(No Model.) 2 Sheets—Sheet 1.

J. A. YOUNG.

APPARATUS FOR DYEING STRAW GOODS, &c.

No. 446,050. Patented Feb. 10, 1891.

Fig. 1.

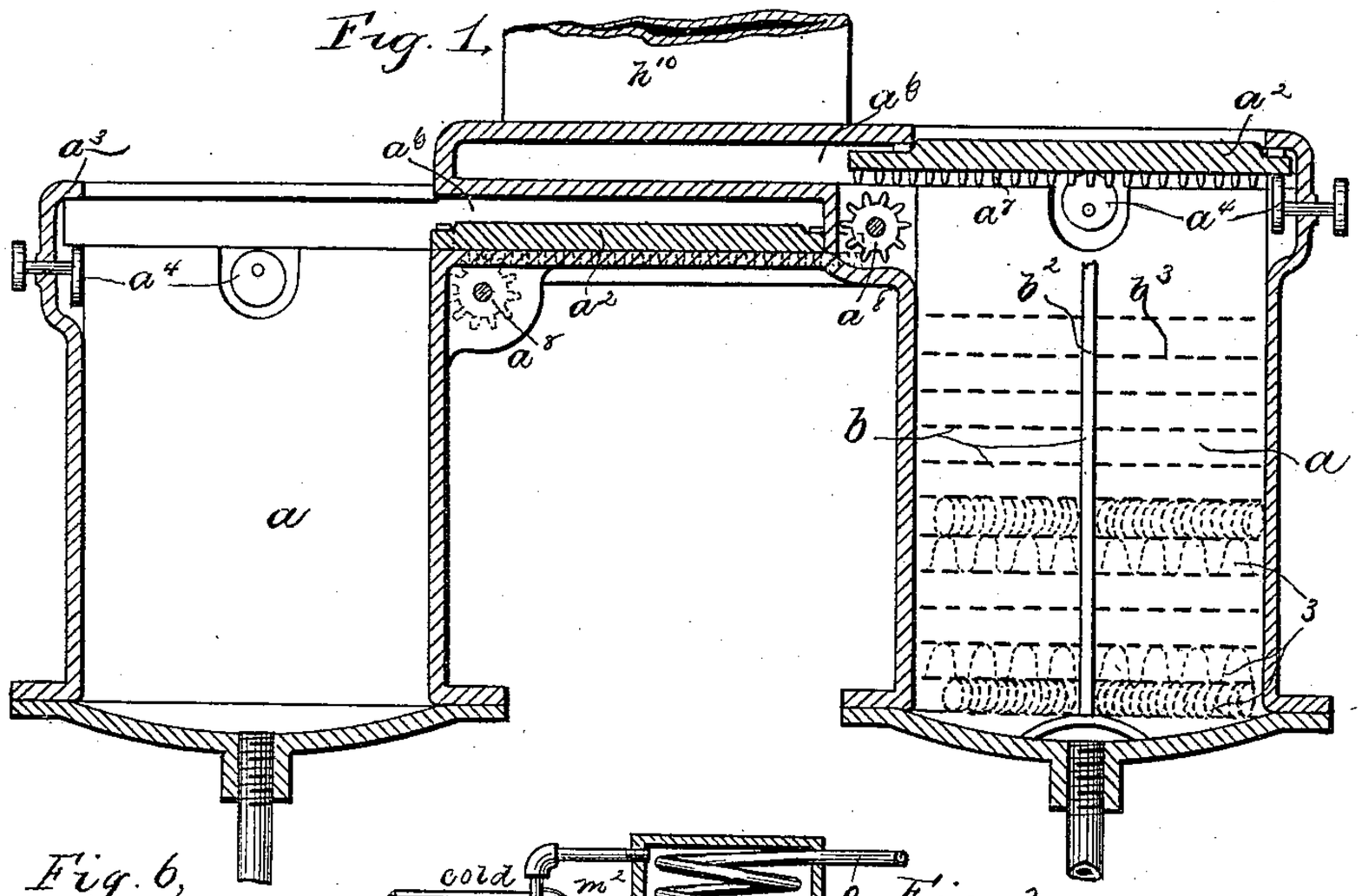
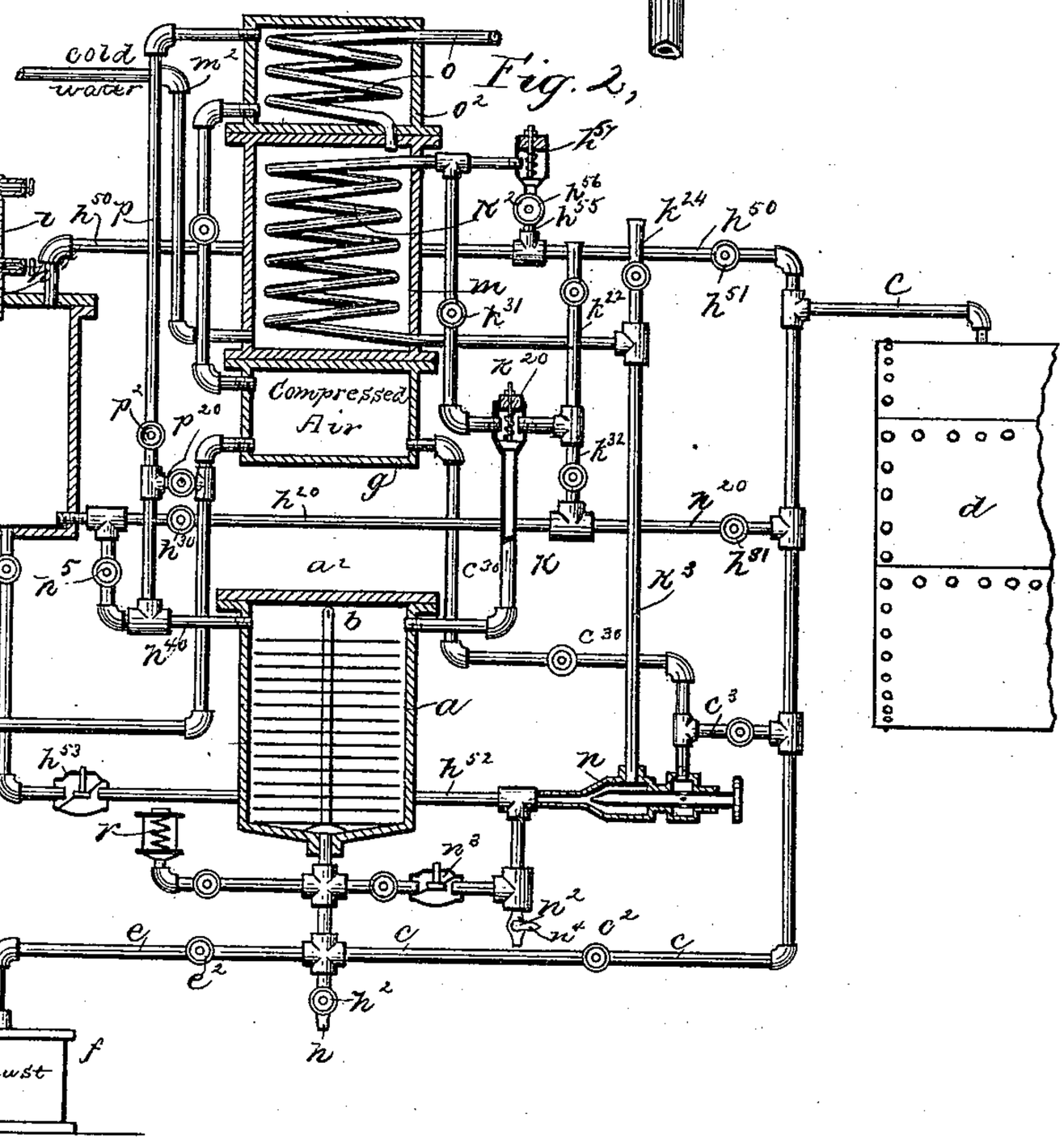


Fig. 6.

Fig. 2.



Witnesses
Jas. J. McMahoney.
Wm. Ed. Hall

Inventor,
James A. Young,
by Jno. P. Livermore
Atty.

(No Model.) 2 Sheets—Sheet 2.

J. A. YOUNG.

APPARATUS FOR DYEING STRAW GOODS, &c.

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Fig. 3,

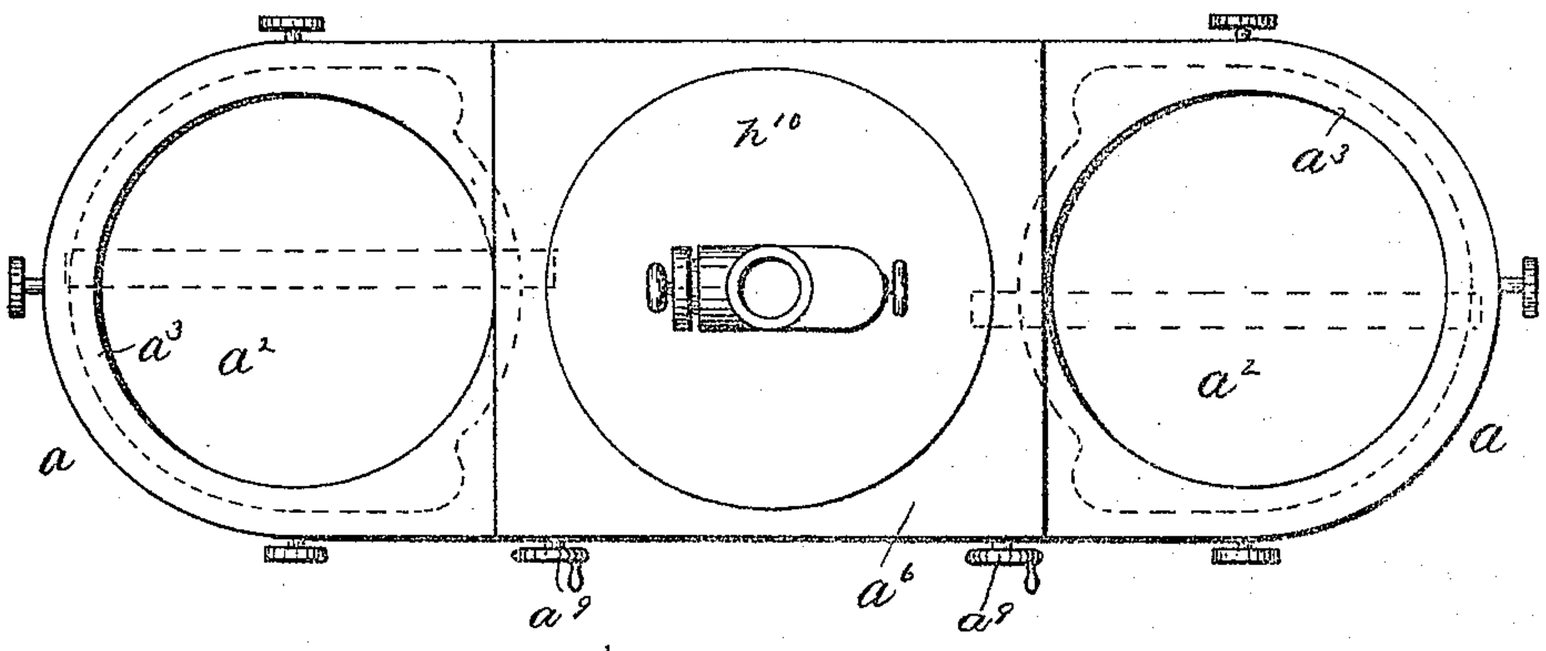


Fig. 4.

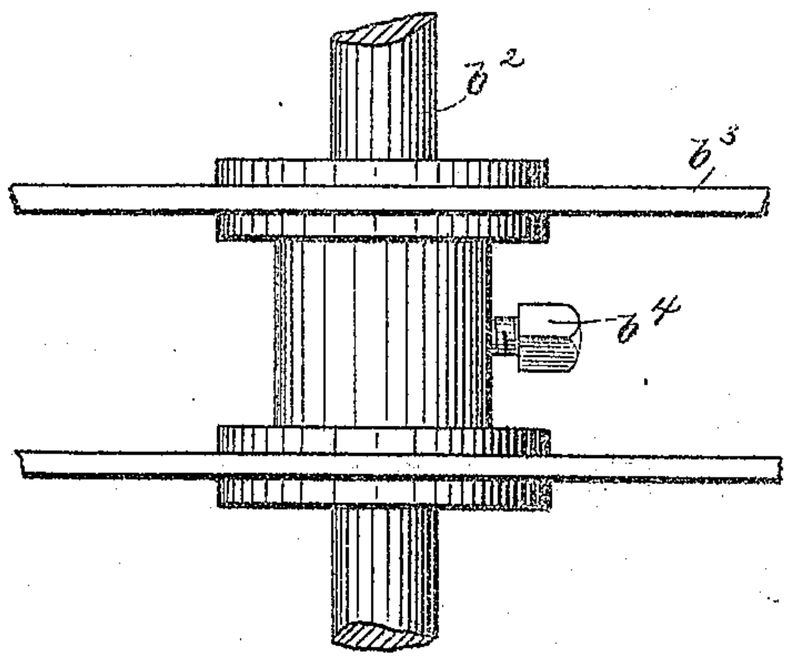
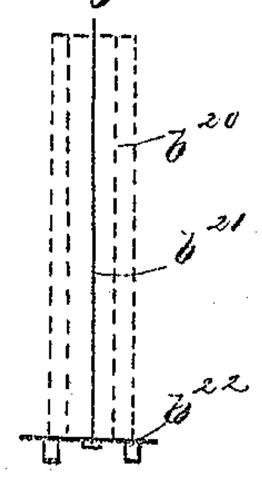


Fig. 5,



Witnesses.
Jas. J. Mealoney.
M. E. Hill.

Inventor.
James A. Young.
by Jos. P. Livermore
Atty.

UNITED STATES PATENT OFFICE.

JAMES A. YOUNG, OF MANSFIELD, ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE YOUNG COLORING COMPANY, OF BOSTON, MASSACHUSETTS.

APPARATUS FOR DYEING STRAW GOODS, &c.

SPECIFICATION forming part of Letters Patent No. 446,050, dated February 10, 1891.

Application filed April 21, 1890. Serial No. 348,940. (No model.)

To all whom it may concern:

Be it known that I, JAMES A. YOUNG, of Mansfield, county of Bristol, State of Massachusetts, have invented an Improvement in Apparatus for Dyeing Straw Goods, &c., of which the following description, in connection with the accompanying drawings, is a specification, like letters and figures on the drawings representing like parts.

My invention relates to an apparatus for dyeing straw goods, which apparatus may also be employed for performing analogous operations in which material is to be subjected to the action of surrounding liquors or chemicals—as, for example, in bleaching. As is now generally practiced, the braided straw is dyed in large masses previous to being made up into hats, and the process of dyeing takes a long time, which is very objectionable with goods of this kind, as it frequently happens that there is a quick demand for hats of a certain color; but as a considerable amount of time is required to dye the straw and then make it up into hats it is often the case that the goods are not wanted by the time that they are ready, and thus considerable loss to the manufacturer ensues. Another objection to the method of dyeing the straw before it is made up is that it requires that the thread should match the straw in color, while if it were possible to dye the hats after being made up the straw and thread might be made to receive the same color in the dyeing process.

The object of the present invention is to produce an apparatus capable of dyeing goods in large quantities after being made up into hats or other articles, the process of dyeing by the improved apparatus requiring but very little expenditure of time, so that if the uncolored hats are made up an order for any given color may be supplied within a few hours after it is received. This obviates the necessity of carrying a large stock of colored goods, which, owing to changes in fashion, are likely to go out of demand, and thus cause loss to the owner.

In the process of dyeing straw heretofore generally practiced the straw is boiled in the dye-liquor in open kettles, and, owing to the peculiar character of the enamel or surface of the straw, the boiling has to be continued for a long time, and in some cases the straw has to be treated by alkalies, the effect of which has to be subsequently neutralized, sometimes requiring that during the dyeing process the material should be repeatedly removed from the kettle, so that it becomes cool and causes precipitation when again acted upon in the kettle, thereby increasing the time and labor required for properly dyeing the goods, and after the dyeing is completed additional time is required to thoroughly dry the straw before it can be used to make a satisfactory product.

In accordance with the present invention the straw hats or articles to be dyed, which may have been previously made up into finished shape, are supported on a suitable carrier and then placed in a closed chamber or vessel capable of standing a considerable internal pressure, in which vessel the dyeing and subsequent drying of the straw are carried on, and, owing to the fact that the vessel is closed, the material may be retained at a sufficiently high temperature to soften the surface of the straw and cause it to take the dye without requiring the action of alkalies to effect this result.

Means are provided for admitting dry steam to the cylinder or chamber containing the goods to be dyed, subsequently exhausting the air and water of condensation from the said chamber, and then admitting the dye-stuff thereto, heating the same, and maintaining ebullition or agitation of the said dye-stuff in the chamber, so that it acts uniformly upon all parts of the goods.

Means are also provided for withdrawing the liquor from the chamber and then drying the dyed material while still in the chamber by causing hot air to flow through the same or by permitting cool compressed air to expand around the same.

Apparatus has been devised for subjecting fibrous materials, such as threads, yarns, woven fabrics, &c., to the action of bleaching or dyeing agents or other liquids or gases in a closed tight chamber under pressure; but with such apparatus the liquids were caused to circulate into and out from the chamber and were forced through and through the materials to be treated—an operation which could

not be employed to dye the materials for which the apparatus forming the subject of the present invention was devised, the main feature of which consists in the means hereinafter described for maintaining agitation or ebullition of the dye-liquor without producing bodily movement thereof into and out from the chamber and through the material to be dyed contained therein. In other words, I imitate the action of the open-kettle boiling process in so far as that the dye-liquor, while continually in ebullition or agitation, is at all times contained in the kettle or vessel and does not circulate in, through, and out from the same, this action being one most advantageous and efficient in producing regularity of color and work; but whereas, in the open-kettle boiling process the pressure can never exceed that of the atmosphere and the heat can never exceed 212°, with the result of making the dying operation a tedious, prolonged, and expensive one, by my improvement that pressure can be and is greatly enhanced, as is also the heat, so that the boiling takes place under a pressure of many atmospheres and a greatly-increased temperature, thus greatly reducing the time required for the dyeing operation and obtaining important advantages in other respects—as, for example, the increased heat and pressure serve to soften the enamel on the straw without making necessary the use for that purpose of alkalies, which must be used in the open-kettle boiling process, but which are detrimental to the proper action of certain dyes, such as aniline dyes.

Figure 1 is a vertical section of a portion of an apparatus for dyeing embodying this invention; Fig. 2, a sectional and diagram view illustrating the operative relations of the several parts of the apparatus and the passages for the various fluids employed in the apparatus; Fig. 3, a plan view of the portion of the apparatus shown in Fig. 1; Fig. 4, an enlarged detail illustrating the construction of the frame or support upon which the goods to be dyed are held while undergoing the dyeing process; Fig. 5, a modification of the means for supporting the material to be dyed, and Fig. 6 a detail to be referred to.

The various operations on the material to be dyed take place in a chamber a, shown as cylindrical in shape, which in practice may be five or six feet in length and diameter, so as to contain a large quantity of the material to be dyed.

In a working apparatus there are preferably two or more of the cylinders a, as represented in Fig. 1, used in connection with the other parts of the apparatus, so that one operation may be going on in one while another operation is going on in another cylinder. For example, while the material is being subjected to the action of the dyeing-liquor in one cylinder the material already dyed in the other cylinder may be dried, removed, the cylinder again filled, and the material prepared for receiving the dye-liquor, during which time the material in the first cylinder will have been thoroughly dyed and ready for the drying and removal and restocking of the said cylinder while the dyeing operation is going on in the other one, and so on.

The cylinders a are provided with covers a^2, so arranged that they can be conveniently operated for opening and closing the cylinders. As shown in Figs. 1 and 3, each cylinder has near its top an enlargement to receive the cover a^2, which seats from below against an overhanging flange a^3, against which it may be pressed by suitable cams or eccentrics a^4, operated from outside the cylinder, as will be understood from Figs. 1 and 3. When the cylinder is under pressure, the said pressure will tend to keep the cover a^2 tightly seated upon the under side of the flange a^3, between which and the edge of the cover a suitable gasket or packing may be interposed.

Each cylinder near its top communicates with a lateral recess a^6, into which the cover may be moved when it is desired to open the cylinder, the covers being shown in this instance as each provided with a rack a^7 at its under surface, which comes into engagement with a pinion a^8 when the cover is lowered by turning down the eccentrics a^4. The pinions a^8 are operated by hand-wheels a^9 (see Fig. 3) in convenient position, and by rotating said hand-wheels the cover may be moved laterally into the recess a^6, leaving the tops of the cylinders open and unobstructed, as shown at the left hand of Fig. 1. The racks of the two covers are slightly offset with relation to one another, as shown in Fig. 3, (in which their position is represented in dotted lines,) so as to economize space, the rack of the left-hand cover passing by the pinion that operates the right-hand cover, as shown in Fig. 1. The two recesses a^6 are completely cut off from one another, as shown in Fig. 1, so as to prevent communication between the two cylinders. When the cylinder is open, the cage or frame b, (see Fig. 1,) upon which the material to be dyed is supported, is lowered into the cylinder, a suitable crane or hoisting apparatus being provided for facilitating this operation when required. The said frame consists of a central stem b^2, on which are supported foraminous shelves b^3, provided at their middle with socket-pieces capable of longitudinal movement on the stem b^2, and provided with set-screws b^4, by which they are made fast when placed at the proper height. (See Fig. 4.)

For certain kinds of material it is desirable to leave a small space—an inch or two, for example—between the consecutive pairs of shelves, so as to afford a body of the dyeing-liquor unobstructed by the material to be dyed at various levels in the dyeing-chamber a. In this way I avoid danger of channeling the goods or making passages through them,

which is apt to occur when the liquor is forced through goods placed in layers directly one upon the other. The clear spaces between the layers afford a place where the liquid, after passing one layer, can gather and then exert an even action upon the next layer.

In filling the cage or support b the lowermost shelf will have the articles to be dyed placed upon it as close as possible to one another, after which the next shelf is lowered down to just engage the upper part of said articles, so as to prevent them from being displaced by the agitation of the liquor, and in some cases the articles may be placed immediately upon the next shelf, and so on; but in other cases the articles may be placed on every alternate shelf with the space intervening between the shelf that rests on the top of the articles below and the next shelf above that supports articles upon it, as has just been stated.

In packing the articles to be dyed they are commonly nested one within the other to form long columns, which may be coiled up spirally upon the shelves of the supporting-frame, as shown at the lowermost shelf in Fig. 1, although it may occasionally be necessary or desirable to set the articles side by side on the shelves, as indicated at 3, Fig. 1.

Fig. 4 represents the construction in which spaces are to be left in the cylinder between the horizontal rows or layers of the material to be dyed, in which case two of the shelves having such space between them may be connected with a single sleeve or thimble, which is adjusted on the stem b^2 so that the lower shelf just engages the top of the material supported on the next shelf below to prevent the same from rising or becoming displaced by the agitation of the liquid.

For some kinds of goods, especially those which are kept in shape by size, it may be necessary to provide supports for each hat or article to keep the same in shape while being operated upon in the cylinder, such support being made of soft wire, which can be bent to sustain the hat or other article being operated upon.

The chamber a is provided with a steam-inlet pipe c, by which steam may be taken from a boiler d and admitted to the interior of the said chamber.

The pipes and passages communicating with the chamber a are best seen in Fig. 2. The steam-pipe c is controlled by a stop-valve c^2. The chamber a also communicates by a pipe e with the exhaust-chamber f, from which air may be exhausted by a pump f^2 or other suitable exhausting device, and, if desired, the same pump may be employed to compress air into a compressed-air receiver g at any suitable point, the purpose of which will be hereinafter described.

The pipe e is controlled by a stop-valve e^2, and as both pipes c and e communicate with the chamber a through a common inlet entering at the lower end of the chamber one of said valves c^2 or e^2 will commonly have to be closed before the other is opened. The passage entering the lower end of the chamber is also extended, so as to form the outlet or drain pipe h, controlled by a valve h^2.

At some suitable position at a higher level than the chamber a is placed a preparing-chamber h^{10}, in which the various liquors required for dyeing—such as mordants, dyes, and raising or saddening liquors—are prepared, such chamber h^{10} being filled with water and being provided with a steam-inlet pipe h^{20}, controlled by valves h^{30} h^{31}, (see Fig. 2,) so that steam may be admitted to raise the liquid to the boiling temperature or above the usual boiling-point, if required, as the said vessel h^{10} is closed, so that it can withstand an internal pressure.

In order to introduce dye-stuff into the chamber h^{10} without reducing the pressure of said chamber, and also to insure the proper solution or distribution of the dye in the liquid, the chamber is provided with the following mechanism for introducing the dye-stuff, (best shown in Fig. 6:) The chamber is provided with an inlet pipe or passage i, having two valves or gates i^2 i^3 at a sufficient distance apart to provide a chamber or space between them in said pipe of sufficient size to receive a cage or basket i^4, which may be of wire-netting and may contain the dye-stuff. The said cage i^4 is connected with a cord or chain wound upon a pulley i^5, operated by a handle i^6 at the outside of the chamber, so that the cage may be raised or lowered by turning the said handle. The stem connecting the pulley i^5 and handle i^6 works in a stuffing-box and is longitudinally movable, so that the pulley i^5 may be withdrawn laterally from the port of the pipe i to permit the cage i^4 to pass it. When the dye-stuff is to be introduced, the valve i^2 is closed and the valve i^3 opened and the dye-stuff placed in the basket i^4, which may be withdrawn from the pipe to receive the dye-stuff, if required, and is then lowered into the chamber or space in the pipe i between the valves i^2 and i^3. The valve i^3 is then closed and the valve i^2 opened, and the basket i^4 is then lowered by turning the handle i^6 into the liquid, where it remains suspended until the dye-stuff is all dissolved or taken up by the liquid. These appliances prevent the dye-stuff from settling to the bottom of the chamber h^{10}, as might happen if the dye-stuff were merely permitted to drop by gravity.

In working the apparatus thus far described the materials to be dyed, after having been suitably packed or loaded upon the cage b, are introduced into the chamber a, the cover of which is then closed, and steam is then admitted through the pipe c to the chamber, all other passages leading to and from the said chamber being closed by their respective valves. Dry steam is then caused to permeate through the material to be dyed at a sufficiently high temperature to soften the

enamel or surface of the straw and prepare it to receive the dye. The heat of the steam expands the air in the straw and expels it therefrom. The steam is then cut off by closing the valve c^2, and the chamber placed in communication with the exhaust f by opening the valve e^2 when any water of condensation which may have formed will pass out from said chamber, together with the steam and air contained therein, so that a nearly perfect vacuum is formed in the chamber. The expulsion of the air from the straw and subsequent withdrawal of the air from the chamber leave the meshes of the straw ready to receive and draw in the dye-liquor when introduced into the chamber, so that the latter will act upon all parts of the surface of the straw and color the same between overlying portions or layers of the braid, so that in the subsequent shaping of the hat by pulling and shaping over blocks there is no danger of exposing any undyed portion. The valve e^2 is then closed, and the dye-liquor, which has been previously prepared in the reservoir h^{10} by introducing a sufficient portion of the coloring-matter into a body of water in said chamber and heating the same by admission of steam through the pipe h^{20}, may be permitted to flow by gravity through the pipe h^{40}, controlled by the valve h^5, into the chamber a.

With some dye-liquors it will be necessary or desirable to introduce the dye-liquor to the chamber a with great rapidity in order that its effect may be uniform on the materials contained in the said chamber, and for this purpose the introduction of the liquor from the chamber h^{10} into the chamber a may be accelerated by steam-pressure, which may be introduced to the upper part of the chamber h^{10} through the steam-pipe h^{50}, controlled by the valve h^{51}. The liquor is thus introduced into the chamber a, so as to act directly on the material to be dyed; but it is necessary in most cases for efficient action that the liquor should be agitated, as otherwise the coloring material is likely to settle upon the material to be dyed or into the bottom of the chamber instead of being applied uniformly over the material. In order to effect such agitation of the liquor in the chamber, so as to have a similar effect to that of boiling in an open kettle, with the advantage that the action can be carried on at a much higher temperature and pressure, owing to the fact that the chamber a is confined and may be subjected to a greater pressure than the atmospheric pressure, the following means are provided for effecting such agitation of the liquid. It may, however, first be necessary to admit more steam from the boiler directly into the mass of the liquor in order to raise the same to substantially the temperature of the water in the steam-generator, which may be done by admitting more steam through the pipe c. When, however, the steam has brought the liquor to substantially the same temperature as that in the steam-generator, there would be no further agitation of the liquor, and in order to provide for such agitation the upper portion of the chamber a is provided with a passage k, communicating with a suitable condenser (shown as a coil) k^2, contained in a chamber m, into the lower portion of which cold water is admitted through the pipe m^2, said cold water surrounding the pipe k^2 and condensing any steam which may pass into the said pipe through the pipe k from the chamber a. The passage k is provided with a pressure-valve k^{20}, which may be similar to an ordinary safety-valve and operate to maintain any desired pressure in the pipe k below it and in the chamber a, but is opened when the pressure increases above the point for which the valve is set and permits the steam to pass out through the valve and into the condenser-coil k^2. The water that condenses in the pipe k^2 is led through a pipe to an injector n, which may be of any suitable or usual construction and which is set in operation by admitting steam through the pipe c^3 to said injector. An overflow is provided at n^2, which may be opened in order to start the operation of the injector, and a check-valve is provided at n^3 between the injector and the inlet to the chamber a. After the operation of the injector is started the overflow-passage n^2 is closed by a suitable stop-cock n^4, and the combined jet of steam and condensed water passes on through the check-valve n^3 into the chamber a, thus agitating the liquor therein, while a sufficient portion of steam forms in the upper part of said chamber and is conveyed therefrom to the condenser k^2 to keep up the operation, it being understood that when the operation begins the liquor does not quite fill the chamber a. By this means a continued agitation or ebullition of the liquid is maintained in the chamber a without bodily movement or flow of the liquid, and the dye becomes very rapidly applied to the material to be dyed, owing to the high temperature and pressure at which the operation takes place, and in practice it is necessary to maintain this operation for a period varying for a few minutes to two or three hours instead of for many hours or even a day, as is necessary in the operation of dyeing as heretofore generally practiced. After this operation has been carried on for a sufficient length of time steam is shut off from the injector and the discharge-passage h is opened, permitting the liquor that has been used to flow out from the chamber a, after which it is only necessary to dry the material that has been dyed to make the material ready for use. This drying operation is preferably performed while the material still remains in the chamber a by means of the following appliances: The water in the chamber m becomes heated in condensing the steam in the pipe k^2 and is permitted to escape from the upper part of the chamber m through a pipe o, which passes in the form of

a coil through a chamber o^2, into which compressed air is admitted from the compressed-air chamber g or directly from the compressor, if desired. The water in flowing through the pipe o thus tends to heat the compressed air in the chamber o^2, which may be further heated by other means, if desired, and in order to dry the material in the chamber a the said compressed air is admitted through a pipe p, controlled by a valve p^2, into the upper portion of the said chamber, through which it passes downward, escaping through a suitable pressure or safety valve r, which thus causes the pressure to be maintained in the chamber a, so that the air penetrates and acts upon all parts of the straw, the said air rapidly absorbing the moisture from the material that has been dyed, so that it is quickly dried, and it is then ready for removal from the chamber, which can be immediately used to dye another lot. The air becomes cool and laden with moisture in acting on the wet straw, and the cool moist air naturally passes to the bottom of the chamber and escapes through the valve r as it is displaced by the dry air entering at the top of the chamber through the pipe p.

In some cases it may be objectionable to subject the goods to dry heat, and in such cases they may be dried by the action of cool compressed air, which may be admitted from the chamber g through the branch pipe p^{20}, controlled by a suitable valve, or when necessary the said air may be cooled after being compressed. During the time the compressed air from chamber g is being admitted into the dye-chamber the action of the compressor-pump is of course suspended.

For drying by cool air the outlet-pipe h may be partly open, so as to permit the air to escape more freely, thus giving it an opportunity to expand in the chamber a, and thereby take up the moisture from the straw.

The dye-preparing chamber h^{10} is preferably provided with a gage (shown as a float) r^{10}, the stem of which passes through a suitably-packed opening in the said chamber, and by its position indicates the height of the liquor in the reservoir. By this means it is possible to determine the proportions of the various materials very accurately, the material to be dyed being weighed, if necessary, while upon the frame or cage b, the amount of liquid in the chamber h^{10} being measured accurately, so that there need be no waste of the dyeing material, which may be prepared in capsules or small packages properly proportioned for definite amounts of liquid and material to be dyed. The said capsules may be coated with paraffine or other material that will protect the coloring-matter in handling, but will melt or dissolve when the capsule is lowered into the liquor in the chamber a, and as the said liquor is properly heated the said coloring-matter will diffuse itself throughout the liquor.

It may be necessary or desirable at times to maintain an artificial ebullition or agitation in the preparing-chamber h^{10}, in order that the dye stuff may be properly distributed in the liquor and the latter brought to a higher temperature than it otherwise could. This result may be effected by substantially the same means as are employed in connection with the chamber a, there being a branch pipe h^{52} leading from the injector n to the lower portion of the chamber h^{10}, the said pipe containing a check-valve h^{53} and stop-valve h^{54}, and the vapor is permitted to escape from the upper part of the chamber through the pipe h^{50}, which for this purpose communicates with a branch h^{55}, controlled by a stop-valve h^{56} and pressure-valve h^{57}, and with the condenser-coil k^2, it being understood that the stop-valve h^{51} is closed while this operation is going on. As the vapor escapes from the chamber a at a high temperature and pressure, it may in some cases be employed to effect the ebullition in the chamber h^{10}. For this purpose a stop-valve k^{31} in the pipe k, leading from the chamber a to the condenser, is closed, and a branch pipe k^{32} from the outlet of the valve k^{20} to the pipe h^{20} is opened, the valve h^{31} on the boiler side of said branch in the pipe h^{20} being closed and the valve h^{30} being opened. Thus the vapor which passes out from the upper part of the chamber a would pass through pipes k, k^{32}, and h^{20} into the lower part of the chamber h^{10}. The pipe h^{50}, opening into the upper part of the chamber h^{10}, would have its valve h^{51} closed, while the valve h^{56} in the pipe h^{55}, leading to the condenser, would be open, thus permitting the vapor to pass from the chamber h^{10} to the condenser. With this mode of operation ebullition would be maintained in the chamber a by the steam entering from the injector n, while the vapor that escaped from the upper part of the said chamber a would enter the lower part of the chamber h^{10} at somewhat less pressure, and the vapor would escape from the upper part of the chamber h^{10} and pass to the condenser k, where it condenses and is returned by the injector n to the cylinder a. The pressure on the valves k^{20} and h^{57} would be properly adjusted for this operation to maintain the desired pressure in the two chambers.

If it is desired, the same apparatus may be used for sizing the articles after they have been dried, the sizing material being prepared in a suitable reservoir above the level of the chamber a and caused to flow into the chamber in the same manner as the dyeing materials, and then the surplus size may be drawn off and the articles dried to the proper temper for the subsequent blocking or shaping.

It is frequently necessary in the process of dyeing to subject the material to the action of different liquids. In the process heretofore commonly practiced in dyeing braided-straw goods this necessitates the removal of the material from the kettle or receptacle in which it is exposed to the action of one liquid and the loosening or opening up of said material,

which may have become matted during the previous boiling, so that the next liquid to which it is exposed may have access to all parts of the material. In the apparatus forming the subject of the present invention, however, the materials to be treated may be exposed to different agents successively without being removed from the chamber *a*, it being merely necessary to draw off the liquid that has been acting upon the material from the said chamber *a* and introduce the liquid the action of which is next required into the chamber *a* from the preparing-receptacle h^{10}, in which the said liquid has been prepared, while the first liquid is acting upon the materials in the chamber *a*. The steam or vapor that passes from the dyeing-chamber to the condenser does not carry the coloring-matter with it, and it may sometimes be necessary or desirable to permit a portion of the condensed liquid to escape instead of carrying it back into the dyeing-chamber. For example, if the material to be dyed and the liquor used are such as to require the ebullition to be maintained for a considerable length of time, the constant addition of steam delivered through the injector will increase the body of liquid and thus dilute it, and if such increase becomes objectionable in amount the flow of steam through the injector may be reduced and the overflow opened, permitting a portion of the condensed liquid to escape, after which the normal operation of the injector may be again carried on.

The valves *r* and k^{20} are called "safety-valves," because they are or may be of the same construction as an ordinary safety-valve; but it is to be understood that their function is not primarily to protect the chamber *a* against overpressure, but to hold back, as it were, the fluid, so as to maintain it under a certain amount of pressure in the chamber, so that it will tend to enter and permeate all parts of the material being acted upon, it being understood, however, that the pressure of the fluid entering the chamber is higher than that maintained by the said safety-valve, so that there is practically a constant admission of fluid to the chamber and escape of fluid from the chamber through the said valve *r* while the operation is going on.

It may in some cases be desirable to dye the braid before being made up into hats or other articles, in which case the line of braid may be wound spirally and preferably only a single layer deep upon tubular cores b^{20} (see Fig. 5) of gauze, perforated plate, or other foraminous material, the said tubes being of different size, so that one can be placed within another, being supported, for example, upon a spider or perforated base-piece b^{22}, provided with a rod b^{21}, by which the material can be lowered into and removed from the chamber *a*.

The herein-described plan of maintaining ebullition or agitation of the liquid around the material that is being acted upon by the liquid may be applied advantageously in some cases when it is not desired to raise the temperature above the boiling-point or when it is desired to keep the temperature below the normal boiling-point. For example, it is desirable in bleaching at times to subject the material thoroughly to the action of liquid without raising the temperature to any great extent, although the effectiveness of the liquor on the material would be increased if its pressure could be raised, as the liquor would thus more thoroughly penetrate the interstices and meshes of the material. This result can be effected with the herein-described apparatus by introducing air with or without condensed liquor into the chamber *a* and permitting it to escape through the pressure-valve k^{20}, which may be set to maintain any desired pressure. To accomplish this result the apparatus may be provided with a pipe c^{30}, extending from the compressed-air chamber to the inlet of the injector *n*, the pipes c^{30} and c^{3} being provided with stop-valves, so that either may be closed when the other is open. In this manner air at any desired temperature may be caused to enter the chamber *a* under sufficient pressure to maintain an agitation of the liquor therein similar to that produced by boiling, the said air passing out through the pipe *k* and pressure-valve k^{20}, the outlet of which may, if desired, communicate with a pipe k^{22}, opening into the open air; but as the air escaping from the chamber *a* will usually be heavily laden with moisture it may be desirable to close the pipe k^{22} and permit the air to pass into the condensing-coil k^{2}, where the moisture will condense out. This pipe k^{22} also serves as a by-passage, through which steam in excess of that required to maintain the proper level of liquid in the chamber *a* may be discharged from the apparatus; or as an equivalent for this purpose the overflow of the injector may be used, the opening of the overflow permitting the water of condensation taken by the action of the injector to be discharged at that point instead of being carried into the chamber *a*. In this way dilution of the dye-liquor can be prevented and it can be maintained at the proper strength. The return-pipe k^{3} is provided with a branch pipe k^{24}, extending upward, which may then be opened to permit the air to escape while the liquid flows by gravity down the pipe k^{3} and is carried back into the chamber *a* with the jet of air. It is obvious that it is not essential that the moisture passing out from the chamber *a* should be condensed and returned either when the apparatus is operated with air or with steam. In either case the pipe k^{3} between the pressure-valve k^{20} and the condenser-coil might be closed by a stop-valve and the steam or vapor permitted to escape through the pipe k^{22}; but the preferable plan is to condense the liquid and return it, as by this means the liquor in the chamber can be retained at proper strength instead of becoming concentrated,

as it might if the moisture were carried off and dispersed.

I claim—

1. In dyeing apparatus, the combination, with a tight-closed dye-chamber having an inlet at the bottom and an outlet in the top thereof, of means for injecting through said inlet steam or heated air into the body of the dye-liquid to keep the same in ebullition under pressure in said chamber, and a pressure-valve controlling the outlet for permitting the escape at a predetermined pressure of steam or other gaseous fluid which may gather in the top of said chamber above the liquor, whereby the dye-liquor in the chamber is kept in continual ebullition or agitation under pressure, but without bodily movement into, through, and out of said chamber, and a condenser communicating on the one hand with the pressure-valve and on the other hand with the injector, substantially as and for the purposes hereinbefore set forth.

2. In dyeing apparatus, the combination of a tight-closed dye-chamber having an inlet at the bottom and an outlet at the top thereof, means for injecting through said inlet steam into the body of the dye-liquid, a pressure-valve controlling the outlet for permitting the escape of steam, a condenser communicating on the one hand with the pressure-valve and on the other hand with the injector, and a valve or cock controlled discharge-passage, such as k^{22}, whereby fluid in excess of that required to maintain the proper level of dye-liquor in the dye-chamber may be discharged from the apparatus, substantially as and for the purposes hereinbefore set forth.

3. A dyeing apparatus comprising, in combination with one and the same tight-closed dye-chamber, the preparing-chamber and the compressed-air reservoir communicating through valve or cock controlled pipes with the upper part of said dye-chamber, the pressure-valve controlling an outlet in the top of the dye-chamber, the injector communicating with an inlet in the bottom of the dye-chamber, the condenser communicating on the one hand with the pressure-valve and on the other hand with the condenser, the exhaust *f*, and the pressure-valve *r*, connected by a valve or cock controlled pipe with the inlet in the bottom of the dye-chamber, all under the arrangement and for operation substantially as and for the purposes hereinbefore set forth.

4. The combination, with a preparing-chamber provided with an inlet-passage, of two valves inclosing a chamber between them in said inlet-passage, a foraminous cage working through said passage, and a raising and lowering device for said cage, substantially as described.

5. The combination of the tight dyeing-chamber and the frame or support for the material to be dyed therein with an air-compressor and ducts for introducing compressed air into the upper part of said chamber and an outlet-duct at the lower part of said chamber provided with a pressure-valve, substantially as and for the purpose described.

6. The dye-chamber provided with an overhanging flange around its open end and a lateral recess below said flange, combined with the laterally-movable cover working in said recess and adapted to seat against the under side of said flange to close the cylinder, substantially as described.

7. The dye-cylinder provided with an overhanging flange around its open end and a lateral recess below said flange, combined with the laterally-movable cover working in the said recess and adapted to seat against the under side of the said flange to close the cylinder, and cams provided with operating-handles outside the cylinder for seating and unseating the cover, substantially as described.

8. The dye-cylinder provided with an overhanging flange around its open end and a lateral recess below the said flange, combined with the laterally-movable cover working in the said recess and adapted to seat against the under side of said flange to close the cylinder, and a rack and pinion for moving the said cover laterally into and out from the said recess, substantially as described.

9. A supporting-frame for goods to be dyed, comprising a central stem and foraminous shelves, between which the goods to be dyed are placed, each pair of shelves between which goods are placed being separated from adjoining pairs by clear spaces to afford an unobstructed body of dyeing-liquor at various levels in the dyeing-chamber and between the several layers of goods, substantially as and for the purposes hereinbefore set forth.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

JAMES A. YOUNG.

Witnesses.

JOS. P. LIVERMORE,

JAS. J. MALONEY.