Dec. 19, 1939. W. H. RANDALL ET AL 2,183,869

MACHINE FOR PRODUCING MOLDED FIBROUS PULP ARTICLES

Filed May 7, 1937 2 Sheets-Sheet 1

Fig.1

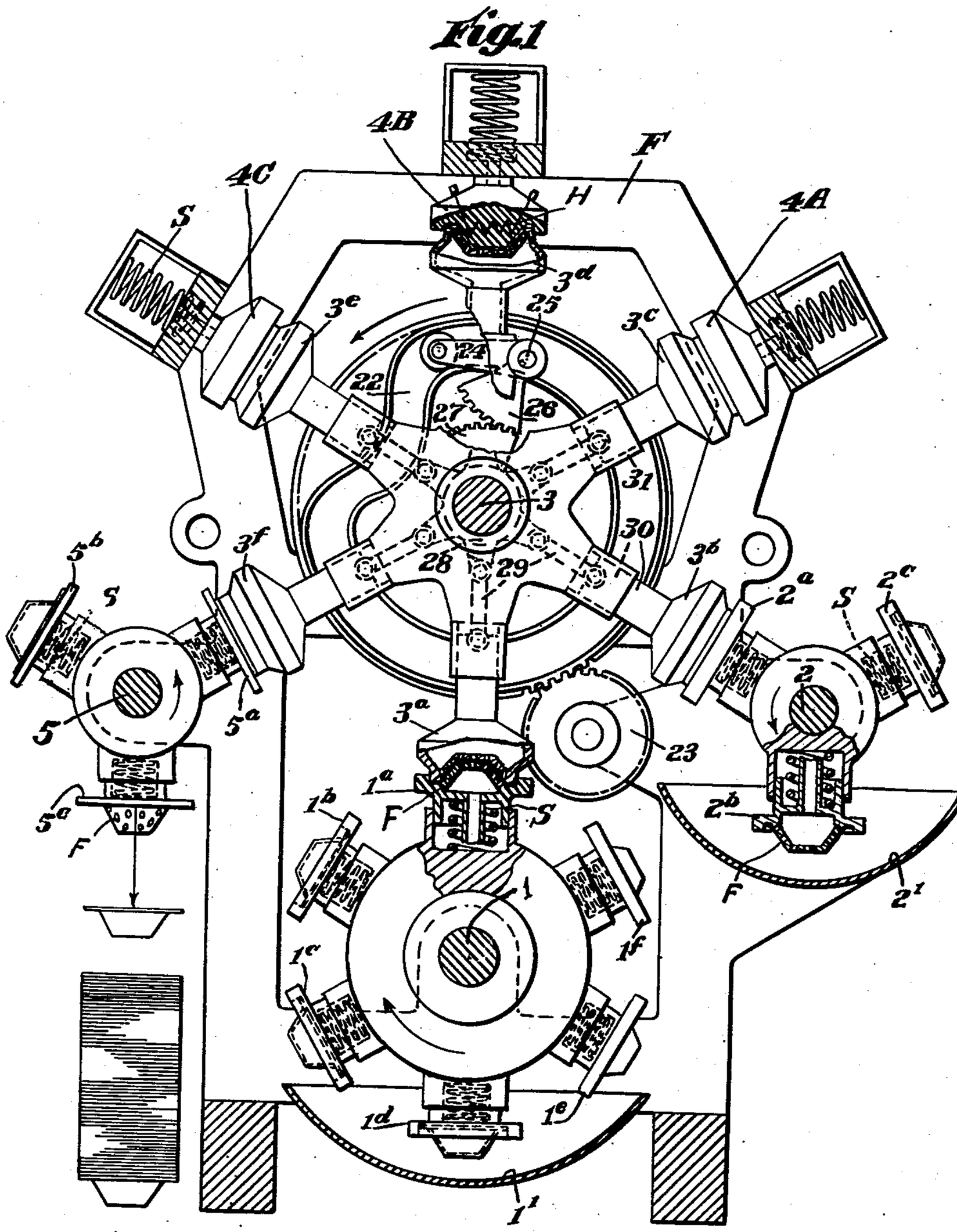

Fig.1A

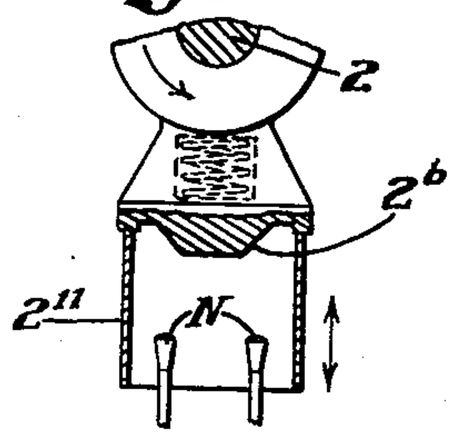

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Fig. 2

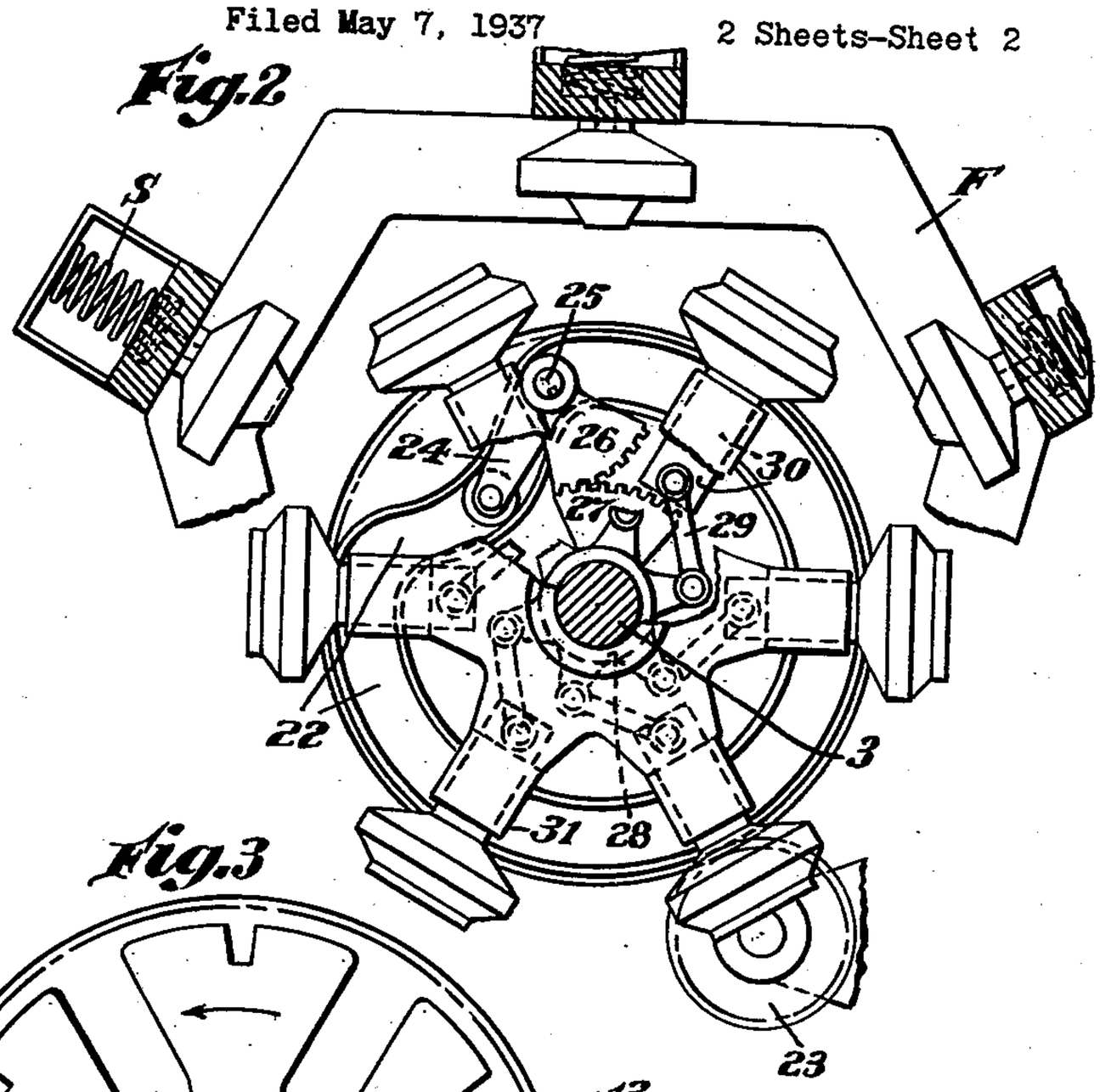
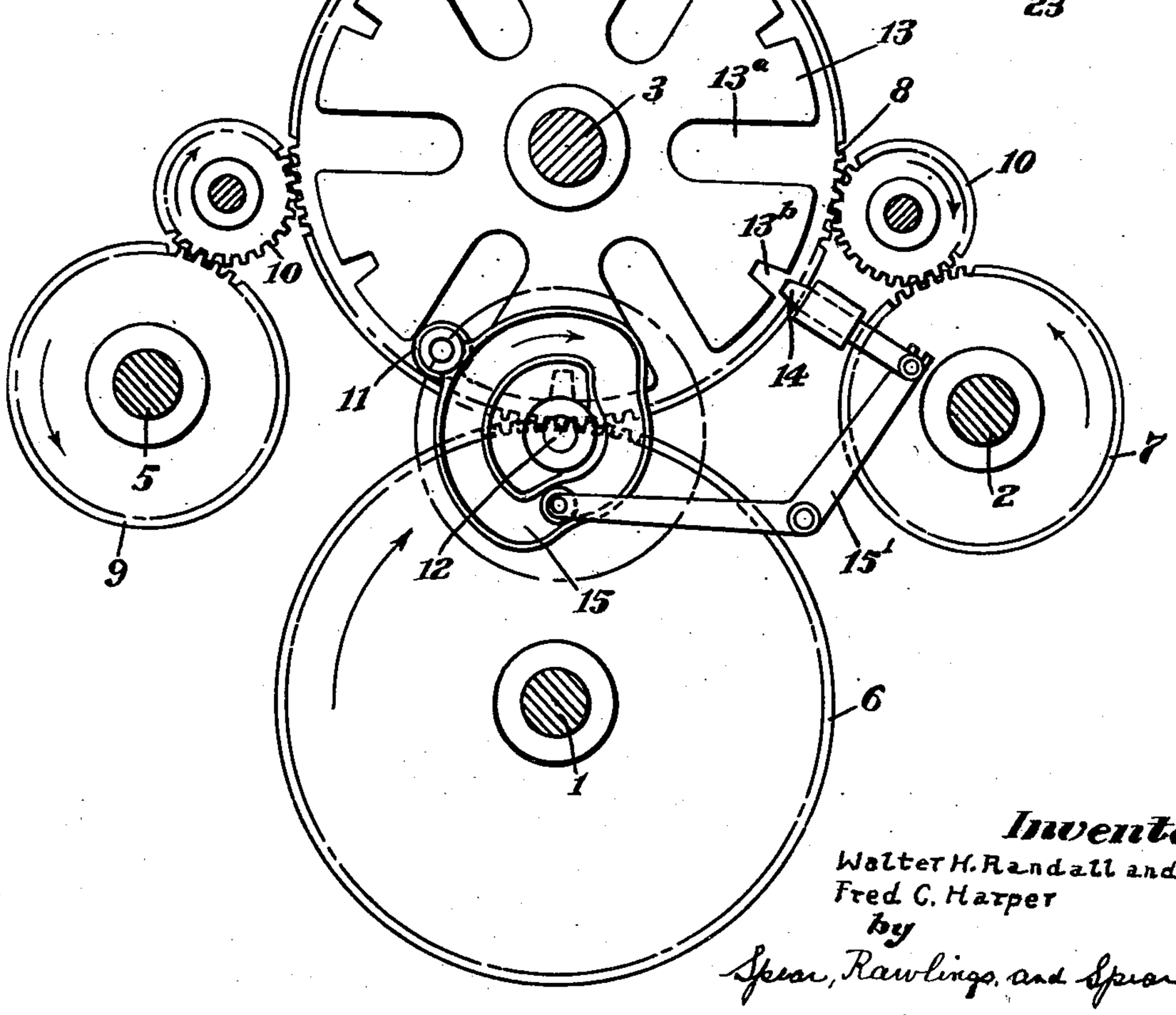


Fig. 3



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UNITED STATES PATENT OFFICE

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MACHINE FOR PRODUCING MOLDED FIBROUS PULP ARTICLES

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Application May 7, 1937, Serial No. 141,292

8 Claims. (Cl. 92—56)

Our present invention relates to the production of individual molded pulp articles. Its general object is to provide a commercially satisfactory machine and method by means of which the articles are formed, dried and smooth-finished under heat, vacuum and pressure in the form of the desired commercial article.

While our invention is especially adapted for the production of multilayer articles it is not confined thereto and the principles of our invention apply equally to the manufacture of single layer articles. For the purposes of this application, however, we have shown and described a machine and method for producing multilayer articles. In such machine we provide an intermittently rotating holding die unit and outside the orbit of such unit we arrange two or more independent intermittently rotating forming die units, one or more relatively fixed heated drying and finishing dies, and an intermittently rotating ejector die unit. Pulp stock tanks arranged beneath each forming die unit provide for the formation of independent article layers on the respective dies of said units.

With such a machine, the independently formed article layers are transferred from the dies of the forming die units to the dies of the holding die unit, consolidated on said holding dies as composite articles, and pressed, dried and smooth finished between said holding dies and the drying and finishing dies, the articles being retained on the holding dies during the drying cycle and eventually being removed from the holding dies by the ejector dies.

All rotating die units are simultaneously stepped and locked in their paused positions. All the holding dies are simultaneously projected towards and coact with mating dies of the forming and ejector die units and the relatively fixed series of heated drying and finishing dies whenever the holding dies are paused in registration with said dies.

When the die units are in paused position, one holding die coacts with a forming die on the first forming unit for the transfer thereto of the article layer which had been formed on said forming die at an earlier step in the machine cycle.

A second holding die, on which an article layer had previously been deposited by a die of the first forming unit at a preceding step in the machine cycle, coacts with a forming die of the second forming unit for superimposing such layer under vacuum and pressure upon the article layer which had been formed on said first-named forming die at an earlier step in the machine cycle, both layers being thereafter carried by said holding die as a composite article.

A third, fourth and fifth holding die, each carrying a composite article coacts with the several relatively fixed drying and finishing dies to progressively dry, bond and smooth finish the composite articles under heat, vacuum and pressure.

The sixth holding die, carrying a dried and finished article, coacts with an ejector die of the ejector unit for the removal of said article from said holding die and the subsequent ejection thereof from the machine.

Previous to the stepping of the rotating units all holding dies are retracted to clear their mating dies.

It is obvious that by providing simultaneous reciprocating motion to all of the holding dies on the holding die shaft we avoid the necessity of providing such motion to each of the mating dies on the several units outside the orbit of the holding dies. This simplifies and reduces to the minimum the amount of mechanism necessary to obtain coaction between the various mating dies.

In the accompanying drawings we have shown a preferred form of our invention, together with a simple variant thereof, which is suggestive of the many possible modifications in design for achieving the objects indicated. Throughout the specification and drawings like reference numerals are employed to indicate corresponding parts, and in the drawings:

Fig. 1 is a vertical section through the preferred embodiment of our invention, showing all intermittently rotating units in a dwell position with the holding dies coacted with mated dies of the forming and ejector units and with the several stationary drying and finishing dies.

Fig. 1A is a detail of a modification.

Fig. 2 is a vertical elevation, partly in section, through the holding unit including the heated drying and finishing dies, the dies of the holding unit being retracted, and a stepping cycle being approximately half completed, and

Fig. 3 is an end view showing a mechanical arrangement for the simultaneous stepping and latching of the intermittently rotating units shown in Fig. 1.

We have indicated at 1 an intermittently rotating primary forming die unit carrying any desired number of forming dies for the suction formation of article layers from one grade of pulp stock contained in a stationary stock tank 1^1, and at 2 an intermittently rotating forming

die unit carrying any desired number of forming dies for the suction formation of article layers from a second grade of pulp stock contained in a stationary stock tank 2[1].

We have indicated at 3 a holding die unit carrying any desired number of reciprocating holding or receiving dies which may be heated if desired. Each die successively removes a formed article layer from a forming die of each forming unit. Thus a two-layer article is consolidated on each holding die under vacuum and pressure as a composite article. The composite articles are carried by said holding dies through the drying and finishing stage which covers the period during which they are successively contacted with any desired number of relatively fixed heated drying and finishing dies 4A, 4B and 4C, and are finally removed from the holding dies as dried and finished articles and ejected from the machine by means of an intermittently rotating ejector unit 5 carrying any desired number of ejector dies.

The intermittently rotating units 1, 2, 3 and 5 are all simultaneously stepped and latched in each paused position by any convenient mechanism.

The units 1, 2 and 5 are mounted radially adjacent the orbit of the unit 3, as are the relatively fixed drying and finishing dies 4A, 4B and 4C and the dies carried by the holding unit 3 are reciprocated for coaction with the dies of the units 1, 2 and 5 and the drying and finishing dies, by cam-operated or other mechanism.

Such mechanism is so timed that the holding dies are retracted immediately prior to the start of the stepping cycle, are held retracted while stepping and are closed on their respective mating dies after stepping is completed.

Conveniently, the four rotating die units 1, 2, 3 and 5, may all be geared together to rotate in unison as shown in Fig. 3, wherein master gear 8 on shaft of unit 3 drives gears 6, 7 and 9 on shafts of units 1, 2 and 5 respectively, to thereby rotate said units. Intermediate gears 10 are interposed between gears 8, 7 and 9 for the purpose of obtaining required direction of rotation of the units driven by gears 7 and 9 as shown by the arrows in said figure.

Step by step motion may be simultaneously imparted to the units 1, 2, 3 and 5 by means of a modified Geneva drive, as shown in Fig. 3. The Geneva roll 11 is driven by a continuously rotating drive shaft 12. The Geneva wheel 13 is mounted on and drives shaft of unit 3 and is provided with a series of spaced slots 13[a], corresponding in number and spacing to the number and spacing of the holding dies.

During the period in which the Geneva 11 is disconnected from the Geneva wheel 13, the Geneva wheel is locked in its dwell position by means of latch pawl 14 which is operated through suitable linkage 15[1] from a cam 15 fast on drive shaft 12, the wheel 13 being notched as at 13[b] to receive the latch pawl.

While we have shown a Geneva drive for intermittently rotating the units 1, 2, 3 and 5 simultaneously, other drive means may be employed, as for example, a cam and latch mechanism.

Any suitable mechanism may be employed for advancing and retracting the reciprocating holding dies relative to the dies of units 1, 2 and 5 and the drying and finishing dies 4A, 4B and 4C in timed relation to the stepping of said units.

As here shown (see Figs. 1 and 2) we provide a cam-operated toggle for imparting this movement to the holding dies. Cam 2 is loosely mounted on the same shaft as holding unit 3, and is geared to continuously rotating gear 23. Cam 22 actuates cam arm 24 which is keyed to shaft 25 carried by holding unit 3. Also keyed to shaft 25 is segmental gear 26 which meshes with a segmental gear 27. Gear 27 is carried by an oscillating member 28 loosely mounted on the shaft which carries the holding unit 3 and oscillating member 28 is provided with toggle links 29, which links are connected to slide rods 30 carrying the holding dies, these slide rods being radially guided and supported in guide blocks 31.

Referring to Fig. 1 wherein all units are shown paused in their rotation, the cam 22 has swung the cam arm 24 to a position where the toggle linkage 29 is straightened to thereby force the holding dies radially outwardly into coaction with their respective mating dies.

The position of the cam arm with relation to the cam raceway previous to the start of the stepping motion of unit 3 is approximately that shown in Fig. 2, where the holding dies have been retracted and the stepping motion of unit 3 started. As soon as the holding dies have been retracted by the cam operated mechanism the stepping of the unit starts. During the stepping period the relation between the speed of rotation of cam 22 and the stepping of unit 3 is such that the holding dies are held in the retracted or open position shown in Fig. 2. As soon as the stepping motion is completed and unit 3 comes to rest, the continued rotation of cam 22 swings the cam arm to the position in the cam raceway shown in Fig. 1, thereby causing the holding dies to move out radially and coact with their respective mating dies.

The speed of rotation of cam 22 with respect to the stepping and dwell motion of the holding unit 3 is such that cam 22 rotates approximately 300° from the position shown in Fig. 1 before the rotating units begin to step. This amount of rotation of the cam 22 not only holds the holding dies in contact with their respective mating dies during a large percentage of the dwell period, but also just previous to the start of the step, the cam arm, by reason of the shape of the cam raceway, is thrown an angular amount sufficient to retract the holding dies from their respective mating dies and to give sufficient mechanical clearance so that the rotating units may step without any interference between holding dies on unit 3 and their mating dies on the other rotating or stationary units.

Means are provided to apply vacuum to the dies of the forming units for the suction formation of article layers thereon. Both vacuum and air are used on the forming units and the ejector unit for article transfer as may be required.

The holding dies are provided with connections for applying vacuum to hold the articles and/or article layers thereon during the travel of said dies and/or to remove the steam vapors given off by the drying articles, and provision is also made for sending a blast of air through each holding die when registered with an ejector die to transfer the dried and finished articles thereto.

The heated drying and finishing dies may, if desired, also be provided with connections for applying vacuum to remove the steam vapors given off by the drying articles being compressed between these dies and the holding dies.

The machine is equipped with appropriate ports and valves for properly timing the application of vacuum and air to the various dies as required.

For convenience of reference, the dies of forming die unit 1 are consecutively designated from 1^a to 1^f; those of forming die unit 2 from 2^a to 2^c; those of holding die unit 3 from 3^a to 3^f; and those of ejector unit 5 from 5^a to 5^c. All dies of the units 1, 2, 3 and 5 are foraminous as indicated at F. The drying and finishing dies are provided with heating means conventionally shown at H. However, if it is desired to accelerate the rate of drying the dies of the unit 3 may likewise be heated.

In operation, all rotating units are simultaneously stepped and locked in their paused positions. While so locked, forming die 1^d of unit 1 and forming die 2^b of unit 2 are immersed in tanks 1^1 and 2^1, respectively, for the suction formation of article layers thereon (see Fig. 1).

All holding dies on unit 3 have been projected outwardly and are coacting with their mating dies. Holding die 3^a is in pressure contact with a previously formed article layer on form die 1^a. Holding die 3^b with a previously deposited layer thereon, is in pressure contact with an independently formed article layer on forming die 2^a and both layers are being consolidated as a composite article. Holding dies 3^c, 3^d and 3^e with their composite articles thereon are coacted with the drying and finishing dies 4A, 4B and 4C respectively. Holding die 3^f with a dried and finished article thereon is coacted with ejector die 5^a of the ejector unit 5 for the transfer of the dried article thereto and for subsequent ejection from the machine.

After an interval which is determined by the amount of drying time at each of the three drying stations all holding dies are retracted (see Fig. 2) and the several rotating units step one full step ahead (it being noted that in Fig. 2 the holding unit is shown as only approximately half way through a step).

Holding die 3^a with the article layer which was placed thereon by forming die 1^a of unit 1 when at the position of Fig. 1 now occupies the position formerly occupied by holding die 3^b so that when the several rotating units again pause and the holding dies are again coacted with their mating dies, there will be placed on holding die 3^a a second article layer from forming die 2^c of unit 2. The other holding dies have, of course, likewise stepped ahead one die position. The composite articles on dies 3^b, 3^c and 3^d are being progressively dried, bonded, and smooth-finished by dies 4A, 4B and 4C, the dried and finished article on holding die 3^e is being removed by ejector die 5^c and holding die 3^f is having a new article layer placed on it by forming die 1^b of unit 1.

Any desired medium, as steam, electricity or the like may be employed for heating the drying and finishing dies and/or the holding dies, and the dwell time for each stepping cycle of the machine is of sufficient duration to insure that after contact with the final drying die 4C the article is sufficiently dry for its removal from the machine.

All dies except the holding dies are preferably spring-backed as indicated at S to insure uniform pressure on the article or article layers when the dies coact.

Obviously, the machine may be equipped with a third forming unit if desired for the formation of a three-layer article. Obviously also as many adjacent sets of die units may be mounted on the shafts 1, 2, 3 and 5 as desired, with corresponding increase in drying and finishing dies.

Obviously also by omitting the second forming die 2, a single layer article may be manufactured by this machine. If so desired a fourth drying die may be mounted in the position occupied by forming unit 2 thus accelerating drying when the machine is used for the manufacture of a single layer article.

It is also obvious that in its most simplified form the machine may have only one reciprocable holding die on rotating unit 3 and one forming die on forming unit 1 (and one forming die on forming unit 2 if a multi-layer article is being manufactured) and one die on ejector unit 5 and one finishing die located as may be desired between the forming die unit (or units) and the ejector die unit 5.

It is obvious that the number of dies on the holding unit may be increased to more than six with corresponding increase in the number of finishing dies. Such an increase in the number of drying stations would decrease the required time for drying at any one station thus shortening the stepping cycle and increasing the rate of producing finished articles. Increasing the number of dies on the holding unit would not necessitate any increase in the number of dies on either the forming or ejector units.

While we have shown and described a series of rotating units driven from a single source and stepping in unison, it is obvious that each rotating unit might have its own independent drive and that if so driven the stepping of the units need not necessarily be in unison so long as the required coaction between mating dies is obtained.

It is obvious that if desired the machine as above described may be so modified that two or more pulp layers may be transferred in superimposed order to each holding die from two or more forming dies of one or all of the forming units. This may be readily accomplished by rotating the forming unit or units two or more steps for each step of the holding unit and successively coacting each holding die with each of the forming dies thus stepped in registration with it for successively removing the pulp layer from each forming die and transferring them in superimposed order to the holding die. For example it might be desired to have a multi-layer article of such characteristics that it would be an advantage to have it composed of two or more individual layers of pulp from forming dies of unit 1 only or one or more pulp layers from the forming dies of both units 1 and 2.

In the modification of Fig. 1A we provide for spraying of a pulp layer on forming dies of either of the rotating forming die units instead of immersing said dies in a pulp stock tank as in Fig. 1. In this figure we have indicated at 2^{11} a cylinder which is adapted to be raised and lowered in timed relation to the intermittent travel of the forming dies by any appropriate means, not shown. Spray nozzles N located interiorly of the cylinder are supplied with liquid pulp mixture under pressure from any suitable supply source. The sprays are under the control of valves (not show) adapted to be opened and closed during the period in which the cylinder is raised in contact with a forming die for the spraying of a pulp layer thereon.

Other various modifications in machine and method may obviously be resorted to within the spirit and scope of our invention as defined by the appended claims.

We claim—

1. In a pulp molding machine for producing individually die molded and die dried fibrous pulp articles, a foraminous forming die, a drying die, and a radially reciprocable foraminous holding die, means for depositing a pulp layer on said forming die, means for heating said drying die, means for revolving the forming die and the holding die step by step through orbitally adjacent paths into paused coactive alinement with each other and thereafter for bringing the holding die into paused coactive alinement with the drying die, means for radially projecting the holding die in a sliding rectilinear path first towards and away from the forming die to transfer the pulp layer from the forming die to the holding die and thereafter for radially projecting the holding die in a sliding rectilinear path towards the drying die to dry the pulp layer under heat and pressure between the holding die and the drying die, and means for ejecting the dried article from the machine.

2. In a pulp molding machine for producing individually die-molded and die-dried multi-layer fibrous pulp articles, a drying die, a radially reciprocable foraminous holding die, independent forming units each having a foraminous forming die, means for depositing a pulp layer on each forming die, means for heating said drying die, means for revolving the forming dies and the holding die step by step in orbitally adjacent paths to bring the holding die successively into paused coactive alinement first with each forming die and thereafter into paused coactive alinement with the drying die, means for successively radially projecting the holding die in a sliding rectilinear path towards and away from the forming die of each forming unit to transfer the pulp layers from the forming dies in superimposed order to the holding die and thereafter for radially projecting the holding die in a sliding rectilinear path towards the drying die to dry and bond the composite article under heat and pressure between said dies, and means for ejecting the dried article from the machine.

3. In a pulp molding machine for producing individually die-molded and die-dried multi-layer fibrous pulp articles, a series of foraminous forming dies, a drying die, and a radially reciprocable foraminous holding die, means for heating said drying die, means for revolving the forming dies and the holding die step by step in orbitally adjacent paths to bring the holding die successively into paused coactive alinement first with each forming die and thereafter into paused coactive alinement with the drying die, means for depositing a pulp layer on each forming die, means for successively radially projecting the holding die in a sliding rectilinear path towards and away from said forming dies to successively transfer a desired number of pulp layers from the forming dies in superimposed order to the holding die and thereafter for radially projecting the holding die in a sliding rectilinear path towards the drying die to dry and bond the composite article under heat and pressure between said dies, and means for ejecting the dried article from the machine.

4. A fibrous pulp molding, drying and finishing machine, comprising a pair of spaced parallel intermittently revolving shafts, a foraminous forming die mounted on one shaft, a radially reciprocable foraminous holding die of complemental shape to the forming die mounted on the other shaft for timed coaction with the forming die, a relatively fixed dry die of complemental shape to the holding die mounted outside but adjacent to the orbit of the holding die for timed contact by said holding die, means for heating said drying die, means for revolving the holding and forming die shafts step by step to carry the respective dies thereon through orbitally adjacent paths into paused coactive alinement with each other and thereafter in the continued stepping of the holding die shaft to bring the holding die into paused coactive alinement with the drying die, means for locking said shafts in their paused positions, means for forming a wet article on said forming die, a single means operative while said shafts are paused for radially projecting the holding die in a sliding rectilinear path into contact with and retracting it from the forming die to transfer the wet article from the forming die to the holding die and thereafter for radially projecting the holding die in a sliding rectilinear path into contact with and retracting it from the drying die to dry and finish the article under heat and pressure between said holding and drying dies, and means for ejecting the dried and finished article from the machine.

5. The machine of claim 4, the means for radially reciprocating the holding die comprising a free-running cam on the holding die shaft, means for continuously rotating said cam in timed relation to the step by step rotation of the holding die shaft, a cam arm actuated by said cam, a shaft carried by the holding die unit to which said cam arm is keyed, a segmental gear keyed to said last named shaft and actuated by said cam arm, an oscillating member free-mounted on the holding die shaft and having a segmental gear meshing with and oscillated by the first named segmental gear, a radial slide carrying the holding die, and a toggle link connected to said oscillating member and to said radial slide rod.

6. A fibrous pulp molding, drying and finishing machine, comprising a pair of spaced parallel intermittently revolving shafts, two angularly spaced foraminous forming dies mounted on one shaft, a radially reciprocable foraminous holding die of complemental shape to the forming dies mounted on the other shaft for successive coaction with each forming die, a relatively fixed drying die of complemental shape to the holding die mounted outside but adjacent to the orbit of the holding die for timed contact by said holding die, means for heating said drying die, means for revolving said shafts step by step to carry the dies on the forming die shaft in an orbitally adjacent path to the die on the holding die shaft to bring the holding die successively into paused coactive alinement first with each of the forming dies and thereafter into paused coactive alinement with the drying die, means for locking said shafts in their paused positions, means for forming a wet article layer on each forming die, a single means operative while said shafts are paused for radially projecting the holding die in a sliding rectilinear path successively into contact with and retracting it from each forming die to transfer the wet article layers from the forming dies in superimposed order to the holding die and thereafter for radially projecting the holding die in a sliding rectilinear path into contact with and retracting it from the drying die to dry, bond and finish the composite article under heat and pressure between the holding and drying dies, and means for ejecting the dried and finished article from the machine.

7. A fibrous pulp molding, drying, and finishing

machine, comprising an intermittently revolving shaft on which is mounted a radially reciprocable foraminous holding die, a pair of spaced parallel intermittently revolving shafts adjacent and parallel to the holding die shaft, a foraminous forming die on each of said pair of shafts of complemental shape to the holding die, a relatively fixed drying die of complemental shape to the holding die mounted outside but adjacent to the orbit of the holding die for timed contact by the holding die, means for heating said drying die, means for revolving the holding and forming die shafts step by step to carry the dies thereon in orbitally adjacent paths to bring the holding die successively into paused coactive alinement with each forming die and thereafter into paused coactive alinement with the drying die, means for locking said shafts in their paused positions, means for forming a wet article layer on each forming die, a single means operative while said shafts are paused for radially projecting the holding die in a sliding rectilinear path successively into contact with and retracting it from each forming die to transfer the wet article layers from said forming dies in superimposed order to the holding die and thereafter for radially projecting the holding die in a sliding rectilinear path into contact with and retracting it from the drying die to dry bond and finish the composite article under heat and pressure between said holding and drying dies, and means for ejecting the dried and finished article from the machine.

8. A fibrous pulp molding, drying, and finishing machine, comprising an intermittently revolving shaft on which is mounted a series of angularly spaced radially reciprocable foraminous holding dies, a pair of spaced parallel intermittently revolving shafts adjacent and parallel to the holding die shaft, a series of angularly spaced foraminous dies of complemental shape to the holding dies on each of said pair of shafts, a series of angularly spaced relatively fixed drying dies of complemental shape to the holding dies mounted outside but adjacent to the orbit of the holding dies, means for heating said drying dies, means for revolving the holding and forming die shafts step by step to carry the dies on the forming shafts in orbitally adjacent paths to the dies on the holding die shaft to bring each holding die successively into paused coactive alinement with a forming die on each forming die shaft and thereafter into paused coactive alinement with each drying die, means for locking said shafts in their paused positions, means for forming a wet article layer on each forming die, a single means operative while said shafts are paused for radially projecting each holding die in a sliding rectilinear path successively into contact with and retracting it from a forming die on each forming die shaft to transfer the wet article layers from said forming dies in superimposed order to the holding die and thereafter for successively radially projecting each holding die in a sliding rectilinear path into contact with and retracting it from each drying die to progressively dry, bond and finish the composite article under heat and pressure between said holding and drying dies, and means for ejecting the dried and finished articles from the machine.

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