Dec. 12, 1961 M. CAMRAS 3,013,123

ELECTROMAGNETIC PLAYBACK SYSTEM

Filed March 15, 1954 2 Sheets-Sheet 1

Fig. 1

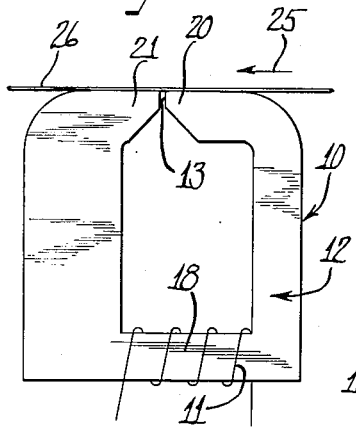


Fig. 2

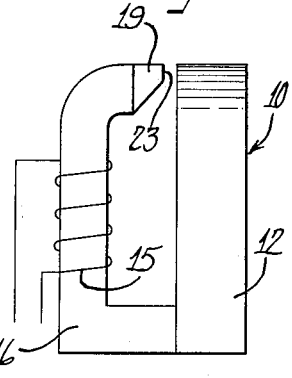


Fig. 3

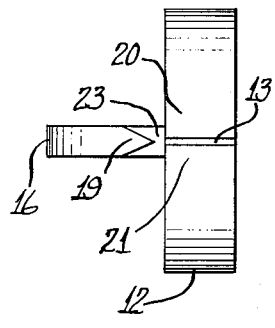


Fig. 4

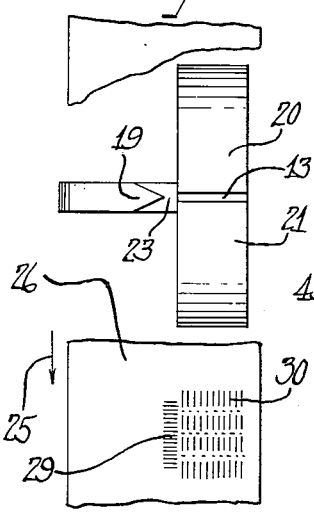


Fig. 7

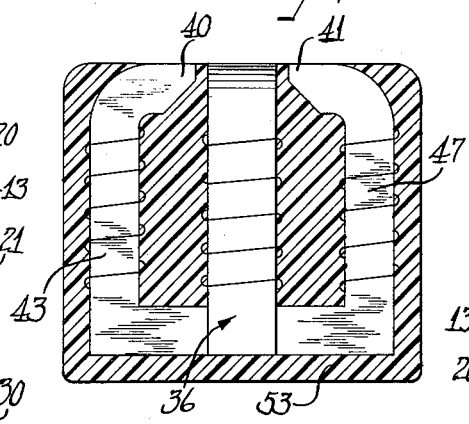


Fig. 5

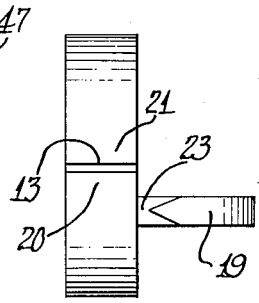


Fig. 6

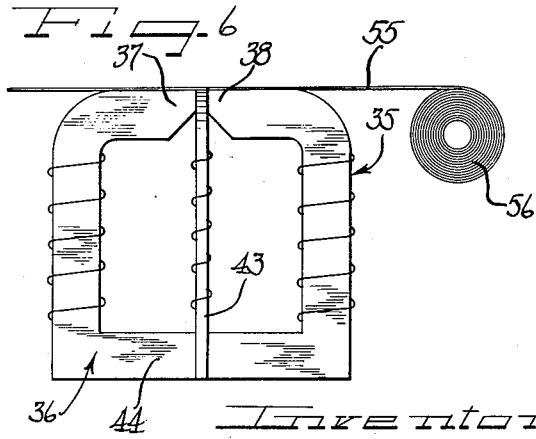
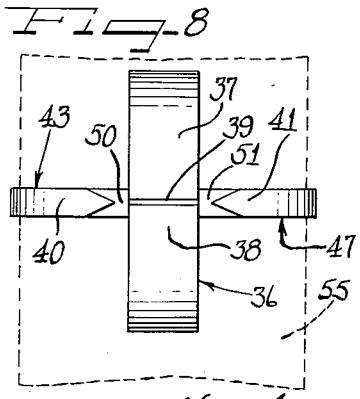


Fig. 8



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Dec. 12, 1961 M. CAMRAS 3,013,123

ELECTROMAGNETIC PLAYBACK SYSTEM

Filed March 15, 1954 2 Sheets-Sheet 2

FIG. 9

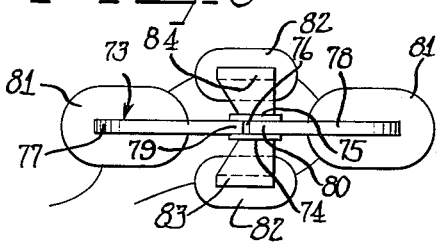


FIG. 10

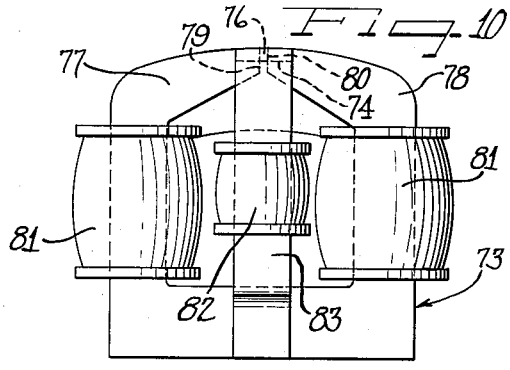


FIG. 11

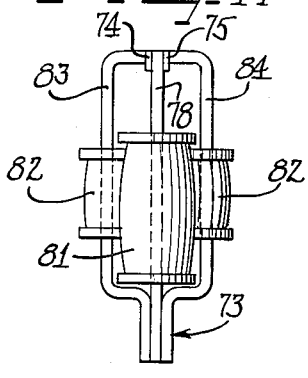


FIG. 12

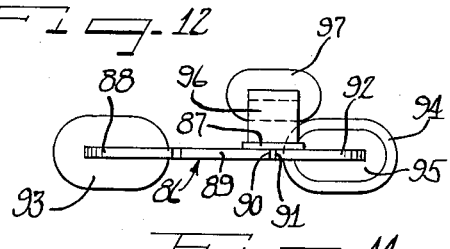


FIG. 14

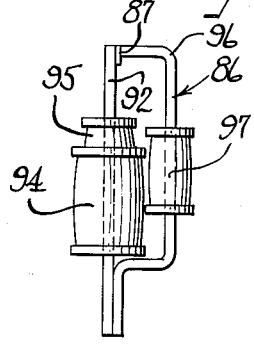


FIG. 13

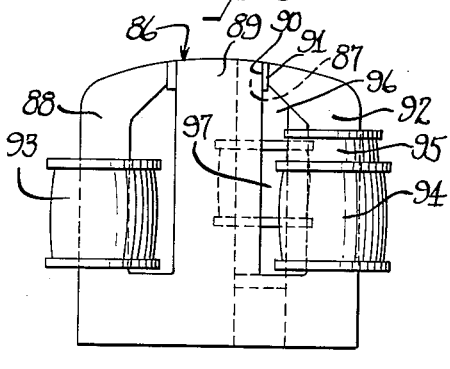


FIG. 16

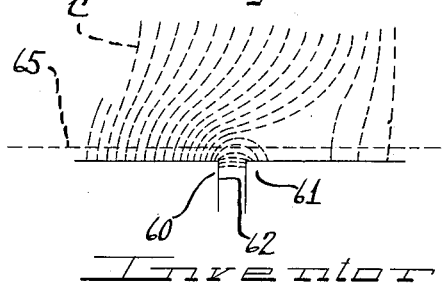
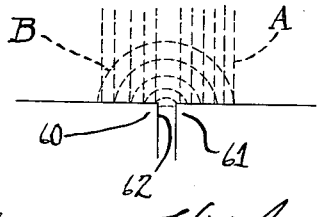


FIG. 15



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United States Patent Office 3,013,123 Patented Dec. 12, 1961

3,013,123
ELECTROMAGNETIC PLAYBACK SYSTEM

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Filed Mar. 15, 1954, Ser. No. 416,187
1 Claim. (Cl. 179—100.2)

This invention relates to an electromagnetic playback system for reproducing signals recorded on magnetic record media.

In my U.S. Patent No. 2,803,708 I have disclosed and claimed a system for recording signals by shaping the longitudinal recording field so as to have a very rapidly decaying magnetic intensity in the region of the trailing pole. This is accomplished by superimposing upon the main recording field at the trailing pole an auxiliary field of magnitude and direction so as to oppose and modify the main recording field. Important new results are obtained by positioning the erase gap of a two gap head sufficiently close to the recording gap so that leakage flux from the erase magnetic circuit is superimposed on and modifies the high frequency bias field in the region of the trailing pole. Thus while said patent discloses in certain embodiments the use of magnetic poles laterally offset from the main longitudinally spaced poles, the controlling concept specifically disclosed in said patent is to impose a signal of the same frequency on both the laterally offset poles and the longitudinally spaced poles.

The presently claimed invention resides in a playback system comprising in combination a magnetic record member having a layer of magnetizable material with a pair of contiguous but laterally offset recorded traces extending therealong, one of said traces having magnetic fields extending substantially longitudinally to constitute a longitudinally recorded trace and the magnetic fields varying in the longitudinal direction along the record member in accordance with higher frequency components of a signal recorded on the record medium, the other of said traces having magnetic fields extending substantially transversely to constitute a transversely recorded trace, the magnetic fields varying in the longitudinal direction along the record member in accordance with lower frequency components of the signal recorded on the record medium, said recorded traces having substantially stronger leakage fields at a surface of said layer of magnetizable material than at the opposite surface of the record member, magnetic playback head means cooperating with said surface of said layer of magnetizable material and having a pair of pole portions defining a longitudinal gap for coupling the head means to said longitudinally recorded trace and having a pair of transversely spaced pole portions defining a transverse gap for coupling the head means to said transversely recorded trace, said magnetic playback head means having a longitudinally magnetic circuit including said pair of pole portions defining said longitudinal gap and having a transverse magnetic circuit including said transversely spaced pole portions and said transverse gap, said playback head means having a first output element linking said longitudinal magnetic circuit but spaced from said transverse circuit, and having a second output element coupled to said transverse circuit but spaced from said longitudinal magnetic circuit, and means for moving said record member relative to said playback head means to move the longitudinally recorded trace in the longitudinal direction across said longitudinal gap and to move said transversely recorded trace in the longitudinal direction across said transverse gap for producing an electric output from the first output element varying in accordance with the high frequency components of the signal recorded on the record medium and for producing

an electrical variation in the second output element in accordance with the lower frequency components of the signal recorded on the record medium.

Other objects and features which I believe to be characteristic of my invention are set forth with particularity in the appended claim. My invention itself, however, both as to its organization, manner of construction, and method of operation, together with further objects and advantages thereof, may be best understood by reference to the following description taken in connection with the accompanying drawings, in which:

FIGURE 1 is a diagrammatic side elevational view of a first embodiment of an electromagnetic transducer head according to the present invention;

FIGURE 2 is a left side elevational view of the structure of FIGURE 1;

FIGURE 3 is a diagrammatic plan view of the structure of FIGURE 1;

FIGURE 4 is a diagrammatic plan view similar to FIGURE 3 but illustrating the manner in which a signal is recorded on an elongated magnetizable medium by means of the head construction of FIGURE 1;

FIGURE 5 is a diagrammatic plan view similar to FIGURE 3, but illustrating the auxiliary pole piece as being off-set longitudinally as well as laterally from the main gap;

FIGURE 6 is a diagrammatic front elevational view of a third embodiment of electromagnetic transducer head according to the present invention;

FIGURE 7 is a diagrammatic side elevational view of the structure of FIGURE 6 and indicating a housing for the head in section;

FIGURE 8 is a diagrammatic plan view of the structure of FIGURE 6 and indicating diagrammatically the relative position of an elongated magnetizable medium travelling over the head;

FIGURE 9 is a diagrammatic top plan view of a further modified form of the present invention utilizing a pair of auxiliary poles for establishing an auxiliary cross field to modify the main recording field of the head;

FIGURE 10 is a diagrammatic front elevational view of the head assembly of FIGURE 9;

FIGURE 11 is a diagrammatic side elevational view of the head assembly of FIGURE 9;

FIGURE 12 is a diagrammatic top plan view of a still further modified form of the present invention utilizing a single auxiliary pole;

FIGURE 13 is a diagrammatic front elevational view of the head assembly of FIGURE 12;

FIGURE 14 is a diagrammatic side elevational view of the head assembly of FIGURE 12;

FIGURE 15 is a diagrammatic illustration of the superposition of a cross field upon a longitudinal recording field; and

FIGURE 16 is a diagrammatic illustration of the resultant field corresponding to the superimposed fields of FIGURE 15.

As shown on the drawings:

The embodiments of FIGURES 1 through 8 of the present invention illustrate transducer heads utilized in recording a combination longitudinal and transverse magnetic track on a magnetizable record member. These heads have been found to have the advantage of properly recording both low and high frequencies, and are thus particularly suitable for video recording involving a wide range of frequency components.

The disclosure of FIGURES 9 through 16 of the present application involve subject matter divided from Camras application Serial No. 248,360 entitled "Electromagnetic Transducer Head and Method of Recording" of which the present application is a continuation-in-part. Said Camras application Serial No. 248,360 is in turn a

continuation-in-part of Camras U. S. Serial No. 137,001, filed January 5, 1950, and entitled "Electromagnetic Transducer Head," now Patent No. 2,628,285. The subject matter of FIGURES 9 through 16 relates to a transducer head construction for modifying a main recording field by means of a cross field to set up a resultant field with a very rapidly decaying magnetic intensity in the region of the trailing pole of the head assembly.

In the magnetic trasducer head **10** indicated diagrammatically in FIGURES 1 to 4, the high frequency component of a signal to be recorded is applied to the winding **11** linking the core **12** of the head for setting up the longitudinal recording field in the gap **13**. The low and medium frequency components of the signal are applied by means of the coil **15** to the auxiliary pole piece **16** which connects centrally of the base **18** with the main core **12**. The leg **16** has a pole piece **19** spaced laterally from the longitudinal pole pieces **20** and **21** to establish a transverse recording field in the recording gap **23**, which is preferably of the order of 3 to 15 mils (one mil=.001 inch) wide depending on the response and on the output level desired. As indicated in FIGURE 1 by the arrow **25** an elongated record member **26** is adapted to move first over the pole **20**, then the gap **13**, and then over the pole **21**. The high frequency components may be applied to the coil **11** without bias, but high frequency bias may be used in certain cases. The low and medium frequency components are preferably recorded with the aid of high frequency bias.

FIGURE 4 indicates the resultant magnetized sound track when the head of FIGURES 1 to 3 is employed, the sound track including a transverse magnetized region **29** and a longitudinally magnetized region **30**.

As indicated in FIGURE 5, the auxiliary pole piece **19** may be off-set longitudinally from the longitudinal gap **13** if desired.

FIGURES 6, 7 and 8 illustrate a transducer head **35** which is particularly suited for video recording with an auxiliary sound track for the audio part of the signal. In this case, the longitudinal core **36** has a pair of poles **37** and **38** defining a non-magnetic gap **39**, and the head is provided with auxiliary poles **40** and **41**, one on each side of the main core **36**. The core portion **43** providing the pole **40**, for example, connects with the base portion **44** of the core **36**, as does the core portion **47** providing the pole **41**. The pole **40** defines a transverse gap **50** with the main core **36**, while the pole **41** defines a transverse gap **51**. The gap **50** may be utilized to record the low and medium frequency components of a video signal, while the gap **51** may be utilized to record the sound corresponding to the video signal. For ease in editing the tape, it is convenient to have the gaps **50** and **51** substantially aligned with the longitudinal gap **39**. As indicated in FIGURE 7, the entire head may be embedded in a resin housing **53**, and an elongated record member **55** may be moved across the gaps **39**, **50** and **51**, and wound on a take-up spool **56**, FIGURE 6.

In each of the embodiments, the low and medium frequency auxiliary core, core **16** in FIGURE 2, and cores **43** and **47** in FIGURE 7, may be made of a ferrite composition or of mumetal, while the high frequency core, such as **12** in FIGURE 1 and 36 in FIGURE 6, may be of a ferrite composition.

By way of illustration of a further application of the lateral pole type head, in FIGS. 9, 10 and 11 is illustrated a magnetic transducer head for establishing a cross field to alter the shape and characteristics of the high frequency bias field at the main gap and/or the shape and characteristics of an intelligence signal field in the region of the main gap. In this case the effect of the auxiliary poles is to superimpose a cross field, indicated at A in FIGURE 15, onto the conventional longitudinal recording field B between the poles **60** and **61** defining the non-magnetic gap **62**. The cross field A and the longitudinal field B may represent the bias field at the recording gap, or the intelligence signal to be recorded. Since the two magnetic fields A and B are superimposed on each other and are of the same frequency, a resultant magnetic field is obtained which has a shape as indicated by the lines C in FIGURE 16. Since the lines of equal magnetic potential lie at right angles to the flux lines shown in the various figures of the drawing, it will be readily understood by those skilled in the art that a very rapidly decaying magnetic field occurs in the region of the trailing pole **61**.

It will furthermore be observed from an inspection of FIGURE 16 that the flux lines of the resultant field C extend generally at right angles to the magnetic record member **65** in the region of the leading pole **60**, but lie substantially parallel thereto in the region of the trailing pole **61**. Thus a much more nearly true longitudinal field is obtained than is the case with the conventional electromagnetic transducer heads of the present time which produce so-called longitudinal magnetic recording.

It will also be observed that by reversing the polarity of the field A with respect to the field B, a transverse recording field may be obtained rather than a longitudinal field, since in such event the vertical portion of the field will be in the region of the trailing pole piece **61** and the longitudinal portion will be in the region of the leading pole piece **60**.

Adjustment of the exact resultant field C desired may be made by varying the number of turns on the main core portions, by reversing connections to the coils with respect to one another, or by locating an auxiliary coil on either or both legs of the main core portion. A preferred adjustment is to have the superimposed cross field A at the record gap **62** of the same order of magnitude as or less than bias field required by the record medium **65** at the record gap. One adjustment which has been successfully used is to make the cross field two-thirds of the required bias field at the record gap. A null point in the perpendicular component near the recording gap may be produced by adjusting the perpendicular components of the cross field and the bias field in the preferred manner.

In FIGURES 9, 10 and 11 of the drawings, I have shown a form of head construction in which a head **73** includes a generally ring type main core portion and a pair of auxiliary poles **74** and **75** mounted at the sides of a record gap **76** defined by core legs **77** and **78**. The legs **77** and **78** have respectively a leading pole portion **79** and a trailing pole portion **80**. A pair of signal or voice coils **81** are mounted on the core legs **77** and **78** and a pair of bias coils **82** are mounted on the auxiliary legs **83** and **84**.

The voice and bias coils are illustrated as being connected in series and may thus be supplied with both the intelligence signal and the bias voltage. The auxiliary poles may be mounted in alignment with the gap **76**; but if it is desired to obtain a longitudinally curving field in order to obtain better cancellation and thus a more rapidly diminishing field at the trailing pole, the auxiliary poles may be longitudinally offset from the gap **76**. For example, if the auxiliary poles are longitudinally offset toward the leading pole (**60** in FIGURE 15), it will be understood that the flux lines A in FIGURE 15 would be curved so that the field can be adjusted to produce better cancellation with field B and a more nearly complete null point in the perpendicular component of the resultant flux C at the trailing pole **61** near the recording gap. Furthermore, the field from an offset auxiliary pole will progressively diminish in intensity beyond the recording gap so that the desired sharp gradient may be obtained near the gap without excessive field being impressed on the record member after leaving the gap.

The auxiliary bias coils **82** are advantageously left connected during playback, since an improved pick-up is obtained as well as improved recording.

In the case where both voice and bias voltages are

fed to all the coils, the flux diagrams of FIGURES 15 and 16 would be applicable to either the voice field or the bias field and to the resultant of the two fields in its general configuration. It will be understood by those skilled in the art that the head 73 of FIGURE 10 will give a voice field which is more uniform in the lateral direction when the bias coils 82 also receive the voice voltage.

In FIGURES 12, 13 and 14 of the drawings is illustrated a second form of the invention in which a head 86 has only a single auxiliary pole 87. The head may include an erase gap defined by an outer leg 88 and a center leg 89 and a record gap defined by a leading pole portion 90 of the center leg 89 and a training pole portion 91 of the other outer leg 92. Spacing of the gaps may be such that the erase coil has no substantial effect on the bias field as with conventional two-gap heads.

In this case an erase coil 93 is mounted on the outer leg 88 and a voice coil 94 and a bias coil 95 are illustrated as being mounted on the outer leg 92. The auxiliary leg 96 has an auxiliary coil 97 thereon. The erase coil 93 may be energized separately with the auxiliary coil 97, the voice coil 94 being energized with both bias and voice voltages, and the bias coil 95 not being used, or the erase coil 93, auxiliary coil 97 and bias coil 95 may all be energized from the same high frequency source.

As with the embodiment of FIGURES 9, 10 and 11, the auxiliary pole 87 may be displaced longitudinally as well as laterally from the longitudinal gap if desired.

It is to be understood that the present invention is not limited to the recording operation, since a reciprocal relation holds between recording and reproduction, as is usually the case in magnetic recording, and therefore beneficial results of a generally similar nature are obtained by the use of a head according to this invention in play-back or reproduction of a signal impressed upon a medium.

Referring to FIGURES 15 and 16, it will be seen that the cross field A should approximate in magnitude the main field B and cannot be negligible relative thereto if a substantially modified resultant field is to be obtained, such as indicated in FIGURE 16.

In the case of the two angularly related recording gaps, such as gaps 13 and 23 in FIGURE 4, it will be understood the gap 23, for example, could be disposed for perpendicular or vertical recording if desired by rearranging the polepiece 19, the perpendicular gap being arranged to define a record track distinct from that defined by the longitudinal gap 13. However, the transverse recording as shown appears more convenient.

It will be understood that modifications and variations may be effected without departing from the scope of the novel concepts of the present invention.

I claim as my invention:

A playback system comprising in combination a magnetic record member having a layer of magnetizable material with a pair of contiguous but laterally offset recorded traces extending therealong, one of said traces having magnetic fields extending substantially longitudinally to constitute a longitudinally recorded trace and the magnetic fields varying in the longitudinal direction along the record member in accordance with higher frequency components of a signal recorded on the record medium, the other of said traces having magnetic fields extending substantially transversely to constitute a transversely recorded trace, the magnetic fields varying in the longitudinal direction along the record member in accordance with lower frequency components of the signal recorded on the record medium, said recorded traces having substantially stronger leakage fields as a surface of said layer of magnetizable material than at the opposite surface of the record member, magnetic playback head means cooperating with said surface of said layer of magnetizable material and having a pair of pole portions defining a longitudinal gap for coupling the head means to said longitudinally recorded trace and having a pair of transversely spaced pole portions defining a transverse gap for coupling the head means to said transversely recorded trace, said magnetic playback head means having a longitudinal magnetic circuit including said pair of pole portions defining said longitudinal gap and having a transverse magnetic circuit including said transversely spaced pole portions and said transverse gap, said playback head means having a first output element linking said longitudinal magnetic circuit but spaced from said transverse circuit, and having a second output element coupled to said transverse circuit but spaced from said longitudinal magnetic circuit, and means for moving said record member relative to said playback head means to move the longitudinally recorded trace in the longitudinal direction across said longitudinal gap and to move said transversely recorded trace in the longitudinal direction across said transverse gap for producing an electric output from the first output element varying in accordance with the high frequency components of the signal recorded on the record medium and for producing an electrical variation in the second output element in accordance with the lower frequency components of the signal recorded on the record medium.

References Cited in the file of this patent

UNITED STATES PATENTS

1,643,467	O'Neill	Dec. 20, 1927
1,949,409	Cohen	Mar. 6, 1934
2,213,246	Heller	Sept. 3, 1940
2,272,821	Roys	Feb. 10, 1942
2,285,079	Behre	June 2, 1942
2,536,029	Camras	Jan. 2, 1951
2,539,400	Camras	Jan. 30, 1951
2,547,464	Hehr	Apr. 3, 1951
2,643,130	Kornei	June 23, 1953
2,712,572	Roberts	July 5, 1955
2,803,708	Camras	Aug. 20, 1957
2,832,839	Muffly	Apr. 29, 1958

FOREIGN PATENTS

174,220	Austria	Mar. 10, 1953