METHOD OF ANODIZING SLIDE FASTENERS

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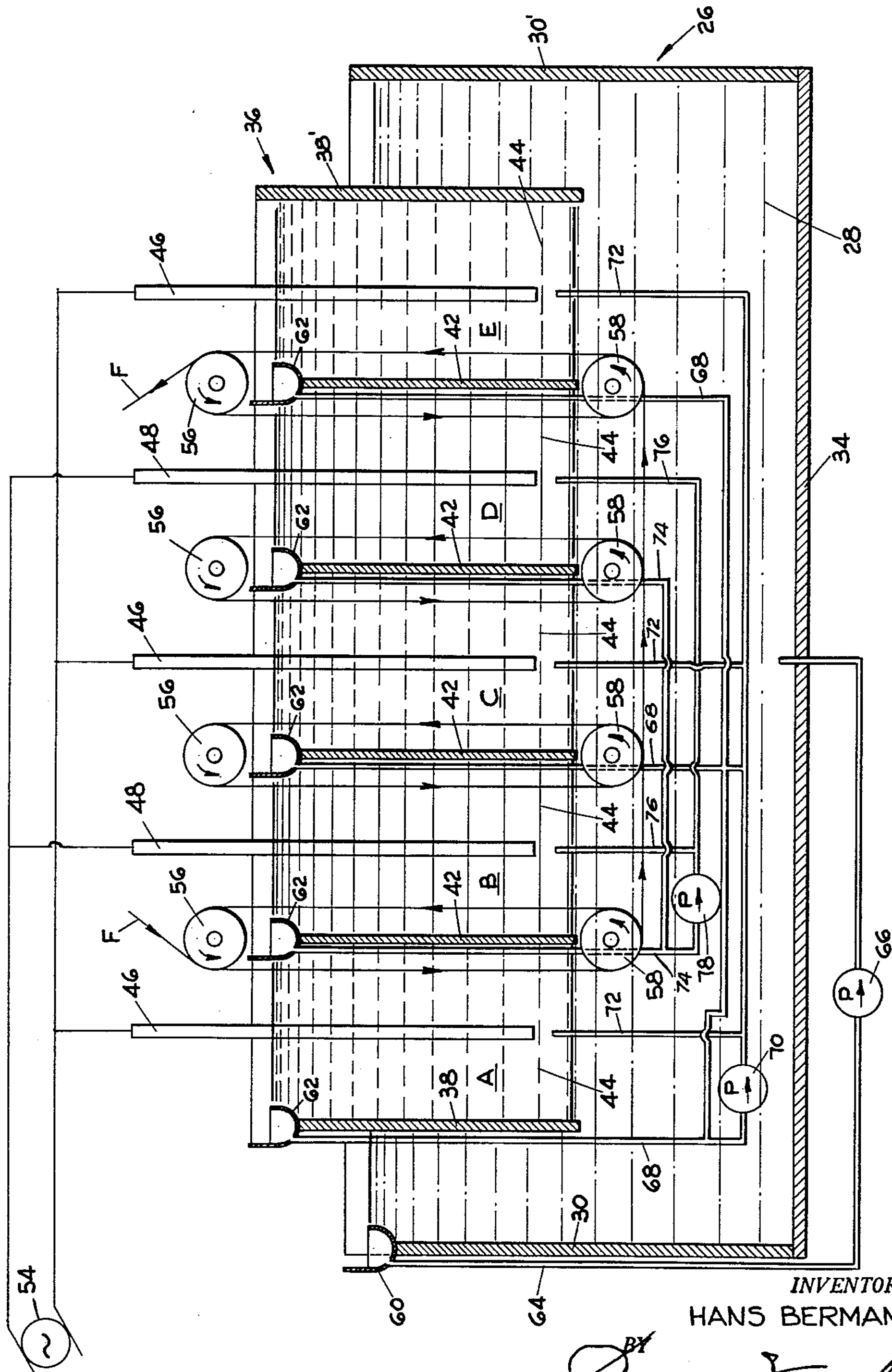

FIG. 1

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Oct. 31, 1961 H. BERMAN 3,006,820

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Filed Aug. 21, 1956 2 Sheets-Sheet 2

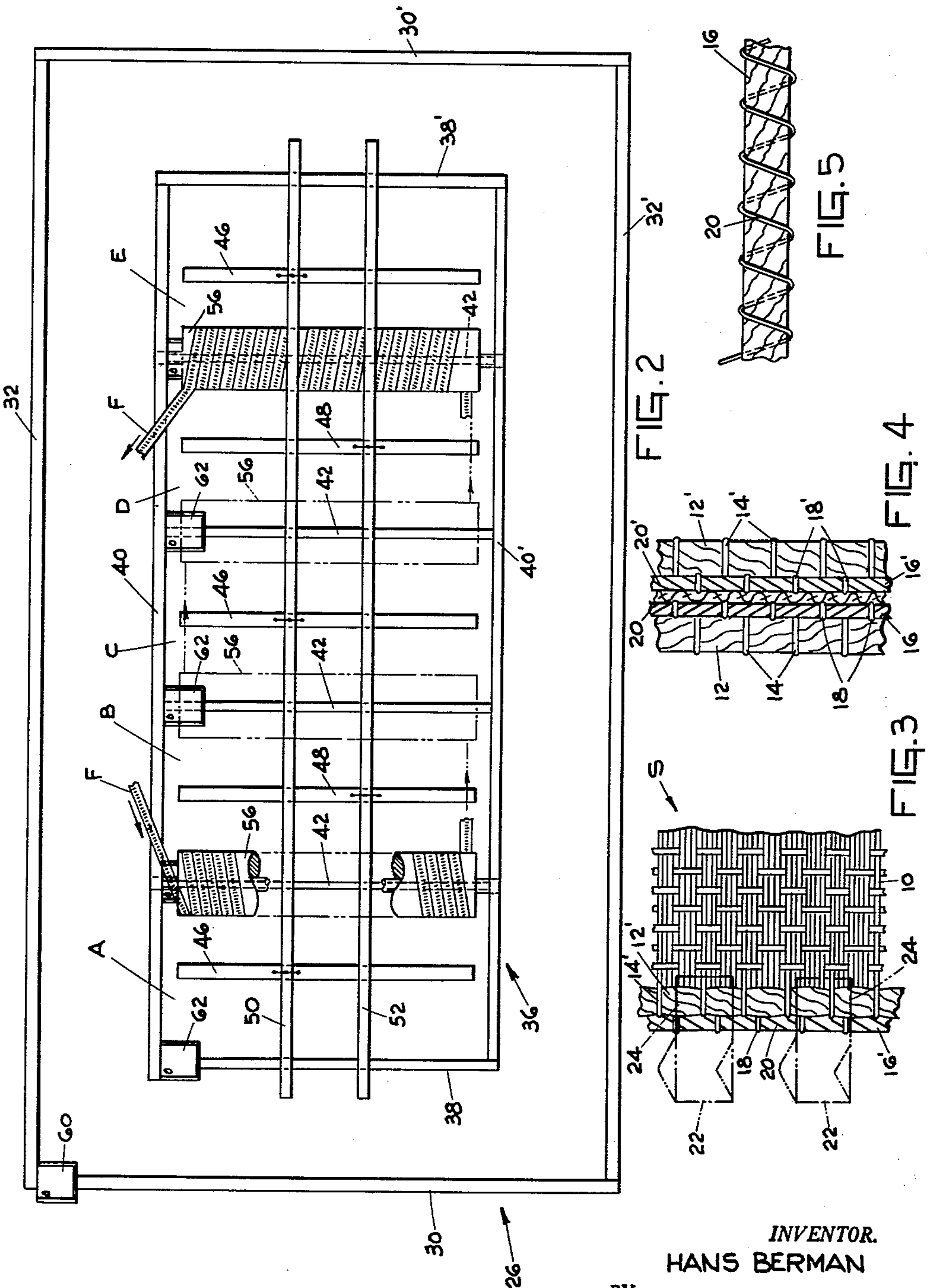

FIG. 2 FIG. 3 FIG. 4 FIG. 5

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METHOD OF ANODIZING SLIDE FASTENERS

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The invention relates generally to the art of anodizing metal elements of slide fasteners and, more particularly, to the anodizing of aluminum elements of slide fasteners.

Slide fasteners are used to a great extent in garments, and it is desired that the color of the metal elements as well as the tape harmonize with, or possess the same color as, the color of the garment. It is well-known that an anodically produced oxide film on aluminum and its alloys may be dyed in a great variety of colors, and that an anodic film properly formed on the fastener elements additionally would provide excellent resistance to the mechanical and chemical abuses normally encountered in slide fastener usage.

One of the methods of slide fastener manufacture in wide commercial usage does not permit anodizing the wire or strip of aluminum from which the fastener elements are made prior to forming and securing the elements to the tape. The fastener elements are punched from the aluminum strip in a manner so that the most visible parts of the elements would present bare or unanodized surfaces. Thus, the anodic treatment of the fastener elements made in accordance with this well-known method must be accomplished after the elements have been formed and clamped in spaced relation onto the electrically insulating textile tape.

A number of proposals have been made for making anodizing current available to fastener elements secured in spaced relation to the tapes of slide fasteners. Intricate strip shapes have been devised to furnish metal continuity between the fastener elements after their assembly with the tape. Such methods, however, have complicated slide fastener manufacturing procedures, requiring added operations, including the removal of the temporary connecting metal parts. The temporary connecting parts must be discarded, and with the added operations involved, the product is very expensive to manufacture. Moreover, the points where the temporary connecting metal parts are severed or broken away from the fastener elements leave small unanodized areas on the elements.

A variety of current-carrying metal contact members, such as combs, springs, foil, drums, etc. have been suggested for supplying anodizing current to the individual, insulatedly spaced fastener elements. This approach to the problem has not been commercially successful, because it is difficult to obtain uniform pressure at the many points of contact between a current-carrying metal contact member and each fastener elements. As a result, differences in resistance occur at the points of contact so that the anodic film is not uniformly formed. Upon dyeing, the color possesses a nonuniform appearance. Also, unlike a plated metal deposit, an anodic film is insulating in character so that contact is needed throughout the anodizing cycle, it being apparent that such contact leaves marks on the finished product. Thus where contact is made with each fastener element by the metal current-carrying contact member unattractive spots are produced marring the appearance of the finished product. Further, if only one element in a fastener length is not contacted, a "skip" results, and the fastener is rendered unsaleable.

The use of metal current-carrying contact members

possesses other limitations. It is customary and usually necessary to make said current carrying contact members of aluminum alloys. An aluminum oxide coating is formed on the contact member as rapidly as it is formed on the fastener elements. The electrically insulating oxide coating formed on the contact member does not permit repeated use of the contact member, unless the coating is stripped therefrom. Stripping causes design problems. A high degree of dimensional accuracy is required to provide direct and proper physical contact between the contact member and the fastener elements. Stripping the anodic coating from the surface of the contact member results in a dimensional loss corresponding to the thickness of metal transformed into oxide by anodizing, wherefore the useful life of any aluminum contact member is relatively short. Furthermore, stripping is an added operation, and adds to the expense of manufacturing the product.

In order to eliminate "skips," it has been proposed to supplement the current-carrying function of a metal contact member by incorporating a longitudinally extending electrical conductor in the edge of the tape to interconnect the individual fastener elements. Such conductor must be in the form of a very thin, flexible filament, thread or tinsel in order not to unduly impair the flexibility of the slide fastener. Although complete unanodized elements, or "skips," may be eliminated by the supplementary interconnecting electrical conductor, the disadvantages hereinbefore described in connection with the use of metal contact members are still present.

The primary object of the invention is to provide a method of continuously anodizing the aluminum elements of slide fasteners at a uniform quality level so that the manufacture of the product is qualitatively and economically desirable.

Another object of the invention is to provide a method for anodizing the fastener elements of slide fasteners in a manner which will provide a uniformly formed anodic film or oxide coating on the elements, there being no sign or spots on the elements as a result of having been contacted by a current-carrying member.

A further object of the invention is to provide a method of continuously anodizing the metal elements of slide fasteners at a rate of speed hitherto unattained in the art, which rate of speed is inherently practically limitless.

These, and other objects, advantages and results of the invention will be apparent from the following detailed description, taken in conjunction with the drawings, in which:

FIG. 1 is a diagrammatic side elevation, partly in section, of a preferred form of apparatus for carrying out the method of anodizing the fastener elements of slide fasteners in accordance with the invention;

FIG. 2 is a diagrammatic top plan view of the apparatus shown in FIG. 1, the liquids used being omitted for clarity in illustration;

FIG. 3 is a fragmentary elevational view of a tape, with the fastener elements clamped to the edge thereof shown in phantom, which preferably is used in carrying out the method of the invention;

FIG. 4 is an enlarged end view of the edge of the tape shown in FIG. 3; and

FIG. 5 is an enlarged side elevation of one of the warps used in the edge of the tape shown in FIG. 3, the warp being provided with conducting means to electrically interconnect the fastener elements along the length of a stringer.

Generally, the invention resides in electrically interconnecting, by a thin, flexible conductor extending longitudinally of the tape, the otherwise insulatedly spaced fastener elements secured to the edge of the usual nonconducting tape. A continuous or long length of stringer, or pair of meshed stringers, thus formed is passed continuously through at least a pair of tanks or compartments, each compartment containing an electrolyte and an electrode. The electrodes are connected to a suitable source of current and the electrolytes are insulated from each other. There is no physical contact between the stringer or stringers and an electrode. Where alternating current is used, the electrolyte in each tank comprises a suitable anodizing solution. If direct current is used, the electrolyte in the tank containing the electrode of negative polarity comprises an anodizing solution, and the electrolyte in the tank containing the electrode of positive polarity may be any suitable current-conducting liquid.

The anodizing current is supplied to the fastener elements by a circuit which extends from one electrode through the electrolyte in which a segment of the moving stringer is located, to the fastener elements on such segment, through the longitudinally extending interconnecting electrical conductor in the portion of the moving stringer located in an insulating bridge path between the electrolytes, to the fastener elements in the segment of the moving stringer in the second electrolyte, through the second electrolyte, to the second electrode, and back to the source of current. The stringer itself, in its passage through and between the electrolytes, serves as the means for completing the electrical circuit, thereby permitting anodizing current to be supplied to the fastener elements without the elements being in physical engagement or contact with a metal current-carrying contact member at any time. In this manner, the problems inherent in the use of a current-carrying member to supply anodizing current to the individual fastener elements, as hereinbefore described, are eliminated.

The conductor which electrically interconnects the fastener elements must possess a small cross-sectional area in order not to appreciably impair the flexibility of the stringer or materially stiffen the finished product. The stringer in passing from one compartment to the other moves over an insulating bridge path between the conductive but mutually insulated electrolytes. With a conductor of such small cross-sectional area, the portion of the same located in the insulating bridge path is subject to overheating, coupled with the corrosive effects upon the conductor of acid carried over from the anodizing solution, which acid is heated by the current-carrying conductor. However, by moving the stringer at a speed so that the time interval of movement of the same over said bridge path is not greater than the time within which the conductor in its movement over said bridge path could overheat, corrode, and burn out, interruption of the circuit is prevented and a successful continuous process is achieved. Furthermore, with the time of transit of the moving stringer over said bridge path being kept to a small interval, the small area conductor is able to carry a substantial amount of current. In fact, increasing the rate of movement of the stringer through the tanks or compartments increases the capacity of the conductor to carry current, thereby increasing the efficiency of the operation by both factors.

A slide fastener stringer may be provided with a longitudinally extending conductor electrically interconnecting the fastener elements in any suitable manner. It is preferred, however, to use a stringer as shown in FIGS. 3 to 5. As there illustrated, the stringer S comprises a woven tape **10** having a pair of warp cords **12, 12'** at the edge thereof woven as an integral part of the tape. The cords, of opposite twist, are held in position at the edge and on opposite sides of the tape by the spaced filling or weft threads **14, 14'**. Forward of the cords **12, 12'** and at the extreme front edge of the tape, a pair of warp cords **16, 16'** are provided. These cords, which are of a lesser number of plies than the cords **12, 12'** and therefore of smaller size, are held in position by weft threads **18, 18'**. The cords **16, 16'** are each helically wound with thin conductors **20, 20'** of metal tinsel, preferably aluminum. When fastener elements **22** are clamped to the corded edge of the tape, excellent contact between each element and the fine conductors is obtained, because the conductors are located in the crotch between the leg portions **24** which secure the element to the tape and the elements are pressed against the conductors. The tape may be woven with warps and wefts of cotton, nylon or any other suitable fiber. It is preferred that the cords **16** be made of nylon. The comparative elasticity of nylon, and its other desirable characteristics provide a support for the thin aluminum tinsel which inhibits breakage of the tinsel.

FIG. 1 and 2 illustrate a preferred form of apparatus for carrying out the process of the invention. Also, in the embodiment shown, a pair of meshed stringers F, or chain as it is called, is processed by the apparatus. It will be understood, however, that a single continuous or endless stringer may also be treated. The chain may be gapped or continuous. The apparatus comprises a tank **26** containing a heavy insulating or electrically non-conducting liquid **28**, such as carbon tetrachloride, trichloroethylene or perchloroethylene. The tank has side walls **30, 30'** connected to the longitudinally extending walls **32, 32'** and a bottom wall **34**. A bottomless tank **36** having laterally extending side walls **38, 38'** and longitudinally extending walls **40, 40'** is suspended from a suitable structure (not shown) and mounted to be lowered into and raised from the larger tank **26**. Such mounting of the tank **36** permits threading of the chain F outside the tank **26**, and the relative positioning of the tanks with respect to each other in a vertical direction. The bottomless tank **36** is divided into a series of compartments or sub-tanks, designated A, B, C, D and E, the sub-tanks being formed by the partitions **42** which extend between the longitudinally extending side walls **40** and **40'**. The compartments are sealed off from each other, and each contains a suitable anodizing solution **44**, such as sulphuric acid, oxalic acid or sulfamic acid. A 15% sulphuric acid solution is preferred. Each compartment is provided with an electrode disposed in the anodizing solution, a pair of electrodes **46** and **48** in adjacent compartments being suspended from the rods **50** and **52**, respectively, as shown in FIG. 2, which are connected to the opposite sides of a suitable source of alternating current **54**, as shown in FIG. 1.

A short distance above the top edge of each partition **42**, a roll **56** having a length slightly less than the width of the tank **36** is rotatably mounted, and just beneath the lower edge of the partition a second roll **58** is rotatably mounted. The rolls are formed of electrically non-conducting material, or at least the surfaces thereof are so formed, and they are journaled in bearings, formed in the walls **40** and **40'**. As shown, the periphery of the roll **56** is spaced but a short distance above the level of the anodizing solution, and the periphery of the lower roll **58** is spaced a short distance below the lower level of the anodizing solution. With rolls of comparatively small diameter, the distance that the chain F must travel from one compartment to the other and thus over the intervening or bridging insulating path is thereby kept short. In this manner the heating of the fine aluminum tinsel as the chain F passes over this bridge path is kept to a minimum. The insulating liquid surrounding the bottom roll in the bottom bridge path dissipates heat. Four (4) pairs or banks of rolls **56, 58**, one bank for each adjoining pair of compartments of the five compartments, A, B, C, D and E, are provided. The top rolls **56** and bottom rolls **58** are connected to a suitable source of power (not shown) for their rotation in the direction indicated by the arrows.

The level of the insulating liquid **28** is maintained above the lower ends of the partitions **42** and the end walls **38, 38'** so that the anodizing solutions **44** in the bottomless compartments are insulated from each other, thereby preventing the current from by-passing the fastener elements. This is accomplished by the relative positioning of an overflow catch **60** for the insulating liquid and overflow catches **62** for the anodizing solutions. For example, if the anodizing solution is a 15% sulphuric acid solution and the insulating liquid is carbon tetrachloride, with their known specific gravities of 1.102 and 1.595, respectively, for each twelve (12) inch height of compartment, the overflow for the carbon tetrachloride will be located below the overflow point of the anodizing solution by an amount of approximately 3.7 inches. This difference in level is obtained by multiplying the number of inches of compartment height by a factor of

$$1-\frac{1.102}{1.595}$$

As shown, the continuous length of chain F, formed of a pair of meshed stringers S, is led over the roll **56** of the first bank or rolls, into the compartment A, down over the roll **58**, through compartment B and back over the roll **56**. The chain is moved in a helical path around each pair of top and bottom rolls **56, 58**, in and out of the adjacent compartments A and B, and then is led over to the second bank of rolls, in and out of the adjacent compartments B and C, and so on, until the chain emerges from the tank **36** after passing a number of times through the last pair of compartments, D and E.

In the specific embodiment shown, the current flows from the electrode **46** in compartment A, through the anodizing solution in the compartment, to the fastener elements on the segment of moving chain in the compartment, through the electrically interconnecting aluminum tinsel threads **20** along the short portions of chain in the top insulating bridge path, namely the air between the top levels of the anodizing solutions in compartments A and B as well as in the insulating liquid between the lower levels of the anodizing solutions in the compartments, to the fastener elements in the segment of chain in compartment B, through the anodizing solution in this compartment, to the electrode **48** and back to the source of current. This same circuit obtains for supplying anodizing current to the fastener elements of the moving chain in each pair of adjacent compartments B, C and C, D and D, E until the chain emerges from the tank. With alternating current, as shown, anodizing of the fastener elements on the moving chain occurs in each compartment, hydrogen being evolved during a portion of each cycle of the current source.

The textile tapes of the stringers, in moving from one compartment to the other, through the air at the top and through the electrically insulating liquid at the bottom, carry with them a small amount of anodizing solution tending to unbalance the system. Proper and constant levels of insulating liquid and of anodizing solutions are maintained by circulating the liquids overflowing into the aforementioned catches **60** and **62**. As shown in FIG. 1, a conduit or pipe **64** having a pump **66** in the line returns the insulating liquid **28** to the tank **26**. Pipes **68** leading from the catches **62** of the compartments A, C and E have a pump **70** in the line, anodizing solution being returned to the stated compartments by the pipes **72**. The anodizing solutions from compartments B and D are returned by conduits **74** and **76**, there being a pump **78** in the line. Separate sump tanks may be provided for the circulating liquids. Also, to maintain the desired and constant temperature of the anodizing solutions in their respective compartments, the solutions are passed through heat exchangers (not shown) located in the lines. It is preferred to replace the anodizing solutions in each compartment about two to four times each minute. The insulating liquid may be replaced at a lower rate.

As previously indicated, the longitudinally extending conductors in the edge of the tape which electrically inter-connect the fastener elements of the endless stringer must be sufficiently thin and flexible so as not to interfere with the desired flexibility of the finished slide fasteners. In anodizing the elements of a number 3 size fastener, for example, and with the preferred 15% sulphuric acid anodizing solution, the total current required to suitably anodize the elements may vary from 420 amperes, at 20 to 22 volts, to 650 amperes, at 24 to 26 volts, depending on the thickness of anodic or oxide coating desired. For four (4) banks of chain loops passing through each pair of adjacent compartments, as shown, there may be 22 loops in each bank, or a total of 88 loops. The current flowing in each loop may range from 4.8 to 7.4 amperes. Each loop has two portions each approximately ten (10) inches in length in the anodizing solution of each compartment as the chain moves through a pair of compartments. The distance between electrolytes in adjacent compartments may be approximately ten (10) inches at the top and at the bottom. The same current flows through both legs of each loop. The current density is approximately 112 to 172 amps./square foot. With a conveyor speed of fifty (50) feet per minute, the total anodizing time will be thee minutes and the total anodizing current 336 to 516 amp.-mins./sq. ft. With a pair of tinsel strands in each stringer, or four strands in the pair of meshed stringers or chain F, each tinsel in the bridging portions of chain between compartments at the top, as it passes through the air, or at the bottom, as the chain passes through the insulating liquid, must carry 0.6 to 0.9 ampere. The aluminum tinsel may have a cross-section as fine as 0.0015 inch x 0.012 inch, and still provide a substantial safety factor; for with a conductor of such small size, only approximately one-half to three-fourths of its current-carrying capacity is utilized.

While the chain is passing through the anodizing solutions, the interconnecting tinsel is cooled by the electrolyte. Passage through the insulating liquid at the bottom of the compartments also dissipates heat. When the chain passes over the upper rolls and through the insulating bridge path provided by the air, the conductors will heat up. It is to avoid overheating and in the extreme to prevent burning out or fusing of the conductor, that the arrangement is made such that the time interval of the movement of the conductor over the insulating bridge path be not greater than the time within which the conductor will burn out or fuse with the anodizing currents employed. As practised, the conductor is permitted to heat up only to a normal extent. By increasing the speed of the moving chain, the interval of time without cooling is made shorter. Thus also, with increase in the rate of movement of the chain, the amount of current permissible is increased. It should be further observed that by providing multiple fastener loops of relatively short length multiple closely spaced electrical connections are made between the fastener elements and the positive pole of the source of current through the medium of the anodizing solution through which the fastener elements are moving.

It will be apparent that the invention is applicable to any fastener element size, and that the foregoing detailed description with respect to a number 3 size fastener is simply illustrative of the invention. Fasteners of smaller size, such as number 2, or fasteners of larger size, such as number 5, may similarly be anodized. Greater or less anodizing current may be required, depending on the size of the elements. With fasteners of increased size, the fastener element connecting conductors may be of larger cross-section than in the example given without appreciably impairing the flexibility of the stringers or finished fasteners.

After anodizing, the fastener chain is rinsed free of acid, and the elements are dyed with the desired color and sealed, as well-known in the art.

The combination of sulphuric acid and chlorinated solvent attacks most structural materials, particularly metals, if stray currents are involved. The tanks including the compartment walls, the rolls about which the chain is led, guides and the pipes are made of or covered with non-plasticized poly-vinyl chloride. The electrodes are of graphite, as are also the heat exchanger tubes. In the pumps for the anodizing solutions, carbon-filled furan plastic is used. Teflon is used for gaskets. For the rolls' driving mechanism and for the insulating liquid pump, a high grade of stainless steel, suitably insulated, is used.

While single phase alternating current has been specifically described, and is preferred, it is within the purview of the invention to use three-phase alternating current or direct current. If direct current is used, a compartment having the electrode of negative polarity contains an anodizing solution, the fastener elements being anodized in such compartment, whereas in the adjacent compartment, having the electrode of positive polarity, hydrogen is evolved. The electrolyte in the second compartment may be any suitable electrically conducting fluid. Also, it is not necessary to use as many compartments or tanks, as specifically described. A single pair of compartments is sufficient if a sufficient number of turns of chain are moved in and out of the compartments to furnish the desired anodizing time.

It is within the scope of the invention to use individual tanks or compartments lined up adjacent to each other, and to pass the continuous stringer or pair of meshed stringers in and out of the tanks, instead of using tanks which are open at the bottom and sealed off with insulating fluid as shown in the preferred embodiment of the invention.

From the foregoing description, it will be apparent that the invention is applicable to the treatment of fastener elements formed of any anodizable metal. To simplify the description, however, reference has been made to the most common metal used in the manufacture of slide fasteners; namely, aluminum or alloys thereof. It is not intended, however, to limit the scope of the invention by references to aluminum, since any metal suitable for fabrication into fastener elements and capable of being anodized may be used in practicing the invention.

It is believed that the novel methods of the present invention, as well as the advantages thereof will be apparent from the foregoing detailed description. Anodizing slide fasteners, which heretofore has been most difficult to accomplish on a commercial scale in a manner which would provide elements having an anodic coating of uniform character, without marks or signs of contact, can now be accomplished at a high quality level and economically. It will be apparent that while the invention has been described in a preferred form, changes may be made without departing from the spirit and scope of the invention, as sought to be defined in the following claims.

I claim:

1. A method of anodizing the fastener elements of a pair of meshed slide fastener stringers of continuous length, each stringer having the fastener elements secured in spaced relation to the edge of a tape, said elements being interconnected by an electrical conductor extending longitudinally of each tape, the conductor being sufficiently thin so that the flexibility of the stringers is not appreciably impaired, said method comprising continuously passing said stringers through a plurality of adjacent compartments each containing an electrolyte and an electrode, said compartments being open at their top and bottom ends with the electrolytes in said compartments being electrically insulated from each other by an insulating liquid extending partially into said compartments at their bottom ends and by the atmosphere at their top ends, the electrolyte in at least one of the compartments comprising an anodizing solution, a source of current connected to said electrodes, said stringers passing through the electrolytes in spaced relation with respect to said electrodes the path of movement of said stringers being from the electrolyte in one compartment, through said insulating atmosphere, into the electrolyte in an adjacent compartment, through said insulating liquid, and back into the electrolyte of said one compartment, the anodizing current being supplied to the fastener elements by a circuit extending from one electrode, through the electrolyte in which a segment of the stringers is located, to the fastener elements, through said electrical conductors interconnecting the fastener elements in a portion of the meshed stringers between electrolytes, to the fastener elements in the segment of the stringers in the electrolyte in an adjacent compartment, through the electrolyte in said adjacent compartment, and to the electrode in said compartment, the distance betwen the electrolytes being sufficiently short and the rate of movement of the stringers being sufficiently rapid so that the time for the stringers to pass between electrolytes is less than the time which will allow the interconnecting conductors to unduly overheat.

2. A method as set forth in claim 1, further including circulating the electrolytes and insulating liquid, and maintaining substantially constant levels of electrolytes and insulating liquid.

3. A method as set forth in claim 1, wherein there are at least three compartments each containing an anodizing solution, the method further including leading the meshed stringers back and forth a plurality of times between the first and second compartments and back and forth a plurality of times between the second and third compartments, the source of current being alternating.

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