Aug. 3, 1954 W. A. STARKEY ET AL 2,685,536

METHOD FOR ELECTROSTATICALLY COATING ARTICLES

Filed Sept. 29, 1944

2 Sheets-Sheet 1

FIG. 1

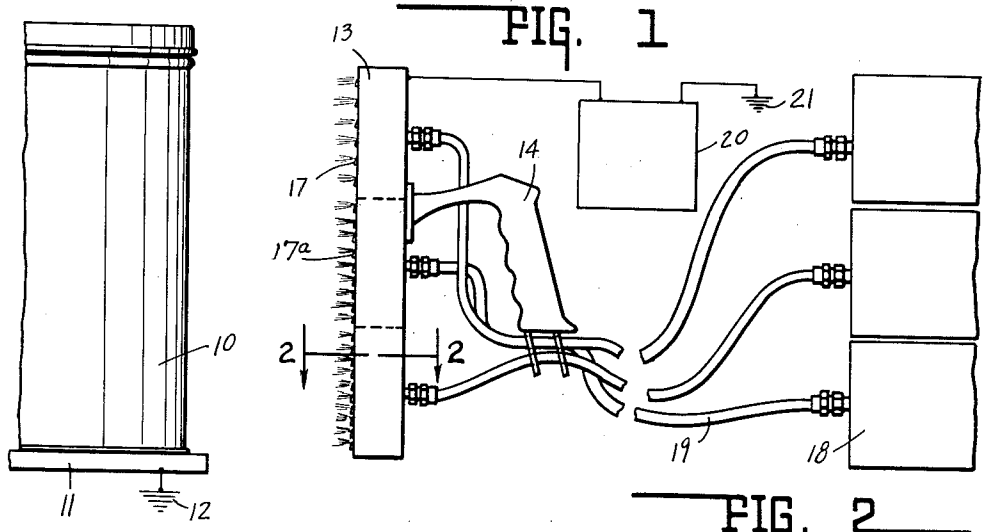


FIG. 2

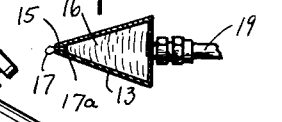


FIG. 3

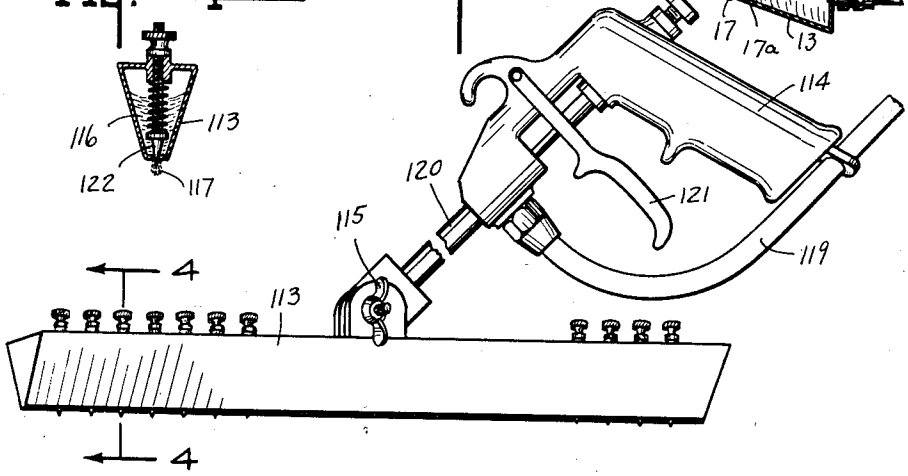


FIG. 4

FIG. 5

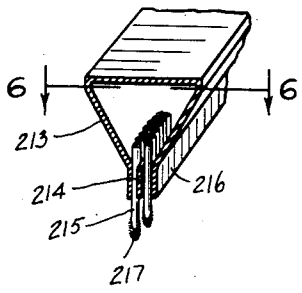
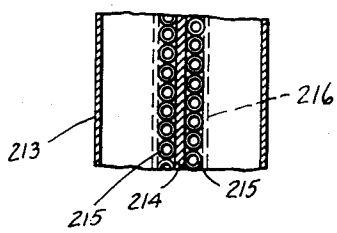


FIG. 6



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2 Sheets-Sheet 2

FIG. 7

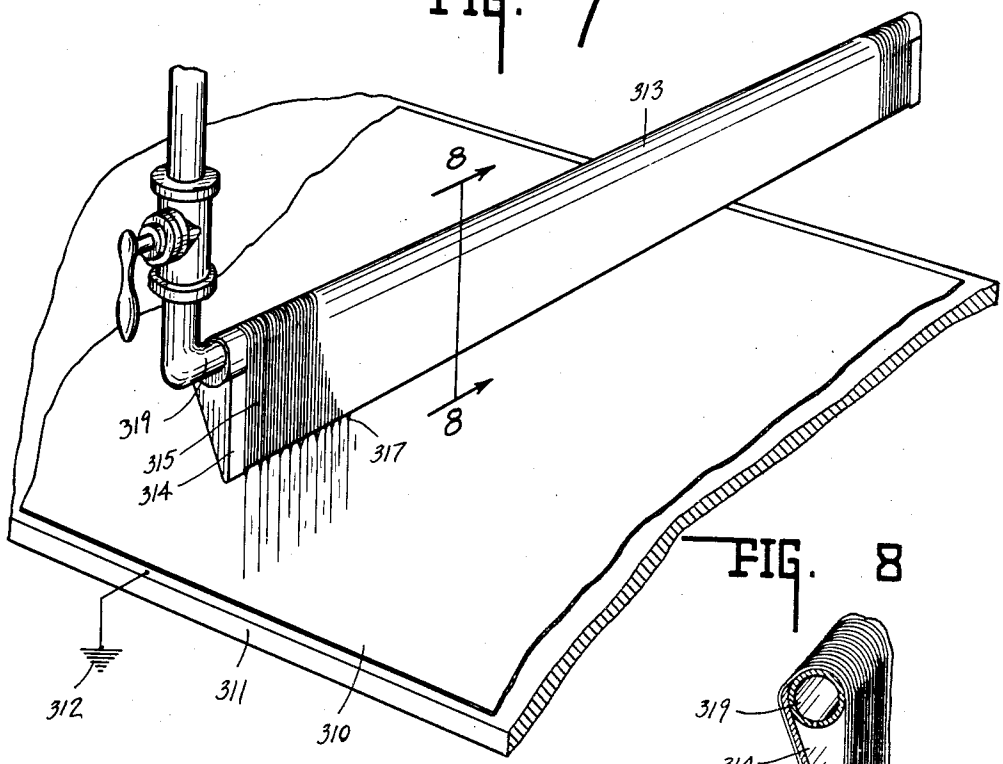
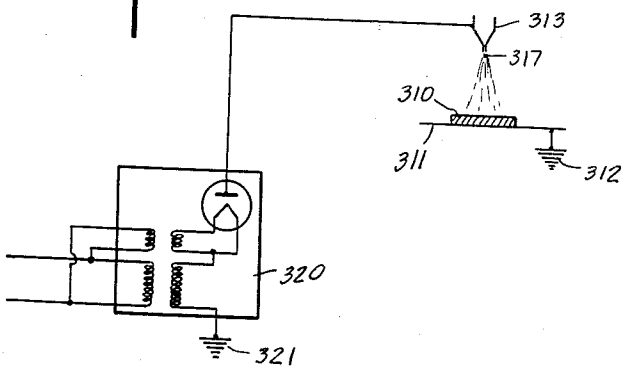


FIG. 8

FIG. 9



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METHOD FOR ELECTROSTATICALLY COATING ARTICLES

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Application September 29, 1944, Serial No. 556,390

11 Claims. (Cl. 117—93)

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This invention relates to a method and apparatus for electrostatically coating articles with a liquid coating material, such as paint, lacquer, ink, wax and the like. Such articles to be coated may be of either conducting or non-conducting material, may be structural in character or comprise fabric or paper sheets.

In respect to the method of electrostatically coating articles by discharging a spray of coating material from an air operated or air atomizing spray gun reference may be made to such prior patents as Pugh, No. 1,855,859, issued April 26, 1932, for "Method and Apparatus for Coating Articles," and Ransburg and Green, Nos. 2,247,963 and 2,334,648, issued July 1, 1941, and November 16, 1943, for "Apparatus for Spray Coating Articles" and "Method of Spray Coating Articles," respectively.

However, in the use of spray guns or the like many disadvantages develop in that the air operated spray gun is limited to a comparatively small field of dispersion, but more important it causes the coating material to be discharged in non-uniform sized particles, and in variable patterns. Thus, there is an uneven dispersion of the coating particles over the surface to be coated due to the inertia generated in the discharge, causing the larger particles to travel further in the field than the more finely divided particles. In some arrangements, depending upon the direction of the discharge, a variable pattern of spray is created and reproduced on the surface to be coated, the heavier coating particles being caused to impinge over one area and the more finely divided particles over another area. By reason of such variance, it has been found necessary in practice under certain conditions of coating to arrange a sizeable battery of spray guns with particular regard to their variable patterns of coating application so that the several guns complement each other to even out the pattern as a battery.

It is the purpose of this invention to meet this problem of coating articles in an electrostatic field by eliminating the use of such spray guns and employ in place thereof a new method and apparatus for supplying the coating material for electrostatic precipitation upon the surface to be coated. This is accomplished by providing in the field a series or plurality of small inert droplets of coating material and establishing such electrostatic force in the field as to develop and transmit finely divided particles of coating material from said droplets to the surface of the article to be coated. In describing as "inert"

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the drops or droplets from which atomization takes place, it is our purpose to indicate that during the coating process each drop is supported on the head as above described, and that while the drop may be continuously giving off liquid for atomization, replacement enables its identity as a supported body of liquid to be maintained.

Such method and apparatus has several important advantages over the spray gun arrangements heretofore employed. The coating material may be introduced into the electrostatic field by an applicator head having a series of orifices through which the material may ooze in the form of inert droplets. Such applicator head may be substantially coextensive with the surface to be coated and thereby take the place of a battery of spray guns as heretofore employed. The droplets will be developed into finely divided particles by the electrostatic force so that all particles will be transmitted or precipitated upon the surface to be coated uniformly over the entire surface.

A feature of the invention, as above described, resides in the applicator head including formation of the discharge orifices therein and the control of the rate of discharge of the material to form the inert droplets at approximately the rate of their electrostatic discharge. Thus, depending upon the viscosity and other characteristics of the material, the control of the applicator head will be such as to permit discharge of just the right quantity and size of the droplets to effect the greatest efficiency in coating a surface.

The full nature of the invention will be understood from the accompanying drawings and the following description and claims:

Fig. 1 is a diagrammatical illustration showing one arrangement of applicator in respect to the article to be coated. Fig. 2 is a section taken on the line 2—2 of Fig. 1. Fig. 3 is a perspective view of a modified form of applicator with a control handle associated therewith. Fig. 4 is a section taken on the line 4—4 of Fig. 3. Fig. 5 is a perspective sectional view showing a portion of a further modification of the applicator head. Fig. 6 is the same as Fig. 5, taken on the line 6—6 thereof. Fig. 7 is a perspective view of a further modification of the applicator head in association with the surface to be coated. Fig. 8 is a section taken on the line 8—8 of Fig. 7. Fig. 9 is a diagrammatical illustration of the circuit and one of the arrangements of the applicator head relative to the article to be coated.

The invention is illustrated by one modification

thereof in Figs. 1 and 2 wherein there is shown an article 10 to be coated mounted or carried upon a suitable support or conveyor 11 which is grounded at 12. An applicator head 13 is provided which is preferably substantially co-extensive with the surface to be coated. Said applicator head may be fixedly or adjustably mounted on a suitable support, or hand manipulated by a handle 14. The applicator head, as indicated in Fig. 2, is V-shape in cross section and along its reduced discharge edge 17a it is provided with a series of orifices 15 through which the coating material indicated at 16 may be oozed out in the form of droplets 17. The applicator head may be connected with a source of supply of coating material by a flexible tube, there being herein illustrated three compartments in the head, each connected with an individual source of supply 18 by a tube 19. The discharge edge 17a has an extent many times the maximum cross-sectional dimension of the passageways provided by the tubes 19. Sufficient pressure will be created in the containers forming the source of supply 18 for maintaining the material 16 in the head under just the proper pressure to cause the droplets to ooze therefrom as they are dispersed by the applied electrostatic force.

As illustrated, the applicator head is connected to a source of high voltage indicated at 20 through one terminal thereof, the other terminal of said source being grounded at 21 and through ground connected with an article 10 to be coated. Accordingly, the space or field between the applicator head and articel 10 is electrostatically charged by reason of the article being grounded and the applicator head being at high potential. The effect thereof is to cause an electrical force to act on the droplets 17, causing them to be broken up into finely divided or minute particles of coating material, such as to be attracted to the grounded article for deposition thereon. Thus, the grounded article may be referred to as a collecting electrode of one potential with the applicator head serving as a discharge electrode of a different potential. It is found that the electrostatic force set up in the field between the electrodes is such as to develop and transmit finely divided particles of the droplets 17 from one electrode to the other. In this connection it will be noted that as the droplets are caused to slowly ooze from the applicator head they are inactive or inert, but subject to being broken up into finely divided particles and distributed over the surface of the opposed electrode. The same action will take place wherein the applicator head may be grounded and the article directly connected with the source of high voltage and thus be charged at a high potential.

Another modification is illustrated in Figs. 3 and 4, wherein the applicator head 113 is adjustably supported by the handle 114 through a pivotal connection secured by thumb nut 115. The hose 119 leading from a source of coating material maintained under pressure, is connected with a valve operated conduit 120 controlled by the finger operated valve 121. Also, the droplets of coating material 117 may be controlled, depending upon the viscosity of the material indicated at 116 by a needle adjustment 122, which needle adjustably controls the orifice through which the material 116 is forced to provide the desired inert droplets.

Figs. 5 and 6 show a further modification of the applicator head indicated at 213. In this head the orifices through which the coating material flows are provided by a plate 214 clamped

between opposed rows of needles 215. The needles are cylindrical so that the material will be caused to flow between them, the plate 214 and the clamping walls 216 so as to come out in the form of an inert droplet 217 of coating material.

In the modification of Figs. 7 and 8 there is illustrated a grounded surface 310 to be coated. This may be a continuously moving sheet of paper or any other article, it being understood that wherein such article or material is non-conducting, it is carried by and on a support or conveyor 311 of grounded conducting material. In this arrangement the applicator head 313 is supported across and above the surface to be coated, and coating material is fed thereto through the valve controlled pipe 314 leading from the source of such material. Said pipe extends through the head, having a series of orifices or openings therein through which the material may drip by gravity. Mounted on and connected to a source of high voltage through the pipe 319, there is a supporting shield 319 extending downwardly and terminating below the pipe to provide a frame for a wire wrapping 315. The coating material accumulates from the drippings into a pocket formed by the wire wrappings, as indicated at 316. The wire wrappings are slightly or sufficiently spaced to permit the coating material to slowly ooze or drip therebetween from the accumulation in the pocket indicated at 316 to form the droplets 317. In this instance the discharge or oozing of the material from the applicator head is aided by gravity, the droplets being thereupon broken up or developed into finely divided particles by the electrostatic force developed between the applicator head and the surface to be coated. Such finely divided particles will thereupon be dispersed by the electrostatic force over said surface and be applied to said surface. The applicator head can be grounded and the work maintained at high potential with equally efficient results.

By way of example, the arrangement of the overhead applicator of Fig. 7 is shown diagrammatically in Fig. 9, wherein the source of high voltage indicated at 320 has one terminal grounded at 321 and the other terminal connected with the applicator head 313 which is thereby maintained at high potential relative to the support or conveyor 311, which is connected with ground at 312.

As above pointed out, it is immaterial as to whether the article or the applicator head comprises the grounded electrode, since the electrostatic force set up therebetween will have the same effect on the droplets of coating material. Also, it is immaterial as to whether or not the article to be coated is of conducting or non-conducting material, and such article of non-conducting material is herein considered to be one of the electrodes wherein it is associated with or masks a grounded support of conducting material.

The invention claimed is:

1. A method of electrostatically distributing liquid as a coating on an article, comprising the steps of supporting liquid coating material in spaced relation to the surface of the article, forming a spray by electrostatically atomizing such coating material from a plurality of points so closely spaced as to form a substantially continuous extended atomizing zone, said points being distributed relative to the article surface, electrostatically dispersing the discrete coating-

material particles formed at each point of atomization, electrostatically depositing such dispersed discrete particles and while still in liquid state on the article surface to form a finished coating, and force feeding coating material to the points of atomization at a controlled substantially uniform rate to maintain thereat a supply of coating material for atomization, said atomization, dispersion and deposition all being effected in quiescent air by a single electrostatic field maintained between the supported coating material and the article surface, the distance between the article surface and the supported coating material being many times greater than the distance between adjacent ones of the points at which atomization of the coating material takes place.

2. In a method of electrostatically distributing liquid as a coating on a surface wherein liquid supplied at a controlled rate to a single-fluid atomizing head is atomized into discrete particles and such particles are dispersed to form a spray and deposited in dispersed condition while still in liquid state as a finished coating on a surface spaced a substantial distance from the head, the step of maintaining between the head and the article an electrostatic field which electrostatically effects said atomization, dispersion, and deposition.

3. A method of electrostatically distributing liquid as a coating on an article, comprising the steps of positioning a body of the liquid at an atomizing zone in spaced relation to the article, atomizing discrete particles of the liquid as a spray from said body at said zone, force feeding the body with liquid at a controlled rate to replace that so atomized, and dispersing said particles widely in at least two mutually perpendicular directions and electrostatically depositing them still so dispersed and as discrete spray-particles while still in liquid state as a finished coating on the article, the movement of the spray particles being through a quiescent atmosphere whereby the electrostatic forces effect deposition on an adjacent article surface of at least a majority of the spray particles which would have otherwise not deposited on the article surface, the distance between the article and the atomizing zone being great enough to permit said dispersion of the finely divided liquid spray particles as they proceed toward the article under the influence of electrostatic forces.

4. A method of electrostatically distributing liquid as a coating on an article, comprising the steps of supplying liquid coating material at a controlled rate to an atomizing zone located in spaced relation to the article, establishing said liquid as an electrode of an electrostatic field, atomizing finely divided discrete spray particles from the liquid at the atomizing zone, and dispersing such particles widely in at least two mutually perpendicular directions and depositing them still so dispersed and while still in liquid state as discrete spray particles on the article to form a finished coating thereon, the distance between the atomizing zone and the article being great enough to permit said dispersion of the particles as they proceed toward the article, the atmosphere in the region between the atomizing zone and the article being quiescent whereby electrostatic forces will be the predominant factor determining the paths respectively followed by the atomized particles as they move toward deposition, and moving said article relative to said atomizing zone so as to effect a substantial displacement of the article surface transverse

to the general direction of the lines of force of the field during particle deposition to cause such lines of force to sweep such article surface.

5. In a method of electrostatically distributing liquid as a coating on an article wherein liquid coating material supplied at a controlled rate to a single-fluid atomizing head is force fed to and atomized into discrete particles from a plurality of points so closely spaced as to form a substantially continuous atomizing zone and such particles are dispersed and deposited in dispersed condition and while still in liquid state on an article spaced from said atomizing zone, the step of maintaining between the head and the article an electrostatic field capable of electrostatically effecting atomization, dispersion, and deposition of the coating material, the distance between the head and article being equal to at least several times the distance between adjacent ones of the points at which said atomization occurs.

6. A method of electrostatically distributing liquid as a coating on an article, comprising the steps of supplying liquid at a controlled rate, forming the liquid into an extended film and causing the film to flow toward an atomizing zone, atomizing finely divided, discrete particles of liquid at a plurality of closely spaced aligned points at said atomizing zone, and electrostatically dispersing such particles and depositing them on the article as a spray while still in liquid state, the distance between the atomizing zone and the article being materially greater than the film will bridge and great enough to permit the dispersion of the particles as they proceed toward the article under the influence of electrostatic forces.

7. The method of electrostatically distributing liquid as a coating on an article, comprising the steps of supporting a body of liquid coating material in the form of a film having an exposed surface, the terminus of said film being spaced from said article, establishing between said article and the terminus of the film an electrostatic field of such strength as both to be capable of electrostatically atomizing finely-divided, discrete liquid spray particles from said terminus of the film and of electrostatically dispersing such particles and depositing them still as discrete spray particles and while still in liquid state upon the surface of said article to form a finished coating on the same, and continuously and at a controlled rate replenishing in said body the coating material atomized therefrom for deposition by the action of the electrostatic field, the gap between the said terminus of the film and the article being wide enough both to insure that it will not be bridged by the supported liquid coating material and to permit the atomized particles, before being deposited, to be dispersed and distributed over a substantial area.

8. The method of electrostatically distributing liquid as a coating on an article, comprising the steps of positioning a body of liquid coating material in opposed spaced relation to the article, said body having an exposed surface, causing said body to flow forwardly, establishing between the article and the liquid body an electrostatic field of sufficient strength both to electrostatically atomize finely divided, discrete liquid spray particles from a plurality of aligned points so closely spaced as to provide a substantially continuous extended atomizing zone along the terminus of the exposed surface nearest the article and to electrostatically disperse said particles

and to deposit them on the article still in the form of discrete spray particles while still in liquid state, and continuously and at a controlled substantially uniform rate adding additional liquid coating material to said body at a point spaced rearwardly from said terminus to maintain said flow, said terminus and the article being spaced apart by a distance great enough to permit the atomized spray particles, before being deposited, to be dispersed and distributed as discrete spray particles over a substantial area.

9. The method of electrostatically distributing liquid coating material as a coating on an article, comprising the steps of causing the liquid to flow in a continuous stream and at a positively regulated rate to a point of atomization where such stream has an exposed surface, positioning the point of atomization opposite to and spaced from the article to be coated, establishing between the article and the exposed surface of the stream an electrostatic field, and with the aid of said field atomizing discrete particles from said exposed surface, dispersing such discrete particles, moving them through quiescent air and depositing them as a liquid spray on an adjacent article surface to form a finished coating thereon, the distance between the point of atomization and the article being greater than the stream will bridge and great enough that the deposited particles will be distributed over an area having each of its dimensions many times greater than the minimum cross-sectional dimension of the stream at the point of atomization.

10. The method of electrostatically distributing liquid as a coating on an article, comprising the steps of moving the article past and in spaced relation to a zone of atomization, feeding liquid coating material in a relatively narrow stream, spreading said stream to form it into a body of liquid coating material having an extent many times the maximum cross-sectional dimension of said stream, maintaining at such zone of atomization the body of liquid coating material with said body having a plurality of closely spaced aligned exposed termini of relatively small area, establishing between the exposed termini of the coating material and the article moving past it an electrostatic field of sufficient strength that it both electrostatically atomizes small particles of coating material from such exposed termini and electrostatically deposits them still in the form of discrete spray particles while still in liquid state for distribution into a continuous finished coating upon the article as it moves past the zone of atomization, and continuously and at a controlled rate maintaining said stream to supply coating material to said body to replace the coating material atomized therefrom by the action of the electrostatic field, said atomization and deposition both being effected in quiescent air, the direction of movement of said article relative to said body of coating material being such as to effect a substantial displacement of the article surface transverse to the general direction of the lines of force of the field during particle deposition to cause such lines of force to sweep such article surface, the spacing of said body of coating material from the article being great enough that the atomized particles will disperse under the action of the field as they move toward the article until they are distributed over and deposited onto a portion of the article surface having an area many times the area of the exposed termini.

11. A method of electrostatically depositing liquid as a coating on an article, comprising the steps of supplying liquid as a film to an extended atomizing zone in spaced relation to the article, atomizing discrete particles of the liquid as a spray from said zone, force feeding the zone with liquid at a controlled rate to replace that so atomized, dispersing said particles widely transversely and longitudinally of the extent of the atomizing zone, and creating an electrostatic charge differential between the particles and the article of a strength to move the particles toward the article sufficiently rapidly to deposit them thereon while still in liquid state and while still so dispersed, the movement of the spray particles being through a quiescent atmosphere whereby the electrostatic forces effect deposition on an adjacent article surface of spray particles which would have otherwise not deposited on the article surface, the distance between the article and the atomizing zone being great enough to permit said dispersion of the finely divided liquid spray particles as they proceed toward the article under the influence of electrostatic forces.

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