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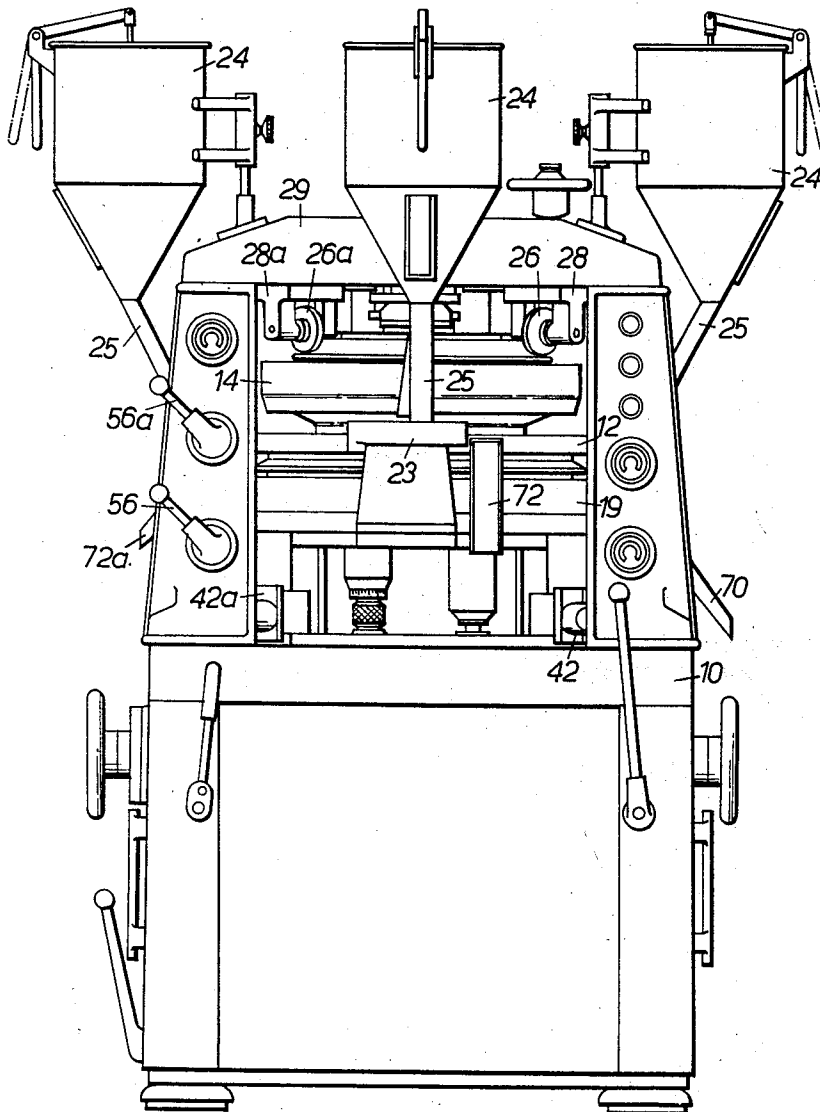
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MULTI-LAYER TABLET MAKING MACHINES

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-FIG. 1.-

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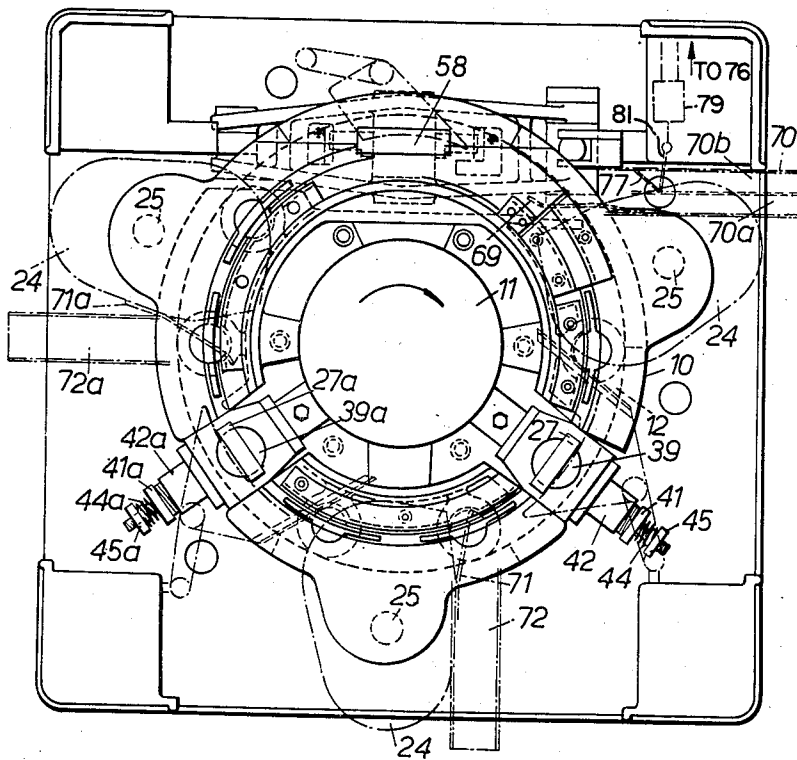
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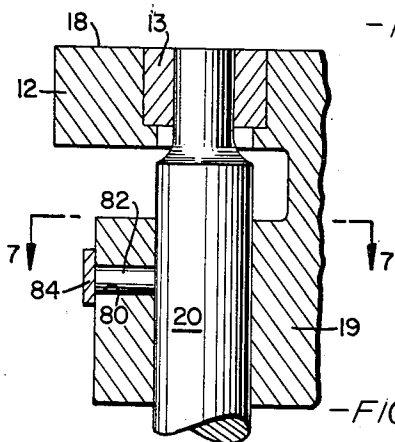
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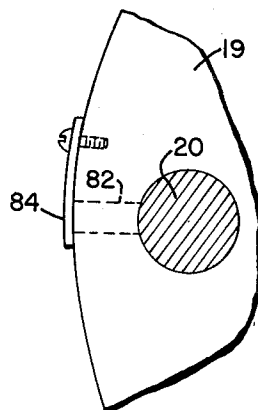
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- FIG. 2 -



- FIG. 6 -



- FIG. 7 -

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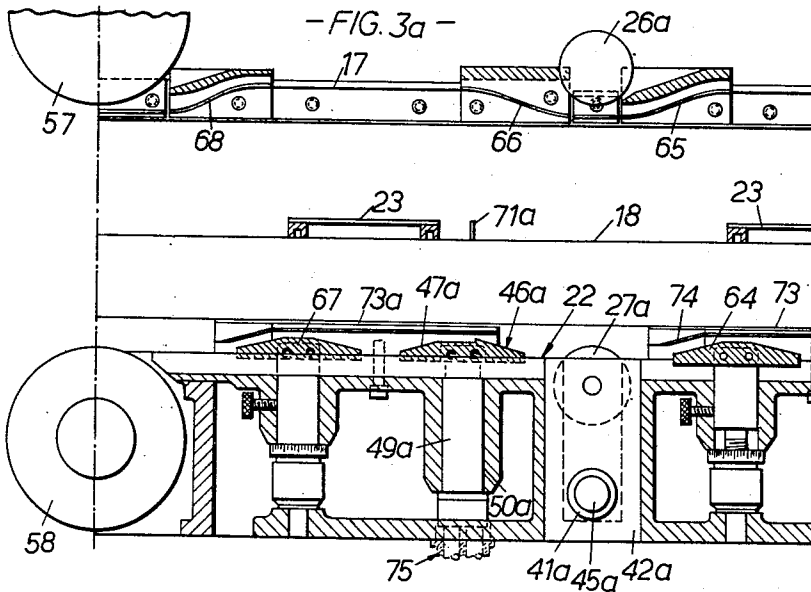
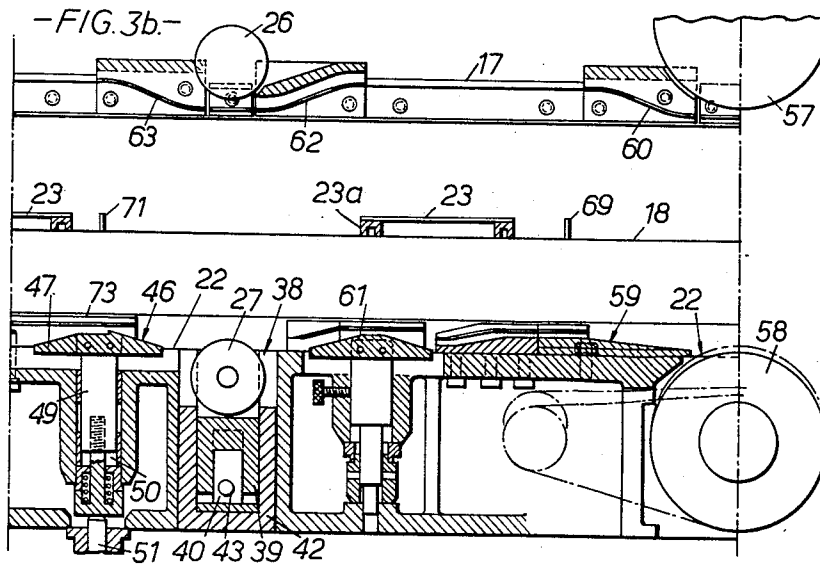
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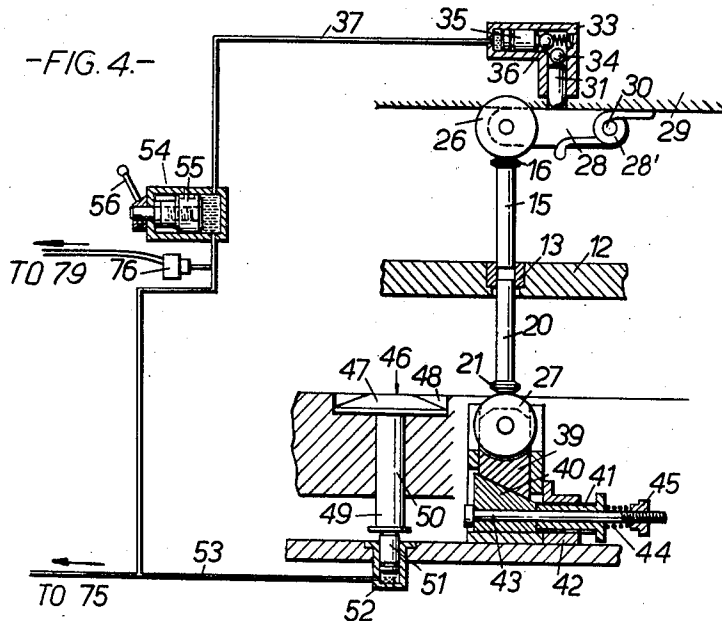
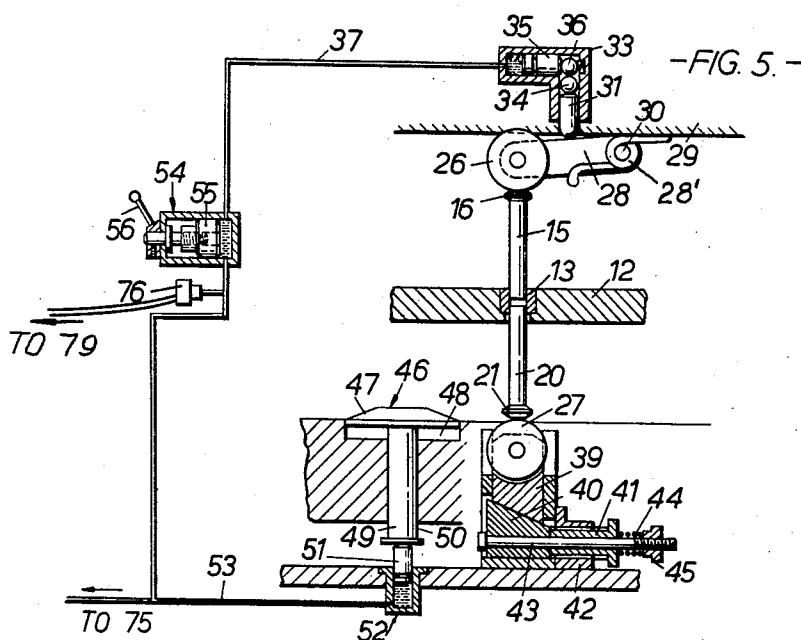
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MULTI-LAYER TABLET MAKING MACHINES

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MULTI-LAYER TABLET MAKING MACHINES

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Claims priority, application Great Britain, Feb. 21, 1962, 6,666/62

8 Claims. (Cl. 107—17)

This invention concerns multi-layer tablet making machines, that is to say machines for producing compressed tablets composed of two or more superimposed layers. More particularly, the invention concerns machines (hereinafter referred to as "a machine of the type described") comprising a plurality of dies each of which successively receives a plurality of powder fills (the number of which corresponds to the desired number of layers in the finished tablet) which fills are "tamped" or individually pre-compressed prior to the successive fill entering into the die.

The tamping of the individual fills is effected, inter alia, to ensure a clear delineation, between the individual layers in the finished tablets, which is clearly visible where powders of different colours are employed for successive fills. However, in practice, the extent to which the individual fills are compressed is critical. If too little "tamping" or pre-compression is effected, it does not consolidate the respective powder fill and clear separation of the layers does not occur. On the other hand, if the tamping pressure is too great, the corresponding layer is highly consolidated to produce a very hard layer. In this event, the layers present such a hard surface to the subsequent fill that the latter will not, when compressed, adhere to the previously formed layer. The layers of the finished tablet, therefore, are not adequately bonded together, and they will separate easily.

It is necessary, therefore, in the production of multi-layer tablets, to ensure that only sufficient tamping pressure is applied to the individual fills (as compared with the final overall compression of the tablet) to ensure consolidation thereof in the die without making the layers too hard for a subsequent layer to adhere thereto.

In the manufacture of multi-layer tablets, it is desirable to be able to "sample" the layers of the tablets at the various stages of the production thereof, and it is known to provide, in multi-layer tablet-making machines of the type described, for ejection of the tamped or pre-compressed layer or layers, as required, e.g. for weight checks. However, it is found that if the pressure under which the layers are tamped is kept sufficiently low to ensure adequate adhesion of subsequent layers thereto, the sampled layer or layers are not sufficiently coherent to ensure their integrity upon ejection from the dies. Such sampled layers will, therefore, disintegrate upon ejection from the dies.

An object of the present invention is to provide an arrangement wherein this difficulty is overcome, and with this object in view the present invention provides a multi-layer tablet making machine of the type described wherein the tamped layer or layers can be sampled characterised by compression means permitting the sampled layer or layers to be subjected to compression sufficient to ensure the integrity thereof, prior to ejection from the respective die.

In a preferred embodiment of the machine according to the invention, the machine comprises a rotary die table having a plurality of dies spaced therearound and having an upper and lower punch associated with each die, a plurality of powder feeding stations past which the dies are moved, upon rotation of the die table, to feed successive powder fills to each die, means for controlling the positions of the upper and lower punches in their dies as the die table rotates, so as to raise each upper punch as its

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die reaches each powder feeding station, and, between successive powder feeding stations, a pair of tamping rollers between which the upper and lower punches pass so as to tamp successive fills.

In such machine, the compression means permitting the sampled layer or layers to be subject to compression sufficient to ensure the integrity thereof may conveniently comprise means for displacing one of the tamping rollers of the respective pair towards the other. Preferably the upper tamping roller is so displaced.

The displaceable tamping roller is preferably carried upon a shiftable mounting, and the means for displacing the same may advantageously be hydraulically operated.

For sampling the layer or layers there is preferably provided, between successive powder feeding stations, a sampling cam selectively displaceable into or out of the path of the lower punches after the latter have passed the corresponding tamping rollers.

In the preferred embodiment of the invention, such sampling cam is also hydraulically operable, and in such instance both the hydraulically displaceable tamping roller and the corresponding hydraulically displaceable sampling cam may conveniently be connected to a common operating device to displace both arrangements simultaneously.

In order that the invention may be fully understood, it will be described further, by way of example, with reference to the accompanying drawings which illustrate one practical embodiment thereof. In the drawings:

FIG. 1 is a front elevation of a preferred embodiment of multi-layer tablet making machine constructed in accordance with the invention;

FIG. 2 is a plan view, with certain parts omitted so as to show the lower cam track of the machine, corresponding to FIG. 1;

FIGS. 3a and 3b together are a development showing a development of the cams, cam tracks, tamping rolls and pressure rolls, which act upon the punches as the die table revolves. For convenience, FIGS. 3a and 3b will be referred to together as FIG. 3;

FIG. 4 is a diagram showing details of one pair of tamping rollers and its associated sampling cam, these being illustrated in their positions for normal tablet production;

FIG. 5 is a view similar to FIG. 4 but showing the tamping rollers and sampling cam in their positions for layer sampling; and

FIG. 6 is an enlarged fragmentary sectional view showing the means by which the ends of the lower punches are held flush with the die table; and

FIG. 7 is a fragmentary sectional view of the line 7—7 of FIG. 6.

In the drawings a rotary multi-layer tablet making machine constructed in accordance with the invention comprises a base or frame 10 supporting a vertical column 11 around which is rotatable a circular die table 12 around which are disposed a plurality of tablet dies 13 (see FIGS. 4 and 5) which extend vertically through the die table 12. Disposed above the die table 12 and integral with the latter is an upper flange 14 (FIG. 1) having disposed therearound a plurality of upper punches 15 (FIGS. 4 and 5), one aligned with each die 13, each extending through the upper flange 14 and engaging, by a head 16 at its top, with an upper cam track 17 (FIG. 3) which raises and moves the upper punch heads 16 along such tracks 17, according to the tablet making cycle which will hereinafter be described. The upper level of the die table 12 is indicated at 18 in FIG. 3. Similarly, disposed below and fixedly arranged relative to the die table 12 is a lower flange 19 (FIG. 1) carrying a plurality of lower punches 20 (FIGS. 4 and 5), one in register with each die 13, a toe 21 on the lower end of each lower punch

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20 running along a cam track 22 (FIG. 3) which similarly raises and lowers the lower punches 20.

At three equispaced positions around the die table are three tablet material feed stations, each comprising a feed shoe 23 supported from the machine base 10 and disposed above the die table 12, a respective powder hopper 24 being disposed above and terminating in an outlet 25 leading to the feed shoe 23. The latter may, if desired, incorporate agitators, rotors or the like (not shown) so as to ensure mobility of the material being fed and, consequently, efficient filling of the dies 13.

Arranged between the first and second of the material feed stations are a first pair of tamping rollers namely an upper tamping roller 26 disposed above the upper flange and a lower tamping roller 27 disposed below the lower flange. The upper tamping roller 26 is carried upon a mounting 28 which is arranged upon the underside of a stationary platform 29 disposed above the upper flange 14. The mounting 28 is arranged so as to be vertically movable relative to such platform. To this end, as shown in FIGS. 4 and 5, the mounting 28 is pivoted on a fulcrum 30 connected to the platform 29 and is spring-loaded upwards as by spring 28' so as to tend to abut the underside of the platform 29, as shown in FIG. 4, and to be engaged by the lower end of a plunger 31 extending vertically through the platform 29 and projecting into an upper tamping roller hydraulic housing 33 secured in the platform 29. The housing 33 comprises a vertical passage into which the plunger 31 projects and which has a ball 34 disposed in the upper end thereof. Such passage joins with a horizontal passage containing a hydraulic piston 35 and a second ball 36 which abuts the ball 34 in the vertical passage. A pressure fluid line 37 connects with the horizontal passage at the side of the piston 35 remote from the balls 36, 34 so that when pressure fluid is fed to the piston 35, the latter is displaced so as to displace the balls 36, 34, resulting in corresponding downward movement of the plunger 31. The latter produces corresponding downward movement of the mounting 28, and therefore the upper tamping roller 26 is displaced downwards, as shown in FIG. 5.

The lower tamping roller 27 is disposed in a recess 38 (FIG. 3) in the lower cam track 22 of the machine and is carried by a displaceable U-shaped mounting 39 the end of which remote from the roller 27 is inclined and abuts against a wedge 40 which is displaceable by a hand-operable screw 41 threaded into a body part 42 wherein the mounting 39 and wedge 40 are disposed. Rotation of the screw 41 causes movement of the wedge 40 across the end of the mounting 39, with corresponding adjustment of the height of the lower tamping roller 27 relative to the lower cam track 22. A bolt 43 extending through the wedge 40 and the screw 41 is surrounded by a spring 44 abutting against a nut 45 on the bolt 43 and the screw 41, so that the spring 44 acts to maintain the wedge 40 in engagement with the confronting end of the screw 41 in the normal operating cycle. In the event of an overload occurring spring 44 allows the wedge 40 to retract from the end of the mounting 39.

Between the first pair of tamping rollers and the second material feed station, and arranged in the lower cam track 22 is a sampling cam 46, this being mushroom shaped to provide a head 47 disposed in a recess 48 (see FIGS. 4 and 5) in the lower cam track 22 and a shank 49 slidable in a socket 50 below such cam track. This is shown in detail in FIG. 3, and diagrammatically in FIGS. 4 and 5. Axially disposed below the socket 50 and aligned with the shank 49 is the piston rod 51 of a sampling ram 52 (FIGS. 4 and 5) to which pressure fluid is supplied through a pressure fluid line 53 which connects with the fluid line 37 previously referred to and a selector 54 which comprises a hand-operable piston 55, displaceable by swinging of a lever 56 in one direction to force pressure fluid into the lines 37 and 53 aforesaid, and in the reverse direction to relax the pressure in such

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lines 37, 53. Thus, by operation of such lever 56 in one direction, the upper tamping roller 26 is displaced downwards and the sampling cam 46 is raised as shown in FIG. 5, whilst movement of the lever 56 back to its original position permits movement of the upper tamping roller 26 back up to its starting position and of the sampling cam back downwards to its initial position, as shown in FIG. 4.

Similarly arranged between the second and third material feed stations are a second pair of tamping rollers 26a, 27a, substantially similar to the first tamping rollers 26, 27, with a second sampling cam 46a similar to the first sampling cam 46, these being connected by hydraulic lines to a second selector 54. The parts associated with the tamping rollers 26a, 27a and sampling cam 46a which are similar to those associated with the tamping rollers 26, 27 and sampling cam 46 have been allocated similar reference numerals with the index letter *a* added thereto, and need not be described further, since they act in exactly the same way as the parts already described.

Between the third and first material feed stations are a pair of final tablet pressure rollers 57, 58, and between the latter and the first material feed station the lower cam track 22 has a raised finished tablet ejection portion 59, in correspondence with such tablet ejecting portion, the upper cam track has an upper punch raising portion 60.

Assuming the hoppers 24 of all three material feed stations to be full of powder and the die table 12 being driven, the machine produces a three-layer tablet in each die 13 as follows:

Firstly, the die 13 is moved towards the first material feed station, and as it approaches the latter the upper punch 15 is raised by the upper punch raising portion 60 of the upper cam track 17, out of the die 13. The die moves under the first feed shoe 23 at the right hand side of FIG. 3b and receives a first fill of powder therefrom. As the die moves away from the first material feeding station, the lower punch 20 is raised by a predetermined amount by a first weight adjustment cam 61 so that a small amount of the powder in the die 13 is ejected as the die 13 moves past the rear wall 23a of the shoe 23. This ensures a constant fill of powder in each die 13. The upper punch 15 is then lowered by a pull down part 62 of the upper cam track 17 so that its lower end enters into the die 13, whereafter the two punches 15 and 20 pass between the first tamping rollers 26 and 27 which are in the FIG. 4 positions and act to consolidate the first fill.

The die 13 then moves on past the first sampling cam 46, which will be in the lowered position of FIG. 4, to the second material feed station whereat a second powder fill is received by the die 13 from the second feed shoe 23 shown at the left hand side of FIG. 3b and the right hand side of FIG. 3a, after raising of the upper punch by a second upper punch raising portion 63 of the upper cam track 17. As with the first fill, the lower punch 20 is raised by a second weight adjustment cam 64 to eject a small amount of the second fill and thereupon the upper punch 15 is lowered by a second pull down part 65 of the upper cam track 17 onto the second fill, whereupon the upper and lower punches 15, 20 pass between the second tamping rollers 26a, 27a. This serves to consolidate the second fill as a layer on top of the consolidated layer from the first fill, both the fills being compressed between the punches 15, 20.

Finally, the die 13 passes to and under the third material filling station whereat a third fill of powder enters the die 13 (the upper punch 15 having previously been raised by a third upper cam raising portion 66 of the upper cam track 17) the amount of the fill being maintained constant by a third weight adjustment cam 67 raising the lower punch 20 as previously described. The upper punch 15 is then lowered by a pull down part 68 of the upper cam track 17 whereupon the punches

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15, 20 pass between the final tablet pressure rollers 57, 58 which applies a high pressure to all the fills in the die 13 to form a strong, highly coherent tablet in the die 13. Thereupon, the upper punch 15 is raised by the raising portion 60, as also is the lower punch 20 by the tablet ejecting portion 59 of the lower track 22, the lower punch 20 raising the tablet to the level of the top 18 of the die table 12, to encounter a take-off plate 69 or the like extending across the table 12 obliquely to the path of the tablet, so that the latter is deflected into path 70a of a feed-off chute 70 (see FIG. 2).

It will be apparent, from the foregoing description, that the machine can, in addition to being used for producing three-layer tablets, be employed for producing two-layer tablets (in which case material will be provided only in two of the material feed station hoppers 24) or for producing "single layer" tablets (in which case powder will be provided only in one of the hoppers 24).

With the machine set up for making three-layer tablets as described, sampling of the layers can be effected after tamping of the first layer or after tamping of the second layer. To effect sampling of the first layer, the first selector 54 is actuated by the lever 56 to raise the first sampling cam 46 and the second sampling cam 46a and to lower the upper tamping roller 26 as shown in FIG. 5. Thus, the material in each die 13 whose punches 15, 20 move between the first pair of tamping rollers 26, 27 are compressed to a much higher degree than would otherwise be the case. Thereafter, the upper punches 15 of each such dies 13 are raised and the lower punches 20 thereof encounter the first sampling cam 46, so as to raise the highly compressed first fill layers to the surface level 18 of the die table, to be swept off by a deflector 71 to a first sampling chute 72.

After ejecting the first layer, the lower punch is held by a friction pad in its raised position against a cam 73 so that the tip of such lower punch is flush with the surface level 18 of the die table 12. FIGS. 6 and 7 show the manner in which the tip of the lower punch is held flush with the die table. A radial hole 80 is provided in the die table 12 in correspondence with each punch 20 and a plastic plug 82 disposed in such radial hole and urged inwardly by a flat spring 84 merely presses on the punch and applies friction thereto so that the punch will remain in any position to which it is brought by the usual cams. With the lower punch 20 in this position, no powder enters the die as it passes under the shoe 23 of the second feeding station. To prevent damage to the punch tips when the upper punch 15 enters the dies 13 at the second tamping rollers 26a, 27a, the lower punch 20 is pulled down by a pull down part 74 of the lower cam track 22 after leaving the second feed station and prior to reaching the second tamping rollers 26a, 27a. If the lower punch 20 were allowed to pass under the feed shoe 23 of the third feeding station in the lowered position, then a fill of the third layer material, equivalent in volume to the total volume of the three separate layers, would be taken in the die 13. To prevent this from occurring, a slave cylinder 75 under the second layer sampling cam 46a and pipes into the same hydraulic circuit as the ram 52 of the first sampling cam 46 lifts the second sampling cam 46a which raises the lower punch 20 flush with the surface level 18 of the die table 12, allowing the die 13 to pass under the shoe 23 of the third feed station without any intake of powder.

To cover the possibility of a layer being partly ejected by the trailing end of the second sampling cam 46a at the instant of operation, and therefore not of correct weight, a hydraulic pressure switch 76 (FIGS. 4 and 5) operates a reject gate 77 pivoted to the final chute 70 to move the reject gate 77 to a position wherein the product from the die 13 is deflected by the take-off plate 69 and the reject gate 77 into the path 70b of the chute 70.

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Pressure switch 76 actuates a solenoid 79 connected to reject gate 77 by a flexible coupling 81 to effect movement of said gate into reject position. This automatically prevents an inferior tablet from mixing with the good tablets and reflects such inferior tablets into the reject path 70b of the chute 70.

Apart from the first few tablets that pass down the reject path 70b of the chute 70 immediately after first layer sampling commences, no other tablets are made from the second and third materials during the whole time layer sampling is in operation. When the lever 56 is returned to normal, a time delay device between the pressure switch 76 and the reject gate 77 delays the movement of the reject gate 70 back to the position illustrated in FIG. 2 until the flow of good tablets recommences.

Similar sampling operations can be carried out at the second pair of tamping rollers 26a, 27a and the second sampling cam 46a, it being appreciated, of course, that the sampling is effected here only when no sampling is being carried out at the first sampling cam 46. Thus, the tamping rollers 26a, 27a serve to compress both the first and second layers into a coherent tablet which is ejected into a second sampling chute 72a. Weight determination of the second layer can, therefore, be effected by comparison with the sampled first layers.

The invention is not confined to the precise details of the foregoing example and variations which fall within the scope of the appended claims may be made thereto.

I claim:

1. A multi-layer tablet making machine comprising, a rotary die table having a plurality of dies spaced therearound and having an upper and lower punch associated with each die, a plurality of powder feeding stations past which the dies are moved upon rotation of the die table to feed successive powder fills to each die, means for controlling the positions of the upper and lower punches in their dies as the die table rotates so as to raise each upper punch as its die reaches each powder feeding station, sampling means for sampling any of the successive powder fills, and adjustable compression means for causing a light compression of a powder fill between a die and its corresponding punch in said die table at a location between said powder feeding stations and their corresponding sampling means in response to the condition of said corresponding sampling means during normal machine operation when said corresponding sampling means is inoperative and when said sampling means is in an operative condition for effecting a stronger compression of the powder fill sufficient to ensure the integrity thereof prior to its ejection from the respective die.

2. A multi-layer tablet making machine as set forth in claim 1 wherein said compression means comprise a pair of tamping rollers between which the upper and lower punches pass so as to tamp successive fills between successive powder feeding station.

3. A multi-layer tablet making machine as set forth in claim 2 wherein the compression means includes means for displacing one of the tamping rollers of the respective pair towards the other.

4. A multi-layer tablet making machine as set forth in claim 3 wherein the upper tamping roller is adapted to be displaced.

5. A multi-layer tablet making machine as set forth in claim 2 wherein, for sampling the layer or layers, there is provided, between successive powder feeding stations, a sampling cam selectively displaceable into or out of the path of the lower punches after the latter have passed the corresponding tamping rollers.

6. A multi-layer tablet making machine as set forth in claim 5 wherein the sampling cam is hydraulically operable.

7. A multi-layer tablet making machine as claimed in claim 5 wherein the displaceable tamping roller and

the corresponding hydraulically displaceable sampling cam are connected to a common operating device to displace both arrangements simultaneously.

8. A multi-layer tablet making machine as set forth in claim 1 wherein means are provided for maintaining the lower punch raised flush with the die table after ejection of a sampled layer. 5

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