

[54] PLANT FOR PROCESSING CASTING RESIN

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[22] Filed: **Feb. 22, 1972**

[21] Appl. No.: **228,084**

Related U.S. Application Data

[63] Continuation of Ser. No. 03,488, Jan. 16, 1970.

[30] Foreign Application Priority Data

Jan. 18, 1969 Germany..... P 19 02 486.3

[52] U.S. Cl..... 259/4, 222/135, 259/27

[51] Int. Cl..... B01f 15/04

[58] Field of Search..... 222/134, 135, 145; 259/4, 27, 47; 23/252; 425/120, 130, 257

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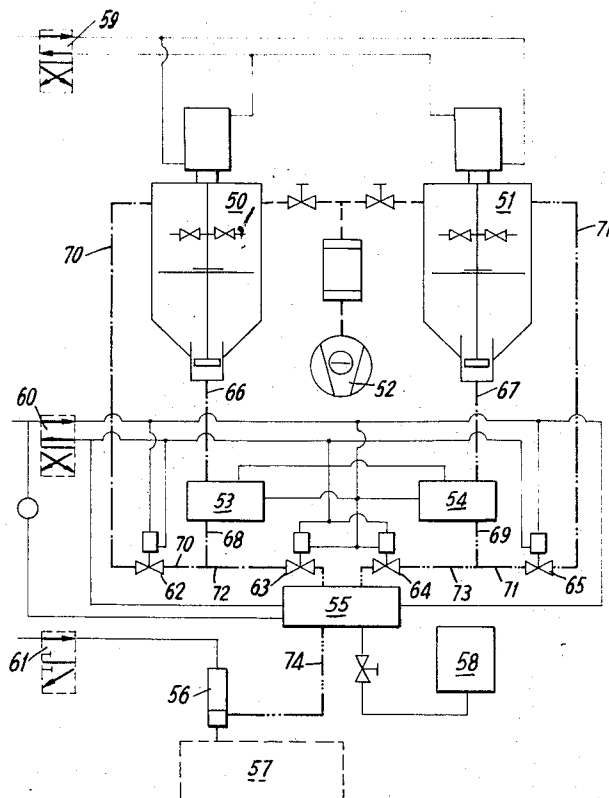
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ABSTRACT

In a plant for preparing the constituent materials of a casting resin, a premixer forms a chamber for the constituent materials. A pump having a reciprocating piston is located within and at the outlet end of the premixer. The pump has a cylinder with at least one opening for receiving material from the chamber in the premixer. In the pump as the piston completes its suction stroke the opening is uncovered and materials flow into the cylinder and during the exhaust stroke of the piston the materials are discharged from the premixer outlet. The pump piston has a reciprocating rod which extends upwardly through the premixer chamber where it supports and actuates a mixing disk. Metering pumps receive the material from the premixers and deliver it into a final mixer. In the final mixer another reciprocating rod is provided with a mixing element for the final mixing and delivery of the materials to a metering head or a simple casting valve. Valves are provided for controlling and integrating the various operations of the plant.

24 Claims, 6 Drawing Figures



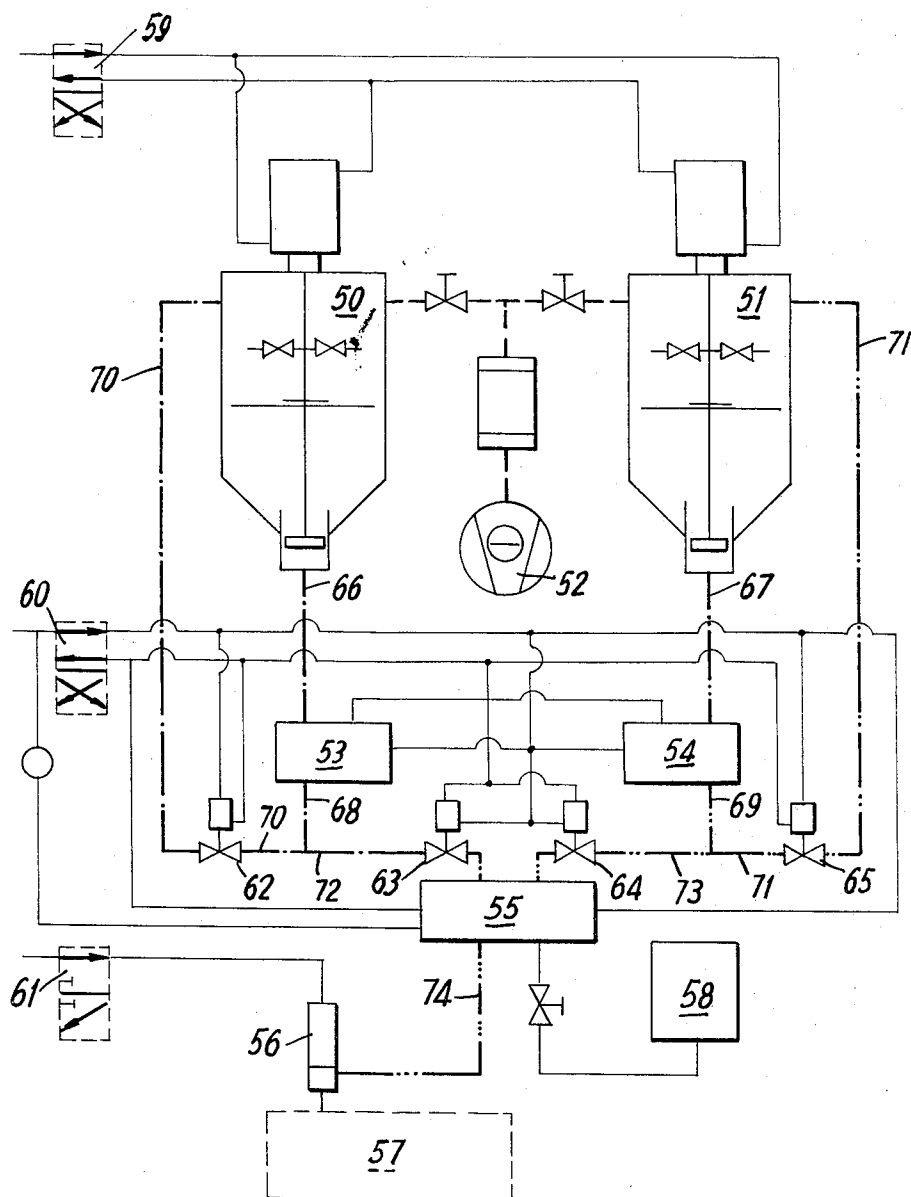


FIG. 1

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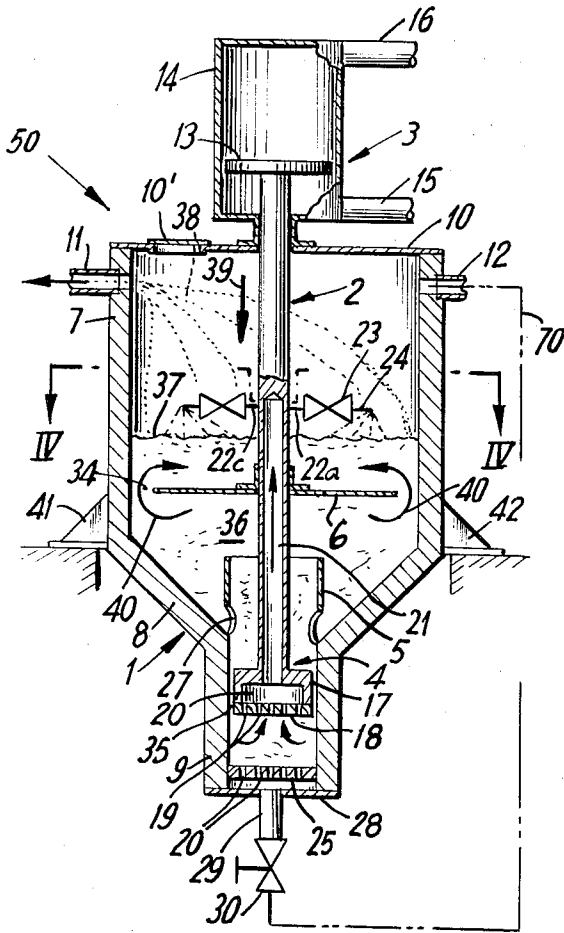


FIG. 2

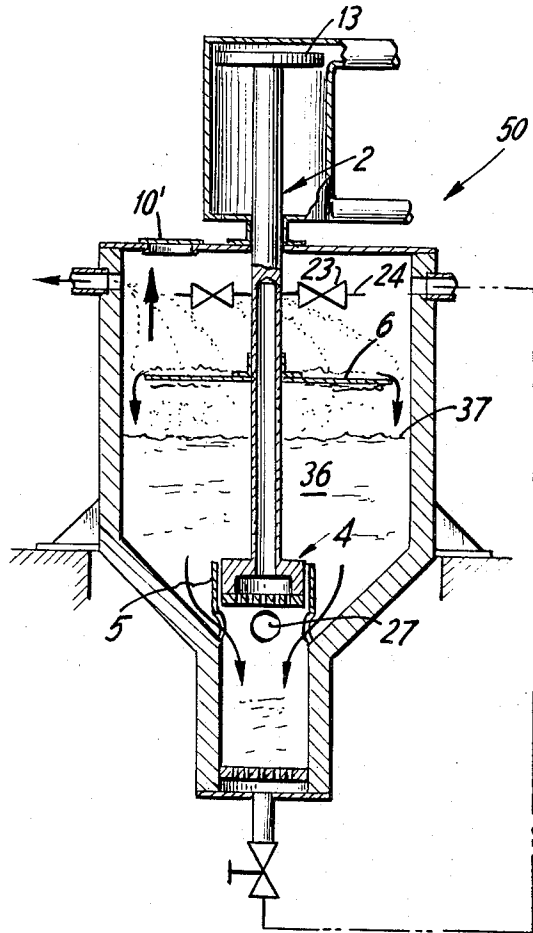


FIG. 3

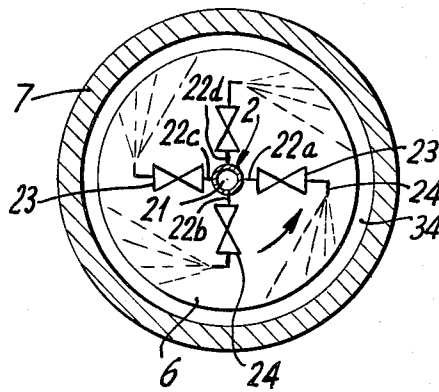


FIG. 4

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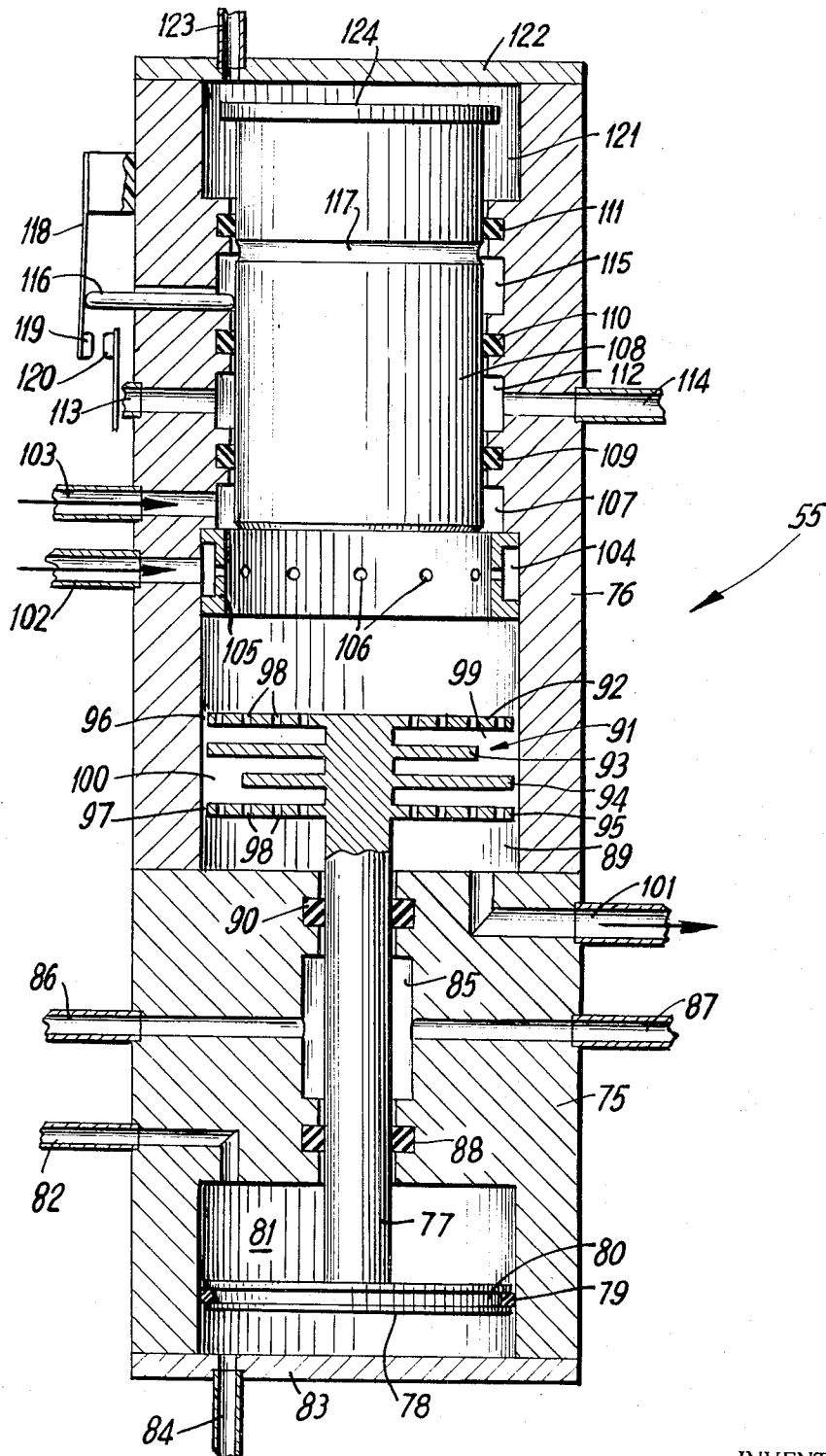


FIG. 5

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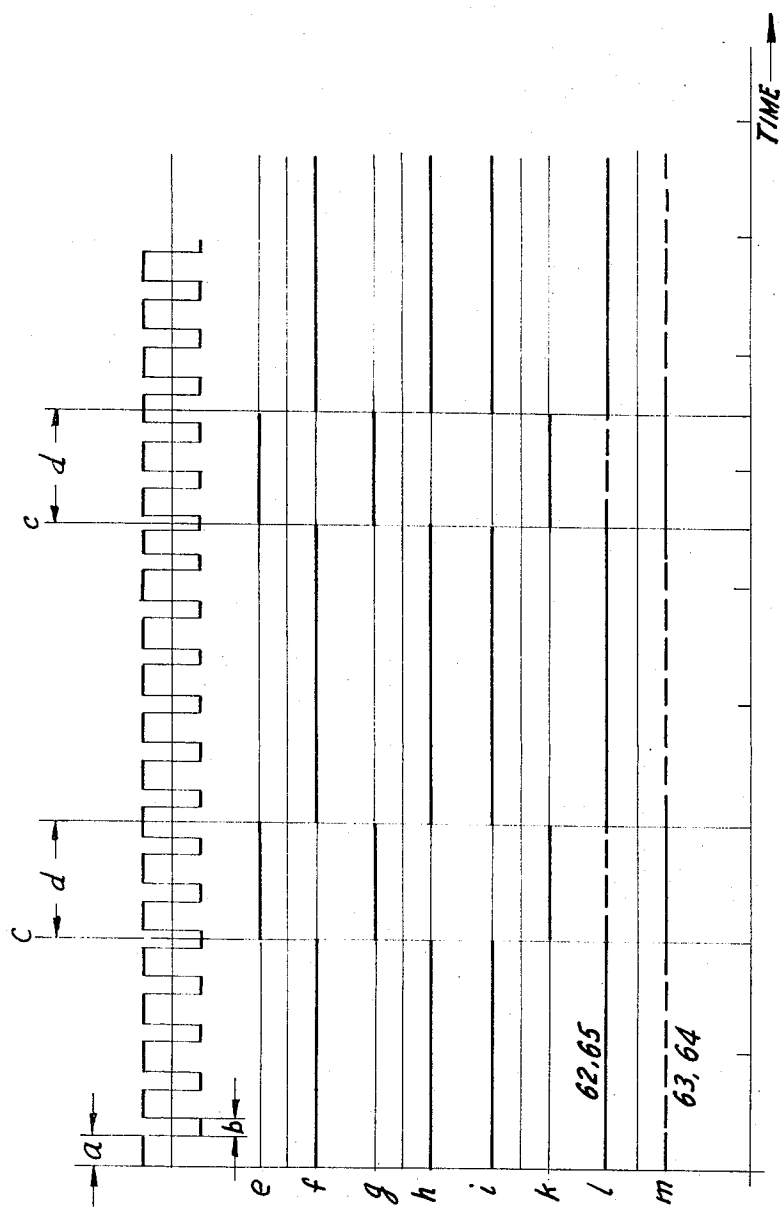


FIG. 6

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PLANT FOR PROCESSING CASTING RESIN

This is a continuation of application Ser. No. 3,488 filed Jan. 16, 1970

SUMMARY OF THE INVENTION

The invention is directed to a plant for processing casting resin formed of at least two constituent materials with the plant comprising at least one premixer in which a vacuum can be established, a final mixer, and a metering pump for supplying selected amounts of the constituent materials from the premixer to the final mixer. More specifically, the invention concerns the construction of the premixer and the final mixer in which correlated reciprocating actions are provided for mixing and discharging the constituent materials.

Casting resins are used for many purposes. One preferred field for such resins is in electrical engineering where they are used primarily for impregnating coils and other electrical parts where a good electrical insulation and good protection against external influences, such as moisture, are important.

In processing casting resins, initially two constituent materials are prepared which by themselves do not undergo any rapid chemical or physical changes. These constituent materials are mixed together shortly before the casting operation. When mixed, the constituent materials react within a relatively short time so that the cast material solidifies. The time period during which the mixture to be cast can remain in a tank without losing its ability to be poured, is called the "pot time."

A plant for preparing and casting multiple constituent material resins must meet the following requirements:

The constituent materials of the casting resin must be capable of being mixed rapidly and thoroughly in an exactly measured composition and it must be possible to use viscous casting materials containing a large amount of filler material. The constituent materials must be capable of being degassed under a vacuum. Any new absorption of gas after the degassing operation must be avoided. It must be possible to measure the casting resin exactly in the processing plant in accordance with the size of the workpiece to be formed. To maintain the plant operative, hardening residues such as hardening casting resin or filler material must be avoided in the different parts of the plant. To permit the use of casting resins which have a considerable wearing effect on the plant, particularly casting resins with abrasive fillers, it is necessary to utilize easily replaceable and long wearing parts which prevent the deposit of constituent materials or of the mixed casting resin. It must be possible to heat and cool the plant in order to maintain the required temperature conditions.

In known plants for the preparation or processing of a casting resin, premixers with stirrers are utilized in which electric motors are used as the drive means. The discharge of the constituent materials from the premixers to metering pumps requires either the ventilation of the premixer chamber or the location of the premixer at such a height that the column of the constituent material can no longer be retained by a vacuum. If vacuum conditions are removed from the premixer chamber there is the risk that gases will again be absorbed into the materials, on the other hand by locating the premixer chamber at a considerable height greatly increases the cost of the plant and, frequently, for construction reasons it is not possible to locate the pre-

mixer chamber in such a manner. As a rule, the constituent materials are supplied to the final mixer in predetermined amounts and the amount charged into the mixer must be cast within an admissible pot time. If interruptions in the casting operation are to be avoided, it is important if an additional charge of the materials can be mixed during the casting of one charge.

The primary object of the present invention is to provide a processing plant in which the premixers can be maintained under a vacuum even while the constituent materials are being discharged so that continuous operation of the plant is possible.

Therefore, in accordance with the present invention, the problems experienced in the past are overcome by employing a piston pump at the outlet from the premixer so that the pump cylinder extends inwardly into the body of material contained in the premixer and an opening is provided through the wall of the cylinder in communication with the body of material for admitting the material into the cylinder at the end of the suction stroke of the piston so that the material can be discharged during the exhaust stroke of the piston.

In such a plant the constituent materials can be supplied from the premixer to the metering pump while maintaining the vacuum within the premixer and without positioning the premixer at a considerable height above the metering pump. Such discharge of the material from the premixer is possible since no marked pressure gradient is required when the material is discharged by means of the piston pump. Since the cylinder of the pump is located below and extends into the body of material in the premixer when its opening is uncovered, the material flows by gravity into the cylinder. As the pump piston performs its pressure or exhaust stroke on the material within the cylinder, it is fed by positive displacement, without any overpressure, into the metering pump. Since the material is discharged by the piston the metering pump can be located above the outlet from the premixer. This arrangement is of great advantage for the construction of the entire plant.

In one preferred embodiment of the plant, in accordance with the present invention, a reciprocating rod extends through the chamber of the premixer into the cylinder of the piston pump. Within the chamber of the premixer a mixing element is supported on the rod and during a portion of the reciprocating stroke of the rod the mixing element passes through the material in the chamber. The mixing element can be in the form of one or several members extending transversely from the rod, such as disks, and the piston portion of the pump is mounted on the lower end of the reciprocating rod for effecting its upward and downward movement within the pump. In such a premixer its operation can be carried out with only the reciprocating movements of the rod. The stirring-in of rising gas bubbles, as takes place in rotating stirring mechanisms, does not take place in the operation of the premixer constructed in accordance with the present invention.

In a particularly advantageous embodiment of a processing plant, in accordance with the present invention, the reciprocating action employed for the premixers can also be used for the metering pumps and the final mixer. With this type of drive, it is possible to control the plant in such a way that the different reciprocating drives can be coordinated in accordance with the extent to which the final mixer is filled. In such coordinated operation, as the premixer performs a discharge

or exhaust stroke the metering pump performs a suction stroke so that the constituent materials can be delivered into the metering pump. Similarly, during an exhaust or discharge stroke of the metering pump a mixing element within the final mixer also performs a correlated operation.

With a reciprocating drive being used in the final mixer, it is preferable to utilize a mixing element within the chamber of the final mixer which is reciprocated by means of a rod, with the rod being connected to the piston of a double acting pressure cylinder to provide the requisite reciprocating operation. The mixing element can be disk-shaped and formed of multiple parts some only slightly spaced from the wall of the chamber and others spaced a greater distance.

The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, its operating advantages and specific objects attained by its uses, reference should be had to the accompanying drawing and descriptive matter in which there is illustrated a preferred embodiment of the invention.

BRIEF DESCRIPTION OF THE DRAWING

In the Drawing:

FIG. 1 is a schematic representation of a plant for preparing a casting resin in accordance with the present invention;

FIG. 2 is a vertical sectional view through a mixer such as used in the plant shown in FIG. 1 with its reciprocating rod in its downward or discharge stroke;

FIG. 3 is a vertical sectional view similar to FIG. 2, however, the reciprocating bar is in its upward position, that is, the end of its suction stroke;

FIG. 4 is a horizontal sectional view taken along the line IV—IV in FIG. 2;

FIG. 5 is a vertical sectional view through a final mixer as utilized in the plant set forth in FIG. 1; and

FIG. 6 is a diagram representing the timed operation of the different parts of the plant as set forth in FIG. 1.

DETAILED DESCRIPTION OF THE INVENTION

In FIG. 1 a plant for processing and mixing the constituent materials for a casting resin is shown comprised of the following elements:

A pair of premixers 50, 51, a vacuum pump 52 is in communication with the two premixers, a pair of metering pumps 53, 54 each arranged in communication with one of the premixers, a final mixer 55 arranged to receive the constituent materials from the metering pumps, a fine metering head 56 in communication with the outlet from the final mixer, and a vacuum casting tank 57 arranged to receive the casting resin from the metering head. A solvent tank 58 is connected to the final mixer. The operation of the plant is obtained through a pair of reversing valves 59, 60, another control valve 61 which is disposed in communication with the metering head, and two pairs of valves 62 and 63, 64 and 65, each pair in communication with the outlet lines from one of the metering pumps.

The outlets from the premixers 50, 51 are connected by pipe lines 66, 67 with the metering pumps 53, 54, respectively.

The metering pumps 53, 54 are each provided with an outlet line 68, 69, respectively, and each of the outlet lines branches into a pair of outlets 70, 72 and 71, 73.

The branch outlets 70, 71 form bypass lines returning to the premixers 50, 51, respectively, and each of the branch outlets contains a valve 62, 65 respectively. The other two branch outlets 72, 73 contain valves 63, 64 and terminate at the final mixer 55. The outlet from the final mixer 55 is connected by a line 74 to the fine metering head 56.

While the plant is shown schematically in FIG. 1, in FIGS. 2, 3 and 4 the premixers 50, 51 are set forth in detail and, similarly, the details of the final mixer 55 are illustrated in FIG. 5.

Since the construction of the premixers 50, 51 are the same only one of the premixers 50 is shown in FIGS. 2, 3 and 4. The premixer 50 is formed of an upright tank 1 through which a rod 2 is reciprocated, that is, moved in an up and down manner by a double-acting pressure cylinder 3 located above the upper end of the tank. At the lower end of the tank 1, a pump piston 4 is secured to the lower end of the rod 2 and moves in the vertical direction within a pump cylinder 5. Secured to and extending transversely from the rod 2 within the tank 1 and above the pump cylinder 5 is a mixing element 6 in the form of a disk.

The tank 1 has a vertically arranged cylindrically shaped upper part 7, a frusto conically shaped part 8 is secured to the lower end of the upper part and extends downwardly to another cylindrically shaped part 9 which has a diameter substantially smaller than that of the diameter of the part 7. The top of the tank 1 is sealed in a vacuum tight manner by means of a cover 10. Within the cover 10, a filler hole is arranged and is closed by a smaller cover 10'. Adjacent the upper end of the tank, on the left-hand side as shown in FIG. 2, a suction pipe 11 is provided which connects the interior of the tank with the vacuum pump 52, see FIG. 1. Another pipe connection 12 is arranged on the opposite side of the tank from the vacuum connection for the return of excess material into the premixer from the metering pump 53, in FIG. 1 note the branch line 70. At the lower end of its upper part 7 the tank is carried by means of brackets 41, 42 on supports.

At its upper end the rod 2 is connected to a piston 13 which is vertically displaceable within the cylindrically shaped chamber 14 of the double-acting pressure cylinder 3. The piston 13 is sealed against the inner wall of the chamber 14. A pair of pressure lines 15 and 16 are connected to the lower and upper ends of the chamber 14 for alternately admitting a pressure medium, for instance, compressed air, for reciprocating the rod in an upward and downward movement through the premixer 50. At the lower end of the rod 2 the piston 4 consists of a bell-shaped upper part 17 and a screen plate 18 extending transversely across the lower end face of the upper part and forming a chamber 20 within the upper part. A plurality of bores 19 are provided through the screen plate communicating between the chamber 20 and the interior of the cylinder 5. The lower end of the rod 2 is hollow and provides a bore 21 extending upwardly from the chamber 20 to a point within the upper part 7 of the premixer chamber. As can be noted in FIG. 4, four lines 22a, 22b, 22c, and 22d are equally angularly spaced about the rod and extend radially outwardly toward but in spaced relationship from the outer wall of the upper part 7 of the premixer chamber. Each of the lines 22a - 22d contains a valve 23 and terminates in a nozzle 24 which, as can be seen in FIG. 4, extends tangentially to a circle passing

through the outer ends of the lines. As can be noted from the illustration in FIG. 2, the nozzles 24 are directed slightly downwardly providing the spray action indicated by the dotted lines shown in FIGS. 2 and 4. The outside diameter of the bell-shaped upper part 17 forming the piston 4 has a diameter which is smaller than the inside diameter of the cylinder so that an annular space 35 is formed between the exterior of the piston and the inner surface of the pump cylinder 5.

At its lower end the pump cylinder 5 is closed by a scree-plate 25 containing a plurality of bores 26. The cylinder 5 extends upwardly into the lower end of the premixer chamber formed by the frusto-conically shaped part 8. Four feed openings 27 are provided in the circumferential wall of the cylinder 5 for providing communication between the interior of the cylinder and the body of material located within the premixer chamber.

The lower end of the bottom part 9 of the tank 1 is closed by means of a cover 28 to which a pipe connection 29 is attached. The pipe connection 29 extends downwardly and terminates in a valve 30 and, as indicated in FIG. 1, the line 66 extends from valve 30 to the metering pump 53.

The mixing element 6 secured to the rod 2 within the premixer chamber has a disk-like form whose outside diameter is less than the inside diameter of the cylindrically shaped part 7 of the tank so that an annular space 34 is provided between the outer edge of the mixing element and the inner surface of the premixer chamber. Though only one disk is shown on the rod 2, it would be possible to use several disks disposed one above the other and the disks could be perforated. Alternatively, other shaped parts, such as wings, blades and the like, could be used in place of the disks.

At start-up, the constituent material 36 is supplied to the premixer chamber to a level so that the chamber is about half filled, that is, up to the level 37 as shown in FIGS. 2 and 3. If the material 36 is to be degassed, the chamber formed by the tank 1 is connected by means of the suction pipe 11 to the vacuum pump 52. The exhaust of gases under the vacuum is indicated by the dotted lines 38 in FIG. 2.

As the opposite sides of the piston 13 within the pressure cylinder 3 are pressurized through the lines 15 and 16, the rod 2 is reciprocated in an up and down manner within the premixer. In this type of drive overstressing of the parts is avoided since the pressure acting within the cylinder 3 limits the driving forces correspondingly. As indicated by the arrow 39 in FIG. 2, the rod 2 is in the process of moving downwardly. As the rod 2 moves downwardly the disk-like mixing element 6 is forced into the body of material 36 so that it flows around the peripheral edges of the element through the annular space 34 as indicated by the arrows 40. At the same time the piston 4 at the lower end of the rod is forced through the material within the cylinder 5 and with the valve 30 closed the material flows upwardly through the bores 19 into the chamber 20 and from the chamber 20 passes upwardly through the bore 21 in the rod 2. At the upper end of the bore 21 the material flows into the lines 22a - 22d through the overpressure valves 23 to the nozzles 24 at the outlets from the lines. When the material passes through the overpressure valves it is homogenized. As the material is pressed upwardly through the bore 21 it is ejected outwardly from the nozzles and, as a result, a torque is exerted by the reac-

tion effect of the ejected material so that the rod 2 begins to turn. Any material which adheres to the walls of the premixer chamber is removed due to the turning action of the rod and the ejection action of the material. Since the outer surface of the piston bore is spaced inwardly from the wall of the cylinder 5 a part of the material below the piston is squeezed through the gap 35 and returns to the supply of material above the piston.

In FIG. 3 the upper dead center position of the piston 4 is represented, that is, at the end of its suction stroke and at the beginning of its exhaust or discharge stroke. Additionally, it will be noted that the mixing element 6 has been lifted upwardly by the rod 2 until it is positioned above the level 37 of the body of material 36 within the premixer chamber. In the position shown in FIG. 3, the piston 4 is located above the openings 27 which communicate between the interior of the cylinder 5 and the body of material 36 within the premixer chamber. As a result, the material 36 flows by gravity into the cylinder and such action can be increased by an overpressure on the level 37 when the plant is not operating under a vacuum. When the mixing element 6 has been lifted upwardly out of the body of material 36, it carries some of the material along with it so that the surface of the material is considerably increased which is advantageous for the degasification of the material. As indicated above, the dotted lines indicate how the gas is withdrawn from the material.

In FIG. 5, the final mixer is formed of a lower body part 75 on which a cylindrically shaped upper part 76 is mounted. The lower body part has an upwardly extending opening through which a rod 77 extends into the upper part 76. At its lower end the rod 77 is rigidly attached to a piston 78 located within a cylinder 81 formed in the lower end of the lower part 75. A piston ring 79 is inserted into an annular slot 80 formed about the periphery of the piston 78 and forms a seal with the inner wall of the part 75 within the cylinder 81. The piston 78 is displaceable in the vertical direction through the cylinder 81 by means of a line 82 which opens into the upper end of the cylinder and another line 84 which opens through a cover 83 into the cylinder. The cover 83 closes the lower end of the cylinder.

Spaced above the cylinder 81 a chamber 85 encircles the rod 77 and a pair of lines 86, 87 extending through the wall of the lower part 75 are connected to the chamber 85 for flushing the space within the chamber. Between the cylinder 81 and the chamber 85 a gasket 90 88 provides a seal about the rod 77 and above the chamber 85 in the lower part 75 a gasket provides a seal about the rod 77 at a point closely spaced below lower end of the upper part 76.

The upper end of the lower body part 75 forms a closure for the lower end of a mixing chamber 89 within the upper part 76 of the final mixer. The rod 77 extends into the mixing chamber 89 and a mixing element 91 is located at its upper end within the chamber. As shown in FIG. 5 the mixing element 91 is composed of four disks 92, 93, 94 and 95. The uppermost and lowermost disks 92 and 95 have substantially the same diameter as the mixing chamber 89 so that only narrow annular gaps 96, 97 are provided between the exterior circumference of these disks and the inner wall of the upper part 76 forming the mixing chamber 89. However, the disks 93, 94 positioned between the other two disks 92, 95 have a somewhat eccentric shape being

closer to the wall of the mixing chamber at one point than at another diametrically disposed point. Accordingly, the annular gap formed between the disks 93, 94 and the inner surface of the mixing chamber is non-uniform in width as indicated by the reference numerals 99, 100 which indicate the wider portion of the annular gap for each of these disks.

At the lower end of the mixing chamber 89 an outlet line 101 extends downwardly and outwardly through the lower part 75 of the final mixer. At the upper end of the mixing chamber a pair of inlet lines 102, 103 are provided. The line 102 opens into an enclosed annular duct 104 which is limited on the outside by the interior surface of the upper part 76 and on the inside by a ring-shaped part 105 having a U-shaped cross section for forming the annular duct 104. A plurality of openings 106 are provided through the ring-shaped part 105 communicating between the annular duct 104 and the interior of the mixing chamber 89. Above the line 102, the line 103 terminates in an annular duct 107 which is defined on the outside by the interior surface of the upper part 76 and on the inside by a storage piston 108.

The storage piston 108 is located within the opening formed by the cylindrically shaped upper part above the mixing chamber 89 and a plurality of vertically spaced gaskets 109, 110 and 111 are provided between the exterior surface of the piston 108 and the inner surface of the upper part 76. Between the gaskets 109, 110 an annular duct 112 is provided between the outer surface of the piston 108 and the inner surface of the upper part 76 and the duct is connected to a pair of lines 113, 114 for performing a flushing or rinsing cycle about the storage piston. Between the gaskets 110 and 111 another annular duct 115 is provided between the outer surface of the storage piston and the inner surface of the upper part 76 and a feeler member 116 extends through an opening in the upper part 76 into the annular duct 115.

The feeler member 116 is biased into surface contact with the outer surface of the storage piston. As shown in FIG. 5 an annular groove 117 is provided about the storage piston 108 located above the level of the feeler 116, however, if the storage piston drops downwardly until the annular slot is at the level of the feeler member 116, the feeler member is biased inwardly by means of a contact spring 118 acting on its outer end so that the feeler member seats itself within the annular groove 117 and a contact stud 119 on the spring 118 comes in contact with a corresponding and oppositely disposed contact stud 120.

At its upper end the storage piston 108 is located within a chamber 121 which has a larger diameter than the remainder of the opening through the upper part 76 through which the storage piston projects. At its top, a cover 122 provides a closure for the upper part 76 and a line 123 formed in the cover communicates with the top of the chamber 121. At its upper end the storage piston has a narrow outwardly extending flange 124 which acts as a stop to limit the downward movement of the storage piston through the vertically disposed opening within the upper part 76.

During operation, the plant, according to the present invention, works in the following manner:

The constituent materials for forming the casting resin are initially prepared in the premixers 50, 51 that is, they are degassed by means of a vacuum produced by the vacuum pump 52 and they are mixed with filler

material, and or other colorants and modifying substances. During the initial stage of operation the premixers 50, 51 operate along in connection with the vacuum pump. The premixers are controlled by means of electrical time switches, not shown, which actuate the reversing valve 59 for affording the desired reciprocating action. At this point the metering pumps 53, 54 are rinsed with the valves 62 and 65 opened, in order to prevent the deposit of solids. At the outset the pneumatically or hydraulically operated valves 62, 63, 64 and 65 are arranged so that only the return or bypass lines 70, 71 are open for returning the materials to the premixer chamber but preventing passage to the final mixer 55. After the initial preparations are completed, the casting process is commenced electrically. At this point in operation, the working cycle of the premixer depends on the metering pumps 53, 54 and on the final mixer 55 that is, the control valves 59 and 60 are actuated synchronously to provide the proper correlation of operation. While the pistons, not shown, of the metering pumps 53, 54 move into the receiving position, the pistons 4 in the cylinders 5 at the lower ends of the premixers 50, 51 displace the constituent materials to the metering pumps so that a rapid supply is provided. The valves 63, 64 are closed and the valves 62, 65 are opened so that any excess material supplied by the pistons can flow back into the premixer chambers. In accordance with the movements of the metering pumps 53, 54 the final mixer 55 also performs a mixing movement. It is possible to provide several mixing movements to the metering pump stroke, however, this is unnecessary in most cases.

If the storage volume, that is the mixing chamber 89, in the final mixer is empty, as is the case at the outset of operations, or if it is used up to the minimum level during the casting operation, the control contacts 119, 120, see FIG. 5, located on the upper end of the upper part 76 of the final mixer cause the metering pumps to perform a delivery or discharge stroke. Simultaneously, the reciprocating rods 2 in the premixers 50, 51 move into the upper position that is, the end of the suction and the beginning of the discharge stroke and the mixing element 91 in the final mixer is moved into the starting position.

For admitting the constituent materials into the final mixer 55, the valves are at first reversed, that is, the valves 62, 65 are closed and the valves 63, 64 are opened. The mixture within the final mixer 55 is under pressure and is cast intermittently from the fine metering head into the vacuum casting tank 57 or under atmospheric pressure conditions. Since a regulable pressure of several atmospheres is available for filling the metering head 56, it is possible to supply charges of the casting resins in rapid succession.

After the metering pumps 53, 54 have completed their discharge stroke, the pistons move into the receiving position and they are replenished with the constituent materials from the premixers. From the metering pumps the constituent materials flow to the final mixer through the lines 102, 103. As the materials enter the final mixer, not FIG. 5, the material passing through the line 103 flows through the narrow gap at the lower end of the annular duct 107 formed between the outer surface of the storage piston 108 and the inner surface of the annular part 105 and in this manner is evenly distributed. At the same time the material passing through the line 102 enters the annular duct 104 and flows

through the openings 106 into the mixing chamber 89 in the form of jets which mix with the material entering through the line 103 which flows downwardly past the openings 106. Due to this type of constituent material supply to the mixing chamber 89, a good mixing of the materials is achieved. As the mixing element 91 moves upwardly and downwardly within the mixing chamber 89, the mixing of the constituent materials supplied into the upper end of the chamber is continued. As the mixing element moves upwardly the mixed constituent materials pass through the bores 98 in the upper disk 92 and are forced by the disks 93 and 94 to flow through a somewhat spiraling path due to the spacing between the outer edges of the disks 93 and 94 and the inner surface of the mixing chamber. Finally, the mixed constituent materials are forced through the bores 98 in the lowermost disk 96 and as a result of this action a very thorough mixing is accomplished.

Once the complete operation of the plant is commenced, it continues automatically as a function of the amount of the casting resin passing through the fine metering head.

It is also possible to carry out the processing of the casting resin either partly or completely under atmospheric pressure. Accordingly, if vacuum degasification is not possible, the vacuum pump 52 can be eliminated. On the other hand, the constituent materials in the pre-mixer can be prepared under a vacuum, the subsequent final mixing can also be carried under vacuum conditions and then the mixed constituent materials can be cast under atmospheric pressure.

The rate of flow of the mixture of the constituent materials from the final mixer 55 is controlled by a "pot time" relay, not shown, and is made dependent on the number of strokes of the metering pump per unit of time. The risk that the final mixer 55 or the fine metering head 56 will become jammed is thus indicated optically or acoustically and can be eliminated by increasing the casting velocity (washing out with fresh material) or by flushing the final mixer and the other parts coming into contact with the mixed material with solvents from the tank 58.

If a continuous casting jet of the resin is to be produced, the fine metering head 56 is replaced by a simple casting valve with a reducing nozzle. The maximum rate of flow through the casting nozzle is so great that the metering pumps 53, 54 are ready to deliver the constituent materials when the final mixer makes contact. The storage volume of the final mixer is never completely used up.

In the casting above a certain minimum velocity, the supply of the casting material into the mold can be performed by the metering pumps 53, 54. The sum of the weights of the individual constituent materials is equal to the weight of the material being supplied from the casting valve. This arrangement has the advantage that a minimum of parts are exposed to the activated material.

Though not illustrated in the drawing, the processing plant has a heating system so that all parts coming in contact with the material can be heated.

The control of the plant is described below based on the time diagram represented in FIG. 6. Though the control is automatic, it is extremely simple since the movements of the pneumatically or hydraulically operated parts run in synchronization during the processing and casting operation.

As indicated in FIG. 1, all of the parts of the plant, with the exception of the casting valve or the metering head 56 whichever is used, can be controlled by the two pneumatic or hydraulically operated reversing valves 59, 60. The electric control of these reversing valves is accomplished by the switch contact 119, 120 of the storage device (the storage piston 108) mounted on the final mixer, note FIG. 5. The action of this contact 119, 120 depends on the removal of the material from the final mixer.

In the control diagram set forth in FIG. 6, the operation of the various parts of the plant is plotted against time.

In FIG. 6 the top line indicates the activity of the fine metering head 56. It will be noted that the top line is divided into sections designated *a* and *b*, during the time period designated *a* the casting cycle performed by the fine metering head is carried out, and during the time period *b* the mixed constituent materials are charged from the final mixer into the fine metering head. It is assumed in the diagram that the casting cycle is somewhat longer than the charging interval.

When the amount of the mixed casting material from the final mixer has dropped to a level that the storage piston is displaced downwardly under the action of air pressure introduced above it through the line 123 so that the feeler 116 engages the slot 117 then the contact 119, 120 is closed and the elapsed time indicated by the line *c* is reached. Accordingly, at the time designated by the line *c*, an electric timer is connected for a time period indicated by *d*. During the time period *d* the metering pumps 53, 54 complete a discharge stroke for supplying material into the final mixer 55. While this filling process is being accomplished, the casting operation continues, as can be noted from the diagram in FIG. 6. After about another six casting cycles the contact 119, 120 closes again and the timer commences the time period *d* for filling the final mixer.

The lines *e* to *m* indicate the operation of various parts of the processing plant. Along the line *e* the heavy solid line indicates that the mixing element 91 within the final mixer 55 is in its upper position, that is, in the position adjacent the lower end of the storage piston 108. The line *f* indicates when the mixing element of the final mixer is moving downwardly within the mixing chamber 89. The lines *g* and *h* indicate the activity of the metering pumps 53, 54. As indicated above, the metering pumps deliver the constituent materials to the final mixer during the time intervals *d* and discontinue operation at the termination of the time period *d*. When the time period *d* is completed the metering pumps return to the charging position and are filled by the pistons 4 within the premixers which are moving downwardly into the discharge or exhaust position. After the casting cycles again reach the time designated *c* the filled metering pumps commence a new delivery stroke for filling the final mixer 55.

The lines *i* and *k* represent the operation of the premixers 50, 51. During that portion of the plant operation which occurs outside the time interval *d*, the reciprocating parts of the premixers 50, 51 are in their lower positions and when the time *c* is reached they move rapidly into their upper end position. During the time period *d* the cylinder 5 at the lower ends or outlets of the premixers 50, 51 is filled with the constituent material from the body of material in the premixer chamber. When the time period *d* is completed the contents of

the pump cylinders 5 are forced into the metering pumps.

The lines *l* and *m* indicate the operation of the valves 62, 63, 64 and 65. Along these lines the solid portions designate the open position and the broken or dashed portions designate the closed position. During the time period *d* the valves 62, 65, that is the valves in the return lines 70, 71 are closed and the valves 63, 64 are open that is, the valves controlling flow from the metering pumps into the final mixer. Accordingly, during the time period *d* the constituent materials can flow only into the final mixer since they can flow in no other direction with the valves 62, 65 closed. When the metering pumps are filled, the valves 63, 64 are closed and the valves 62, 65 are opened so that any excess constituent materials can flow through the lines 70 and 71 back into the premixer chambers. To avoid wear by abrasion, intensive flushing or rinsing is provided for all parts which might be exposed to such conditions. The rinsing or flushing action is accomplished by the metering pumps which are provided for this purpose with stepped delivery pistons, that is, the metering pumps also deliver the suitable flushing or rinsing agent along with the constituent material. The flushing agent is supplied to and removed from the final mixer through the lines 86, 87 and 113, 114, as shown in FIG. 5.

I claim:

1. A plant for preparing casting resin from at least two constituent materials in which the plant comprises at least one upwardly extending premixer having an outlet at its lower end, said premixer having an upwardly extending axis and forming an axially extending chamber in which a vacuum can be established and said chamber arranged to receive one of the constituent materials and to provide a level of the material below the upper limit of the chamber in said premixer, a final mixer, at least one metering pump for supplying selected quantities of the constituent material from said premixer to said final mixer, and conduit means for conveying the material from said premixer to said metering pump and from said metering pump to said final mixer, wherein the improvement comprises means located at the outlet end of said premixer, said means forming a cylinder within said premixer which is in communication with the lower end of said chamber formed therein, said cylinder having an inlet and an outlet with its outlet located below its inlet and adjacent to the outlet from said premixer, said means including a piston pump having a piston axially displaceable within said cylinder between an upper position for admitting flow of the constituent material from said chamber into said cylinder and a lower position for blocking flow from said chamber into said cylinder, a mixing element located within said chamber in said premixer and operatively connected to said piston pump for upward and downward movement in said chamber passing above and below the level of the material in said chamber, said cylinder arranged to receive material from the body of material in the chamber of said premixer with said piston located within said cylinder and to discharge at least a portion of the material received from the premixer chamber from the outlet of said premixer to said metering pump, said piston forming a chamber in communication with the material in said cylinder, and said means including a bore communicating between the chamber in said piston and said premixer chamber for returning material from said cyl-

inder upwardly into said premixer chamber, said cylinder being open at its upper end, and said piston having an outside diameter which is smaller than the inside diameter of said cylinder whereby a narrow annular gap is formed between the outside surface of said piston and the inside surface of said cylinder so that said piston does not contact the surface of said cylinder and material within said cylinder below said piston can flow upwardly through the annular gap to a point above said piston as it executes its downward exhaust stroke through said cylinder.

2. A plant, as set forth in claim 1, wherein said piston is axially displaceable through said cylinder in a suction stroke which terminates at a location remote from the outlet from said cylinder and an exhaust stroke which terminates at a location closer to said outlet than the location of the termination of the suction stroke, said cylinder extending from the outlet of said premixer into the body of material within said chamber in said premixer, said cylinder having at least one opening in the circumferential periphery thereof intermediate its ends for admitting material from the body of material in said premixer into said cylinder, and the opening in said cylinder being located between the outlet end of said cylinder and the location of the end of the suction stroke of said piston within said cylinder

3. A plant, as set forth in claim 2, wherein a plate is secured to and extends across the lower end of said cylinder adjacent the outlet end of said premixer, and said plate having a plurality of openings therethrough for discharging material from said cylinder during the downward exhaust stroke of said piston within said cylinder.

4. A plant, as set forth in claim 2, wherein a bypass line having an inlet end and an outlet end is secured at its inlet end to the outlet from said premixer and at its outlet end into said chamber in said premixer above the level of the body of material therein.

5. A plant, as set forth in claim 2, wherein said means includes a reciprocating rod positioned within and extending axially upwardly through said chamber in said premixer, said piston in said piston pump is secured to the lower end of said reciprocating rod and is located within said cylinder for executing a suction stroke and an exhaust stroke therein, and said mixing element in said chamber formed by said premixer is secured to and extends transversely from said reciprocating rod within said chamber in said premixer.

6. A plant, as set forth in claim 5, wherein the portion of said chamber within which said mixing element reciprocates is cylindrically shaped, said mixing element has a disk-like shape and the outside diameter of said disk-like shaped mixing element is less than the inside diameter of the portion of said chamber in which said mixing element reciprocates in said premixer for forming an annular flow space between the outer periphery of said disk in the inner surface of said chamber.

7. A plant, as set forth in claim 6, wherein a pressure cylinder disposed above said premixer and in axially alignment with said reciprocating rod, the upper end of said reciprocating rod extending into said pressure cylinder, a piston secured to the upper end of said reciprocating rod within said pressure cylinder, and means for supplying a pressurized fluid into said pressure cylinder on the opposite sides of said piston for effecting the reciprocating action of said reciprocating rod.

8. A plant, as set forth in claim 6, wherein said disk-like mixing element is perforated so that material can pass through the perforations as said mixing element is reciprocated by said reciprocating rod within said pre-mixer chamber.

9. A plant, as set forth in claim 5, wherein said piston of said piston pump located on the lower end of said reciprocating rod within said cylinder comprises walls forming the chamber in said piston which is open at its downward end, a plate extending across and forming a closure for the lower end of said chamber in said piston, said plate having a plurality of bores therethrough communicating between the interior of said cylinder and the interior of said chamber in said piston, and said reciprocating rod forming the bore which extends axially through said reciprocating rod from said chamber in said piston upwardly to a location in said reciprocating rod above the level of the body of material within said chamber in said pre-mixer so that material entering into the chamber formed by said piston passes upwardly through said bore for return into the body of material within said pre-mixer chamber.

10. A plant, as set forth in claim 9, wherein means secured to said reciprocating rod in communication with said bore therethrough for returning the material into said pre-mixer chamber, said means comprising an over-pressure valve through which the material passes before it is returned into said pre-mixer chamber.

11. A plant, as set forth in claim 10, wherein said means connected to said bore in said reciprocating rod comprising a plurality of lines extending radially outwardly from said reciprocating rod, one said over-pressure valve located in each said line, and a nozzle secured to the outlet end of each said line for discharging the material into said pre-mixer chamber with a tangential component relative to an imaginary cylinder within said pre-mixer chamber passing through the outlet ends of said lines and a downward component directed toward the level of the body of material within said pre-mixer chamber.

12. A plant, as set forth in claim 10, wherein said means communicating with said bore through said reciprocating rod are located at a spaced distance above said mixing element secured to said reciprocating rod so that during the reciprocating action of said rod means are located above the level of the body of material within said pre-mixer chamber while said mixing element moves upwardly and downwardly into an out of the body of material in said pre-mixer chamber.

13. A plant, as set forth in claim 1, wherein means for initiating a reciprocating action within said final mixer and said metering pump.

14. A plant, as set forth in claim 13, wherein said final mixer comprises a lower upwardly extending part and an upper part extending upwardly from the upper end of said lower part, said upper part forming an upwardly extending cylindrical space closed at its lower end by the upper end of said lower part and having an inside surface with an inside diameter, said lower part forming a pressure cylinder and an opening extending through said lower part from said pressure cylinder to said cylindrical space in said upper part, and said means for effecting reciprocating action in said final mixer comprising a reciprocating rod extending upwardly from said pressure cylinder in said lower part into said cylindrical space in said upper part, seal means disposed between said reciprocating rod and

said lower part in the opening extending through said lower part communicating with said cylindrical space in said upper part, a piston secured to the lower end of said reciprocating rod within said pressure cylinder in said lower part, and a mixing element secured to the upper end of said reciprocating rod within said cylindrical space in said upper part.

15. A plant, as set forth in claim 14, wherein said mixing element secured to the upper end of said reciprocating rod in said final mixer comprises a disk-shaped element having an outside diameter slightly smaller than the inside diameter of said cylindrical space in said upper part so that a narrow annular space is provided between the outside periphery of said mixing element and the inside surface of said cylindrical space in said upper part, and said disk-shaped element being perforated to permit constituent materials supplied into said cylindrical space in said upper part to pass therethrough.

16. A plant, as set forth in claim 14, wherein said mixing element comprises a plurality of transversely arranged disks secured to said reciprocating rod and extending transversely therefrom, said disks comprising an upper disk and a lower disk having a diameter slightly smaller than the inside diameter of said cylindrical space in said upper part for forming narrow annular gaps between the outside periphery of said disks and the inside surface of said cylindrical space in said upper part, said upper and lower disks being perforated for passing constituent materials therethrough, and at least one intermediate disk spaced between said upper and lower disks and having an eccentric peripheral surface spaced a greater distance from the inside surface of said cylindrical space in said upper part at one point than at a diametrically opposed point so that an annular space of non-uniform width is formed between the outside of said intermediate disk and the inside surface of said cylindrical space in said upper part, so that material passing through the perforations in said upper and lower disks effects at least partly circular motion due to the eccentric shape of said intermediate disk.

17. A plant, as set forth in claim 14, wherein means are disposed within said cylindrical in said upper part of said final mixer for forming a movable transversely extending wall defining the upper end of a mixing chamber formed within the lower part of said cylindrical within said upper part.

18. A plant, as set forth in claim 17, wherein said means comprises a storage piston, a resiliently biased feeler member extending through the wall of said upper part of said final mixer into contact with a surface on said storage piston defining the upper end of the mixing chamber, a groove in the surface on said storage piston for receiving said feeler when said means move downwardly, a first electrical contact positioned on the outer surface of said upper part in engagement with said feeler, a second electrical contact disposed on the outside of said upper part and arranged to be contacted by said electrical contact when said feeler is seated within the groove in the surface of said storage piston when said storage piston has reached a predetermined lower level within said cylindrical space in said upper part.

19. A plant, as set forth in claim 18, wherein means are provided for responding to the contact between said first electrical contact and said second electrical contact for effecting coordinated reciprocal movements in said premixers, metering pumps, and final

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mixer for supplying constituent materials from the cylinder in said premixer to said metering pumps and then to the mixing chamber in said final mixer.

20. A plant, as set forth in claim 17, wherein said means defining the upper limit of the mixing chamber within said cylindrical space in said upper part of said final mixer comprises a storage piston located within said cylindrical space and extending upwardly there-
through above said mixing element therein, said cylindrical space in said upper part forming a pressure chamber at its upper end within which the upper end of said storage piston is located, seal means disposed between the sides of said storage piston and the inside surface of said cylindrical space in said upper part, and an inlet duct connected to said pressure chamber for admitting a pressurized fluid therein for urging said storage piston in the downward direction through said cylindrical space in the upper part.

21. A plant, as set forth in claim 20, wherein said lower part of said fixed mixer having an annular groove formed in the opening extending between said pressure chamber and the upper end of said lower part, an annular groove formed in the inner surface of said upper part in the range of said storage piston and duct means communicating with both of said annular grooves for effecting a flushing action therethrough.

22. A plant, as set forth in claim 20, wherein means disposed within said cylinder in the upper part of said final mixer for supplying constituent materials into the mixing chamber formed in the lower end of said cylindrical space in said upper part.

23. A plant, as set forth in claim 22, wherein said means for supplying constituent materials into said mixing chamber comprises an annular member posi-

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tioned within said cylinder and having a portion of its outer surface in contact with the inner surface of said cylindrical space in said upper part, said annular member extending transversely across said cylindrical space in said upper part and having an annular channel-shaped groove formed about its outer surface so that in combination with the inner surface of said cylindrical space in said upper part said groove provides an annular inlet chamber, an inlet duct extending through said upper part into communication with said inlet chamber, said annular member having a plurality of angularly spaced openings therethrough communicating between the inlet chamber and the interior of said mixing chamber in said cylindrical space in said upper part for supplying a constituent material into said mixing chamber in a plurality of jets.

24. A plant, as set forth in claim 23, wherein said upper part having an annular groove formed in its inner surface extending upwardly from the upper end of said annular member, the lower end of said storage piston being disposed opposite said annular groove and forming therewith a second inlet chamber for supplying constituent material into said mixing chamber in said final mixer, the outside diameter of said storage piston being slightly less than the inside diameter of said annular member located below said annular groove so that a narrow annular outlet opening is provided from said second inlet chamber for admitting a thin film-like flow of the constituent material from said second inlet chamber into the mixing chamber passing downwardly through the jets from said inlet chamber formed by said annular member.

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