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(54) A REPRODUCTION DEVICE FOR REPRODUCING A SIGNAL FROM A RECORD CARRIER

(71) We, TED BILDPLATTEN AKTIENGESELLSCHAFT AEG-TELEFUNKEN-TELDEC, a Swiss Body Corporate, of Postfach 126, Hanibühl 8, Zug, Switzerland, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

10 This invention relates a reproduction device for reproducing a signal from a record carrier.

15 It is already known to store video signals in grooves on a disc. The invention relates to a driving mechanism for playing back such video records.

20 The mechanism usually employed for playing back discs carrying sound recordings (gramophone records) is not readily suitable for playing back records carrying high density stored signals, e.g. video recording (video discs).

25 The differences between the conventional audio records and the video records consist inter alia in the substantially shorter wavelengths (1 μm —10 μm) and higher record to pick-up speeds (up to 16 m/sec.) which have to be used for video recordings. Furthermore, in contrast to sound recordings, it is expedient to record with frequency modulation, i.e. with virtually constant amplitude. By reason of the shallow structure of the grooves and the length of the engagement surface of the pick-up in the direction of movement which is considerable compared with the recorded wavelength, care must be taken that the pick-up is in good contact with the groove and is always guided exactly tangentially thereto.

40 According to the invention there is provided a reproduction device for reproducing a signal from a record carrier in the form of a spirally grooved disc in which signals representing a frame of a television picture or whole

multiples thereof are recorded in each groove turn comprising a drive mechanism for the record carrier, a pick up for picking up signals from the record carrier, positive guide means for guiding the pick up over the record carrier in coordination with the rotation of the record carrier and resilient means for connecting the pick up to the positive guide means whereby if the positive guide means is rendered ineffective, the resilient means will permit the pick up to transverse one or more groove turns and thereafter jump back over one or more groove turns cyclically. 45 50 55

In the case of sound recording equipment which utilises a signal carrier wherein the signals are stored in grooves, it is known to use a positive guide for recording the signals. If the same carrier is also used for reproduction on the same equipment which was used for recording, then the positive guide system is still present although the groove guiding system would be adequate on its own. 60 65

Furthermore, in the case of magnetically operated sound dictating equipment carrying disc-shaped grooveless recording carriers, it is known to provide a positive guiding for recording and play back purposes. 70

In the case of video disc players which use video discs carrying video signals stored in grooves, however, a radial positive guiding of the pick-up is not known. In conjunction with further structural measures, as will be explained subsequently, it allows particular forms of pick-up, forms which have not been used during recording and play-back of sound. 75

The positive guide system according to the invention may be achieved, for example, by a transmission mechanism (gearwheel, worm or friction drive) coupled to the drive shaft of the turntable and providing the feed for the pick-up holding arrangement. This ensures that the pick-up is moved radially inwardly in proportion to the rotation of the turntable. 80 85

[Price 25p]

Price 75p

The transmission ratio may be so selected that the radial feed corresponds to that of the cutting equipment used when recording the video signals and with which for example 80 to 120 grooves/mm are cut. Indexing errors, radial disc wobble and other inaccuracies are compensated in that the pick-up is elastically mounted on the positively guided holder, for example through a springing arrangement and/or a sprung tube.

The rigid coupling of the holder guide system to the turntable drive ensures that the feed of the pick-up corresponding to the distance travelled in the spiralling groove, regardless of whether the disc is rotating slowly or fast. The positive guiding system can therefore be used equally well for drives of variable speed (e.g. for those which have a constant pick-up velocity relative to the record carrier) and also for those with a constant speed of rotation.

The invention will now be described in greater detail, by way of example, with reference to the drawings, in which:—

Figure 1 shows the principle of the positive guiding system;

Figure 2 shows the elastic mounting of the pick-up on its positively guided holder;

Figure 3 shows the mathematical relationships, and

Figures 4 and 5 show stops for changing the spring constant of the elastic pick-up mounting.

Figure 1 shows the video disc 1, the turntable 2 carrying the disc, the turntable drive shaft 3 which is mounted vertically upright, and the drive motor 4. The pick-up 5 is elastically mounted on the positively guided holder 6. The holder 6 is transported on the rail 7 by the cord 8 over the video disc 1 in such a way that the pick-up moves radially. The cord 8 is driven via the pulley 9 which is driven by a worm 12, and by the change speed gear mechanism 10 which permits of variable feed, by the drive element 11 (gearwheel or wormwheel) mounted on the turntable drive shaft 3. Between the pulley 9 and the drive element 11 there is also a coupling 13 which makes it possible to disengage the drive for the feed in order to achieve certain effects which will be explained hereinafter.

Figure 2 shows the elastic mounting of the pick-up, which consists of a piezo-ceramic transducer 15 and a stylus 16 in skid form made from very hard material, e.g. diamond, which is mounted thereon. The video disc is identified by reference numeral 17. An elastic intermediate layer 19 is provided between the carrying tube 18 and the body 15 of the transducer. The tube 18 is connected to the positively guided holder 21 through a resilient joint 20 consisting, for example, of synthetic plastics material. The cushioning member 22 engaging the tube 18 and mounted in the holder 21 provides an additional spring

force and ensures the necessary damping effect.

A particular effect is achieved if the rigid coupling between turntable drive and positive feed guide is disconnected, for example, via the coupling 13 (Figure 1). The pick-up holder then, due to the absence of drive for the positive guide system, remains substantially radially stationary. However, due to the guide effect provided by the groove, the pick-up will be entrained by the grooves for a few more revolutions against the resistance of the elastic suspension. The spiralling groove continues to carry the pick up with it until such time as it is held back again by the force exerted on the pick up by the elastic suspension exceeds the force exerted on the pick up by the groove walls. Thereupon the pick up jumps back a few grooves. The cycle: deflection by the groove guiding system and jump back due to spring force of the mounting is repeated, so that the data recorded in the portion of the groove traversed is also repeated.

The discs are so cut that the groove at all times holds one half-image (or a whole multiple thereof) per revolution, the data stored on adjacent grooves thus differs only slightly. The synchronisation (line and image pulses) does not change between adjacent grooves. If only a few grooves are repeated, then the image will appear to be stationary from the moment when the feed of the pick up is switched off. If the repetition extends over several grooves, then the movement processes will be constantly repeated. For movement studies of all kinds, for education purposes and the like, such a reproduction possibility is of great importance.

Further effects which are advantageous for video reproduction can be achieved if the feed is not stopped as described above but is accelerated or retarded in comparison with normal playback. By a simple variation in the transmission ratio between turntable rotation and pick-up feed, during operation, it is possible to achieve a time-lapse or high-speed effect. In these cases, the accompanying sound must be switched off.

The number of grooves repeated at any time depends essentially upon the spring constant of the elastic mounting and of the pick-up mounting, the pick-up pressure, the angle formed between the sides of the grooves and the plane of the disc, and the groove pitch. It is intended to explain these relationships in greater detail with reference to Figure 3. In this illustration, A denotes the pick-up skid. It is pressed on the side F of the groove with the force c , the groove side F enclosing the angle φ with the straight line N drawn perpendicular to the plane P of the disc. The force c is composed of the repelling force a of the spring pick-up mounting and the pick-up pressure b . With a line drawn perpendicular to the disc, it forms the angle ψ , and cor-

respondingly the angle $(\varphi + \psi)$ with the side F of the groove.

If with increasing force a the angle $(\varphi + \psi)$ is greater than 90° , then the pick-up jumps back. As long as $(\varphi + \psi)$ is less than 90° , the pick-up remains in the groove and continues to be drawn on by the groove spiral.

While this happens a and hence also ψ will increase.

If, due to increase of force a $(\varphi + \psi)$ becomes greater than 90° , then the pick-up runs up the side of the groove and jumps back.

According to Figure 3:

$$\operatorname{tg} \psi = \frac{a}{b}$$

hence

$$\psi = \arctg \frac{a}{b}$$

Therefore, the condition for jump-back is:

$$(\varphi + \psi) = \varphi + \arctg \frac{a}{b} > 90^\circ$$

$$\arctg \frac{a}{b} > 90^\circ - \varphi$$

$$\frac{a}{b} > \operatorname{tg}(90^\circ - \varphi) = \operatorname{ctg} \varphi$$

$$a > b \cdot \operatorname{ctg} \varphi$$

In the following example, let the pick-up pressure be

$$b = 0.2 \text{ p,}$$

$$\varphi = 75^\circ,$$

returning force of the pick-up suspension to be 0.3 p/mm.

According to the equation stated above,

$$a \leq b \cdot \operatorname{ctg} \varphi,$$

if the pick-up jumps back.

$$a \leq 0.2 \cdot 0.27 = 0.054 \text{ p.}$$

In the border line case $a = 0.054 \text{ p}$, the deflection x is:

$$x = \frac{0.054}{0.3} = 0.18 \text{ mm}$$

In the case of 120 grooves/mm, therefore, 22 grooves will be jumped. Experience has

shown that quite satisfactory results are obtained if the pick-up is so elastically mounted and if the other elements (pick-up pressure, groove shape and pitch) which influence deflection are so chosen that at least 10 and preferably 25 to 100 grooves are jumped.

If, for a given system of pick-up and disc, the pressure b is increased, then the pick-up must be further deflected before it jumps back. Varying the pressure is therefore a means of varying the length of the repeated portion.

The choice of the spring constant of the pick-up suspension is a further means of bringing the repetition duration to a definite value. The arrangement can also be such that the spring constants can be adjustably varied. Figures 4 and 5 show examples of embodiments thereof.

Figure 4 shows the spring retaining tube 30 for the pick-up, the positively guided holder 31 and an adjustable stop 32 for adjusting the effective spring constant. As indicated by the double-headed arrow, the stop can be displaced in both longitudinal directions. It does not come into action for small movements of the pick-up. If the feed of the holder 31 is switched off and the pick-up entrained by the groove, then it strikes the bent-in end. The returning force of the retaining tube 30 is thus substantially increased. The returning force is now determined essentially by the free length of the retaining tube 30. The pick-up will thus jump back sooner than if the stop 32 is not present.

In the case of the arrangement shown in Figure 5, there are two stops 33 and 34 which are adjustable in both longitudinal directions. This is particularly important for mechanisms wherein the speed of the pick-up feed can be varied by a variable transmission. By virtue of the adjustable stops 33 and 34, preset repetition times can be set independently of each other for low and high-speed replay.

The stops described in Figures 4 and 5 may themselves be spring elements, so that another combined spring characteristic is achieved.

This makes it possible to vary the returning force in the horizontal and the force acting in the vertical direction, which is achieved in that the moments of resistance in a vertical and horizontal direction are different. It is desirable for the horizontal restoring force to be increased by the stops, while restoring force should remain as far as possible unchanged.

The stop can for example be made from flat material, with its thickness vertical and its largest dimension horizontal.

The mechanism for varying the rate of feed can be very simple in construction. It may be a step-wise or infinitely variable gearing. The gearing can be disengaged and therefore the pick-up feed switched off by a coupling which must in any case be provided for return of the pick-up.

WHAT WE CLAIM IS:—

1. A reproduction device for reproducing a signal from a record carrier in the form of a spirally grooved disc in which signals representing a frame of a television picture or whole multiples thereof are recorded in each groove turn comprising a drive mechanism for the record carrier, a pick up for picking up signals from the record carrier, driven positive guide means for guiding the pick up over the record carrier in coordination with the rotation of the record carrier and resilient means for connecting the pick up to the positive guide means whereby if the positive guide means is rendered ineffective, the resilient means will permit the pick up to traverse one or more groove turns and thereafter jump back over one or more groove turns cyclically.
2. A device according to Claim 1, wherein drive of the positive guide means can be disengaged.
3. A device according to Claim 1 or 2, wherein the pick-up is elastically mounted on a positively guided holder.
4. A device according to Claim 3, wherein the drive of the positively guided holder can be switched off, whereupon the pick-up is entrained for a few grooves by engagement with the grooves against the elasticity of the mounting until the elastic force of the mounting overcomes the guiding force of the grooves and the pick-up jumps back.
5. A device according to Claim 4, wherein the pick-up mounting elasticity is such that it allows the pick-up to jump 22 grooves.
6. A device according to Claim 4, wherein the elasticity of the mounting of the pick-up and the further parameters (pick-up pressure, groove form and pitch) which influence entrainment of the pick-up with the groove are so chosen that, after the drive of the guide is disengaged, the pick-up is entrained for and jumps back at least 10 grooves.
7. A device according to Claim 6, wherein the elasticity of the mounting of the pick-up and the further elements which influence entrainment of the pick-up with the groove are so selected that, after disengagement of the drive of the guide, the pick-up is entrained for and jumps back 25 to 100 grooves.
8. A device according to any one of the preceding Claims, wherein the drive of the positive guide means for the pick-up is coupled to the turntable drive shaft through gearing.
9. A device according to Claim 8, wherein

the positive guide means is connected to the drive shaft of the turntable by a step-wise or infinitely variable gearing.

10. A device according to Claim 9, wherein with time lapse or high speed work, any accompanying sound is switched off.

11. A device according to any one of the preceding Claims, wherein the pressure of the pick-up is variable.

12. A device according to Claim 3, wherein a spring tube mounted in the positively guided holder serves to carry the pick-up.

13. A device according to Claim 12, wherein the tube is mounted in the holder by means of a resilient joint.

14. A device according to Claim 12 or 13, wherein the end of the tube which is mounted in the holder is enclosed by a cushioning member.

15. A device according to Claim 3, 12 or 13, wherein the spring constant of the spring holder of the pick-up is variable.

16. A device according to Claim 15, wherein to vary the spring constant, a longitudinally displaceable stop disposed on the holder parallel with the tube is used, having a bent-over end against which the tube effectively bears from the time it reaches a definite deflection.

17. A device according to Claim 16, wherein a plurality of adjustable stops are provided.

18. A device according to Claim 17, wherein the stops are separately adjustable.

19. A device according to Claim 16, 17 or 18, wherein the stops are constructed as spring elements.

20. A device according to Claim 19, wherein the resilience of the spring elements are different in vertical and horizontal directions.

21. A device according to Claim 20, wherein the stops which are constructed as spring elements consist of flat material and are disposed with the greater cross-sectional dimension in a horizontal direction.

22. A reproduction device for reproducing a signal from a record carrier substantially as described herein with reference to the drawings.

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