

The invention relates to a process according to the precharacterizing clause of claim 1 and to an apparatus suitable for carrying out the process according to the invention, according to the precharacterizing clause
5 of the first substantive claim.

In the recording of information, such as for example digital data for data processing systems or digital or analog data for sound or image reproduction equipment, recording tapes which store the information
10 can be used. This may take place by magnetic, optical or other processes known to a person skilled in the art.

In the use of the said recording tapes, they are usually wound forward or back at various speeds. In this respect, a distinction is often drawn between on the one
15 hand the speeds at which the information is read from the recording tape. This comprises the so-called playback speed and the so-called search.

On the other hand, given a suitable opportunity, the playback tape is wound fast forward or back. If in
20 this case winding continues to the respective end, it is referred to here as fast winding.

In the following, the invention is described with reference to the fast winding of a video cassette. It should however be pointed out that the invention is not
25 restricted to this.

The magnetic tape of a video cassette usually has an end-of-tape marking, which takes the form of a transparent tape, respectively a few centimeters from its two ends. This marking is detected by a video recorder used,
30 which thereupon brakes a first reel, from which the recording tape is unwound, and a second reel, onto which the recording tape is wound, by means of a braking device.

Since this braking takes place only with a
35 predetermined maximum retardation, it may be the case that the tape comes up against the end stop at an excessively high speed. This may result in tearing of the tape. If, on the other hand, the braking takes place with greater retardation, tape loops may occur.





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Known embodiments restrict the winding speed or, to be more precise, the rotational speed of the first reel, for unwinding, to a maximum speed of such a value that the retardation by the braking operation is adequate to avoid the tape coming up against the end stop.

However, by restricting the winding speed to this maximum speed, the winding takes quite a long time.

It is the object of the present invention to realize winding of a recording tape in which, on the one hand, the time required for this, the so-called winding time, is reduced and, on the other hand, the recording tape to be wound is prevented from coming up against the end stop at an excessively high speed.

This object is achieved in the case of the system of the generic type, comprising the process according to the invention and an apparatus suitable for carrying out the process according to the invention, by the characterizing features of claim 1 and by the characterizing features of the first substantive claim, respectively.

According to the invention, first of all a set value is determined for the end rotational speed, which the first reel, i.e. the reel from which the recording tape is unwound, is to have before its braking by a braking device, which is controlled by an end-of-tape marking. This determination may take place, for example, as a function of the braking action of the braking device, and of the distance of the end-of-tape marking from the actual end of the tape.

Furthermore, a set value for the deceleration with which a rotational speed of the first reel is decelerated to the end rotational speed is determined. This may take place, for example, by the force with which the second reel is driven, that is to say that reel onto which the recording tape is wound, being reduced. This may take place with consideration for the total mass of the recording tape, the reels, and other circumstances.

In order then to keep the winding time as short as possible, the second reel is accelerated by a drive motor to a maximum rotational speed and is usually,

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dependent on the characteristics of the drive motor, kept subsequently at this rotational speed. The rotational speed of the first reel is continuously increased, which is caused by, inter alia, the fact that the circumference
5 of the recording tape to be wound up constantly increases, but that of the tape to be unwound constantly decreases.

To prevent the recording tape coming up against the end stop at excessively high speed, the rotational
10 speed (W_1) of the first reel is increased to a maximum rotational speed (W_m) for as long as the remaining winding time is adequate to decelerate the rotational speed of the first reel to a predetermined end rotational speed (W_0) in accordance with a predetermined set value
15 for the deceleration (a_1).

Advantages of the system according to the invention are that, by virtue of the prompt initiation of the deceleration, on the one hand the mechanical stressing of the recording tape used is reduced and on the other hand
20 the ease of operation is increased.

If the winding time is determined from the number of turns on the first reel at a given time, this has in particular the advantage that the system according to the invention also functions satisfactorily if recording
25 tapes with different tape lengths are used or if the winding is started when part of the tape has already been wound.

The number of turns at a given time can be determined from the thickness of the recording tape, if
30 appropriate from the radius of a hub onto which the recording tape is wound up and from the thickness of the total recording tape on the first reel. This makes possible a simple system for determining the number of turns at a given time.

35 If existing sensors are used, and the process steps further specified in the claims are observed, simple, inexpensive systems are realized.

Further features, advantages and details of the invention are explained in the following exemplary

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embodiments with reference to the drawing, in which:

Fig. 1 shows an exemplary embodiment of the apparatus according to the invention;

5 Fig. 2 shows the flow chart of a first exemplary embodiment of the process according to the invention;

Fig. 3 shows the variation over time of the winding speed according to the invention;

Before describing the exemplary embodiments in more detail, it should be pointed out that the blocks
10 individually represented in the figures serve only for a better understanding of the invention. Usually, a few or some of these blocks are combined into units. These may be realized using integrated or hybrid technology or as program-controlled microcomputers, or as part of a
15 program suitable for controlling the latter.

It goes without saying that the elements [lacuna] in the individual stages can also be configured separately.

In the following, means and signal waveforms
20 having the same meanings are respectively provided in the figures with the same reference symbols.

Fig. 1 symbolically shows an exemplary embodiment of the apparatus according to the invention. Shown as a detail are elements of a video recorder or playback
25 device, in which a corresponding cassette is wound. Only those means which are essential for an understanding of the invention are represented.

An electronic control device 10 receives from a first rotational-speed sensor 11 signals which represent
30 a measure of the rotational speed W_1 of a first reel 12, from which a recording tape 13 is wound onto a second reel 14.

The first reel 12 is formed by a first hub 12a having the radius R_0 , and a residual amount 12b, which
35 contains N_1 turns of the playback tape 13, which has a thickness e , whereby the total thickness D_1 of the residual amount 12b becomes

$$D_1 = N_1 * e.$$

The first total radius R_1 is consequently ob-





tained from

$$R1 = R0 + D1.$$

5 The second reel 14 is formed analogously to the first reel 12 from a second hub 14a, which in this exemplary embodiment has the same radius $R0$ as the first hub 12a, and a wound-up amount 14b having $N2$ turns, which has the thickness $D2$:

$$D2 = N2 * e.$$

This gives the second total radius $R2$

10
$$R2 = R0 + D2.$$

The rotational speed $W2$ of the second reel 14 is sensed by a second rotational-speed sensor 15, which emits corresponding signals to the electronic control device 10.

15 The rotational-speed sensors 11 and 15 are preferably such that digital markings which are provided on a rotor (not shown) are sensed and used to conclude the rotational speed. The rotational speed of one of these rotors is linked to the rotational speed of the associated reel 12 or 14, producing periods of time
20 between the individual markings which are inversely proportional to the reel speed under consideration.

The electronic control device 10 also receives signals BE from an end-of-tape sensor 16, which detects
25 an end-of-tape marking of the recording tape 13. This marking may be electrical, optical, magnetic or the like and the end-of-tape sensor 16 is designed accordingly.

The first reel 12 is connected to a first rotating device 17, which contains first driving means (not
30 shown), such as for example an electric motor including the associated activation device, and also first braking means (not shown). The electronic control device 10 emits to the first rotating device signals $M1$, which activate the said first driving means, and signals $B1$, which
35 activate the said first braking means.

By analogy with the first rotating device 17, a second rotating device 18 is provided with a second driving means (not shown) and a second braking means (not shown). These contain [sic] corresponding activation

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signals M2 and B2 from the electronic control device 10.

Instead of second driving means, which are contained in the rotating devices 17 and 18, a single driving means may be used, the driving effect of which is directed by means of suitable deflecting means to the reel 12 or 14 respectively to be driven.

The first driving means, or the said deflection of the driving effect to the first reel 12, is necessary for winding only whenever it is also to take place in the second direction, that is to say from the second reel 14 to the first reel 12. Such a winding operation proceeds analogously to that described in more detail here.

Also provided is a memory 19, in which a set value relating to a maximum braking speed W_0 , a value relating to a maximum deceleration a_1 , values e for the thickness of the playback tape 13 and values for the radius R_0 of the hubs 12a and 14a are stored and which emits corresponding signals to the electronic control device 10. Also stored is a surface-area value q , which is defined further below.

A reading head 20, which detects additional markings impressed on the recording tape 13, may also be additionally provided. As a result, corresponding signals, such as for example a "beginning-of-film" identification, can be emitted to the electronic control device 13, which thereupon instigates stopping during winding.

Two winding reels 21 and 22 serve for suitable guidance of the recording tape 13.

The process according to the invention is now explained with the aid of the flow chart of Fig. 2 and the diagram of Fig. 3.

Once a winding operation has been started in step 100, in step 101 the electronic device 10 reads in the following values from the memory 19:

- the set value for the braking speed W_0 , which the first reel is to have before its braking by the braking device,
- the maximum value for the deceleration a_1 ,
- a value for the tape thickness e ,

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- the surface-area value q , which depends on the total surface area A of the tape 13 which is to be wound and the tape 13 which is wound-up and also the surface area of the hubs 12a, 14a, thus

$$q^2 = k * (R1^2 + R2^2),$$

- the value R_0 .

According to a first version of this exemplary embodiment, the said values stored in the memory 19 have been determined at the works and correspond to average values or critical extreme values which are obtained when customary video cassettes are used.

In the case of further versions, these values can be determined by the playback device used, on the basis of a tape identification.

In step 102, the values $W1$ and $W2$ are read in from the rotational-speed sensors 11 and 15, respectively.

From the variables read in, in step 103 a first term 1 is calculated

$$(2 * a1)/e * (R1 - R_0) \quad (1)$$

In step 104, a second term is determined from:

$$W1^2 - W_0^2 \quad (2)$$

The term (1) is a conversion of the expression

$$4 * \pi * a1 * N1. \quad (3)$$

The expression (3) is obtained from the following fundamental equations:

$$dN1/dt = W1/(2 * \pi), \quad (a)$$

which indicates the relationship between the variation over time of the number $N1$ of turns on the first reel 12 and the rotational speed $W1$ of the latter.

As a further fundamental equation, the following is entered into the expression (3):

$$dW1/dt = - a1, \quad (b)$$

which indicates the relationship [lacuna] the variation over time of the rotational speed $W1$ and the set value of the deceleration $a1$.

With introduction of the abbreviation

$$p = R1/R2 \quad (c)$$

and taking into consideration

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$$R1 = p * q / (1 + p^2)^{1/2} \quad (d)$$

the expression (1) leads to

$$2 * a1 / e * (p * q / (1 + p^2)^{1/2} - R0). \quad (4)$$

Consequently, taking into consideration the already mentioned definitions of the individual variables, the first term T1 in the form of (1) or (4) represents a value for the winding time which is required in order to decelerate the rotational speed of the first reel 12 with the deceleration a1 to the predetermined end rotational speed Wo.

In step 105, it is checked whether the first term T1 is greater than the second term T2. If "yes", step 106 follows, where the rotational speed W1 of the first reel 12 is further increased. Following this, the process leads to step 102, with the result that steps 102 to 105 are repeated.

If it is established in step 105 that the first term T1 is not greater than the second term T2, there follows a step 107, in which the rotational speed W1 of the first reel 12 is reduced in accordance with the set value of the deceleration a1.

The effect of the process according to the invention can be seen from Fig. 3, comprising Fig. 3a and Fig. 3b. The rotational speed W1 of the first reel 12 initially increases up to a maximum value Wm and is subsequently decelerated with the set deceleration a1 to the value of the predetermined end rotational speed Wo.

Fig. 3b shows different profiles of the rotational speed W1. These may be caused, for example, by different starting points for the winding.

It can be seen that the set deceleration a1 and the end rotational speed Wo are always of the same magnitude. The values of the maximum rotational speed Wm vary, however.

In the case of a second exemplary embodiment, the first term and the second term are transformed in such a way that a calculation and the subsequent comparison can be carried out as quickly as possible by the electronic control device 10.

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Since

$$p = R1/R2 \quad (c)$$

becomes very much smaller than 1 toward the end of the winding operation, it follows from (d) by approximation
5 that

$$R1 = q * p, \quad (e)$$

whereby the following is obtained from (4) and (2) as a new first term $T1'$

$$dT^2(2*a1/e*(q*p - Ro) + 1/dTo^2) \quad (5)$$

10 In this case, $T = 1/W1$ and $To = 1/Wo$.

The new first term $T1'$ according to (5) is then checked as to whether it is greater than or less than the new second term $T2'$, which constantly has the value "1".

15 The corresponding process proceeds analogously to the flow chart of Fig. 2, but " $T1'$ " is to be entered instead of " $T1$ " and " $T2'$ " [sic] is to be entered instead of " $T2$ ".

A further speeding up of the calculation is obtained in the case of a further exemplary embodiment.

20 The second driving means, which is contained in the second rotating device 18, is rigidly connected to a rotor (not shown), which includes digital markings which have optical, magnetic or other characteristics and are sensed by a suitable sensor.

25 The number of markings which are sensed within one revolution of the first reel 12 lead [sic] to the signal FG1 and the number of markings which are sensed within one revolution W2 of the second reel 14 lead [sic] to a signal FG2.

30 Since the second reel 14 is usually driven at the maximum rotational speed of the second driving means, the rotational speed of the reel 14 is constant, and consequently so too is FG2.

35 The rotational speed of the first reel 12, on the other hand, increases with decreasing first radius $R1$, where

$$R1/R2 = FG1/FG2 = p \quad (c')$$

The calculation of the new first term according to (5) can be speeded up if constants are grouped

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together, as for example

$$dT^2 * (K1 FG1 * K2) \quad (5a)$$

where

$$K1 = 2 * a1 * q / (e * FG2);$$

$$K2 = 1/dTo^2 - 2 * a1 * q * Ro / (e * FG2).$$

In addition, further usual approximations can be carried out in the term (5) or (5a).

One version for both cited exemplary embodiments takes into consideration the case in which a recording tape 13 is used whose characteristic variables such as thickness e , hub radius Ro , surface-area value q , etc. deviate considerably from the values stored as the average value in the memory 19.

It may then happen that the new first term (5), (5a) becomes negative. Since the calculations are usually carried out digitally, under certain circumstances there is obtained a complementary value which is interpreted as a high positive value, with the result that the enquiry in step 105 produces "yes" and renewed acceleration takes place during the deceleration phase.

This is avoided by a flag which prevents subsequent accelerations being set upon initiation of the deceleration phase, that is to say after the maximum speed Wm has been exceeded.

It is also conceivable that an enquiry is made as to whether the value of the term under consideration is continually changing.

If the term under consideration becomes negative, the winding operation takes place at constant speed Wo .

Further versions of the exemplary embodiments presented may include at least one of the following variants:

- for deciding whether acceleration or deceleration is carried out, there serve instead of individual values a multiplicity of values from which in each case one corresponding average value is formed;
- hysteresis may be provided in the enquiry in step 105, thereby avoiding pronounced hunting;
- the radii $R1$, $R2$ may be determined by sensors (not

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shown). For instance, the thicknesses D1, D2 may be determined by measurements of optical variables, such as for example the distance of the outer turn from a reference point, or by measurements of magnetic variables or other processes R1 and R2 [sic] known to a person skilled in the art;

- in the deceleration phase from W_m to W_o , the D component of a PID controller used for the activation of the electric motor is changed in such a way that overshooting is reduced to a great extent.

There is consequently presented a system, comprising a process and an apparatus suitable for carrying out this process, which allows fast winding of a recording tape from a first reel onto a second reel.

According to the invention, there is determined an end rotational speed, from which the tape can be braked by means of a braking device without excessive mechanical loading.

Furthermore, there is determined a maximum set deceleration, which is usually accomplished by reduced activation of a driving means used (electric motor) without use of the said braking device. This set deceleration is chosen such that loop formation is avoided and that bearing of the tape against sensors which detect special marks, such as, for example the beginning of a film on a video tape [lacuna].

According to the invention, the unwinding first reel is accelerated for as long as the remaining winding time is adequate for decelerating with the set deceleration to the end rotational speed.

The remaining winding time is compared with the required time by comparison of terms into which there are entered along with the end rotational speed and the set deceleration operational variables such as the radii of the first reel and the second reel, the associated rotational speeds and the like.

Also taken into consideration are variables which depend on the type of recording tape used. These variables may either be stored as average values in a memory

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and be taken into consideration in the calculation.
Alternatively, the type of recording tape used is identified by a tape-identification device. Then characteristic values which have been stored beforehand in a table can
5 be used, or else the corresponding values can be calculated.

By the system according to the invention, the winding time required is greatly reduced in comparison with known system [sic] (approx. 100 seconds for a 180
10 minute video tape). Furthermore, severe mechanical loading of the recording tape is avoided and continuous contact with a read head obtained.

By way of addition it should be mentioned that when large hubs 12a, 14a are used, in the approximation for
15 equation (d) p in the denominator is set to "1".

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Patent claims

1. Process for the fast winding of a recording tape from a first reel onto a second reel, characterized in that the rotational speed (W_1) of the first reel is increased to a maximum rotational speed (W_m) for as long as the remaining winding time is adequate to decelerate the rotational speed (W_1) of the first reel to a predetermined end rotational speed (W_o) in accordance with a predetermined set value for the deceleration (a_1).
2. Process according to claim 1, characterized in that a value which represents a measure of the remaining winding time is determined from the number of turns of the recording tape on the first reel at a given time.
3. Process according to claim 2, characterized in that the number of turns at a given time is determined from the thickness (e) of the recording tape, from the radius (R_o) of a hub of the first reel onto which the recording tape is wound up, and from the thickness (D) of the total recording tape on the first reel.
4. Process according to one of claims 1 to 3, characterized in that the number of revolutions of a rotor which rotates at a speed linked to the rotational speed (W_2) of the second reel is sensed and in that the remaining winding time is calculated from a first value and a second value which are determined from the number of revolutions of the said rotor during the periods of time in which the first reel and the second reel respectively complete one revolution.
5. Apparatus for the fast winding of a recording tape (13) from a first reel (12) onto a second reel (14), characterized in that there are provided means 919) which receive operational values from sensors (11, 15, 16), read out predetermined values (W_o , a_1 , R_o , e , q) from a memory (19) and, on the basis of calculations and comparisons, activate second driving means in such a way that the rotational speed (W_1) of the first reel (12) is increased to a maximum rotational speed (W_m) for as long as the remaining winding time is adequate to decelerate



the rotational speed (W_1) of the first reel (12) to a predetermined end rotational speed (W_0) in accordance with a predetermined set value for the deceleration (a_1).

6. Apparatus according to claim 5, characterized in that the means (10) determine the number of turns at a given time from the value of the thickness (e) of the recording tape, from the value of the radius (R_0) of a hub of the first reel onto which the recording tape is wound up, and from the value of the thickness (D) of the total recording tape on the first reel.

7. Apparatus according to one of Claims 5 or 6, characterized in that there is provided a sensor which senses the number of revolutions of a rotor which rotates at a speed linked to the rotational speed (W_2) of the second reel and emits a corresponding signal to the means (10), which calculates the remaining winding time from a first value (FG_1) and a second value (FG_2), which are determined from the number of revolutions of the said rotor during the periods of time in which the first reel (12) and the second reel (14) respectively complete one revolution.

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Abstract

1. Process and apparatus for the fast winding of a recording tape

5 2.1 There is presented a system, comprising a process and an apparatus suitable for carrying out this process, which allows fast winding of a recording tape from a first reel onto a second reel. It is intended in this case for the winding time to be as short as possible and for mechanical stressing of the tape and loop formation to be reduced.

10

- 2.1 According to the invention, an end rotational speed is determined, from which the tape can be braked by means of a braking device without excessive mechanical loading.

15 Furthermore, a maximum set deceleration is determined, which is usually accomplished by reduced activation of a driving means used (electric motor) without use of the said braking device. This set deceleration is chosen such that loop formation is avoided and that bearing of the tape against sensors which detect special marks, such as for example the beginning of a film of a video tape [lacuna].

20

According to the invention, the unwinding first reel is accelerated for as long as the remaining winding time is adequate for decelerating with the set deceleration to the end rotational speed.

25

The remaining winding time is compared with the required time by comparison of terms into which there are entered, along with the end rotational speed and the set deceleration, operational variables such as the radii of the first reel and of the second reel, the associated rotational speeds and the like.

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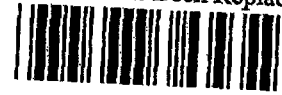
2.3 The system according to the invention can be used with preference for the winding of video cassettes.

3. Fig. 2

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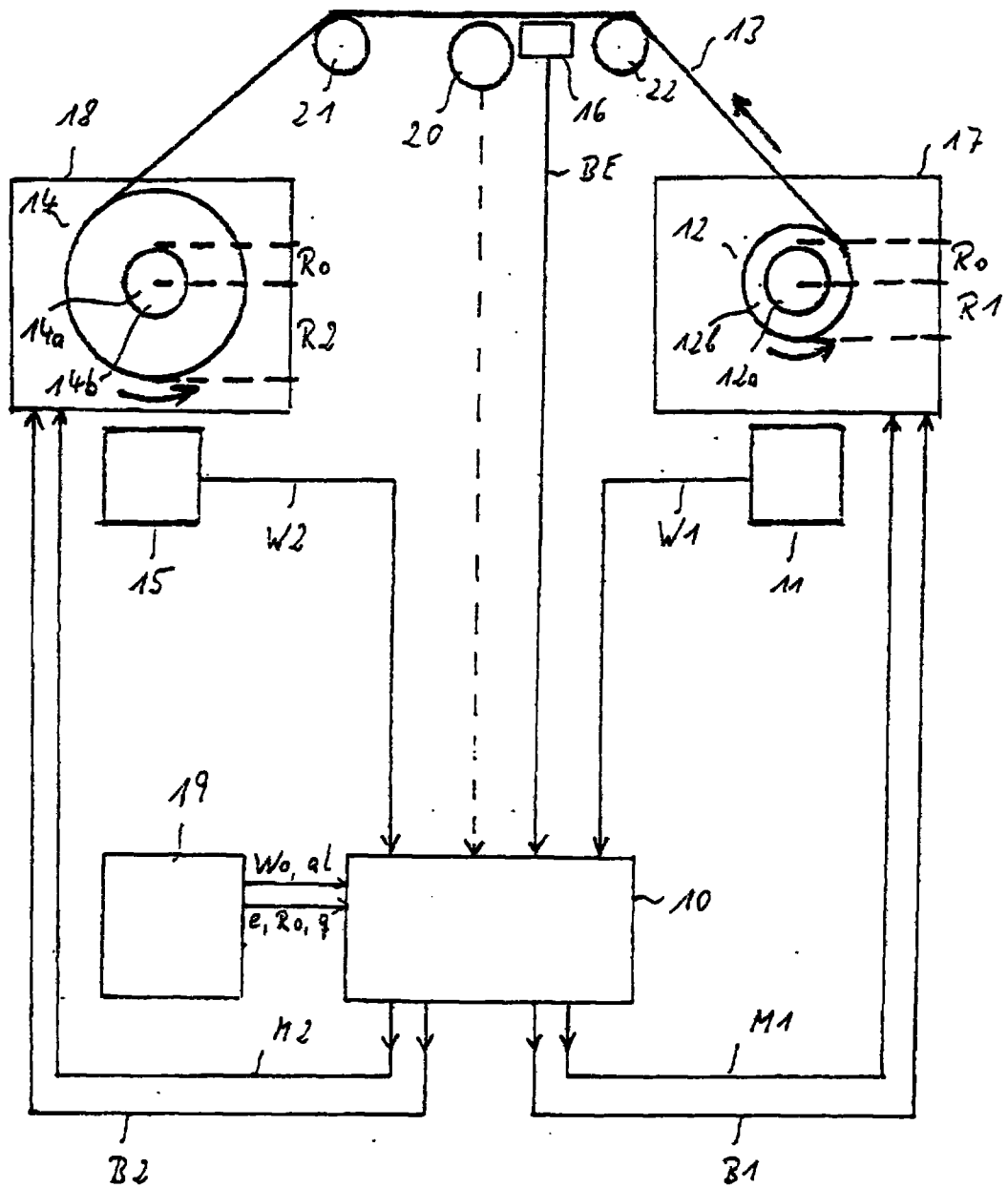


Fig. 1



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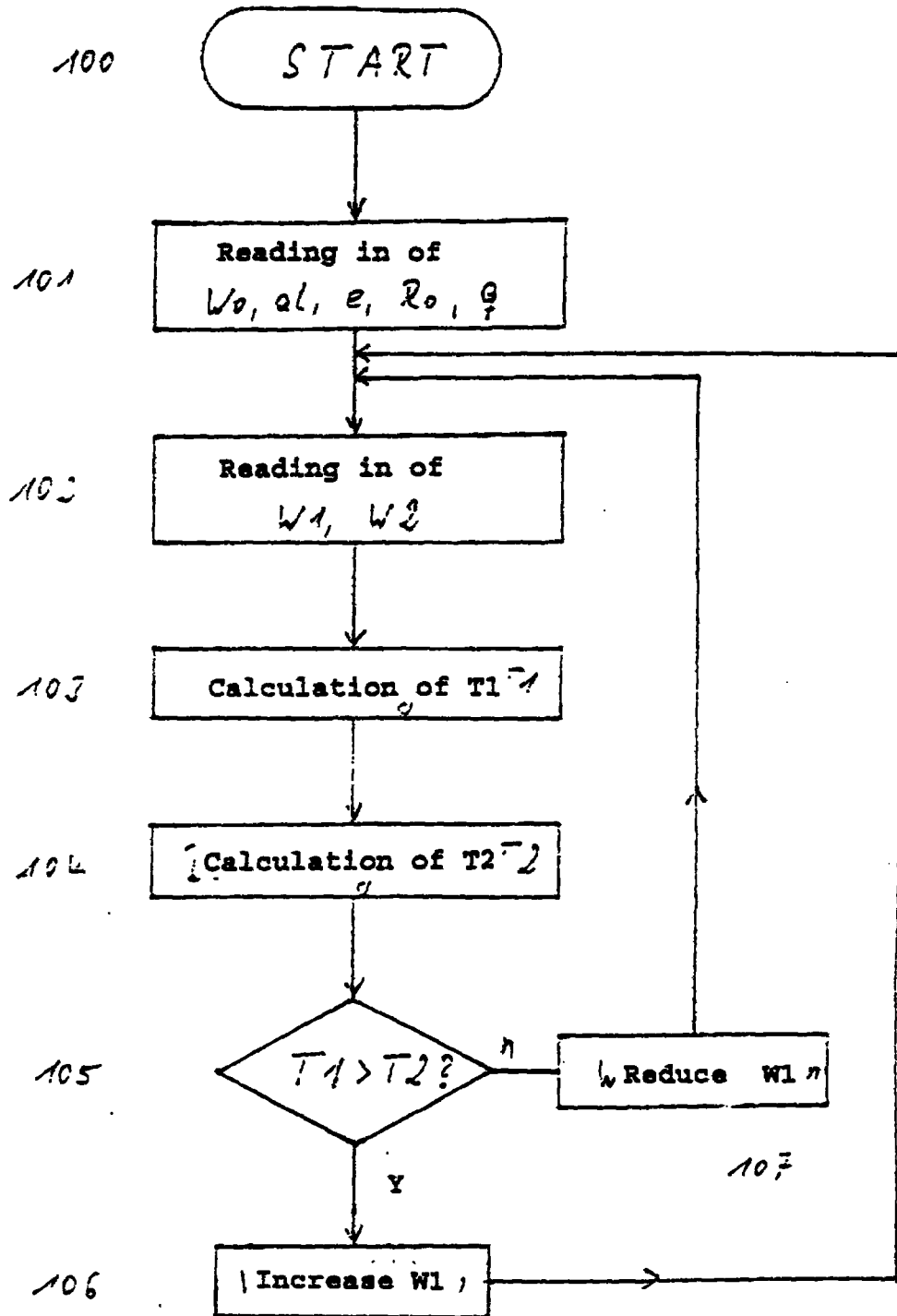


Fig. 2

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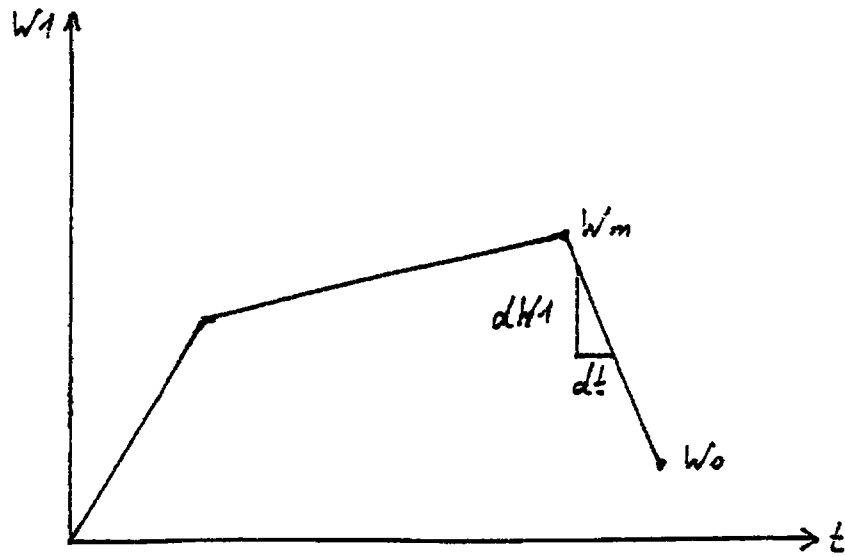


Fig. 3a

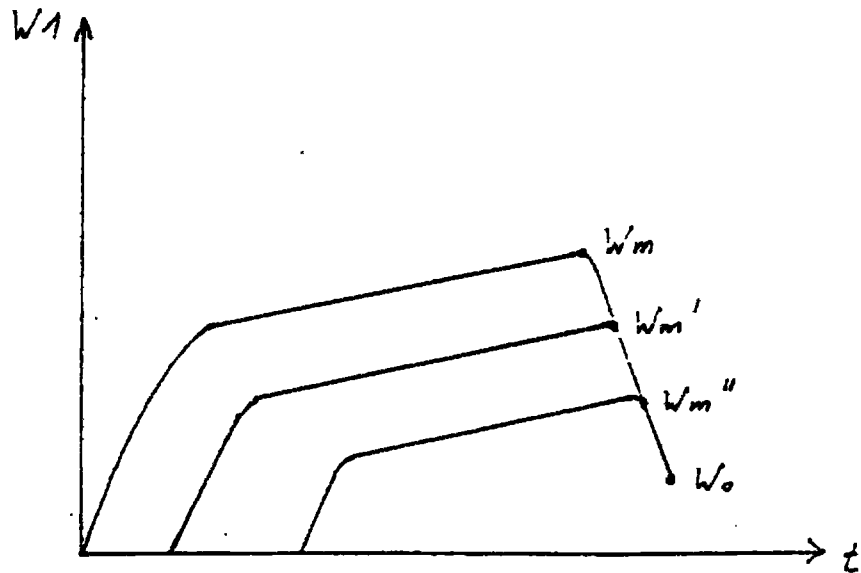


Fig. 3b

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PROCESS AND APPARATUS FOR THE FAST WINDING OF
A RECORDING TAPE

The invention relates to a process according to the precharacterizing clause of claim 1 and to an apparatus suitable for carrying out the process according to the invention, according to the precharacterizing clause of the first substantive claim.

In the recording of information, such as for example digital data for data processing systems or digital or analog data for sound or image reproduction equipment, recording tapes which store the information can be used. This may take place by magnetic, optical or other processes known to a person skilled in the art.

In the use of the said recording tapes, they are usually wound forward or back at various speeds. In this respect, a distinction is often drawn between on the one hand the speeds at which the information is read from the recording tape. This comprises the so-called playback speed and the so-called search.

On the other hand, given a suitable opportunity, the playback tape is wound fast forward or back. If in this case winding continues to the respective end, it is referred to here as fast winding.

In the following, the invention is described with reference to the fast winding of a video cassette. It should however be pointed out that the invention is not restricted to this.

The magnetic tape of a video cassette usually has an end-of-tape marking, which takes the form of a transparent tape, respectively a few centimeters from its two ends. This marking is detected by a video recorder used, which thereupon brakes a first reel, from which the recording tape is unwound, and a second reel, onto which the recording tape is wound, by means of a braking device.

Since this braking takes place only with a predetermined maximum retardation, it may be the case that the tape comes up against the end stop at an excessively high speed. This may result in tearing of the tape. If, on the other hand, the braking takes place with greater retardation, tape loops may occur.

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Known embodiments restrict the winding speed or, to be more precise, the rotational speed of the first reel, for unwinding, to a maximum speed of such a value that the retardation by the braking operation is adequate to avoid the tape coming up against the end stop.

However, by restricting the winding speed to this maximum speed, the winding takes quite a long time.

It is the object of the present invention to realize winding of a recording tape in which, on the one hand, the time required for this, the so-called winding time, is reduced and, on the other hand, the recording tape to be wound is prevented from coming up against the end stop at an excessively high speed.

This object is achieved in the case of the system of the generic type, comprising the process according to the invention and an apparatus suitable for carrying out the process according to the invention, by the characterizing features of claim 1 and by the characterizing features of the first substantive claim, respectively.

According to the invention, first of all a set value is determined for the end rotational speed, which the first reel, i.e. the reel from which the recording tape is unwound, is to have before its braking by a braking device, which is controlled by an end-of-tape marking. This determination may take place, for example, as a function of the braking action of the braking device, and of the distance of the end-of-tape marking from the actual end of the tape.

Furthermore, a set value for the deceleration with which a rotational speed of the first reel is decelerated to the end rotational speed is determined. This may take place, for example, by the force with which the second reel is driven, that is to say that reel onto which the recording tape is wound, being reduced. This may take place with consideration for the total mass of the recording tape, the reels, and other circumstances.

In order then to keep the winding time as short as possible, the second reel is accelerated by a drive motor to a maximum rotational speed and is usually,

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dependent on the characteristics of the drive motor, kept subsequently at this rotational speed. The rotational speed of the first reel is continuously increased, which is caused by, inter alia, the fact that the circumference of the recording tape to be wound up constantly increases, but that of the tape to be unwound constantly decreases.

To prevent the recording tape coming up against the end stop at excessively high speed, the rotational speed (W_1) of the first reel is increased to a maximum rotational speed (W_m) for as long as the remaining winding time is adequate to decelerate the rotational speed of the first reel to a predetermined end rotational speed (W_0) in accordance with a predetermined set value for the deceleration (a_1).

Advantages of the system according to the invention are that, by virtue of the prompt initiation of the deceleration, on the one hand the mechanical stressing of the recording tape used is reduced and on the other hand the ease of operation is increased.

If the winding time is determined from the number of turns on the first reel at a given time, this has in particular the advantage that the system according to the invention also functions satisfactorily if recording tapes with different tape lengths are used or if the winding is started when part of the tape has already been wound.

The number of turns at a given time can be determined from the thickness of the recording tape, if appropriate from the radius of a hub onto which the recording tape is wound up and from the thickness of the total recording tape on the first reel. This makes possible a simple system for determining the number of turns at a given time.

If existing sensors are used, and the process steps further specified in the claims are observed, simple, inexpensive systems are realized.

Further features, advantages and details of the invention are explained in the following exemplary

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embodiments with reference to the drawing, in which:

- Fig. 1 shows an exemplary embodiment of the apparatus according to the invention;
Fig. 2 shows the flow chart of a first exemplary embodiment of the process according to the invention;
Fig. 3 shows the variation over time of the winding speed according to the invention;

Before describing the exemplary embodiments in more detail, it should be pointed out that the blocks individually represented in the figures serve only for a better understanding of the invention. Usually, a few or some of these blocks are combined into units. These may be realized using integrated or hybrid technology or as program-controlled microcomputers, or as part of a program suitable for controlling the latter.

It goes without saying that the elements [lacuna] in the individual stages can also be configured separately.

In the following, means and signal waveforms having the same meanings are respectively provided in the figures with the same reference symbols.

Fig. 1 symbolically shows an exemplary embodiment of the apparatus according to the invention. Shown as a detail are elements of a video recorder or playback device, in which a corresponding cassette is wound. Only those means which are essential for an understanding of the invention are represented.

An electronic control device 10 receives from a first rotational-speed sensor 11 signals which represent a measure of the rotational speed W_1 of a first reel 12, from which a recording tape 13 is wound onto a second reel 14.

The first reel 12 is formed by a first hub 12a having the radius R_0 , and a residual amount 12b, which contains N_1 turns of the playback tape 13, which has a thickness e , whereby the total thickness D_1 of the residual amount 12b becomes

$$D_1 = N_1 * e.$$

The first total radius R_1 is consequently ob-

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tained from

$$R1 = R0 + D1.$$

The second reel 14 is formed analogously to the first reel 12 from a second hub 14a, which in this exemplary embodiment has the same radius $R0$ as the first hub 12a, and a wound-up amount 14b having $N2$ turns, which has the thickness $D2$:

$$D2 = N2 * e.$$

This gives the second total radius $R2$

$$R2 = R0 + D2.$$

The rotational speed $W2$ of the second reel 14 is sensed by a second rotational-speed sensor 15, which emits corresponding signals to the electronic control device 10.

The rotational-speed sensors 11 and 15 are preferably such that digital markings which are provided on a rotor (not shown) are sensed and used to conclude the rotational speed. The rotational speed of one of these rotors is linked to the rotational speed of the associated reel 12 or 14, producing periods of time between the individual markings which are inversely proportional to the reel speed under consideration.

The electronic control device 10 also receives signals BE from an end-of-tape sensor 16, which detects an end-of-tape marking of the recording tape 13. This marking may be electrical, optical, magnetic or the like and the end-of-tape sensor 16 is designed accordingly.

The first reel 12 is connected to a first rotating device 17, which contains first driving means (not shown), such as for example an electric motor including the associated activation device, and also first braking means (not shown). The electronic control device 10 emits to the first rotating device signals M1, which activate the said first driving means, and signals B1, which activate the said first braking means.

By analogy with the first rotating device 17, a second rotating device 18 is provided with a second driving means (not shown) and a second braking means (not shown). These contain [sic] corresponding activation



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signals M2 and B2 from the electronic control device 10.

Instead of second driving means, which are contained in the rotating devices 17 and 18, a single driving means may be used, the driving effect of which is directed by means of suitable deflecting means to the reel 12 or 14 respectively to be driven.

The first driving means, or the said deflection of the driving effect to the first reel 12, is necessary for winding only whenever it is also to take place in the second direction, that is to say from the second reel 14 to the first reel 12. Such a winding operation proceeds analogously to that described in more detail here.

Also provided is a memory 19, in which a set value relating to a maximum braking speed W_0 , a value relating to a maximum deceleration a_1 , values e for the thickness of the playback tape 13 and values for the radius R_0 of the hubs 12a and 14a are stored and which emits corresponding signals to the electronic control device 10. Also stored is a surface-area value q , which is defined further below.

A reading head 20, which detects additional markings impressed on the recording tape 13, may also be additionally provided. As a result, corresponding signals, such as for example a "beginning-of-film" identification, can be emitted to the electronic control device 13, which thereupon instigates stopping during winding.

Two winding reels 21 and 22 serve for suitable guidance of the recording tape 13.

The process according to the invention is now explained with the aid of the flow chart of Fig. 2 and the diagram of Fig. 3.

Once a winding operation has been started in step 100, in step 101 the electronic device 10 reads in the following values from the memory 19:

- the set value for the braking speed W_0 , which the first reel is to have before its braking by the braking device,
- the maximum value for the deceleration a_1 ,
- a value for the tape thickness e ,

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- the surface-area value q , which depends on the total surface area A of the tape 13 which is to be wound and the tape 13 which is wound-up and also the surface area of the hubs 12a, 14a, thus

$$q^2 = k * (R1^2 + R2^2),$$

- the value R_o .

According to a first version of this exemplary embodiment, the said values stored in the memory 19 have been determined at the works and correspond to average values or critical extreme values which are obtained when customary video cassettes are used.

In the case of further versions, these values can be determined by the playback device used, on the basis of a tape identification.

In step 102, the values $W1$ and $W2$ are read in from the rotational-speed sensors 11 and 15, respectively.

From the variables read in, in step 103 a first term 1 is calculated

$$(2 * a1)/e * (R1 - R_o) \quad (1)$$

In step 104, a second term is determined from:

$$W1^2 - W_o^2 \quad (2)$$

The term (1) is a conversion of the expression

$$4 * \pi * a1 * N1. \quad (3)$$

The expression (3) is obtained from the following fundamental equations:

$$dN1/dt = W1/(2 * \pi), \quad (a)$$

which indicates the relationship between the variation over time of the number $N1$ of turns on the first reel 12 and the rotational speed $W1$ of the latter.

As a further fundamental equation, the following is entered into the expression (3):

$$dW1/dt = - a1, \quad (b)$$

which indicates the relationship [lacuna] the variation over time of the rotational speed $W1$ and the set value of the deceleration $a1$.

With introduction of the abbreviation

$$p = R1/R2 \quad (c)$$

and taking into consideration



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$$R1 = p * q / (1 + p^2)^{1/2}$$

(d)

the expression (1) leads to

$$2 * a1 / e * (p * q / (1 + p^2)^{1/2} - R0). \quad (4)$$

Consequently, taking into consideration the already mentioned definitions of the individual variables, the first term T1 in the form of (1) or (4) represents a value for the winding time which is required in order to decelerate the rotational speed of the first reel 12 with the deceleration a1 to the predetermined end rotational speed Wo.

In step 105, it is checked whether the first term T1 is greater than the second term T2. If "yes", step 106 follows, where the rotational speed W1 of the first reel 12 is further increased. Following this, the process leads to step 102, with the result that steps 102 to 105 are repeated.

If it is established in step 105 that the first term T1 is not greater than the second term T2, there follows a step 107, in which the rotational speed W1 of the first reel 12 is reduced in accordance with the set value of the deceleration a1.

The effect of the process according to the invention can be seen from Fig. 3, comprising Fig. 3a and Fig. 3b. The rotational speed W1 of the first reel 12 initially increases up to a maximum value Wm and is subsequently decelerated with the set deceleration a1 to the value of the predetermined end rotational speed Wo.

Fig. 3b shows different profiles of the rotational speed W1. These may be caused, for example, by different starting points for the winding.

It can be seen that the set deceleration a1 and the end rotational speed Wo are always of the same magnitude. The values of the maximum rotational speed Wm vary, however.

In the case of a second exemplary embodiment, the first term and the second term are transformed in such a way that a calculation and the subsequent comparison can be carried out as quickly as possible by the electronic control device 10.

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Since

$$p = R1/R2 \quad (c)$$

becomes very much smaller than 1 toward the end of the winding operation, it follows from (d) by approximation that

$$R1 = q * p, \quad (e)$$

whereby the following is obtained from (4) and (2) as a new first term $T1'$

$$dT^2(2*a1/e*(q*p - Ro) + 1/dTo^2) \quad (5)$$

In this case, $T = 1/W1$ and $To = 1/Wo$.

The new first term $T1'$ according to (5) is then checked as to whether it is greater than or less than the new second term $T2'$, which constantly has the value "1".

The corresponding process proceeds analogously to the flow chart of Fig. 2, but " $T1'$ " is to be entered instead of " $T1$ " and " $T2'$ " [sic] is to be entered instead of " $T2$ ".

A further speeding up of the calculation is obtained in the case of a further exemplary embodiment.

The second driving means, which is contained in the second rotating device 18, is rigidly connected to a rotor (not shown), which includes digital markings which have optical, magnetic or other characteristics and are sensed by a suitable sensor.

The number of markings which are sensed within one revolution of the first reel 12 lead [sic] to the signal FG1 and the number of markings which are sensed within one revolution W2 of the second reel 14 lead [sic] to a signal FG2.

Since the second reel 14 is usually driven at the maximum rotational speed of the second driving means, the rotational speed of the reel 14 is constant, and consequently so too is FG2.

The rotational speed of the first reel 12, on the other hand, increases with decreasing first radius $R1$, where

$$R1/R2 = FG1/FG2 = p \quad (c')$$

The calculation of the new first term according to (5) can be speeded up if constants are grouped

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together, as for example

$$dT^2 * (K1 FG1 * K2) \quad (5a)$$

where

$$K1 = 2 * a1 * q / (e * FG2);$$

$$K2 = 1/dTo^2 - 2 * a1 * q * Ro / (e * FG2).$$

In addition, further usual approximations can be carried out in the term (5) or (5a).

One version for both cited exemplary embodiments takes into consideration the case in which a recording tape 13 is used whose characteristic variables such as thickness e , hub radius Ro , surface-area value q , etc. deviate considerably from the values stored as the average value in the memory 19.

It may then happen that the new first term (5), (5a) becomes negative. Since the calculations are usually carried out digitally, under certain circumstances there is obtained a complementary value which is interpreted as a high positive value, with the result that the enquiry in step 105 produces "yes" and renewed acceleration takes place during the deceleration phase.

This is avoided by a flag which prevents subsequent accelerations being set upon initiation of the deceleration phase, that is to say after the maximum speed Wm has been exceeded.

It is also conceivable that an enquiry is made as to whether the value of the term under consideration is continually changing.

If the term under consideration becomes negative, the winding operation takes place at constant speed Wo .

Further versions of the exemplary embodiments presented may include at least one of the following variants:

- for deciding whether acceleration or deceleration is carried out, there serve instead of individual values a multiplicity of values from which in each case one corresponding average value is formed;
- hysteresis may be provided in the enquiry in step 105, thereby avoiding pronounced hunting;
- the radii $R1$, $R2$ may be determined by sensors (not



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shown). For instance, the thicknesses $D1$, $D2$ may be determined by measurements of optical variables, such as for example the distance of the outer turn from a reference point, or by measurements of magnetic variables or other processes $R1$ and $R2$ [sic] known to a person skilled in the art;

- in the deceleration phase from W_m to W_o , the D component of a PID controller used for the activation of the electric motor is changed in such a way that overshooting is reduced to a great extent.

There is consequently presented a system, comprising a process and an apparatus suitable for carrying out this process, which allows fast winding of a recording tape from a first reel onto a second reel.

According to the invention, there is determined an end rotational speed, from which the tape can be braked by means of a braking device without excessive mechanical loading.

Furthermore, there is determined a maximum set deceleration, which is usually accomplished by reduced activation of a driving means used (electric motor) without use of the said braking device. This set deceleration is chosen such that loop formation is avoided and that bearing of the tape against sensors which detect special marks, such as, for example the beginning of a film on a video tape [lacuna].

According to the invention, the unwinding first reel is accelerated for as long as the remaining winding time is adequate for decelerating with the set deceleration to the end rotational speed.

The remaining winding time is compared with the required time by comparison of terms into which there are entered along with the end rotational speed and the set deceleration operational variables such as the radii of the first reel and the second reel, the associated rotational speeds and the like.

Also taken into consideration are variables which depend on the type of recording tape used. These variables may either be stored as average values in a memory

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and be taken into consideration in the calculation. Alternatively, the type of recording tape used is identified by a tape-identification device. Then characteristic values which have been stored beforehand in a table can be used, or else the corresponding values can be calculated.

By the system according to the invention, the winding time required is greatly reduced in comparison with known system [sic] (approx. 100 seconds for a 180 minute video tape). Furthermore, severe mechanical loading of the recording tape is avoided and continuous contact with a read head obtained.

By way of addition it should be mentioned that when large hubs 12a, 14a are used, in the approximation for equation (d) p in the denominator is set to "1".

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Patent claims

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1. Process for the fast winding of a recording tape from a first reel onto a second reel, characterized in that the rotational speed (W_1) of the first reel is increased to a maximum rotational speed (W_m) for as long as the remaining winding time is adequate to decelerate the rotational speed (W_1) of the first reel to a predetermined end rotational speed (W_o) in accordance with a predetermined set value for the deceleration (a_l).
2. Process according to claim 1, characterized in that a value which represents a measure of the remaining winding time is determined from the number of turns of the recording tape on the first reel at a given time.
3. Process according to claim 2, characterized in that the number of turns at a given time is determined from the thickness (e) of the recording tape, from the radius (R_o) of a hub of the first reel onto which the recording tape is wound up, and from the thickness (D) of the total recording tape on the first reel.
4. Process according to one of claims 1 to 3, characterized in that the number of revolutions of a rotor which rotates at a speed linked to the rotational speed (W_2) of the second reel is sensed and in that the remaining winding time is calculated from a first value and a second value which are determined from the number of revolutions of the said rotor during the periods of time in which the first reel and the second reel respectively complete one revolution.
5. Apparatus for the fast winding of a recording tape (13) from a first reel (12) onto a second reel (14), characterized in that there are provided means 919) which receive operational values from sensors (11, 15, 16), read out predetermined values (W_o , a_l , R_o , e , q) from a memory (19) and, on the basis of calculations and comparisons, activate second driving means in such a way that the rotational speed (W_1) of the first reel (12) is increased to a maximum rotational speed (W_m) for as long as the remaining winding time is adequate to decelerate



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the rotational speed ($W1$) of the first reel (12) to a predetermined end rotational speed ($W0$) in accordance with a predetermined set value for the deceleration ($a1$).

6. Apparatus according to claim 5, characterized in that the means (10) determine the number of turns at a given time from the value of the thickness (e) of the recording tape, from the value of the radius ($R0$) of a hub of the first reel onto which the recording tape is wound up, and from the value of the thickness (D) of the total recording tape on the first reel.

7. Apparatus according to one of Claims 5 or 6, characterized in that there is provided a sensor which senses the number of revolutions of a rotor which rotates at a speed linked to the rotational speed ($W2$) of the second reel and emits a corresponding signal to the means (10), which calculates the remaining winding time from a first value ($FG1$) and a second value ($FG2$), which are determined from the number of revolutions of the said rotor during the periods of time in which the first reel (12) and the second reel (14) respectively complete one revolution.

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Abstract

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Process and apparatus for the fast winding of a recording tape

There is presented a system, comprising a process and an apparatus suitable for carrying out this process, which allows fast winding of a recording tape from a first reel onto a second reel. It is intended in this case for the winding time to be as short as possible and for mechanical stressing of the tape and loop formation to be reduced.

According to the invention, an end rotational speed is determined, from which the tape can be braked by means of a braking device without excessive mechanical loading.

Furthermore, a maximum set deceleration is determined, which is usually accomplished by reduced activation of a driving means used (electric motor) without use of the said braking device. This set deceleration is chosen such that loop formation is avoided and that bearing of the tape against sensors which detect special marks, such as for example the beginning of a film of a video tape [lacuna].

According to the invention, the unwinding first reel is accelerated for as long as the remaining winding time is adequate for decelerating with the set deceleration to the end rotational speed.

The remaining winding time is compared with the required time by comparison of terms into which there are entered, along with the end rotational speed and the set deceleration, operational variables such as the radii of the first reel and of the second reel, the associated rotational speeds and the like.

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The system according to the invention can be used with preference for the winding of video cassettes.

Fig. 2

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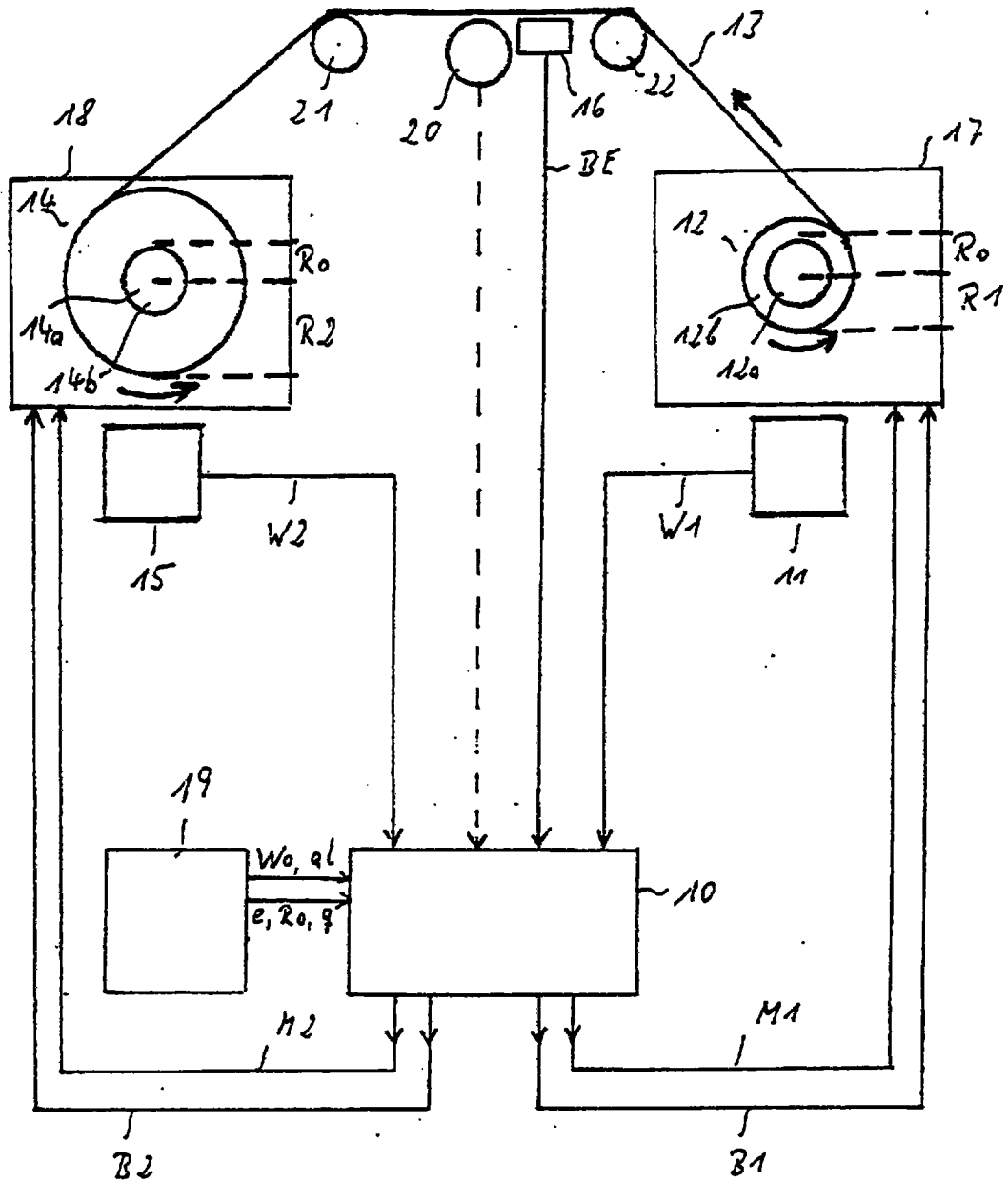


Fig. 1

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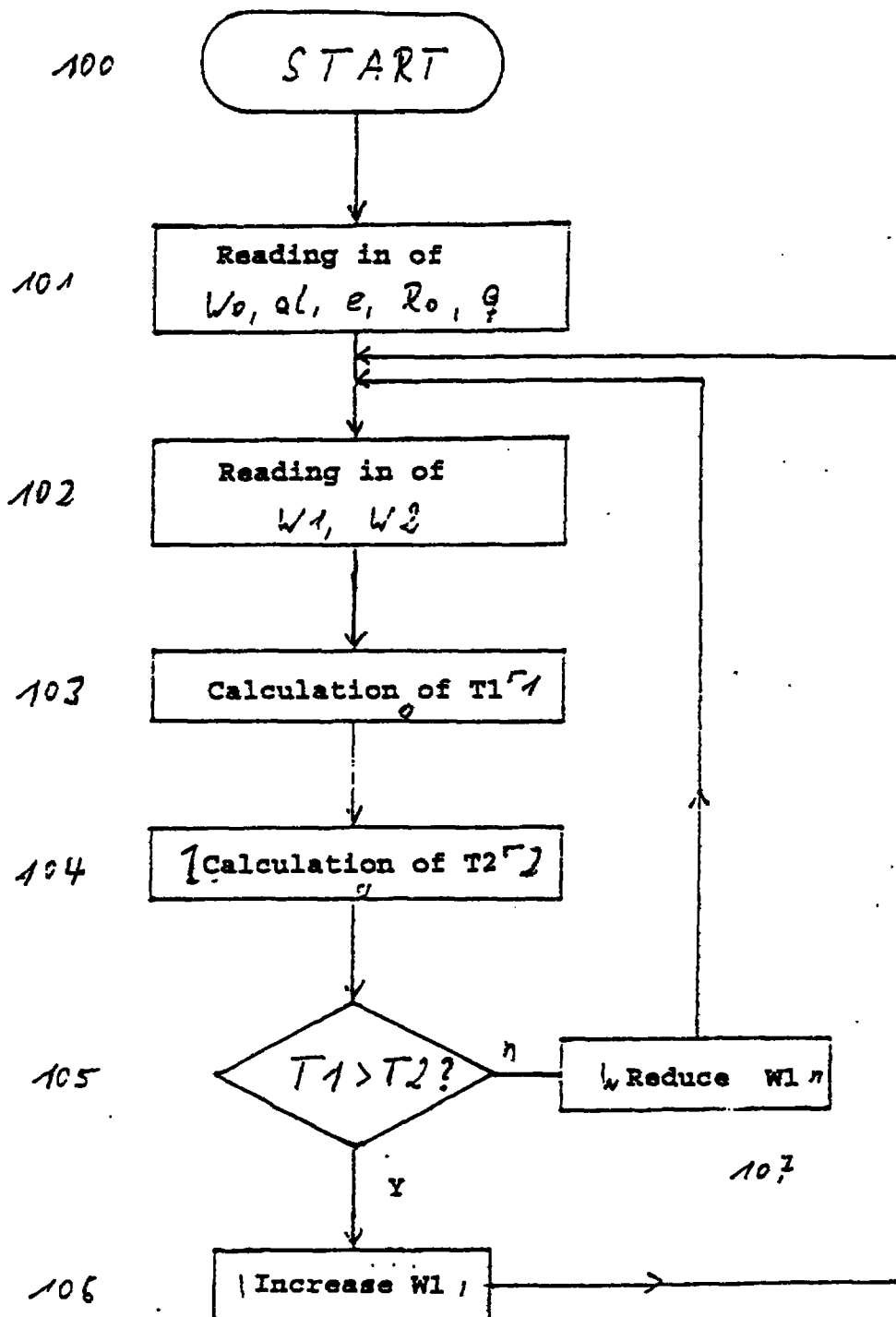


Fig. 2

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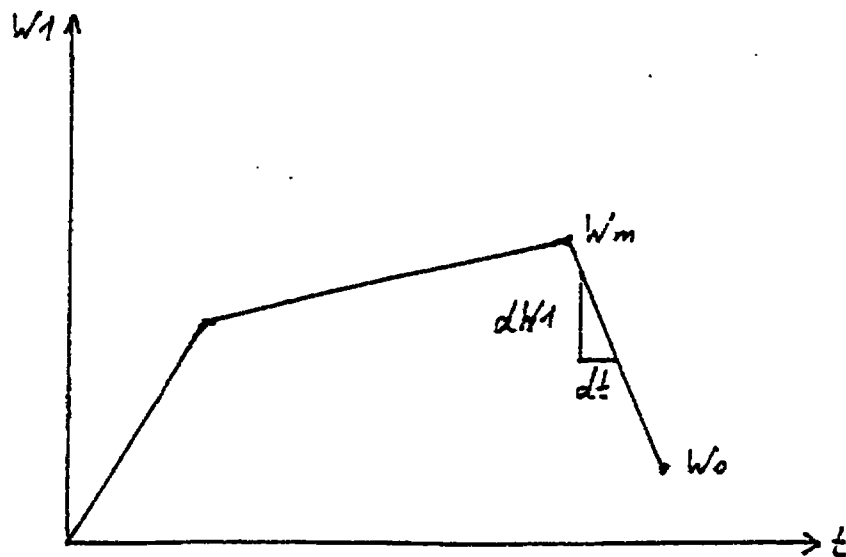
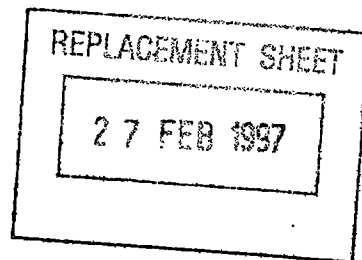


Fig. 3a

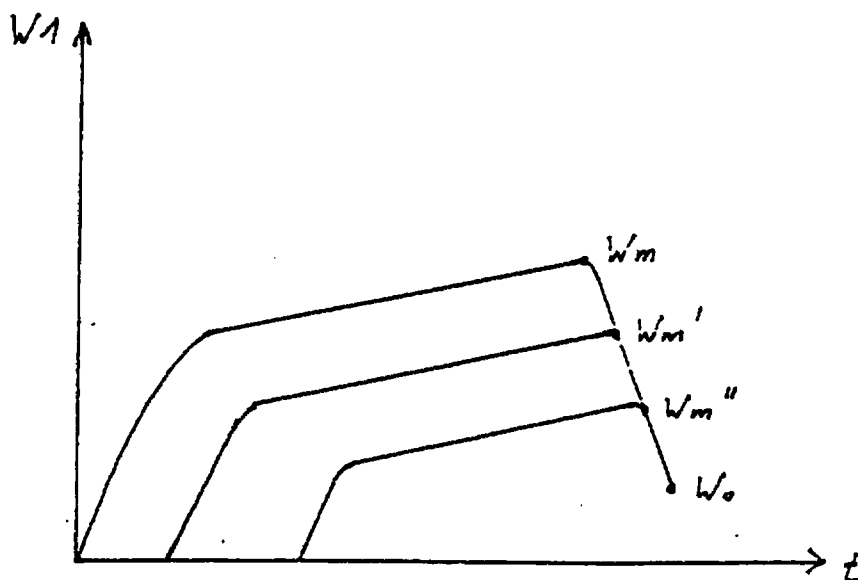


Fig. 3b

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QUICK REWINDING PROCESS AND DEVICE FOR RECORDING TAPES

The invention relates to a method in accordance with the first part of claim 1 and also to a device in accordance with the first part of the first apparatus claim that is suitable for carrying out the method in accordance with the invention.

When recording items of information, such as items of digital data for data processing equipments or digital or analogue data for sound or picture reproducing devices for example, recording tapes may be used for storing the items of information. This can be done by means of magnetic, optical or any other methods known to the skilled person.

When using the said recording tapes, these are usually wound forward or are rewound at varying speeds. From one aspect thereby, a distinction is frequently made between the speeds at which the items of information are read from the recording tape. These speeds are the so-called play back speed and the so-called search mode.

However, on appropriate occasions, the recording tape is fast wound forwards or backwards. If, in so doing, the tape is wound back to the respective end, then this is referred to here as fast winding.

Hereinafter, the invention will be described on the basis of the fast winding of a video cassette. It should however be noted that the invention is not limited thereto.

Conventionally, the magnetic tape of a video cassette has a respective end of tape marking a few centimetres from its two ends, this being constructed in the form of a transparent tape. This marking is detected by the video

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recorder being used which thereupon brakes a first spool from which the recording tape is being wound-off and also a second spool onto which the recording tape is being wound-on by means of a braking device.

Since this braking process only occurs with a predetermined maximum braking action, it may happen that the tape hits the stop at an impermissibly high speed. This may lead to the tape tearing. If, on the other hand, the braking process occurs with a stronger braking action, then looping of the tape can occur.

Known constructions limit the winding speed, or, put more precisely, the rotational speed of the first wind-off spool, to a maximum speed whose value is at a level such that the deceleration due to the braking process is sufficient to avoid the tape hitting the stop.

However, due to the limiting of the winding speed to this maximum speed, the winding process can last a long time.

The object of the present invention is to implement the winding of a recording tape in which, on the one hand, the time needed therefor, the so-called tape winding time, is reduced while, on the other hand, preventing the recording tape that is to be wound-on from hitting the stop at an impermissibly high speed.

This object is respectively achieved in the case of the system defined in the prior art parts of the claims, and consisting of the method in accordance with the invention and a device that is suitable for carrying out the method in accordance with the invention, by the characterising part of

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claim 1 and the characterising part of the first apparatus claim.

It is known from JP-A-1 008 540 to reduce the winding speed of a recording tape towards the end of the tape in sufficient time as to prevent any excessive tensile loading of the recording tape in every case. There, the criterion for starting the reduction in speed is that of whether the momentarily detected tape speed has been reached or has not been exceeded by a value that is calculated from the product of the period of rotation of the feed spindle and the tape speed.

It is known from US-A-4,478,376 to provide a respective motor for driving each tape spool for the purposes of winding a magnetic recording tape in the shortest possible time, whereby the two motors are controlled by means of pulse type signals from a tacho generator. For the purposes of reducing the tape speed there, the control of the motor occurs in dependence on the length of tape wound-off using an exactly predetermined waveform of the control signals when a predetermined number of pulses corresponding to a predetermined wound-off length of tape has been reached. In so doing, the momentarily remaining winding time is likewise not included there.

In accordance with the invention, a reference value for a final rotational speed is initially determined, this being the value the first spool, i.e. the spool from which the recording tape is being wound off, should have before it is subjected to a braking action by a brake device which is controlled by means of an end of tape marking. This determination may be effected, for example, in dependence on

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the braking effect of the brake device and also on the distance between the tape end marking and the actual end of the tape.

Furthermore, there is determined a reference value for the deceleration with which the rotational speed of the first spool is to be decelerated down to the final rotational speed. This may be effected for example, in that the force with which the second spool is being driven is reduced, the second spool being the one onto which the recording tape is being wound. This may be done by taking into account the total mass of the recording tape, the spools and also other matters.

Now in order to keep the winding time as short as possible, the second spool is accelerated up to a maximum rotational speed by a drive motor and usually, in dependence on the properties of the drive motor, it is then maintained at this rotational speed. The rotational speed of the first spool is constantly increasing, this being caused inter alia by virtue of the fact that the peripheral size of the recording tape being wound up is constantly increasing while that of the tape being wound off is constantly decreasing.

In order to prevent the recording tape hitting the stop at an impermissibly high speed, the rotational speed (W_1) of the first spool is increased up to a maximum rotational speed (W_m) for as long as the remaining winding time is sufficient for decelerating, in accordance with a predetermined reference value for the deceleration (a_1), the rotational speed of the first spool down to a predetermined final rotational speed (W_0).

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The advantages of the system in accordance with the invention are, in one respect, that the mechanical stress on the recording tape being used is reduced by the timely introduction of the deceleration process and, in another respect, that the ease of use is increased.

If the winding time is determined from the momentary number of windings present on the first spool, this has the especial advantage that the system in accordance with the invention will also function satisfactorily when recording tapes of different lengths are being used or when the winding process is started at a time when part of the tape has already been wound on.

The momentary number of windings may be determined from the thickness of the recording tape, possibly too from the radius of a hub onto which the recording tape is being wound and from the thickness of the total amount of recording tape that is located on the first spool. A simple system for determining the momentary number of windings is thereby made possible.

Simple and economical systems can be implemented by utilising already available sensors and by taking into consideration the further method steps indicated in the claims.

Further features, advantages and the details of the invention will be explained in the following embodiments with the help of the drawing. Therein

Fig. 1: shows an embodiment of the device in accordance with the invention;

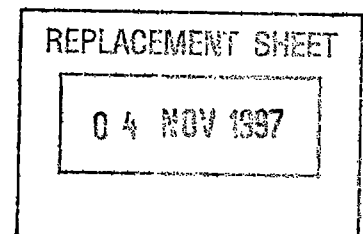


Fig. 2: the flow diagram for a first embodiment of the method in accordance with the invention;

Fig. 3: the behaviour over time of the winding speed in accordance with the invention;

Before going into the description of the embodiments in detail, it is pointed out that the individual blocks illustrated in the Figures merely serve for a better understanding of the invention. Usually, individual ones or several of these blocks are combined into units. These may be realised using integrated or hybrid technology or as a program controlled micro-computer or as a part of a program suitable for its control.

It goes without saying that the elements contained in the individual stages may also be executed separately.

Hereinafter, means and signal waveforms having the same significance are respectively provided with the same reference symbols in the Figures.

Fig. 1 shows symbolically an embodiment of the device in accordance with the invention. Thereby, we are concerned in outline with the elements of a video recorder or of a playback equipment in which an appropriate cassette has to be wound up. Only those means are shown as are essential to an understanding of the invention.

An electronic control device 10 receives from a first rotational speed sensor 11 signals that represent a measure

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for the rotational speed $W1$ of a first spool 12 from which a recording tape 13 is being wound onto a second spool 14.

The first spool 12 is made up of a first hub 12a having a radius R_o and a remaining portion 12b that holds the $N1$ windings of the play-back tape 13 which has a thickness e , whereby the total thickness $D1$ of the remaining portion 12b amounts to

$$D1 = N1 \times e.$$

Hence, the first total radius $R1$ amounts to

$$R1 = R_o + D1.$$

The second spool 14 is made up, analogously to the first spool 12, of a second hub 14a which, in this embodiment, has the same radius R_o as the first hub 12a and a wound on quantity 14b of $N2$ windings which have the thickness $D2$:

$$D2 = N2 \times e.$$

From this, there results for the second total radius $R2$

$$R2 = R_o + D2.$$

The rotational speed $W2$ of the second spool 14 is detected by a second rotational speed sensor 15 which passes on appropriate signals to the electronic control device 10.

The respective rotational speed sensors 11 and 15 are preferably portrayed {sic} that digital markings which are applied to a not illustrated rotor are detected and

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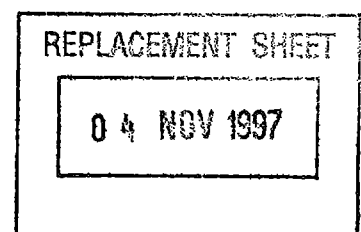
conclusions can thereby be made regarding the rotational speed. The rotational speed of one of these rotors is coupled to the rotational speed of the appertaining spool 12 or 14 whereby time periods occur between the individual markings that are inversely proportional to the observed rotational speed of the spools.

The electronic control device 10 also receives signals BE from an end of tape sensor 16 which identifies an end of tape marking on the recording tape 13. This marking may be electrical, optical, magnetic or the like and the end of tape sensor 16 is constructed accordingly.

The first spool 12 is connected to a first rotating device 17 which includes not illustrated first drive means such as an electric motor incorporating the appertaining control device for example, and also not illustrated first brake means. The electronic control device 10 emits signals M1, which control the said first drive means, and signals B1, which control the said first brake means, to the first rotating device.

Analogously to the first rotating device 17, a second rotating device 18 is provided with a not illustrated second drive means and a not illustrated second brake means. These receive corresponding respective control signals M2 and B2 from the electronic control device 10.

A single drive means, whose driving action is conveyed to the respective spool 12 or 14 that is to be driven via appropriate coupling means, may be used instead of the two drive means contained in the rotating devices 17 and 18.



The first drive means, or the said coupling for conveying the drive action to the first spool 12, is only needed for the winding process when this is also intended to occur in the second direction i.e. from the second spool 14 onto the first spool 12. Such a winding process occurs in analogous manner to the one described in detail here.

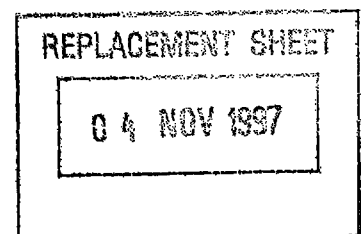
Furthermore, a store 19 is provided in which there are stored a reference value relating to the maximum braking rotational speed W_0 , a value relating to the maximum deceleration a_1 , values e for the thickness of the play-back tape 13 and values for the radius R_0 of the hubs 12a and 14a and which store emits corresponding signals to the electronic control device 10. Furthermore, a surface value q , which will be defined hereinbelow, is also stored.

In addition, there may also be provided a reading head 20 for identifying additional markings that are stamped onto the recording tape 13. Corresponding signals, such as a "film start" identifier for example, may thereby be emitted to the electronic control device 13 {sic} which thereupon brings the winding process to a halt.

Two deflecting pulleys 21 and 22 serve for the appropriate guidance of the recording tape 13.

The method in accordance with the invention will now be explained with the aid of the flow diagram in Fig. 2 and the diagram in Fig. 3.

After a winding process has been started in step 100, the electronic control device 10 reads the following values out of the store 19 in step 101:



- the reference value for the braking rotational speed W_0 which the first spool ought to have before it is braked by the braking device,
- the maximum value for the deceleration a_1 ,
- a value for the thickness of the tape e ,
- the surface value q which is dependent on the total area A of the tape 13 that is still to be wound off and that which has been wound on as well as the areas of the hubs 12a, 14a, i.e.

$$q^2 = D \times (R_1^2 + R_2^2),$$

- the value R_0 .

In accordance with a first version of this embodiment, the said values stored in the store 19 have been determined in the factory and correspond to average values or critical extreme values that result when using conventional video cassettes.

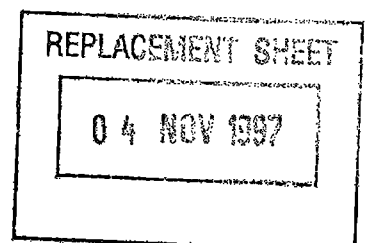
In the case of other versions, these values may be determined by the play-back apparatus being used on the basis of an identifier on the tape.

The values W_1 and W_2 are read by the respective rotational speed sensors 11 and 15 in step 102.

A first term T_1 is calculated in step 103 from the quantities that have been read

$$T_1 = (2 \times a_1) / e \times (R_1 - R_0) \quad (1)$$

A second term is determined in step 104 from:



$$W_1^2 - W_0^2 \quad (2)$$

The term (1) is a conversion from the expression

$$4 \times \varnothing \times a_1 \times N_1 \quad (3)$$

The expression (3) results from the following fundamental equations

$$-dN_1/dt = W_1 / (2 \times \varnothing) \quad (a)$$

which indicates the relationship between the variation over time of the number of windings N_1 on the first spool 12 and its rotational speed W_1 .

As a further fundamental equation entering the expression (3), we have:

$$dW_1/dt = - a_1 \quad (b)$$

which indicates the interrelationship of the variation over time of the rotational speed W_1 and the reference value for the deceleration a_1 .

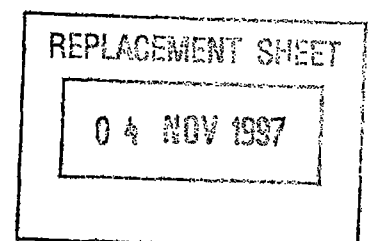
By introducing the contraction

$$p = R_1/R_2 \quad (c)$$

and taking into consideration

$$R_1 = p \times q / (1 + p^2)^{1/2} \quad (d)$$

the expression (1) then results in



$$2 \times a_1 / e \times (p \times q / (1 + p^2)^{1/2} - R_0) \quad (4)$$

Hence, in the form of (1) or (4) and taking into consideration the already mentioned definitions of the individual quantities, the term T_1 represents a value for the winding time which is needed in order to decelerate the rotational speed of the first spool 12 down to the predetermined final rotational speed W_0 using the deceleration a_1 .

It is checked in step 105 as to whether the first term T_1 is greater than the second term T_2 . If "yes", there follows step 106 wherein the rotational speed W_1 of the first spool 12 is increased further. Following upon this, the method leads to step 102 so that the steps 102 to 105 are run through afresh.

If, in step 105, it is determined that the first term T_1 is not greater than the second term T_2 , then a step 107 occurs in which the rotational speed W_1 of the first spool 12 is reduced in correspondence with the reference value of the deceleration a_1 .

The effect of the method in accordance with the invention is apparent from Fig. 3, which consists of Fig. 3a and Fig. 3b. The rotational speed W_1 of the first spool 12 initially climbs up to a maximum value W_m and thereafter is decelerated down to the value of the predetermined final rotational speed W_0 using the reference deceleration a_1 .

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Fig. 3b shows various waveforms for the rotational speed W_1 . These may be caused for example, by virtue of different starting points for the winding process.

It is apparent that the reference deceleration a_1 and the final rotational speed W_0 are always equally large. The values of the maximum rotational speed W_m differ however.

In a second embodiment, the first and the second terms are transformed in such a manner that a calculation and the subsequent comparison can be carried out as quickly as possible by the electronic control device 10.

Since

$$p = R_1/R_2 \quad (c)$$

becomes very much smaller than 1 towards the end of the winding process, then from (d) we have the approximation

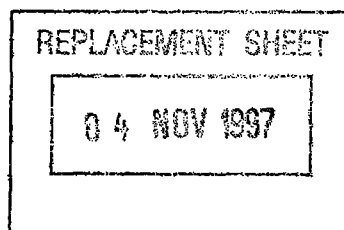
$$R_1 = q \times p \quad (e)$$

whereby, there results from (4) and (2) as a new first term T_1'

$$dT^2(2 \times a_1/e \times (q \times p - R_0) + 1/dT_0^2) \quad (5)$$

Herein, $T = 1/W_1$ and $T_0 = 1/W_0$.

The new first term T_1' in accordance with (5) is now checked as to whether it is greater or smaller than the new second term T_2' which has the constant value "1".



The corresponding method runs analogously to the flow diagram of Fig. 2 but "T1'" instead of "T1" has to be employed and "T2'" instead of "T2".

A further speeding up of the calculating process will be apparent from a further embodiment.

The second drive means, which is contained in the second rotating device 18, is rigidly connected to a not illustrated rotor that incorporates digital markings, which may have optical, magnetic or any other properties, these being detected by a suitable sensor.

The number of markings that are detected within one revolution of the first spool 12 lead to the signal FG1 and the number of markings that are detected within one revolution of the second spool 14 lead to a signal FG2.

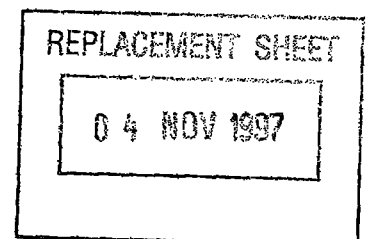
Since the second spool 14 is usually driven at the maximum rotational speed of the second drive means, the rotational speed of the spool 14, and hence too FG2, is constant.

In contrast thereto, the rotational speed of the first spool 12 increases with decreasing first radius R1. The following then applies

$$R1/R2 = FG1/FG2 = p \quad (c')$$

The calculation of the new first term in accordance with (5) can be speeded up if the constants are combined, such as, for example

$$dT^2 \times (K1 \text{ FG1} \times K2) \quad (5a)$$



where

$$K1 = 2 \times a1 \times q / (e \times FG2);$$

$$K2 = 1/dTo^2 - 2 \times a1 \times q \times Ro / (e \times FG2).$$

In addition, the usual further approximations for the term (5) or (5a) can be effected.

One version for both of the embodiments mentioned takes account of the case where a recording tape 13 is used whose characteristic dimensions such as the thickness e, the hub radius Ro, the surface value q, etc., deviate markedly from the values stored as average values in the store 19.

It may then happen that the new first term (5), (5a) is negative. Since the calculations are usually carried out in a digital manner, then, in certain circumstances, it may happen that a complementary value will be formed which is signified as a high positive value so that the interrogation in step 105 will result in "yes" and there will be a fresh acceleration during the deceleration phase.

This is avoided in that upon the commencement of the deceleration phase, that is to say, after the maximum speed Wm has been exceeded, a flag is set which then prevents any subsequent acceleration.

It is also conceivable to have an interrogation as to whether the value of the term being considered is continually altering.

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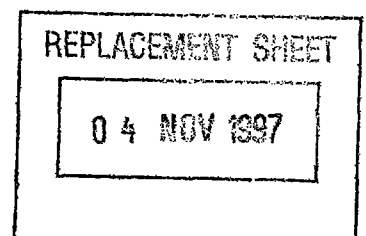
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If the term being considered is negative, then the winding process occurs at a constant speed W_o .

Further versions of the proposed embodiments may include at least one of the following variants;

- for the decision as to whether there should be an acceleration or a deceleration, a plurality of values from which a corresponding average value is formed may serve instead of individual values;
- in the case of the interrogation during step 105, a hysteresis function may be provided whereby large oscillations in the regulating process will be avoided;
- the radii R_1 , R_2 may be determined by not illustrated sensors. Thus, the thicknesses D_1 , D_2 may be determined by measuring optical quantities such as for example, the distance of the outer winding to a reference point, or, R_1 and R_2 can be determined by measuring magnetic quantities or by any other method known to the skilled person;
- during the deceleration phase from W_m down to W_o , the D component of a PID regulator used for controlling the electric motor is altered in such a manner that any overshoot is, to a large extent, reduced.

Thus, there has been proposed a system consisting of a method and of a device suitable for carrying out this method which allows rapid winding of a recording tape from a first spool onto a second spool.



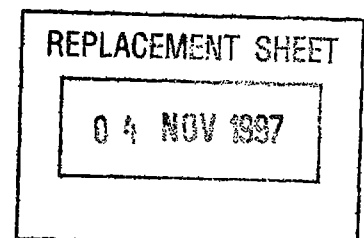
In accordance with the invention, a final rotational speed is determined as from which the tape can be braked by means of a brake device without any too great a mechanical loading.

Furthermore, a maximum reference deceleration is determined which is usually achieved by reduced control of the drive means (electric motor) being used without the use of the said braking device. This reference deceleration is chosen such that any build up of loops is avoided and that the tape lies closely adjacent sensors which identify special markings such as the start of a film on a video tape for example.

The first feed tape is, in accordance with the invention, accelerated for as long as the remaining winding time is sufficient for the deceleration process down to the final rotational speed using the reference deceleration.

The remaining winding time is compared with the time needed, by comparing terms in which operational quantities such as the radii of the first and second spools, the appertaining rotational speeds and the like are included in addition to the final rotational speed and the reference deceleration.

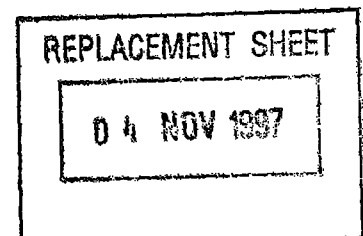
Furthermore, items are also taken into consideration which are dependent on the type of recording tape being used. These items may either be stored as average values in a store or taken into account during the calculation. Alternatively however, the type of recording tape being used is identified by means of a tape identifying device. In this respect, characteristic values may be used which have been



previously entered in a table or else the appropriate values may be calculated.

Due to the system in accordance with the invention, the time needed for the winding process is considerably reduced vis a vis the known systems (ca 100 seconds for a 180 minute video tape). Furthermore, heavy mechanical loads on the recording tape are avoided and constant contact with a reading head is achieved.

In addition, it should also be mentioned that when using large hubs 12a, 14a, the p in the denominator in the approximation for equation (d) is set to "1".



Claims

1. Method of fast winding a recording tape (13) from a first spool (12) onto a second spool (14), wherein the rotational speed W_1 of the first spool (12) is dependent on the length of the wound-off tape, characterised in that, the rotational speed W_1 of the first spool (12) is increased for so long as the remaining winding time suffices for decelerating the first spool (12) from the rotational speed W_1 down to a predetermined final rotational speed W_0 using a predetermined deceleration a_1 .

2. Method in accordance with Claim 1, characterised in that, a value, which represents a measure for the remaining winding time, is determined from the momentary number of windings of the recording tape (13) that are located on the first spool (12).

3. Method in accordance with Claim 2, characterised in that, the momentary number of windings is determined from the thickness e of the recording tape (13), from the radius R_0 of a hub (12a) of the first spool (12) upon which the recording tape (13) is wound and from the thickness D of the total amount of recording tape (13) that is located on the first spool (12).

4. Method in accordance with any of the Claims 1 to 3, characterised in that, the number of revolutions of a rotor, which rotates at a speed that is coupled to the rotational speed W_2 of the second spool (14), is detected and that the remaining winding time is calculated from a first and a second value which are determined from the number of revolutions of the said rotor during the time period in



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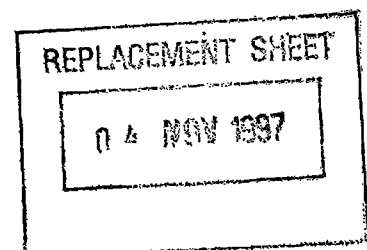
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which the first spool (12) or the second spool (14) covers one revolution.

5. Device for fast winding a recording tape (13) from a first spool (12) onto a second spool (14), wherein the rotational speed W_1 of the first spool is dependent on the length of the wound-off tape, characterised in that, there are provided means (10) which receive operational values from sensors (11, 15, 16), read out predetermined values W_0 , a_1 , R_0 , e , q from a store (19) and, on the basis of calculations and comparisons, control driving means in such a way that the rotational speed W_1 of the first spool (12) is increased for so long as the remaining winding time suffices for decelerating the first spool (12) from the rotational speed W_1 down to a predetermined final rotational speed W_0 using a predetermined deceleration a_1 , wherein, W_0 is the predetermined final rotational speed, a_1 is the predetermined deceleration, R_0 is the radius of the hub of the first spool, e is the thickness of the recording tape and q is the surface value of the tape.

6. Device in accordance with Claim 5, characterised in that, the means (10) determine the remaining winding time on the basis of the momentary number of windings which results from the value of the thickness e of the recording tape, from the value of the radius R_0 of a hub of the first spool upon which the recording tape (13) is wound and from the value of the thickness D of the total amount of recording tape (13) that is located on the first spool (12).

7. Device in accordance with either of the Claims 5 or 6, characterised in that, there is provided a sensor (15) which detects the number of revolutions of a rotor that rotates at



a speed which is coupled to the rotational speed W_2 of the second spool (14), and emits an appropriate signal to the means (10) which calculates the remaining winding time from a first value FG1 and a second value FG2 which are determined from the number of revolutions of the said rotor during the time period in which the first spool (12) or the second spool (14) covers one revolution.



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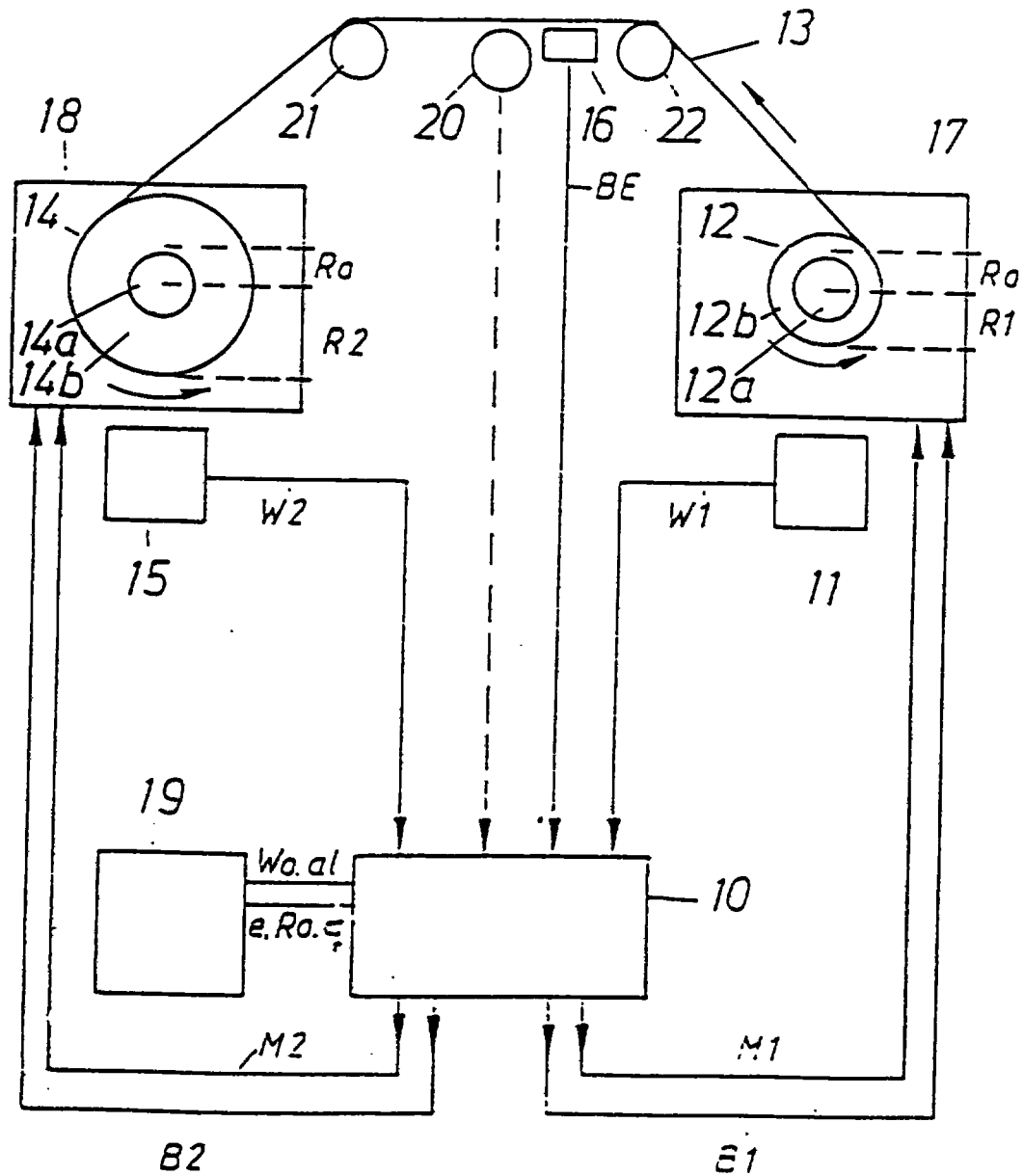


FIG.1

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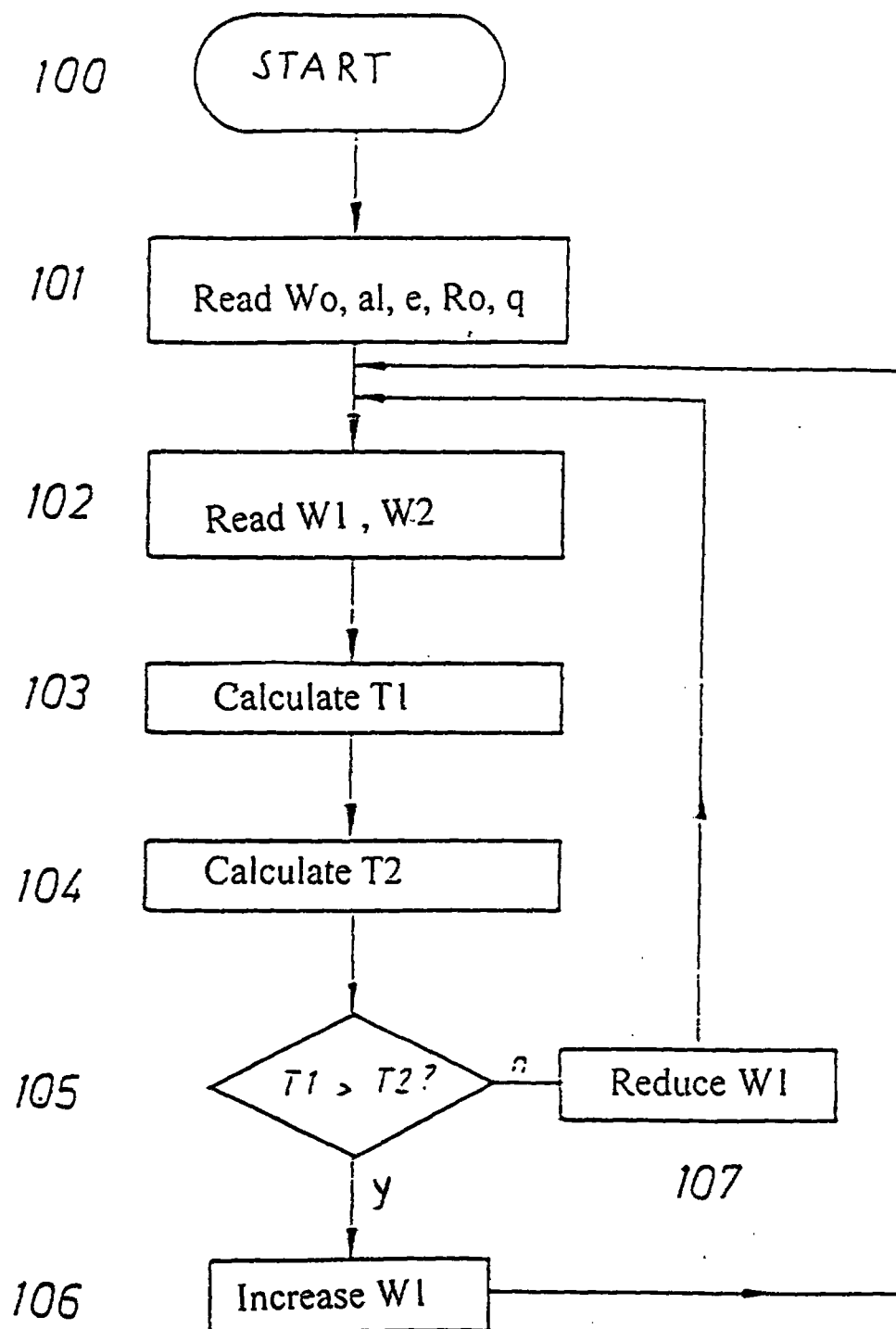
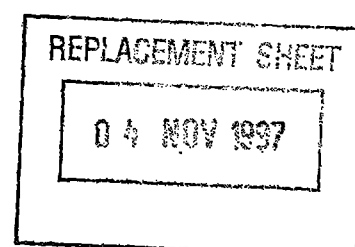


FIG. 2



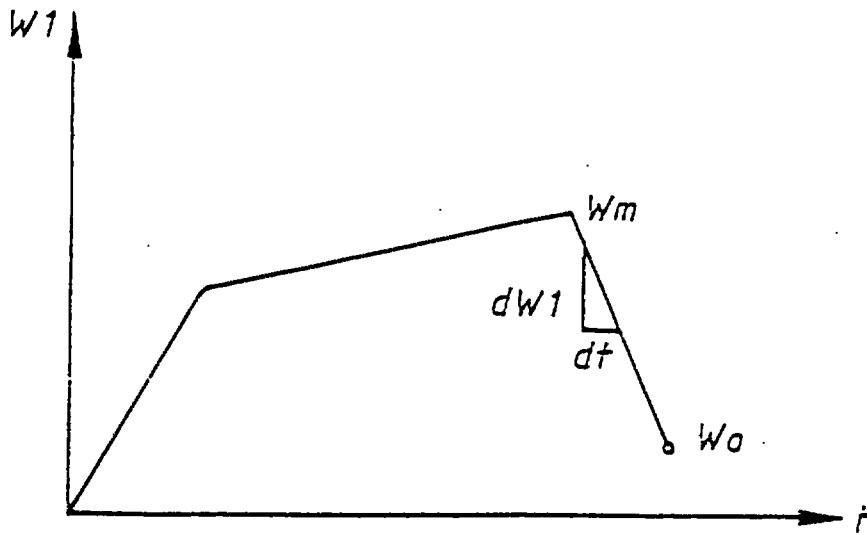


FIG. 3a

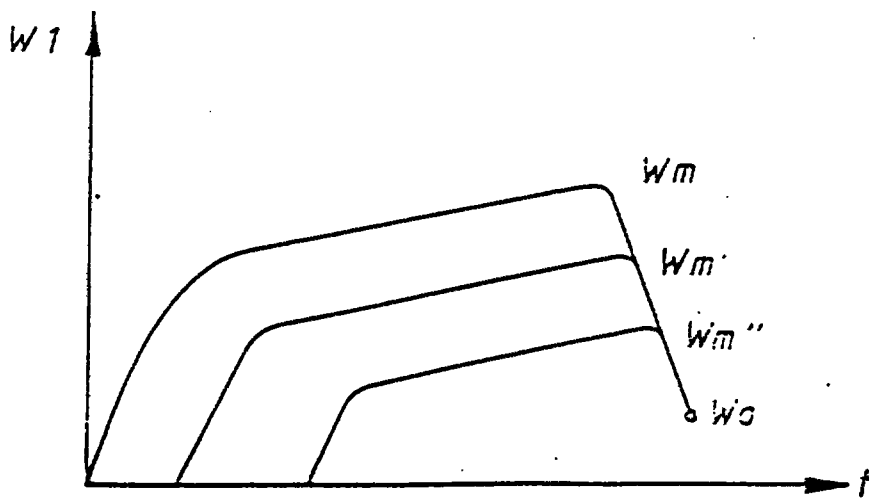
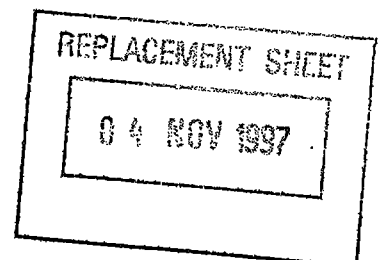


FIG. 3b



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Abstract

Process and apparatus for the fast winding of a recording tape

There is presented a system, comprising a process and an apparatus suitable for carrying out this process, which allows fast winding of a recording tape from a first reel onto a second reel. It is intended in this case for the winding time to be as short as possible and for mechanical stressing of the tape and loop formation to be reduced.

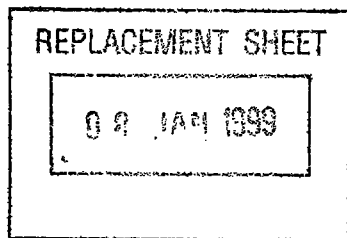
According to the invention, an end rotational speed is determined, from which the tape can be braked by means of a braking device without excessive mechanical loading.

Furthermore, a maximum set deceleration is determined, which is usually accomplished by reduced activation of a driving means used (electric motor) without use of the said braking device. This set deceleration is chosen such that loop formation is avoided and that bearing of the tape against sensors which detect special marks, such as for example the beginning of a film of a video tape [lacuna].

According to the invention, the unwinding first reel is accelerated for as long as the remaining winding time is adequate for decelerating with the set deceleration to the end rotational speed.

The remaining winding time is compared with the required time by comparison of terms into which there are entered, along with the end rotational speed and the set deceleration, operational variables such as the radii of the first reel and of the second reel, the associated rotational speeds and the like.

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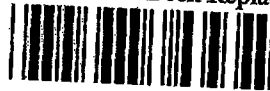
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The system according to the invention can be used with preference for the winding of video cassettes.

Fig. 2

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QUICK REWINDING PROCESS AND DEVICE FOR RECORDING TAPES

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The invention relates to a method in accordance with the first part of claim 1 and also to a device in accordance with the first part of the first apparatus claim that is suitable for carrying out the method in accordance with the invention.

When recording items of information, such as items of digital data for data processing equipments or digital or analogue data for sound or picture reproducing devices for example, recording tapes may be used for storing the items of information. This can be done by means of magnetic, optical or any other methods known to the skilled person.

When using the said recording tapes, these are usually wound forward or are rewound at varying speeds. From one aspect thereby, a distinction is frequently made between the speeds at which the items of information are read from the recording tape. These speeds are the so-called play back speed and the so-called search mode.

However, on appropriate occasions, the recording tape is fast wound forwards or backwards. If, in so doing, the tape is wound back to the respective end, then this is referred to here as fast winding.

Hereinafter, the invention will be described on the basis of the fast winding of a video cassette. It should however be noted that the invention is not limited thereto.

Conventionally, the magnetic tape of a video cassette has a respective end of tape marking a few centimetres from its two ends, this being constructed in the form of a transparent tape. This marking is detected by the video

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AbstractQUICK REWINDING PROCESS AND DEVICE FOR RECORDING TAPES

There is presented a system, comprising a process and an apparatus suitable for carrying out this process, which allows fast winding of a recording tape from a first reel onto a second reel. It is intended in this case for the winding time to be as short as possible and for mechanical stressing of the tape and loop formation to be reduced.

According to the invention, an end rotational speed is determined, from which the tape can be braked by means of a braking device without excessive mechanical loading.

Furthermore, a maximum set deceleration is determined, which is usually accomplished by reduced activation of a driving means used (electric motor) without use of the said braking device. This set deceleration is chosen such that loop formation is avoided and that bearing of the tape against sensors which detect special marks, such as for example the beginning of a film of a video tape [lacuna].

According to the invention, the unwinding first reel is accelerated for as long as the remaining winding time is adequate for decelerating with the set deceleration to the end rotational speed.

The remaining winding time is compared with the required time by comparison of terms into which there are entered, along with the end rotational speed and the set deceleration, operational variables such as the radii of the first reel and of the second reel, the associated rotational speeds and the like.