amplitudes of respective ones of said separate currents.

13. A device of the character described in claim 10 which includes, in addition, means for converting said separate currents into audible tones.

14. A device of the character described in claim 10 in which the amplitudes of said separate currents are a maximum when the light reflected from said area at any instant is a minimum.

15. The combination which includes a cathode ray tube, means for producing a visible spot of light on the screen of said tube; a source of oscillations having a nominal frequency; means for modulating the frequency of said oscillations between predetermined limits, and for synchronous-

7

ly deflecting said spot at a predetermined fixed rate; means for modulating the intensity of said spot in accordance with said frequency modulated oscillations; means for focusing said spot on a surface characterized by having elemental areas of different reflectivity whereby the movement of said spot scans said surface in a given direction, said surface and said spot being relatively movable in a direction perpendicular to said given direction, and means responsive to the light reflected from said surface for producing a tone characteristic of the position of said spot.

16. A device of the character described in claim 15 in which said means responsive to the light reflected from said surface includes a phototube.

17. A device of the character described in claim 15 in which said means responsive to the light re-

8

flected from said surface for producing a tone characteristic of the position of said spot includes means for generating a plurality of separate audio frequency currents, and means for controlling the amplitudes of said currents in accordance with the amount of light reflected from said surface.

LESLIE E. FLORY.

REFERENCES CITED

10 The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,320,366	Houskeeper	Oct. 28, 1919
1,350,954	Barr et al.	Aug. 24, 1920
1,352,940	Brown	Sept. 14, 1920