

July 6, 1965

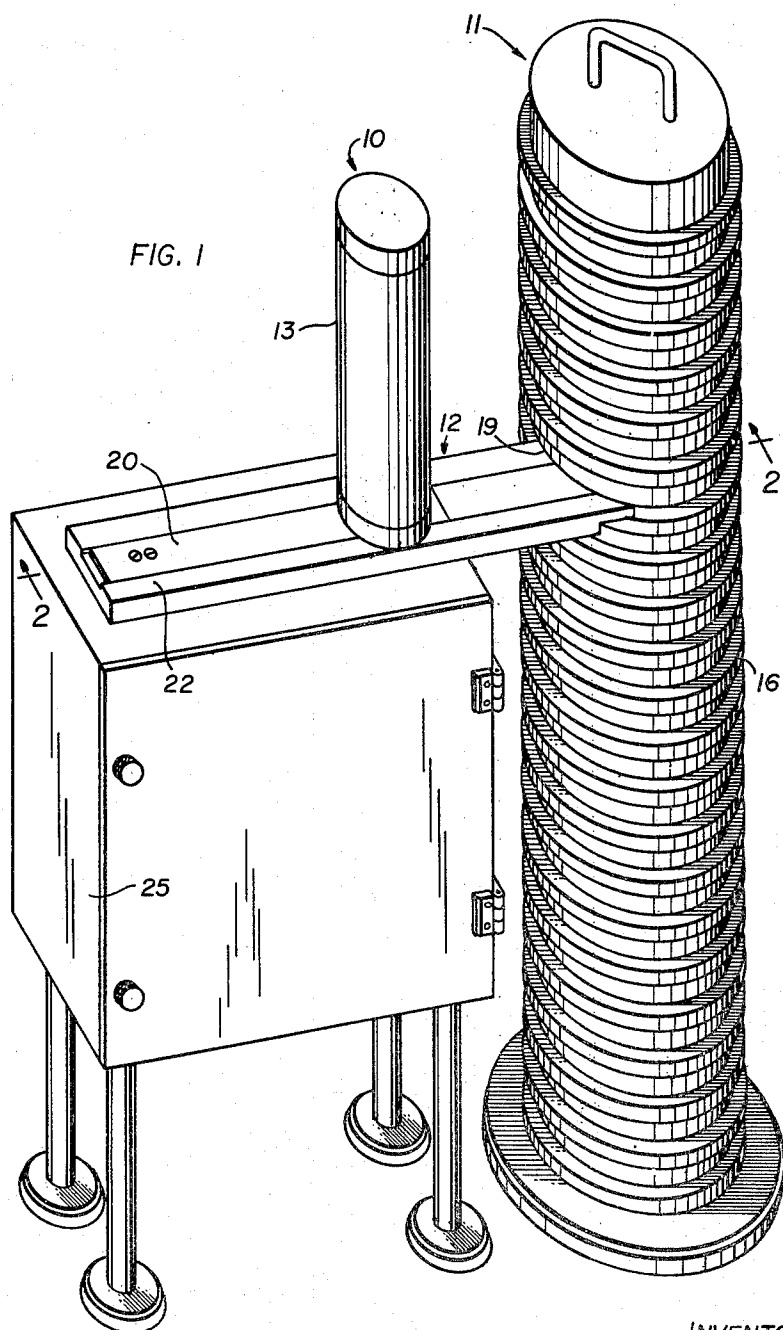
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3,193,684

AUTOMATIC SAMPLE CHANGER

Filed July 21, 1961

4 Sheets-Sheet 1



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4 Sheets-Sheet 2

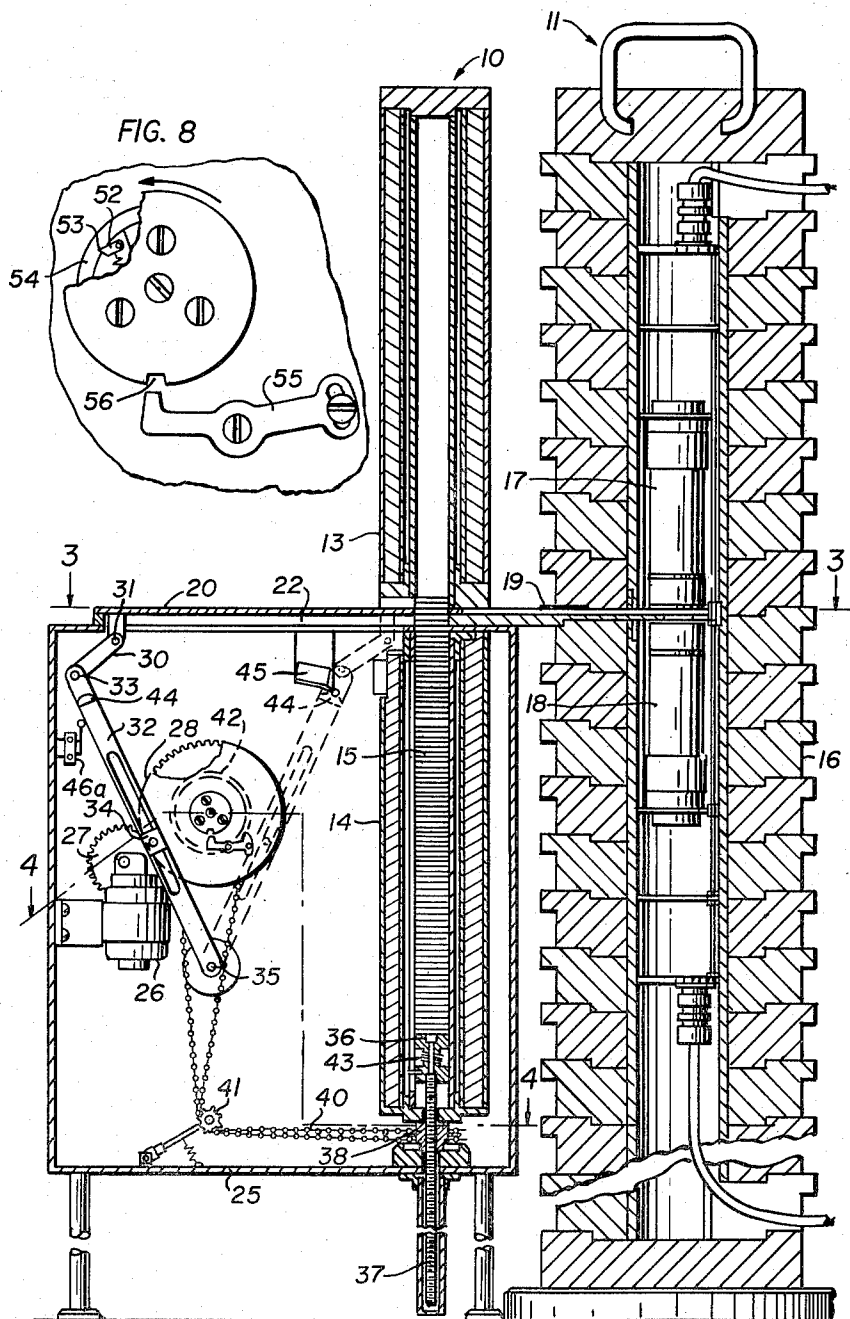


FIG. 2

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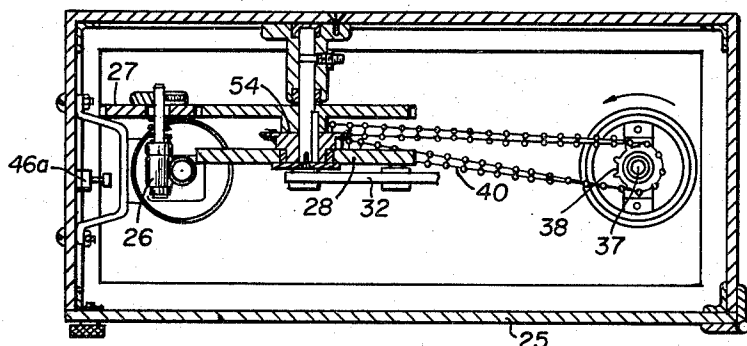


FIG. 4

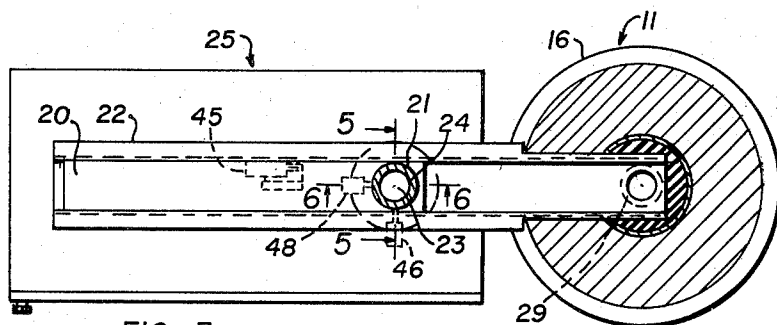


FIG. 3

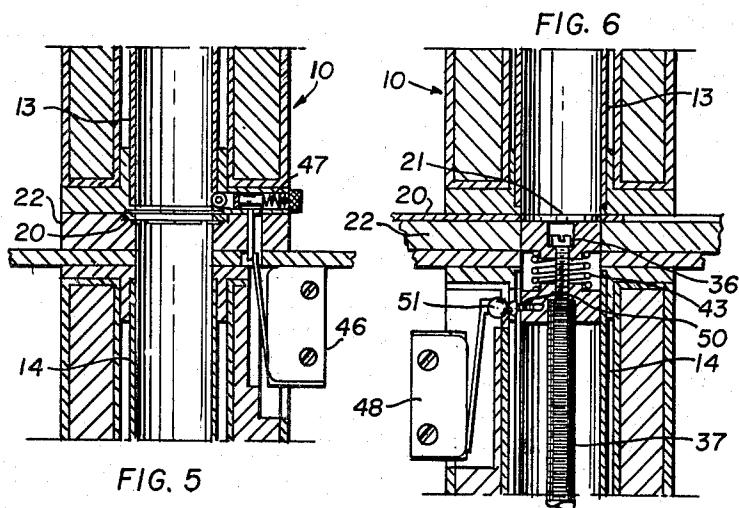


FIG. 5

FIG. 6

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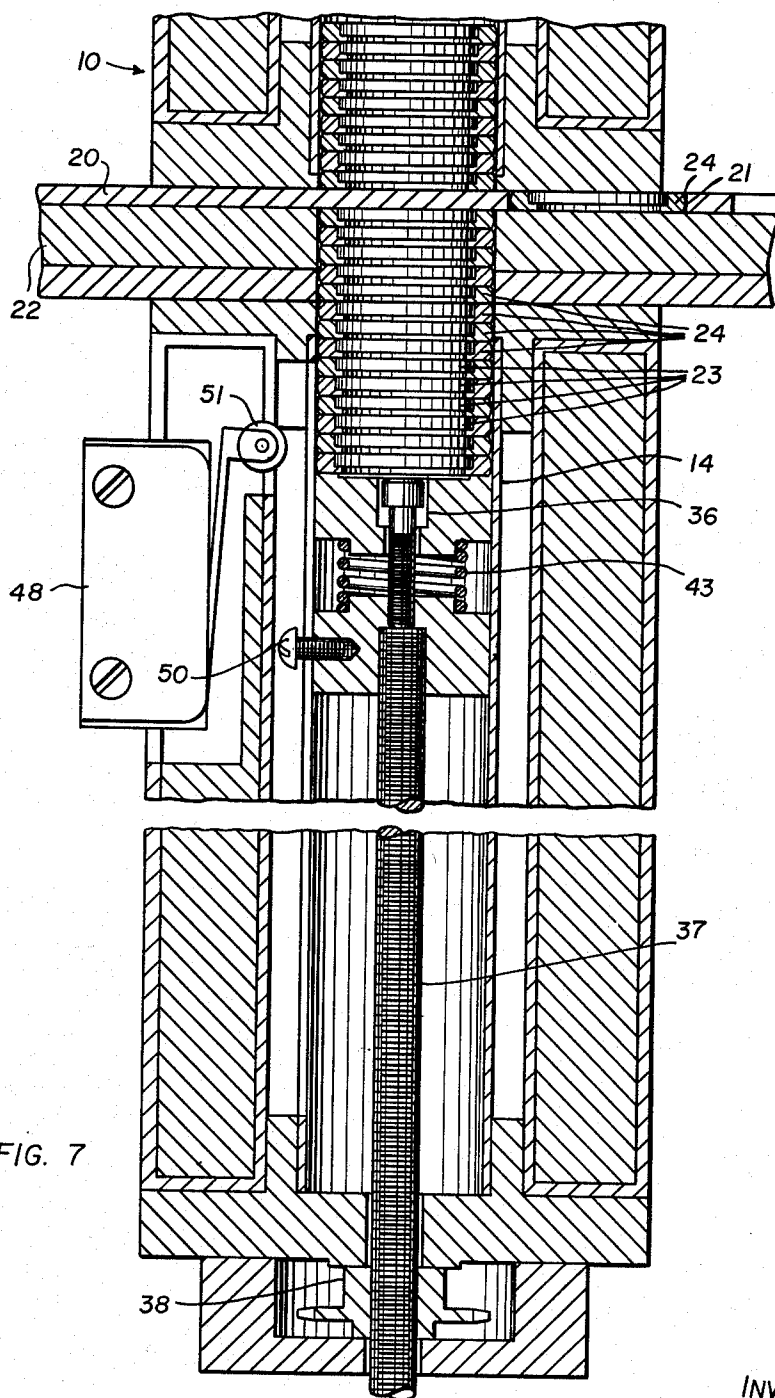


FIG. 7

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AUTOMATIC SAMPLE CHANGER

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7 Claims. (Cl. 250-106)

This invention relates to apparatus for transporting a radioactive sample and is of particular advantage in automatically transporting radioactive samples from a storage station to a counting station where the radiation from the samples is counted, and returning the samples to the storage station after they have been counted.

Such apparatus is commonly known as an automatic sample changer and is used to position radioactive samples in a lead castle where the radiation from the samples is counted by a radiation measurement device, for example, by an electroscope or by scintillation counters. The radioactive samples, which usually take the form of wires, foils or evaporated solutions, are mounted on trays which are placed in holders for counting.

Prior to applicant's invention, a well known automatic sample changer consisted of a horizontal turntable for carrying sample containing holders in a circular path from a storage station to one or more counting stations. The holders were stacked one on top of the other in a magazine above the turntable at the storage station. The holders were accepted one by one by the turntable which rotated taking the holders in a circular motion in turn to the counting station where the radiation from the samples was counted. After counting, the turntable returned the holders to the storage station where they were removed from the turntable by being lowered into a magazine below the turntable.

This type of automatic sample changer had certain serious disadvantages. At the counting station, which usually consisted of a lead castle containing the electroscope or the scintillation counters, there must be an opening in the castle which is large enough to accept the sample carrying holders and the means for transporting them. As can be readily appreciated, the use of a turntable necessitated an opening in the castle large enough to accept a substantial sector of the turntable's area. This created a serious disadvantage in that the electroscope or the scintillation counters were not adequately shielded from either background radiation or radiation from the stored samples. In addition, the maximum diameter of a turntable was limited by design considerations which meant that the counting station had to be in close proximity to the storage station. Thus, extra shielding was required for the scintillation counters to protect them from radiation from the stored stack of samples.

The present invention provides an automatic sample changer that permits the scintillation counters or the electroscope in the lead castle to be well shielded from both background radiation and radiation from the stored samples by requiring that the opening in the lead castle be only slightly larger than a sample containing holder.

According to the invention, apparatus is provided for transporting a radioactive sample from a storage station to a counting station which comprises a shielded storage means at the storage station for storing the sample, carrying means adapted upon linear motion in one direction to transport the sample from the storage station to the counting station and transfer means to transfer the sample from the storage means to the carrying means at the storage station. Drive means are provided to cause the transfer means to transfer the sample from the storage means to the carrying means at the storage station and

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to cause linear motion of the carrying means in said one direction.

The drive means is further adapted to cause linear motion of the carrying means in the opposite direction to said one direction to return the sample to the storage station after the radiation from the sample has been counted and to cause the transfer means to transfer the sample at the storage station from the carrying means back to the storage means.

The radiation from many samples can be automatically counted by adapting the drive means to cause repetitive reversible linear motion of the carrying means between the storage and counting stations. For the storage means, applicant prefers to use axially aligned first and second chambers each adapted to store a stack of sample containing holders, and for the carrying means, an elongated slide having an aperture therein for receiving a sample containing holder. The slide is located intermediate the first and second chambers and is normal to the longitudinal axis thereof. This slide is adapted to be moved to a storage position and a counting position, the aperture being in axial alignment with the first and second chambers when the slide is in its storage position and being at the counting station when the slide is in its counting position. The transfer means is adapted to transfer one sample from the first chamber to the aperture and another sample from the aperture to the second chamber whenever the slide is in its storage position.

Because the slide can be of any desired length, the storage station can be kept a considerable distance away from the counting station. Thus, a minimum of extra shielding is required for the scintillation counters to protect them from stray radiation from the stored stack of samples.

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

FIGURE 1 is a general perspective view of the apparatus and a lead castle for counting the radiation,

FIGURE 2 is a sectional view taken along line 2-2 of FIGURE 1 showing the internal mechanism of the apparatus and the scintillation counters in the lead castle,

FIGURE 3 is a plan view partly in section taken along line 3-3 of FIGURE 2 showing the carrying means of the apparatus,

FIGURE 4 is a sectional view taken along line 4-4 of FIGURE 2 showing details of the drive means and the transfer means of the apparatus,

FIGURE 5 is a sectional view taken along line 5-5 of FIGURE 3,

FIGURE 6 is a sectional view taken along line 6-6 of FIGURE 3,

FIGURE 7 is a greatly enlarged view of a portion of FIGURE 2 and

FIGURE 8 is an enlarged view of another portion of FIGURE 2.

Referring to the drawings, there is shown in FIGURE 1 a storage station 10, a counting station 11 and a carrying means 12. As best shown in FIGURE 2, there is a storage means at the storage station 10 comprising first and second axially aligned elongated shielded chambers 13 and 14 respectively. Each chamber is adapted to store a stack of radioactive samples 15. At the counting station 11, a conventional lead castle 16 is provided having therein a pair of axially aligned scintillation counters 17 and 18 adapted to count radiation from the radioactive samples. The carrying means 12 is best illustrated in FIGURES 2, 3 and 8 and comprises an elongated slide 20 having an aperture 21 therein. The slide 20 rides in a track 22 intermediate the first and second chambers 13 and 14 and normal to the longitudinal axes thereof. The track 22 extends through a small aperture 19 in the lead castle and terminates inter-

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mediate the scintillation counters 17 and 18. An aperture 29 is provided in the track 22 in axial alignment with the counters 17 and 18 so that all the radiation from the sample can be counted, i.e. the counters are capable of 4π counting geometry. The slide 20 is adapted to be moved to a storage position and to a counting position, the aperture 21 being in axial alignment with the first and second chambers 13 and 14 when in its storage position and in axial alignment with the scintillation detectors 17 and 18 when in its counting position. The radioactive samples which usually take the form of wires or foils are mounted on trays 23 (FIGURE 7) which are carried by holders 24. The aperture 21 is of a size to receive one holder 24 therein. The aperture 19 is just large enough to accept the track 22 and the slide 20 which partially block the hole 19 providing some additional shielding at this point.

A drive means, a transfer means and the second chamber 14 are enclosed in a cabinet 25. As best illustrated in FIGURES 2 and 4, the drive means comprise a reversible motor 26, a gear 27 driven by the motor 26 which in turn drives an annular rotatable member 28. A linkage mechanism comprises a first arm 30 pivotally attached to the slide 20 at 31 and pivotally attached to one end of a second arm 32 at 33. The arm 33 is driven by the rotatable member 28 at a point 34 radially removed from the center thereof. The other end of the arm 32 is pivotally attached at 35. The drive means is thus adapted to cause repetitive, reversible linear motion of the slide 20 between its storage and counting positions, the arms 30 and 32 being shown in solid lines for the storage position and in dotted lines for the counting position.

The transfer means comprises a piston member 36, best illustrated in FIGURE 7, located in the second chamber 14 and adapted to abut the bottom sample containing holder 24 therein. Means are provided for causing axial movement of the piston member 36 within the second chamber 14 comprising a lead screw 37 connected to the piston member 36, a driven nut 38 for driving the lead screw 37, an endless chain belt 40 (FIGURES 2 and 4) for driving the nut 38, the chain belt 40 passing over a sprocket wheel 41 and connected to a gear 42 which is coaxial with the rotatable member 28 and is driven thereby. The axial lead of the screw 37 is so chosen that one revolution of the rotatable member 28 will axially move the piston member 36 the thickness of one sample containing holder 24. The piston member 36 is adapted to be moved downwardly when the reversible motor 26 is operating in its forward direction and upwardly when operating in its reverse direction. When the slide 20 is transporting a sample containing holder 24 into the lead castle 16, and the piston member 36 is moving upwardly, the top holder 24 is pushed against the slide 20. Ordinarily, this would jam the top holder 24 against the slide. However, a spring means 43 is carried by the piston member 36 which is adapted to be compressed the thickness of one holder 24 when the piston member 36 is moving upwardly during the interval when the slide 20 is away from its storage position. The spring 43 is adapted to be expanded the thickness of one holder 24 when the slide 20 is returned to its storage position which expansion forces the top holder 24 into the aperture 21 and the holder 24 carried by the aperture 21 into the first chamber 13.

When the slide 20 is in its counting position, a cam 44 carried by the arm 32 (FIGURE 2) actuates a first switching means comprising a microswitch 45 which is adapted to stop the motor 26 when actuated. The length of time that the microswitch 45 is actuated is controlled by a preset timing mechanism which provides means (not shown) to short out the switch 45 when the time to count the radiation from the sample has elapsed.

A second switching means comprising a microswitch 46 is provided (FIG. 5). This switch 46 is normally closed when the first chamber 13 contains at least one holder 24 and the piston member 36 is moving downwardly. The switch 46 is kept closed by the compression of a spring 47. When the last sample containing holder 24 leaves the first

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chamber 13, the spring 47 expands opening the switch 46. The switch 46 is connected in parallel with a switch 46A, the latter switch being closed by the arm 32 when the slide 20 is in its storage position. When the switch 46 is thus opened and the switch 46A is closed by the arm 32, the motor 26 is reversed.

As best shown in FIGURE 8, a spring biased dog 52 is adapted to disengage a notch 53 formed in the periphery of a hub 54 of the rotatable member 28. This prevents the slide 20 from reciprocating when it is desired to restack the samples from the second chamber 14 to the first chamber 13, without the counting operation taking place. A locking device 55 is adapted to engage a notch 56 in the periphery of the hub 54 so that the slide 20 will operate with both the forward and reverse directions of the motor 26 when the counting operation is required to take place.

A third switch means comprising a microswitch 48 is provided (FIGURE 6). This switch is normally open when the second chamber 14 contains at least one holder 24 and the piston member 36 is moving upwardly. When the last sample containing holder 24 leaves the second chamber 14, a screw 50 (FIGURE 7) actuates the contact 51 of the switch 48 which closes. The switch 48, when closed again reverses the motor.

The operation of the apparatus will now be described. Before a counting cycle begins, all the sample containing holders 24 are stacked in the first chamber 13. The slide 20 is in its storage position where, due to gravity, the aperture 21 accepts one holder 24 from the first chamber 13. Additional shielding in the form of lead bricks, for example, may be provided between the cabinet 25 and the lead castle 16. When the cycle begins, the motor 26 is operated in its forward direction and the slide 20 transports the holder 24 carried in the aperture 21 into the lead castle 16. The cam 44 closes the switch 45 which stops the motor 26 during the interval when the scintillation counters 17 and 18 are counting the radiation from the sample. After the counting has been completed, the switch 45 is shorted out and the motor starts the cycle going again. The slide 20 returns the holder 24 to the storage position where it drops into the second chamber 14. It is to be noted that during the interval when the slide 20 travelled from its storage position to its counting position and back again, the piston member 36 moved downwardly the thickness of one holder 24. The changing process continues until all the samples have been counted. After the last holder 24 is transferred from the first chamber 13 to the aperture 21, the switch 46 is opened and the cycle continues until the switch 46A is closed at which time the motor 26 is reversed. At this stage, two modes of operation are possible:

(1) The holders 24 may be restacked from the second chamber 14 to the first chamber 13 without counting. In this case the slide 20 remains in its storage position.

(2) The samples can be recounted in the reverse direction. In this case, the slide 20 operates normally.

In the first mode of operation, the dog 52 disengages the notch 53 so that the slide 20 moves only when the motor 26 is driving the holders 24 down. Therefore, the slide 20 remains in its storage position as the piston member 36 moves upwardly. In the second mode of operation, the locking device 55 engages the notch 56 so that the slide 20 operates for both the forward and reverse directions of the motor.

The first or second mode of operation continues until the last holder 24 is transferred from the second chamber 14 to the aperture 21 at which time the screw 50 actuates the contact 51 of the switch 48 closing the switch and the motor 26 again reverses to its forward direction and the whole cycle begins again. As override time control (not shown) may be provided to allow the whole apparatus to be turned off when the required number of counting cycles has been completed.

Thus, according to the invention the applicant has provided an apparatus for transporting a radioactive sample

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from a storage station to a counting station whereby the counters are protected from background radiation and from stray radiation from the storage station.

What I claim as my invention is:

1. Apparatus for transporting a radioactive sample from a storage station to a counting station where radiation from the sample is to be counted, comprising drive means, axially aligned stationary, elongated first and second shielded storage chambers each adapted to store a stack of sample containing holders, an elongated slide having an aperture therein for receiving a sample containing holder, the slide being intermediate said first and second chambers and normal to the longitudinal axes thereof, the slide being adapted to be moved to a storage position and a counting position, said aperture being in axial alignment with said first and second chambers when the slide is in its storage position and being at the counting station when the slide is in its counting position, transfer means under control of the drive means being adapted to transfer one sample containing holder from said first chamber to said aperture and another sample containing holder from said aperture to said second chamber whenever the slide is in its storage position, the drive means causing repetitive reversible linear motion of the slide between its storage and counting positions.

2. Apparatus according to claim 1, comprising means responsive to the last sample holder being transferred from said first chamber to said aperture and adapted to cause said transfer means under control of the drive means to transfer one sample containing holder from said second chamber to said aperture and another sample containing holder from said aperture to said first chamber whenever the slide is in its storage position.

3. Apparatus according to claim 2, further comprising means adapted to disengage the slide from the drive means thereby to retain the slide in its storage position when restacking samples into said first chamber.

4. Apparatus according to claim 1 comprising means responsive to the last sample containing holder being transferred from said second chamber to said aperture and adapted to cause said transfer means under control of the drive means to transfer one sample containing holder from said first chamber to said aperture and another sample containing holder from said aperture to said second chamber whenever the slide is in its storage position.

5. Apparatus according to claim 4 wherein the drive

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means comprises a reversible motor, an annular rotatable member driven by said motor, an elongated linkage mechanism connected to the slide and driven by said rotatable member at a point radially removed from the center thereof, one revolution of said rotatable member causing said linkage mechanism to reciprocate the slide between its storage and counting positions.

6. Apparatus according to claim 5 wherein said first and second chambers are upper and lower chambers respectively, the transfer means comprises a piston member in said lower chamber adapted to abut the bottom sample containing holder therein, means for causing axial movement of the piston member within said lower chamber, said means comprising a lead screw connected to the piston member, a driven nut, an endless chain belt and a gear coaxial with said rotatable member, the gear being driven by the rotatable member, said chain belt being driven by the gear, said nut being driven by said chain belt and the lead screw being driven by said nut, the axial lead of the screw being such that one revolution of said rotatable member will axially move the piston member the thickness of one sample containing holder, the piston member moving downwardly when the reversible motor is operating in its forward direction and moving upwardly when the reversible motor is operating in its reverse direction.

7. Apparatus according to claim 6 comprising spring means carried by the piston member, the spring means being adapted to be compressed the thickness of one sample containing holder when the piston member is moving upwardly during the interval when the slide is away from its storage position and the spring means being adapted to be expanded the thickness of one sample containing holder when the slide is returned to its storage position.

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