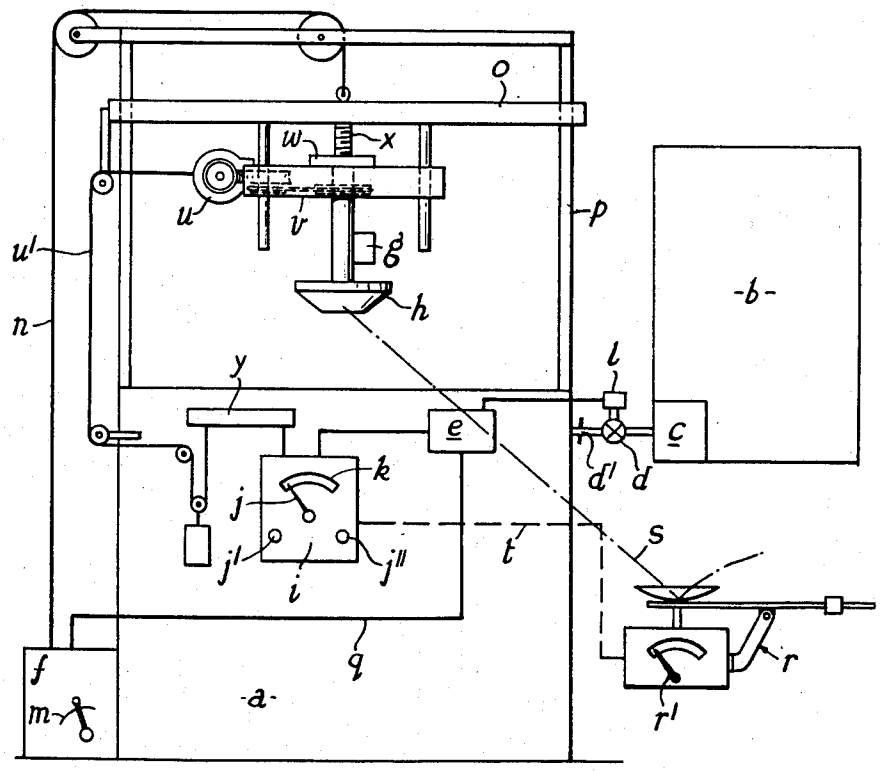
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METHOD AND APPARATUS FOR PRODUCING QUALITY CONTROLLED PULP MOLDED ARTICLES

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Inventor
Thomas S. McLeod
By Ralph B. Stewart
Attorney

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# METHOD AND APPARATUS FOR PRODUCING QUALITY CONTROLLED PULP MOLDED ARTICLES

Thomas Symington McLeod, Redholme, Gomshall, England, assignor to The Plessey Company Limited, Ilford, England, a British company

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This invention relates to the manufacture of felt bodies from pulp and has for an object to facilitate in mass production the maintenance of predetermined limits of the fibre content of the bodies produced.

In a well known method of producing felt bodies, for example loudspeaker cones, from fibrous pulp, fibrous material is caused to form the body on the surface of a porous mandrel or "form," which is mechanically dipped into a bath of a pulp constituted by a suspension of the fibres, while a suction pump is connected to the interior of the mandrel. Assuming the concentration of the pulp and the speed of the dipping operation to be constant, the amount of fibres deposited will depend upon the period during which the mandrel is immersed, and thus on the level of the pulp in the bath, and upon the level at which the dipping movement reverses its direction.

In series or mass production the apparatus is first set up to produce cones (or other bodies) of the desired weight by adjusting the setting of the dipping mechanism while maintaining the pulp at a predetermined level. Thereafter the pulp is replenished after each dipping through a manually operated stop cock or the like, and each cone or other body produced is weighed, those of which the weight falls outside predetermined limits being discarded. It is an object of the invention to facilitate the operation of the process and to reduce the risk of producing bodies which have to be rejected by reason of their inadequate or excessive weight.

Another object is to provide a method of correcting weight deviations which is effective with a minimum of time delay.

According to a feature of the invention the replenishment of pulp for each dipping cycle is effected by means of an automatically operated cut-off valve controlled by an adjustable automatic timing device, preferably an electronic timer, which may be calibrated in units of weight. If weight checks show the weight to vary one way or the other from the set valve, the setting of the timer is altered in accordance with the amount of the difference.

Although in this manner the tendency of the weight to, say, increase, will be arrested, the correcting effect will only become noticeable gradually.

For this reason according to a feature of the invention the adjustment means for correcting the timing of the replenishing device are preferably coupled with adjustment means for the dipping mechanism in such manner that the dipping depth is varied so as to balance immediately the alteration in weight.

The adjustment means may be operated by means of a computer to which is fed the error in weight, and which automatically determines the required adjustments.

The accompanying drawing is a somewhat diagrammatic elevation illustrating an embodiment of the invention.

The apparatus comprises a so-called slurry tank *a*, in which the level and concentration of the slurry (diluted pulp) is kept substantially constant by periodic replenishment with concentrated pulp from a pulp reservoir *b* by means of a pump and mixer *c* under the control of a pneumatically operated replenisher cut-off valve *d* and a metering aperture $d^1$; the pneumatic operation of the cut-off valve is controlled by a solenoid *l* in conjunction with an electronic timing device *e*. Such timing device may consist of a capacitor and resistance as described in section 39 of the book "Radio Technology" by B. F. Weller, published by Chapman & Hall, 1946. Alternatively the opening of the valve may be used to initiate the action of a one-shot multivibrator, a pulse for causing the valve to close being derived by differentiation means from the trailing edge of the resulting multivibrator operation as described in chapter 12, section 12–7 (p. 606) of F. E. Terman's book "Radio Engineering," 3rd edition, published 1951 by McGraw-Hill. As explained in the cited section of Terman's book, the resulting time delay can be adjusted by varying the circuit constants or electrode voltages of the multivibrator.



To produce a felt body, for example a loudspeaker cone, a form or mandrel *h*, which is porous and is connected with a suction pump *g*, is dipped into the slurry tank *a* by means of a periodically operating dipping device *f*. As is well known, the thickness and thus the weight of the felt body thus produced depends upon the time for which the form *h* is submerged in the slurry inside the tank *a*, and in order to enable the apparatus to be set up so as to produce felt bodies of the requisite weight, the dipping device *f* is provided with an adjustable timing device *m*, which varies the point of reversal of the dipping movement, and which may be provided with an adjusting scale graduated according to the number of seconds taken up by each complete immersion period. The adjustable timing device *m* may, similarly to the electronic timing device *c*, comprise a one-shot multivibrator and be constructed in the manner described in Terman's book as above specified. The dipping device for example by means of a rope or chain *n*, moves a supporting frame *o* periodically up and down along guides *p* while an electric connection *q* from the dipping device *f* to the electronic timing device *e* ensures that once during each dipping cycle a quantity of concentrated pulp which is determined by the timing device *e*, is fed from tank *b* to the slurry tank *a* to replace the pulp used up during the last preceding felting operation.

In practice it is necessary, in order to ensure accuracy of weight within prescribed limits, to weigh, at least from time to time, the produced felt bodies and to adjust the operation of the apparatus if the result of the weighing shows a tendency of producing cones (or other felt bodies) of excessive or insufficient weight. For this purpose the produced felt body is transferred to a balance *r*, either manually or by automatic conveying means indicated by the chain dotted line *s*. The balance is preferably pre-set for the desired weight, so that its scale $r^1$ indicates directly the error in weight, for example in grams, and whether it is over or underweight. This error value is then transferred to an electronic correcting device *i* described. The transfer of the error from the scale *r* to the device *i* may be effected electrically as indicated by the broken-line connection *t*, but in general it has been found sufficient if the transfer is effected manually by setting an input lever *j* to the point on the scale *k* which corresponds to the absolute weight error and then pressing either button $j^1$ or button $j^{11}$ accordingly as the error is due to overweight or underweight of the felt body. The lever *j* may be the operating lever of a potentiometer providing the variable electrode voltage for an adjustable timing device which causes an adjuster motor to operate for the time determined by the setting of the potentiometer in one direction or the other, according to whether button $j^1$ or $j^{11}$ was pressed, to effect an adjustment in the setting of the timing device *e* corre-

sponding to the weight error, whereby the quantity of pulp replenished from the reservoir *b* after each felting operation is increased or reduced according to the error indicated by the balance *r* and set up on scale *k*. At the same time a second electronic circuit controlled by the same device *i* increases or decreases the period for which the form or mandrel *h* is submerged during each felting period, by an amount likewise corresponding to the weight error of the last felt body weighed.

In the illustrated embodiment this is effected by raising or lowering the mandrel *h* relative to the carrier member *o*, whereby the moments of immersion and emersion are brought closer together, thus reducing the immersion period, or moved further apart, thus increasing the said period, accordingly as the weight indicated by the balance *r* was excessive or insufficient. This raising or lowering of the mandrel *h* relative to the carrier *o* (the movement of which is not affected), is obtained by means of a servo-motor *u* which, through reducing gear means *v*, turns a hand wheel *w* cooperating with the screw threads of a vertical spindle *x* fixed on the carrier *o*. The motor *u* is controlled through its lead $u^1$ by a follow-up switch or time switch mechanism *y* so that the motor will come to rest automatically after effecting raising or lowering of the mandrel *h* by an amount corresponding to the setting of the potentiometer *j*. In practice it has been found that in order to produce, for example, loudspeaker cones having a weight of 2 grams with an error margin of $\pm 0.1$ gram, it is sufficient to weigh only occasional samples of the production, so that even in the absence of automatic transmission from the balance *r* to the correcting device *i*, a single operator is sufficient to ensure the accuracy of production of three or more cone-making machines thereby almost completely eliminating the production of rejects.

What I claim is:

1. In a cyclic felting process, each cycle of which includes dipping a porous felting form into and lifting it out of a receptacle containing a bath of pulp at a predetermined level thus obtaining immersion for a predetermined period of time, the steps of periodically weighing the so produced bodies to determine any variation in weight from a predetermined value, correcting any errors in weight by adjusting the amount of flow of pulp into the receptacle from a reservoir during each cycle and changing the length of time of immersion of the porous felting form.

2. A felting apparatus for use with a porous felting form, comprising a dipping receptacle, means for feeding pulp to said receptacle at a predetermined rate, cut-off means for controlling the supply of pulp by said feeding means, adjustable automatic timing means controlling said cut-off means to allow when operated the supply of pulp for a period of predetermined length and then cutting off said supply, means for lowering such felting form from a top position into said receptacle at a predetermined rate and to a predetermined bottom position and similarly returning it to said top position, means for maintaining a reduced pressure in such form at least during said lowering and return movement, and means for adjusting the timing of the lowering and raising means to permit variation of the effective length of the period of immersion of the form in the pulp.

3. Apparatus as claimed in claim 2, comprising joint control means for co-ordinated adjustment of the pulp-feed timing means and the immersion time control means.

4. A felting apparatus for use with a porous felting form, comprising a dipping receptacle, means for feeding pulp to said receptacle at a predetermined rate, cut-off means for controlling the supply of pulp by said feeding means, adjustable automatic timing means controlling said cut-off means to allow when operated the supply of pulp for a period of predetermined length and then cutting off said supply, means for lowering such felting form from a top position into said receptacle at a predetermined rate and to a predetermined bottom position and similarly returning it to said top position, means for maintaining a reduced pressure in such form at least during said lowering and return movement, and means for adjusting the distance of the form from the level of the pulp in the receptacle when in its topmost position to permit variation of the effective length of the period of immersion of the form in the pulp.

5. A felting apparatus in accordance with claim 4 including weighing means for determining the departure of the weight of a product produced by the felting form from a predetermined weight and means responsive to the weighing means for controlling the adjustment of the timing means and form distance in accordance with said departure to correct the weight of the product.

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