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(54) CASSETTE LOADING AND TAPE TENSIONING SYSTEM

5 (71) We, BASF AKTIENGESELL-SHAFT, 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:

10 The present invention relates generally to a tape transport mechanism and, more particularly, to a method and apparatus for automatically loading the tape transport mechanism with tape from a supply pack of magnetic recording tape contained in an openable tape cassette. The tape transport mechanism is of the type comprising a take-up hub and a shaft mounted on a carriage for carrying the supply tape pack, said hub and said carriage being urged towards a tape capstan in order that in use the periphery of the capstan is able drivingly to engage the outermost turn of tape on the supply tape pack and simultaneously the take-up hub, or the outermost turn of the tape wound on to the take-up hub from the supply tape pack.

25 Many variations of tape transport mechanisms are known and used in the magnetic recording industry wherein the supply tape pack is driven by surface engagement with a capstan. In certain of such systems a tape cassette is utilized to protect the supply tape pack. In operation, the cassette is inserted into a receiving means and the tape pack hub is brought into engagement with a shaft which is part of the transport mechanism. The supply tape pack is then caused to come into contact with the capstan and threading of the tape about the take-up hub begins. In addition, some means is generally used to remove any slack in the supply tape pack

resulting from the threading operation.

With such known systems, the supply tape pack loading, threading and tensioning operations are accomplished by numerous differing means. It has been found, however, that the complex mechanical and electronic systems heretofore utilized to control the loading, threading and tensioning steps have resulted in many problems relating to their reliability and high cost which have prohibited their practical use in the home entertainment field.

The present invention was developed in order to provide a simple and relatively inexpensive system which controls and sequences the loading, threading and tensioning steps.

According to one aspect of the present invention there is provided a method for automatically loading a tape transport mechanism with tape from a supply pack of tape contained in an openable cassette, the tape transport mechanism being of the kind comprising a take-up hub and a shaft rotatably mounted on a carriage for carrying the supply tape pack, said hub and said carriage being urged towards a tape drive capstan in order that in use the periphery of the capstan is able drivingly to engage the outermost turn of tape on the supply tape pack and simultaneously the take-up hub, or the outermost turn of tape wound on to the take-up hub from the supply tape pack, the method comprising locating the cassette so that the supply tape pack surrounds the said shaft, automatically moving the carriage towards the capstan to effect opening of the cassette thereby to expose said supply tape pack and bring its outermost turn of tape into contact with the periphery of the capstan, automatically rotating the capstan to feed the leading

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end of the tape partly around the rotating capstan before being wound onto the take-up hub, automatically reducing the contact pressure between the supply tape pack and the capstan to apply tension to the outermost turn of tape on the supply tape pack, and automatically increasing the contact pressure after removal of slack in the supply tape pack has been effected.

According to another aspect of the invention there is provided an apparatus for automatically loading the tape transport mechanism with a tape from a supply pack of tape contained in an openable cassette, the tape transport mechanism being of the kind comprising a take-up hub and a shaft rotatably mounted on a carriage for carrying the supply tape pack, said hub and said carriage being urged towards a tape drive capstan in order that in use the periphery of the capstan is able drivingly to engage the outermost turn of tape on the supply tape pack and simultaneously the take-up hub, or the outermost turn of tape wound on to the take-up hub from the supply tape pack, the apparatus comprising actuating means for mechanically engaging and controlling the movement of the carriage towards and away from said capstan, means for opening the tape cassette sufficiently to expose the supply tape pack for engagement by the capstan, means for rotating said capstan, and means for automatically sequencing the operation of said actuating means, cassette-opening means and capstan-rotating means so that said cassette is opened as said supply tape pack is advanced into close contact with the capstan, said tape then being threaded about said take-up hub after which said carriage is moved away from the capstan so that the supply tape pack is caused to be withdrawn from close contact with the capstan so that slack may be removed therefrom by applying tension to the outermost turn of tape on the supply tape pack, said carriage then being caused to advance again towards said capstan so that the supply tape pack is again brought into its operative position in close contact with the capstan.

The invention will now be described by way of example with particular reference to the accompanying drawings, in which:

Figure 1 is a perspective view of a cassette loading and tape tensioning apparatus constructed in accordance with an embodiment of the present invention;

Figure 2A a top plan of the apparatus shown in Figure 1;

Figure 2B is a top plan similar to Figure 2A, but showing several elements thereof in a different sequential position.

Figure 3A is a partial enlarged top plan of the apparatus shown in Figure 2A;

Figure 3B is a partial, enlarged top plan similar to Figure 3A, but showing several

elements thereof in the sequential position illustrated in Figure 2B;

Figure 4A is a sectional side view taken along line A-A of Figure 3A;

Figure 4B is a sectional side view similar to Figure 4A, but taken along line B-B of Figure 3B;

Figure 5 is a block diagram showing the sequence of the loading and tensioning operations; and

Figure 6 is a block diagram showing the sequence of the supply tape pack unloading operation.

Figure 1 generally illustrates an embodiment of a cassette loading and tape tensioning apparatus constructed in accordance with the present invention. The apparatus is shown being utilized with a tape transport mechanism having a capstan 10 which simultaneously drives supply reel 20 (see Figure 2A) and take-up reel 30 by surface engagement of the outermost layer of magnetic tape 40 on each reel.

As can be seen from Figure 2A, 2B, supply reel 20 comprises hub 21 secured to rotatable shaft 22 mounted on swing-arm carriage 23. Similarly, take-up reel 30 comprises hub 31 secured to rotatable shaft 32 mounted on swing-arm carriage 33. Carriages 23, 33 individually urge supply and take-up reels 20, 30 inward against capstan 10 by means of a constant tension spring 11 which interconnects the carriages at points 24, 34. In this manner, as the diameter of the tape pack wound about each reel varies in use as tape 40 is transported past record/playback head 15, the carriages will rotate about pivot points 25, 35 so as to allow for independent movement of the reel hubs toward or away from the capstan.

The first operation in the loading process consists of inserting hinged cassette 41, in which supply tape pack 42 wound about hub 21 is stored, into cassette receiving means 60. Receiving means 60 comprises a hinged door 61 (shown in phantom lines) which is located in such a position that snapping it closed will urge hub 21 onto supply shaft 22. Tabs 62A, 62B located respectively on the ends of pivotal arms 64A, 64B will enter slots 44A, 44B located in the forward portion of cassette halves 46A, 46B and release the internal cassette locking mechanism (not shown) holding the halves of the cassette closed. When this is accomplished, the cassette halves are ready to be pivoted open about pivot 47 so that the supply tape pack can subsequently be advanced into contact with the capstan.

Supply tape pack 42 is advanced into an operative position wherein its outermost tape layer is in close contact with capstan 10 by means of the pivotal motion of supply carriage 23 which is urged toward the capstan by constant tension spring 11.

5 Figures 2A, 2B, 3A, 3B, 4A and 4B best illustrate a means for sequencing the operation of the tape transport apparatus which comprises a threaded, rotatable leadscrew 50 having a corresponding internally threaded nut 51 mounted for translational movement thereon. Leadscrew 50 is rotated by means of motor 52 acting through belt 53 and pulley 54 attached to one end of the leadscrew. The other end of the leadscrew is rotatably secured to the transport frame 12 through bearing 55.

10 Nut 51 has a circular cross-section with the internally threaded portion through which the leadscrew extends formed perpendicular to its axis. The nut is prevented from rotating about the leadscrew as it is rotated due to a pin 56 extending therefrom which slides along slot 57, which is formed in the frame of the transport, as the nut traverses back and forth across the leadscrew.

15 Due to the pivotal force exerted by constant tension spring 11, the supply carriage will be urged against nut 51 at carriage projection 26. Hence, as nut 51 transverses toward and away from the capstan, it will also control the movement of supply carriage 23 and tape pack 42 toward and away from the capstan.

20 Referring now to the system for opening the hinged cassette 41, supply carriage 23 has a rounded plate 27 mounted slightly about carriage projection 26 which mechanically engages flange portion 63 of pivot arm 64A. Extension 65 of pivot arm 64B is urged against the other side of the flange, which in turn is urged against carriage plate 27, by means of pivotal force exerted on the arms by springs 67A, 67B. Hence, as carriage 23 advances toward the capstan, arms 64A, 64B will pivot about their respective pivot points 66A, 66B in a manner so as to cause the halves of cassette 41 to pivot open about their hinge 47.

25 In operation, once cassette 41 is loaded in the transport mechanism in the manner described above, leadscrew motor 52 is activated thereby rotating leadscrew 50 in a forward direction wherein nut 51 will traverse across the leadscrew toward capstan 10. This beginning position of the loading sequence is illustrated by Figures 2A, 3A and 4A.

30 As the nut traverses toward the capstan, supply carriage 23 will cause the tape pack 42 to advance toward the capstan as carriage projection 26 follows nut 51. As the supply carriage moves toward the capstan, arms 64A, 64B will be allowed to pivot outwards, thereby opening the cassette 41 about its pivot point 47 sufficiently to allow tape pack 42 to come into contact with the capstan. At this point, the opening of the cassette will cease as limit pins 68A, 68B mounted on the arms reach the end of their travel in pivot slots 69A, 69B respectively.

When tape pack 42 is brought into contact with capstan 10 as illustrated in Figures 2B, 3B and 4B, nut 51 will stop its travel toward the capstan due to the activation of logic circuit 80 which electrically controls the operation of the leadscrew motor 52. Logic circuit 80 consists of conventional AND, OR, NAND and NOR gates and FLIP-FLOP which control the start, stop, and forward-backward motion of the leadscrew motor, which in turn controls the movement of nut 51 across leadscrew 50, in response to electrical signals generated by several simple signaling means.

70 The first of these signaling means 81 indicates when the tape pack comes into contact with the capstan. Signaling means 81 is essentially a contact switch comprising on one side of the circuit, leadscrew nut 51 and, on the other side of the circuit, carriage projection 26. As is best illustrated by Figure 4B, when tape pack 42 comes into contact with capstan 10, the movement of supply carriage 23 will be blocked as nut 51 continues to traverse towards the capstan. Thus, the engagement of the tape pack by the capstan will necessarily cause the contact between carriage projection 26 and nut 51 to be broken. Since these two elements are also acting as respective sides of an electrical circuit switch, this circuit also will be broken as the leadscrew nut continues to be driven toward the capstan, which in turn will signal the logic circuit to stop the leadscrew motor.

80 After the leadscrew motor is stopped as a result of the tape pack coming into contact with the capstan, the logic circuit causes the capstan to rotate and thereby begin the threading of the tape about the capstan and take-up reel 30.

85 A second signaling means 82 (Figures 2A, 2B) indicates when the threading operation is completed. This signaling means consists of a photosensor 83 which is responsive to a light source 84 which is disposed on the opposite side of the path followed by the tape about capstan tape guide 14. This arrangement permits, by the use of a transparent leader in conjunction with opaque recording tape, the sensing of the leader-tape junction by the photosensor. In addition, the removal of the opaque recording medium from a portion of the transparent tape base will also cause a signal to be generated when this portion (a so-called "washout") passes between the photosensor and light source. It is desirable that the length of the transparent leader or the distance between the tip of the leader and the "washout" be sufficient to assure that the threading operation has been performed properly before the photosensor signal is generated.

90 When the photosensor circuit signals that the tape threading operation has been satisfactorily completed, the logic circuit will

5 cause the leadscrew motor to reverse, thereby causing nut 51 to once again come into contact with carriage projection 26 and begin driving tape pack 42 backwards, away from capstan 10. At this point, electrical contact between nut 51 and projection 26 is reestablished, thereby generating a signal to the logic circuit which will be in turn cause the leadscrew motor to stop. The inherent overrun of nut 51 should be sufficient to withdraw the supply tape pack from close contact with the capstan in order to allow for slack removal. However, an appropriate delay timing sequence may be built into the logic circuit to allow for such withdrawal if the inherent nut overrun is insufficient to provide for this operation.

10 Once the above-mentioned close frictional contact between capstan 10 and tape pack 42 is broken, the slack removal operation begins through the operation of a brake 70 acting upon the supply reel shaft 22. Brake 70 consists essentially of a flexible cord which is wrapped several times about the lower end of shaft 22 in order to provide a frictional bearing contact therewith, and which is resiliently attached at its ends to the transport frame 12. The drag upon shaft 22 by brake 70 will cause all slack to be removed from the tape transport system as take-up reel 30 and capstan 10 pull the tape off of tape pack 42 under the tension caused by brake 70 once close frictional contact between the tape pack and capstan is broken. Once this contact is broken, the slack removal operation is completed very quickly and the logic circuit will once again cause the leadscrew motor to drive nut 51 in a forward direction thereby bringing tape pack 42 back into its operative position in close contact with capstan 10.

35 The completion of the slack removal operation may be indicated by a simple timing arrangement such as locating another "washout" or transparent tape window a certain distance from the beginning of the tape. (For example, in one embodiment of the present invention such a "washout" or window is already located 34 inches from the beginning of the tape and is primarily utilized to control the rewind operation of the tape.) When the above-described photosensor circuit signals the appearance of this "washout" or window to the logic circuit it will cause leadscrew motor 52 to drive nut 51 and following carriage projection 26 forward until close contact between tape pack 42 and capstan 10 is reestablished. At this point nut 51 will continue to be driven along leadscrew 50 until the end of its travel is indicated by engagement of limit switch 85. (See the nut position indicated as 51' in Figures 3B, 4B.) The closing of limit switch 85 will signal the logic circuit to stop the leadscrew motor, which in turn will stop the travel of nut 51. In the embodiment of the invention shown in

the drawings, the distance nut 51 must be driven along leadscrew 50 after the tape pack engages the capstan must be sufficient to allow for free clearance of carriage projection 26 with respect to nut 51 as the tape pack is exhausted from hub 21 in use.

70 When it is desired to unload the tape cassette from the tape transport, the above loading sequence is reversed in the following way. After the tape and leader have been fully rewound onto tape pack 42, photosensor circuit 82 will generate a signal in the above-discussed manner indicating that the end of the tape has passed. This signal causes the logic circuit to begin driving the leadscrew motor backwards, thereby causing nut 51 to traverse the leadscrew away from the capstan. As nut 51 so traverses across leadscrew 50 it will once again engage carriage projection 26 thereby causing tape pack 42 to retract away from the capstan and back into its cassette which will be mechanically closed about it through the reverse operation of pivot arms 64A, 64B which engage cassette halves 46A, 46B.

85 The completion of the tape pack unloading operation is indicated by the engagement of limit switch 86 by nut 51 at the outer end of its travel along leadscrew 50 (see Figure 4A). The closing of this outer limit switch will signal the logic circuit to stop the leadscrew motor, which in turn will stop the travel of nut 51. At this point hinged door 61 may be opened and the cassette containing tape pack 42 removed from the cassette receiving means.

90 It should be understood that various obvious changes and modifications may be made to the above-described embodiment of the present invention, and it is therefore intended to include all such modifications and changes as may fall within the scope of this invention as defined in the appended claims.

105 WHAT WE CLAIM IS:

110 1. A method for automatically loading a tape transport mechanism with tape from a supply pack of tape contained in an openable cassette, the tape transport mechanism being of the kind comprising a take-up hub and a shaft rotatably mounted on a carriage for carrying the supply tape pack, said hub and said carriage being urged towards a tape drive capstan in order that in use the periphery of the capstan is able drivingly to engage the outermost turn of tape on the supply tape pack and simultaneously the take-up hub, or the outermost turn of tape wound on to the take-up hub from the supply tape pack, the method comprising locating the cassette so that the supply tape pack surrounds the said shaft, automatically moving the carriage towards the capstan to effect opening of the cassette thereby to expose said supply tape pack and bring its outer-

most turn of tape into contact with the periphery of the capstan, automatically rotating the capstan to feed the leading end of the tape partly around the rotating capstan before being wound onto the take-up hub, automatically reducing the contact pressure between the supply tape pack and the capstan to apply tension to the outermost turn of tape on the supply tape pack, and automatically increasing the contact pressure after removal of slack in the supply tape pack has been effected.

2. An apparatus for automatically loading a tape transport mechanism with a tape from a supply pack of tape contained in an openable cassette, the tape transport mechanism being of the kind comprising a take-up hub and a shaft rotatably mounted on the carriage for carrying the supply tape pack, said hub and said carriage being urged towards a tape drive capstan in order that in use the periphery of the capstan is able drivingly to engage the outermost turn of tape on the supply tape pack and simultaneously the take-up hub, or the outer-most turn of tape wound on to the take-up hub from the supply tape pack, the apparatus comprising actuating means for mechanically engaging and controlling the movement of the carriage towards and away from said capstan, means for opening the tape cassette sufficiently to expose the supply tape pack for engagement by the capstan, means for rotating said capstan, and means for automatically sequencing the operation of said actuating means, cassette-opening means and capstan-rotating means so that said cassette is opened as said supply tape pack is advanced into close contact with the capstan, said tape then being threaded about said take-up hub after which said carriage is moved away from the capstan so that the supply tape pack is caused to be withdrawn from close contact with the capstan so that slack may be removed therefrom by applying tension to the outermost turn of tape on the supply tape pack, said carriage then being caused to advance again towards said capstan so that the supply tape pack is again brought into its operative position in close contact with the capstan.

3. An apparatus according to claim 2, wherein a portion of said actuating means is adapted to engage mechanically said carriage as said supply tape pack advances towards the capstan and to disengage from said carriage when said supply tape pack comes into close contact with the capstan thereby causing said threading operation to begin.

4. An apparatus according to claim 2 or 3, wherein the cassette opening means comprises an arm which engages the opening portion of the cassette and which mechanically engages means fixed to said carriage so that the opening of said cassette is controlled by the movement of the carriage towards the

capstan.

5. An apparatus according to claim 2 or 3, wherein the cassette opening means comprises a pair of arms which engage opening halves of said cassette at side corner portions thereof located on either side of a hinge point of said cassette, said pair of arms also mechanically engaging means fixed to said carriage so that said cassette halves pivot open simultaneously with the advancing of the carriage carrying said supply tape pack toward the capstan.

6. An apparatus according to any of claims 2 to 5, comprising a brake acting on said shaft to assist in the removal of slack from said supply tape pack.

7. An apparatus according to any of claims 2 to 6, wherein the actuating means comprises a motor-driven, rotatable leadscrew having a nut mounted thereon which is driven along said leadscrew as the latter is rotated, said nut being adapted mechanically to engage, and control the movement of, said carriage.

8. An apparatus according to claim 7, wherein the sequencing means comprises a first means for signaling when said supply tape pack is brought into contact with said capstan and a second means for signaling when said tape is threaded about said take-up hub.

9. An apparatus according to claim 8, wherein the sequencing means further comprises a logic circuit which controls the operation of said motor-driven leadscrew and which receives electronic input signals from said signaling means.

10. An apparatus according to claim 9, wherein the logic circuit comprises a means for causing said leadscrew motor to rotate said leadscrew in a forward direction wherein said nut will traverse toward said capstan, thereby causing said movable carriage to advance said supply tape pack toward said capstan causing said cassette opening means which mechanically engages said movable carriage to open said cassette, said leadscrew motor being operated until said first signaling means indicates that said supply tape pack is in contact with said capstan.

11. An apparatus according to claim 9 or 10, wherein the logic circuit further comprises a means for activating said capstan rotating means when said first signaling means indicates that said supply tape pack is in contact with said capstan.

12. An apparatus according to any of claims 9 to 11, wherein the logic circuit further comprises a means for causing said leadscrew motor to rotate said leadscrew in a backward direction wherein said nut will traverse away from said capstan, thereby causing said movable carriage to withdraw said supply tape pack from close contact with said capstan, when said second signaling

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means indicates that said tape is threaded about said take-up hub.

5 13. An apparatus according to claim 12, wherein the logic circuit further comprises a means for stopping the backward rotation of said leadscrew motor when said first signaling means indicates the said supply tape pack has been withdrawn from close contact with said capstan.

10 14. An apparatus according to any of claims 9 to 13, wherein the logic circuit further comprises a timing means which causes said leadscrew motor to rotate said leadscrew in a forward direction wherein said nut will traverse toward said capstan, thereby causing said movable carriage to advance said supply tape pack again into its operative position in close contact with the capstan, after a period of time has elapsed sufficient to allow slack to be removed from said supply tape pack.

15 15. An apparatus according to any of claim 9 to 14, wherein the sequencing means further comprises an inner limiting means for signaling when said nut has traversed toward said capstan a distance sufficient that it will not interfere with the movement of said carriage as said supply tape pack is exhausted in use.

20 16. An apparatus according to any of claims 9 to 15, wherein the logic circuit further comprises a means for stopping the forward rotation of said leadscrew motor when said inner limit signaling means is engaged by said nut.

25 17. An apparatus according to any of claims 9 to 16, wherein the sequencing means further comprises a means for signaling when the tape has been fully rewound onto said supply tape pack.

30 18. An apparatus according to any of claims 9 to 17, wherein the logic circuit further comprises a means for causing said leadscrew motor to rotate said leadscrew in a backward direction wherein said nut will traverse away from said capstan, thereby causing said movable carriage to withdraw said supply tape pack from contact with said capstan and back within said cassette which is closed about it by the reverse operation of said cassette opening means when said rewind signaling means is activated.

35 19. An apparatus according to any of claims 9 to 18, wherein the sequencing means further comprises an outer limiting means for signaling when said nut has traversed away from said capstan a distance sufficient that said supply tape pack has fully withdrawn back within said closed cassette.

40 20. An apparatus according to any of claims 9 to 19, wherein the logic circuit further comprises a means for stopping the backward rotation of said leadscrew motor when said outer limit signaling means is engaged by said nut.

21. An apparatus according to any of claims 8 to 20, wherein the first signaling means comprises a contact switch having as one side of the circuit said leadscrew nut and as the other side of the circuit said carriage. 70

22. An apparatus according to any of claims 8 to 21, wherein the second signaling means comprises a photosensor circuit having a photosensor located on one side of the path followed by the tape about said capstan which is responsive to a light source disposed on the other side thereof. 75

23. An apparatus according to any of claims 8 to 22, wherein the second signaling means (further) comprises a transparent or translucent tape portion located at the beginning of the tape, which activates said photosensor circuit when said tape is threaded about said take-up hub. 80

24. An apparatus according to claim 14, wherein the timing means comprises a transparent or translucent tape portion located on said tape a predetermined distance from the beginning thereof, which activates said photosensor circuit after a period of time has elapsed sufficient to allow slack to be removed from said supply tape pack. 85

25. An apparatus according to claim 15, wherein the inner limit signaling means comprises a first limit switch which is engaged by said nut at the inner limit of its travel along said leadscrew toward said capstan. 90

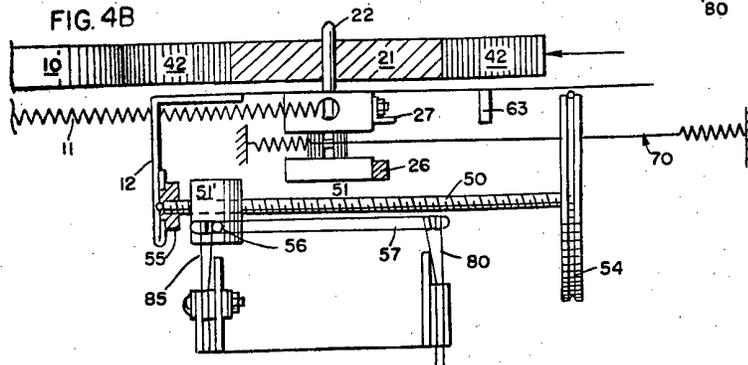
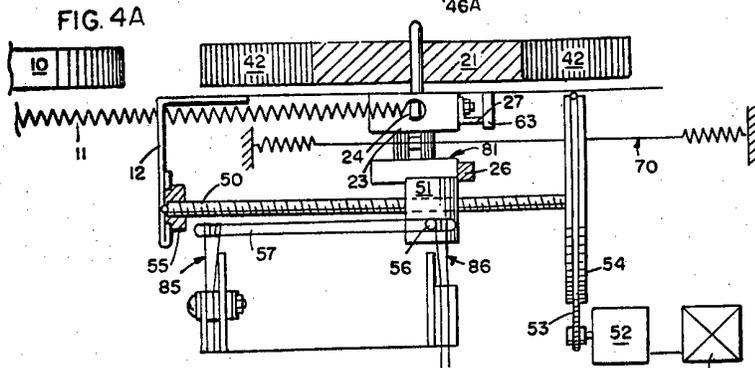
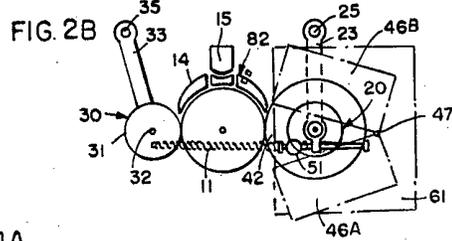
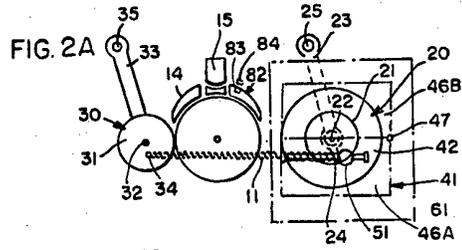
26. An apparatus according to claim 17, wherein the rewind signaling means comprises said second signaling means. 95

27. An apparatus according to claim 19, wherein the outer limit signaling means comprises a second limit switch which is engagable by said nut at the outer limit of its travel along said leadscrew away from said capstan. 100

28. An apparatus for automatically loading a tape transport mechanism, the apparatus being substantially as hereinbefore described with reference to, and as illustrated in, the accompanying drawings. 105

29. A magnetic tape record/playback apparatus comprising a tape loading apparatus as claimed in any of claims 2 to 28. 110

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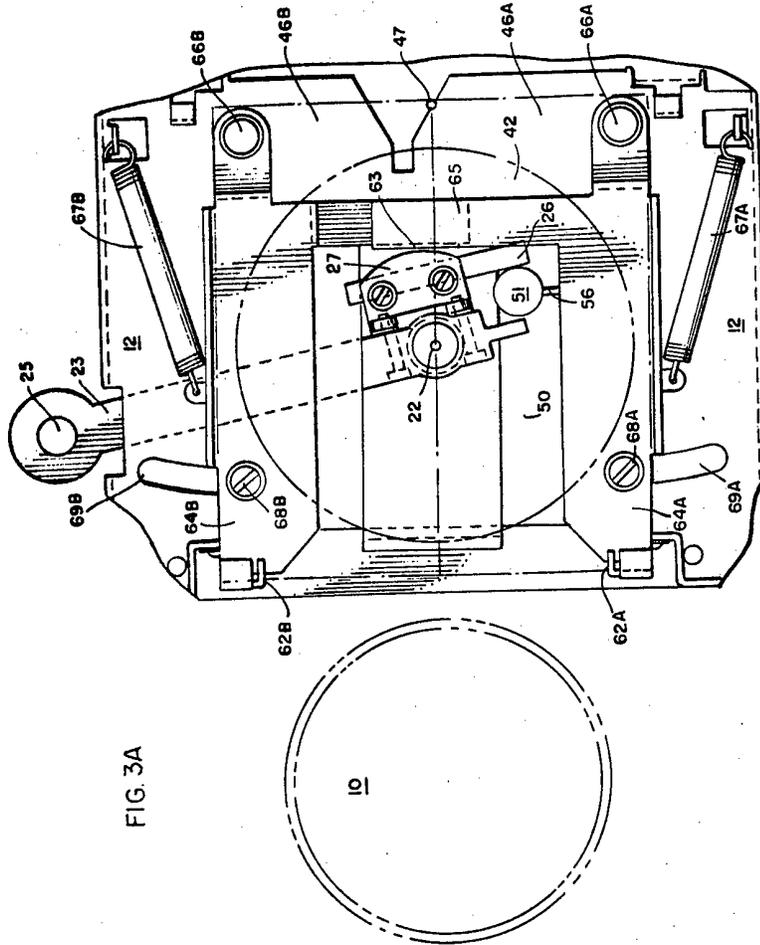


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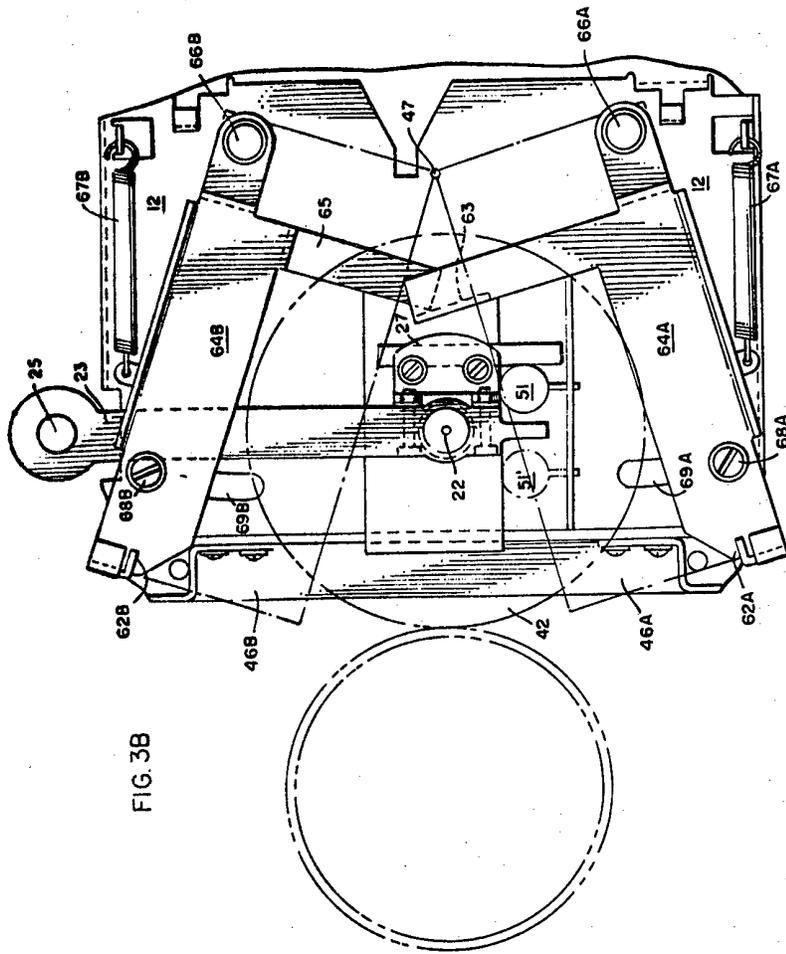


FIG. 3B

