The invention relates to a convergence and geometry adjusting device for a video projector having several cathode ray tubes.

A video projector is a television receiver projecting images on a screen having larger dimensions than those of the normal screens of cathode ray tubes. The most common type comprises three cathode ray tubes, one for each primary colour and, for each of these tubes, optics for projection onto a screen.

A video projector normally comprises geometry correction circuits acting on the scanning of the three tubes in order to correct the usual television image distortions such as the north-south pincushion distortion, the east-west pincushion distortion and the specific distortions of the video projector, which are due to the variable inclination of the axes of the tubes with respect to a perpendicular to the screen. In fact, the most common case is a vertical screen and tubes whose axes are not in a horizontal plane but in a plane which is upwardly inclined in the direction of projection; the shape of the projection surface also constitutes a possible cause of geometric distortion of the image.

These geometry defects are corrected by acting on the horizontal and vertical deflection fields by means of geometry correction circuits. Such geometry correction circuits are known for example from the document US-A-4 395 662. Certain geometry corrections are independent of the orientation of the tubes with respect to the screen or of the shape of said tubes; they are generally performed by the manufacturer. The other corrections are performed by the user (or installer): they concern horizontal keystone distortion, vertical linearity and vertical amplitude defects. The vertical amplitude defect is a deviation of the height of the image with respect to the normal; the vertical linearity defect consists in the non-conservation of distances in the vertical direction and the horizontal keystone distortion is a distortion of the image which, instead of being rectangular, has the shape of a trapezium with horizontal parallel edges.

These corrections can be performed by adjusting the position of the screen with respect to that of the video projector. This operation is relatively difficult to perform. That is why provision is often made for acting on the scanning in order to perform these corrections; in the known devices, three adjustments are provided on the device: the first for amplitude, the second for linearity and the third for the keystone distortion. These adjustments are also difficult to carry out.

The invention overcomes this disadvantage.

The adjusting device according to the invention comprises a geometry adjusting circuit to be operated by the user, a single parameter (and therefore a single adjustment) being used for correction of all the horizontal keystone distortion, vertical linearity and vertical amplitude defects. The adjustment means is preferably on a remote control unit.

In one embodiment, each of the three tubes comprises an auxiliary coil to which are applied the geometry correction signals, whether these corrections are performed by the manufacturer or by the user.

In one example, there is provided an integrator of a signal having a frame frequency whose initial value (which constitutes the said single parameter) can be adjusted by the user and whose output signal is used for performing the vertical amplitude and horizontal keystone distortion corrections as well as a second integrator fed by the output signal of the first integrator for controlling the vertical linearity correction.

Furthermore, the images produced by the three tubes must be perfectly superimposed on the screen. This result is practically impossible to achieve by means of simple adjustments of the orientation of the tubes and of the projection optics. There are various reasons for this impossibility: the spread, which is inherent in mass production, of the shapes of the images produced by each of the tubes; the lenses which are usually made from plastic material and which, for reasons of economy, do not have chromatic corrections and which do not therefore

have the same refraction index for the three primary colours; the axes of the three tubes cannot all be perpendicular to the projection screen: in general the axis of the tube projecting the green image is in principle perpendicular to the screen and the axes of the tubes projecting the red and blue images are inclined in opposite directions with respect to this perpendicular; thus the green image can be rectangular while the red and blue images have the shape of a trapezium with parallel vertical edges (vertical keystone distortion).

That is why a video projector comprises a convergence adjusting or correction circuit which generates currents feeding coils acting on the horizontal and vertical deflections of the electron beams of two of the tubes, in general the red tube and the blue tube, in order to shape the corresponding images so that they are superimposed, on the screen, on the image projected by the first tube, namely the green tube. Such a convergence correction circuit is known for example from the document US-A-3 943 279. This correction is carried out either directly on the currents of the line (horizontal) deflection and frame (vertical) deflection coils by means of active elements and modulators, or by means of auxiliary deflectors, preferably the same as those used for the geometry corrections.

Other characteristics and advantages of the invention will appear with the description of certain of its embodiments, this description being given with reference to the appended drawings in which:

- Figure 1 is a simplified diagram of a video projector having three tubes,
- Figure 2 is an overall block diagram of a circuit according to the invention,
- Figure 3 is a more detailed block diagram, and
- Figure 4 is a diagram of a remote control unit forming part of the device of the invention.

In the example, the video projector 10 comprises three monochrome tubes 11, 12 and 13 projecting green G, red R and blue B colour images respectively on a screen

14 by means of lenses 11_1, 12_1 and 13_1 respectively.

Each tube comprises main deflectors for providing the horizontal and vertical scanning of the electron beam produced by the electron gun in that tube and a pair of auxiliary deflectors also acting on the electron beam in order to perform the geometry and convergence corrections. In Figure 1, for the green tube 11, the pair of main deflectors bears the reference 11_2 and the auxiliary pair bears the reference 11_3.

Each pair of deflectors comprises two coils, one for the horizontal deflection 14 and the other for the vertical deflection 15. In Figure 2, the reference numbers of these coils have been given an index corresponding to the colour of the corresponding tube, G for green, R for red, and B for blue. Each coil is fed with electrical current by a convergence amplifier, referenced 16 for the horizontal deflection and referenced 17 for the vertical deflection. Each amplifier 16, 17 supplies at its output a current whose value is proportional to the voltage applied to its input. The deflection of the spot on the screen with respect to its nominal position is proportional to the value of the current passing through the deflector.

In Figure 2 there is shown, on the one hand, the geometry correction circuit 18 and, on the other hand, a convergence adjusting circuit 19. The geometry correction circuit 18 has two outputs 18_1 and 18_2 feeding the inputs of all of the horizontal and vertical convergence amplifiers, and a third output 18_3 controlling an east-west modulator (not shown) associated with the main deflectors. As will be seen hereafter with reference to Figure 3, this circuit 18 has two inputs 18_4 and 18_5 receiving signals at the horizontal (or line) scanning frequency f_h and vertical (or frame) scanning frequency f_v respectively.

The geometry correction circuit 18 feeds the three pairs of convergence amplifiers 16 and 17. On the other hand the convergence correction circuit 19 feeds only two pairs of convergence amplifiers, those which are

associated with the red (R) tube 12 and with the blue (B) tube 13. In order to allow the simultaneous feeding of these convergence amplifiers 16_R, 16_B, 17_R, 17_B by the circuits 18 and 19 an adder 20_R, 21_R, 20_B, 21_B is provided for each of these four amplifiers.

The circuit 19 has, like the circuit 18, two inputs 19_1 and 19_2 receiving signals at the line scanning frequency f_h and at the frame scanning frequency f_v. Before its four outputs 19_3 to 19_6 feeding the corresponding inputs of the adders 20_R, 21_R, 20_B, 21_B, it comprises digital-analog converters 22_R, 23_R, 22_B, 23_B.

The convergence adjusting circuit 19, whose function is to superimpose the red and blue images on the green image, is based on the division of the screen into 208 zones: 16 zones in the horizontal direction and 13 zones in the vertical direction of which one initialization zone 24 corresponds to the frame suppression interval.

Four correction values, i.e. four signals on the outputs 19_3 to 19_6, are applied to each of the zones.

The division into zones is carried out by means of an address generator 26 receiving the signals at the frequencies f_h and f_v and, in order to allow the modification of the sequence of the address signals in the case of a change of standard, by means of a microprocessor 27, also forming part of the circuit 19 and which has an input 27_1 receiving signals from a remote control unit (figure 4). The microprocessor also intervenes for computing the correction signals.

These correction signals are stored in a random access memory RAM 28 having a capacity of 2 kilo-bytes with an input 28_1 connected to the output of the address generator 26 and an input-output 28_2 connected to an input-output 27_2 of the microprocessor 27. This random access memory 28 is associated with an accumulator (not shown) for saving its content when the circuit is disconnected from its electrical power supply.

The output 28_3 of the memory 28 is connected to the input of an interpolator 29 whose function to smooth

the correction values from one vertical zone to another (in one and the same column). The output signals of this interpolator 29 are in series, like the signals from the memory 28; they feed a demultiplexer 30 connected to the four outputs 19_3 to 19_6 via the digital-analog converters 22 and 23.

The microprocessor 27 is used during the convergence adjusting phase for modifying the content of the memory 28 as a function of the commands given by the user. This microprocessor 27 is also used for automatically converting the correction values stored in the memory 28 when there is a change of standard, without the user having to intervene, for example when changing from the SECAM standard to the NTSC standard having 525 lines per image. In other words it is not necessary to carry out a new adjustment when changing standards.

The geometry correction circuit 18 (Figure 3) generates signals, which cannot be modified by the user, for performing the conventional corrections of geometry defects intrinsic in television scanning. This circuit 18 also generates signals which can be adjusted by the user by means of a remote control unit acting on the input 18_6 using the key 130 (Figure 4). These adjustments which are accessible to the user are those which allow compensation for the non-perpendicularity with the screen 9 of the three light beams projected by the lenses 11_1, 12_1 and 13_1. These adjustments firstly affect the vertical amplitude, i.e. they modify the image height. They also affect the vertical linearity, i.e. they allow the re-establishing of distances in the vertical direction. Finally the user can also carry out the "horizontal keystone distortion" adjustment in order to modify the length of the lines in order to re-establish the rectangular shape of the image.

The adjustments which are not accessible to the user also comprise vertical amplitude, vertical linearity and horizontal keystone distortion adjustments. Furthermore, provision is made for horizontal linearity, horizontal amplitude, horizontal curvature, north-south

pincushion and east-west pincushion corrections.

In order to generate the geometry corrections which cannot be adjusted by the user and which are called "fixed", the starting point is a reference voltage V_{ref} which is integrated at the line frequency f_h and at the frame frequency f_v in order to form signals proportional to x, to x^2, to y, to y^2 to xy and to x^2 y, x and y being the horizontal and vertical coordinates respectively of the spot on the screen.

For the corrections which are accessible to the user, called "variable" corrections, the starting point is a control voltage V_{cont}, whose value can be adjusted by the user from the remote control unit, which is integrated at the frame frequency in order to form signals proportional to y and y^2.

The signal V_{ref} is applied to the input of a first integrator 31 reset to zero at the line frequency f_h and to the input of an integrator 32 reset to zero at the frame frequency f_v. At the output of the integrator 31 a signal x is obtained which is applied to the input of a second integrator 33 also controlled at the frequency f_h and thus supplying on its output a signal x^2.

The output of the integrator 31 is connected to the first input of a multiplier 34 whose second input receives the output signal of the integrator 32, i.e. the signal y. Thus the output of the multiplier 34 supplies a signal xy which is applied to an input 35_1 of an adder 35 by the intermediary of a potentiometer 36 for adjusting horizontal keystone distortion.

The output signal of the integrator 31 is also applied to a second input 35_2 of the adder 35 by the intermediary of another potentiometer 37 for adjusting horizontal amplitude. The adder 35 comprises a third input 35_3 receiving the x^2 output signal of the integrator 33 with a coefficient which depends on the adjustment of a horizontal linearity potentiometer 39. The output of the adder 35 constitutes the horizontal correction output 18_1 of the generator 18.

The x^2 output signal of the integrator 33 is also

applied to the first input 41_1 of another adder 41 by the intermediary of a potentiometer 42 for adjusting the horizontal curvature. The output of the adder 41 constitutes the vertical correction output 18_2 of the generator 18.

The xy output of the multiplier 34 is applied to the input of another integrator 43 controlled at the line frequency f_h and therefore supplying at its output a signal x^2y which is applied, by the intermediary of a potentiometer 44, to the second input 41_2 of the adder 41. The signal on the input 41_2 performs the north-south pincushion correction.

The output of the integrator 32 which supplies a signal y is transmitted to the third input 41_3 of the adder 41 by the intermediary of a potentiometer 45 for adjusting the vertical amplitude. The output signal of the integrator 32 is also applied, by the intermediary of a potentiometer 46, to the first input 47_1 of an adder 47 whose output constitutes the output 18_3 of the circuit 18 which is connected to an east-west modulator, i.e. to a circuit performing a multiplication by x. The signal applied to the input 47_1 performs a horizontal keystone distortion correction.

The output signal y of the integrator 32 is applied to the input of another integrator 48 controlled at the frame scanning frequency and therefore supplying at its output a signal y^2 which is applied, by the intermediary of a potentiometer 49, to the fourth input 41_4 of the adder 41. This signal on the input 41_4 contributes to the correction of vertical linearity. The signal y^2 is also applied to the second input 47_2 of the adder 47 by the intermediary of another potentiometer 50 in order to perform the east-west pincushion correction.

The control voltage V_{cont} which can be adjusted by the user by means of the remote control (key 130, Figure 4) is applied to the input of an integrator 51 controlled at the vertical frequency f_v and thus supplying at its output a signal proportional to y, namely αy. This signal αy is transmitted to the fifth input 41_5 of the adder 41

by the intermediary of a resistor 52 (or several resistors) multiplying by a coefficient K_1. The signal $K_1 \alpha y$ on the input 41_5 allows the vertical amplitude correction to be carried out.

The output signal αy of the integrator 51 is applied, by the intermediary of one (or more) resistor (s), 53 multiplying by a coefficient K_3, to the third input 47_3 of the adder 47. The signal at 47_3 contributes to the correction of horizontal keystone distortion.

The signal αy supplies the input of an integrator 54 controlled at the vertical scanning frequency and thus supplying at its output a signal αy^2 which is transmitted to a sixth input 41_6 of the adder 41 by the intermediary of one (or more) resistor (s) 55 multiplying by a coefficient K_2. The signal $K_2 \alpha y^2$ applied to the input 41_6 allows the vertical linearity correction to be carried out.

It should be noted that the east-west modulator, which receives the output signals of the adder 47 and which forms part of the basic circuit of the video projector, supplies the correction of greatest amplitude, which is particularly useful for the correction of horizontal keystone distortion which is the most important correction to be performed.

Finally the reference voltage of the integrators at vertical frequency 32, 48, 51 and 54 can be adjusted, under the control of the microprocessor 27, when there is a change of standard. It should also be noted that the reference voltage of the converters 22, 23, can also be adjusted for the same reason.

In order to control the video projector and to perform the adjustments, the user has a remote control unit 110 (Figure 4) which comprises the conventional keys 111 for stored channel numbers, and 112 for adjusting sound volume, brightness, colour intensity, station search and frequency tuning. This unit furthermore comprises a set 113 of keys for the geometry (key 130) and convergence corrections, and a switch 114 allowing, depending on its position, the remote control unit 110 to

be used in normal mode N for the control of the functions of the video projector, i.e. for the use of the keys 111 and 112, or in adjustment mode indicated by the "convergence" positions in Figure 4 with two positions corresponding to the two standards (525 lines and 625 lines). Furthermore a position ZR is provided for the zero reset, or for a return to an initial state, of the content of the memory 28.

It should be noted that the convergence and geometry adjusting circuit of the invention can be used not only for the adjustment by the user but also during manufacturing for quality checks.

Normally, the d.c. supply voltages of the various electronic components are produced from the VHT supply. The same applies to the single reference voltage used for the digital-analog converters 22, 23. It is important that this reference voltage should remain constant or should hold a value always having the same effect on the electron beam. Now, when the power supplied by the VHT increases, the electron beam acceleration voltage reduces and the efficiency of the convergence deflectors becomes greater, which modifies the adjustment. In order to overcome this disadvantage a regulation circuit is provided which reduces the reference voltage of the digital-analog converters when the VHT power increases.

In order to avoid an error in the operation of the remote control unit 110 after the adjustments have been performed, a switch is provided on the casing which, when it is in a predetermined position, inhibits the action of the keys 113.

* C L M S *

CLAIMS

1. Geometry adjusting device for a colour video projector having three monochrome tubes (11, 12, 13) each projecting a picture of a predetermined colour onto a screen (9), characterized in that it comprises a geometry correcting circuit (18) adjustable by the user for performing, by the modification of a single signal (V_{cont}), a correction of vertical amplitude, of vertical linearity and of horizontal keystone distortion by acting upon the scanning of each tube.

2. Device according to Claim 1, characterized in that the correction signals are applied to auxiliary geometry correcting coils (14, 15) of the three tubes.

3. Device according to either of Claims 1 or 2, characterized in that it comprises an integrator (51) integrating a signal having the frame frequency (f_v) whose value corresponds to the said single signal (V_{cont}) and is adjustable by the user, the output signal of the integrator (51) being used for performing the said vertical amplitude corrections and the horizontal keystone distortion correction, and that it comprises a second integrator (54) fed by the output signal of the first integrator (51) in order to control the vertical linearity correction.

4. Device according to any of the preceding claims, characterized in that it comprises a remote control unit (110) for example of the infrared type, having keys for the usual functions of a television receiver as well as adjustment keys (113), a single one of these keys (130) serving for the said geometry correction.

5. Device according to Claim 2, characterized in that it comprises a circuit for correcting convergences, which circuit applies signals to the auxiliary coils of the second and the third tubes.

6. Device according to Claim 2, characterized in that the geometry adjustments accessible to the user

operate on the auxiliary coils for vertical deflection and on the east-west modulation.

7. Device according to Claim 3, characterized in that the reference voltage of the integrators is adjustable in the event of a change of standard.

