United States Patent

[11] 3,612,776

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[54] **RADIO CARTRIDGE WITH AUTOMATIC TUNING DEVICE FOR USE WITH MAGNETIC TAPE CARTRIDGE PLAYER**
9 Claims, 14 Drawing Figs.

[52] **U.S. Cl.** **179/100.11,** 325/471, 334/24
[51] **Int. Cl.** **G11b 31/00,** H04b 1/32, H03j 3/00
[50] **Field of Search** 179/100.11; 334/18, 20, 24, 25, 39; 325/471

[56] **References Cited**

UNITED STATES PATENTS

2,662,975	12/1953	Schwartz	179/100.11 X
2,880,311	3/1959	Bray	325/471
2,081,752	5/1937	Linsell	179/100.11
3,536,859	10/1970	Tolar	179/100.11

OTHER REFERENCES

Billboard, 22 Apr. 1967, pp. 70–71.

Primary Examiner—Bernard Konick
Assistant Examiner—Raymond F. Cardillo, Jr.
Attorney—Jacobs & Jacobs

ABSTRACT: A radio cartridge with a radio receiving circuit for use with a player unit for an endless magnetic tape cartridge. The radio cartridge includes a lever rotatably mounted within a casing, and a pinch roller rotatably mounted on the lever. The pinch roller is moved by the swingable lever to abut against a capstan which is provided within the player unit, and is rotated by the capstan. Rotation of the pinch roller is imparted to an operating shaft of a tuning element in the radio receiving circuit to vary the radio receiving frequency. The lever is swung in such a direction to move the pinch roller away from the capstan when the radio is tuned to the radio wave so that rotation of the operating shaft is terminated and the radio is automatically tuned.

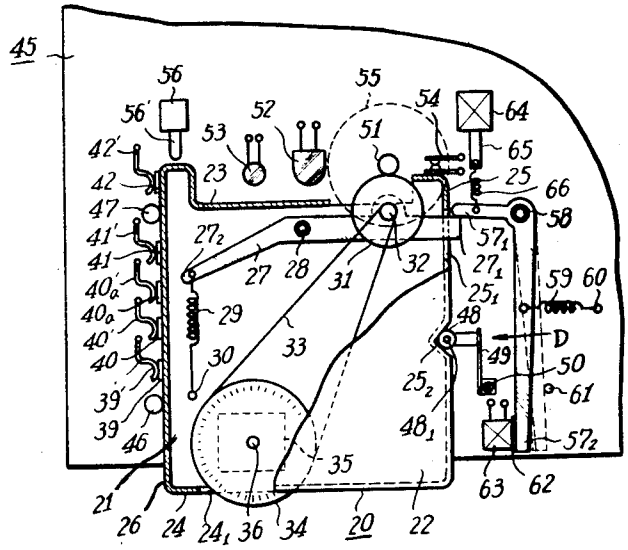
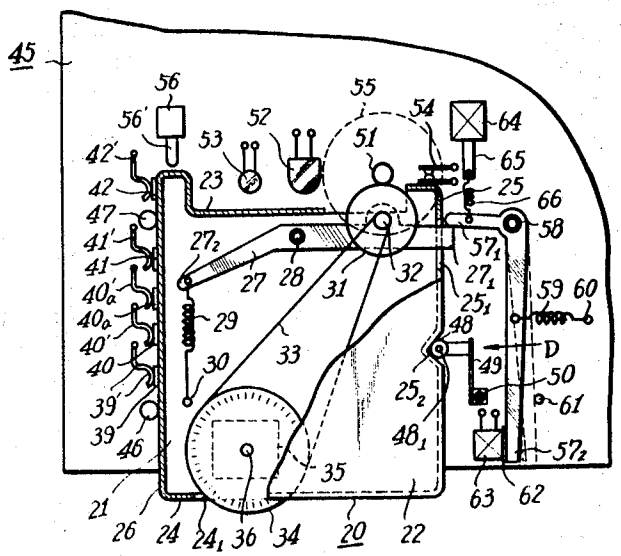


FIG. 1



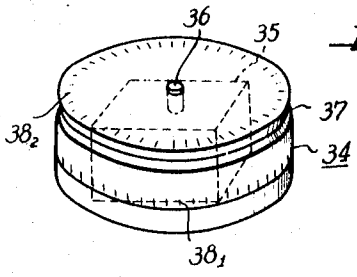


FIG. C

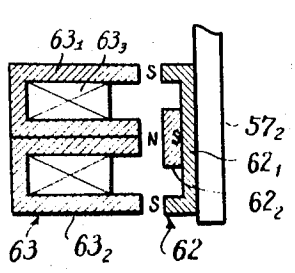


FIG. 3a

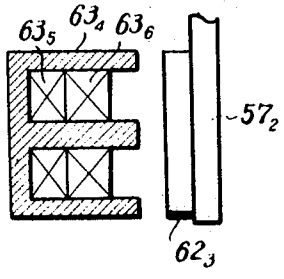


FIG. 3b

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Fig. 4

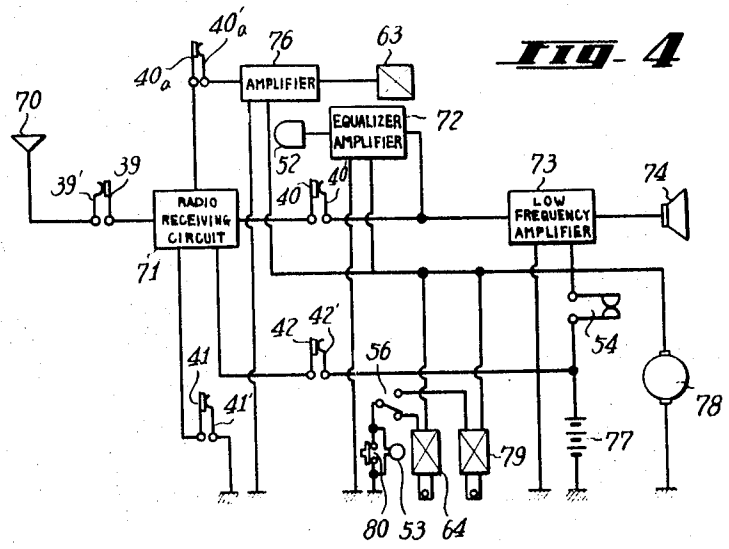
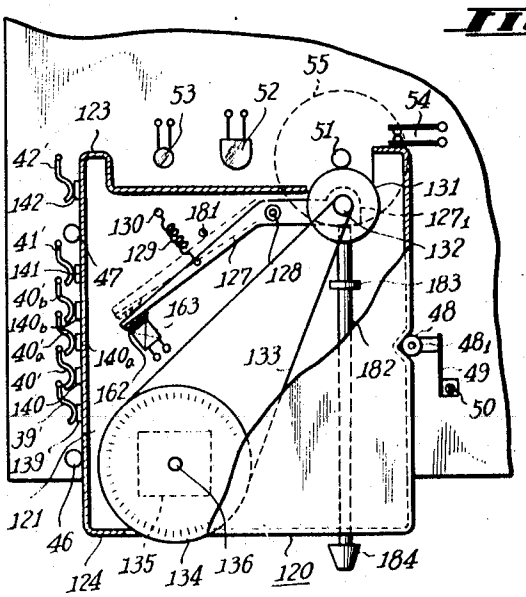


Fig. 5



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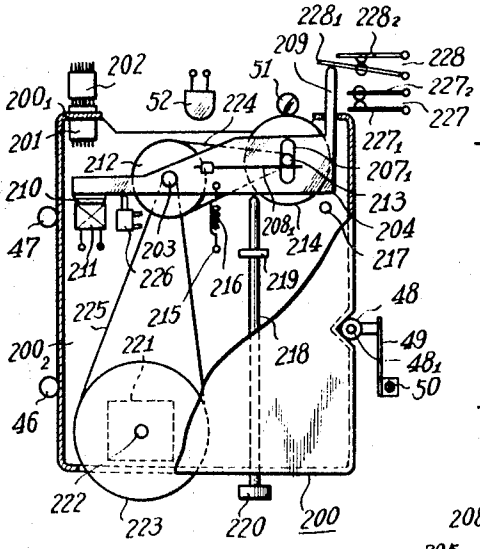


Fig. 6

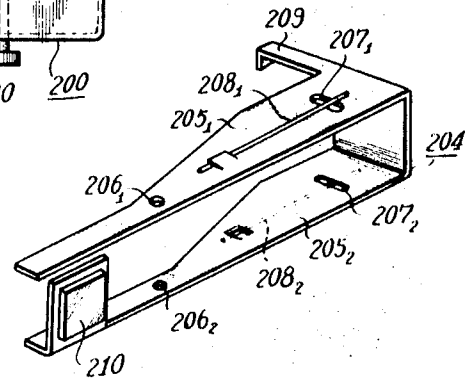


Fig. 7

Fig. 8

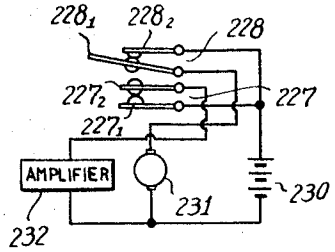


Fig. 9

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Fig. 10

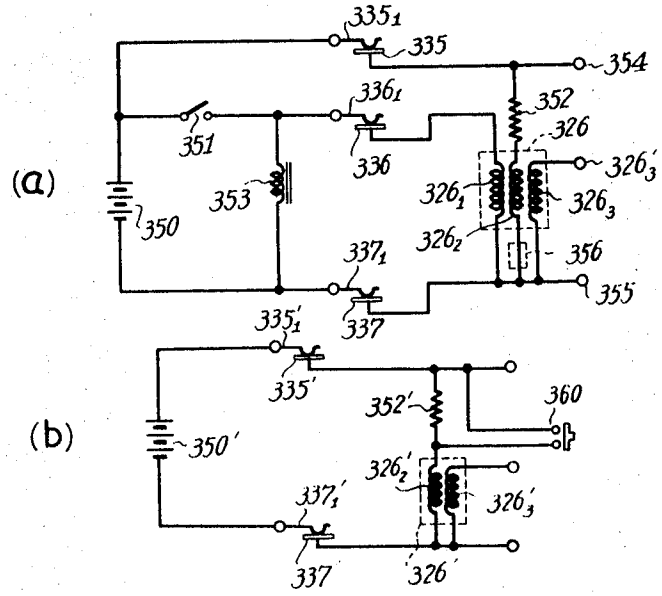


Fig. 11

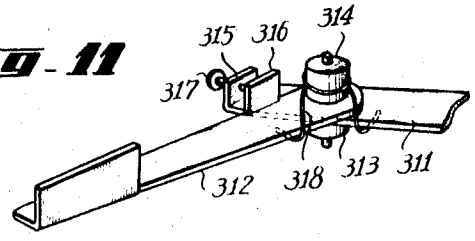
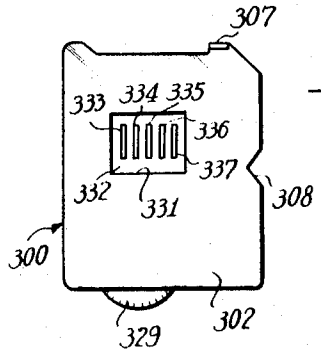


Fig. 12



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RADIO CARTRIDGE WITH AUTOMATIC TUNING DEVICE FOR USE WITH MAGNETIC TAPE CARTRIDGE PLAYER

BACKGROUND OF THE INVENTION

The present invention relates to a radio cartridge with a radio receiving circuit which enables one to listen to the radio by utilizing a magnetic tape cartridge player unit, and more particularly to a radio cartridge capable of automatic tuning. A radio cartridge of such a class has been commercially available, which includes a radio receiving circuit and which is adapted to be convertible for an endless magnetic tape cartridge for reproducing recorded information by means of the player unit which is so called "car stereo, home stereo." The radio cartridge of this class is actuated by inserting the same in the tape player unit, as in the same manner as the endless magnetic tape cartridge, to allow it to receive the electrowaves such as AM (amplitude modulation), or FM (frequency modulation). Such a radio cartridge must, of course, have tuning elements such as a variable condenser, variable inductance coil or the like to rotate an operating shaft of the tuning element to thereby tune to the frequency of the desired radio broadcast wave. Since the radio cartridge of the class as described is adapted to convertibility for the endless magnetic tape cartridge, it provides a small front portion which is exposed when inserted into the player unit. On the other hand, a tuning dial for rotatably operating the operating shaft for the tuning element and a station-indicator dial must be provided in this limited exposed portion. This causes the size and configuration of the dial to be reduced and its operation to be difficult, particularly when the driver of the car is trying to concentrate on driving. The tuning element should preferably be for automatic tuning, but it is difficult to employ a pushbutton switch for automatic tuning in a radio cartridge since five to 10 pushbuttons are required to this end.

SUMMARY OF THE INVENTION

It is therefore a primary object of the invention is to provide a radio cartridge with a radio receiving circuit which is adapted to be inserted into a player unit for an endless magnetic tape cartridge.

A further object of the invention is to provide a radio cartridge wherein an operating shaft for a tuning element for the radio receiving circuit is rotated by the rotating force of a capstan in the player unit.

Another object of the invention is to provide a radio cartridge wherein a pinch roller is rotatably mounted on a rotatable lever, said pinch roller being rotated by abutting against the capstan to rotate a tuning element operating shaft.

Still another object of the invention is to provide a cartridge wherein the tuning element operating shaft is caused to initiate its rotation and continue the same by actuating means for swinging a lever from a first to second position to abut the pinch roller against the capstan, an electromagnet for maintaining the lever in said second position, and the electromagnet is caused to release the lever from its engagement by an electric signal produced in response to the tuning of the radio receiving circuit to return the lever to said first position while the tuning element is maintained in a position to receive the desired radio broadcast wave.

A still further object of the invention is to provide a radio cartridge capable of manual operation of the tuning element by allowing a portion of a drum which is mounted on the tuning element operating shaft to project from the cartridge casing.

According to the present invention, a radio cartridge is provided so that the pinch roller is away from the capstan when the tuning element is in the receiving position for the desired radio broadcast wave to fully disconnect the operating shaft from the rotating power source whereby no slight aberration of tuning is caused by motor inertia as in the case of conventional tuning means.

These and other objects and advantages of the invention will be apparent from the following description and accompanying drawing in which:

BRIEF DESCRIPTION OF THE DRAWING

FIG. **1** is a plan view of a radio cartridge embodying the invention with a portion in transverse section;

FIG. **2** is an enlarged perspective view of the drum shown in FIG. **1**;

FIGS. **3***a* and **3**(*b*) are sectional plan views showing the detailed construction of the electromagnet of FIG. **1** and relationship between a magnetic substance plate and the electromagnet;

FIG. **4** is a circuit diagram for the radio cartridge and the player unit shown in FIG. **1**;

FIGS. **5** and **6** are plan views of another forms of the radio cartridge according to the present invention with a portion in transverse section;

FIG. **7** is an enlarged perspective view of the rotatable lever shown in FIG. **6**;

FIG. **8** is a circuit diagram for the purpose of illustrating the operation of the switch shown in FIG. **6**;

FIG. **9** is a plan view of another modified form of the radio cartridge inserted in the player unit with a portion in transverse section;

FIGS. **10**(*a*) and **10**(*b*) show electrical circuits different to each other which are for the electromagnet shown in FIG. **9**;

FIG. **11** is an enlarged perspective view of the two levers of FIG. **9** with a portion being omitted away;

FIG. **12** is a plan view of the radio cartridge shown in FIG. **9**.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. **1**, numeral **20** indicates a radio cartridge casing which comprises a bottom plate **21**, top plate **22**, front wall **23**, rear wall **24**, and a pair of sidewalls **25**, **26** and is substantially similar to a currently available endless magnetic tape cartridge casing in its shape. A lever **27** is pivotally mounted by a shaft **28** on the bottom plate **21** within the interior of the casing **20**. One end 27_2 of lever **27** is connected through a spring **29** to a pin **30** projecting from the bottom plate **21** so as to be urged counterclockwise and the other end 27_1 passes through a window 25_1 in the sidewall **25** outwardly of the casing **20**. A pinch roller **31** is secured to a rotatable shaft **32** rotatably pivoted to the lever **27**. The pinch roller **31** has the same structure as that of a pinch roller stored in a conventional endless magnetic tape cartridge and it passes from a window 23_1 formed in the front wall **23** outwardly of the casing **20**. A belt **33** extends around a rotatable shaft **32** and a drum **34**. Positioned within the drum **34** is a tuning element **35** such as a variable condenser which is mounted on the bottom plate **21**. The drum **34** is in turn mounted on an operating shaft **36** for rotating the tuning element **35**. As best seen from FIG. **2**, the drum **34** is provided with a belt groove **37** at the periphery thereof. Tuning dials 38_1 and 38_2 are engraved on the upper surface and the periphery of the drum **34**, respectively. The top plate **22** of the casing **20** is made of a transparent material so as to enable one to see the tuning dial 38_2. A window 24_1 is provided in the rear wall **24** to allow a portion of the drum **34** to project therefrom. This enables the user to manually operate the drum while seeing through the tuning dial 38_1. In the casing **20** there are incorporated a radio amplifier, local oscillator, mixing, intermediate radio amplifier, and a detection circuit which are required to reproduce an audible signal. Contacts **39**, **40**, **40***a*, **41** and **42** are insulated in relation to one another and are fixed to the exterior of the sidewall **26**. The contact **39** is connected to the input terminal of an antenna coil for the radio amplifier circuit accommodated within the casing **20**. The contact **40** is connected to the output terminal of the detection circuit. The contact 40_a is also connected to the output terminal of AVC voltage of AVC (automatic volume control) circuit. The contact **41**, **42** are connected to the power source input terminal of the circuit. Depression 25_2 is formed in the sidewall **25** of the casing.

The radio cartridge as referred to in the foregoing is inserted into the player as in the case of a conventional endless magnetic tape cartridge. Numeral **45** denotes a deck which is provided within a container (not shown) of the player unit. Guide pins **46**, **47** and a guide roller **48** are provided on the deck **45** to guide the radio cartridge which is inserted into the unit from the direction of arrow C. The guide roller **48** is pivoted to a shaft 48_1 carried by a free end of a bracket **49** of resilient metal plate of which one end is mounted by a screw **50** on the deck **45**. The guide roller **48** is urged in the direction of arrow D by the bias of the resilient bracket **49**. When the radio cartridge is fully inserted into the unit, the guide roller **48** is also received in the depression 25_2 and is brought in a predetermined position on the radio cartridge deck **45**, as shown in FIG. **1**. Insertion of the casing **20** into the unit causes the end 27_1 of the lever **27** to engage the guide roller **48**. On the other hand, the guide roller **48** is moved by the resilient force of the bracket **49** in the direction reversed to that of arrow D and is away from the travel path of the lever **27**. A capstan **51**, magnetic head **52**, endmark sensor **53**, and a door switch are provided on the deck for reproducing an endless magnetic tape cartridge. The capstan **51** is mounted on a flywheel **55** and passes through a hole (not shown) formed in the deck **45**. The door switch **54** is operated by the front wall **23** of the casing **20** to apply current from the power source to the player unit when the radio cartridge is fully inserted. Contacts **39'**, **40'**, $40_a'$, **41'**, and **42'** are insulated in relation to one another and are fixed to the deck **45**. These contacts are adapted to contact with the other contacts **39**, **40**, $40_a'$, **41** and **42**, respectively when the casing is brought into a predetermined position. The contact **39'** is connected to an antenna (not shown). The contact **40'** is connected to the input terminal of an amplifier (not shown). The contact $40_a'$ is connected to the input terminal of an amplifier **76** (FIG. **4**) as will be described hereinafter. The contact **41'** is connected to the negative pole of a power source (not shown). The contact **42'** is connected to the negative pole of the power source. A microswitch **56** is mounted on the deck **45** so as to be opposed to the front wall **23** of the casing **20** when positioned. An actuator **56'** for the microswitch is adapted to be operated by the front wall **23**. The microswitch is designed to be operated only by the radio cartridge and not the endless magnetic tape cartridge. To this end, the front wall **23** is provided with a raised portion to which the actuator **56'** may be opposed. The operation of the microswitch **56** will be detailed hereinafter.

An escape arrangement is provided for disengaging the pinch roller from the capstan. This arrangement comprises a swingable lever **57**, and electromagnet **62** for retaining the lever **57** and an electromagnetic plunger **63** for controlling swing movement of the lever **57**. The L-shaped lever **57** is rotatably pivoted by a shaft **58** mounted on the deck **45**. The lever **57** is positioned to allow the one end 57_1 thereof to engage the one end 27_1 of the lever **27** when the casing **20** is fully brought into a predetermined position. A spring **59** is interposed between the lever **57** and a pin **60** on the deck to urge the lever **57** counterclockwise. Swing movement of the lever **57** by the spring **59** is arrested by engagement of lever **57** with a stop pin **61**. A magnetic plate **62** is fixed to the other end 57_2 of the lever **57** and an electromagnet **63** is secured to the deck **45** so as to be opposed to the magnetic plate. The lever **57** is connected at its end 57_1 to an armature **65** of an electromagnetic plunger **64** by means of a spring **66**. The plunger **64** when energized functions to swing the lever **57** against the bias of the spring **59**.

FIG. **3**(*a*) shows relationship between the electromagnet **63** and the magnetic plate **62** illustrated in FIG. **1**. The magnetic plate **62** is of substantially U-shaped configuration and includes a mild steel plate 62_1 fixed to the lever **57** at the end 57_2 thereof and a ferrite magnet 62_2 which is magnetized and secured to the center of the steel plate 62_1. The opposite ends of the steel plate 62_1 are S poles by action of the ferrite magnet 62_1. The electromagnet **63** comprises a combination of a pair of yokes 63_1, 63_2 of substantially U-shaped configuration to form E-shaped configuration thereof, as shown, and an exciting coil 63_3 wound to the joint portion of the yokes. The open ends of the yokes 63_1, 63_2 are opposed to the opposite ends of the mild steel plate 62_1 and the ferrite magnet 62_2, respectively. With this arrangement, the magnetic plate **62** is magnetically attracted to the electromagnet **63** when the plate **62** is in close proximity of the yokes 63_1, 63_2. Normally deenergized exciting coil 63_3 is adapted to be energized at the point of a receiving station, as referred to hereinafter, and thereby the drift of the current applied to the coil is in a manner of erasing the magnetic flux of the ferrite magnet 62_2. Energization of the coil 63_3 causes, therefore, the electromagnet **63** to release the magnetic plate **62** from magnetically attractive engagement therewith.

FIG. **3***b* shows relationship between a modified form of the electromagnet **63** and magnetic plate **62**. In this instance, the magnetic plate only includes a mild steel plate 62_3 and the electromagnet comprises a yoke 63_4 and the pair of exciting coils 63_5, 63_6. Normally energized exciting coil 63_5 may generate the magnetic flux so that the electromagnet and the magnetic plate are magnetically attracted to each other when the steel plate 62_3 is in close proximity of the yoke 63_4. The other exciting coil 63_6 is normally deenergized as in the aforementioned coil 63_3 but is energized at the point of a receiving station so that the drift of the current applied to the coil is in a manner of erasing the magnetic flux of the exciting coil 63_5. Energization of the coil 63_6 causes, therefore, the yoke 63_4 to release the mild steel plate 62_3 from magnetically attractive engagement therewith. These arrangement illustrated in FIGS. **3**(*a*) and (*b*) may perform the same object.

FIG. **4** shows a circuit arrangement for the apparatus of FIG. **1**. Like parts are denoted by like numerals in FIG. **1**. The radio broadcast wave received by an antenna **70** is applied through the contacts **39'**, **39** to a receiving station **71** when the casing is held in a predetermined position of the deck. The receiving station **71** is built into the casing **20** and includes the tuning element **35** of FIGS. **1** and **2**. The output signal of the receiving station **71** is applied through the contacts **40**, **40'** to the input terminal of an audiofrequency amplifier **73** in the player unit. An equalizer amplifier **72** is adapted to receive the output signal from the magnetic head **52**. The output terminal of the equalizer amplifier **72** is connected to the input terminal of the audiofrequency amplifier **73**. The output signal of the equalizer amplifier **72** is nil unless the endless tape cartridge is used. A speaker **74** is connected to the output side of the audiofrequency amplifier **73**. AVC (automatic volume control) voltage of the receiving station **71** is applied through the contacts 40_a, $40_a'$ to an amplifier **76**. The amplifier **76** is arranged in the circuit to generate the positive pulse signal when the AVC voltage reaches the extreme value. The output pulse of the amplifier **76** is applied to the exciting coil 63_3 (FIG. **3**(*a*)) of the aforementioned electromagnet **63**. The current for actuating the receiving station **71** is supplied through the contacts **42**, **42'** and **41**, **41'** from the power source **77**. The current for actuating a motor **78** for the capstan **51** (FIG. **1**), the equalizer amplifier **72**, the audiofrequency amplifier **73**, and the amplifier **76** is also supplied through the door switch **54** from the power source **77**.

Numeral **79** indicates an electromagnetic plunger which is included in the prior art device in which the recording track on the endless magnetic tape is changed over by vertically moving the magnetic head. The plunger **79** is connected through the microswitch **56** and a pushbutton switch **80** to the power source **77**. The microswitch is closed on the side of the plunger **64**, as seen from FIG. **4**, when the radio cartridge is used, whereas when the endless magnetic tape cartridge is used the microswitch is changed over to the side of the plunger **79**. From the foregoing it is apparent that the plunger **64** is connected through the microswitch **56**, pushbutton switch **80** to the power source **77** in the use of the radio cartridge. The pushbutton switch **80** serves to change over the recording track in the use of the endless magnetic tape cartridge or select the channel in the use of the radio cartridge. The endmark sensor **53** comprises a pair of contacts which is

short-circuited by the endmark of conductive foil, as well known, on the endless magnetic tape.

The operation of the apparatus in FIGS. 1 to 4 will be detailed hereinafter.

When the radio cartridge is moved in the direction of arrow C to the deck for insertion, the lever **27** engages at the one end 27_1 thereof the other lever **57** (positioned in the dotted line shown in FIG. 1) at the one end thereof at the final stage of the cartridge movement and the lever **27** is slightly swung against the bias of the spring **29** by the strong resilient force of the spring **59**. This causes the casing **20** to be brought into a predetermined position on the deck **45** while the pinch roller **31** is away from the capstan **51**. The positioning of the casing **20** on the deck **45** as shown in FIG. **1** brings the contacts **40**, 40_a, **41**, **42** into contact with the respective contacts **40'**, $40_a'$, **41'**, **42'** and opens the door switch **54** while the microswitch **56** is changed over to thereby allow whole the circuit to be activated. Now, the pushbutton switch **80** is depressed to apply the pulse current to the electromagnetic plunger **64**, the armature **65** is actuated and the lever **57** is clockwise swung by the spring **66** against the resilient force of the spring **59**. Further, the lever **57** is swung from the dotted line to the solid line shown in FIG. **1**, so that the magnetic plate **62** and the electromagnet **63** are magnetically attracted to each other to arrest further movement of the lever **57**. On the other hand, the lever **27** is swung by the bias of the spring **29** to abut the pinch roller **31** against the capstan **51** for rotating the pinch roller **31**. Rotation of the pinch roller **31** rotates the shaft **36** of the tuning element **35** through the shaft **32**, belt **33**, and drum **34** to thereby vary the tuning frequency. With this in mind, when the tuning frequency corresponds to the radio broadcasting wave frequency, AVC voltage of the receiving station **71** reaches the extreme value and the pulse current is applied from the amplifier **76** to the coil 63_3 (FIG. 3(*a*)) or 63_5 (FIG. 3(*b*)). As a result, retention of the lever **57** by magnetic attraction of the electromagnet **63** and the magnetic plate **62** is released to return the lever **57** to the position shown by the dotted line of FIG. **1**. With return of the lever **57**, the lever **27** is also returned to its original position to disengage the pinch roller **31** from the capstan **55** so that the tuning element **35** is maintained in the condition when it has been set to the tuning position of the radio broadcasting wave. It will be readily understood that if another wave is to be received, the pushbutton **80** is again depressed and the tuning element will be automatically set to the tuning position for that wave as in the manner as set forth in the above.

As described hitherto, the radio cartridge is capable of selecting the channel automatically or manually, by way of manual rotation of the drum **34**.

FIG. **5** shows a modified embodiment of the present invention, in which like parts are designated by like numerals in FIG. 1. Pivotally mounted on a shaft **128** fixed to a bottom plate **121** of a casing **120** for radio cartridge is a swingable lever **127** to which at the top end 127_1 a rotatable shaft **132** is pivoted through a pillow block (not shown). A pinch roller **131** is attached to the shaft **132**. A spring **129** is interposed between a pin **130** attached to the bottom plate **121** and the lever **127** at the midportion thereof to urge the lever clockwise centering round a shaft **128**. A stop pin **181** projects from the bottom plate **121** to arrest swing movement of the lever **127** in a position shown by a dotted line of FIG. **5**. Fixed to the other end 127_2 of the lever **127** on one side thereof, is a magnetic plate **162** to which an electromagnet **163** is opposed and attached to the bottom plate **121**. A pushbutton rod **182** is slidably supported by a guide **183** within the casing **120** and the one end of the rod **182** is opposed to the one end 127_1 of the lever **127** on one side thereof while the other passes through an opening (not shown) in a rear wall **124**. A pushbutton **184** is secured to the other end of the rod **182** projecting from the rear wall **124**. A tuning element **135** is provided within the casing **120** as in the case of the radio cartridge in FIG. **1**. A drum **134** is fixed to an operating shaft **136** for rotating the tuning element **135**. A belt **133** extends between the shaft **132** and the drum **134**. Mounted on the sidewall **126** are contacts **139**, **140**, 140_a, **141**, **142**, and a contact 140_b for energizing the electromagnet **163**, which correspond to the contacts **39**, **40**, 40_a, **41**, **42** shown in FIG. **1** except for the electromagnet **163**. When the casing **120** is received in the player unit, these contacts are brought into contact with respective further contacts **39'**, **40'**, $40_a'$, $40_b'$, **41'**, **42'**. The contact 40_b is not shown in FIG. **1**, however, it is connected to the output terminal of the amplifier **76** (FIG. **4**) so that it is not used in the radio cartridge as shown in FIG. **1**.

Now the operation of the embodiment shown in FIG. **5** will be described hereinafter.

Depression of the pushbutton rod **182** causes the lever **127** to be counterclockwise swung against the bias of the spring **129** to abut the pinch roller **131** against the capstan **51** allowing the magnetic plate **162** to be attracted by the electromagnet **163**. The lever **184** may be maintained in the position shown by the solid line of the drawing even if depression of the pushbutton **184** is released since the lever **127** is magnetically retained by the electromagnet **163**. This allows the pinch roller **131** to be continuously rotated to thereby rotate the drum **134** with the operating shaft **136** for the tuning element **135**.

When the tuning element **135** tunes in the frequency of the radio wave, the pulse current is applied to the electromagnet **163**, as in the manner of the embodiment of FIG. **1** to release the electromagnet **163** from magnetical attraction of the magnetic plate **162**. At this point, the lever **127** is returned by the bias of the spring **129** to the position shown by the dotted line of the drawing Thus, the pinch roller **131** is moved away from the capstan **51** so that the tuning element **135** is maintained in the condition where it is set to the desired tuning position. In this manner, the radio cartridge in FIG. **5** may be automatically tuned as in the same manner of the embodiment in FIG. **1**. According to the embodiment in FIG. **5**, the cartridge is not required to have the electromagnetic plunger **64** and the microswitch **56**. Further, the electromagnet **163** may be received in the casing to not only simplify the arrangement but also serve for practical use.

Another modified radio cartridge is shown in FIG. **6**. Like parts are denoted by like numerals in FIG. **1**. Mounted within the inside of the front wall 200_1 of a casing **220** are a high frequency input terminal, detection output terminal, AVC voltage output terminal, power source terminal which are all for a receiving station (not shown) stored in the casing **220**. A connector **201** is also provided within the inside of the front wall 200_1 and includes a plurality of connecting pins to which switches are connected. The connector **201** is adapted to be electrically connected to a connector **202** which is mounted in the player unit when the radio cartridge is received in the player unit. Rotatably pivoted by a pillow block (not shown) to a bottom plate 200_2 of the casing **220** is a shaft **203** which pivotally carries a swingable lever **204**. The lever **204** includes a pair of parallel plates 205_1 and 205_2 which are provided with apertures 206_1 and 206_2, respectively. These apertures allow the shaft **203** to pass therethrough. Slits 207_1 and 207_2 are also bored through the plates 205_1 and 205_2, respectively. Rod springs 208_1 and 208_2 of which one ends are secured to the plates extend beyond these slits. An extension **209** is integrally formed with the plate 205_1. The extension **209** passes through an opening (not shown) formed in the front wall 200_1 and projects forwardly of the casing. A magnetic plate **210** is fixed to a flange portion projecting from the plate 205_2. An electromagnet **211** is attached to the bottom plate 200_2 to be opposed to the magnetic plate **210**. The magnetic plate **210** and the electromagnet **211** are similar to those shown in FIG. **1**. A belt wheel **212** is fixed to the shaft **203** between the plates 205_1 and 205_2. A pinch roller **214** is also attached to a shaft **213** which is loosely carried by the slots 207_1 and 207_2. The shaft **213** is normally urged upwardly by the two rod springs 208_1 and 208_2 as shown in FIG. **6**. A spring **216** extends between the lever **204** and a pin **215** fixed to the bottom plate 200_2 to urge the lever **204** counterclockwise. It will be understood that the

rotating force of the lever **204** is arrested by a stop pin **217** attached to the bottom plate 200_2. A pushbutton rod **218** is slidably supported by a guide **219** within the casing **200** and the one end of the rod **218** is opposed to the one end of the lever **204** at the plate 205_2 while the other passes through the opening (not shown) in a rear wall 200_3. A pushbutton **220** is attached to the one end of the rod **218** projecting downwardly of the casing **200**. A tuning element **221** is provided within the casing **200** and a drum **223** is attached to an operating shaft **222** for rotating the tuning element. A belt **224** extends round the shaft **213** and the belt wheel **212**. The drum **223** is thus rotated by the belt **224**, belt wheel **212**, shaft **203**, belt **225** when the capstan **214** is rotated. The drum **223** is similar to the drum **34** in the structure in FIG. **2**. A microswitch **226** is fixed to the bottom plate 200_2 so as to allow the actuator to be positioned adjacent the lower plate 205_2. The microswitch **226** is adapted to close its contact when the lever is in a normal position or to open it contact when the lever **204** is retained by the electromagnet **211**. The microswitch **226** is also incorporated in a circuit for connecting the inspection output terminal for the receiving station (not shown) in the casing and the contact pin corresponding to the output terminal of the connector **201**. Two switches **227** and **228** are provided within the player unit for the radio cartridge, the former having a function of the door switch **54** (FIG. **1**) and the latter being operated by the lever extension **209**.

The switch **228** in FIG. **8** comprises a movable contact 227_1 operated by the casing **200** being inserted into the player unit, and a fixed contact 227_2 opposite to the contact 227_1. The switch **228** further comprises a movable contact 228_1 which is opposed to the fixed contact 227_2 and is operated by the lever extension **209** and a fixed contact 228_2 in opposite to the movable contact 228_1. Connection between the movable contact 227_1 and the fixed contact 227_2 is broken off if the radio cartridge is not inserted into the player unit. At this point, the fixed contact 227_2 is brought into contact with the fixed contact 228_1. When the radio cartridge is inserted into the player unit, the movable contact 227_1 is depressed by a portion of the front wall 200_1 and is caused to contact the fixed contact 227_2 while the movable contact 228_1 is depressed by the extension **209** to break off connection with the fixed contact 227_2. At this time, the movable contact 228_1 is not brought into contact with the fixed contact 228_2. Contact **228** is depressed by the extension **209** and caused to contact the fixed contact 228_2 when the lever **204** is rotated for selecting the channel.

As shown in FIG. **8**, the switches **227**, **228** are incorporated in a current supply circuit for amplifier stations each provided in a capstan motor and the player unit. That is, a capstan motor **231** is connected through the switch **228** or the movable contact 228_1 and the switch **227** to the power source **230** while an amplifier station **232** is connected through the switch **227** to the power source **230**. The switches **227**, **228** in FIG. **8** are such that the lever **204** is retained by the electromagnet **211** when the radio cartridge is inserted into the player unit. That is, the movable contact 227_1 is brought into contact with the fixed contact 227_2 and the other movable contact 228_1 is caused to contact with the other fixed contact 228_2 so that the capstan motor **231** and the amplifier station **232** are energized by the current from the power source **230** and are actuated.

Again, referring to FIG. **6**, the operation of the radio cartridge is as follows. When the radio cartridge is inserted into the player unit, the connector **201** and **202** are electrically connected to supply current as desired to the receiving station (not shown) for its actuation and the movable contact 227_1 and the fixed contact 227_2 are connected to each other to energize the amplifier station (FIG. **8**). However, the movable contact 228_1 for the switch 228_2 is not brought into **204** is positioned to engage the stop pin **217** to keep the pinch roller **214** away from the capstan **51**. This causes the capstan motor **231** (FIG. **8**) not to be energized. When the pushbutton rod **218** with the button **220** is depressed, the lever **204** is counterclockwise rotated to allow the magnetic plate **210** to attract the electromagnet **211** and to cause the movable contact 228_1 to contact the fixed contact 228_2. The capstan motor **231** is then energized to rotate the capstan **51** and the pinch roller **214** abuts against the capstan **51**, as shown in FIG. **6**. As a result, rotation of the capstan **51** is imparted to the drum **223** rotating the shaft **222** for the tuning element **221**.

Now, the tuning element **221** is tuned to the frequency of the radio broadcast wave, the pulse current is drained to the electromagnet **211**, as in the same manner of the embodiment in FIG. **1**, to disengage the electromagnet **211** from the magnetic attraction of the magnetic plate **210** so that the lever **204** is returned to its normal position by the bias of the spring **216**. This allows the pinch roller **214** to move away from the capstan so that the tuning element **221** is maintained in the desired tuning position. In addition, the movable contact 228_1 and the fixed contact 228_2 for the switch **228** are disconnected from each other and the capstan motor **231** is deenergized to prevent rotation of the capstan **51**. As mentioned above, the radio cartridge in FIG. **6** is capable of automatic tuning as in the cartridge in FIGS. **1** and **5**. The radio cartridge illustrated in FIG. **6** provides the advantage that the current used is very small and good reception is obtained with less noise since the capstan motor **231** is only operated during automatic tuning and is not operated in receiving the radio broadcast wave. During automatic tuning in which the tuning element **221** is varied, the microswitch **226** is operated by the lever **204** to prevent the detection output signal for the receiving station from being applied to the amplifier station **232** so that noise cannot be generated from the speaker during nontuning. Further, abutment of the pinch roller **214** with the capstan **51** is sufficiently effected by the bias of the rod springs 208_1 and 208_2.

Referring to FIG. **9**, there is shown a casing of a type different from each of these as described heretofore. Like parts are also indicated by like numerals.

A bottom plate **301** is provided at the front edge thereof with an abutment **307** which is of slidable member and may be engaged by the capstan **51**. The guide roller **48** is so positioned in the player unit that a depression **308** formed in a sidewall **306** does not fully receive the roller and thereby the roller **48** may engage the depression **308** at the open end thereof. With this arrangement, the force by the bracket **49** is resolved into a force urging the casing **300** leftwardly or upwardly. Accordingly, the abutment **307** may abut against the capstan **51** by the bias of the bracket **49**. The abutment **307** is of slidable member not to interfere with rotation of the capstan **51** and is substantially coplanar with the bottom plate **301** but not positioned in the path of the pinch roller when engagement of the capstan is established. Two rotatable levers **311**, **312** are coaxially mounted on a shaft **310** attached to the bottom plate **301**. These levers **311**, **312** are provided with respective sleeves **313**, **314**, as will be detailed in FIG. **11**, by which the levers **311**, **312** are supported. An upwardly projecting end **315** is formed on the lever **311** at one end thereof and an upwardly projecting portion **316** is formed on the other lever **312** on one side thereof so as to be opposed to the end **315**. An adjusting screw **317** is mounted on the end **315** and extends to the portion **316**. A spring **318** which is wound to the sleeve **314** is interposed between the sleeves **311** and **312** to be urged in the reverse directions in relation to each other. The bias of the spring **318** is arrested by abutment of the adjusting screw **317** with the portion **316**. A pinch roller **320** is rotatably mounted on a shaft **319** attached to the lever **311** and a belt wheel **321** is fixed to a pinch roller **320**. The lever **311** is provided at the other end thereof with an extension 311_1 which passes through an opening (not shown) formed in a slant wall **309** between the front wall **303** and the sidewall **306** and projects outwardly of the casing **300**. A spring **322** extends between the lever **312** and a pin **323** on the bottom plate **301** to urge the lever **312** clockwise. Swingable movement of the lever **312** is prevented by abutting the lever **311** against a stop pin **324** projecting from the bottom plate **301**. When the lever **311** abuts against the stop pin **324**, the end of the extension 311_1 is positioned rearwardly of the plane defined by the front wall **303** but pro-

jects from such the plane by rotation of the lever **311** counterclockwise. Attached to the upwardly projecting flange portion of the lever **312** is a magnetic plate **325** to which an electromagnet **326** is opposed and fixed to the bottom plate **301**. The electromagnet **326** includes three exciting coils 326_1, 326_2, 326_3, as shown in FIG. **10**(*a*), which will be detailed hereinafter. The casing **300** stores a tuning element **327** and a drum **329** fixed to a tuning element operating shaft **328**. The drum **329** is similar to the drum **34** in FIG. **2** and is provided with tuning dials on the surface and the periphery thereof. A portion of the drum **329** passes through an opening 304_1 in the rear wall **304** and projects outwardly of the casing **300** so as to be manually operated. A belt **330** extends round the drum **329** and the belt wheel **321** to reduce rotation of the pinch roller **320** and impart the same to the drum. Bored through the top plate **302** is an opening **331** (FIG. **12**) adjacent which five contacts **333**, **334**, **335**, **336**, and **337** are arranged. These contacts are insulated by an insulating base **332** which is mounted within the casing **300**. Each surface of these contacts is aligned with the plane of the top plate **302**. The contact **333** serves as the high frequency signal input terminal for the receiving station (not shown) with the tuning element **327** (FIG. **9**) within the casing **300**. The contact **334** is the detection signal output terminal for the receiving station. The contact **335** is the positive voltage input terminal for the receiving station and for the exciting coil 326_2 (FIG. **10**(*a*)) of the electromagnet **326** (FIG. **9**). The contact **336** is the positive voltage input terminal for the exciting coil (FIG. **10**(*a*)) of the electromagnet **326** (FIG. **9**). And, the contact **327** is the negative voltage input terminal for the receiving station and each coil of the electromagnet **326**. Further five contacts are also provided within the player unit to be brought into contact with the above-mentioned contacts when the radio cartridge is inserted into the player unit. Three contacts such as 335_1, 336_1, and 337_1 are opposed to the contacts **335**, **336**, and **337** are shown in FIG. **10**(*a*).

Referring back to FIG. **9**, a microswitch **338** is provided within the player unit so as to be opposed to the extension 311_1 of the lever **311**. The microswitch **338** is adapted to close its contact by depression of an actuator 338_1 by the extension 311_1 when the lever **311** is rotated. The microswitch **338** with a manually operating switch **339** is incorporated in a circuit for energizing a capstan driving motor **340**. That is, the closing of the microswitch **338** and the switch **339** will apply the current from a power supply **341** to the motor **340** for its actuation. An amplifier circuit **342** is connected by the switch **339** to the power supply **341** to amplify the detection output signal for the receiving station when using the radio cartridge or the output signal for the magnetic head **52** when using the endless magnetic tape cartridge.

The operation of the circuit for the electromagnet **326** is now described with reference to FIG. **10**(*a*). Like parts are denoted by like numerals in FIGS. **9** and **12**.

The exciting coil 326_1 is connected at the one end thereof through the contacts **336**, 336_1 and a manually operating pushbutton switch **351** in the player unit to the plus pole of the power supply **350** while it is also connected at the other end thereof through the contacts **337**, 337_1 to the minus pole of the source **350**. The closing of the switch **351** allows the exciting coil 326_1 to receive the current from the power source **50** to thereby generate the high magnetic flux. Energization of the exciting coil 326_1 attracts the magnetic plate **325** (FIG. **9**) to rotate thereover **312** against the bias of the spring **322**. At this point, the lever **311** with the lever **312** is rotated to abut the pinch roller **309** against the capstan **51**. The exciting coil 326_2 is connected at the one end thereof through a resistor **352**, and the contacts **335**, 335_1 to the plus pole of the source **350** while it is connected at the other end thereof through the contacts **337**, 337_1 to the minus pole of the source **350**. Therefore, the weak current controlled by the resistor **352** is normally applied to the exciting coil 326_2. The magnetic flux generated in the exciting coil 326_2 is not enough to attract the lever **312** against the bias of the spring **322** as is the flux generated in the coil 326_1 but is enough to prevent the once attracted lever **312** by the coil 326_1 from returning to its original position by the spring **322** after the coil 326_1 is deenergized. The exciting coil 326_3 is connected at the one end thereof to the AVC voltage output terminal for the receiving station while it is connected at the other end thereof through the contacts **337**, 337_1 to the minus pole of the source **350** so that the current in response to the AVC voltage is applied to the coil 326_3. The drift of the magnetic flux generated in the coil 326_3 is such that it erases the magnetic flux generated in the coil 326_2 and the magnetic force decays when the AVC voltage reaches the extreme value in tuning of the receiving station to thereby return the lever **312** to its original position by the bias of the spring **322**. The pushbutton switch **351** is used for selecting the recording track or the channel in the use of the endless magnetic tape cartridge and serves to control energization the electromagnetic plunger **353** for vertically moving the magnetic head. Numerals **354**, **355** are the power source input terminals. As mentioned, in this instance the electromagnet **326** includes the three exciting coils.

FIG. **10**(*b*) shows a circuit in which an electromagnet having two exciting coils is used. Like parts are designated by like numerals with primes in FIG. **10**(*a*). The electromagnet **326'** includes two exciting coils $326_2'$, $327_3'$ which are similar to the coils 326_2, 326_3 but has no coil corresponding to the coil 326_1 in FIG. **10**(*a*). A pushbutton switch **360** is provided in parallel to a resistor **352'** incorporated in a circuit for energizing the coil $326_2'$. The closing of the switch **360** applies the strong current to the coil $326_2'$ to attract the lever **312** (FIG. **9**) against the bias of the spring **322**. The opening of the switch **360** normally applies the weak current controlled by the resistor **352'** to the coil $326_2'$ and mode of operation of the coil $326_2'$ is the same as that of the coil 326_2. Similarly, the coil $326_3'$ is the same as the coil 326_3. In this instance, the coil $326_2'$ functions as the coils 326_1, 326_2 in FIG. **10**(*a*).

Mode of operation of the radio cartridge in FIG. **9** is as follows.

Depression of the pushbutton switch (FIG. **10**(*a*)) allows the electromagnet **326** to attract the magnetic plate **325** to thereby rotate the rotatable lever **312** with the lever **311**. With rotation of the lever **311**, the extension 311_1 depresses the actuator 338_1 to close the contact of the microswitch **338** so that the capstan motor **340** is actuated, and if the switch **339** is closed, the capstan **51** is rotated while the pinch roller **320** abuts against the capstan **51** to rotate the pinch roller **320** and the drum **329**. Even after releasing depression of the pushbutton switch **351**, the magnetic plate **325** is maintained attractive to the electromagnet **326** by the magnetic flux generated in the exciting coil 326_2 FIG. **10**(*a*)). Accordingly, the capstan motor **340** keeps on its rotation so that abutment of the pinch roller **320** with the capstan **51** is maintained to rotate the drum **329**. This rotation of the drum **329** varies the tuning element **327** and until the receiving frequency at the receiving station corresponds to the frequency of the radio wave at which time the magnetic flux generated in the coil 326_2 (FIG. **10**(*a*)) is erased by the current drained to the coil 326_3 (FIG. **10**(*a*)) to release the electromagnet **326** from attraction of the magnetic plate **325** so that the levers **311**, **312** are returned to their original position by the bias of the spring **322**. As a result, the contact of the microswitch **338** is opened to deenergize the capstan motor **340** to terminate rotation of the capstan **51** to thus keep the pinch roller **320** away from the capstan **51** terminating rotation of the drum **329**. Consequently, the tuning element **327** is set to the point to tune in the frequency of the arrival electric wave. It is apparent that SN ratio of the receiving station is improved since the capstan motor **340** is no longer actuated after automatic tuning is completed. In automatic tuning, abutment of the capstan **51** with the pinch roller **320** is effected by the bias of the spring **318** (FIG. **11**) interposed between the levers **311** and **312** so that relative position of the lever **312** and the electromagnet **326** is roughly controlled.

In order to product a slight gap between the magnetic circuit open end of the electromagnet **326** and the magnetic plate **325** when the electromagnet attracts the magnetic plate, the angle formed the levers **311** and **312** is adjusted by turning the screw **322**. In this manner, the period of time in which the levers **311** and **312** are returned to its original position, may be reduced when the current for erasing the magnetic flux generated in the coil 326_2 is applied to the coil 326_3. With this arrangement, the tuning element **329** is accurately set to the tuning position of the radio wave. The slight gap between the magnetic circuit open end of the electromagnet and the magnetic plate is formed by allowing the abutment **307** to abut against the capstan **51** to constantly hold a distance between the capstan **51** and the pinch roller **320**. In order to constantly hold the distance between the capstan and the pinch roller, a stop pin (not shown) against which the front wall **303** abuts may be fixed to the player unit deck. In FIG. **10**(*a*), the magnetic flux generated in the coil 326_2 is erased by the current applied to the coil 326_3, however, the exciting coil 326_3 may be omitted and a switching transistor **356** may be provided as shown by the dotted line in series to the coil 326_2 to apply the AVC voltage of the receiving station to the base pole of the switching transistor **356** to thus control energization of the coil 326_2 by action of the switching transistor **356**. Although the magnetic plate **325** is fixed to the lever **312** according to the embodiment in FIG. **9**, such THE MAGNETIC plate **325** may be omitted if the lever **312** is made of mill steel.

The detection output signal may be taken out by the magnetic head provided within the casing but not the contact, that is, the variation of the magnetic flux generated in the magnetic head is picked up by the magnetic head in the player unit. This is the case with the use of the radio cartridge or the endless magnetic tape cartridge.

The invention and its attendant advantages will be understood from the foregoing description. It is to be understood that changes and variations may be made without departing from the spirit and scope of the invention as defined in the appended claims.

What is claimed is:

1. A radio cartridge for reception and playing of radio broadcasts through the audio output stage of a magnetic tape cartridge player unit, said player unit having a tape driving device including a capstan and an electrical motor for driving the capstan, and a tape recording and reproducing circuit, comprising a casing having the same dimensions as the magnetic tape cartridge, said casing having a front wall with an opening therein, a radio receiving circuit in said casing, said radio receiving circuit having a tuning element provided with an operating shaft, lever means mounted for pivotal movement in said casing, a rotatable pinch roller mounted on said lever means, said lever means being positioned in said casing such that a portion of said pinch roller passes through said opening, said pinch roller being adapted to be positioned adjacent said capstan when the radio cartridge is in the player unit, first maintaining means for maintaining said lever means in a first position where said pinch roller is remote from said capstan when the radio cartridge is in the player unit, operating means for moving said lever means from said first position to a second position where said pinch roller is engaged with and rotated by said capstan when said radio cartridge is in the player unit, second maintaining means for maintaining said lever means in said second position, means for imparting the rotation of said pinch roller to said operating shaft, a sensing circuit for producing an electrical signal in response to sensing that said radio receiving circuit is tuned to a broadcasting radio wave, means for applying said electrical signal to said second maintaining means, said second maintaining means being adapted to release said lever means in response to said electrical signal, means for moving said lever means from the second position to the first position when said second maintaining means is released, and a group of contacts mounted on said casing for applying electrical current to said radio receiving circuit and for generating the output signal of the circuit, each contact of said group of contacts being adapted to be brought into electrical contact with a corresponding group of contacts on said player unit when said radio cartridge is in said player unit.

2. A radio cartridge for reception and playing of radio broadcasts through the audio output stage of a magnetic tape cartridge player unit, said player unit having a tape driving device including a capstan and an electrical motor for driving the capstan, and a tape recording and reproducing circuit, comprising a casing having the same dimensions as the magnetic tape cartridge, said casing having a front wall with an opening therein, a radio receiving circuit in said casing, said radio receiving circuit having a tuning element provided with an operating shaft, lever means mounted for pivotal movement in said casing, a rotatable pinch roller mounted on said lever means, said lever means being positioned in said casing such that a portion of said pinch roller passes through said opening, said pinch roller being adapted to be positioned adjacent said capstan when the radio cartridge is in the player unit, spring means biasing said lever means to a first position where said pinch roller is remote from said capstan when the radio cartridge is in the player unit, operating means for moving said lever means against the bias of said spring means from said first position to a second position where said pinch roller is engaged with and rotated by said capstan when said radio cartridge is in the player unit, an electromagnet for magnetically attracting said lever means and for maintaining said lever means in said second position by magnetic force, means for imparting the rotation of said pinch roller to said operating shaft, a sensing circuit for producing an electrical signal in response to sensing that said radio receiving circuit is tuned to a broadcasting radio wave, means for applying said electrical signal to said electromagnet, said electromagnet being adapted to release said lever means in response to said electrical signal whereby said lever means is returned to the first position at the same time that rotation of said operating shaft of said tuning element is interrupted and said tuning element is automatically set to the receiving position for the broadcasting wave, and a group of contacts mounted on said casing for applying electrical current to said radio receiving circuit and for generating the output signal of the circuit, each contact of said group of contacts being adapted to be brought into electrical contact with a corresponding group of contacts on said player unit when said radio cartridge is in said player unit.

3. A radio cartridge as set forth in claim **2** wherein a drum is mounted on said operating shaft for rotation with said shaft, said drum being provided with a tuning dial at the periphery thereof, and a portion of said drum passes through an opening formed in the rear wall of said casing and outwardly extends beyond said casing.

4. A radio cartridge as set forth in claim **3** wherein said lever means including an extension extending beyond said casing, said extension having adapted to operate a switch in the player unit for actuating said motor when said lever means is swung from said first to said second position.

5. A radio cartridge as set forth in claim **3** wherein said actuating means is a rod slidably mounted within said casing, one end of said rod being adjacent to said lever means, the other end projecting from the casing through a hole formed in said rear wall of the casing, said other end being provided with a pushbutton, said rod being positioned such that manual depression of the pushbutton moves said lever means to said second position.

6. A radio cartridge as set forth in claim **5** wherein said means imparting rotation of said pinch roller to said operating shaft of said tuning element is a belt which extends round said axis of the pinch roller and said drum.

7. A radio cartridge as set forth in claim **5** wherein said electromagnet includes a normally energized first exciting coil and a second exciting coil adapted to be excited by said electric signal, said coils being arranged such that the magnetic flux generated in said second exciting coil erases the magnetic flux generated in said first exciting coil to release retention of said lever means by said electromagnet.

8. A radio cartridge as set forth in claim 3 wherein said electromagnet includes a plurality of exciting coils, and said operating means is an exciting coil adapted to generate a magnetic flux sufficient to swing said lever means from said first to said second position.

9. A radio cartridge as set forth in claim 8 wherein said casing is provided with an abutment, said abutment being adapted to abut against said capstan when the radio cartridge is in the player unit to accurately maintain the relative position of said pinch roller and the capstan when said lever means is in said first position.