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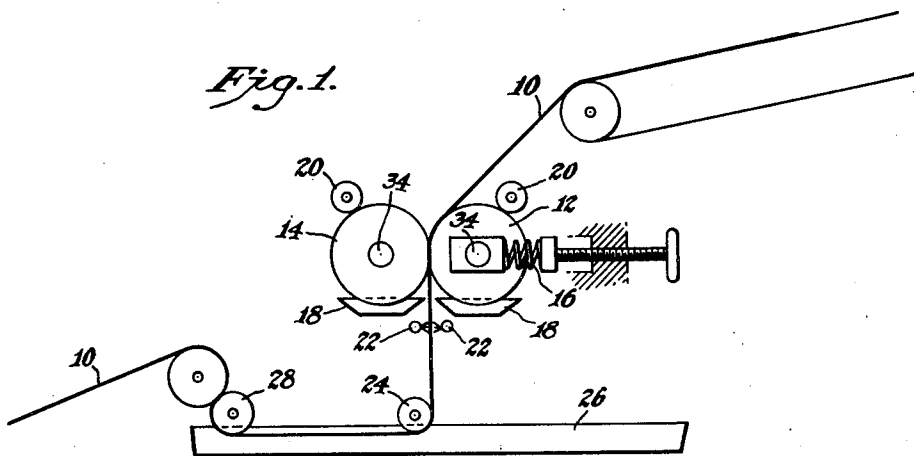
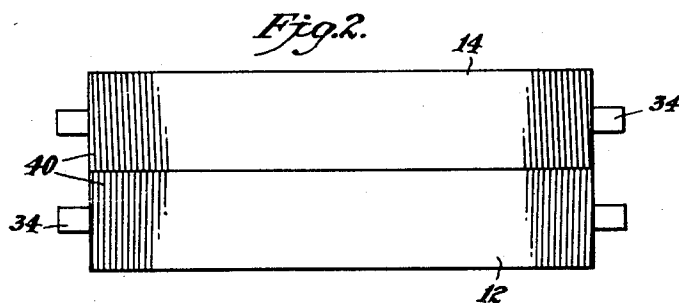
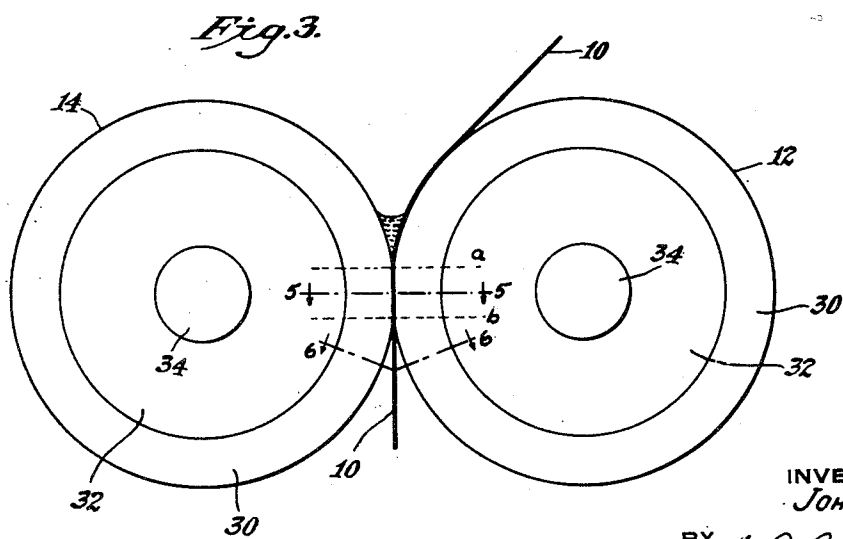
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2,530,407

PRESSURE ROLL FOR FORMING BONDED FIBER WEBS

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2 Sheets-Sheet 1



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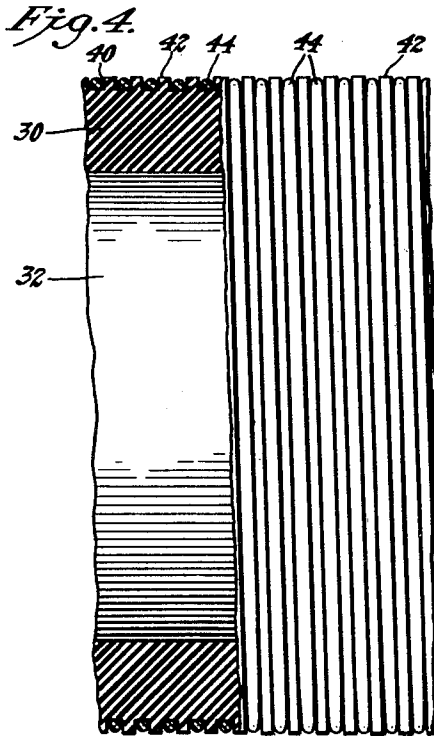
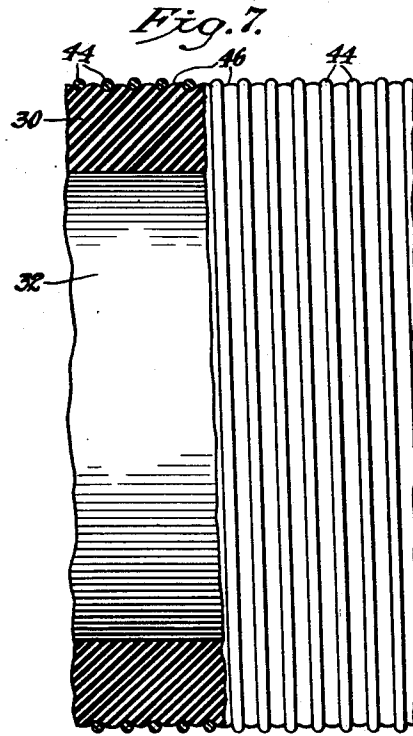
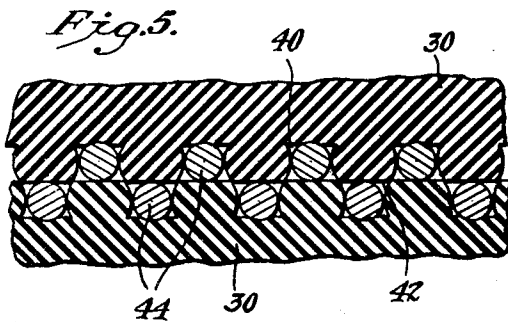
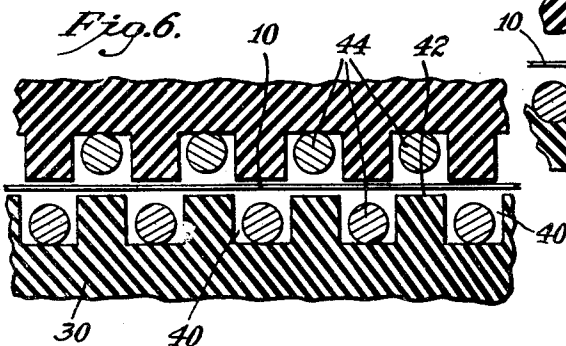
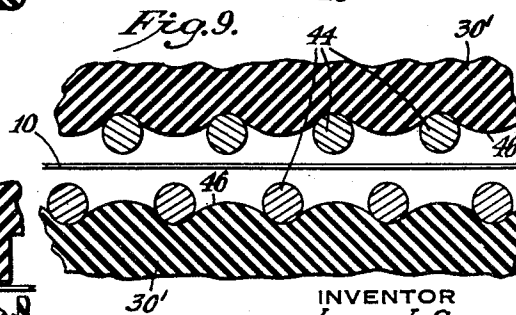
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PRESSURE ROLL FOR FORMING BONDED FIBER WEBS

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2 Sheets-Sheet 2



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PRESSURE ROLL FOR FORMING BONDED
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12 Claims. (Cl. 68—127)

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This invention relates to apparatus for forming bonded fiber webs by the process of gelatinizing or parchmentizing sheets of unattached cellulose fibers; for example, carded cotton webs.

Tough, water-resistant, bonded webs have been made from unwoven cotton webs by softening the fibers of the web by immersion in a parchmentizing solution such as sulphuric acid and subsequently or simultaneously pressing the softened fibers together to bond them and thereafter washing out the acid.

In one form of apparatus, a sheet formed of a carded cotton web or of a plurality of superposed webs is pressed between two rolls which are wetted with a solution of sulphuric acid. The acid softens the fibers as the web comes in contact with the wet rolls and the pressure of the rolls bonds the fibers together in a sheet. The acid is washed out very quickly after the fibers are pressed together and a strong, non-woven bonded sheet results which can be washed and dried and used in many ways for cloth.

In this process, the surfaces of the pressure rolls are continuously wetted with acid solution and, in the former practice of the process, difficulty has resulted from the webs sticking to the rolls. Many attempts have been made to prevent this, for example, by roughening the surfaces of the rolls, as by grinding, but none of these attempts which have come to my attention have solved the problem more than temporarily. The rolls are ordinarily made of elastic material such as soft rubber of suitable plastometer rating in order to assure proper pressure on the web. A sulphuric acid solution of a concentration of 75% may be used in the process and, while suitably compounded rubber rolls appear to resist action of the acid satisfactorily beneath the surface and thus maintain their over-all elasticity, the acid appears to attack the small projections of the roughened surface so that the roughened roll quickly loses its quality of preventing sticking.

My invention prevents sticking of the fiber webs to the wet pressure rolls, and I accomplish this by a novel construction of the rolls, particularly at their surfaces. I provide each of the rolls with a composite and slightly irregular surface formed of alternating compressible portions or elements and incompressible portions or elements which collectively form a substantially continuous or regular surface (whether plane or cylindrical) when subjected to pressure but present minute variations from a true cylindrical surface when not subjected to pressure. The elements of one type move radially with respect to elements of the other type as the rolls are rotated, providing air

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channels beneath the web and functioning as ejectors or strippers which automatically and positively remove the web from the rolls as it passes between them.

This may be accomplished by various arrangements, some of which are illustrated by way of examples in the accompanying drawings, in which;

Fig. 1 is a diagrammatic end elevation of the wet pressure rolls of an apparatus constructed in accordance with the invention;

Fig. 2 is a diagrammatic plan view of a pair of rolls embodying one form of my invention;

Fig. 3 is an enlarged end view of the pressure rolls shown in Fig. 2;

Fig. 4 is an enlarged fragmentary view of a wet pressure roll, partly in longitudinal section and partly in elevation;

Fig. 5 is an enlarged longitudinal section of the portions of the rolls in contact at the nip, the section being taken on the line 5—5 of Fig. 3;

Fig. 6 is a view corresponding to Fig. 5, showing sections of the rolls as they appear just after leaving the nip, the section being taken on line 6—6 of Fig. 2;

Fig. 7 is a view corresponding to Fig. 4 of a modified form of the invention;

Fig. 8 is a section corresponding to Fig. 5 of the modified form; and

Fig. 9 is a section corresponding to Fig. 6 of the modified form.

Referring to the drawings, a carded cotton web 10 is fed between a pair of pressure rolls 12 and 14 which are mounted in any suitable bearings urged together by adjustable bearing springs 16. The rolls are geared together and positively driven in known manner. The rolls dip into pans 18 which contain the parchmentizing solution, for example, sulphuric acid, continuously supplied in any suitable manner, not shown. Wiping rolls 20 run in contact with the pressure rolls 12 and 14 to remove excess acid and to regulate the amount of acid on the surfaces of the rolls where they contact the web. The web is saturated with the acid and squeezed between the rolls, then passes between the pans 18 and, if desired, between water sprays 22, thence under a roll 24 into a rinsing vat 26. The rinsed web passes out of the vat under a roll 28 for further rinsing, processing and drying.

The structure described is known in the art, and its particular arrangement forms no part of my invention which is directed to the structure, surface configuration and relationship of the pressure rolls.

The rolls may be formed of any suitable elas-

tic material such as rubber, as previously described. This may have a hardness and resilience comparable to that of rubber heels or automobile tire treads, or it may be softer, if desired. The rolls may take the form of a cylindrical rubber shell 30, suitably secured to a steel core 32 having bearing shafts 34. The shell 30 is sufficiently thick to give the effect of a resilient roll; for example, in a roll having a diameter of 12", the radial thickness of the shell 30 may be 1½". As seen in Fig. 3, the rolls are pressed together with sufficient force in the bearing springs 16 to flatten the rolls at the nip to provide a planar zone of contact *a-b* which may be, for example, 1½" wide. The web 10 is subjected to pressure during all the time it takes to pass through this zone.

The surface of the roll is formed with alternate compressible and incompressible portions distributed over its entire circumference and along its entire operative length. These may be formed in a variety of ways. As indicated in Figs. 2 and 4, a narrow, shallow helical groove 40 is cut in the surface of the roll, leaving a projecting helical land 42. The width of this land is approximately equal to width of the groove so that the land forms, in effect, a plurality of rings of elastic material extending radially from the surface of the roll and separated by spaces approximately equal to their width. The groove 40 is almost, but not completely, filled by a filament 44 of inert, incompressible material wound in the groove, preferably round and preferably wound under tension. The filament is formed of any suitable material inert to the parchmentizing solution, for example, platinum, or a material from the class known as plastics, such as the vinylidene chloride polymer known by the trade name Saran. It will be observed that the outer surfaces of the rings or land 42 lie in a cylindrical surface and that the outermost line of the filament 44 determines a cylindrical surface. Preferably, these cylindrical surfaces are of different but approximately equal diameters; for example, in a 12" roll, the diameter of the land may be 12.000", while the diameter of the cylinder determined by the filament may be 11.990".

Figs. 5 and 6 show the action of the rolls 12 and 14 at the zone of contact with the web. As the material of the rolls comes together under pressure, the spiral land of each roll is compressed radially by contact with the opposite roll. This causes the surface of the land to move radially inward until it is stopped where the surface of the incompressible filament comes into contact with the opposite roll, while the land, compressed radially, flows axially so that the incompressible filament now more nearly or completely fills the groove. Any further pressure on the roll will flatten or compress the roll in its entirety by radial displacement inward of both the incompressible filament and the surface of the land, these two surfaces forming, in effect, a substantially continuous planar surface in the zone of contact. The web 10 is compressed between these two substantially continuous plane surfaces.

Fig. 6 shows the condition of the rolls and the web upon leaving the zone of contact. As the material of the rolls separates, the pressure is released, the material again assumes a round form and the resilient land moves outward radially of the cylinder so that its outer surface is again slightly outside the cylinder determined by

the filament. This relative motion of the land and the filament forms air channels over the filament and positively ejects or disengages the web from the surface of both rolls, so that the web falls freely from the rolls into the rinsing vat 26.

I am aware that, technically, it is considered that some forms of rubber are incompressible and that the apparent compression of rubber is due to flow of the rubber rather than compacting of the molecules which would result in a change of total volume. It is immaterial to my invention whether the action is one of strict compression or one of flow, and herein I use the term compression to include both, the important consideration being that the land is compressed or changes dimension radially of the cylinder when pressure is applied throughout the plane of contact of the two rolls, and that the land be restored to its original position and condition upon release of the pressure. Likewise, it is not essential that the filament be made of material which is absolutely incompressible, it being desirable to have relatively low compressibility with respect to the compressibility of the lands, so that the lands on one roll will not materially compress the filament on the opposite roll. This assists in effecting and maintaining a plane zone of contact in the nip of the rolls. This compressibility of the filament may be substantially zero, by which is meant that within the range of pressure employed, the filament does not appreciably change its diameter.

It will be observed that the structure of Fig. 4 functions as a plurality of resilient, compressible members which move radially in and out with respect to a plurality of incompressible members and my invention contemplates achieving this structure in the surface of the roll by any suitable means. For example, the convolutions of the filament and the convolutions of the land, individually considered, are, in effect, a plurality of spaced rings and these can be constructed in any suitable manner. Also, the structure functions as a resilient roll having non-resilient members imbedded in the resilient material at and beneath its surface, and my invention contemplates achieving this result in any suitable manner, as by molding incompressible members or elements in the rubber.

As an example of an alternative form of construction, I may simply wind the filament 44 of the inert material in a helix of suitable pitch, and under suitable tension, about a resilient roll 30', as indicated in Fig. 7. Preferably, the tension under which the filament is wound and the pitch at which the helix is formed are such as to compress the resilient material of the roll immediately under the convolutions of the filament more than the material may be compressed between the convolutions so that the material between the convolutions flows radially outward to provide the resilient members of the invention, and the filament, to a certain extent, imbeds itself in the resilient material or forms a compressed helical groove which holds the filament. In this case, the filament is equivalent to a plurality of spaced rings stretched over the roll under sufficient circumferential tension to imbed themselves somewhat in the material of the roll.

The action of the filament arranged in this manner is indicated in Figs. 8 and 9 and is similar to the action of the lands and filament in Figs. 5 and 6. In this case, the compressible members are the areas 46 of the exposed rubber

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between the convolutions of the filament, and the cylinder determined by the outermost line of the filament is of slightly larger, rather than smaller, diameter than the cylinder determined by the surface of the resilient members. As the rolls are compressed by contact with each other, the convolutions of the filament are pressed deeper into the rolls and the material of the rolls flows out between the convolutions until it is stopped by contact with the opposite roll, and the filament and the rubber between its convolutions forms, in effect, a substantially continuous planar surface, as indicated in Fig. 8. As the rolls separate and the pressure is released, the resilient material and the convolutions of the filament are restored to their original positions and condition, as indicated in Fig. 9, and the convolutions of the filament act as positive ejectors of the web to remove it from the surface of the rolls.

Preferably, in both forms of the invention shown in Figs. 4 and 7, the filaments are wound in helices of opposite pitch on the two rolls, as indicated in Fig. 2, so that they maintain their relationship and do not cross one another as the rolls run together.

Rolls constructed as described have been found to produce strong, water-resistant sheets weighing less than one ounce per square yard from carded cotton webs, continuously and without sticking of the acid-saturated web to the wet rolls.

I claim:

1. In apparatus for forming bonded fiber webs, a pressure roll having an elastic compressible outer layer and a continuous filament of incompressible material wound under tension in a helix having spaced convolutions about the surface of the outer layer to compress said resilient material beneath the convolutions of the helix, the resilient material between the convolutions being exposed between the convolutions and less compressed than the resilient material beneath the convolutions and forming a cylindrical surface approximately equal in diameter to the diameter of the cylinder determined by the outer surface of the helix, but different from the diameter of said determined cylinder.

2. In apparatus for forming bonded fiber webs, a pressure roll having an elastic outer layer, the layer having an operating pressing surface including both a plurality of radially compressible elastic members projecting from the surface of the roll in spaced distribution over said surface and radially incompressible members disposed between said compressible members and substantially but not completely filling the spaces therebetween.

3. In apparatus for forming bonded fiber webs, a pressure roll formed of elastic material having one or more members of substantially incompressible material distributed in spaced relation over the surface of the roll and disposed within the elastic material entirely beneath its surface, the members of incompressible material and the elastic material both being exposed at the surface of the roll.

4. Apparatus for making bonded fiber webs comprising in combination a pair of pressure rolls having elastic outer portions, the rolls being adapted to be rotated to feed a fiber web between them, the surface of each roll being composed of interspaced flexible elements having relatively high and relatively low compressibility respectively radially of the roll, and means for urging the rolls together to deform the surfaces into a substantially plane surface of contact

between the rolls and to move the outer surfaces of the elements of high compressibility radially with respect to the surfaces of the elements of low compressibility, whereby the high compressibility elements will move radially with respect to the low compressibility elements as the surfaces of the rolls separate from each other in rotating.

5. In apparatus for making bonded fiber webs the combination of a pressure roll having a pressing surface, said pressing surface comprising interspaced elements of two kinds, the elements of the first kind being elastic and deformable radially of the roll and having their outer surfaces normally disposed substantially in a cylindrical surface, the elements of the second kind being substantially incompressible radially of the roll and having their outer surfaces normally disposed substantially in the surface of a coaxial cylinder whose diameter is approximately equal to, but different from the diameter of the cylinder of the first elements, and means for exerting pressure radially of the roll to displace a portion of the outer surface of each elastic element radially of the roll into substantial alignment with the outer surfaces of the other elements, said elastic elements being adapted to return to their original form and position with respect to the other elements when the pressure is removed.

6. In apparatus for making bonded fiber webs the combination of a pair of pressure rolls each having a pressing surface, said pressing surface comprising interspaced elements of two kinds, the elements of the first kind being elastic and deformable radially of the roll and having their outer surfaces normally disposed substantially in a cylindrical surface, the elements of the second kind being substantially incompressible radially of the roll and having their outer surfaces normally disposed substantially in the surface of a coaxial cylinder whose diameter is approximately equal to, but different from the diameter of the cylinder of the first elements, and means for rotating the rolls and means for urging the rolls toward each other to displace a portion of the outer surface of each elastic element radially of the roll into substantial alignment with the outer surfaces of the other elements, said elastic elements being adapted to return to their original form and position with respect to the other elements as the surfaces of the rolls separate in turning.

7. In apparatus for making bonded fiber webs the combination of a pressure roll having a pressing surface, said pressing surface comprising interspaced elements of two kinds, the elements of the first kind being elastic and of relatively high compressibility radially of the roll and having their outer surfaces normally disposed substantially in a cylindrical surface, the elements of the second kind being of relatively low compressibility radially of the roll and having their outer surfaces normally disposed substantially in the surface of a coaxial cylinder whose diameter is approximately equal to, but different from the diameter of the cylinder of the first elements, and means for exerting pressure radially of the roll to displace a portion of the outer surface of each elastic element radially of the roll into substantial alignment with the outer surfaces of the other elements, said elastic elements being adapted to return to their original form and position with respect to the other elements when the pressure is removed.

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8. In apparatus for making bonded fiber webs the combination of a pressure roll having an elastic compressible outer layer, said outer layer having an operative pressing surface comprising interspaced elements of two kinds, the elements of the first kind being elastic and deformable radially of the roll and having their outer surfaces normally disposed substantially in a cylindrical surface, the elements of the second being flexible and substantially incompressible radially of the roll and having their outer surfaces normally disposed in a cylinder whose diameter is approximately equal to but different from the diameter of the cylinder of the first elements and means for exerting pressure to flatten a sector of the compressible outer layer of the roll, the elastic elements being adapted substantially to form a plane with the other elements under the influence of such pressure and to return to their original form and positions with respect to the other elements when the pressure is removed.

9. In apparatus for forming bonded fiber webs, a pressure roll having an elastic compressible outer layer, the outer layer having an operative pressing surface including both a plurality of spaced rings of flexible incompressible material and elastic rings of compressible material interposed between the incompressible rings.

10. In apparatus for forming bonded fiber webs, a pressure roll having an elastic compressible outer layer, the outer layer having an operative pressing surface including both a plurality of spaced rings of flexible incompressible material and elastic rings of compressible material interposed between the incompressible rings, the incompressible rings being under substantially uniform circumferential tension and compressing the material of the elastic outer layer beneath the rings.

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11. In apparatus for forming bonded fiber webs a pressure roll having an elastic, compressible outer layer, said layer having an outer pressing surface, formed by the combination of a radially compressible elastic helical land projecting from the body of the roll and a substantially incompressible flexible filament wound in the groove between the convolutions of the land, the filament substantially filling the width of the groove.

12. In apparatus for forming bonded fiber webs a pressure roll having an elastic, compressible outer layer, said layer having an outer pressing surface, formed by the combination of a radially compressible elastic helical land projecting from the body of the roll and a substantially incompressible flexible filament wound in the groove between the convolutions of the land, the filament substantially filling the width of the groove and substantially but not completely filling the depth of the groove.

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