Jan. 25, 1955 R. H. CURTIS 2,700,326

METHOD AND APPARATUS FOR MAKING ACCRETED FIBROUS TUBULAR BODIES

Filed July 29, 1949 3 Sheets-Sheet 1

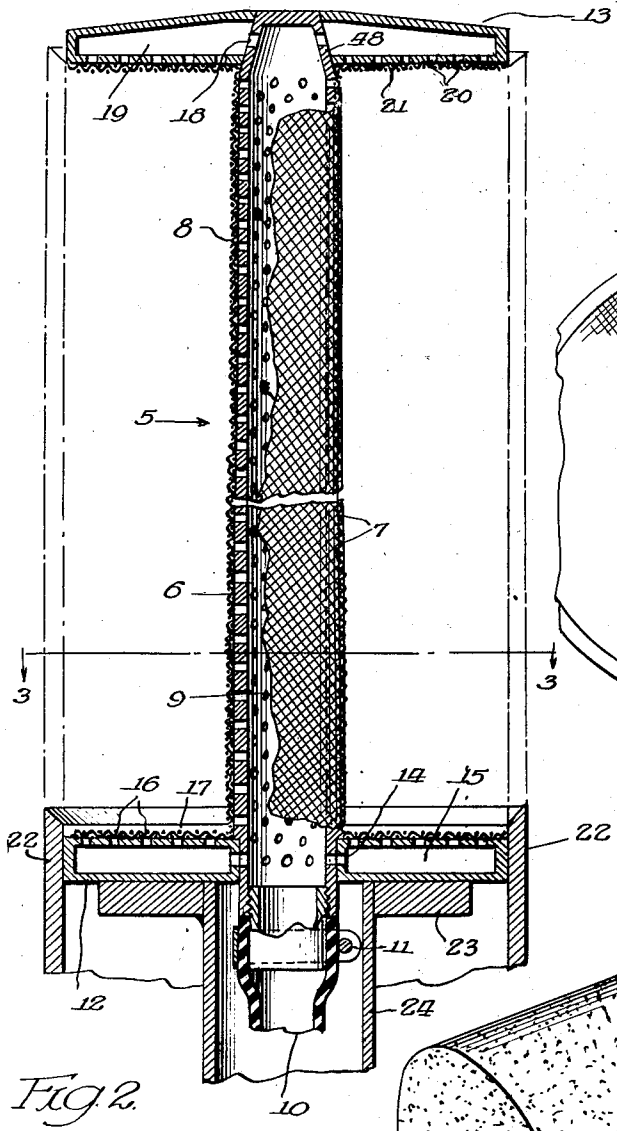

Fig. 2.

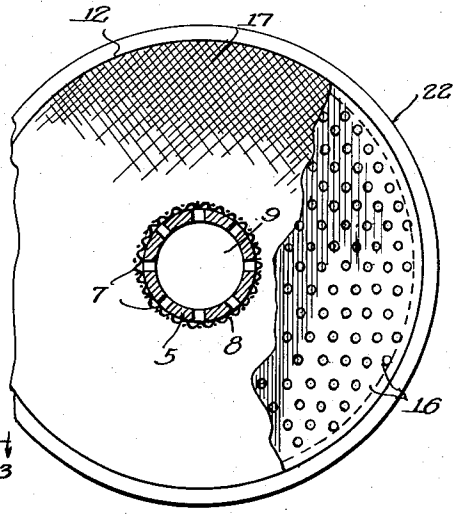

Fig. 3

Fig. 1

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FIG. 6

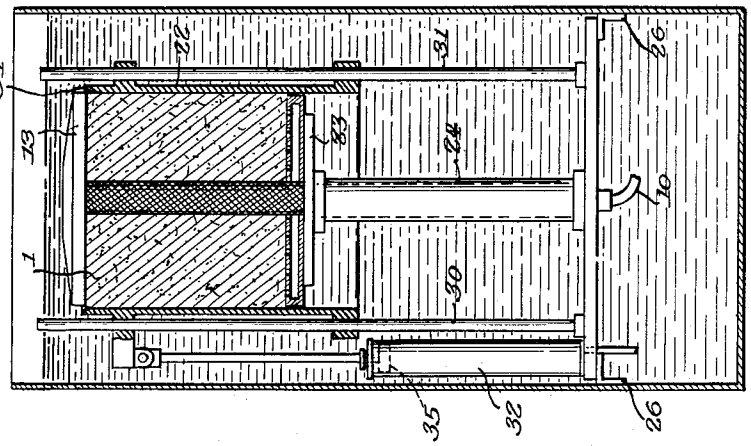


FIG. 5.

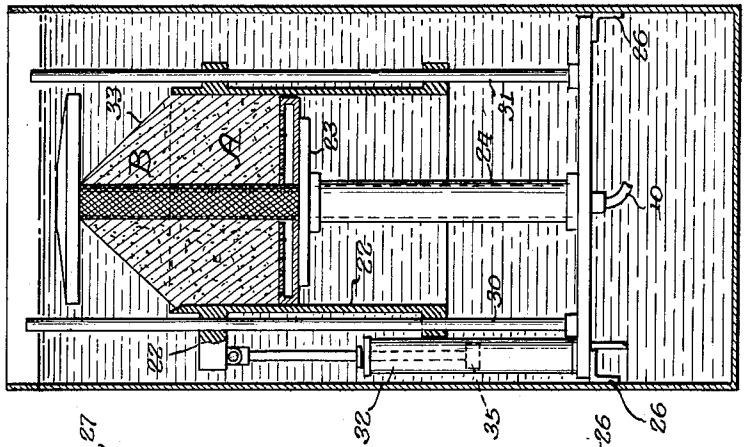
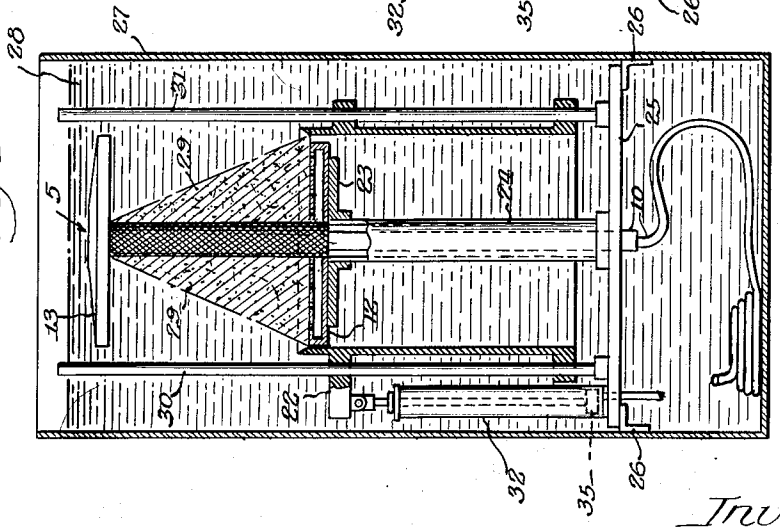


FIG. 4



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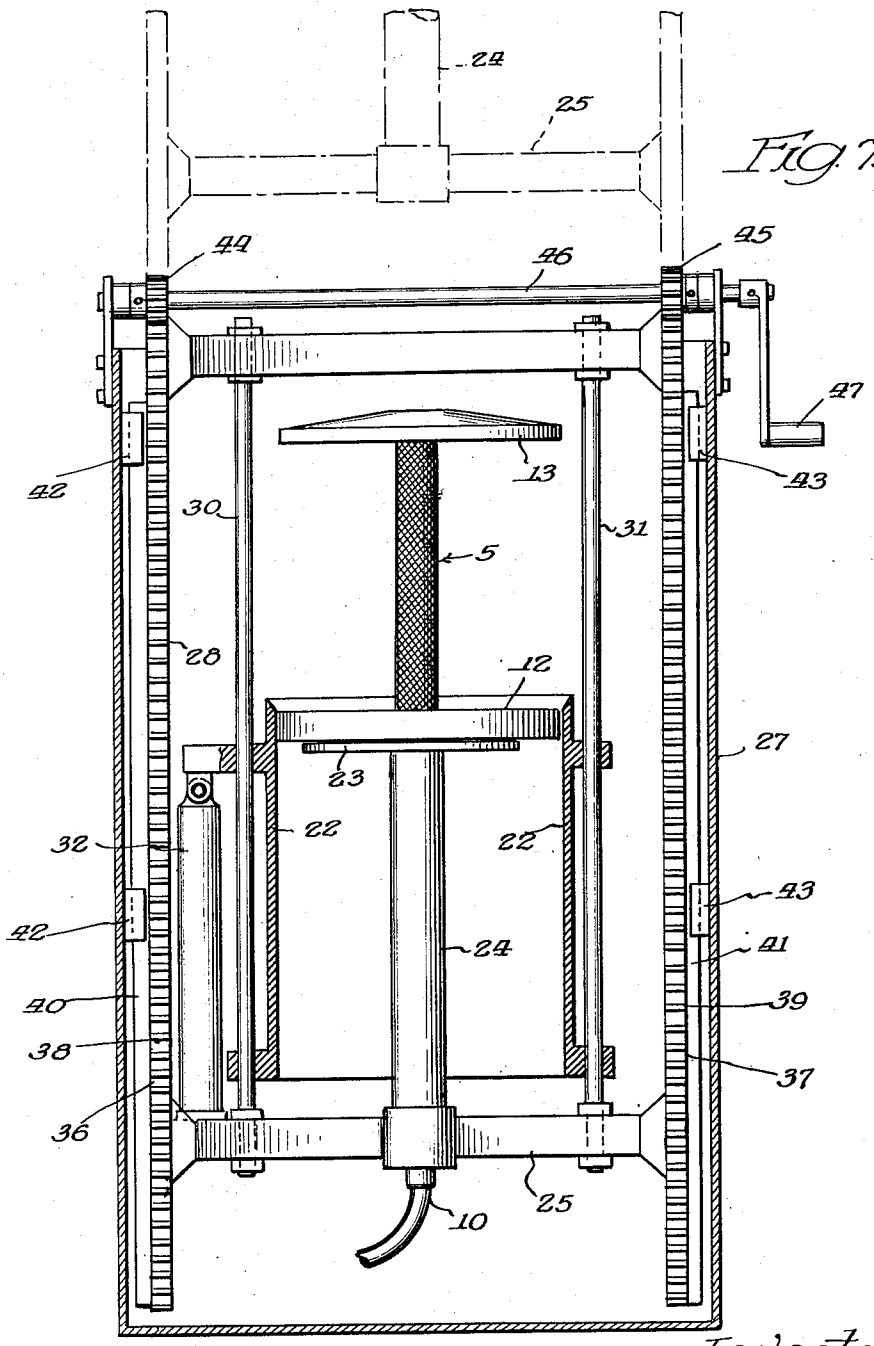

Fig. 7.

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METHOD AND APPARATUS FOR MAKING ACCRETED FIBROUS TUBULAR BODIES

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Application July 29, 1949, Serial No. 107,423

4 Claims. (Cl. 92—57)

This invention relates to a novel method and apparatus for making tubular or elongated annular accreted fibrous bodies, more particularly filter elements of integral molded fibrous construction.

It is well known that relatively thick layers of accreted fibrous materials may be obtained by immersing a foraminous member in a slurry of fibrous material and applying suction to the member to thereby deposit or felt an integral layer of fibrous material onto said member. It is characteristic of the felting process that the deposited fibrous layer will be thicker at the bottom of the former than at the top, in spite of vigorous agitation. Hence, if a foraminous member is placed vertically in the bath of fibrous slurry the layer depositing on the member will be thick at the bottom and progressively thinner towards the top. The result is an article having tapered sides.

One object of this invention is to provide an improved apparatus for accreting integrally molded fibrous bodies.

Another object is to provide an apparatus for accreting molded fibrous filter elements having straight vertical sides.

A further object is to provide an apparatus for making molded fibrous filter elements which are substantially tubular in shape and which do not require trimming.

A still further object is to provide a new and improved method of accreting fibrous materials.

Another object is to provide a method of accreting on a vertical former to prevent tapering of the sides of the finished product.

A further object is to produce a tubular or elongated filter formed from accreted fibers and having a substantially uniform density from one end to the other.

Another object is to provide a method of accreting a fibrous body of uniform dimensions on a vertical former directly and without the necessity of trimming.

These and other objects of the invention will be more completely understood by considering the following disclosure and drawings in which:

Figure 1 is a perspective view of a finished filter element prepared according to this invention;

Figure 2 is a sectional view with parts broken away of one embodiment of the forming apparatus of the present invention showing the foraminous tubular former and the dimension controlling member;

Figure 3 is a cross-sectional plan view taken along the line 3—3 of Figure 2 with parts broken away;

Figure 4 is a side sectional view of the apparatus soon after the beginning of the felting cycle;

Figure 5 is a side sectional view of the apparatus showing the felting partially completed;

Figure 6 is a side sectional view of the apparatus showing the arrangement of the parts of the apparatus at the completion of the felting cycle; and

Figure 7 is a side sectional enlarged view of the apparatus showing means for raising and lowering the forming elements in slurry or bath of fibrous materials.

The invention provides a method for forming a layer of fibrous material in tubular form and progressively shaping the exterior surface thereof during the forming operation so as to produce an accreted fibrous article directly without the necessity of trimming. It is especially useful in preparing tubular filters. By the practice of the invention it is now possible to achieve a heretofore unknown result, namely, elimination of the tapered shape of an accreted article prepared on a vertical former.

With further reference to the drawings, Figure 1 shows one type of finished molded fibrous filter element made by

the practice of the invention. The filter element **1** as shown is composed of a body portion **2**, a circular hole **3** through the center of the body **2** along the longitudinal tubular axis, and a peripheral or exterior surface portion **4** parallel or concentric to the tubular axis. The article shown in Figure 1 is intended to represent the type of molded fibrous element which may be made on the apparatus disclosed herein so that the finished article will have uniformity of dimension, thereby eliminating the necessity of trimming a crudely shaped article.

Figure 2 shows a foraminous tubular former **5** composed of a relatively heavy metal tube **6** having a number of holes **7** therein and covered with a screen **8** which completely surrounds the tube **6**. The hollow center portion **9** of the tube **6** is provided for carrying away the liquid which is forced through the screen **8** and through the holes **7** by a pressure differential created by applying reduced pressure to the conduit **10**. One end of the conduit **10** is attached with clamp **11** to the foraminous tube **6** and at its other end is connected to a source of reduced pressure (not shown).

Attached to the former tube **6** is the bottom member **12** and the top member **13**, each of which is adapted to receive reduced pressure from the interior **9** of the former tube **6**. Reduced pressure from the tube interior **9** is transmitted to the hollow portion **15** of the bottom member **12** through opening **14**. The upper face of the bottom member **12** has a number of holes **16** therein which are covered by a screen **17**. Through this arrangement liquid passes from the high pressure side to the low pressure side of the foraminous structure. The top member **13** is similarly constructed having the communicating openings **18** connecting the interior portion **9** of the tube **6** with the hollow space **19**. The top member **13** likewise has a number of openings **20** in the lower face thereof and a covering screen **21** corresponding to the screen **17** of the bottom member.

The top of the shaping or enclosing means **22** is near the bottom member **12** when in retracted position, as shown in full lines in Figures 2 and 7, and adjacent the top member **13** when in advanced position, as shown in dotted lines in Figure 2 and in full lines in Figure 6. The member **22** in the form shown is tubular.

The bottom member **12** is affixed to and supported by a platform member **23** welded to a tubular pedestal **24** which is affixed to the base plate **25** supported by brackets **26, 26** on the inside of tank **27** as shown in Figures 4, 5 and 6 or attached to a carriage as shown in Figure 7.

Figures 4, 5 and 6 represent progressive stages of the felting operation showing how the accreted article is built up around the foraminous former **5**, and showing how the shaping tube **22** is raised to control the accretion of fibers. As shown in Figure 4 the tank **27** is filled with an aqueous slurry of fibrous material **28** until the former **5** is completely immersed in the slurry. Vacuum is then applied through the conduit **10** and is transmitted through the hollow support pedestal **24** to the interior of the former tube **6**, extending into both the upper plate **13** and the lower plate **12**.

In operation, a layer of accreted fibrous material begins to form on the former screen **8** and deposits nonuniformly, tapering in thickness toward the top of the former, as shown by dotted lines **29** which exaggerate the taper for the purpose of illustration. When the accreted layer has built up to a substantial thickness on the base screen **17** of the bottom member **12**, as generally illustrated in Figure 4, the tubular enclosing member **22** is raised gradually from its retracted position in Figure 4 through an intermediate position shown in Figure 5 to its top position shown in Figure 6. The member **22** is guided in close engagement with the base **12** of the former **5** by means of the guide rods **30** and **31**.

The elevation of the member **22** is achieved by any suitable means as, for example, by the double acting air cylinder mechanism **32**. As member **22** is raised the taper shortens as shown by dotted lines **33** in Figure 5. Since the member **22**, as it rises, encloses and confines the fibrous body of the article being formed, it changes the suction effect in predetermined portions of the former. The pressure drop across the area A decreases while the pressure drop across the area B increases. Thus, optimum

utilization of the reducing pressure is obtained and a product of uniform dimensions results.

In Figure 6 the enclosing member 22 is shown in fully extended position so that the upper end 34 comes into engagement with the top member 13 of the former 5. In this position the accreting from the bath is completed and the accreted filter member has been formed in the wet state.

Figure 7 illustrates a simplified arrangement for elevating or lowering the entire apparatus in the slurry tank. It is contemplated that any suitable arrangement may be employed for such an operation and the present device is shown only for illustrative purposes. At the completion of the felting cycle the apparatus is elevated from the bath, and the enclosing member 22 is lowered into its retracted position by applying air pressure to the upper side of piston 35 in air cylinder 32. The elevation of the forming element 5 from the bath 28 is accomplished by a pair of racks 36 and 37 provided with gear teeth 38 and 39 and guide rails 40 and 41 which travel in the guides 42, 42 and 43, 43, respectively. The gear teeth 38 and 39, respectively, engage pinions 44 and 45 mounted on shaft 46 which can be rotated by turning the crank 47. As the crank 47 is turned the rack and pinion arrangement causes the platform 25 to be elevated and thereby elevates the former 5 until it emerges from the bath. The maximum elevated position is shown by the dotted lines at the top of the drawing. The suction may be maintained for a period long enough to substantially reduce the moisture content of the accreted article. The top portion 13 of the former 5 frictionally engages the tapered portion 48 of the foraminous tube 6 and is readily removed by lifting. When the top 13 is lifted the finished accreted article 1 may be removed by pulling or lifting it from the tube 6. The finished article 1 may then be further dried if desired by any suitable means, as by drawing hot air therethrough or by passing the fibrous article through an oven.

A large number of fibrous materials are known and are available for use in the present invention. It is contemplated that any suitable fiber may be employed so long as it may be accreted from a liquid suspension onto a porous former. Animal, vegetable, mineral, and synthetic fibers may be employed, or any combination of these. Wool fibers, cotton linters, wood fiber, and grass fibers are examples of inexpensive and readily available materials. In addition, glass fibers or synthetic fibers may be employed if their specialized properties justify the cost.

In some instances, it may be desirable to increase the strength of the finished article or to otherwise alter the characteristics thereof by the addition of resins to the fibrous material. A large number and variety of resins are available as, for example, the melamine wet-strength type resins and the phenol-aldehyde type resins.

Fibrous filters made by accretion on vertical formers merely by rotating the former in a liquid suspension of fibrous materials are characterized by lower density at the top than at the bottom. A filter having the desired physical characteristics at the bottom will not have the same characteristics at the top and will not meet uniformity requirements. Filters made in accordance with the present invention, on the other hand, are of substantially uniform density from top to bottom and will satisfy such requirements.

From the foregoing it will be apparent that the practice of the present invention now makes possible a controlled accretion of fibers, and the formation of accreted tubular fibrous articles of uniform cross-section and uniform density from top to bottom on vertical formers. The resultant fibrous article is relatively inexpensive to make because of the elimination of the trimming step and the further elimination of the waste from the trimming step.

The invention is hereby claimed as follows:

1. A method of forming a thick tubular article of accreted fibrous material which comprises immersing a tubular foraminous former with its longitudinal axis in a substantially upright position in an aqueous suspension of fibers, reducing the pressure in the interior of said former to cause a layer of fibrous material to deposit thereon, and progressively elevating a shaping tube concentric to said former and within said aqueous suspension gradually as the deposited fibers come into contact with said shaping tube.

2. An apparatus for forming an article of accreted fibrous material which comprises a tubular foraminous former, means for holding said former substantially vertically in contact with dispersed fibers to be deposited thereon a tank adapted to receive a slurry of said fibrous material and said former, a transversely extending foraminous flange member at the upper and lower ends of said tubular former, means for reducing the pressure within said former and said flange members, tubular enclosing means spaced from said former for limiting the accretion of fibers about said former and movable parallel to the longitudinal axis of said former from the lower to the upper flange, and means for raising said movable tubular enclosing means during the deposition of fibers on said former gradually as the deposited fibers come into contact with said movable enclosing means.

3. An apparatus for forming an article of accreted fibrous material which comprises a tubular foraminous former, means for holding said former substantially vertically in contact with dispersed fibers to be deposited thereon a tank adapted to receive a slurry of said fibrous material and said former, a transversely extending foraminous flange member at the upper and lower ends of said tubular former, means for reducing the pressure within said former and said flange members, tubular enclosing means spaced from said former for limiting the accretion of fibers about said former and movable parallel to the longitudinal axis of said former from the lower to the upper flange, means for raising said movable tubular enclosing means during the deposition of fibers on said former gradually as the deposited fibers come into contact with said movable enclosing means, and means for removing said upper flange member to permit discharge of said accreted article.

4. An apparatus for forming an article of accreted fibrous material which comprises a tubular foraminous former, means for holding said former substantially vertically in contact with dispersed fibers to be deposited thereon, a tank adapted to receive a slurry of said fibrous material and said former, a transversely extending flange member at the upper and lower ends of said tubular former, means for reducing the pressure within said former, tubular enclosing means spaced from said former for limiting the accretion of fibers about said former and movable parallel to the longitudinal axis of said former from the lower to the upper flange, and means for raising said movable tubular enclosing means during the deposition of fibers on said former gradually as the deposited fibers come into contact with said movable enclosing means.

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