

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

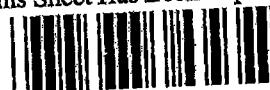
$$D_1 = N_1 * e.$$

The first total radius R_1 is consequently ob-



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tained from

$$R1 = Ro + D1.$$

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 Ro 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 $R2$

$$R2 = Ro + D2.$$

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_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
5 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
10 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
15 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
20 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
25 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
30 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.

35 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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