United States Patent

Kelch

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[54] **GRAVITY FEED WITH AXIALLY MOVABLE ATTACHING MEANS**

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[52] **U.S. Cl.**.....**340/174.1 C,** 346/137

[51] **Int. Cl.**.....**G11b 3/62,** G11b 17/04

[58] **Field of Search**.....346/74 MD, 137; 274/4 H, 41.4; 340/173.1 A, 174.1 C

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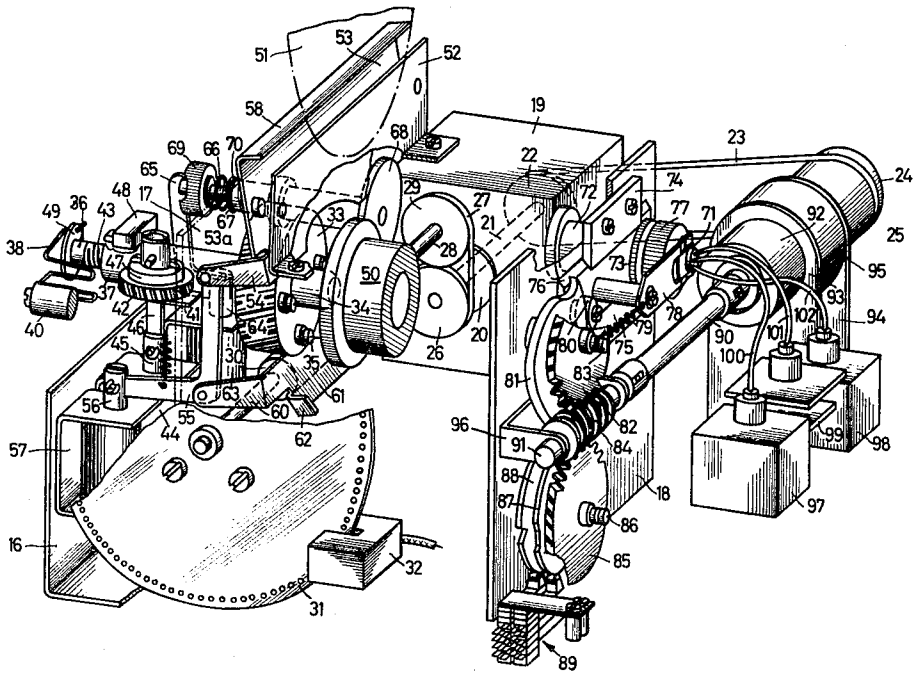
[57] **ABSTRACT**

Apparatus for reproducing information which is recorded on concentric tracks of rotary disk-shaped carriers has a continuously driven motor which can be connected with a centering and rotating device for carriers and with a carriage which shifts the reproducing head into registry with a selected track of a centered carrier. The motor drives a timer wheel for generation of synchronizing pulses which are transmitted to a revolution counter. A programming circuit which receives signals from the counter and from the reproducing head controls a unit which records the reproduced information.

13 Claims, 10 Drawing Figures



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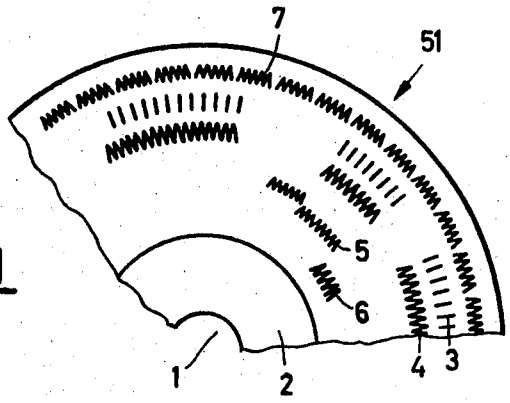

Fig.1

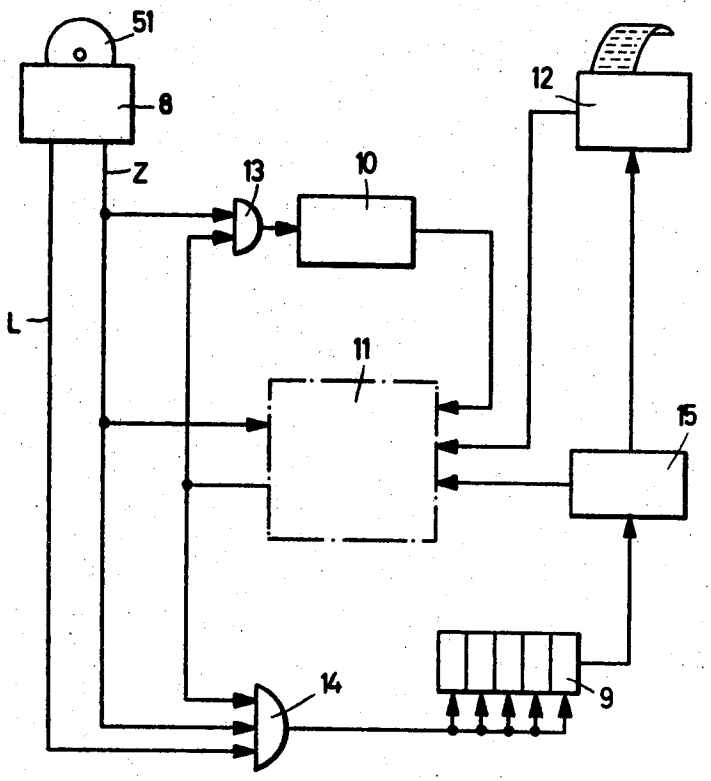

Fig.2

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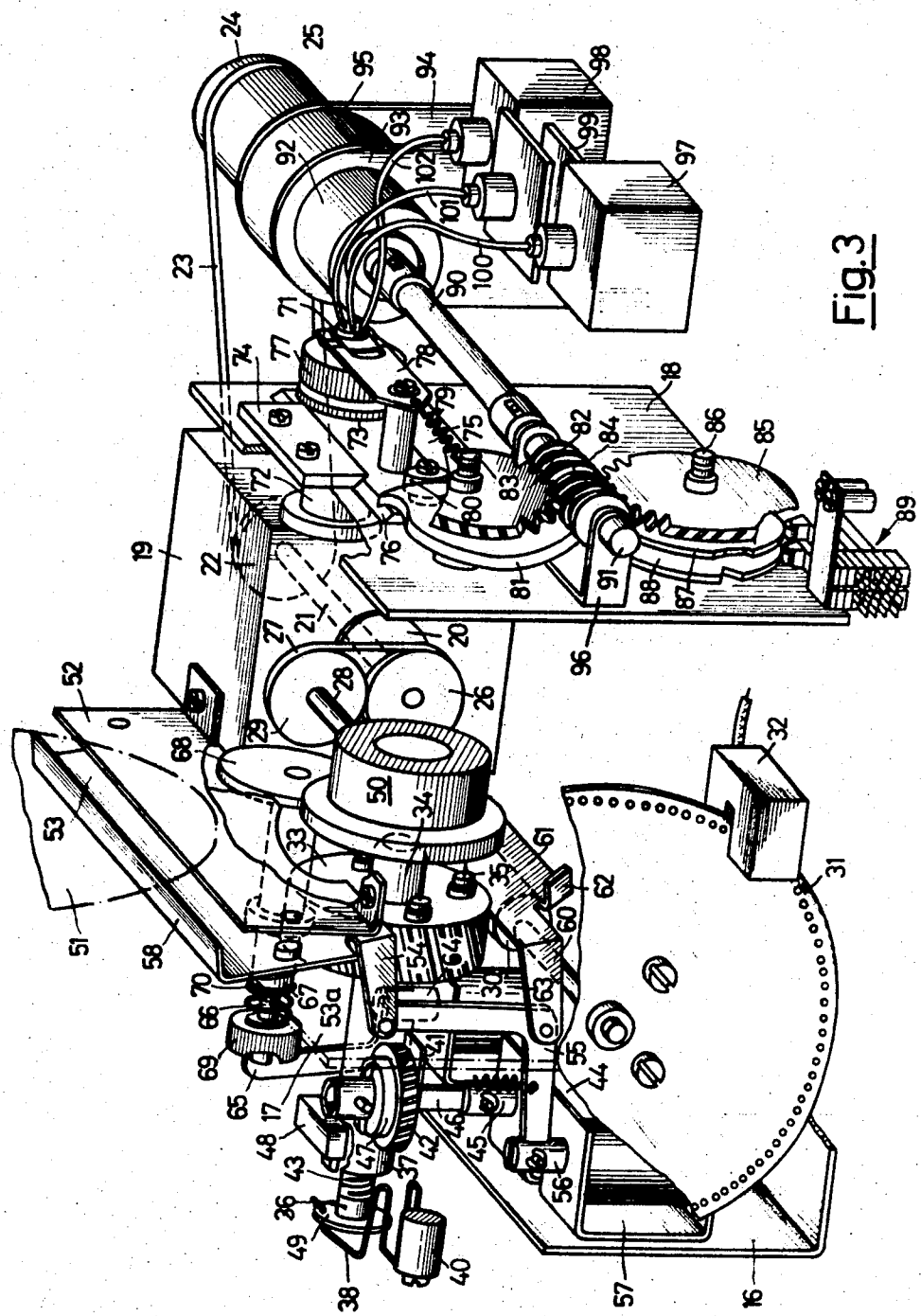

Fig.3

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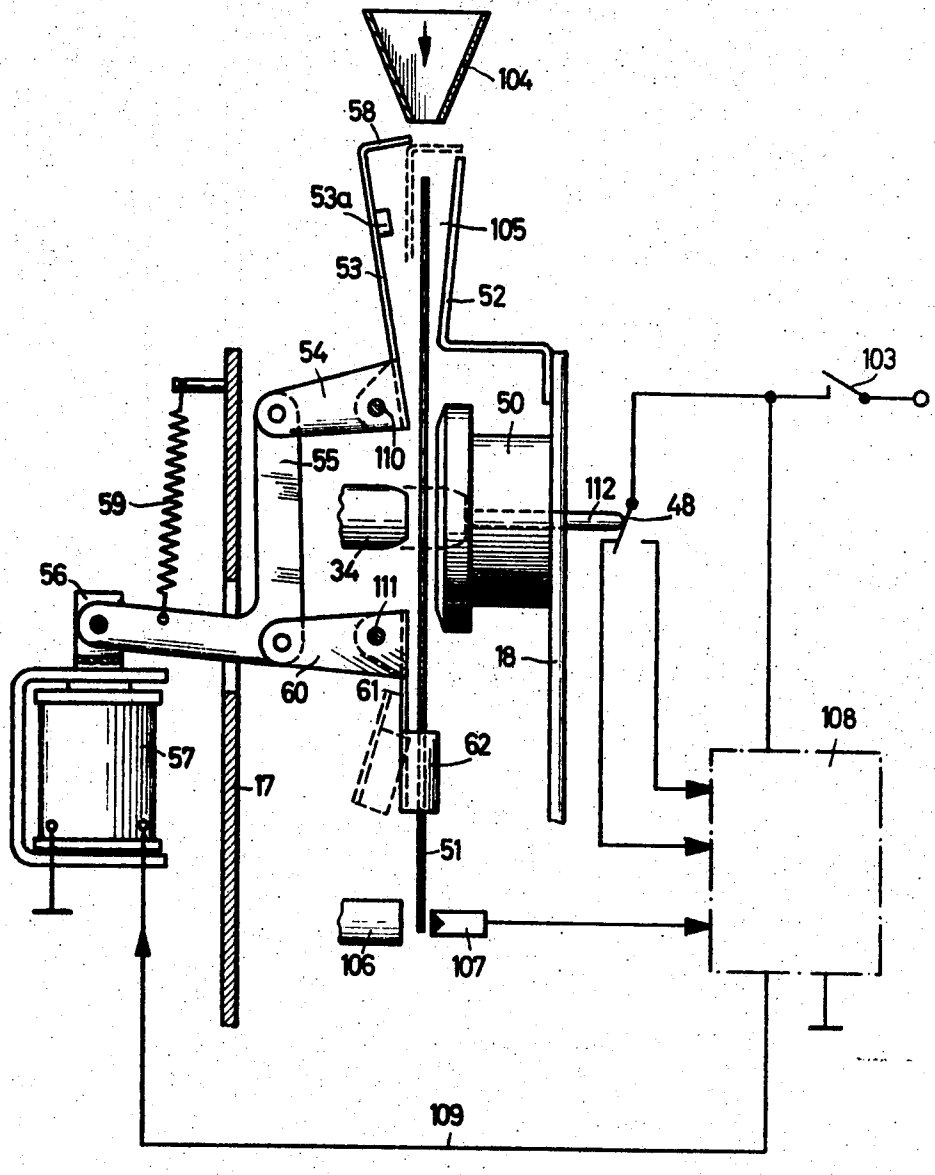

Fig.4

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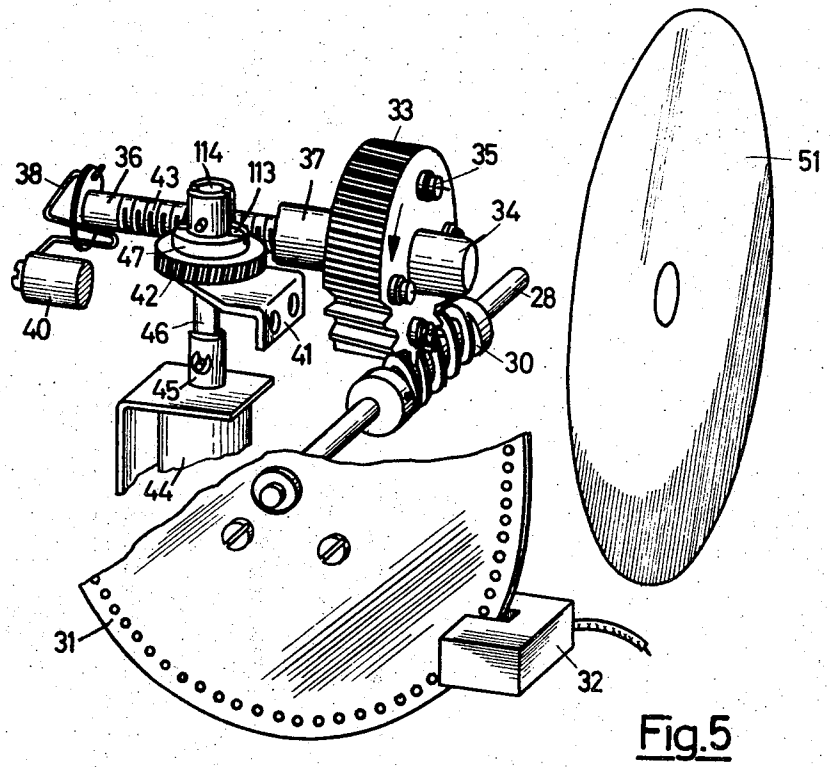

Fig.5

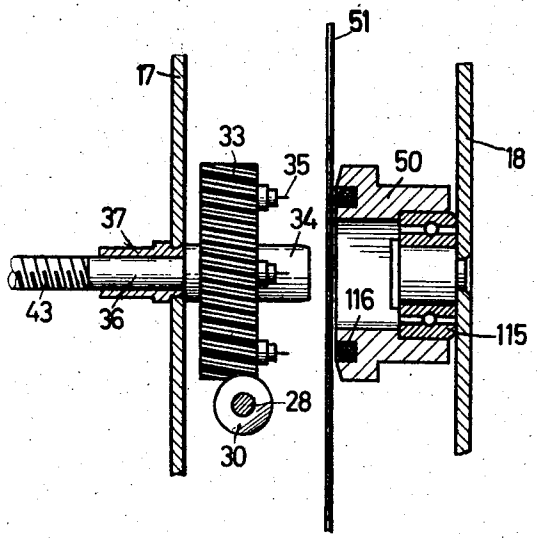

Fig.6

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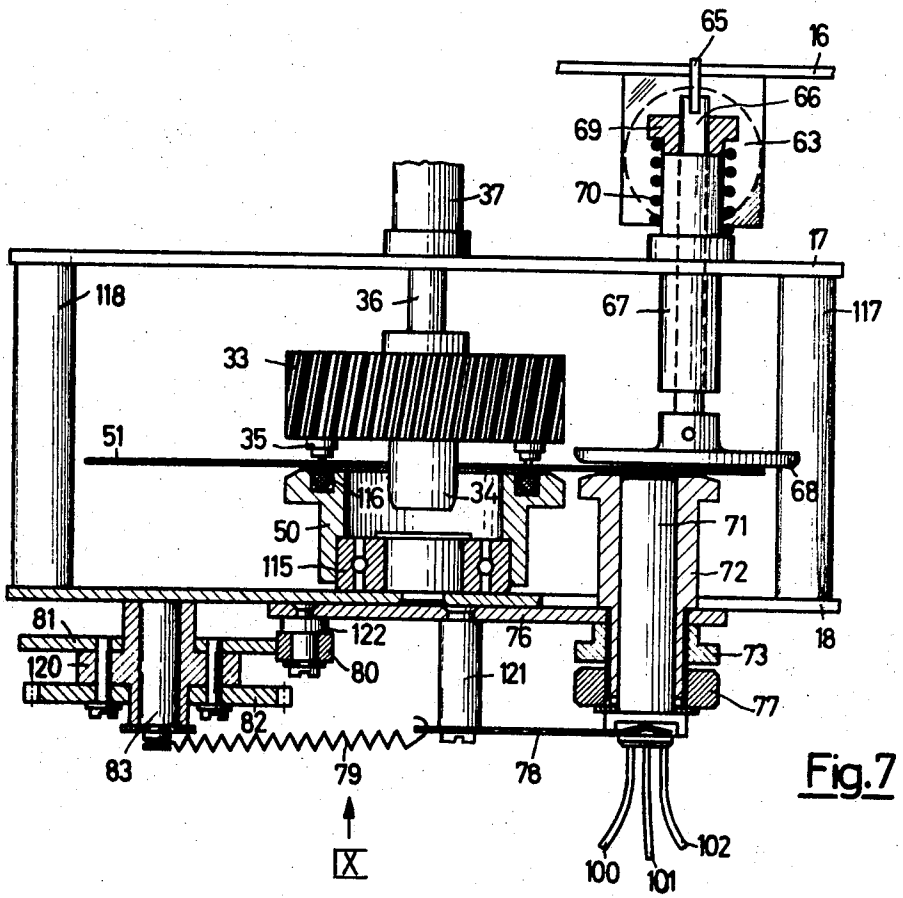

Fig.7

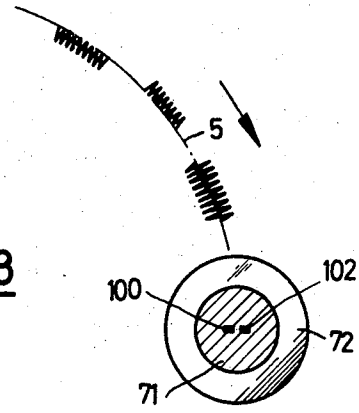

Fig.8

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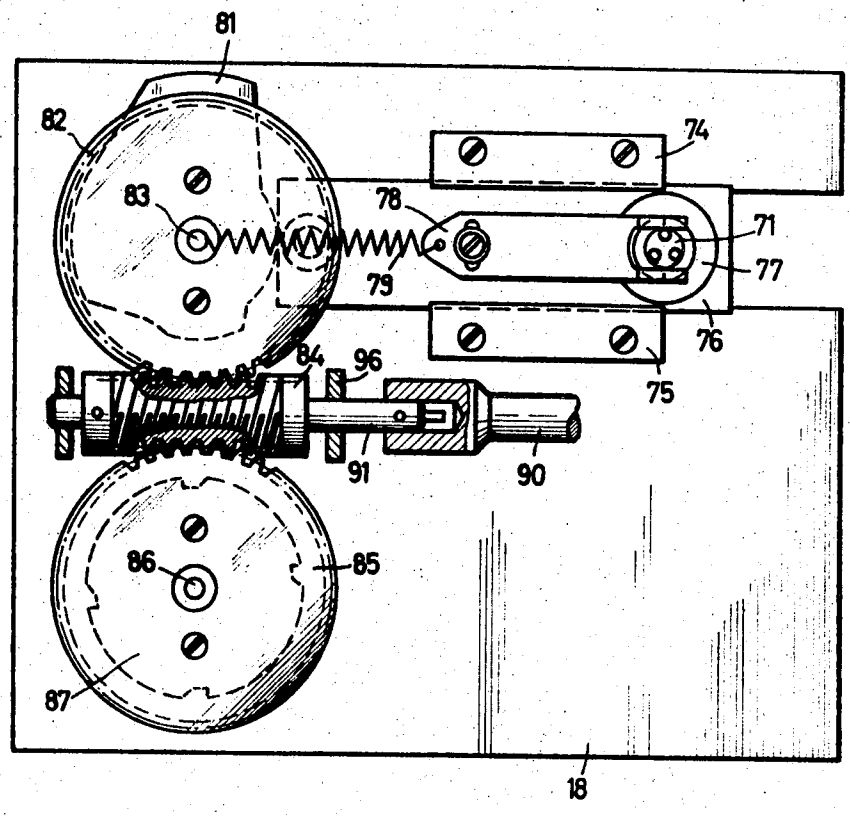

Fig.9

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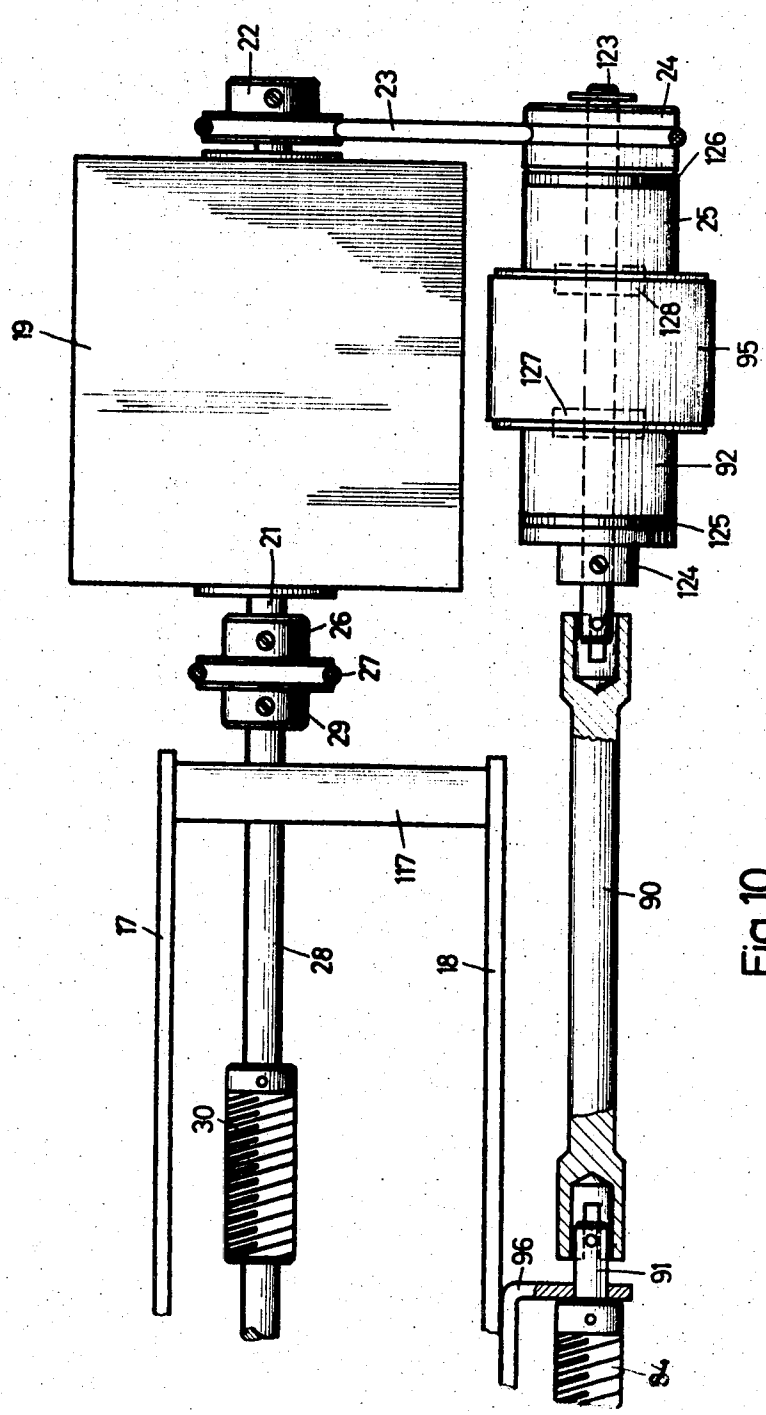

Fig.10

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GRAVITY FEED WITH AXIALLY MOVABLE ATTACHING MEANS

BACKGROUND OF THE INVENTION

The present invention relates to improvements in apparatus for automatic reading or reproduction of information which is recorded on disk-shaped carriers. More particularly, the invention relates to improvements in apparatus for the reproduction of information which is stored on one or more concentric circular tracks of rotary disk-shaped carriers.

In the mass manufacturing and/or processing of articles in modern high-speed automatic machine tools, especially in machine tools which are grouped together to form automatic production lines, optimum utilization of each machine tool can be achieved only by accurate evaluation of all factors which influence the output, the defects in parts, the periods of idleness and/or other criteria. At the present time, two basic methods are employed to collect data which are indicative of factors that affect the quantity and quality of manufactured and/or treated products. In accordance with the first of these methods, all information is transmitted to a central station where the data are recorded and evaluated for the purposes of effecting appropriate adjustments in order to increase the output, to reduce the periods of idleness, to eliminate flaws in the finish of articles and/or to effect savings in personnel. In accordance with the second method, the information is collected and evaluated at the locale of treatment, i.e., on or immediately adjacent to the monitored machine or machines. The information can be recorded on strips of paper in the form of diagrams so that it can be readily evaluated by the persons in charge.

An advantage of the second method is that it enables the persons in charge to directly evaluate the output and to immediately strive to correct any flaws, especially those which are due to human error. Thus, a conscientious workman will try to insure that the record produced by the apparatus is "clean", i.e., the recordal of information on or at the monitored machine has a desirable educational effect, and the workmen in charge have the feeling of participation in and are in a position to control the output and the quality of produced or treated parts. The method of recording the information on the spot does not create the feeling that the persons in charge are continuously spied upon by automatic monitoring equipment.

A drawback of presently known recording and reproducing apparatus which operate in accordance with the second method is that the recordal of various data necessitates the utilization of a large number of discrete carriers of information. Therefore, in order to insure proper evaluation of all data which pertain to the operation and output of a complicated automatic machine, the collected data must be evaluated at a central station. Carriers in the form of disks with one or more concentric circular tracks for the storage of information are preferred in such apparatus because they can be manipulated with greater facility than webs of paper, coils of recording wire and the like. Each track of a disk-shaped carrier can be used for recordal of a different type of information, for example, data indicating the number of articles which are produced or processed per shift, the number and duration of periods of idleness, the number and duration of periods of

operation, the number of defective articles, and/or others. When the data pertaining to the operation and output of an entire production line (which can consist of a large number of automatic machines) is to be recorded on disk-shaped carriers, the evaluation of such information (including the recordal on paper) can be carried out only by resorting to automatic reproducing apparatus. The reproduced information is thereupon used to effect changes in programming and/or to undertake other corrective measures which result in the elimination of flaws, reduction of the periods of idleness, savings in personnel, and in a higher output. The automatic reproducing apparatus reads the information which is recorded on the disk-shaped carriers and is combined with suitable automatic devices which produce a written or printed record of the information.

The record can indicate the periods of idleness in minutes, the total number of parts which are produced per minute, per hour, per shift or other unit of time, the percentage of defective parts and/or other information. The data which are collected automatically can be supplemented with those which are fed into the reproducing apparatus by hand.

It will be seen that a reproducing apparatus for the reading of information which is stored on a large number of disk-shaped carriers must satisfy a host of requirements so as to insure that the stored information can be reproduced and evaluated with requisite dispatch as well as with a high degree of accuracy. The reproduction of information necessitates a movement of disk-shaped carriers with reference to one or more reproducing heads, or vice versa. It is normally desirable to move the carriers relative to the head and to hold the head at a standstill while it scans the information on a selected track of the moving carrier. In order to reduce the periods of idleness of the reproducing apparatus, the length of intervals required for centering, acceleration, deceleration and evacuation of successive disk-shaped carriers should be reduced to a minimum. Moreover, the speed of a moving carrier must be properly synchronized with the speed of a suitable timer to thus insure that the reproduced information will indicate proper relationship between successive increments of time and the output of parts, periods of idleness or the like. In other words, the angular movement of a carrier during the interval between any two successive synchronizing pulses must correspond exactly to a given interval in the operation of the monitored machine.

Furthermore, it can happen that only one track of a particular carrier was employed for the storage of information whereas another carrier was used for storage of information on two or more of its tracks. Therefore, the reproducing apparatus should be capable of automatically insuring that all of the information on a carrier is invariably reproduced as well as to insure that no time is wasted for the scanning of tracks which are without information. In order to insure that each carrier can store a large amount of information, the tracks are preferably closely adjacent to each other so that the movement of a reproducing head must be regulated with a high degree of precision; this prevents skipping of one or more tracks during reproduction. It is clear that the reproducing apparatus can embody a substantial number of reproducing heads, one for each track of

a carrier; however, such apparatus must be provided with very complicated electronic circuits which contribute to the bulk and cost and are likely to require frequent inspection and repair.

Finally, a satisfactory reproducing apparatus should be designed in such a way that the reproduction of information which is stored on a driven carrier cannot be affected by another carrier or other carriers which are held in readiness or by the preceding carriers. Automatic operation of the reproducing apparatus necessitates the generation of signals in response to proper centering of a carrier, in response to completion of scanning of a given track, in response to completion of adjustment of the reproducing head, in response to completion of scanning of the last track on a carrier, in response to evacuation of a freshly scanned carrier, and/or in response to other stages in the manipulation of carriers. Such signals should be generated without undue delay and preferably by mechanical, optical, pneumatic, electrical electronic and/or other signal generators which are sufficiently rugged to stand continuous and prolonged use.

SUMMARY OF THE INVENTION

An object of the invention is to provide a simple, compact, reliable, rugged and inexpensive apparatus for the reproduction of information which is stored on disk-shaped carriers and to construct and assemble the apparatus in such a way that it satisfies at least the majority of the aforeenumerated requirements for an efficient and versatile reproducing apparatus.

Another object of the invention is to provide an apparatus which can reproduce the information on a single track of a carrier or on two or more tracks, wherein the information can be reproduced by resorting to a single reproducing head, which insures rapid and accurate centering of successive carriers in an optimum position for the reproduction of information on their tracks, and which can be used for reproduction of information collected in the course of the operation of a machine tool, of two or more automatic machines in a production line, of an automotive vehicle, and/or in the course of the operation of any other machine or apparatus whose operation must be monitored to raise the output, to reduce the periods of idleness, to improve the quality of products, and/or for other purposes.

The invention is embodied in an apparatus for the reading or reproduction of information which is recorded on the preferably circular tracks of rotary disk-shaped carriers. The apparatus comprises a reproducing device, such as a reproducing head, displacing means operative to move the reproducing device to a selected one of a plurality of positions in each of which the reproducing device registers with a selected track of a carrier which assumes a predetermined position, rotating means operative to engage, hold and rotate a carrier in such predetermined position with reference to the reproducing device, timer means operative to move in response to rotation of a carrier in the predetermined position and to produce synchronizing signals, and a common drive for the displacing, rotating and timer means.

The novel features which are considered as characteristic of the invention are set forth in particular in the appended claims. The improved reproducing apparatus itself, however, both as to its construction and its mode of operation, together with additional features and advantages thereof, will be best understood upon perusal of the following detailed description of certain specific embodiments with reference to the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a fragmentary plan view of a disk-shaped carrier which can be manipulated in the reproducing apparatus of the invention;

FIG. 2 is a diagrammatic view of an evaluating arrangement which includes the improved reproducing apparatus;

FIG. 3 is a perspective view of the reproducing apparatus, with certain parts shown in section;

FIG. 4 is a side elevational view of a portion of the reproducing apparatus, showing the means for guiding a carrier to and from a predetermined position with reference to the reproducing device;

FIG. 5 is a perspective view of the rotating, holding and centering means;

FIG. 6 is a fragmentary axial sectional view of the means shown in FIG. 5;

FIG. 7 illustrates the structure of FIG. 5 and the displacing means for the reproducing device;

FIG. 8 illustrates in section the reproducing device while it scans the information on a selected track of a disk-shaped carrier;

FIG. 9 is a view as seen in the direction of arrow IX in FIG. 7; and

FIG. 10 is a plan view of the common drive means for the displacing, rotating and timer means.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 illustrates a portion of a disk-shaped carrier 51 which can be manipulated in the reproducing apparatus of the present invention. The information which is recorded on the concentric circular tracks of the carrier 51 may represent intervals of time, discrete quantities, reference data and/or other information which is stored on the carrier by a suitable recording apparatus preferably an apparatus which is directly associated with the machine or machines whose operation is to be monitored.

The carrier 51 is formed with a circular central opening 1 and includes an annular portion 2 which immediately surrounds the opening 1 and serves for temporary or permanent recordal of certain information, such as the machine number(s), order number, personal data of the person(s) in charge, and/or others. The marginal portion of the carrier 51 can be provided with a printed or otherwise applied scale (not shown) whose graduations represent increments of time.

The track 3 of the carrier 51 stores information in the form of short radially extending lines each of which can represent a single workpiece or a group of workpieces which are produced, shaped or otherwise treated in the monitored machine. The track 4 stores information in the form of bars which indicate those periods of time when the machine was running or when the machine was in the process of making, shaping and/or otherwise treating plastic, metallic or other workpieces. The tracks 5, 6 serve for recordal of infor-

mation in the form of bars which indicate the nature of causes of interruption in the output of the machine. The bars on the track 5 are narrower than those on the track 6 and may include radially staggered arcuate sections. Thus, the track 5 is subdivided into two concentric tracks each of which can receive information in the form of bars whose width is preferably half the width of bars on the track 4 or 6. As stated before, the information which is stored on the tracks 5 and 6 can represent various causes for interruptions in the operation and/or output of the monitored machine.

An additional track 7 is outwardly adjacent to the track 3 and serves for storage of an interrupted bar curve. The interruption or interruptions in such curve can denote the factor for multiplication of the numerical values represented by the radial lines of the track 3 in order to arrive at the actual output of the machine.

The block diagram of FIG. 2 illustrates schematically certain components of an arrangement which employs the improved reproducing apparatus. Such arrangement serves for reading and recording the information which is stored on carriers of the type shown in FIG. 1. The numeral 8 denotes the reading or reproducing apparatus which can furnish signals to a signal storage unit 9 by way of an AND-gate 14. The apparatus 8 is further connected with a revolution counter 10 by way of another AND-gate 13. A programming unit 11 transmits signals to the AND-gates 13, 14 and receives signals from the reading apparatus 8, from the revolution counter 10, from a recording unit 12, from the storage unit 9 and from an automatically operated keyboard 15 for the unit 12. This keyboard is further connected to the signal storing unit 9 and to the recording unit 12.

The reproducing apparatus 8 comprises means for reading the information stored on a disk-shaped carrier 51, for transmitting appropriate signals to the gates 13, 14 and to the programming unit 11, and for further supplying a timing signal or synchronizing signal. The synchronizing signal can be furnished at the rate of, for example, 10 pulses per minute so that when a carrier 51 completes a full revolution within a span of 12 hours, the apparatus 8 furnishes a total of 7,200 synchronizing pulses. The AND-gate 13 has two inputs one of which is connected to the output Z of the reproducing apparatus 8. The AND-gate 14 has three inputs one of which is also connected to the output Z. The synchronizing pulses which the apparatus 8 produces are transmitted to the programming unit 11 which starts its operation as soon as another condition for starting is met. Such condition can be satisfied in response to actuation of the electrical keyboard 15 for the recording unit 12. When the programming unit 11 furnishes a signal, the AND-gates 13, 14 respectively transmit signals to the revolution counter 10 and storage unit 9. The revolution counter 10 can be constructed as a typical binary counter and serves to record signals furnished by the AND-gate 13. When it receives a total of 7,200 signals, it transmits to the programming unit 11 a signal which indicates that the carrier 51 has completed a full revolution.

When the output L of the reproducing apparatus 8 furnishes a signal to the corresponding input of the AND-gate 14 while the other inputs of the gate 14 receive signals from the output Z and from the programming unit 11, the gate 14 transmits a signal to the storage unit 9 which can be constructed in a known manner as a binary-decimal unit and totals such signals to record the reproduction time.

When the reproducing apparatus 8 reads the information on the track 3 of the carrier 51, it furnishes reading pulses which are transmitted to a further input (not shown) of the storage unit 9 in accordance with the program determined by the unit 11.

When the revolution counter 10 furnishes a signal indicating the completion of a full revolution of the carrier 51, the programming unit 11 produces a signal which initiates the transfer of information which was accumulated in the storage unit 9. At the same time, the reproducing apparatus 8 preferably moves its head into register with another track of the carrier 51. Upon completion of recordal of the information in the unit 12 (such recordal is initiated in response to a signal from the programming unit 11), the next cycle begins and is carried out in the same way as the just described cycle. The next cycle is preferably started by erasing the information which was stored during the preceding cycle, particularly the information in the storage unit 9.

The exact construction of the components 9–15 shown in FIG. 2 and/or the mode of operatively connecting such components forms no part of the present invention. The preceding description of the operation of the structure shown in FIG. 2 has been furnished for the sole purpose of facilitating the understanding of the basic design and basic operation of the arrangement which can utilize the reproducing apparatus of the present invention.

FIG. 3 illustrates the majority of elements which together constitute the reproducing apparatus 8 of FIG. 2. This apparatus comprises a frame including a base (not shown) which carries three upright supporting walls or frame members 16, 17 and 18. The base further supports a drive which includes a motor 19 serving to drive an electromagnetic clutch 25 by way of a belt transmission including a pair of pulleys 22, 24 and an endless belt 23. The pulley 22 is driven by an intermediate shaft 21 whose driver pulley 20 receives torque from the output shaft of the motor 19. However, it is equally within the purview of the invention to mount the pulley 22 directly on such output shaft. The motor 19 is preferably an electric motor.

The intermediate shaft 21 (or the output shaft of the motor 19) further drives a pulley 26 which rotates a pulley 29 by way of an endless belt 27. The pulley 29 is mounted on a drive shaft 28 which is rigidly connected with a perforated timer wheel 31 and with a worm 30. The timer wheel 31 cooperates with a photoelectric signal generator 32 which furnishes the aforementioned synchronizing pulses (for example, 7,200 pulses during each full revolution of the carrier 51).

The worm 30 meshes with a worm wheel 33 which is provided with a centering mandrel 34 and with retaining, clamping and torque transmitting projections 35 (see particularly FIGS. 5 and 6) which are pointed so that they can penetrate into and through the body of a carrier 51. The projections 35 extend from that end face of the worm wheel 33 which supports the mandrel 34; the latter serves to enter the central opening 1 of a carrier 51 when the latter assumes a predetermined position for reproduction of information on its track 3, 4, 5, 6 or 7.

The worm wheel 33 is mounted on a drive shaft or centering shaft 36 which is reciprocable in a tubular guide 37 and is biased rearwardly (to the left, as viewed in FIG. 3) by a spring 38 one end of which is anchored in a post 40 secured to the wall 17 and the other end of which engages with a disk 49 on the rear end of the centering shaft 36. The shaft 36 is provided with a worm 43 which meshes with a second worm wheel 42 mounted on a bracket 41. The tubular guide 37 is formed with a cutout or window (not shown) through which a portion of the worm wheel 42 extends to mesh with the worm 43 on the centering shaft 36. The worm wheel 42 can be braked by a braking device which includes an electromagnet 44 having a movable armature 45 supporting a shaft 46 which carries a brake disk 47 (FIG. 5) adjacent to one end face of the worm wheel 42. A suitably mounted switch 48 is located in the path of movement of the disk 49 on the centering shaft 36 and is actuated when the mandrel 34 enters the opening 1 of a carrier 51. FIG. 4 illustrates a slight modification of the manner in which the switch 48 is mounted to be actuated in response to engagement between a carrier 51 and the mandrel 34. The mandrel 34 can displace a trip 112 which then causes the movable contact of the switch 48 to move from engagement with a first fixed contact into engagement with a second fixed contact.

That side of the wall 18 which faces the wall 16 supports a cylindrical back support or anvil 50 for carriers 51.

The guide means for guiding a carrier 51 into registry with the centering mandrel 34 and back support 50 comprises two panels 52, 53 which define a compartment 105 (see FIG. 4) for reception of a carrier 51 which is dropped into a funnel 104 and is permitted to descend by gravity in a direction as indicated by the arrow. The panel 53 is pivotable with reference to the panel 52 by a structure which is shown in FIG. 3 and includes a link 54 and a bell crank lever 55 which is articulately connected with the link 54 and with the armature 56 of an electromagnet 57. The upper portion 58 of the movable panel 53 is bent forwardly toward the panel 52 to form a cover or lid which prevents entry of a fresh carrier 51 into the compartment 105 when the panel 53 assumes the broken-line position of FIG. 4. The lower arm of the bell crank lever 55 is biased by a helical spring 59 which tends to maintain the cover 58 in the operative position. The panel 53 is provided with one or more cushioning projections 53a of rubber or the like which are installed in the compartment 105 to prevent excessive deviation of a carrier 51 from a predetermined optimum position.

The bell crank lever 55 is articulately connected with an arm 60 which carries a downwardly extending intercepting gate 61 having two horizontal lugs 62 which can intercept a carrier 51 while the latter enters the compartment 105 by gravity, provided that the panel 53 is held in the solid-line (open) position of FIG. 4. When the gate 61 is pivoted to the broken-line retracted or inoperative position of FIG. 4, its lugs 62 permit a carrier 51 to leave the compartment 105 by gravity and to thus provide room for a fresh carrier which can enter as soon as the panel 53 moves to open position. The lugs 62 are preferably inclined in such a way that they intercept a descending carrier 51 in a position in which the central opening 1 of such carrier is in exact or substantial register with the mandrel 34.

The armature 64 of a further electromagnet 63 can pivot a bell crank lever 65 which carries a rod 66 guided by a sleeve 67 mounted on the wall 17. The forward end portion of the rod 66 carries a disk-shaped platform or table 68 which can move close to one side of a carrier 51 abutting against the back support 50 on the wall 18. A helical spring 70 surrounds the rod 66 and serves to urge the table 68 to retracted position. The bias of the spring 70 can be regulated by a nut 69 which serves as a retainer for the spring and meshes with an externally threaded portion of the rod 66. The forward end of the spring 70 abuts against the sleeve 67.

The table 68 is located opposite a reproducing device here shown as a head 71 which is surrounded by a protecting sleeve 72. The latter is secured by a screw 73 to a carriage 76 which forms part of the displacing means for the head 71. The carriage 76 is reciprocable in dovetailed ways 74, 75 provided on the wall 18. An adjusting screw 77 is provided to facilitate lengthwise adjustment of the reproducing head 71 in the protecting sleeve 72. A leaf spring 78 which is secured to a post on the carriage 76 serves to hold the reproducing head 71 in the selected position with reference to the protecting sleeve 72.

The carriage 76 is biased by a helical spring 79 and is provided with a roller follower 80 which tracks the face of a disk cam 81. The cam 81 is fixedly secured to a worm wheel 82 which is mounted for rotation on a shaft 83 supported by the wall 18. The worm wheel 82 is driven by a worm 84 which further meshes with a worm wheel 85 mounted for rotation on a shaft 86 of the wall 18. The worm wheel 85 is fixed to disk cams 87 and 88. These cams cooperate with a switch 89 to form therewith a position indicator for the reproducing head 71. The switch 89 can be mounted directly on the base of the machine frame. The shaft 91 of the worm 84 is driven by a connecting shaft 90 which connects the shaft 91 with the shaft 123 (FIG. 10) of the pulley 24 when the clutch 25 is engaged. An electromagnetic brake 92 is provided to act on the shaft 123 of the pulley 24; the shaft 123 is journalled in bearing plates 93, 94 of a bearing block 95. The shaft 91 of the worm 84 is journalled in a bracket or bridge member 96 which is secured to the wall 18.

The base of the frame further supports two photoelectric amplifiers 97, 98 and a light source 99. Light-conducting cables 100, 101, 102 connect the reproducing head 71 with the amplifier 97, light source 99 and amplifier 98.

The operation of various portions of the reproducing apparatus 8 will now be described with reference to FIGS. 4 to 10. The reproducing head 71 produces a single signal or a series of signals when it registers with the track 3 of a carrier 51 which is centered by the mandrel 34 and abuts against the back support 50. The photoelectric signal generator 32 produces a synchronizing pulse whenever it registers with a perforation of the timer disk 31. A further signal is produced when a record carrier 51 drops into the compartment 105; such signal is employed to start the centering operation whose termination is indicated by still another signal which is transmitted to the control circuit 108 of the apparatus. The thus transmitted signal effects the generation of a signal which results in clos-

ing of the top of the compartment **105** by the lid **58** of the panel **53** and in opening of the bottom of the compartment **105** (by the lugs **62** of the gate **61**). At the same time, the table **68** is caused to move forwardly close to a portion of the carrier **51** in the compartment **105**. When the reproduction of information on the track **3** is completed, i.e., after the carrier **51** completes a full revolution, the reproducing head **71** is caused to move into registry with another track of the carrier whereby the switch **89** produces a signal which indicates the new position of the head **71**. The just described sequence of signals insures a fully automatic operation of the apparatus during reproduction of the information which is stored on the tracks of a carrier **51** or a series of successively scanned carriers.

The means for receiving carriers **51** in predetermined positions for reproduction of the information which is stored on the tracks of such carriers includes the aforedescribed parts such as the panels **52, 53**. A master switch **103** which is shown in FIG. **4** must be closed in order to start the operation of the reproducing apparatus. When a fresh carrier **51** is thereupon dropped into the funnel **104**, such carrier descends into the compartment **105** between the panels **52, 53** and comes to rest on the lugs **62** of the gate **61** adjacent to the back support **50**. The lowermost portion of the carrier **51** moves into the gap between a photoelectric receiver **107** and a light source **106** (FIG. **4**) whereby the receiver **107** generates a signal which is transmitted to the control circuit **108**. Such signal indicates that a carrier **51** is located in the compartment **105**. The circuit **108** then energizes the electromagnet **44** which starts the centering of the carrier **51** in the compartment **105** with the result that the disk **49** or the trip **112** actuates the switch **48**. The arrangement is such that the movable contact of the switch **48** assumes the position of FIG. **4** when the centering mandrel **34** is retracted and that such movable contact engages the right-hand fixed contact when the mandrel **34** enters the central opening **1** of the carrier **51** and its projections **35** penetrate through such carrier to thereupon enter a soft ring **116** (FIG. **6**) in the back support **50**. The thus actuated switch **48** transmits to the control circuit **108** a signal which indicates that the carrier **51** is properly centered, i.e., that it is held by the needle-like torque transmitting projections **35**, back support **50** and centering mandrel **34**. The control circuit **108** transmits to the electromagnet **57** a signal by way of conductor means **109** (shown in FIG. **4**); such signal results in deenergization of the electromagnet **57** whereby the spring **59** is free to pivot the bell crank lever **55** to move the lid **58** of the pivotable panel **53** to closed position and to move the intercepting gate **61** to inoperative position. The panel **53** is pivotable on a fixed pintle **110** and the gate **61** is pivotable on a second fixed pintle **111**. The inlet at the upper end of the compartment **105** is then closed and the outlet at the lower end of the compartment **105** is open so that the carrier **51** can leave such compartment as soon as the centering means is moved to retracted position.

When the reproduction of information on one or more tracks of the carrier **51** in the compartment **105** is completed so that the carrier is to be removed from its predetermined position, the control circuit **108** transmits a signal which results in retraction of the centering mandrel **34** and in return movement of movable contact of the switch **48** to the position shown in FIG. **4**. The electromagnet **57** is energized with a certain delay following such actuation of the switch **48**, namely, when the descending carrier **51** moves downwardly and beyond the gap between the photoelectric receiver **107** and light source **106**. Energization of the electromagnet **57** results in movement of the panel **53** and lid **58** to open positions and in movement of the intercepting gate **61** to operative position; the compartment **105** is then ready to accommodate a fresh carrier **51** which must be admitted by way of the funnel **104** and the inlet at the upper ends of the panels **52, 53**.

The centering and clamping operation is carried out as follows:

When the master switch **103** (FIG. **4**) is closed, the motor **19** is started and rotates the shaft **28** by way of the shaft **21**, pulleys **26, 29** and belt **27**. The shaft **28** drives the worm **30** which rotates the worm wheel **33** and the timing wheel **31** so that the generator **32** produces a sequence of synchronizing pulses. The worm wheel **33** rotates the centering shaft **36** (FIG. **5**). As explained above in connection with FIG. **4**, a carrier **51** in the compartment **105** interrupts the light beam between the light source **106** and photoelectric receiver **107** so that the control circuit **108** energizes the electromagnet **44** which attracts the armature **45** and shaft **46** for the brake disk **47**. The latter supports a pressure transmitting member **113** and is provided with a groove into which a portion of the member **113** extends. The member **113** thereby urges the brake disc **47** (or a washer between the parts **42, 47**) against the worm wheel **42** which is rotatable on a shaft **114** of the bracket **41**. The worm wheel **42** is then urged against the bracket **41** (or against a washer between the parts **41, 42**) and opposes rotation of the worm **43** on the centering shaft **36**. Normally, the worm wheel **42** is at a complete standstill when the electromagnet **44** is energized. However, the shaft **36** is driven by the worm wheel **33** so that the rotating worm **43** cooperates with the arrested worm wheel **42** to effect axial movement of the shaft **36** and centering mandrel **34** toward the back support **50**. As shown in FIGS. **5** and **6**, the axial length of the worm wheel **33** is such that it remains in mesh with the worm **30** in each axial position of the shaft **36**; therefore, the worm wheel **33** is designed as a spiral or helical gear which is capable of receiving torque from the worm **30** while it shares the axial movement of the shaft **36** and worm **43**.

During the initial stage of axial movement of the shaft **36** against the opposition of the spring **38**, the mandrel **34** enters the opening **1** of a carrier **51** in the compartment **105** whereupon the projections **35** penetrate into and through the body of the carrier. The latter is pressed against the revolving back support **50** which is mounted in an antifriction bearing **115** in the wall **18**. The tips of the projections **35** penetrate into the elastic ring **116** of the back support **50** when the shaft **36** reaches its foremost position. The back support **50** is rotated by the carrier **51** and projections **35**. Thus, the worm wheel **33** drives the carrier **51** in synchronism with the times wheel **31** because the worm **30** on the shaft **28** of the wheel **31** drives the centering shaft **36**. The resistance which the back support **50** then offers to further forward movement of the shaft **36**

rises to such a value that the worm wheel **42** is caused to rotate in response to continued rotation of the worm **43** while the shaft **36** is held against further axial movement toward the wall **18**. The stresses which arise are taken up mainly by the bearing **115** in the wall **18**. The worm wheel **42** rotates by overcoming the braking action of the electromagnet **44**. When the reproduction of information on the carrier **51** is terminated, the control circuit **108** deenergizes the electromagnet **44** so that the worm wheel **42** is free to rotate on the shaft **114**. The spring **38** is then free to return the shaft **36** to its retracted position whereby the mandrel **34** leaves the opening **1** and the projections **35** are withdrawn from the body of the carrier **51** which descends along the opened gate **61**.

An important advantage of the braking electromagnet **44** is that it continuously produces a braking force which acts on the shaft **36** and thus insures exceptionally accurate synchronization between the rotary movements of the carrier **51** and timer wheel **31**.

The movements of the reproducing head **71** are controlled as follows: As shown in FIG. 7, the guide sleeve **67** for the rod **66** of the table **68** is mounted on the wall **17** which is connected to the wall **18** by distancing bolts **117 118**. The electromagnet **63** can remain energized during centering and clamping of a carrier **51** in the compartment **105** or is energized in response to actuation of the switch **48** by the disk **49** or trip **112**. When energized, the electromagnet **63** causes the armature **64** to pivot the lever **65** which pushes the rod **66** against the opposition of the spring **70** so that the table **68** moves directly behind the centered carrier **51** opposite the reproducing head **71**. The width of the gap between the protecting sleeve **72** and the table **68** is then just sufficient to permit scanning of recorded information by the head **71**. The carriage **76** can move the sleeve **72** and the head **71** substantially radially of the carrier **51** on the centering mandrel **34** so that the head **71** can move into registry with a selected track on the carrier. The diameter of the table **68** is such that it remains in register with the protecting sleeve **72** in each position of the head **71**, i.e., regardless of whether the head is in line with the inner-most or with the outermost track of the carrier **51** on the mandrel **34**.

For example, let it be assumed that, at the start of a tracking operation, the head **71** is in line with the rightmost portion of the table **68**, as viewed in FIG. 7. The head **71** is then ready to track the outermost groove (see the groove **7** in FIG. 1). Once the tracking of the outermost groove is completed, the control circuit **108** produces a signal which causes the carriage **76** to move along the ways **74, 75** and to thus shift the sleeve **72** which is secured to the carriage by the nut **73**. For example, the carriage **76** can move the head **71** into registry with the next-to-the-outermost track on the carrier **51** which is centered by the mandrel **34**. Shifting of the carriage **76** is effected in response to energization of the clutch **25** which then drives the shaft **91** for the worm **84** which rotates the worm wheel **82** and cam **81**. The latter is tracked by the roller follower **80** of the carriage **76**. The connection between the worm wheel **82** and cam **81** comprises a cylindrical holder **120** (FIG. 7) which is rotatable on the shaft **83** of the wall **18**. The spring **79** is connected to the shaft **83** and to the leaf spring **78** which is mounted on a post **121** of the carriage **76**; therefore, the spring **79** pulls the roller follower **80** against the cam **81** (see also FIG. **9**). The shaft for the roller follower **80** is shown at **122**.

The transitions between the lobes and valleys of the cam **81** are preferably gradual (for example, sinusoidal) to avoid excessive acceleration of the carriage **76**; such acceleration could result in damage to the sensitive light transmitting cables **100–102**.

When the worm **84** drives the worm wheel **82**, it also rotates the worm wheel **85** and the cams **87, 88**. These cams then actuate the switch **89** which furnishes a signal indicating the new position of the head **71** with reference to the carrier **51**. The control circuit **108** evaluates such signal and disengages the clutch **25** if the new position of the head **71** corresponds to the preselected program or the circuit **108** continues to energize the clutch **25** if the head **71** is to move into registry with another track of the carrier.

FIG. **8** shows the reproducing head **71** in registry with the track **5** of a carrier on the centering mandrel **34**. As shown, the track **5** stores information which is indicative of three different causes of interruption in the operation of the monitored machine. The arrow indicates the direction of rotation of the carrier. The information on the track **5** is tracked by the terminals of the cables **100** and **102**. The cable **101** furnishes light which effect uniform illumination of both terminals. The cables **100, 102** convey to the photo-sensitive receivers **97** and **98** light which is reflected on the information in the track **5**.

The drive means:

As explained above, the drive means comprises a single motor **19** which moves all rotary parts of the reproducing apparatus **8**. This motor is started in response to closing of the master switch **103** and rotates continuously as long as the switch **103** remains closed. The motor **19** then drives the timer wheel **31** by way of the shaft **28** whereby the worm **30** drives the centering shaft **36**. When the clutch **25** is deenergized, the pulley **24** rotates on the shaft **123** (FIG. **10**) which carries a flange **124** and the armature **125** of the braking electromagnet **92** which is continuously energized so that its armature **125** cooperates with the flange **124** to hold the shaft **123** against rotation with the pulley **24**.

When the control circuit **108** furnishes a signal which results in a change of the position of the reproducing head **71** with reference to a carrier **51** on the centering mandrel **34**, the electromagnet **92** is deenergized and the clutch **25** is energized at the same time so that the armature **126** of the clutch **25** couples the shaft **123** with the pulley **24**. The shaft **123** is rotatable in antifriction bearings **127** and **128** which are mounted in the bearing block **95**. When the clutch **25** is energized, the shaft **123** receives torque from the pulley **24** and drives the shaft **90** and worm **84** to effect an adjustment in the position of the reproducing head **71** in a manner as described in connection with FIGS. **8** and **9**. The clutch **25** is deenergized in response to a signal from the switch **89** when the carriage **76** reaches the new position. At the same time, the control circuit **108** energizes the electromagnetic brake **92** which immediately arrests and holds the shafts **123, 90** against further rotation.

An important advantage of the improved reproducing apparatus is that the aforedescribed operations can be carried out by resorting to simple and compact mechanisms. Also, a fresh carrier **51** can be readily introduced into the apparatus, merely by dropping it into the Funnel **104**, whereupon the carrier is automatically centered, clamped, held rotated in synchronism with the times wheel **31**. The fact that the apparatus **8** is in the process of reproducing the information on the track or tracks of a properly centered carrier **51** can be immediately noted because the lid **58** of the movable panel **53** closes the upper end of the compartment **105** when the latter contains a carrier. This reduces the likelihood of improper manipulation of the apparatus and eventual damage to its parts and/or a carrier in the compartment **105**. Still another advantage of the reproducing apparatus is that the rotation of a carrier **51** on the centering mandrel **34** is automatically synchronized with rotation of the timer wheel **31**; this is achieved by the braking device including the electromagnet **44** and worm wheel **43**. The table **68** cooperates with the protecting sleeve **72** to eliminate undue clearance for that portion of the carrier **51** on the mandrel **34** which is adjacent to the reproducing head **71** and the projections **35** prevent wobbling of the carrier with reference to the centering means. The mass of the revolving parts of the centering means is small so that the clamping and releasing operations can be completed within short intervals of time. The same applies for the mass of the displacing means which move the reproducing head **71** with reference to the wall **18** so as to place it into register with a selected track of a carrier on the mandrel **34**. All this enables the apparatus to reproduce the information on a selected carrier within short periods of time so that the apparatus can receive and discharge a large number of carriers per unit of time.

It is clear that the improved reproducing apparatus is susceptible of many additional modifications without departing from the spirit of the present invention. For example, the apparatus can accept and manipulate disk-shaped carriers for any kind of information, i.e., not necessarily for information pertaining to the output and other characteristics of automatic machine tools. Thus, each carrier **51** can store information pertaining to the operation of an automotive vehicle or any other information. At least some such information is preferably recorded in the form of bars so that it can be readily observed with the naked eye. The construction of the electronic control circuit **108** and of the circuitry in the arrangement shown in FIG. **2** depends on the nature of information which is stored on the carriers, on the desired outlay for electronic components, and on the intended use of the reproduced information.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can, by applying current knowledge, readily adapt it for various applications without omitting features which fairly constitute essential characteristics of the generic and specific aspects of my contribution to the art and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the claims.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended.

I claim:

1. Automatic attaching and driving apparatus for rotary record carriers, comprising, in combination, a rotary support for a record carrier, mounted for free rotation about an axis and non-movable in axial direction; guide means for guiding a record carrier to a predetermined position directly adjacent said rotary support in which the carrier is substantially coaxial with said support, rotary attaching and driving means located on the side of said guide means remote from said rotary support and being coaxial with said rotary support, said rotary attaching and driving means being mounted for movement in the direction of said axis between an inoperative position axially spaced from said record carrier and said rotary support, and an operative position attaching said record carrier to said rotary support for rotation therewith, so that said rotary freely rotatable support, and said record carrier are rotated by said rotary attaching and driving means; sensing means for generating a signal when a record carrier is in said predetermined position; and control means responsive to a signal generated by said sensing means to move said rotary attaching and driving means to said operative position so that the record carrier in said predetermined position is attached to said rotary support and rotated with said rotary support.

2. Automatic attaching and driving apparatus for rotary record carriers, comprising a rotary support nonmovable in axial direction; guide means for guiding a carrier to a predetermined position adjacent said rotary support and substantially concentric with said rotary support; sensing means generating a signal when sensing a carrier in said predetermined position; driven rotary attaching means movable in the axial direction of said rotary support between an inoperative position, and an operative position attaching said carrier to said rotary support for rotation therewith, said driven rotary attaching means including a shaft having worm thread; and control means responsive to a signal generated by said sensing means to move said driven rotary attaching means to said operative position so that said carrier is attached to said support and rotated, said control means including an electromagnet controlled by said signal of said sensing means, a worm gear meshing with said worm thread, and friction brake means actuated by said electromagnet for braking said worm gear so that said worm thread with said shaft and said driven rotary attaching means moves to said operative position until said rotary support resist further axial movement of said rotary driven attaching means so that said friction brake means slips.

3. Automatic attaching and driving apparatus for rotary record carriers, comprising a rotary support nonmovable in axial direction; guide means for guiding a carrier to a predetermined position adjacent said rotary support and substantially concentric with said rotary support; a compartment in which said carrier is held in said predetermined position by said guide means, said compartment having an inlet; closure means for closing said inlet; a spring-biased electromagnet for operating said closure means; said guide means being movable between a normal position for holding said carrier in said predetermined position and a releasing position in which said carrier drops out of said predetermined position; said actuated electromagnet effecting movement of said guide means to said releasing position; sensing means generating a signal when sensing a carri-

er in said predetermined position, said sensing means controlling said electromagnet to open said closure means and to move said guide means to said normal position when a carrier has dropped out of said predetermined position; driven rotary attaching means movable in axial direction of said rotary support between an inoperative position, and an operative position attaching said carrier to said rotary support for rotation therewith; and control means responsive to a signal generated by said sensing means to move said driven rotary attaching means to said operative position so that said carrier is attached to said support and rotated, said control means including a switch actuated by said driven rotary attaching means during movement to said operative position, said spring biased electromagnet being actuated by said switch.

4. Apparatus for the reproduction of information which is recorded on the tracks of rotary disk-shaped carriers, comprising a reproducing device; displacing means operative to move said reproducing device to a selected one of a plurality of positions in each of which the reproducing device registers with a different track of a carrier which assumes a predetermined position; timer means operative to produce synchronizing pulses; rotating means operative to center, clamp, and rotate a carrier in such predetermined position and including a centering shaft driven by said drive means, a centering mandrel provided on said shaft and movable therewith into centering engagement with a carrier in said predetermined position, and torque transmitting means provided on said shaft and movable into torque transmitting engagement with a carrier in said predetermined position, and further comprising a braking device for said shaft, and control means for activating said braking device in response to movement of a carrier to said predetermined position; and common drive means for said displacing, rotating, and timer means.

5. Apparatus for the reproduction of information which is recorded on the tracks of rotary disk-shaped carriers, comprising a reproducing device; displacing means operative to move said reproducing device to a selected one of a plurality of positions in each of which the reproducing device registers with a different track of a carrier which assumes a predetermined position; timer means operative to produce synchronizing pulses; rotating means operative to center, clamp and rotate a carrier in such predetermined position; common drive means for said displacing, rotating, and timer means; guide means defining a compartment for a carrier in said predetermined position, said guide means comprising a portion movable between open and closed positions to respectively permit and prevent admission of carriers into said compartment; means for moving the movable portion of said guide means to said closed position in response to transmission of said signals to said control means; said guide means comprising means for intercepting a carrier which is admitted into said compartment in the open position of said movable portion so that the thus intercepted carrier registers with said rotating means; first signal responsive control means for connecting said rotating and displacing means with said drive means, and means for transmitting to said control means signals when a carrier assumes said predetermined position; and second signal generating means operative to move the movable portion of said guide means to said closed position to render said intercepting means inoperative in response to operation of said rotating means.

6. Apparatus for the reproduction of information which is recorded on the tracks of rotary disk-shaped carriers, comprising a reproducing device; displacing means operative to move said reproducing device to a selected one of a plurality of positions in each of which the reproducing device registers with a different track of a carrier which assumes a predetermined position; timer means operative to produce synchronizing pulses; rotating means operative to center, clamp and rotate a carrier in said predetermined position, said rotating means comprising a centering shaft driven by said drive means, a centering mandrel provided on said shaft and movable therewith into centering engagement with a carrier in said predetermined position, and torque transmitting means provided on said shaft and movable into torque transmitting engagement with a carrier in said predetermined position, and further comprising a braking device for said shaft, said shaft being provided with a worm and said braking device comprising a worm wheel in mesh with said worm and means activatable to oppose the rotation of said worm wheel in response to rotation of said shaft; and common drive means for said displacing, rotating, and timer means.

7. Apparatus as defined in claim 6, wherein said shaft is arranged to move axially in response to braking of said worm wheel and further comprising a rotary back support against which a carrier in said predetermined position is urged by said torque transmitting means in response to axial movement of said shaft.

8. Apparatus as defined in claim 7, further comprising biasing means which opposes the axial movement of said shaft in response to braking of said worm wheel.

9. Automatic attaching and driving apparatus for rotary record carriers, comprising a rotary support nonmovable in axial direction; guide means for guiding a carrier to a predetermined position adjacent said rotary support and substantially concentric with said rotary support; sensing means generating a signal when sensing a carrier in said predetermined position; driven rotary attaching means movable in axial direction of said rotary support between an inoperative position and an operative position attaching said carrier to said rotary support for rotation therewith; and control means responsive to a signal generated by said sensing means to move said driven rotary attaching means to said operative position so that said carrier is attached to said support and rotated, said control means including means biasing said driven rotary attaching means to said inoperative position, and an electromagnet controlled by said signal of said sensing means, and a mechanism actuated by said electromagnet and including threaded means for moving said driven rotary attaching means in axial direction to said operative position during rotation of said driven rotary attaching means.

10. Apparatus as claimed in claim 9 wherein said control means include a switch actuated by said driven rotary attaching means during movement to said operative position; and comprising a compartment in which said carrier is held in said predetermined position by

said guide means, said compartment having an inlet; closure means for closing said inlet; and a spring biased electromagnet for operating said closure means and being actuated by said switch.

11. Apparatus as claimed in claim 9 wherein said sensing means include photoelectric means.

12. Apparatus as claimed in claim 9 wherein said driven rotary attaching means includes a plurality of needle projections penetrating said carrier in said operative position, and a centering mandrel for engaging a central opening in said rotary support.

13. Apparatus as claimed in claim 12 wherein said support includes a soft portion into which said penetrating needle projections enter.

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