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(54) AN ARRANGEMENT AND PROCESS FOR SYNCHRONISING SIGNALS

(71) We, KARL VOCKENHUBER, of 118 Potzleinsdorferstrasse, Vienna 18, Austria, and RAIMUND HAUSER, of 2 Goldeggasse, Vienna 4, Austria, both of Austrian Nationality, 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:—

This invention relates to a process of synchronizing two drive means, such as may be used for synchronizing a motion picture handling appliance and a sound tape-handling appliance. The invention relates also to an apparatus and an appliance for use in carrying out the process.

Numerous different synchronizing processes have been proposed. A synchronous movement requires not only that the two drive means operate at corresponding velocities but the phase angles must also be the same. All systems which synchronize only the velocities have the disadvantage that there is no correct phase coordination. It is particularly difficult to maintain a proper phase coordination when the drive means runs up or slows down. Although it has been proposed to synchronize a film strip and a sound tape with the aid of perforated sprocket-driven sound tapes, perforated sound tapes are not readily available. Synchronization by a pilot tone has also been proposed but phase errors can occur if the pilot tone signals are equal because if one or more signals fail to appear e.g. because of film splicing, a proper phase relationship of the picture and the associated sound will not be established and can only be reestablished with difficulty. This remark is also applicable to those systems in which an absolute number of pulses is stored and the stored pulses derived from each strip are compared.

In accordance with one aspect of the invention there is provided a process for synchronising two signals one of which is generated in synchronism with the movement of a strip running through a first appliance and the other

of which is generated in synchronism with the movement of a strip running through a second appliance each signal recurring cyclically and having a parameter whose value changes progressively along the length of a strip section carrying the signal so that the instantaneous value of the parameter is indicative of a unique position along the strip section, the process comprising comparing the instantaneous values of the two parameters of respective strip signals, providing an output signal when the relative instantaneous values of the two parameters are such as to signify that the movements of the two strips are not exactly in phase with one another, and applying the output signal as a correction value to a motor control circuit which regulates the speed of one of the strips so that the desired in-phase relationship of the movement of the two strips is restored.

In accordance with a second aspect of the invention there is provided an appliance having a first strip transport system, a drive for the system, an arrangement providing on a first signal line first cyclically recurring signals each having a progressively changing parameter and produced in synchronism with the movement of the first strip, a comparator having two input connections to one of which is applied the first signals while the second is adapted to have applied to it second cyclically recurring signals each having a progressively changing parameter and generated in synchronism with a second strip transport system, the comparator being adapted to compare the instantaneous values of the changing parameters at its input and providing an output signal indicative of the extent and direction of any error in the phase relationship in the movements of the two strips from a desired in-phase relationship, and speed control circuitry responsive to the output of the comparator to restore the movements of the two strips to the desired inphase relationship.

In accordance with a third aspect of the invention there is provided a synchronising arrangement comprising a first appliance con-

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taining a first strip transport system, a second appliance containing a second strip transport system which is to run in a desired phase relationship with respect to the first system, a first signal generating assembly adapted to produce a first cyclically recurring signal having a progressively changing parameter the first signal being produced in synchronism with the first strip, a second signal generating assembly adapted to produce a second cyclically recurring signal having a progressively changing parameter, the second signal being produced in synchronism with the second strip, a comparator for comparing the first and second signals and producing an output signal which is a measure of the extent and direction of the phase relationship from the desired phase relationship between the two strips movement, and speed control circuitry responsive to said output signal to adjust the speed of one of the systems so that the desired in-phase relationship of the two strips is restored.

The parameter may consist of the amplitude or preferably of the frequency of the signal. The signal need not be a sound signal but may consist of light signals. The variable parameter preferably has a value which progressively increases or decreases, suitably linearly. If the functional relationship between the parameters of the signals associated with the two drive means is known, a control signal which during an in-phase movement of the two strips has a predetermined, desired value can easily be derived by a comparison of the two signals during the movement of the strips. It is desirable that this desired value is constant. The desired value may vary between two different levels. Whereas the periods of the two signals may differ, they will preferably have equal periods.

When the invention is used in conjunction with cinematograph equipment to maintain a sound strip in step with a film strip, means are preferably provided for adjusting the sound carrier strip to a predetermined position, which means are preferably connected to a mode control switch. This relieves the synchronising equipment from having to perform control functions which may be required as a result of an undefined and undefinable position of the sound carrier at the beginning of a recording or reproduction. The term "mode control switch" used in this connection may include a camera release switch. It will be understood that the invention is not concerned with the two strips starting in step with one another so much as with ensuring that during running of the equipment the desired in-phase relationship between the two strips is maintained despite stretching or shrinking of one strip with respect to the other. Preferably in connection with cameras having a release switch, use is made of an arrangement in which the sound carrier strip is operatively connected to a by-pass switch, which by-passes an interrupter for a motor driving the sound carrier appliance. In this case, the sound carrier strip is adjusted by the motor until it assumes its predetermined position even when the interrupter contacts have been opened. This may be accomplished if the sound carrier strip is provided with conducting surfaces, which may be printed on the sound carrier strip and which are interrupted at a point which corresponds to a predetermined position of the sound carrier strip. In a camera, the problem may be solved without need for additional electrical means. In this case, the sound carrier strip is preferably provided with a locking device for the release switch, which locking device is in its locking position when the sound carrier strip is in a position other than the predetermined position. Under certain circumstances it may be undesirable for the movement of the appliance to be continued in order only to adjust the sound carrier strip to its predetermined position because such adjustment may result in a waste of film. For this reason, the mode control switch, preferably the release switch, may be connected to means for disabling an intermittent strip drive means, e.g., for disengaging a pull-down claw, which means are in operative position when the mode control switch is in the position OFF. When a camera which is provided with such means is stopped and the sound carrier strip does not assume its predetermined position, only a single picture can be over-exposed as a result of a rotation of the shutter. Even this defect may be eliminated if the mode control switch is connected to an auxiliary shutter arranged to block the light path of the main shutter when the appliance has been switched off, and the main shutter may then open again without causing overexposure in a camera. In a projector, such auxiliary shutter can be disposed behind the aperture plate to block the light emitted by the projector lamp and it may take the form of a heat filter.

In an alternative arrangement the mode control switch is connected to an actuating means for a clutch, which is connected between the main drive means of the appliance and the shutter and preferably to an actuating means for a clutch which is connected between the main drive means of the appliance and the intermittent strip drive means. In this case, the main drive means of the appliance may act only on the means for driving the sound carrier rather than the intermittent strip drive means and/or the shutter.

In another arrangement, which is particularly suitable for projector appliances, the sound carrier strip is adapted to be uncoupled from its drive means, preferably by the mode control switch, as it moves to position OFF. In a projector, individual parts, such as the sound carrier may be accessible more easily than in a camera. If the sound carrier can be uncoupled from its drive means, it may be

moved, e.g., by hand, to its predetermined position. This operation may be performed automatically if spring means for returning the sound carrier to its predetermined position are connected to the sound carrier.

The invention will now be described in more detail, by way of examples with reference to the accompanying drawings, in which:

Figure 1 illustrates diagrammatically one arrangement employing a camera, a sound reproducing appliance and a synchronizing device;

Figures 2A, 3A, 4A and 5A each show the relationship of two synchronizing signals;

Figures 2B, 3B, 4B and 5B each represent the resulting signal which results from combining the signals of Figures 2A, 3A, 4A and 5A;

Figures 6 and 7 illustrate how the resulting signals may be used to provide further control signals by comparing them with reference values;

Figures 8 to 18, with the exception of Figure 15 which is an explanatory graph, are electrical circuit diagrams; and

Figures 19 to 25 are diagrammatic representations to assist the explanation of the operation of different mechanical assemblies.

Referring to Figure 1, a first signal is pre-recorded on a sound tape 1 of a tape recorder appliance 2 before a sound recording is made on the tape. During the operation of the appliance 2, the signals on the tape 1 are detected by a sound head (not shown) and fed to a synchronizing device 3. A camera release switch of a camera 4 is operated at the same time. A film, not shown, is contained in a cartridge 5, which is indicated in dotted lines and contained in the camera. A take-up reel in the camera is driven by a shaft 6. Theoretically, signals like those on the sound tape 1 could also be prerecorded on the film. Because this is difficult in practice, the signals are preferably instead generated by a signal generator in the camera and which is controlled in dependence on the velocity of the film in the camera 4.

The signal generator is represented in Figure 1 by a gear 7 secured to the shaft 6, a gear 8 in mesh with the gear 7, and a disc 9, which is driven by the gear 8 and in which the signal is stored which is to be associated with the film. It is desirable to use the disc 9 because only a small space is available in a camera 4 and because a disc can be relatively easily arranged within the space which is provided in the camera 4 for the cartridge. A signal-detecting device, not shown, must also be contained in the camera. The nature of this signal-detecting device will obviously depend on the form in which the signals are stored on the disc 9. If the signals are stored magnetically, a suitable magnetically sensitive sound head is preferably provided. When a gramophone record is used, a suitable pick-up arm

is utilised. In this case and also generally when the signal is in the form of a stylus-cut sound recording, the recording may become worn with use so that preferably several closed signal tracks, with which the pick-up can be selectively aligned are provided. When one of the tracks is worn, a suitable arm shift is operated to align the arm with another track which has not yet been worn. If the disc 9 stores the signal in the form of a film track recording, a light sensitive detector device must be provided in the camera 4 in place of the arm to read the film track.

The signals read from the disc 9 are also fed to the device 3 and are compared with those from the tape 1 to derive a control signal for the camera motor. Because the synchronizing signals associated with the film are not carried by the latter but are generated by a signal generator which operates in synchronism with the movement of the film, it is necessary for good sound reproduction to ensure that, from the beginning, the signals of the sound tape 1, are in phase with those derived from the signal generator of the camera. For this purpose, the camera 4 has a suitable marking device, which causes at least one additional signal to be recorded on the film for each period of the signal derived from the disc and which appears on the film at the beginning of each period of each disc signal. In one arrangement the film marking device comprises essentially a shutter which is opened in synchronism with the movement of the film by a cam arranged coaxially with the gear 8 and which, during each revolution of the gear 8 and thus the disc 9, opens the shutter to expose the film to the marking light path once for each disc revolution.

The previous and subsequent parts of the description are based on the assumption that audio frequency signals, at different frequencies, are generated, but it is to be understood that light signals at different frequencies or signals which differ in amplitude may also be generated and used instead or as well as the audio frequency signals.

Figures 2A, 3A, 4A and 5A show two different relationships of the two signals which can be used to detect correct synchronization by the device 3. The signal indicated in thin line is the signal which is recorded on the tape 1 and the signal represented in thick line is the signal from the camera 4. In the diagrams, time is plotted on the axis of abscissae and frequency on the axis of ordinates. It is apparent that the signals associated with the two drive means of the camera and tape recorder respectively, have a parameter, namely, frequency, which has a value that varies with time. The signals are frequency modulated to give a linear ramp-shaped modulation although other forms and shapes of modulation may be used. The signal period, i.e., the time in which the variable parameter i.e., the signal fre-

quency, rises from its smallest value to its highest value, could in theory correspond to the entire length of the tape strip 1 or of the film strip contained in the cartridge 5. This would have the advantage that a specific parameter value of the signal would be associated with each point of the length of the respective strip. Although the coordination of the two signals could then easily be detected, in practice, with such a long running period of currently available tapes and films the difference between the highest and lowest values of the parameter of the signal would be so large that the signal-handling equipment in the tape recorder 2 and the camera 4 would have to be responsive within a very wide range. Unless this was done, the parameter values could increase only with a rather gentle slope and the signal detectors would then have to perform a very exact function if the differences between the parameter values are to be precisely sensed. It has been found that with frequency-modulated signals the audio frequency values ascend linearly in the range 250—5000 Hertz, and preferably lie between 500—2500 Hertz, in view of the requirements of currently available inexpensive tape recorders.

In the drawing, Figures 2 *aA*, 3 *aA*, 4 *aA* and 5 *aA* represent various ways in which two input signals to the device 3 can be related during synchronous movements of the two strips and Figures 2 *aB*, 3 *aB*, 4 *aB* and 5 *aB* show the corresponding aggregate signals from the device 3. In each case the signal S_1 represented by thin lines is the signal coming from the sound tape 1 whereas the signal S_4 represented by thick lines is the signal from the camera 4. The diagrams shown in column *b* represent the situation when the signal S_4 from the camera leads the signal S_1 from the sound tape so that the period of signal S_4 is terminated earlier than during synchronous movements. The diagrams in column *c* represent the situation when the film lags the sound tape so that the period of signal S_4 terminates later than during synchronous movements.

In Figure 2, the signals S_1 , S_4 are of identical shape although covering slightly different frequency ranges, and are in phase during synchronous movements. The frequencies within each of these signals progressively increase so that in each case a linearly ascending ramp signal results. Other changes in the parameter than linear could be used but then the control equipment for responding to differences in the instantaneous parameter values is necessarily more complicated.

If the signals S_1 , S_4 have equal parameter values and are applied to a comparator, e.g., a bridge circuit, in the device 3, the device would provide no output signal across a load impedance during synchronous operation whereas a deviation from a synchronous condition would result in a signal being generated, as is shown in Figures 2*b* and 2*c*, which

has a sign depending on the direction of the deviation and which appears across the load impedance during asynchronous operation.

The preferred arrangement is as shown in Figure 2 *aA* in which the two signals S_1 , S_4 are of slightly different frequencies and are first superposed to form a resulting signal S_r . The two signals S_1 , S_4 being similar, the resulting signal has a linear waveform S if the signals S_1 , S_4 are subtracted from one another. As an alternative, an addition of the signals S_1 , S_4 having the configuration shown in Figure 2 may be used and in this case the resulting signal would be a ramp having an inclined edge that is approximately twice as steep as the inclined edges of the signals S_1 , S_4 . Such a resulting signal could be used to control drive means but special circuitry would be required for this purpose. For instance, such circuitry could have a variable resistor which is varied in synchronism with the rotation of the controlling drive means to compensate the pulsation of the resulting ramp signal.

A phase difference between the signals S_1 , S_4 associated with the two drive means as is apparent from Figures 2 *aB* and 2 *aC* may be due to a phase displacement alone or to an operation of the two drive means at different speeds. The use of frequency-modulated signals has the advantage that a higher film strip velocity results in a higher frequency of signal S_4 so that an increase in film speed produces an immediately detectable phase lead of signal S_4 associated with the camera drive relative to the sound tape signals S_1 . This results in a very good control response which virtually precludes hunting. A lead of the camera relative to the sound tape results in a resulting signal S_r (Figure 2 *bB*) which may have intermittent negative values if the frequency difference between signals S_1 and S_4 is small during synchronous movements. These negative values may be avoided if the difference between signals S_1 and S_4 during synchronous movements exceeds the difference between the highest and lowest instantaneous frequency values of the two signals producible by variations in drive speed. As is apparent from Figures 2 *aB*, and 2 *aC*, deviations from a synchronous condition result in different resulting signals S_r and S_n , which appear in alternation. These signals may differ in frequency only slightly from the resulting signals S_r denoting synchronous movements and in this case they have a large pulse width as shown in Figures 2 *bB* and 2 *cB*, or they may differ in frequency greatly from the resulting signal S_r and in this case have a small pulse width.

In the signal relationship shown in Figure 3, the signals S_1 , S_4 differ in phase by 180° during synchronous movements, so that this condition results in a resulting signal S_r having two different values in alternation. A comparison of this signal S_r with the signals S_r

(Figure 3 bB) and S_n (Figure 3 cB) which are provided by a deviation from the synchronous condition, show that the upper value of each of the signals S_v , S_n differs only slightly from the upper value of signal S_s . The same remark is applicable to the lower values. This result is obtained by suitable selection of the inclination of the edges of the signals S_1 , S_4 . As a result, the difference between the upper and lower values of signal S_s during synchronism is less than the differences between the upper and lower values of the signals S_v or S_n in the case of a deviation from the synchronous condition. This fact facilitates the generation of a control signal, as will be described later with reference to Figure 7.

Figure 4 represents a signal relationship in which the signals S_1 and S_4 are in phase during synchronous movements but their frequency values vary in mutually opposite directions. It is apparent from Figure 4 Aa that the difference between the mirror image signals S_1 and S_4 decreases continuously during a signal period. If the two signals are aggregated by subtraction, the resulting signal would be a very steep ramp signal like that formed by an addition of the signals in the embodiments shown in Figures 2 and 3. With mirror image signals it is therefore desirable to aggregate them by addition. In this case, the resulting signal S_s during synchronous movements is constant whereas the signals S_v , S_n obtained in case of a deviation from the synchronous condition is shown in Figures 4 bA and 4 cA and is similar to those represented in Figure 2.

These remarks are substantially applicable also to Figure 5, in which the signals S_1 , S_4 are again mirror images but during synchronous movements are in antiphase with one other. In this case, the resulting signals obtained by an addition of signals S_1 , S_4 are similar to those obtained in the embodiment shown in Figure 3.

Figures 2 to 5 represent four examples of how input signals to the comparator device 3 can be chosen and coordinated to provide an indication of asynchronism i.e. an out-of-phase relationship between the movements of the two strips. Other ways of achieving the same effect are of course possible. For instance, sinusoidal signals may be used rather than ramp signals. Also, when utilising signals which are out of phase during synchronous movements, the phase difference need not be 180° but virtually any desired phase difference may be selected.

Figure 6 shows how the resulting signal (S_n , S_v , S_s) may be used to provide a correction signal to restore synchronisation. The aggregate signals of Figure 4 are shown in the right-hand portion of the Figure. The signal S_s (synchronism) is represented by a solid line, the signal S_v by a dotted line and the signal S_n by a dash-dot line. These different

resulting signals which may appear are compared with at least two reference values, namely, an upper reference value Ow and a lower reference value Uw . In addition, the resulting signals are compared to a desired value Sw for synchronous movements. This value Sw corresponds in magnitude to the resulting signal S_s .

The two reference values Ow , Uw correspond respectively to the upper and lower values of signals S_n , S_v which are $\pm 180^\circ$ out of phase and correspond to a deviation which corresponds to a lead or lag of the controlled drive means by 360° ($S_v + S_n$). It is apparent that the upper value of the resulting signal S_v which results during a lead of the camera differs from the upper reference value Ow by the same amount by which its lower level differs from the lower reference level Uw . The same remark is applicable to the signal S_n to that when the resulting signals are suitably filtered and compared with the reference levels Ow and Uw or Sw it can easily be ascertained whether the controlled drive means leads or lags or is synchronized.

In Figure 7, the signals S_s , S_v and S_n are selected from the embodiment shown in Figure 5. During synchronous operation, two values appear in alternation and in this case the two reference values Ow , Uw are equal to the upper and lower values of the signal S_s occurring during such synchronous running. The signals S_1 , S_4 are selected so that the difference between the frequencies of the upper and lower values of the resulting signal S_s is larger than or equal to the deviations in the resulting signal frequency which can occur as a result of a deviation from the synchronous condition. It is found in fact that the upper values of signals S_v , S_n are near the upper reference value Ow and the respective lower values, which differ markedly from the upper reference value Ow , and are near the lower reference value Uw . By suitable filtering it can be established whether the values of the resulting signal are above or below the reference values and thus the direction and magnitude of any deviation from the synchronous condition.

Figure 8 shows an electronic circuit for obtaining the resulting signal, comparing it with reference values Ow , Uw and Sw , and providing a correction signal to re-establish the synchronous condition. The inputs for the signals S_1 , S_4 are shown in the upper left portion of Figure 8. The signal S_1 is directly applied to an amplifier 10. A differentiator 11 enables the signal S_4 to be compared first with a non-modulated reference signal S_R when the signal generator takes the form of the disc 9 (Figure 1) in the camera 4 having the signals stored as a stylus-cut groove in a sound record. In this case, the sound pick-up is sensitive to vibration which may result in an interference signal disturbing the synchro-

nizing control and which must therefore be filtered out. This is best accomplished in that a non-modulated reference signal S_R is recorded on the disc 9 at the same time as the frequency-modulated signal S_A so that any vibration will have the same effect on the signal S_A as on the reference signal S_R . In a sound playing record, the sound grooves are preferably like those of a stereophonic sound recording and the modulated signal S_A is recorded on one flank of the groove while the reference signal S_R is recorded on the other flank. The signals S_A , S_R are then applied to the differentiator 11, in which the interference signal is filtered out. The differentiator 11 may be omitted if the signal S_A has been recorded by a different method. In this case the signal S_A from the camera is directly applied to an amplifier 12. The outputs of the amplifiers 10, 12 are connected to a heterodyning circuit 13, in which the resulting signal is formed. Because the signals S_1 , S_A are frequency-modulated signals, the resulting signal must be applied to a frequency discriminating circuit 14, which has at its input frequency converter 15. The converter 15 virtually constitutes a frequency counter because it generates a pulse in response to every change of the frequency of the resulting signal from the upper value to the lower one. Hence, each pulse of uniform width which is generated by the frequency converter 15 corresponds to a pulse of the resulting signal, regardless of the width of the latter pulse. As a result, the control signal to be formed is independent of the pulse width of the resulting signal. The frequency converter 15 has connected to it a comparator circuit 16, which comprises at least two and in the present embodiment three channels and which serves also as a frequency-voltage converter. For this purpose, a threshold value switch 17a, 17b or 17c is provided at the outlet end of each channel. These threshold value switches have preferably a hysteresis which is smaller than the residual ripple at the input. Each of the three channels is tuned to a predetermined frequency by a suitably dimensioned resistance-capacitance circuit. For instance, a channel 16a is tuned to 2 kHz, a channel 16b to 3 kHz and a channel 16c to 4 kHz. The value of 2 kHz in channel 16a corresponds to a lower reference value U_w of Figure 6, the value of 3 kHz in channel 16b corresponds to the desired value S_w and the value of 4 kHz in channel 16a to the upper reference value O_w . The outputs of the three channels 16a, 16b, 16c are applied to an identifying logic circuit 18, which generates a control signal that is applied to a motor control circuit 19 disposed in the camera.

The motor control circuit 19 has a control transistor 20 controlling a camera motor 21. The base current of the control transistor 20 is regulated by a comparison transistor 22. A voltage divider is connected to the base of the comparison transistor 22. The control sig-

nal delivered by the logic circuit 18 is applied via an input transistor 23 to one section of the voltage divider. This section comprises a relatively small resistance 24. A capacitor 26 is connected between the reference input 25 for the control signal and the base of the comparison transistor 22 to quicken its response to the control signal. The capacitor 26 may be adjustable. A known voltage-stabilizing circuit is connected between the output of the control transistor 20 and the motor 21 and, although shown, will not be described.

In the description of Figure 8, it has been stated in connection with the threshold value switches 17a, 17b, 17c that they should have a hysteresis which is smaller than the residual ripple at their input. This can be achieved by the use in each of a Schmitt trigger circuit such as is shown in Figure 9. This Schmitt trigger comprises in the usual manner an input transistor 27 and an output transistor 28. A difference from known circuits resides in that feedback is accomplished through an adjustable resistor 29, which is connected between the base of the input transistor 27 and the collector of the output transistor 28. The two transistors 27, 28 are complementary transistors. The input transistor 27 is a PNP transistor and the output transistor 28 an NPN transistor. The hysteresis of the Schmitt trigger which is shown may be adjusted by the resistor 29, or alternatively by a variable resistor 30, which is connected to the base of the input transistor 27. A voltage divider consisting of two resistors 31, 32 is included in the emitter circuit of the input transistor 27 and serves to adjust the threshold switching value.

The voltage divider in the emitter circuit of the input transistor 27 includes in series with resistor 32 a diode D_1 for compensating voltage and temperature changes, at least in part. The resistor 32 may be replaced by a series chain of diodes. If the voltage across the diode D_1 is designated U_D , the following calculation may be performed:

$$U_s = \frac{R_{32}(U_o - U_D)}{R_{31} + R_{32}} - U_{BE}$$

(where U_s is the threshold voltage) so that the proportionality of the voltages U_s and U_o is improved.

In many cases it is desirable to fully compensate for voltage and temperature voltages. In this case, an arrangement such as shown in Figure 10 may be adopted, where parts having the same function are provided with the same reference numerals as in Figure 9. A difference resides virtually only in that the emitter circuit of the input transistor 27 is connected by a resistor R_3 to the positive terminal U_o of the power source (not shown) and includes an emitter follower T_{EF} , the base of

which is controlled by a voltage divider consisting of the resistors 31, 32 so that

$$U_s = \frac{R_{32} U_o}{R_{31} + R_{32}}$$

5 and the operating voltage U_o is very well compensated and always proportional to the threshold voltage U_s .

Figure 11 shows an embodiment which is similar to that of Figure 10 but comprises homopolar transistors so that the resistor R_3 is grounded. In practice it will be necessary in such circuit to provide a diode circuit between the collector of the input transistor 27 and the base of the output transistor 28. In the present case, this diode circuit consists of a single Zener diode D_2 . A circuit such as that of Figure 10 might also comprise homopolar transistors if one or more diodes are connected between the collector of the input transistor and the base of the output transistor. If it is desired to use PNP transistors rather than NPN transistors, they may be effected by reversing the polarity of the operating voltage U_o . This measure would necessitate also replacement of the transistors 27, 28 shown in Figures 9 and 10.

When the circuit is to be energized in response to a predetermined threshold voltage and de-energized in response to a threshold voltage which is higher than the first, this may be accomplished by a circuit such as is shown in Figure 12. In Figure 12 there is included an additional transistor T_3 , the base of which is connected to a voltage divider, which shunts the input transistor and consists of two resistors R_4 , R_5 . The emitters of the two transistors 27, T_3 are interconnected. In this case, a first threshold voltage initially renders the Schmitt trigger conducting but a further voltage rise up to a second threshold value blocks the input transistor 27 because the voltage divider R_4 , R_5 is connected to the base of the input transistor 27. The corresponding modification comprising homopolar transistors 27, 28, T_3 is shown in Figure 13, where the base of the transistor T_3 is also connected to the base of the input transistor 27 by a part of the voltage divider R_4 , R_5 and the emitter of the transistor T_3 is connected to the emitter of the input transistor 27. A Zener diode D_2 is provided as in the embodiment of Figure 11.

For the sake of clarity, the Figures 12, 13, and 14 show greatly simplified embodiments, in which compensating circuits are omitted.

55 The switching function of the embodiment shown in Figure 14 is an inversion of the function of the Schmitt trigger shown in Figure 12. The only difference resides in that the input is connected by the series resistor 30 to the base of the input transistor 27 rather than to the additional transistor T_3 . The switching functions of this embodiment and of the re-

maining embodiments will now be explained with reference to Figure 15.

The input voltage U_o represented by a thick line exhibits a linear rise. The thin line represents an output voltage U_{A1} , such as is produced in the circuits shown in Figures 9 to 11. An embodiment as shown in Figure 12 or 13 has such a switching function that the output voltage initially follows the output voltage U_{A1} to a certain value. This means that with a low input voltage the output voltage is virtually zero and rises virtually to the full operating voltage when a predetermined threshold voltage is exceeded. In response to a further increase of the input voltage, the Schmitt trigger is reset to its initial condition. The resulting changes of the voltage U_{A2} are indicated by a dotted line.

In a circuit as shown in Figure 14, a lower input voltage U_o results in the output voltage U_{A2} , which is represented by a dash-dot line and above a predetermined threshold value is returned to zero. The output voltage will respond like the output voltage U_{A1} to a further rise of the input voltage.

Numerous modifications are possible. For instance, homopolar transistors may be used in the embodiment of Figure 14 if the input is applied directly to the base of transistor T_3 .

Figure 16 shows a modification of the motor control circuit 19 shown in Figure 8. The motor control circuit 19 of Figure 8 could be described as a current-voltage control circuit whereas the control circuit shown in Figure 16 is more properly described as a pulse control circuit. This circuit is used to control a motor 33 in a camera which also has a zooming motor 34. The motor 33 is connected to a speed-controlled change-over switch 35 at one input of the control circuit. This change-over switch 35 is connected to the input of a frequency-voltage converter, which comprises a transistor 36. The output of this converter is connected in the usual manner to a smoothing capacitor 37, which may have only a relatively low capacitance and in this respect differs from the conventional circuits. In the known circuits of this kind it is desired to provide at the output of the frequency-voltage converter a voltage which is as smooth as possible. It has now been found that the residual ripple at the output of this converter may be used to control the motor. For this purpose, the frequency-voltage converter has connected to it a threshold value switch consisting of a Schmitt trigger as shown in Figure 9 and comprising an input transistor 27' and an output transistor 28'. For regeneration, a resistor 29' is connected between the collector of the output transistor 28' and the base of the input transistor 27'. Matching is accomplished by an adjusting resistor 38. An adjustable voltage divider 39 for adjusting the threshold value is included in the emitter circuit of the input transistor 27'. The control

signal from the logic circuit 18 (Figure 8) is applied *via* an input terminal 40 to this voltage divider. The output of the Schmitt trigger is coupled to the motor 33 by a conventional switching circuit which comprises a transistor 41 so that the motor 33 is fed with current pulses which have a width that varies in accordance with the reference signal that has been applied. In connection with Figure 2 it has already been pointed out that the two signals S_1 , S_4 associated with the sound tape 1 and the camera 4 may be identical during synchronous movements and that a control signal can then be derived from a comparison of the two parameter values. One way in which such signals may be compared is shown in Figure 17, where the signals S_1 , S_4 are applied to the input of a Wheatstone bridge 42. When the parameter values of the two signals are equal, the bridge 42 is balanced so that no output signal will appear across the load impedance of the bridge circuit 42. Output signals having one sign or the other indicate a lead or lag of the controlled drive means. The output signals of the bridge circuit 42 may then be processed to form a control signal in various ways. According to Figure 17, the load impedance of the bridge circuit 42 comprises a measuring instrument 43, which varies a capacitance 44 included in a a.c. circuit. The resulting modulated alternating current is fed to a control circuit 45 for a motor 46 to control the latter. The instrument 43 may be replaced by a differential amplifier, the output signals of which are applied to a suitable motor control circuit.

An arrangement which comprises a differential amplifier is shown in Figure 18. Each of the signals S_1 , S_4 is applied to a frequency-voltage converter, which comprises transistors 47 and 47a, respectively, and smoothing capacitors 48 and 48a, respectively connected each to one of the transistors. The voltages which correspond to the signals S_1 , S_4 are then applied to a differential amplifier, which comprises the transistors 49, 50, 51. The output of this differential amplifier is connected to the channels 16a, 16b, 16c shown in Figure 8. The signals are then processed further as described with reference to Figure 8.

An arrangement for stopping the camera with the aperture closed and the film in a predetermined position will now be described with reference to Figure 19. A camera housing, not shown, has a camera lens (not shown) and behind it a picture aperture 101, which during a shot is periodically covered by a single-leaf shutter 103, which is secured to a shaft 102. The latter is connected to and driven by the camera motor 33, which for this purpose is energized by a battery 105. A release switch 106 is provided, which is operable to connect a contact 107 to a different current-carrying contact 108 for energizing the motor 33. When the contacts 107 and 108 are con-

nected, the motor 33 runs to drive the shaft 102 so that the picture aperture 101 is periodically opened.

As soon as the switch 106 has returned to the position shown in Figure 19, the shutter leaf 103 must be stopped in the position shown. For this purpose, the disc 103 carries a slip ring 109, which extends around an arc of about 180°. Two stationary wiping contacts 110, 111 cooperate with the slip ring 109 on one side. As long as the slip ring 109 connects the two contacts 110, 111, this by-pass circuit by-passes the contact 108 so that the energization of the motor 33 is continued. This condition is maintained for as long as the shutter disc 103 is in a position in which the picture aperture 101 is open.

As soon as the slip ring 109 is in a position in which it connects a stationary contact 111a to a further contact 112, the motor 33 is short-circuited to brake the shutter disc 103.

For synchronization of sound, a signal generator is provided in the camera and is driven in dependence on the motion of the film. In Figure 19 this signal generator comprises a disc 9, in which synchronizing signals are recorded. As the disc is driven with the film a modulated signal is applied to the synchronizing device 3. In order to ensure at the beginning of the recording on the film and during its subsequent projection that the disc 9 in the camera is in the same position as a corresponding disc in the projector, means are provided which enable the motor 33 to be de-energised, only when the disc 9 is in a predetermined position. For this purpose, the disc 9 carries an additional slip ring 114, which cooperates with two stationary wiping contacts 115, 116. By means of these wiping contacts 115, 116 and of the slip ring 114, the contact 108 is also by-passed until the stationary wiping contacts 115, 116 are in register with indentations 117, 118, as is shown in Figure 19. In this case, the supply of current will be interrupted as soon as the slip ring 109 has ceased to bridge the contacts 110, 111 and the shutter disc 103 then returns to the position shown.

For practical reasons, the period of the synchronizing signal corresponds only to a certain length of the film, e.g., sixteen frames. In practice the by-passing of the contact 108 delays the de-energization of the motor 33 by less than one second if the camera operates normally with 18 frames per second. Such a delay is acceptable to an amateur.

Figure 20 shows a camera which is provided with means for arresting the rotation of the main shaft 102. These arresting means consist substantially of a cam 119 secured to the shaft 102 and having a nose 120. As diagrammatically shown release button 121 is connected by an overcentre spring 122 to one end of a lever 123. A slidable locking member 124 is pivoted to the other end of the lever

123 and arrests the rotation of the shaft as soon as the release button 121 is moved to the left as this causes the locking member 124 to enter the path of the nose 120.

5 To prevent the slidable locking member 124 moving into the path of the nose until the disc 9 is in its predetermined position, a cam 125 connected to the disc 9 is followed by one arm of a lever 126. The other arm of the lever lies in the path of movement of the slidable locking member 124 so that the member 124 cannot enter the path of the nose 120. The cam 125 has a recess 127 at a point which corresponds to the predetermined position of the disc 9. As soon as the lever 126 falls into the recess 127, the lever 126 is shifted out of the path of the slidable locking member 124 which can then assume its position at which it obstructs the nose 120 and stops further rotation of the shaft 102.

By means not shown, contacts for supplying power to the motor of the shaft 102 are connected to the slidable locking member 124 so that even when the release button 121 is moved to the position shown the energization of the motor is continued until the lever 126 falls into the recess 127.

It has already been mentioned that the means which have been described generally delay the de-energization of the camera motor only for a short time so that this results in only a small waste of film. Even this small waste of film can be reduced or avoided by using arrangements now to be described.

35 The embodiment shown in Figure 21 is similar to that of Figure 20 and like parts are designated with the same reference numerals. However the slidable locking member 124 of Figure 20 is replaced by a pivoted locking member 124a, which carries one of the contacts of a motor switch 128. A rotating shutter 103a is connected to the shaft 102 and on the rear carries cams 129 for operating a pull-down lever 130, which is shown in section and which is provided with a claw for engaging the film intermittently to pull it stepwise through a film gate.

To prevent a continued feeding of the film when the camera has been de-energized by a movement of the camera release to the left, a linkage 131 is connected to the release button 121 and provided with a collar 132, which operates a two-armed lever. Upon a movement of the release 121 to the left, the collar 132 imparts to the lever 133 a pivotal movement in the clockwise sense so that the lever 133 disengages the pull-down lever 130 from the cam 129 which controls the engagement of the pull-down claw with the film. As a result, the pull-down claw is moved out of the film so that its further movement through the film gate ceases.

It may be undesirable however, that the frame of the film which is behind the picture aperture when the film is stopped is con-

tinuously exposed and is thus overexposed. This may be prevented if the rod 131 is provided with rack teeth 134, and are in mesh with a pinion 135. A link 136 is connected to the pinion and to an auxiliary shutter 137 for the picture aperture. Displacement of the release 121 to the left results in an upward displacement of the auxiliary shutter 137 in Figure 21 so that the picture aperture, not shown, is closed and exposure of the film frame in the aperture is prevented.

A different embodiment is shown in Figure 22, where a dog clutch section 138 is secured to the shaft 102 for rotation therewith. The shaft 102 passes through a hollow shaft 139, which carries a complementary clutch section 140 as well as a rotating shutter 103b and a cam 129b for operating a pull-down claw. The hollow shaft 139 also carries a cam 119b, which corresponds to the cam 119 in Figures 20 and 21 and has a nose 120b. This nose 120b cooperates with a locking member 142, which is operated by the release 121 by means of an overcentre spring 141 and when the release 121 is released for movement to the position shown, the locking member immediately swings into the path of the nose 120b to arrest the rotation of the hollow shaft 139 with the rotating shutter 103b and the pull-down claw cam 129b. During the pivotal movement of the locking member 142 to the position shown, an extension 143 of the rod 131 connected to the release 121 shifts the coupling section 140 to the left so that the hollow shaft 139 is uncoupled from the main shaft 102. The feeding of the film is thus stopped and an exposure of the frame in the picture aperture is prevented. It has proved desirable that the rotating mass of the coupling to be arrested is relatively small when the clutch 138, 140 is disengaged so that an undesired reaction on the transmission and motor is avoided. Additionally, a friction brake may be provided, which prevents a reversal of the rotation of the hollow shaft 139 when the nose 120 strikes the locking member 142.

When the release 121 returns to the position shown in Figure 22 after the film shot has been taken the feeding of the film is stopped in the manner described. However the rotation of the shaft 102 continues until the lever 126 has fallen into the recess 127 in the cam 125 so that the contacts of the switch 128b for energizing the motor can be opened. The motor is then mechanically or electrically braked in known manner.

Whereas it is desirable with cameras for the motor to return to the disc 9 to its predetermined position, in the case of a tape recorder it may be sufficient to uncouple the drive means so that the latter can be moved to its predetermined position by hand. This arrangement could be mainly usable in projectors having the sound carrier or tape recorder easily accessible.

Figure 23 shows such an arrangement for uncoupling the drive means for the sound carrier. These drive means comprise a shaft 144, to which a worm 145 is secured, which is in mesh with a worm wheel 146. The latter is secured to a shaft 147, which carries also the signal generating disc, not shown, but which is similar to that shown in earlier Figures and identified with the numeral 9. The shaft 147 is secured to a lever 148, which is pivoted on a pivot 149. A spring 150 urges the wheel 146 towards the worm 145.

The sound carrier is provided with a starting button 151, which is slidable to the left in Figure 23 against the force of a compression spring 152. The starting button 151 is connected to a detent lever 154 by a Bowden cable 153. The detent lever 154 is pivoted on a pivot 155 and has an actuating extension 156, which, under the action of the spring 152 and against the action of a spring 150 bears on the arm 148 to displace it about a pivot 149 to the position shown. The lever 148 is thus held in a position in which the worm wheel 146 is out of mesh with worm 145.

A spring 159 has one end secured to pivot 149 for the lever 148 and its other end is secured to a pin 160 secured to the worm wheel 146. When the sound carrier is in operation, the worm 145 drives the worm wheel 146 so that the stress of the spring 159 is periodically increased and decreased. When the appliance is de-energized so that the several parts assume the position shown in Figure 23, the worm wheel 146 is rotated under the action of the spring 159 until the spring 159 attains its relaxed state. This position of the worm wheel 146 corresponds to the predetermined position of the disc 9.

When the sound carrier has been de-energized with the worm wheel 146 in a position such that the pin 160 is in its dead centre i.e., the axes of the pivots 147, 149 and of the pin 160 lie in a plane, a leaf spring 161, which is secured to the sound carrier, moves the pin 160 beyond its dead centre position to allow the spring 159 to reassume control.

A modification of the embodiment of Figure 23 is shown in Figures 24 and 25. In these Figures, similar parts have like reference numerals. The arm 148 is replaced by an arm 162, which carries the shaft 147 to which the disc 9 and the worm wheel 146 are secured. A pawl 164 is mounted on the arm 162 and under the pressure of a spring 165 bears on a stop 166 which is fixed to the sound carrier.

One protruding end portion of a coil spring 168 bears on a pin 167, which is provided on the disc 9. The other protruding end portion of this spring engages a stop pin 169, which is provided on a disc 170, which is mounted on the shaft 147 but rotatable relative thereto. A friction facing 171 brakes any rotation of the disc 170.

When the appliance is started and the arm

162 is moved to the position shown in Figure 24, the resulting rotation of the disc 9 and of the pin 167 winds up the spring 168. Because the disc 170 is braked by the friction facing 171, the stop pin 169 remains initially stationary. After not more than one revolution, the end of the pin 167 which engages the spring reaches the engaging stop pin 169 (Figure 25 shows the two discs in positions which differ from that of Figure 24) and the disc 170 is now positively driven, the friction exerted by the friction facing 171 being overcome.

The spring 168 remains stressed while the appliance is in operation. As soon as the operating button is released the lever 154 and the arm 162 are pivotally moved in the counterclockwise sense so that the worm wheel 146 is disengaged. The spring 168 can now rotate the disc 9 in the counterclockwise sense until a stop 172 provided on the disc 9 is caught by the pawl 164 when the disc 9 has been returned to its predetermined position.

WHAT WE CLAIM IS:—

1. A process for synchronising two signals one of which is generated in synchronism with the movement of a strip running through a first appliance and the other of which is generated in synchronism with the movement of a strip running through a second appliance each signal recurring cyclically and having a parameter whose value changes progressively along the length of a strip section carrying the signal so that the instantaneous value of the parameter is indicative of a unique position along the strip section, the process comprising comparing the instantaneous values of the two parameters of respective strip signals, providing an output signal when the relative instantaneous values of the two parameters are such as to signify that the movements of the two strips are not exactly in phase with one another, and applying the output signal as a correction value to a motor control circuit which regulates the speed of one of the strips so that the desired in-phase relationship of the movement of the two strips is restored.

2. A process as claimed in claim 1, in which the progressively changing parameter is frequency.

3. A process as claimed in claim 2, in which the parameter changes linearly.

4. A process as claimed in any one of the preceding claims in which the in-phase relationship is denoted by zero output signal.

5. A process as claimed in claim 1, 2 or 3, in which the in-phase relationship is denoted by an output signal of constant amplitude.

6. A process as claimed in claim 1, 2 or 3, in which inphase relationship is denoted by an output signal of square wave shape.

7. A process as claimed in any one of the preceding claims, in which one of the signals is generated by movement of a rotary member

Figure 23 shows such an arrangement for uncoupling the drive means for the sound carrier. These drive means comprise a shaft 144, to which a worm 145 is secured, which is in mesh with a worm wheel 146. The latter is secured to a shaft 147, which carries also the signal generating disc, not shown, but which is similar to that shown in earlier Figures and identified with the numeral 9. The shaft 147 is secured to a lever 148, which is pivoted on a pivot 149. A spring 150 urges the wheel 146 towards the worm 145.

The sound carrier is provided with a starting button 151, which is slidable to the left in Figure 23 against the force of a compression spring 152. The starting button 151 is connected to a detent lever 154 by a Bowden cable 153. The detent lever 154 is pivoted on a pivot 155 and has an actuating extension 156, which, under the action of the spring 152 and against the action of a spring 150 bears on the arm 148 to displace it about a pivot 149 to the position shown. The lever 148 is thus held in a position in which the worm wheel 146 is out of mesh with worm 145.

A spring 159 has one end secured to pivot 149 for the lever 148 and its other end is secured to a pin 160 secured to the worm wheel 146. When the sound carrier is in operation, the worm 145 drives the worm wheel 146 so that the stress of the spring 159 is periodically increased and decreased. When the appliance is de-energized so that the several parts assume the position shown in Figure 23, the worm wheel 146 is rotated under the action of the spring 159 until the spring 159 attains its relaxed state. This position of the worm wheel 146 corresponds to the predetermined position of the disc 9.

When the sound carrier has been de-energized with the worm wheel 146 in a position such that the pin 160 is in its dead centre i.e., the axes of the pivots 147, 149 and of the pin 160 lie in a plane, a leaf spring 161, which is secured to the sound carrier, moves the pin 160 beyond its dead centre position to allow the spring 159 to reassume control.

A modification of the embodiment of Figure 23 is shown in Figures 24 and 25. In these Figures, similar parts have like reference numerals. The arm 148 is replaced by an arm 162, which carries the shaft 147 to which the disc 9 and the worm wheel 146 are secured. A pawl 164 is mounted on the arm 162 and under the pressure of a spring 165 bears on a stop 166 which is fixed to the sound carrier.

One protruding end portion of a coil spring 168 bears on a pin 167, which is provided on the disc 9. The other protruding end portion of this spring engages a stop pin 169, which is provided on a disc 170, which is mounted on the shaft 147 but rotatable relative thereto. A friction facing 171 brakes any rotation of the disc 170.

When the appliance is started and the arm

162 is moved to the position shown in Figure 24, the resulting rotation of the disc 9 and of the pin 167 winds up the spring 168. Because the disc 170 is braked by the friction facing 171, the stop pin 169 remains initially stationary. After not more than one revolution, the end of the pin 167 which engages the spring reaches the engaging stop pin 169 (Figure 25 shows the two discs in positions which differ from that of Figure 24) and the disc 170 is now positively driven, the friction exerted by the friction facing 171 being overcome.

The spring 168 remains stressed while the appliance is in operation. As soon as the operating button is released the lever 154 and the arm 162 are pivotally moved in the counterclockwise sense so that the worm wheel 146 is disengaged. The spring 168 can now rotate the disc 9 in the counterclockwise sense until a stop 172 provided on the disc 9 is caught by the pawl 164 when the disc 9 has been returned to its predetermined position.

WHAT WE CLAIM IS:—

1. A process for synchronising two signals one of which is generated in synchronism with the movement of a strip running through a first appliance and the other of which is generated in synchronism with the movement of a strip running through a second appliance each signal recurring cyclically and having a parameter whose value changes progressively along the length of a strip section carrying the signal so that the instantaneous value of the parameter is indicative of a unique position along the strip section, the process comprising comparing the instantaneous values of the two parameters of respective strip signals, providing an output signal when the relative instantaneous values of the two parameters are such as to signify that the movements of the two strips are not exactly in phase with one another, and applying the output signal as a correction value to a motor control circuit which regulates the speed of one of the strips so that the desired in-phase relationship of the movement of the two strips is restored.

2. A process as claimed in claim 1, in which the progressively changing parameter is frequency.

3. A process as claimed in claim 2, in which the parameter changes linearly.

4. A process as claimed in any one of the preceding claims in which the in-phase relationship is denoted by zero output signal.

5. A process as claimed in claim 1, 2 or 3, in which the in-phase relationship is denoted by an output signal of constant amplitude.

6. A process as claimed in claim 1, 2 or 3, in which inphase relationship is denoted by an output signal of square wave shape.

7. A process as claimed in any one of the preceding claims, in which one of the signals is generated by movement of a rotary member





separate from the strip but driven in synchronism with it.

8. A process as claimed in any one of the preceding claims in which a signal track on one strip is read to provide the changing parameter signal.

9. A process as claimed in any one of the preceding claims, in which one of the appliances comprises a motion picture handling apparatus and the associated strip is a film strip.

10. A process as claimed in any one of the preceding claims, in which one of the appliances comprises a sound tape handling apparatus and the associated strip is a sound tape.

11. A process as claimed in any one of the preceding claims, in which an additional signal is recorded on one of said strips which does not carry a parameter-bearing signal, the additional signal being recorded at a predetermined point in each signal period of parameter change.

12. A process as claimed in claim 2 or any one of claims 3 to 11 when dependent thereon, in which the two frequency-modulated signals are mixed and detected to provide an output signal providing, with its magnitude and polarity, a measure of the lack of in-phase relationship between the two signals.

13. A process as claimed in any one of the preceding claims, in which the difference between the largest and smallest value of the parameter is the same for each of the signals.

14. A process as claimed in any one of the preceding claims, in which the changes of the parameter are substantially the same for both signals and in-phase when the strips movements have the desired in-phase relationship, and the signals are subtracted from one another to derive the output signal.

15. A process as claimed in any one of claims 1 to 13, in which the parameter values of the two signals vary in mutually opposite senses and are in antiphase when the strips movements have the desired in-phase relationship, and the two signals are added to one another to derive the output signal.

16. A process as claimed in claim 14 or claim 15 in which the difference between the instantaneous values of the parameters of the two signals when the two strips are moving with the desired in-phase relationship, exceeds the difference between the largest and smallest parameter values of each signal on each strip.

17. A process as claimed in claim 16, in which one of the two signals which is associated with a controlled drive for the associated strip, is composed of repetitive periods in each of which the parameter values increase linearly.

18. A process as claimed in any one of claims 2 to 17, in which the parameter values lie in the range 250 Hz to 5000 Hz.

19. A process as claimed in claim 18 in

which the parameter values lie in the range 500 to 2500 Hz.

20. A process as claimed in any one of the preceding claims, in which the output signal signifying the phase relationship of the movements of the two strips is compared with upper and lower reference values which, if exceeded, individually indicate a lagging or leading error in the phase relationship while the extent of the phase misalignment is signified by the frequency with which the reference value is exceeded by the output signal.

21. A process as claimed in claim 19 when dependent on claim 5 or any one of claims 6 to 19 when dependent on claim 5, in which the upper and lower reference values are equispaced from a third reference value lying between them and which corresponds to the constant output signal maintained during in-phase movement of the two strips.

22. A process as claimed in claim 20 or claim 21, in which the difference between the upper and lower reference values is greater than the variations in the output signal which occur during in-phase movements.

23. A process as claimed in any one of claims 1 to 19, in which the output signal signifying the degree of synchronisation is compared with upper and lower reference values and synchronisation is denoted by two reference values being alternatively equalled, or exceeded by equal amounts, by the output signal.

24. A process as claimed in any one of claims 9 to 23, in which the upper and lower reference values correspond to a phase displacement between the two strips of half a period of the sequence of parameter changes which recurs.

25. An appliance having a first strip transport system, a drive for the system, an arrangement providing on a first signal line first cyclically recurring signals each having a progressively changing parameter and produced in synchronism with the movement of the first strip, a comparator having two input connections to one of which is applied the first signal while the second is adapted to have applied to it second cyclically recurring signals each having a progressively changing parameter and generated in synchronism with a second strip transport system, the comparator being adapted to compare the instantaneous values of the changing parameter at its input and providing an output signal indicative of the extent and direction of any error in the phase relationship in the movements of the two strips from a desired in-phase relationship, and speed control circuitry responsive to the output of the comparator to restore the movements of the two strips to the desired in-phase relationship.

26. An appliance as claimed in claim 25, in which the arrangement comprises a signal

generator driven in synchronism with the first strip transport system.

27. An appliance as claimed in claim 26, in which the generator is an audio frequency signal generator.

28. An appliance as claimed in claim 27, in which the generator comprises a rotary element having an associated take-off member and storing member producing at the take-off member the audio frequency signal when the element is rotated.

29. An appliance as claimed in claim 28, in which the rotary element has two sound tracks recorded on it one of which provides a constant reference frequency.

30. An appliance as claimed in any one of claims 25 to 29, in which the rotary element provides a frequency modulated audio frequency output.

31. An appliance as claimed in claim 30, in which rotation of the element at uniform speed produces a linearly changing frequency modulation.

32. An appliance as claimed in any one of claims 26 to 31, having a mode control switch with "ON" or "OFF" conditions and an arrangement for bringing the signal generator to a predetermined "start" position when the switch assumes the "OFF" condition.

33. An appliance as claimed in any one of claims 25 to 32, constructed as a camera having a motor driving the first transport system and also the signal generator, operation of the motor being controlled by a release switch which is prevented from being effective to stop the motor until the signal generator has been brought to a, or the predetermined, "start" position.

34. An appliance as claimed in claim 28 or any one of claims 29 to 33 when dependant thereon, in which an arcuate, electrically-conductive track is rotated in unison with the rotary element of the signal generator, and electrical contacts which bear on the track are bridged by it to maintain an electrical energisation circuit to the motor after opening of the release switch and until an interruption in the track determining the "start" position, is located beneath at least one contact so breaking a shunt circuit around the release switch provided by way of the track and contacts.

35. An appliance as claimed in claim 33, in which release of the release switch resiliently urges a mechanical device into a "stop" position at which it stops rotation of a shaft driven by the motor, a mechanism controlled by the angular position of the rotary element of the signal generator preventing the mechanical device from reaching the "stop" positions until the signal generator has been brought to the predetermined "start" position.

36. An appliance as claimed in claim 35, in which the mechanism comprises a cam mounted for rotation with the rotary element and controlling the position of a lever having

a first position at which it obstructs movement of the device to the "stop" position, and a second position at which it is held clear of the path of movement of the device.

37. An appliance as claimed in any one of claims 32 to 36, in which the strip transport includes intermittent film strip-driving assembly which is rendered ineffective to drive the film when the mode control switch is in the OFF condition.

38. An appliance as claimed in claim 37, including an auxiliary shutter positionally controlled by the mode-control switch and which interrupts the light path to the film when the mode control switch is in OFF condition.

39. An appliance as claimed in claim 37 or claim 38, in which the camera has a rotary shutter driven through a disconnectable coupling from a motor-driven shaft, the coupling being disconnected by the mode-control switch when in the OFF condition, to halt rotation of the shutter and also operation of the strip-driving assembly which is cam-driven from the coupling.

40. An appliance as claimed in claim 32, including a disconnectable drive coupling through which drive is transmitted to the signal generator from a driven shaft when the mode control switch is in the ON condition, movement of the mode control switch to the OFF condition disconnecting the coupling to allow the sound generator to be moved to the "start" position.

41. An appliance as claimed in claim 40, in which the signal generator is equipped with a spring which is effective, on disconnection of the drive coupling, to move the signal generator to its "start" position.

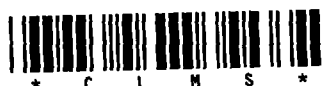
42. An appliance as claimed in claim 41, in which the signal generator has a disc carrying a signal track and rotatable about its axis by the disconnectable drive coupling, the disc being connected at an eccentric position to one end of a tension spring extending in a chordal direction and anchored to a fixed part of the appliance.

43. An appliance as claimed in claim 42, including a cantilever leaf spring having its free end engaged by a part of the disc to flex the leaf spring when the disc axis and the two ends of the spring lie on the same straight line, the leaf spring serving to rotate the disc beyond the 'dead-centre' position, should it have stopped there when the mode control switch is moved to the OFF condition, so that the tension spring can restore the disc to the "start" position.

44. An appliance as claimed in claim 41, in which the signal generator includes a first disc, a coil spring having radially protruding end-portions wound around a drive shaft for the signal generator, one end-portion of the coil spring bearing on a stop on the disc and the other end-portion bearing on a part which, with the disc, winds up the spring when the



- drive shaft is driven, an abutment being provided to limit return of the disc under the influence of the spring when the drive coupling is disconnected so that the signal generator is returned to the "start" position.
- 5 45. An appliance as claimed in claim 44, in which said part comprises a second disc frictionally engaging a surface and coaxially spaced from the first disc, the two discs being
- 10 coupled to one another by the coil spring.
46. An appliance as claimed in claim 28 or any one of claims 29 to 45 when dependent thereon, in which the rotary element has stored on it several sound tracks and the take-off
- 15 member is selectively alignable with each of the tracks.
47. An appliance as claimed in any one of claims 28 to 46, constructed as a camera for receiving film cartridges and provided with a
- 20 cartridge chamber containing a film take-up shaft on which the rotary element of the signal generator is mounted.
48. An appliance as claimed in claim 29 or any one of claims 30 to 47 when dependent thereon, including a mixer in which the two
- 25 sound signals obtained simultaneously from the rotary element are subtracted from one another to provide a signal which is substantially unaffected by vibration of the rotary
- 30 element.
49. An appliance as claimed in claim 48, in which the two sound signals are respectively recorded one on each flank surface of a V-groove cut in the rotary member.
- 35 50. An appliance as claimed in any one of claims 25 to 49, in which the comparator comprises a bridge circuit.
51. An appliance as claimed in claim 50, in which the bridge circuit receives its inputs
- 40 from frequency-voltage conversion circuits.
52. An appliance as claimed in any one of claims 25 to 51, including a motor control circuit for regulating the speed of the first
- 45 strip transport system and comprising a control transistor having a motor connected in its collector circuit, a comparison transistor for controlling the control transistor, a voltage divider connected to the base of the comparison transistor, a relatively low value electrical
- 50 resistance included in one section of the voltage divider and to which said output signal is applied, and a voltage stabilised output circuit supplying the motor.
53. An appliance as claimed in claim 52, in which the voltage divider circuit includes
- 55 a zener diode and the low value electrical resistance is substantially 1 kilohm.
54. An appliance as claimed in claim 52 or claim 53, including a capacitance connected
- 60 between the base of the comparison transistor and the point at which said output signal is applied to the low value electrical resistance.
55. An appliance as claimed in claim 54, in which the capacitance is adjustable.
- 65 56. An appliance as claimed in any one of claims 25 to 51, including a motor control circuit for regulating the speed of the first strip transport system and comprising a speed-controlled frequency-voltage converter circuit supplying a switching circuit for the motor by way of an output stage formed as a threshold value switch having a hysteresis time which is lower than the periodic time of a residual ripple in the output signal.
- 70 57. An appliance as claimed in claim 56, in which the threshold value switch is a Schmidt trigger circuit.
58. A synchronising arrangement comprising a first appliance containing a first strip transport system, a second appliance containing a second strip transport system which is to run in a desired phase relationship with respect to the first system, a first signal generating assembly adapted to produce a first
- 80 cyclically recurring signal having a progressively changing parameter the first signal being produced in synchronism with the first strip, a second signal generating assembly adapted to produce a second cyclically recurring signal having a progressively changing parameter, the second signal being produced in synchronism with the second strip, a comparator for comparing the first and second signals and producing an output signal which is a measure of the extent and direction of the phase relationship from the desired phase relationship
- 85 between the two strips movement, and speed control circuitry responsive to said output signal to adjust the speed of one of the systems so that the desired in-phase relationship of the two strips is restored.
59. A synchronising arrangement as claimed in claim 58, in which the comparator is mounted on one of the appliances.
60. A synchronising arrangement as claimed in claim 59, in which one of the appliances is a tape recorder and the other is a film-handling appliance having a motor which has its speed adjusted by the speed control circuitry and which drives a film strip transport system.
- 90 61. A synchronising arrangement as claimed in claim 58, claim 59 or claim 60, in which a signal generating assembly comprises a member rotated in synchronism with the strip transport system of the same appliance and having stored thereon a signal track providing the changing parameter and which is "read" during operation of the appliance.
62. A synchronising arrangement as claimed in any one of claims 58 to 61, in which a signal generating assembly provides, when operated, a recurring sequence of changes of the parameter.
63. A synchronising arrangement as claimed in claim 62, in which the signal generating assembly provides an audio frequency output, when operated, lying in the range 250 Hz to 5000 Hz.
64. A synchronising arrangement as claimed



in claim 62 or claim 63, in which a recurring linear sequence of changes of the parameter are provided by the signal-generating assembly.

5 65. A synchronising arrangement as claimed in any one of claims 58 to 64, in which the parameter is frequency.

10 66. A process for synchronising two strip transport systems, substantially as hereinbefore described with reference to any one of the embodiments shown in the accompanying drawings.

67. A synchronising arrangement for synchronising two strip transport systems, sub-

stantially as hereinbefore described with reference to any one of the embodiments shown in the accompanying drawings. 15

68. An appliance as claimed in claim 25, arranged and adapted to operate substantially as described with reference to any one of the 20
embodiments shown in the accompanying drawings.

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