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(54) TAPE TRANSPORT APPARATUS AND METHOD

(71) We, BASF AKTIENGESELLSCHAFT, a German Joint Stock Company of 6700 Ludwigshafen, Federal Republic of Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to an apparatus and method for transporting magnetic tape past at least one magnetic transducer head. In particular the invention relates to a transport mechanism operating on the contact-winding principle in which supply and a take-up packs of magnetic tape are simultaneously driven by contacting the outermost layer of tape on each pack with the periphery of a common drive capstan.

In order to record and to reproduce signals, and video signals in particular, contact between the magnetic head and the magnetic tape is necessary.

During the recording/playback operation, the coated side of the magnetic tape is in direct contact with the mirror-like surface of the magnetic head(s) and envelope it with an angle of grip. Especially at high tape transport speeds, the advantage of satisfactory tape/head contact is offset by the disadvantage of heavy wear with regard to both head and tape. In order to keep the wear of the magnetic coating as low as possible, a conventional measure is that of arranging the necessary tape guide elements on the substrate side of the magnetic tape wherever possible.

A closed-loop transport mechanism is known in the case of which a scimitar-shaped tape guide is arranged around part of the circular capstan against part of which latter the tape is urged at two points by means of pressure rollers, the magnetic head(s) being integrated with the surface of the said stationary tape guide in such a way that the coated side of the magnetic tape is in continuous contact not only with the magnetic head(s) for the purpose of recording/reproducing signals, but also with the guide surface. Here, the tape transport is to take place in such a way that, even at the highest transport speeds for video recording or playback the tape makes contact with the guide surface and slides thereon. However, the substrate of the tape faces the pressure roller, so that slip can occur bewteen this pressure roller and the tape, whereby the film forming the substrate is subjected to wear and damage.

Another transport mechanism operating on the contact-winding principle has been disclosed in U.K. Patent Specification No. 1,473,128, which is suitable for maximum tape transport speeds. Here, too, both the tape supply and the tape take-up pack are in contact with a capstan which drives both these packs. Between the points of contact of capstan and tape packs, where there is no or virtually no slip, a scimitar-shaped guide element is arranged in this known transport mechanism near the circumference of the capstan, and the tape is guided by means of an air cushion generated between the guide surface and the substrate of the tape. By means of such an air cushion or film, in conjunction with a stationary guide or deflection element or by means of rotatably supported guide rollers it becomes possible to reduce friction between tape and guide elements to such a degree that very high tape transport speeds become possible.

In this known transport mechanism in which an air cushion or film is provided between tape substrate and guide surface, both the tape and the guide surface should be virtually proof against wear.

In actual fact, however, disturbances do occur during the recording and/or reproduction of viedo signals, notwithstanding the above-mentioned air cushion, because contact between the substrate of the magnetic tape and the guide surface cannot always be avoided.

Another known measure is to provide for protecting the non-coated side of the substrate film with a backing suitable for protecting the substrate material and for improving the winding operation by facilitating the escape of air between the turns of the wound pack.

However, such additional backing is an uneconomic proposition and becomes impossible anyway if the thickness of the video tape is confined to such dimensions that any backing would have to be restricted to less than 1 μm.

The present invention, therefore, has for an aim to enable very thin magnetic tape for recording and/or reproducing signals, and in particular video signals, to be transported at high speeds with little wear of the tape.

According to one aspect of the present invention a tape transport apparatus comprises a pair of hubs around which magnectic tape is adapted to be wrapped to form supply and take-up packs, a drive capstan for simultaneously driving, in use of the apparatus, the supply and take-up packs by peripheral surface engagement of the capstan with the outermost layer of tape on each pack, said capstan and said hubs being mounted for rotational movement and also so as to allow for a variation in the spacings between said capstan and the axes of said hubs, at least one magnetic transducer head, guiding means partly surrounding the capstan and having a guide surface or guide surfaces for guiding, in use of the apparatus, the section of tape between the packs relatively to, and in contact with, the or each magnetic transducer head, and means for generating tape tension, in use of the apparatus, in the section of tape between the packs, the guiding means and transducer head(s) being arranged so that, in use of the apparatus, magnetic tape, having a magnetic coating on a substrate and wrapped to form supply and take-up packs in which the coated side of the tape faces outwardly, is guided between the packs with its coated surface facing said guide surface(s) and contacting said transducer head(s).

According to another aspect of the present invention there is provided a method of transporting magnetic tape, having a magnetic coating on a substrate, past at least one magnetic transducer head with the coated side of the tape in contact with the head(s), which method comprises simultaneously driving supply and take-up packs of magnetic tape by contact with the periphery of a common drive capstan contacting the outermost layer of tape on each pack, guiding the section of tape between the packs relatively to, and in contact with, said head or heads by means of a guide surface or guide surfaces of tape guiding means, and generating tape tension in the section of tape between the packs, wherein the coated side of the tape faces outwardly in the packs and, in the section between the packs, faces said guide surface(s), whereby neither the capstan nor the tape guide surface(s) contact the substrate side of the tape during transport of the magnetic tape past the magnetic transducer head(s).

According to a further aspect of the present invention a method of transporting magnetic tape past a magnetic transducer head with the coated surface of the tape in contact with the head, comprises simultaneously driving supply and take-up packs of magnetic tape by contact with the periphery of a common drive capstan contacting the outermost layer of tape on each pack to cause a section of the tape between the packs to move over a tape guiding element in which the head is located, wherein the coated surface of the tape faces outwardly in the packs and faces the guiding element in the said section between the packs.

According to the invention it is thus possible to exclude, or at least substantially to reduce, disturbances which are known to occur during tape transport and are caused by tape slip, tape edge or guide edge effects, and particularly tape adhesion effects on starting the tape transport.

An essential advantage of the invention is that contact between the substrate of the tape (which substrate typically consists of the abrasive material polyethylene terephthalate) and the tape guide means is avoided. In this way, the hazard of abrasion, which is rather a nuisance in sensitive recording processes such as, for example, in the case of high-frequency viedo or data recording, as will be seen later, is considerably reduced if not entirely eliminated from the outset.

In known tape transporting systems abraded particles are deposited between the turns of each tape pack, causing particles to adhere to the coated side of the tape. In such places, the tape will be lifted off the recording or playback head, and this causes recording or playback faults. Other particles will become deposited on the guide surface of guide elements and form points of disturbance in those places which, in the long run, lead to the formation of dirt agglomerations and grow into mounds the height of which can be up to 200 μm above the level of the guide surface. The tape moving past such a raised portion will continuously wipe them whereby further abrasion debris (from the tape substrate, e.g. a polyester film) are produced. This will also cause scratches in the tape which will become rough. After a comparatively short period of use the accumulation of dirt and the occurrence of faults will increase sufficiently for the tape and the apparatus to become useless. Only by employing known cleaning methods and devicts will it be possible to restore the apparatus to its operating condition. This must increase operator's time and operating costs of the equipment considerably. Frequently, a solid tape which may be subjected to further damage by aggressive cleaning methods becomes entirely useless. Equipment of this type is far too costly for domestic use.

The present invention enables the disadvantages of these known tape transport mechanisms to be avoided and the life of parts of the equipment and of tapes to be prolonged, while maintenance requirements are eliminated at the same time.

Suitably there may be provided during the tape transport a separately generated air cushion or film of pre-determined dimensions between the coated side and the surface of the guide element while, on the one hand, the coated face of the tape is continuously in contact with the magnetic head(s) whereas, on the other hand, an air cushion or film of substantially constant thickness is continuously formed between the guide surface and the coated face of the magnetic tape.

By employing such an air cushion the functioning of the tape transport mechanism is improved still further, especially as regards static charges — if the substrate film runs adjacent the tape guide surface and, otherwise, in view of the tendency of thin, very smooth tape to block (adhesion effect) — if, when the transport mechanism is restarted after stopping the coated face of the tape according to the invention, runs adjacent the guide surface.

A further useful measure consists in providing the tape destined for use in the method of the invention with a coated surface by means of which, during tape transport, at least a slight polishing action on the guide surface is achieved.

In this way the guide surface is automatically kept free of deposits — at least to a large extent — and damage to the coated side of the tape as well as contact failure between the tape and the magnetic head(s) is avoided. Magnetic tape suitable for use as part of the transport mechanism of the invention may contain a magnetic layer consisting of a chromium dioxide dispersion which contains a bonding agent consisting of a mixture of 7.5 parts by weight of polyurethane and 2.5 parts by weight of polyvinyl chloride, this mixture ratio extending to 1.5 parts by weight of polyurethane and to 8.5 parts by weight of polyvinyl chloride, but preferably composed of 4 parts by weight of polyurethane and 6 parts by weight of polyvinyl chloride.

By adapating the hardness of the magnetic coating to the material of the tape guide surface, the blocking tendency of thin video tape at the guide surface can be eliminated, Similarly, hard particles may be introduced in the magnetic dispersion, thus increasing the polishing effect of the tape.

The invention will now be described, by way of example, with reference to the accompanying drawing, the sole figure of which illustrates, in diagrammatic representation and in plan, a contact-winding mechanism according to the invention in which the tape is wound with the magnetic layer facing outwardly and a magnetic head is provided in the tape guide arrangement.

In the following description of the illustrated embodiment, the reference numeral 1 indicates the capstan which drives the rotatably supported tape packs 2 and 3 simultaneously by contact pressure. In the present case, the numeral 2 indicates the supply pack and the numeral 3 the take-up pack, in accordance with the running direction of the tape as indicated by arrow *a*). Those arrows which do not bear reference numerals indicate the sense of rotation of the tape packs and the capstan when the running direction is as indicated by *a*).

Part of the circumference of capstan 1 is surrounded by a tape guide which consists of the parts 4*a* and 4*b*, and in the space intervening between the parts 4*a* and 4*b* there is provided the magnetic head 5 whose gap(s) is (are) situated within the plane in which the tape is guided. The tape 6 has a magnetic coating on one side which is indicated by dash-dot lines, and a substrate film indicated by solid line. As can be gathered from the drawing, the tape is transported with its coated side adjacent the guide surfaces of the guide elements 4*a* and 4*b* and also faces the magnetic head 5 with its coated side. In accordance with the proposed type of transport mechanism, the tape 6 is wound into packs with its coated layer on the outside — and this applies to the supply pack as well as to the take-up pack, so that the substrate film enjoys maximum protection. In accordance with the principle used in this transport mechanism, slip does not occur at point A and B where the capstan circumference is in contact with the packs 3 and 2 respectively, especially if the capstan 1 is provided with a rubber lining or some other suitable resilient cover 7 at its circumference.

Below, the advantages of an arrangement such as proposed by the present invention will be explained with reference to an example.

The magnetic tape used here may be a tape suitable for the recording of video signals comprising a magnetic chromium dioxide layer on a polyethylene terephthalate film substrate such as Mylar film, for example, (a commercial product of DuPont, "Mylar" being its trade name registered by this firm).

The magnetic layer of this chromium dioxide tape is formed by a dispersion consisting of magnetic chromium dioxide particles and a bonding agent. The bonding agent consists, for example, of polyurethane and PVC (polyvinyl chloride) mixed at a ratio of 7.5/2.5 to 1.5/8.5 parts by weight polyurethane/parts by weight PVC, and preferably a ratio of 4:6. The coated side of this magnetic tape has a roughness R_t of between 0.05 μm, and preferably R_t = 0.1 μm, whereas its substrate has a surface roughness R_t of between 0.1 and 0.25 μm. The substrate, i.e. the Mylar film of the magnetic chromium dioxide video tape used in this case, has a thickness of 6 μm and is stretched in the longitudinal direction during manufacture. The above-described magnetic chromium diode tape was moved at a speed of 3 m/s, with a tape tension of 50 p (pond) past a tape guide consisting of V2A steel and comprising two raised portions separated in the longitudinal direction by a groove of concave curvature (depth h = 5 μm). A tape guide of this type is disclosed in U.K. Patent Specification No. 1,515,739.

The same type was transported at the same speed on an air cushion, produced by an air supply, or a film, of a height h = 10 — 25 μm, between the tape and the tape guide. In either case, the upper layer of the tape did not show any scratches after 100 hours of continuous operation. To explain this test result it must be assumed that the coated side of the tape acts in the manner of a polishing belt whose abrasiveness grows with its PVC content, i.e. its polishing action increases with the reduction of the above-quoted ratio. At most, the tape is subjected to a slight abrasive action — without the possibility of scratches occurring. On the other hand, if the tape is transported with its substrate in contact with the same tape guide, then the substrate is damaged in that particles are torn out of the surface of the substrate. These particles are deposited in microscopic recesses of the tape guide and form agglomerations and raised portions which, in turn, produce scratches on the surface of the substrate, and this, in turn, enhances abrasion. Such abrasive action can be even after short tape runs, if the tape transport speed is 3 m/s, as mentioned above. Obviously, it is also possible to employ still higher speeds. The lower limit of the roughness of the guide surface that is possible in practice is determined by the adhesive effects which will be encountered (blocking of the tape, for instance, on re-starting the transport mechanism after a previous stop).

The guide surface of the tape guide may consist of any suitable material of adequate roughness, such as ceramic material, for example. The cross-section of the guide surface may have a concave curvature with the tape maintaining a substantially linear profile across its width as it is transported along the guide surface.

It is of course also possible to achieve the polishing action of the tape by the addition of grinding or abrasive particles to the magnetic particles employed, for example iron oxide or doped iron oxide or pigmented iron, or by using a suitably "hard" bonding agent in conjunction with the employment of such grinding particles. Grinding or abrasive particles may be any particles having a Mohs' hardness greater than 6 (which is Mohs' hardness of iron oxide). Particles consisting of orthoclase, quartz, rock crystal, topaz, corundum, melamite, zirconium oxide, alumina, silicon carbide, boron carbide, titanium carbide, tungsten carbide, chromium dioxide or molybdenum may be used. Chromium dioxide has a Mohs' hardness 8.

WHAT WE CLAIM IS:—

1. A tape transport apparatus comprising a pair of hubs around which magnectic tape is adapted to be wrapped to form supply and take-up packs, a drive capstan for simultaneously driving, in use of the apparatus, the supply and take-up packs by peripheral surface engagement of the capstan with the outermost layer of tape on each pack, said capstan and said hubs being mounted for rotational movement and also so as to allow for a variation in the spacings between said capstan and the axes of said hubs, at least one magnetic transducer head, guiding means partly surrounding the capstan and having a guide surface or guide surfaces for guiding, in use of the apparatus, the section of tape between the packs relatively to, and in contact with, the or each magnetic transducer head, and means for generating tape tension, in use of the apparatus, in the section of tape between the packs, the guiding means and transducer head(s) being arranged so that, in use of the apparatus, magnetic tape, having a magnetic coating on a substrate and wrapped to form supply and take-up packs in which the coated side of the tape faces outwardly, is guided between the packs with its coated surface facing said guide surface(s) and contacting said transducer head(s).

2. Apparatus according to claim 1, in which the or each guide surface consists of steel.

3. Apparatus according to claim 1, in which the or each guide surface consists of a ceramic material.

4. Apparatus according to any of the preceding claims, in which the cross-section of the or each guide surface has a concave curvature.

5. A method of transporting magnetic tape, having a magnetic coating on a substrate, past at least one magnetic transducer head with the coated side of the tape in contact with the head(s), which method comprises simultaneously driving supply and take-up packs of magnetic tape by contact with the periphery of a common drive capstan contacting the outermost layer of tape on each pack, guiding the section of tape between the packs relatively to, and in contact with, said head or heads by means of a guide surface or guide surfaces of tape guiding means, and generating tape tension in the section of tape between the packs, wherein the coated side of the tape faces outwardly in the packs and, in the section between the packs, faces said guide surface(s), whereby neither the capstan nor the tape guide surface(s) contact the substrate side of the tape during transport of the magnetic tape past the magnetic transducer head(s).

6. A method according to claim 5, in which the substrate of the magnetic tape is a polyethylene terephthalate film.

7. A method according to claim 5 or 6, in which an air cushion of substantially constant thickness is generated between the or each of said guide surfaces and the coated side of the magnetic tape.

8. A method according to claim 5 or 6, in which the action of the magentic coating on said guide surface(s) on transport of the tape causes the guide surface(s) to be at least slightly polished.

9. A method according to any of claims 5 to 8, in which the magnetic coating of the tape contains a bonding agent consisting of a ratio from 7.5 parts by weight of polyurethane and 2.5 parts by weight of polyvinyl chloride, to 1.5 parts by weight of polyurethane and 8.5 parts by weight of polyvinyl chloride.

10. A method according to claim 9, in which the ratio is 4 parts by weight of polyurethane and 6 parts by weight of polyvinyl chloride.

11. A method according to claim 9 or 10, in which the magnetic coating is a chromium dioxide dispersion.

12. A metod according to any of claims 5 to 11, in which the or each guide surface of the tape guiding means consists of steel.

13. A method according to any of claims 5 to 11, in which the or each guide surface of the tape guiding means consists of a ceramic material.

14. A method according to claim 12 or 13, in which the magnetic coating of the magnetic tape contains particles having a Mohs' hardness greater than 6.

15. A method of transporting magnetic tape past a magnetic transducer head with the coated surface of the tape in contact with the head, which comprises simultaneously driving supply and take-up packs of magnetic tape by contact with the periphery of a common drive capstan contacting the outermost layer of tape on each pack to cause a section of the tape between the packs to move over a tape guiding element in which the head is located, wherein the coated surface of the tape faces outwardly in the packs and faces the guiding element in the said section between the packs.

16. A magnetic viedo tape transport mechanism constructed and arranged substantially as hereinbefore described with reference to, and as illustrated in, the accompanying drawing.

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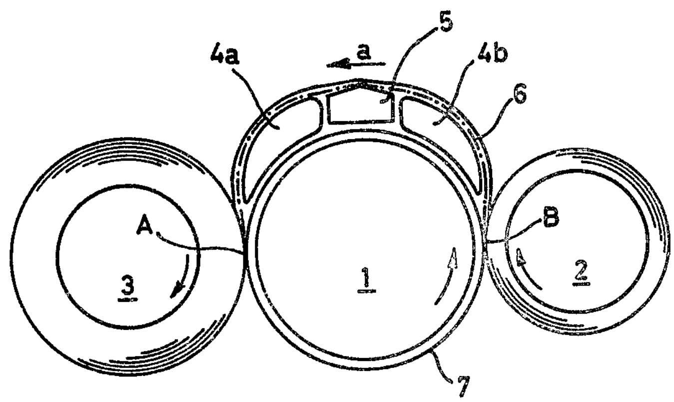
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