

PATENT SPECIFICATION

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DRAWINGS ATTACHED.

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COMPLETE SPECIFICATION.

Rotational Thermofusion Moulding Machine.

I, LOUIS HERBERT BARNETT, a citizen of the United States of America, of 300 West Pafford Street, Fort Worth 10, Texas, United States of America, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a thermofusion moulding machine for use in moulding materials such as, for example, thermoplastic and thermosetting materials and in which a mould charged with the material to be moulded is rotated to effect the moulding, the article shaped in the mould by the said rotation thereof thereafter being removed from the mould.

The present invention consists in a rotational thermofusion moulding machine comprising, in combination, a mechanism adapted to detachably receive and rotate at least one mould about two perpendicularly intersecting axes, said mechanism incorporating a device operative to heat the mould during the rotation thereof about said axes, and mould transport vehicles effective to convey a mould into, and to remove it from, the said receiving and rotating mechanism, each mould transport vehicle incorporating a device effective to cool the mould when it is carried by the said vehicle.

Preferably, the mould transport arrangement comprises at least one mould-transport vehicle and an associated drive arrangement for propelling the vehicle towards and away from the mould-rotating mechanism, and the or each vehicle includes a moveably mounted mould support which is operative when moved to transfer a mould from the vehicle into the mould-rotating mechanism and vice-versa.

[Price 4s. 6d.]

In a preferred construction, the mould-transport arrangements include a transport track having a station at the mould-rotating mechanism and two discrete mould-transport vehicles moveable on the track and each operable to effect alternate cycles of loading and unloading an associated mould into and out of the mould-rotating mechanism. The track can then be arranged, most conveniently, beneath the mould-rotating mechanism. In this preferred construction, the said mould-rotating mechanism includes a frame which detachably receives and supports the mould and is rotated about one said axis and which is provided with a drive transmission operative to effect rotation of the received mould about said other axis when the mould is supported by the frame. The mould-heating arrangement can then be arranged to be rotated with the mould about one or the other of said intersecting axes and can advantageously be rotatable with the said frame about the frame's rotational axis.

The above described combination of the invention lends itself admirably to the construction of a most efficient moulding machine, in which a high degree of utilization of the mould-rotating and heating-arrangements can be achieved, and which machine comprises two discrete combinations as specified in the preceding four paragraphs symmetrically arranged and structurally united as a machine unit.

A manner of performing the invention, in which several-possible component modifications are mentioned, will now be described in more detail, by way of example only, with reference to the accompanying drawings, in which:—

Figure 1 is a diagrammatic side elevation

of a rotational moulding machine in accordance with the invention;

Figure 2 is a detailed plan view of the embodiment of Figure 1, on an enlarged scale;

5 Figure 3 is an enlarged end elevation taken along the plane 3—3 of Figure 2;

Figure 4 is an enlarged side view of a detail in Figure 2;

Figure 5 is a plan view of another detail;

10 Figure 6 is a section along plane 6—6 of Figure 5;

Figure 7 is a plan view along plane 7—7 of Figure 4;

15 Figure 8 is a view along plane 8—8 of Figure 4;

Figure 9 is a side elevation of the machine illustrated in Figure 2, on an enlarged scale, and showing a mould in two different positions in connection with loading and unloading of the machine therewith.

Figure 10 is a plan view, on an enlarged scale, illustrating a part of the machine shown in Figure 2;

25 Figure 11 is a section along plane 11—11 of Figure 10;

Figure 12 is a section along plane 12—12 of Figure 11;

30 Figure 13 is a section along plane 13—13 of Figure 10;

Figure 14 is a section along plane 14—14 of Figure 2;

Figure 15 is an end view of a further detail of the machine;

35 Figure 16 is a section along plane 16—16 of Figure 14;

Figure 17 is a section along plane 17—17 of Figure 2;

40 Figure 18 is an enlarged plan view of a mould-cooling device incorporated in the machine;

Figure 19 is a schematic electrical circuit diagram illustrating a part of electrical control circuit arrangements for the machine, and

45 Figure 20 is another schematic electrical circuit diagram illustrating another part of the electrical control circuit arrangements of the machine.

50 Referring to Figure 1, a general arrangement elevation of a machine according to the invention is shown. It comprises a mould-rotating mechanism 10 positioned between two mould-transport vehicles 12 of a mould transport arrangement. The vehicles 12 are movable on tracks 14 towards and away from the mould rotating mechanism 10. In practice, one of the vehicles 12 will move a mould beneath the mould-rotating mechanism 10. The mould is then raised and properly positioned in the mould-rotating mechanism and the unloaded vehicle 12 is then drawn back. During the ensuing period that the mould is being

70 will be cooled and thereafter the moulded part will be stripped from it. A new charge will be positioned in the mould so that as soon as the moulding cycle is completed, a new mould will be ready. In this way, it is possible to effect maximum utilization of the mould-rotating mechanism 10. The vehicles 12 move in and out towards the mould-rotating mechanism 10 and each of the vehicles 12 carries a mould-cooling system. In addition, each of the vehicles carries a means for rotating the mould as it is cooled. The preferred machine of the invention comprises a symmetrical arrangement of two combinations outlined above, as follows.

80 Referring to Figure 2, the two mould-rotating mechanisms 10 illustrated include a common centre support 16 and discrete end supports 18. Each of two moulds 20 is removably secured in a frame 22, the frames being then rotated about their centres, which are rotatably mounted on the supports 16 and 18. The ends of the moulds 20 are supported for rotation in the frames 22 in a manner later described and, at the same time as the frames are rotating, the moulds are also rotated about an axis generally perpendicular to the axis of rotation of the frames 22. As shown in Figure 2, the corresponding vehicles 12 of the two-symmetri- 95 cally arranged mould processing combinations shown are interconnected by a bridge 24 so that the interconnected pair of vehicles simultaneously move towards and away from the mould rotating mechanisms 10. 100 This feature is not essential and it may be desirable to move the vehicles separately, in which case the bridges 24 will be omitted.

105 Referring now to Figures 14 to 17, the central support 16 includes an outer housing 26 mounted upon a base assembly 28 comprising an upper plate 32 yieldingly mounted by springs 34 on a lower base plate 30. A first electric drive motor 36 is mounted on the plate 32 and its shaft 37 110 carries a gear 38 which drives a shaft 40 by means of a chain 42. The shaft 40, mounted in supports 44, carries a pair of spaced gears 46 (Fig. 15) around which chains 48 pass. The chains 48 run up to the top of 115 the centre support 16 and drive gears 50 fixed on hollow sleeves 52 by collars 54. The sleeves 52 extend through side walls of the housing 26, through bearing supports 56, and are connected by mounting collars or the like 58 (Fig. 17) to the rotating frames 22. Locking collars 60 and mounting plates 62, suitably bolted to each frame 22, complete the connection of sleeves 52 to the frames 22. The drive motor 36 is effective 125 to rotate both of the frames 22 by means of the mechanism described above.

A second drive motor 64 is mounted within the centre support 16, and its shaft 66 carries a gear 68. A chain 70 passes both 130

around gear 68 and a gear 72 positioned at the top of the housing 26. Gear 72 is fixed by a mounting collar 74 to a central shaft 76 through a sleeve 78. Bearings 80 are located between sleeve 78 and sleeves 52, whilst bearings 82 are located between shaft 76 and sleeves 52. Shaft 76, which is rotated by gear 72, extends through sleeves 52, with outboard bearings being located between shaft 76 and the ends of sleeves 52. Each outer end of shaft 76 carries a pair of gears 86 fixed thereto by mounting collars 88. This arrangement is used to provide the drive for rotating the moulds 20 within the frames 22 at the same time as the frames 22 are themselves rotated, as later described below.

In embodiments of the invention in which the mould-transport vehicles 12 are moved independently, the frames 22 can be rotated independently, either through separate drive systems or through a suitable clutch arrangement. In like manner, the selection of the drive system for rotating the moulds 20 in the frames 22 described below can provide for independent drive.

Figure 10 illustrates the details of the mould drive. Chains or the like 90 extend in opposite directions from the gears 86 described in the last but one preceding paragraph. Each of the chains 90 passes around a gear 92 fixed to a drive shaft 94. Each of the drive shafts 94 carries a bevel gear 96 at its inside end, the bevel gears each being in position to rotate a mould mounted within frame 22. Bevel gears are provided at each end of the frame 22 although normally the mould will only be driven from one end. In a modification, not shown, a friction drive replaces the bevel drive with equally satisfactory results.

Each frame 22 includes side frame members 98, each of which has a plurality of generally equally spaced holes 100, and end frame members 102. The space between the end frame members 102 is adjustable by means of the spaced holes 100 so that the frame can accommodate moulds of various sizes. Corner plates 101 and 103 are fastened to the members 98 and 102, with plates 103 overlying drive shafts 94.

Each of the end frame members 102 mounts plates 104, as illustrated in Figures 11 and 12, with the plates mounting small gear motors 106. Plates 108 and 110 are each suitably bolted to the end frame members 102 and are spaced apart a distance sufficient to accommodate a portion of a locking member 112 driven by shaft 114 of the gear motor 106. The locking members 112 each have a somewhat crescent-shaped or U-shaped locking portion 116 which holds an end 118/

spindle 120 positioned ~~on end of each~~ end of a mould 20. The locking members 112 also have a central cylindrical hub 124 which has a cam surface 126 positioned for contact by cam-operated switches or microswitches 128. Rotation of the locking members 112 by the gear motors 106 will lock and unlock a mould 20 in position on the frame 22. The switches 128 are positioned to start and stop the gear motor at the locked and unlocked positions. Plate 108, as shown in Figure 11, has a somewhat wedge-shaped opening 130 which will accept the ends 118 of the mould spindles 120. The ends are passed through the generally central open areas 132 of the locking portions 116 after which the locking members are rotated to hold the mould in position to the frame 22.

The moulds 20 used can have any one of a number of suitable different shapes and sizes. The moulds 20 shown are cylindrical, but they could be, for example, square, rectangular, oval or irregular in cross-section. The mould, which can be composed of two or more assembled sections has a spindle 120 mounted on each of its ends with conical portions 134 directly attaching the spindles 120 thereto. One of the spindles carries a bevel gear 136 which is in mesh with one of the bevel gears 96 to rotate the mould 20 about an axis generally perpendicular to the axis of rotation of the frame 22. In some applications a series of smaller moulds can be attached together and all mounted in one frame 22 or in multiple frame arrangements, not shown.

Various heating arrangements can be provided to heat the mould as it rotates. In the embodiment shown, there is a single heating element for each mould combination indicated generally at 138 which is in the form of a fuel manifold extending along the longitudinal side of the mould 20 and has end arms 140 which extend radially toward the centre of the mould. A plurality of such heating units can be utilized, if desired, to heat a mould. There can be one on the opposite side of the mould, or there can be one in every quadrant therearound. In addition, the invention includes the provision of a heating element extending completely around the mould and fixed to or rotating with the mould. The heating element 138 shown has a plurality of small jets 142 through which jets of flame are directed towards the mould as it rotates. The heating manifold 138 is fed with a suitable gas under pressure such that jets of flame are directed from the jets 142 onto the rotating mould. The gas supply means are described hereinafter.

The outside or outboard supports 18, illustrated in Figure 13, each include a housing indicated generally at 142, with the

of a stem or



upper end of each housing carrying a shaft 144. The shaft 144 extends inwardly through bearing supports 146 held to the housing 142 by bolts, and through the side frame members 98. Cover plates or the like 148 are fixed to the shaft 144 by locking collars 150 and locking members 152. As the frame 22 rotates it rotates the shaft 144 in the bearing supports 146. The shaft 144 is hollow and gas is passed therethrough from an outside source indicated generally at 156, through the gas connection indicated generally at 158 at the inside end of the shaft 144, to the heater 138. The outside supports have a slip ring or commutator assembly indicated generally at 160 and including a slip ring support 162 fixed to the shaft 144 and slip rings 164 mounted in the slip ring support. A brush assembly is indicated generally at 165 and includes brushes 166 in contact with the slip rings 164. A cam-operated switch 168 is used to properly position the frames at the end of a moulding cycle. The brush and slip ring assembly is provided to carry the electrical control signals from the rotating frame to the electrical control panel, as described hereinafter, and may also be used to carry the power for electric heating which may be used in place of gas to heat the rotating moulds.

Referring to Figures 3 and 4, each of the vehicles 12 includes wheels 170 supporting the vehicle along the outside and at the inside front corner. The wheels 170 have generally V-shaped peripheral grooves 172 which co-operate with inverted V-shaped rails 174. The wheels 170 are freely rotatably mounted to brackets 176, which in turn are mounted by springs 178 to the vehicle frame indicated generally at 180. The frame 180 includes end frame members 182 and side frame members 184, suitably connected together.

The inside rear corner of each vehicle 12 is supported on a wheel 186, again having a peripheral V-groove, to ride on the V-shaped rails. The wheels 186 on the two vehicles at each end of the machine are journaled on a common shaft 188, with the shaft 188 being driven from a motor 190, by means of a chain drive including a chain 192, a gear 194 on the drive shaft of the motor, and a second gear 196 fixed to shaft 188. The motor 190 is mounted on the underneath side of the associated bridge 24, previously described with reference to Figure 2. A control box 198 is mounted on each bridge 24. Each bridge 24 includes a rear frame member 200 mounted on top of side frame members 202 which are in turn bolted to the side frame members 184 forming a part of the vehicle frame 180. Each drive motor 190 is effective to move its associated pair of vehicles 12 towards and away from the mould rotating apparatus

and moves these vehicles simultaneously.

Mounted on each frame 180 of each vehicle 12 is an elevator frame 204 including side frame members 206 and end frame members 208. The end frame members 208 are fixed to uprights 210, there being one upright 210 at each corner of the frame 204. Each of the uprights 210 is U-shaped in cross-section as illustrated particularly in Figure 5, and they are slideable on uprights 212 fixed to the frame 180. Each of the uprights 212 carries a rotatable gear 214 at its upper end and a driven gear 216 at its lower end. A suitable chain 218 passes around the gears 214 and 216. Each of the chains 218 is fixed by a screw 220 to the uprights 210. This pin connection is particularly shown at the bottom of Figure 6.

An elevator motor 222 is mounted on the bottom of each vehicle 12 and has a drive shaft 224. A gear 226 is fixed directly on drive shaft 224 and is effective, through a chain 228 and a large gear 230, to drive a shaft 232 journaled in supports 234 at the lower rear of the vehicle 12. Gears 216 and 230 are all fixed on the shaft 232. Also fixed to the drive shaft 224 of each elevator motor 222 is a gear 236 in mesh with a second gear 238 fixed on a rotatable countershaft 240. A gear 242, similar to gear 226, is fixed on shaft 240 and is effective, through a chain 244 to drive gear 246 which in turn is fixed on and drives shaft 248 journaled in supports 250 at the front end of the vehicle 12. The gears 216 at one end of the vehicle are fixed to shaft 232, and at the other end are fixed to shaft 248. The gear arrangement described above is necessary so that the elevator frame 204 will be simultaneously raised and lowered at both ends. Note particularly Figure 9 which shows the raised position of the elevator. The elevator is effective to raise and lower the mould 20 to position it within the rotating frame 22. Other embodiments of the invention, not shown, use hydraulically and pneumatically-operated elevators satisfactorily, instead of an electric motor driven elevator arrangement.

The elevator frame 204 at each end carries a pair of upright brackets 252 each formed by a pair of angles 254 spaced apart and connected together at their upper ends by a small plate 256. A pair of inner angles 258 are positioned within the angles 254 at the top of each bracket 252. Blocks 260 are positioned between pairs of angles 254 and 258 to hold them together, with the angles together defining an opening indicated at 262 to receive the end 118 of each mould spindle 120. The spindle ends are positioned in the openings 262 and the mould is carried by the brackets 252 in such a manner that it may be raised up into the rotatable frame 22 and locked.

Mounted to the bottom of the elevator frame 204 is a motor 264 having a drive shaft 266 carrying a gear 268 for driving a chain 270. The upper end of the chain passes around a gear 272 fixed to a shaft 274. The shaft 274 is journaled at each end in a bracket 276, with each of the brackets being fixed on the upright 210 and the shaft and rollers 278 are effective to rotate a mould 20 positioned on the vehicle 12. The brackets 276 are adjustable on the uprights 210 to accommodate various mould sizes. A similar shaft is mounted on the opposite side of the vehicle and rotatably carries idler rollers 280.

A pan 282 is mounted on the elevator frame 204 directly beneath the mould. Positioned within the pan, preferably along the bottom, as illustrated in Figure 18, is a pipe 284 having a plurality of generally upwardly directed holes 286. A connection 288 supplies a mould-cooling fluid, preferably water, but which may be, as alternatives, either a liquid or gas, to the pipe 284. A spray from the holes 286 is directed against the rotating mould to cool it. In addition to the pipe 284 which lays along the bottom of the pan, there is an upright pipe 290 at one end of the path to spray water against the mould end. The pan has a suitable connection to drain, not shown. The coolant flows in a closed system, although this is not essential. A modified cooling arrangement, not shown, is one wherein the mould is rotated partly or completely submerged in a bath provided in lieu of the pan arrangement.

In summary, each of the vehicles 12 is driven towards and away from the mould rotating mechanism 10 and includes its own elevator and motor to drive the same, as well as its own drive for rotating a mould supported thereon. In addition, each vehicle includes a cooling system, whether it be of the type shown or otherwise, so that each mould can be cooled after it has been removed from the mould rotating mechanism 10.

Figures 19 and 20 illustrate electrical control circuit arrangements for operating the various electric drive motors described above. In Figure 19, AC supply lines are indicated at 292. Motors 36 and 64, which are the drive motors for rotating the frames 22 and the moulds 20 within the frames, are connected in parallel with each other and in series between lines 292 with a pair of normally open push buttons PB13 and PB14, there being one on each of the two control panels 198 on the bridges 24, and a pair of normally opened contacts MCR. The closure of either PB13 or PB14 or contacts MCR is effective to start the motors. Push buttons PB13 and PB14 are for manual operation and are normally used for short

rotational movements of the frame 22 and mould 20.

Also connected between lines 292 is a coil 294 of motor control relay MCR, whose contacts MCR were described above. Normally open contacts TR2 and MCR are in series with coil 294, with normally open contacts MCR being effective to lock in the relay coil once contacts TR2 have closed. A limit switch or cam-operated switch 168 is in series with coil 294 and is effective to always stop the frame 22 in a horizontal position, regardless of what position the frame 22 is in when a timing relay times out.

Also connected between lines 292 is coil 298 of a gas control relay GCR and coil 300 of an interlock relay IR. The gas control relay is effective to control the flow of gas to the heating manifolds 138 and the interlock relay IR prevents vehicle 12 travel while the frame 22 is rotating. In series with these two relays between lines 292 are normally open contacts TR2. Coil 302 of timer relay TR2 is connected between lines 292 and is effective to control the various normally open contacts TR2 which have been described above. Push buttons PB9 and PB10, there again being one on each of the control panels 198, are normally open and are effective, upon closure, to start rotation of the frame 22 and mould 20 and to start operation of the heater 138. When either one of these push buttons is closed, normally open contacts TR2 in parallel with the push buttons will be closed to lock in the coil of relay TR2. Also, in this same circuit, are normally open contacts CR1 which prevent rotation of the frame 22 during travel of the vehicles 12. These contacts will be closed when a vehicle 12 is stationary and open when the vehicle 12 is travelling. Push buttons PB11 and PB12 are effective to stop the rotation of the frame 22 and mould 20 manually. Normally, timer relay TR2 will time out to stop rotation.

Motors 106 for closing the frame locks on the moulds 20 are connected in circuit between lines 292 and are operated by push buttons PB15 and PB16. Switch 128 is used to indicate when locking is completed.

Figure 20 illustrates the control circuits for operating the motors on the vehicles 12. The vehicle travel control circuit includes the vehicle driving motors 190 connected between lines 292. Push button PB1 is depressed to start motors 190. Coil 306 of control relay CR1 will operate to close contacts CR1 to lock in the control relay. Push buttons 308 may be used to stop the forward travel of the vehicles 12 at any time. Normally closed contacts IR are operated by the interlock relay coil 300 illustrated in Figure 19. A microswitch 310 is effective to open at the end of the forward limit

of the vehicle travel to stop the vehicles automatically at a predetermined position beneath the mould rotating mechanism 10. When PB1 is closed, motor reversing relay CR2, whose coil is indicated at 312, will be operated so that the vehicle driving motor 190 will move the vehicle in the forward direction. Pushbutton PB3 is closed to start the rearward travel of the vehicle and the closure of this push button is effective to open or release coil 312 of relay CR2 and so cause the motors 190 to operate in the reverse rotational direction. When push button PB3 is closed, timer relay TR1, whose coil is indicated at 314, will be operated and contacts TR1 in series with it will be closed to operate a coolant solenoid valve 316. Whenever the vehicle is moving in the rearward direction away from the mechanism 10, coolant is supplied to cool the mould supported thereon. A microswitch 318 is utilized to stop this rearward vehicle travel. Timer relay TR1 is effective to open the circuit to solenoid 316 after a predetermined time.

The vehicle mould-rotator circuit includes the motors 264, which may be DC motors, and is supplied through a rectifier 320. Push button PB4 is closed manually to start operation of motors 264 and control relay CR3, whose coil 322 is in parallel with the motors 264 will operate so that the contacts CR3 in series therewith will be closed to lock in operation of the motors. Contacts CR1, controlled by coil 306 described above, are used to rotate the mould automatically whenever the vehicle is moving. Push button PB5 may be used to stop rotation of the mould at any time.

The elevator circuit for raising and lowering the mould on a vehicle 12 includes the motors 222 connected in series with normally closed contacts CR9, normally closed contacts CR1, normally closed microswitch 324, normally closed push button 326, and normally open push button PB6. When PB6 is closed, coil 328 of control relay CR4 will be operated to lock in the operation of the elevator motors 222. At the same time, coil 330 of motor reversing relay CR5 will be operated to change the position of contacts CR5 so that the motor will be operated in a direction to raise the elevator and mould thereon. Microswitch 324 will open when the mould has reached the limit of its upward travel and is properly positioned in the mould rotating mechanism 10. Push button 326 may be used to stop the operation of motors 222 at any time. When it is desired to lower a mould out of the mechanism 10, or to lower an elevator without a mould, push button PB8 is operated to open the circuit to coil 330 of motor reversing relay CR5 to run the motor in a direction

to lower the elevator. At the same time, coil 332 of control relay CR9 will be operated to supply current to motors 222. Microswitch 334 will open at the lower limit of the elevator travel. Normally closed contacts CR1 ensure that the elevator never operates when a vehicle 12 is moving.

The use, operation and function of the invention are as follows:—

In operation, the moulds 20 on one pair of interconnected vehicles 12 are charged with a satisfactory amount of material. Thermoplastic and thermosetting resins are satisfactory. These vehicles 12 are then moved underneath the respective mould-rotating mechanisms 10 and the elevators of each vehicle are simultaneously operated to raise the moulds 20 into position to be fixed in the mould-rotating mechanisms 10. The locks on the mould rotating mechanisms are operated to secure each of the moulds. The vehicles 12 are then backed away and the mould-rotating mechanisms 10 rotate the moulds 20 simultaneously in two planes continuously. During rotation the moulds are heated. The speed of rotation of both the frames 22 and the moulds may vary. Preferably, the frames 22 are always parallel so that both may be loaded and unloaded together.

After the moulds 20 have been rotated for suitable period of time, either determined by the operator or by a time controlled relay, the moulds will stop rotation. Of importance is the fact that the moulds will always end up in a horizontal position, regardless of when the control relay times out or an operator pushes the manual stop button. The mould rotating motors will continue until a switch on the frame 22 is opened, indicating that the frames are horizontal. When the frames have stopped, the same pair of vehicles as were used for loading will move underneath the frames and the elevators will raise up and receive the moulds as they are released from the frames. The elevators will drop the moulds down to the normal transportation position and as the vehicles 12 carry the moulds away from the frames 22, the moulds are simultaneously rotated on the vehicles and cooled by the arrangements earlier described.

At the same time as one interconnected pair of vehicles 12 are removing moulds which have just been rotated and heated, the second pair of vehicles which have been charged during the previous rotating interval, are moving into position under the frames 22 and the rotating and heating cycle begins again.

As can be seen, each pair of vehicles moves in and either picks up and delivers moulds and then moves out. When one pair of moulds are rotating, the other pair of moulds are being stripped of completed

articles and re-charged with new material. Such an arrangement makes maximum use of the rotating and heating mechanisms.

It is also practical to operate each vehicle individually. The sequence of operation will be different from that described above as the vehicles are not operated in pairs. Suitable drive arrangements are then provided for rotating the frames 22 and for co-ordinating operation of the vehicle drive motors.

The particular manner of heating can be varied widely, and the apparatus shown is illustrative of one satisfactory heating arrangement. An infrared type of heating system is satisfactory. Salt brine, either in the form of a bath or a spray, is satisfactory, as is hot air or a burner which completely encloses the rotating mould. Radiant heat, either gas or electric, is satisfactory, as is resistance wire. The heat can be applied generally uniformly throughout the length of the mould or the heat at particular locations along the mould can vary. The heating element itself, which travels with the frame 22, can be contoured to accept certain types of mould. The heating element may completely enclose the mould and rotate with it as distinct from rotating with the frame 22. Such an enclosing heater could also be stationary relative to the mould. The moulds can be painted different colours to locally control thickness of the finished product. The heating period or heating cycle may vary depending upon the material thickness, size and type of article.

The type and size of mould and the number of moulds positioned in a single frame, may vary. The present invention is particularly satisfactory for making large containers.

Although the invention has been described in connection with mould transport arrangements consisting of vehicles that run on tracks beneath the rotating frames 22, other transport arrangements could be satisfactory for moving the moulds into and out of the rotating frames 22 in the general manner described. The tracks could extend along the ceiling of a factory in which the machine is located and the moulds could be slung down from overhead moving vehicles. Cranes could be used to move the moulds in and out of the frames 22 although the vehicles 12 with elevators are preferred. It is not essential to arrange the vehicles to reciprocate towards and away from the rotating frames 22, as in some applications a transport track of closed configuration on which the vehicles 12 could continuously move might be desirable.

The various drives have been described as including a flexible drive member, such as chains. However, one or all of the drives

could instead comprise direct drive gear motors with variable speeds.

Cam-operated switches or microswitches have been described. Any type of disengaging mechanism, for example solenoid-operated, air-operated or hydraulically-operated, is also satisfactory.

WHAT I CLAIM IS:—

1. A rotational thermo-fusion moulding machine comprising, in combination, a mechanism adapted to detachably receive and rotate at least one mould about two perpendicularly intersecting axes, said mechanism incorporating a device operative to heat the mould during the rotation thereof about said axes, and mould transport vehicles effective to convey a mould into, and remove it from, the said receiving and rotating mechanism, each mould transport vehicle incorporating a device effective to cool the mould when it is carried by the said vehicle.

2. A machine according to claim 1, in which the or each mould-transport vehicle includes an associated drive arrangement for propelling the vehicle towards and away from the mould-rotating mechanism.

3. A machine according to claim 2, wherein the or each vehicle includes a moveably mounted mould support which is operative when moved to transfer a mould from the vehicle into the mould-rotating mechanism and *vice-versa*.

4. A machine according to claims 2 or 3, wherein the or a mould-cooling device is mounted on the or each mould-transport vehicle.

5. A machine according to claim 1, claims 2 or 3 as appendant to claim 1, or claim 4, wherein the or each cooling device comprises a coolant medium spray or jet system.

6. A machine according to any one of claims 1 to 5, wherein the mould-transport arrangements include a transport track having a station at the mould-rotating mechanism and two discrete mould-transport vehicles moveable on the track and each operable to effect alternate cycles of loading and unloading an associated mould into and out of the mould-rotating mechanism.

7. A machine according to claim 6, wherein the track passes beneath the mould-rotating mechanism.

8. A machine according to any one of the preceding claims, in which the said mould-rotating mechanism incorporates an electrical brush-and-slip-ring assembly operative to provide electrical services to a mould-support of the mechanism which is rotated with the mould.

9. A machine according to any one of the preceding claims, ~~in which the said~~ rotating mechanism includes a frame which



articles and re-charged with new material. Such an arrangement makes maximum use of the rotating and heating mechanisms.

It is also practical to operate each vehicle individually. The sequence of operation will be different from that described above as the vehicles are not operated in pairs. Suitable drive arrangements are then provided for rotating the frames 22 and for co-ordinating operation of the vehicle drive motors.

The particular manner of heating can be varied widely, and the apparatus shown is illustrative of one satisfactory heating arrangement. An infrared type of heating system is satisfactory. Salt brine, either in the form of a bath or a spray, is satisfactory, as is hot air or a burner which completely encloses the rotating mould. Radiant heat, either gas or electric, is satisfactory, as is resistance wire. The heat can be applied generally uniformly throughout the length of the mould or the heat at particular locations along the mould can vary. The heating element itself, which travels with the frame 22, can be contoured to accept certain types of mould. The heating element may completely enclose the mould and rotate with it as distinct from rotating with the frame 22. Such an enclosing heater could also be stationary relative to the mould. The moulds can be painted different colours to locally control thickness of the finished product. The heating period or heating cycle may vary depending upon the material thickness, size and type of article.

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The various drives have been described as including a flexible drive member, such as chains. However, one or all of the drives

could instead comprise direct drive gear motors with variable speeds.

Cam-operated switches or microswitches have been described. Any type of disengaging mechanism, for example solenoid-operated, air-operated or hydraulically-operated, is also satisfactory.

WHAT I CLAIM IS:—

1. A rotational thermo-fusion moulding machine comprising, in combination, a mechanism adapted to detachably receive and rotate at least one mould about two perpendicularly intersecting axes, said mechanism incorporating a device operative to heat the mould during the rotation thereof about said axes, and mould transport vehicles effective to convey a mould into, and remove it from, the said receiving and rotating mechanism, each mould transport vehicle incorporating a device effective to cool the mould when it is carried by the said vehicle.

2. A machine according to claim 1, in which the or each mould-transport vehicle includes an associated drive arrangement for propelling the vehicle towards and away from the mould-rotating mechanism.

3. A machine according to claim 2, wherein the or each vehicle includes a moveably mounted mould support which is operative when moved to transfer a mould from the vehicle into the mould-rotating mechanism and *vice-versa*.

4. A machine according to claims 2 or 3, wherein the or a mould-cooling device is mounted on the or each mould-transport vehicle.

5. A machine according to claim 1, claims 2 or 3 as appendant to claim 1, or claim 4, wherein the or each cooling device comprises a coolant medium spray or jet system.

6. A machine according to any one of claims 1 to 5, wherein the mould-transport arrangements include a transport track having a station at the mould-rotating mechanism and two discrete mould-transport vehicles moveable on the track and each operable to effect alternate cycles of loading and unloading an associated mould into and out of the mould-rotating mechanism.

7. A machine according to claim 6, wherein the track passes beneath the mould-rotating mechanism.

8. A machine according to any one of the preceding claims, in which the said mould-rotating mechanism incorporates an electrical brush-and-slip-ring assembly operative to provide electrical services to a mould-support of the mechanism which is rotated with the mould.

9. A machine according to any one of the preceding claims, ~~in which the said~~ rotating mechanism includes a frame which



wherein the said mould-



detachably receives and supports the mould and is rotated about one said axis and which is provided with a drive transmission operative to effect rotation of the received mould about said other axis when the mould is supported by the frame.

10. A machine according to claim 7 and any one of claims 8 to 9, wherein the heating arrangement is mounted to rotate with said frame.

11. A machine according to claim 10, wherein the heating arrangement comprises flame jets in row arrangement extending parallel to the axis that intersects the axis about which it rotates.

12. A machine according to claim 11, wherein the heating arrangement also extends radially of the axis that intersects its rotational axis so as to embrace opposing end extremities of the mould.

13. A machine according to any one of claims 1 to 9, wherein the mould-heating arrangement is rotatable with the mould about one or the other of said intersecting axes

14. A machine according to any one of the preceding claims, wherein the mould transport arrangements include means operative to rotate each mould during conveyance thereof.

15. A rotational thermofusion moulding machine comprising two discrete combinations as claimed in any one of the preceding claims, symmetrically arranged and structurally united as a machine unit.

16. A machine according to claims 6 and 15 wherein the corresponding transport vehicles of the two combinations are interconnected for movement in unison and have common propulsion means.

17. A machine according to claim 15 or claim 16, wherein two frames are coaxially aligned for rotation and are rotatably carried by three supports aligned along said axis, namely, two outer supports respectively associated with a different one of the two frames and a central common support.

18. A machine according to claim 17 wherein each outside support includes means for conducting a heating medium to the mould-heating arrangement.

19. A machine according to any of the preceding claims including control arrangements effective to cause the mechanism for rotating the mould about the intersecting axes to halt always in a selected rotational position suited for insertion and removal of moulds.

20. A rotational thermofusion moulding machine constructed and arranged to operate substantially as described herein with reference to, and as illustrated by, the accompanying drawings.

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