May 7, 1957 F. H. BEARDSLEY 2,791,328

MECHANICAL RESONANT DISC SORTING SYSTEM

Filed June 24, 1953 4 Sheets-Sheet 1

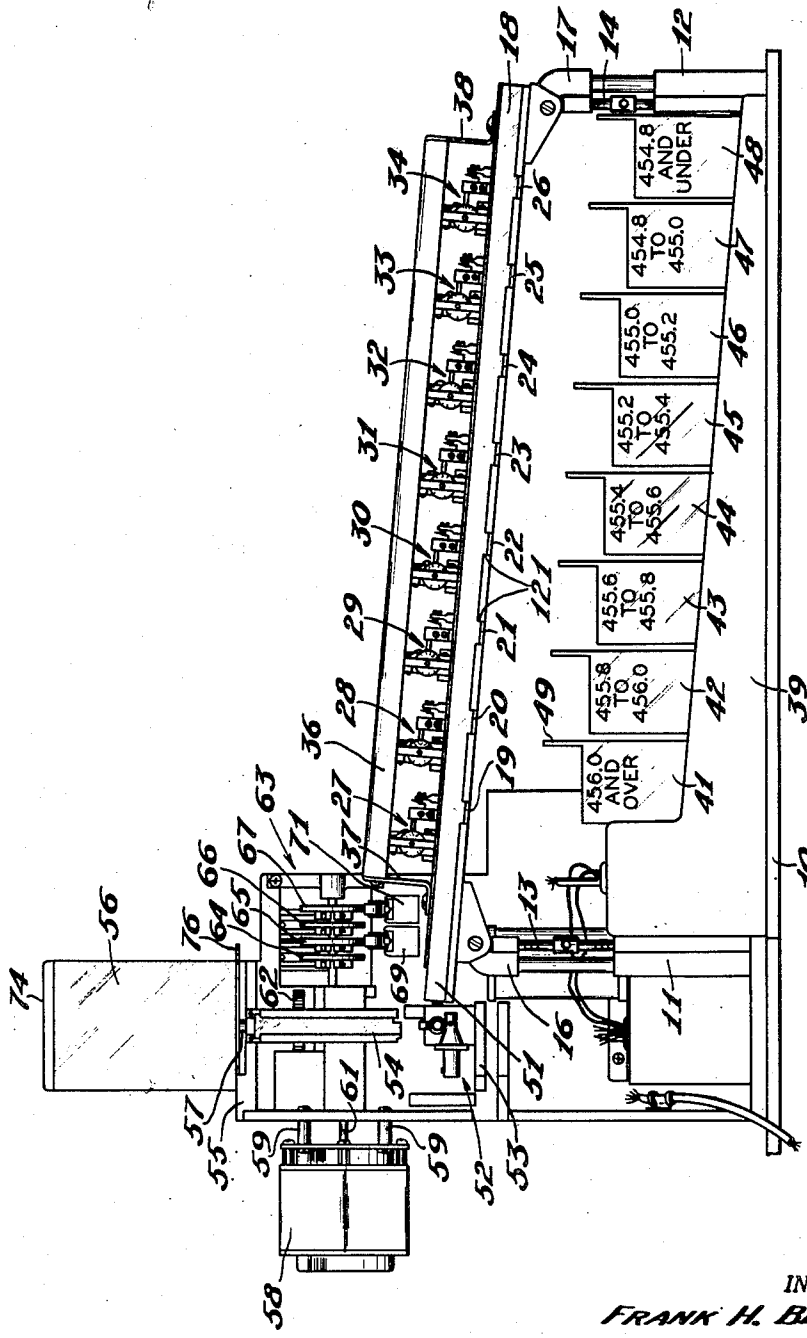


Fig 1

INVENTOR.
FRANK H. BEARDSLEY
BY
Morris Moody

May 7, 1957 F. H. BEARDSLEY 2,791,328

MECHANICAL RESONANT DISC SORTING SYSTEM

Filed June 24, 1953 4 Sheets-Sheet 2

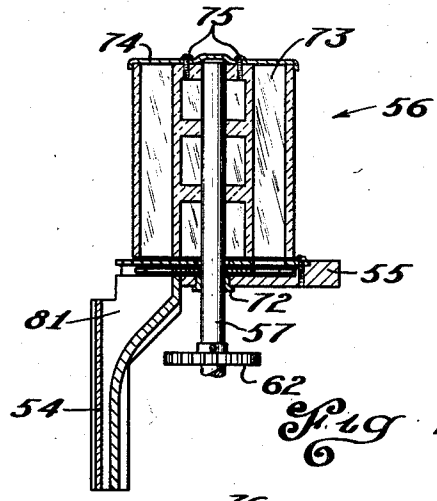


Fig 2

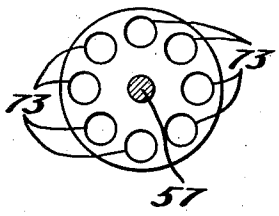


Fig 3

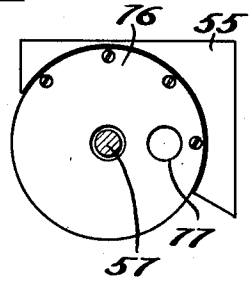


Fig 4

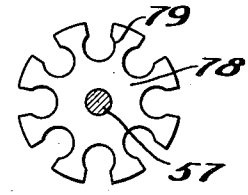


Fig 5

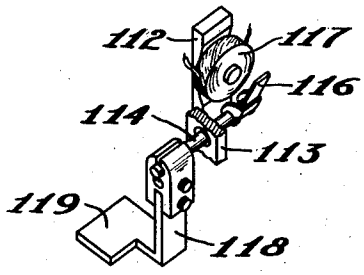


Fig 8

INVENTOR.
FRANK H. BEARDSLEY
BY Morris Moody
ATTORNEY

May 7, 1957 F. H. BEARDSLEY 2,791,328

MECHANICAL RESONANT DISC SORTING SYSTEM

Filed June 24, 1953 4 Sheets-Sheet 3

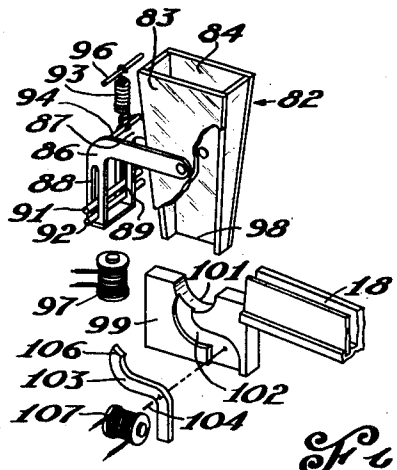


Fig 6

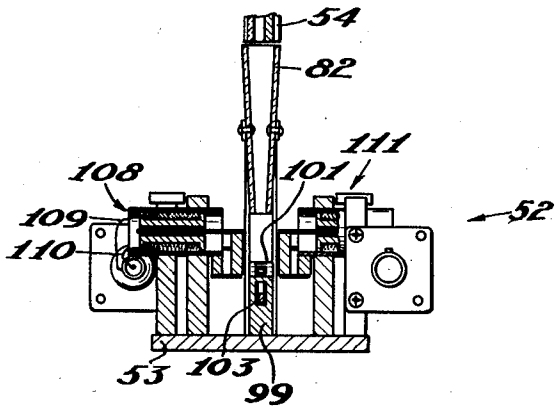


Fig 7

INVENTOR.
FRANK H. BEARDSLEY
BY
Mark Moody
ATTORNEY

May 7, 1957 F. H. BEARDSLEY 2,791,328

MECHANICAL RESONANT DISC SORTING SYSTEM

Filed June 24, 1953 4 Sheets-Sheet 4

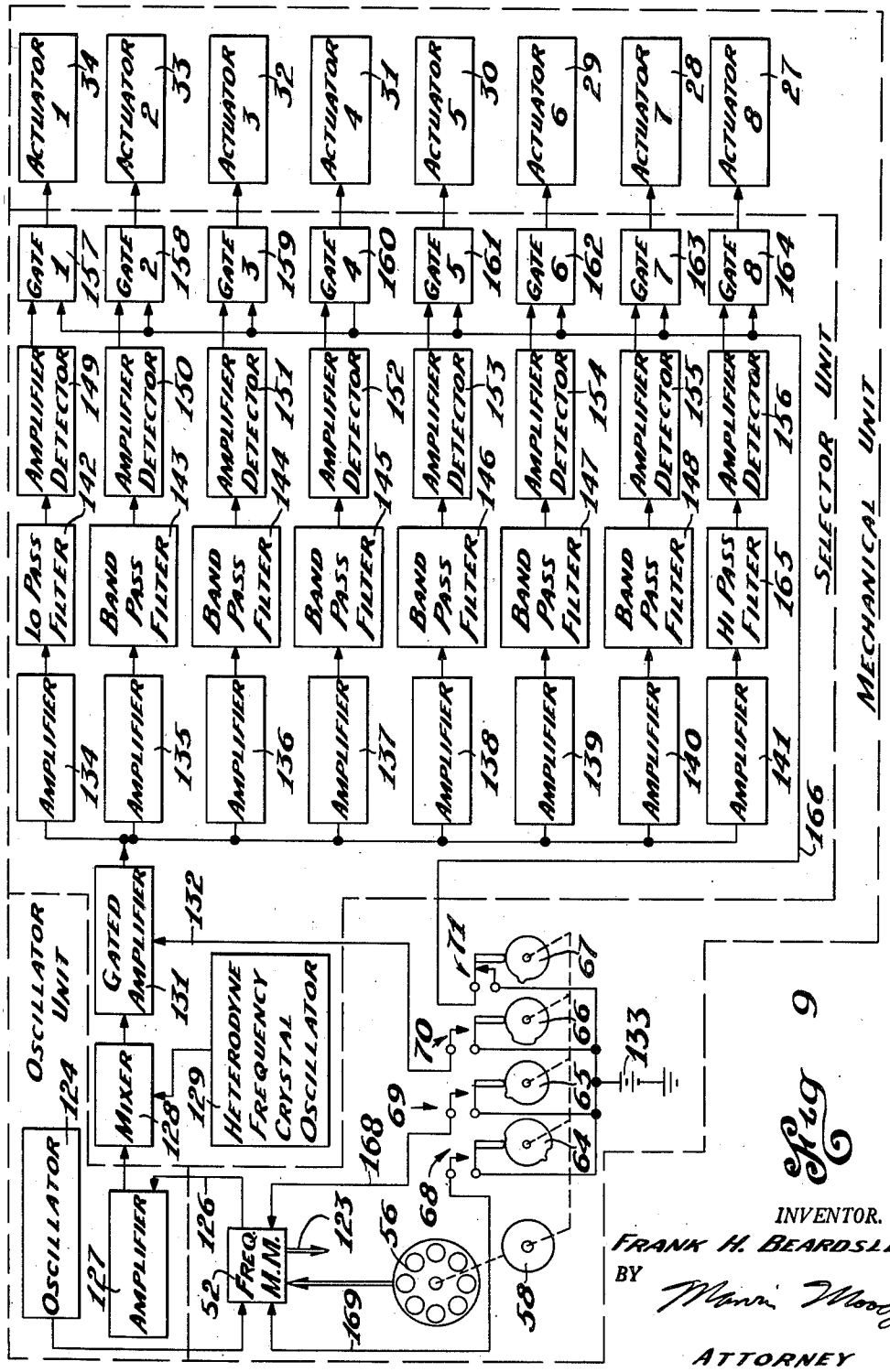


Fig 9

INVENTOR.
FRANK H. BEARDSLEY
BY Marvin Moody
ATTORNEY

United States Patent Office 2,791,328 Patented May 7, 1957

2,791,328

MECHANICAL RESONANT DISC SORTING SYSTEM

Frank H. Beardsley, Glendale, Calif., assignor to Collins Radio Company, Cedar Rapids, Iowa, a corporation of Iowa

Application June 24, 1953, Serial No. 363,891

4 Claims. (Cl. 209—72)

This invention relates in general to sorting means and in particular to apparatus for sorting discs used in electromechanical filters according to their resonant frequencies.

As electromechanical resonators have become recognized as effective means of filtering electrical signals, it has become desirable to produce them on a mass production basis. Electromechanical resonators may take various shapes; however, applicant has discovered that very good results are obtained with disc-shaped resonators which may be formed, for example, by cutting slices off of rod stock. To determine the resonant frequency of each disc by hand is a tedious job and applicant has produced this invention which automatically separates mechanical resonating elements according to their resonant frequency and deposits them in a suitable bin. In this process, the resonators are controlled only by the machine and an operator need only fill the hopper of the machine and empty the bins when they are full. Thus, a tedious manual task has been assumed by a machine.

For a detailed description of mechanical resonators which are sorted by this invention, reference may be made to the Patent Number 2,693,579 entitled, "Longitudinal Support for Mechanical Filters," which issued November 2, 1954. The present invention and Patent No. 2,693,579 are assigned to the same assignee.

It is an object of this invention to provide a sorting machine capable of separating mechanical resonators according to their resonant frequency.

Another object of this invention is to provide an efficient sorting machine which is capable of doing the work of a number of people.

A feature of this invention is found in the provision for a hopper that is connected to a timed feed mechanism which periodically drops a mechanical resonator to a frequency measuring means that in turn actuates one of a plurality of trap doors through which the resonator will fall after being ejected from the frequency measuring means.

Further objects, features and advantages of the invention will become apparent from the following description and claims when read in view of the drawings, in which:

Figure 1 is a side view of the sorting machine of this invention;

Figure 2 is a sectional view through the hopper of this invention;

Figure 3 is a top view of the hopper;

Figure 4 is a top view of the feeder plate;

Figure 5 is a top view of the drive plate;

Figure 6 is an exploded view of the catcher and a frequency measuring support for the ejector mechanism;

Figure 7 is a sectional view of the frequency measuring means;

Figure 8 is a detailed view of a trap door mechanism; and

Figure 9 is a schematic view of the machine showing the inter-relationships.

Figure 1 illustrates a base plate **10** upon which are mounted stand-offs **11** and **12** which may be adjusted by lead screws **13** and **14** so as to vary the height of the upper portions **16** and **17** of the stand-offs. A guide rail **18** is supported between the upper portions **16** and **17** and has a plurality of trap doors **19** through **26** which are shown in detail in Figure 8 and will be described later. Mounted above each trap door is an electromagnetic actuating means **27** through **34** which are supported between the guide rail **18** and an upper supporting member **36** which is connected by brackets **37** and **38** to the guide rail.

A generally triangular base member **39** rests on the base plate **10** between the stand-offs **11** and **12** and a plurality of containers **41** through **48** are mounted thereon. They each have a high side **49** which serves as a deflector partition between the containers.

At the upper end **51** of the guide rail **18** is mounted a frequency measuring means **52** which is supported on a suitable frame structure **53** attached to the base plate **10**. The frequency measuring means also comprises a catcher mechanism and an ejector to be later described. A vertical chute **54** extends toward the frequency measuring means **52** and terminates on an upper supporting plate **55** which is in turn connected to the supporting structure.

A hopper **56** is rotatably supported on a shaft **57** above the chute **54** and periodically drops an electrical resonator to the frequency measuring means **52**. A synchronous motor **58** is attached to the supporting structure **55** by stand-offs **59** and has an output shaft **61** which is geared to a driving gear **62** connected to the hopper **56**. The shaft **61** is also connected to a timing assembly **63** which comprises four cams **64**, **65**, **66** and **67**. The timing cams have irregular surfaces upon which ride rollers that actuate switches **68**, **69**, **70** and **71**. Two of these switches are shown in Figure 1 and the other two are shown in Figure 9.

Before entering into the detailed description, so as to facilitate understanding of the invention, let us trace a mechanical resonator through the system to give a general idea of the operation. A disc which may be the mechanical resonator being tested, falls from the hopper **56** through the chute **54** to the frequency measuring means **52**. The frequency is measured and one of the actuators **27** through **34** responds to the electrical output thus obtained, and causes one of the trap doors **19** through **26** to open. An ejector throws the disc out of the frequency measuring means so that it rolls down the guide rail **18** and falls through the open trap door into the proper container. The timing cams **64** through **67** time various parts so that the sequence is proper.

Figures 2 through 5 disclose the detailed structure of the hopper and it is seen that the shaft **57** is rotatably supported on the member **55** by bearing **72**. The hopper is formed with a plurality of vertical openings **73** into which the mechanical resonators may be placed. A lid **74** may be attached by set screw **75** to cover the hopper when it is loaded. The openings **73** pass clear through the hopper and a supporting plate **76** is mounted to the plate **55** below the hopper and is formed with a single opening **77**.

The discs ride on the supporting plate **76** and as each opening **73** passes the opening **77**, a single disc drops down through the opening **77**. A feeder wheel **78** is rotatably supported by the shaft **57** below the support plate **76** and is formed with a plurality of generally arcuate openings **79** which receive mechanical resonators through the opening **77** from the hopper. The wheel **78** rotates with the hopper and each of the openings **79** will pick up a disc when it passes the opening **77**. The wheel **78** will carry a disc with it until the disc passes the upper

end 81 of the chute 54. Then the disc will fall down the chute 54 to the frequency measuring means.

It is to be particularly noted that the plate 55 is spaced closely adjacent to the bottom of the plate 76 so that the disc cannot fall through but must slide on the plate 55 until the wheel 78 drops it on the chute 54. Thus, the structures shown in Figures 2 through 5 allow a periodic feeding of discs to the chute 54 with only one disc being fed at a time. Since the motor 58 drives shaft 57 through the gear 62, the rate of flow of discs down the chute 54 will depend upon the motor speed and there will be a definite timed relationship between operation of the various parts of the machine.

The frequency measuring means is best shown in Figures 6 and 7. The lower end of the chute 54 is immediately above a catcher 82. The catcher 82 is generally funnel-shaped and is formed with flat sides 83 and 84 which are connected to supporting arms 86 and 87, respectively. The lower ends of the supporting arms 86 and 87 are formed with guide slots 88 and 89 through which extend guide pins 91 and 92, respectively. Guide pins 91 and 92 are connected to the frame in a conventional manner.

A spring 93 extends from a cross bar 94 connected to the arms 86 and 87 to a bar 96 attached to the frame. This provides a spring bias to hold the catcher in the "up" position. An actuating solenoid 97 is mounted to the frame below the catcher and actuates it so as to move it from an "up" to a "down" position.

In the "down" position the lower end 98 of the catcher is closely adjacent a holding barcket 99 which is formed with an arcuate slot 101 and into which the disc is received. As best shown in Figure 7, the holding bracket 99 is supported on the base 53 and is formed with a generally S-shaped slot 102 in which is received an ejector arm 103 that is pivoted by a pin 104 to the holding bracket 99. The ejector arm 103 may move relative to the slot 102 and has disc engaging portion 106 for kicking a disc out of the arcuate slot 101 into the upper end of the guide rail 18. A solenoid 107 is mounted adjacent the lower end of the arm 103 to actuate the ejector.

As shown in Figure 7, on either side of the holding bracket 99 adjacent the slot 101 are mounted magnetostrictive driving and output means such as described in the co-pending application entitled "Air Coupled Tuning Measurement Method for a Mechanically Vibrating Disc," Serial No. 338,801, filed February 25, 1953, now Patent No. 2,716,887 and assigned to the assignee of the present invention. As shown in that patent application, a magnetostrictive driving means 108 has input leads 109 and 110 and an output magnetostrictive means 111 picks up the vibrations that pass through the disc. Since this structure is described in detail in this co-pending application, it will not be described in detail herein. The main function of this structure is to excite the disc so that it will oscillate or vibrate at its resonant frequency and thus furnish an output to the output magnetostrictive means 111. Means 111 is connected to circuitry to be described later.

Figure 8 illustrates one of the trap door electromagnetic actuating means indicated by 27—34 in Figure 1.

A support 112 is attached between members 18 and 36. A second support 113 is attached to member 18 and rotatably supports a trap door supporting shaft 114. One end of shaft 114 supports an armature 116. A coil 117 is attached to the support 112.

The other end of shaft 114 supports an L-shaped trap door 118. The bottom 119 of the trap door is received in a slot 121 formed in member 18 as shown in Figure 1. It is to be realized that each actuating means 27—34 is as above described.

Figure 9 illustrates schematically the mechanical structure and the electrical circuitry required to time and actuate the various portions. The structure shown in Figure 7 has been called a frequency measuring means 52 and is shown in Figure 9. It receives the discs from the hopper 56. The discs are ejected from the hopper into the guide rail 18 as shown by the arrow 123 in Figure 9. It is to be noted that the frequency measuring means 52 receives an input from an oscillator 124 which is supplied to the leads 109 and 110 of the input magnetostrictive driving means so as to excite the disc being tested.

The output of the output magnetostrictive means is supplied by the lead 126 to an amplifier 127 which is connected in turn to a mixer 128 that receives an input from a heterodyne oscillator 129.

The function of this oscillator is to convert the resonant frequency of the disc to a more usable range. The output of the mixer 128 is connected to a gated amplifier 131 which also receives an input by the lead 132 from switch 70 which is controlled by the cam 66.

The switch 70 has an open and closed position and the closed position connects the lead 132 to a battery 133 which has its opposite side connected to ground. It is to be noted that the cam 66 has high and low portions with the high portion being substantially shorter than the low portion.

The output of the gated amplifier is fed to a plurality of amplifiers 134 through 141. The outputs of the amplifiers 134 through 141 are connected to filters with the amplifier 134 being connected to a low pass filter 142 and the amplifier 141 being connected to a high pass filter 165. The amplifiers 135 through 140 are connected to bandpass filters 143 through 148 with each bandpass filter covering a different range with the high side cut-off of one filter coinciding with the low side cut-off of the next filter.

The outputs of the filters 142 through 148 and 165 are connected to amplifier detectors 149 through 156. Gates 157 through 164 are connected to outputs of the detectors 149 through 156. Gates 157 through 164 also receive inputs by the lead 166 from switch 71 which is controlled by the cam 67. Mechanical actuators 27 through 34 are controlled by the outputs of the gates 157 through 164.

It is to be noted that the cam 67 has a high point on its surface. The cams 66 and 67 control the gated amplifier 131 and the gates 157 through 164, respectively, so as to actuate one of the trap doors 118 each time a disc is tested. The output of the mixer 128 will not pass the gated amplifier 131 until a gate is received from the switch 70 and the gates 157 through 164 will not pass a signal until switch 71 is closed. It is to be noted that the cams 66 and 67 are mounted on the common shaft 61 so that they have a predetermined time relationship. It is to be noted that as shown in Figure 6, energizing coils 97 and 107 operate, respectively, the catcher mechanism which catches the disc as it falls from the chute 54 and the ejector for ejecting the disc from the member 99.

These coils are controlled, respectively, by the cams 64 and 65 which are also mounted on the shaft 61. It is to be noted that cam 65 has a single high point which engages switch 69. The switch 69 has its movable contact connected to a battery with its opposite side connected to ground and the other terminal connected to lead 168 which is connected to the solenoid 107 to actuate the ejector 103 once during the cycle corresponding to the position of the projection on the cam 65.

The cam 64 controls the position of switch 68 which has its stationary terminal connected to a battery that has its opposite side grounded and the other terminal is connected to a lead 169 which is connected to relay coil 97 which energizes the catcher mechanism 82. It is to be noted that this cam has two high portions with one being very small and the other extending about half way about its periphery.

Thus, for the large high portion the catcher mechanism is down and for the small high portion it momentarily goes down. At other times it is in the "up" position to allow the disc to be tested. It is to be realized that it

catches the disc and stabilizes it before raising so that it may be tested.

It is seen that this invention provides means for testing the resonant frequency of a plurality of discs in a very efficient manner. As an example, suppose that in the container **41** it is desired to catch all discs which have a frequency of 456.0 kilocycles or over and that in the container **42** it is desired to catch discs which have a frequency within the range of 455.8 to 456.0 kilocycles. Container **43** catches discs with frequencies between 455.6 to 455.8 kilocycles, in container 44 from 455.4 to 455.6 kilocycles, container **45** from 455.2 to 455.4 kilocycles, container **46** from 455.2 to 455.0 kilocycles, container **47** from 455.0 to 454.8 kilocycles, and container **48** receives 454.8 kilocycles and under. Thus all discs tested will be fed into one of the eight containers which are separated 200 cycles in frequency. Then the electromechanical filters may be assembled correctly from the discs without re-testing them.

It is seen that this invention provides a very rapid manner of testing the resonant frequency of discs.

Although it has been described with respect to a particular embodiment thereof, it is not to be so limited as changes and modifications may be made therein which are within the full intended scope of the invention, as defined by the appended claims.

What is claimed is.

1. A machine for automatically sorting electromechanical resonators according to their resonant frequencies comprising, a base member, a hopper holding said resonators and periodically releasing one of them supported on said base member, a frequency measuring means for determining the resonant frequency of the resonators mounted on said base member below said hopper and arranged to receive resonators from said hopper, an ejector forming a part of said frequency measuring means and periodically ejecting a resonator therefrom after its resonant frequency has been determined, a guide rail mounted on said base member adjacent said frequency measuring means and positioned so as to receive the ejected resonators, a plurality of trap doors mounted in said guide rail, actuating means connected to each of said trap doors, a selector unit receiving the output of said frequency measuring means and producing outputs which depend on the frequency of the resonator being measured, said selector unit connected to said actuating means to actuate one of the trap doors corresponding to the frequency of the disc being measured, a plurality of containers mounted below said trap doors, and a timing mechanism connected to said hopper, said frequency measuring means, said ejector, and said actuating means to control the time sequence thereof.

2. Apparatus for automatically separating electromechanical resonators according to their frequencies comprising, a base member, a hopper rotatably supported from said base member, a driving means connected to said hopper, a timing cam assembly connected to said driving means, a vertical chute attached to said hopper, a frequency measuring means mounted below said vertical chute to receive electromechanical resonators therefrom, a catcher mechanism forming a part of said frequency measuring means and mounted below said vertical chute to receive said electromechanical resonators and capable of being actuated up and down, an actuating relay connected to said catcher mechanism to actuate it, said actuating relay controlled by the timing cam assembly, an ejector mechanism forming a part of said frequency measuring means and capable of being actuated, a second relay electrically connected to said timing cam assembly and controlling said ejector mechanism to eject electromechanical resonators from said frequency measuring means, a guide rail mounted to said base member adjacent said frequency measuring means so as to receive the electromechanical resonators therefrom, a plurality of trap doors formed in said guide rail, a plurality of electromagnetic actuators connected to said trap doors and electrically connected to said frequency measuring means and said timing cam assembly, and a plurality of containers mounted, respectively, below each trap door.

3. A machine for automatically separating electromechanical resonators according to their resonant frequencies comprising, a base member, a hopper rotatably supported on said base member and holding said resonators and periodically releasing one of them, a driving means attached to said hopper, a frequency measuring means connected to said base member below said hopper and receiving said mechanical resonators therefrom, said frequency measuring means including magnetostrictive drive and output means, a catcher mechanism forming a part of said frequency measuring means and mounted below the hopper and capable of being actuated from a first to a second position, and an ejector mechanism forming a part of the frequency measuring means and capable of being actuated to eject resonators, an oscillator connected to said magnetostrictive drive means, a series of four timing cams connected to said driving means, a gated amplifier receiving an input from one of said timing cams and an input from said output magnetostrictive means, a plurality of bandpass filters separated in frequency receiving the output of said gated amplifier, a plurality of amplifier detectors connected to the outputs of said filters, a plurality of gates receiving the output of said amplifier detectors and inputs from a second of said timing cams, the catcher mechanism receiving an input from the third timing cam, the ejector receiving an input from the fourth timing cam, a plurality of electromagnetic actuators connected to the outputs of said gates, a guide rail mounted on said base member adjacent said frequency measuring means, a plurality of trap doors formed in said guide rail, said actuators connected, respectively, to said trap doors to control them, and a plurality of containers supported below said trap doors to separate the electromechanical resonators according to their frequencies.

4. A machine for automatically separating electromechanical resonators according to their resonant frequencies comprising, a base member, a hopper rotatably supported on said base member, and holding a plurality of said resonators, a driving means attached to said hopper, a frequency measuring means connected to said base member below said hopper and receiving said mechanical resonators therefrom, said frequency measuring means including magnetostrictive drive and output means, an oscillator connected to said magnetostrictive drive means, a series of four timing cams connected to said driving means, an ejector in said frequency measuring means controlled by one of said timing cams, a catcher in said frequency measuring means controlled by another of said timing cams, a gated amplifier receiving an input from one of said timing cams and an input from said output magnetostrictive means, a plurality of bandpass filters separated in frequency receiving the output of said gated amplifier, a plurality of amplifier detectors connected to the outputs of said filters, a plurality of gates receiving the output of said amplifier detectors and inputs from a second of said timing cams, a plurality of electromagnetic actuators connected to the outputs of said gates, a guide rail mounted on said base member adjacent said disc jig, a plurality of trap doors formed in said gated rail, said actuators connected, respectively, to said trap doors to control them, and a plurality of containers supported below said trap doors to separate the electromechanical resonators according to their frequencies.

References Cited in the file of this patent

UNITED STATES PATENTS

2,566,767 Hunt ---------- Sept. 4, 1951