

June 9, 1925.

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J. F. BRIGGS ET AL

APPARATUS FOR THE PRODUCTION OF ARTIFICIAL SILK AND THE LIKE

Filed May 14, 1923

3 Sheets-Sheet 1

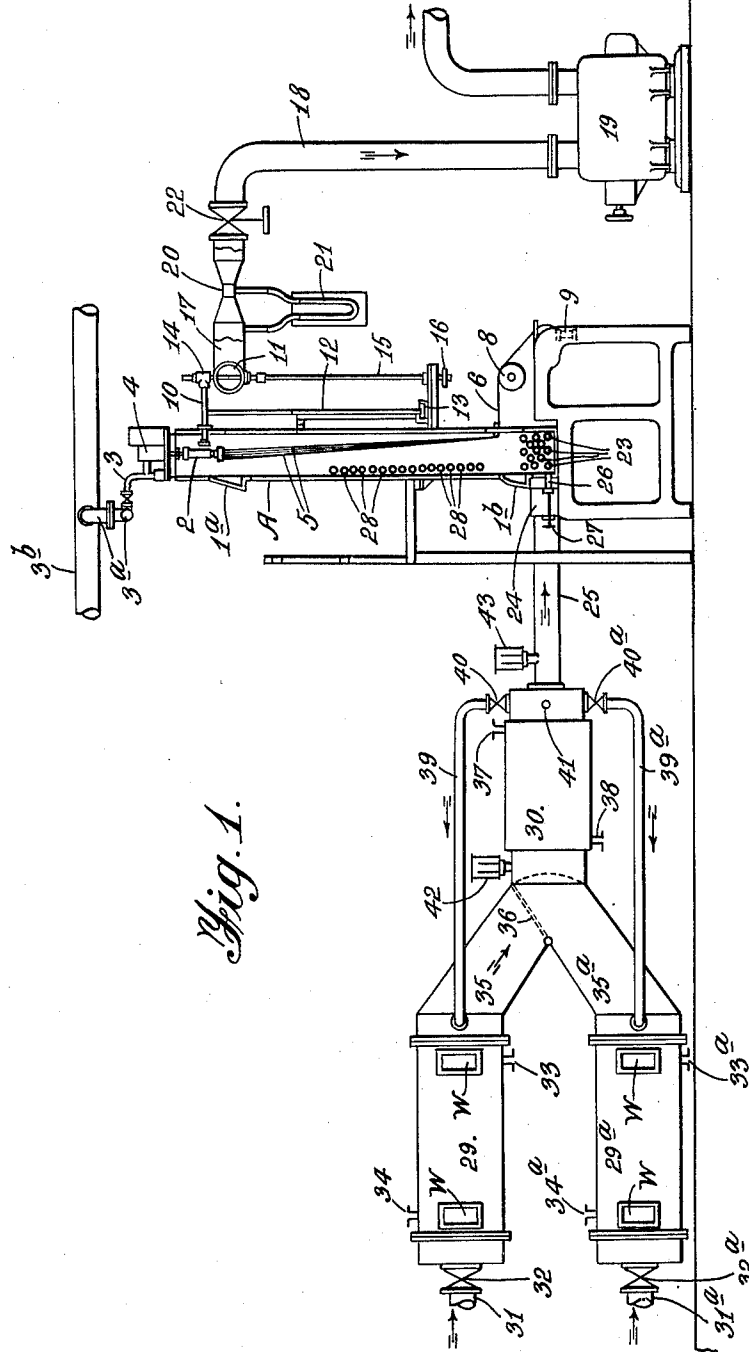


Fig. 1.

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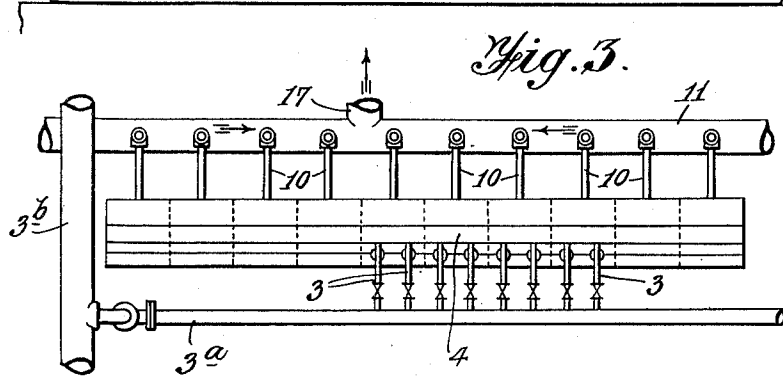
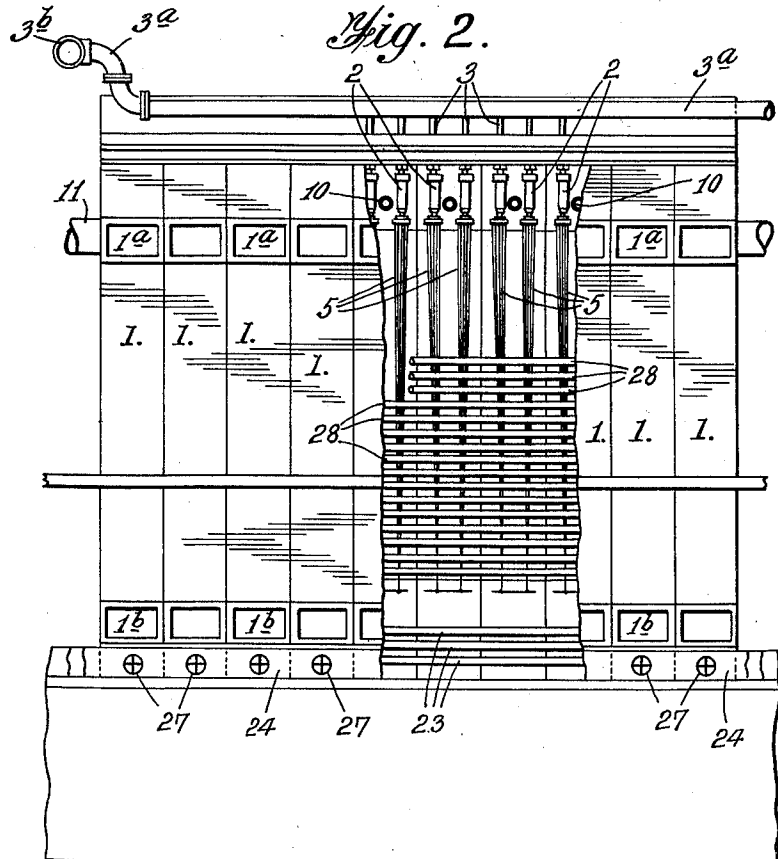
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3 Sheets-Sheet 2



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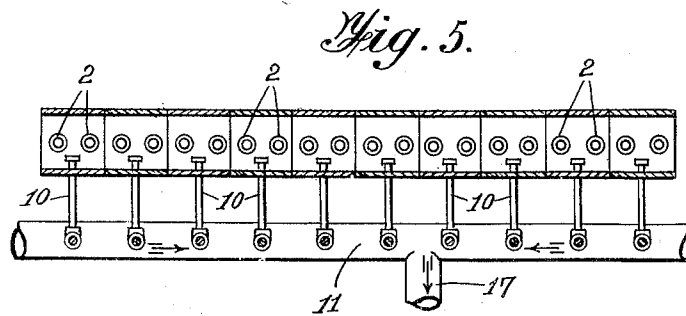
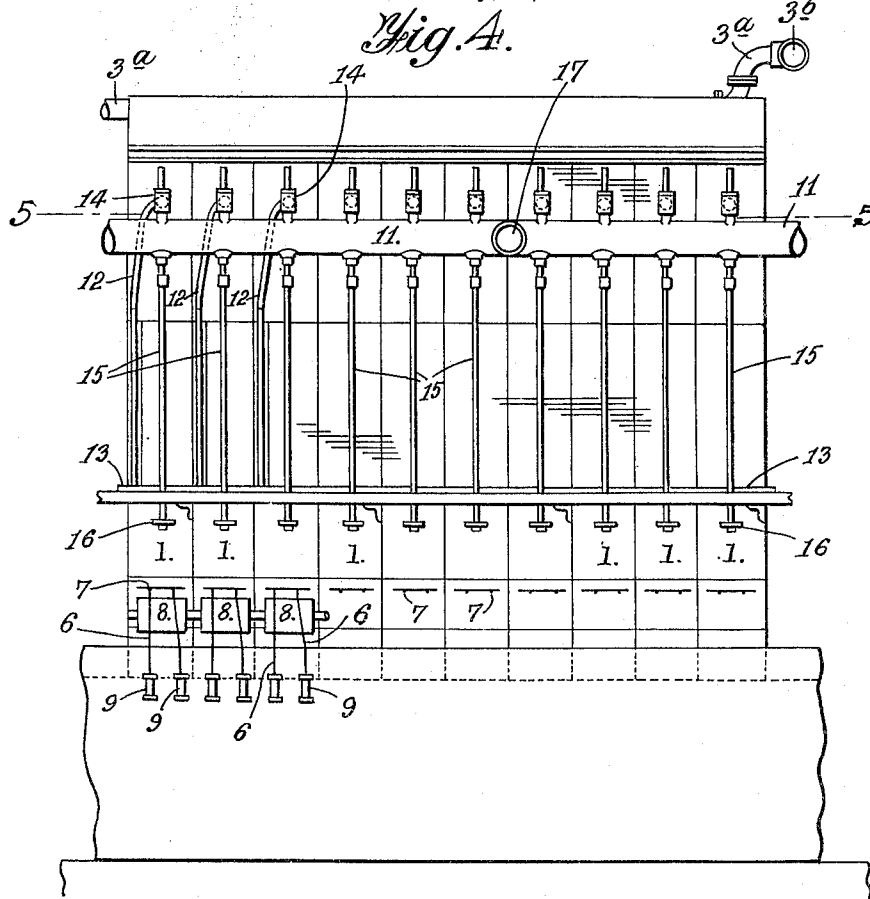
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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE.

JOHN FREDERICK BRIGGS AND WILFRED YORKE, OF SPONDON, NEAR DERBY, ENGLAND, ASSIGNORS TO AMERICAN CELLULOSE AND CHEMICAL MANUFACTURING COMPANY, LIMITED, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

APPARATUS FOR THE PRODUCTION OF ARTIFICIAL SILK AND THE LIKE.

Application filed May 14, 1923. Serial No. 638,904.

To all whom it may concern:

Be it known that we, JOHN FREDERICK BRIGGS and WILFRED YORKE, subjects of the King of Great Britain, and residents of Spondon, near Derby, England, have invented certain new and useful Improvements Relating to Apparatus for the Production of Artificial Silk and the like, of which the following is a specification.

This invention relates to apparatus for the production of artificial silk and like threads or filaments from solutions of cellulose acetates, nitro cellulose, cellulose ethers, or other cellulose derivatives by the evaporative or dry spinning method, wherein a solution of the cellulose derivative in or containing vaporizable solvent is discharged through jets, nozzles or orifices, into a current of hot or warm air drawn or passed through the chambers wherein the solution is discharged, the filaments or threads being solidified by the resulting evaporation of solvent therefrom, and the vapor laden air from the chambers being drawn or conveyed away from the chambers.

This invention applies to apparatus wherein a metier or metiers are divided up into a number of spinning cells or compartments, hereinafter referred to as cells each containing a desired small number of spinnerets. Such apparatus is hereinafter referred to as dry spinning apparatus of the cellular type, it being further understood that any desired number of such metiers or groups of cells may be employed in an installation.

The invention is particularly applicable to apparatus wherein the filaments or threads are spun downwards into the cells of the metier casing from the upper part thereof, and travel down through a current of hot or warm air drawn or passed up through the cells or compartments of the metier and out at the upper part to an evacuating pipe or conduit, the filaments or threads of associated filaments being led out of the metier casing and wound up continuously outside the same, as has been indicated in a previous British specification No. 165,519, but the invention may also be applied to other forms of apparatus working on the evaporative method, where the metier casing is divided up into vertical

cells, each producing a number of threads or filaments.

In practice it has been found that the quality and uniformity of the filaments or threads produced in the cells of a metier or set of sells engaged in spinning any given denier, are liable to be affected by the existence or occurrence of differences in the spinning conditions prevailing in the respective cells, that is to say differences as between cell and cell and that, in order to obtain filaments or threads of similar quality and uniformity, of a given required denier, in the different cells it is important that similar spinning conditions shall be maintained in the different cells producing to given denier. Also for spinning different deniers, it is necessary to adapt the spinning conditions in the cells accordingly.

In the following description the invention will be described in its application to a dry spinning metier casing divided up into cells in a manner similar to that described in the said specification 165,519, the hot or warm air being drawn up through the cells and out at the upper part thereof, it being understood however, that the invention is not restricted to such an arrangement.

We have found that it is of importance that the volume of vapour-laden air passing from each cell of a metier or set of cells producing any given denier, should correspond as uniformly as possible with that passing from its fellows, and that the concentration of this vapour-laden air for any given denier should be as uniform as possible, that is to say, the air volume passing through each cell should be under control and proportional to denier. Also the temperature of the air should be kept as uniform as possible at corresponding points of the different cells.

According to the present invention we provide each cell of a metier or set of cells, with a separate outlet or connection to a pipe or conduit connected to the exhaust and which serves to carry off the vapour laden air from the metier or set or series of cells or compartments, hereinafter referred to as the collecting pipe or header, and we provide each of said outlet pipes or connections with a valve or device for controlling or regulating the flow through same, and

with a flow meter or other device for indicating the volume of vapour-laden air passing from the corresponding cell.

By this means the volume of air passing
5 from each of the cells of the metier or set of cells or compartments can be observed and adjusted as required for any particular denier, and differences which may exist or which may arise in working between the
10 volumes passing from the respective cells in operation can be observed and regulated so as to preserve approximate uniformity between the volumes passing from the respective cells. Also any given compartment
15 or compartments of the metier or set may be cut out by closing their outlet controlling valves or devices when required, without stopping the operation of the other compartments.

20 In addition to providing the outlet pipe or connection of each compartment of the metier or set of cells with indicating and controlling devices as explained, we may also provide in connection or combination
25 with the collecting pipe or header to which they are connected, a flow meter or other devices for indicating the volume flowing through said collecting pipes or header, and a valve or device for controlling or adjusting
30 the flow therein. Such control can thus serve for varying the suction or flow in the collecting pipe or header serving the metier or set of cells, as for example for adjusting
35 the general suction or flow from the metier or set of cells for producing different deniers in the metier or set of cells or for cutting out the same from operation, the individual controlling valves or devices on the outlet connections from the cells providing
40 for any further or individual adjustment which may be necessary.

An installation may comprise one or any
45 desired number of cellular metiers or sets of cells. Usually a number of metiers or sets of cells will be employed, each metier or set of cells being provided with a collecting pipe, or section of collecting pipe, to which the outlets from its cells are connected, each such collecting pipe or section
50 of collecting pipe being preferably separate from or capable of being isolated from the others, and preferably a flow indicating device and a flow controlling device are provided in connection with the collecting pipe,
55 or header or section of collecting pipe, of each metier or set of cells, in such manner that the flow from any given metier or set of cells may be adjusted for the production of a different denier to the device or deniers
60 which are being produced in other metiers or sets of cells, or that the given metier or set of cells may be cut out of operation. A general flow indication and control may, however serve two or other desired number
65 of metiers or sets of cells if desired. The

collecting pipes or sections of collecting pipe of the respective metiers or sets or series of compartments may be connected to a common exhaust main or trunk.

Any known or suitable flow meters or
70 devices may be employed for showing the volume of vapour-laden air passing from the cells, or the volume passing in the collecting pipe or header or in the respective
75 collecting pipes or sections of collecting pipe as before referred to, and such devices may indicate the volume either directly or indirectly. For example we may employ flow meters in the form of water gauges or flow
80 meters of a type analogous to a Venturi flow meter or a Capok flow meter, comprising a constricted portion or throat through which the flow passes and a water gauge serving to indicate or represent the volume
85 flowing at a given moment.

Further according to the invention we may provide means for regulating the temperature in the cells, and preferably we provide each cell with means for regulating
90 the temperature therein so that the temperature in each can be regulated independently. Such means may consist for example of a regulating valve provided between the cell and the air supply which delivers into it.
95 The air regulating valves may be of screw mushroom type or any other suitable form. Usually the hot air rises through the cells from an air heater consisting of steam heated pipes situated in the lower part of the metier or set of cells, and extending through
100 or under the cells thereof.

Auxiliary heating means may if desired be provided in the cells for further heating the air rising through same. Such means may
105 consist for example of steam heated pipes extending through the metier or set of cells at a part near or towards the end of the path of the filaments therein and extending for any desired distance above this point.

Further according to the invention we
110 may employ, in combination with the metiers or sets of cells provided with flow measuring and flow regulating arrangements as referred to, dehumidifying and preliminary heating apparatus serving for
115 dehumidifying the air to be supplied to the metiers or sets of cells or compartments by cooling it to a low temperature in order to deposit moisture therefrom, and for heating the thus dried air to a desired temperature
120 before it passes to the air heating apparatus proper combined or associated with the metiers or sets of cells.

Any suitable apparatus may be employed
125 for this purpose. According to the preferred form such apparatus may comprise two brine cooled air coolers arranged to be connected alternately to a preheater, and each being adapted to be connected to the warm
130 air discharge side of the preheater or other

suitable source of heat, valves or controlling devices being provided, so that when one air cooler is in operation and connected to the inlet side of the preheater, the other can be shut off from the inlet side of the preheater and connected to the discharge side thereof or other source of heat, in order to thaw up the air cooler which has been cut out of operation.

To illustrate how the invention may be carried out, we will describe one arrangement of apparatus constructed in accordance therewith, it being understood that this is given only by way of example and can be varied considerably without departing from the invention. In this apparatus any desired number of metiers are employed of a type similar to that described in the said specification No. 165,519, that is to say the metier is divided up into cells with the jets or spinnerets situated in the upper part of the cells, the threads or filaments being spun downwards through an upward current of hot air in the cells and being led out at the lower part of the cells and wound up outside the metier casing.

The accompanying drawings illustrate diagrammatically as much of an apparatus according to the invention as is necessary to enable the invention to be understood, ten cells of a metier being shown.

Fig. 1 is a general diagrammatic elevation of the apparatus with the metier casing in section.

Fig. 2 is a diagrammatic rear elevation of a ten-cell length or portion of metier looking towards the right of Fig. 1, the rear wall of the metier casing of four of the cells being broken away.

Fig. 3 is a plan of Fig. 2.

Fig. 4 is a diagrammatic front elevation of the said length or portion of metier, and Fig. 5 is a diagrammatic plan in horizontal section on line 5-5 of Figure 4 through the top of the metier cells.

The enclosed metier casing A, Fig. 1 is divided up into vertical cells 1 as before mentioned and may comprise any desired number of such cells, 2 are spinnerets fitted in the top of the cells 1 and supplied with spinning solution through valved pipes 3 from solution piping 3^a, 3^b, by small pumps, similarly to the apparatus of the said specification 165,519, one of the pumps being indicated at 4, Fig. 1. In the drawings, there are two spinnerets per cell, but a number other than two might be employed per cell, even only one spinneret per cell. The filaments 5, spun downwards through the cells 1, are associated into threads 6 and pass out through small openings 7 (Figs. 1 and 3) in the front of the metier casing and are fed by a line of godet rollers 8 to bobbins or winding up devices 9, all as explained in the said specification 165,519. 1^a indicates the win-

dows in each cell at the top of the metier casing, for inspection and access to the spinnerets, and 1^b indicates similar windows at the bottom of the metier casing for inspection and access.

Each cell 1 is fitted at the upper end with an outlet pipe 10, of small diameter, e. g., $\frac{3}{4}$ inch, connected to a collecting air suction pipe or header 11 of larger diameter, e. g., 3 inches, which extends all along the metier. The pipes 10 can thus take the vapour-laden air from upper part of the metier cells. Each outlet pipe 10 outside its cell is connected to a tube 12 which dips into a water trough 13 running the length of the metier and constitutes a water gauge forming a flow meter which represents, by the level of the liquid in the tube, the volume of air flowing from that particular cell at any moment. A regulating valve 14 (Fig. 1) of any known or suitable kind is likewise provided in each outlet pipe 10, so that the flow of vapour laden air from each cell can be regulated, according to requirement, or be entirely cut off, as before explained. The said regulating valves are shown as operated by screw rods 15 extending down to a convenient position and provided with hand wheels 16. Thus the flow from each cell of the metier can be independently regulated to maintain approximate uniformity between the volumes passing from the respective cells of the metier.

The collecting air suction pipe or header 11 is connected through a branch 17 to a main exhaust pipe 18 leading to a fan or exhauster 19 which can deliver the vapour laden air to solvent recovery apparatus in the known way. In the branch 17 is fitted a throat or constricted portion 20 which is connected to one limb of a U-tube 21, the other limb of which is connected to the portion of the branch 18 preceding the throat, so as to form a flow meter and show the volume flowing from the collecting pipe or header 11 of the metier. A regulating valve 22 is also fitted beyond the throat 20 in the branch 17, so that the flow from the metier can be observed and controlled.

The control thus provided by the flow meter 20, 21 and the valve 22 can serve for varying the suction or flow in the collecting pipe or header 11 serving all the cells of the metier or set of cells, as for example for adjusting the general suction or flow from the metier or set of cells for producing different deniers in the metier or set of cells, or for cutting out the metier or set of cells from operation, the individual controlling valves 14 on the outlet pipes 10 from the cells providing for any further or individual adjustment that may be necessary.

23 represents a number of steam pipes passing through the cells of the metier at bottom and forming a heater for heating the

air supplied to the metier from an air trunk 24 extending along the back of the metier casing A and fed from an air supply main 25. The air is admitted from the trunk 24 to each cell of the metier by a pipe connection 26, each connection 26 being controlled by a regulating valve 27 of mushroom or any other suitable form to enable the air admission to the cell to be adjusted as desired, with a view to regulating the temperature of the cells and maintaining the temperature as uniform as possible at corresponding points of the cells of the metier.

The metier is shown provided with auxiliary heating means consisting of horizontal steam heating pipes 28 passing through the metier cells and lying behind the path of the filaments near the lower portion of their travel in the metier and for a desired height above this point.

The air trunk 24 from which the air passes to the bottom of each cell at the part where the heater formed by the pipes 23 is situated, is supplied with air from the main 25 to which it is delivered from dehumidifying and preheating apparatus comprising two brine-cooled air coolers 29, 29^a combined with a preheater 30 for the dried air. The two coolers 29, 29^a have each an air inlet marked respectively 31, 31^a controlled by a valve marked respectively 32, 32^a, and are cooled in the known way by brine, the inlet and outlet connections of which are marked 33, 33^a, 34, 34^a respectively in Fig. 1. The cooling brine supply to the air coolers 29, 29^a can be cut in and out by valves not shown. W, W are the inspection windows of the air coolers. The air coolers 29, 29^a are connected in U-fashion to the preheater 30 by wide ducts 35, 35^a at the junction of which a pivoted damper 36 is fitted which permits the air coolers 29, 29^a to be connected to the preheater 30 in alternation, one being connected while the other is cut out. The preheater is heated by a steam coil, steam jacket or the like, the steam inlet and steam outlet being indicated at 37, 38, and from the delivery end of the preheater 30, air pipes 39, 39^a are connected one to each cooler 29, 29^a, valves 40, 40^a being fitted in these pipes to open and close the communication with the coolers. The preheater 30 is connected at the discharge side to the air main 25 leading to the trunk 24 at the back of the metier, and a thermostatic valve indicated at 41 may be provided at the air discharge side of the preheater 30. A moisture and temperature indicator of the well known kind comprising a thermometer and a hygrometer may be fitted as indicated at 42, 43 at both the intake and discharge side of the preheater 30 to observe the moisture and temperature conditions of the air entering and leaving the same.

By suitably manipulating the damper

36 and valves 40, 40^a, the air can be drawn through one of the coolers 29 or 29^a and the preheater 30 so as to dry it by deposition of moisture in the cooler and to raise it to a desired temperature before it passes on to the metier under the suction of the exhauster 19, and when it is desired to thaw up the cooler the damper 36 can be put over to cut this cooler out and connect the other cooler to the preheater 30. Warm air can then be turned on to the first cooler from the discharge side of the preheater 30 in order to thaw it up while the other cooler is in operation.

Any desired number of metiers constructed and fitted as described may be employed and may be arranged in a row or rows or be otherwise grouped according to requirement, each having its cells individually connected to a collecting pipe or header such as 11 by outlet pipes such as 10, each connected or combined with a flow indicating device and controlling valve as explained, and the collecting pipe or header of each metier being connected to the main exhaust pipe 18 leading to the exhauster. The collecting pipes or headers of the respective metiers may be separate from each other or may be connected together, but preferably they are separate or capable of being isolated from each other by valves or otherwise.

The collecting pipes or headers of the respective metiers will be each connected to the main exhaust air pipe 18 through a corresponding pipe or branch provided, similarly to the branch 17, with a flow meter (such as 20, 21) and a regulating valve (such as 22). Thus the flow from each metier can be observed and controlled, in addition to the individual observation and control provided for the cells of the metier, and any given metier can be adjusted for producing a different denier to another or others, or can be cut out of operation as required.

The throats or constrictions of the flow meters may if desired be made of glass or other transparent material so that if any choking should occur this can be readily seen.

It will be understood that where a number of metiers are employed, the air from the dehumidifying and preheating apparatus can be distributed from the air main 25 from this apparatus to the air trunk (24) of each metier.

We do not confine ourselves to the employment of a number of metiers or sets of cells, as it will be evident that a single metier or apparatus comprising any desired number of cells may be employed provided with means for indicating and controlling the flow of vapour-laden air from the individual compartments.

It will also be understood that the invention may be applied in connection with other forms of apparatus for producing artificial silk and the like by the dry spinning or evaporative method.

What I claim and desire to secure by Letters Patent is:—

1. In dry spinning apparatus of the cellular type for the manufacture of artificial silk and the like, a dry-spinning metier comprising numerous spinning cells, a collecting conduit for carrying off vapour-laden air from the cells of the metier to the exhaust, an individual outlet connection between each of said cells and said collecting conduit, an indicating device in connection with each of said outlet connections for individually indicating the volume of vapour-laden air passing therein from the corresponding cell, and a controlling device to each outlet connection for regulating and cutting off the flow from the corresponding cell.

2. In dry spinning apparatus of the cellular type for the manufacture of artificial silk and the like, a dry spinning metier comprising numerous spinning cells, spinners disposed in the upper part of the cells and arranged to deliver the filaments downwards through same, means for supplying heated air up through the cells from the lower part thereof, a collecting conduit for carrying off vapour-laden air from upper part of the cells of the metier to the exhaust, an individual outlet connection between the upper part of each of said cells and said collecting conduit, an indicating device in connection with each of said outlet connections for individually indicating the volume of vapour-laden air passing therein from the corresponding cell, and a controlling device to each outlet connection for regulating and cutting off the flow from the corresponding cell.

3. In dry spinning apparatus of the cellular type for the manufacture of artificial silk and the like, a dry spinning metier comprising numerous spinning cells, a collecting conduit for carrying off vapour-laden air from the cells of the metier to the exhaust, an individual outlet connection between each of said cells and said collecting conduit, a water gauge device in connection with said outlet connections for individually indicating the volume of vapour-laden air passing therein from the corresponding cell, and a controlling device to each outlet connection for regulating and cutting off the flow from the corresponding cell.

4. In dry spinning apparatus of the cellular type for the manufacture of artificial silk and the like, a dry spinning metier comprising numerous spinning cells, a collecting conduit for carrying off vapour-laden air from the cells of the metier to the

exhaust, an individual outlet connection between each of said cells and said collecting conduit, an indicating device in connection with each of said outlet connections for individually indicating the volume of vapour-laden air passing therein from the corresponding cell, a controlling device to each outlet connection for regulating and cutting off the flow from the corresponding cell, and devices for indicating the volume flowing in said collecting conduit and for regulating and cutting out the flow therein, whereby the flow from the metier can be adjusted or the metier cut off from operation.

5. In dry spinning apparatus of the cellular type for the manufacture of artificial silk and the like, a dry spinning metier comprising numerous spinning cells, a collecting conduit for carrying off vapour laden air from the cells of the metier to the exhaust, an individual outlet connection between each of said cells and said collecting conduit, an indicating device in connection with each of said outlet connections for individually indicating the volume of vapour laden air passing therein from the corresponding cell, a controlling device to each outlet connection for regulating and cutting off the flow from the corresponding cell, a flow indicating device comprising a throat in combination with a water gauge device for indicating the volume flowing in said collecting conduit, and a valve for controlling and cutting out the flow therein, whereby the flow from the metier can be adjusted or the metier cut off from operation.

6. In dry spinning apparatus of the cellular type for the manufacture of artificial silk and the like, a dry spinning metier comprising numerous spinning cells, a collecting conduit for carrying off vapour laden air from the cells of the metier to the exhaust, an individual outlet connection between each of said cells and said collecting conduit, an indicating device in connection with each of said outlet connections for individually indicating the volume of vapour laden air passing therein from the corresponding cell, a controlling device to each outlet connection for regulating and cutting off the flow from the corresponding cell, and means for independently regulating the temperature in each cell.

7. In dry spinning apparatus of the cellular type for the manufacture of artificial silk and the like, a dry spinning metier comprising numerous spinning cells, a collecting conduit for carrying off vapour laden air from the cells of the metier to the exhaust, an individual outlet connection between each of said cells and said collecting conduit, an indicating device in connection with each of said outlet connections for individually indicating the volume of vapour laden air passing therein from the corresponding cell, a

controlling device to each outlet connection for regulating and cutting off the flow from the corresponding cell, an air inlet to each cell and a valve device for regulating the amount of air admitted thereby, whereby the temperature in each cell can be independently regulated.

8. In dry spinning apparatus of the cellular type for the manufacture of artificial silk and the like, a dry spinning metier comprising numerous spinning cells, spinnerets disposed in the upper part of the cells and arranged to deliver the filaments downwards through same, air heating means situated at the lower part of the cells, air inlets to the respective cells in the vicinity of said air heating means, a collecting conduit for carrying off vapour laden air from the upper part of the cells to the exhaust, an individual outlet connection between the upper part of each of said cells and said collecting conduit, an indicating device in connection with each of said outlet connections for individually indicating the volume of vapour laden air passing therein from the corresponding cell, a controlling device to each of said outlet connections for regulating and cutting off the flow from the corresponding cell, and a valve device for regulating the amount of air admitted by each of said air inlets to the respective cells, whereby the temperature in each cell can be independently regulated.

9. In dry spinning apparatus of the cellular type for the manufacture of artificial silk and the like, a dry spinning metier comprising numerous spinning cells, a collecting conduit for carrying off vapour laden air from the cells of the metier to the exhaust, an individual outlet connection between each of said cells and said collecting conduit, an indicating device in connection with each of said outlet connections for individually indicating the volume of vapour laden air passing therein from the corresponding cell, a controlling device to each outlet connection for regulating and cutting off the flow from the corresponding cell, an air inlet to each cell, a valve device for regulating the amount of air admitted thereby, whereby the temperature in each cell can be independently regulated, and auxiliary heating means located in the cells and extended from near the end of the path of the filaments therein for a desired portion of said path.

10. In dry spinning apparatus of the cellular type for the manufacture of artificial silk and the like, a dry spinning metier comprising numerous spinning cells, spinnerets disposed in the upper part of the cells and arranged to deliver the filaments downwards through same, air heating means situated at the lower part of the cells, air inlets to the respective cells in the vicinity

of said air heating means, a collecting conduit for carrying off vapour laden air from the upper part of the cells to the exhaust, an individual outlet connection between the upper part of each of said cells and said collecting conduit, an indicating device in connection with each of said outlet connections for individually indicating the volume of vapour laden air passing therein from the corresponding cell, a controlling device to each of said outlet connections for regulating and cutting off the flow from the corresponding cell, a valve device for regulating the amount of air admitted by each of said air inlets to the respective cells, whereby the temperature in each cell can be independently regulated, and auxiliary heating means located in the cells and extending from near the end of the path of the filaments therein for a desired portion of said path.

11. In dry spinning apparatus of the cellular type for the manufacture of artificial silk and the like, the combination of plurality of dry-spinning metiers each comprising numerous spinning cells, a collecting conduit for carrying off the vapour laden air from its cells to the exhaust, an individual outlet connection between each of its cells and the collecting conduit, an indicating device in connection with each outlet connection for individually indicating the volume of vapour laden air passing therein, and a controlling device to each outlet connection for regulating and cutting off the flow from the corresponding cell, the collecting conduits of the respective metiers being connected to the exhaust and being each provided with devices for indicating the volume flowing in them and with devices for adjusting and cutting out the flow in them respectively, whereby the flow from the respective metiers can be observed and adjusted and cut out of operation as required.

12. In dry spinning apparatus of the cellular type for the manufacture of artificial silk and the like, a dry spinning metier comprising numerous spinning cells, a collecting conduit for carrying off vapour laden air from the cells of the metier to the exhaust, an individual outlet connection between each cell and said collecting conduit, an indicating device in connection with each of said outlet connections for individually indicating the volume of vapour laden air passing therein from the corresponding cell, a controlling device to each outlet connection for regulating and cutting off the flow from the corresponding cell air supply inlets for the respective cells, an air heater combined in the metier, for heating the air supply to the cells and a dehumidifier and preliminary heater for the air supply, connected to the air supply inlets of the cells, said de-

humidifier and preliminary heater being adapted to deposit moisture from the air by cooling and to heat the dried air to a desired temperature before it passes to the heater and cells of the metier.

13. In dry spinning apparatus according to claim 12, a dehumidifier and preliminary heater comprising two brine-cooled air coolers and a preheater, delivery connections between said air coolers and the inlet side of said preheater, warm air connections between the discharge side of the preheater and said air coolers, controlling means for said delivery connections from the air cool-

ers to the preheater, whereby the coolers can be alternately connected to the preheater, and controlling devices for said warm air connections from the discharge side of the preheater, whereby the discharge side of the preheater can be connected to the respective air coolers alternately for thawing up the same, substantially as described.

In testimony whereof we have hereunto subscribed our names.

JOHN FREDERICK BRIGGS,
WILFRED YORKE.