FLUID DISPENSER MANIPULATION

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ABSTRACT

Described is apparatus for dispensing fluid materials such as urethane foams onto terrestrial substrates, in a precisely controlled manner with high thickness uniformity and including such sub-components as chain driven reciprocated carrier means, coupling means and accessories, and supplemental conduit suspension means.

19 Claims, 13 Drawing Figures
FLUID DISPENSER MANIPULATION

BACKGROUND OF THE INVENTION

Workers in the art of coating substrates with urethane foam or like fluid material recognize the need for apparatus which can spray-apply one or several strips of coating material onto a substrate in a precisely controlled manner. A particular problem is to accomplish this while manipulating the spraying unit at high speed; for instance, where a foam dispenser is to be swept back and forth across a substrate very rapidly; yet in a highly controlled manner so as to provide a coating which is very uniform in thickness. The present invention is intended to provide an answer to such problems being illustrated in a novel foam dispensing apparatus embodiment involving several features of novelty.

According to one such feature, a dispenser unit is reciprocated across a given path by a novel “pinned chain” drive mechanism. This mechanism comprises a pair of endless chains strung between respective sprocket pairs which in turn are journaled to a machine frame, with opposed pairs of sprockets being mounted on a common axle, the sprocket pairs threading the two chains and being reciprocatable as a unit relative to the machine frame. At least one of the common-axle sprocket pairs is adapted to be rotated so that mechanism mounted therebetween may thereby be translated along a railway, using the chain as a “treaded winch” drive means, with the foam dispenser mechanism being likewise affixed to the chain and reciprocated by it. The travel distance of the driven (dispenser) load may be adjusted according to its position of attachment on the chains; for instance, the load may be reciprocated twice as far as the sprocket cart (carriage between the sprocket shafts) when pinned to the extreme (outboard) side of the chain span; less than that when pinned elsewhere.

The foregoing pinned-chain drive will be recognized as advantageous in circumstances like those described; for instance, being preferable to the conventional crawler follower or hydraulic piston drive arrangements for reciprocating like dispenser means. This drive, operating somewhat in the manner of a “crawler tractor”, will be seen to accommodate relatively simple, straightforward mechanisms for controlling transport speed, dispenser position, etc.

Another feature of novelty will be seen in the manner of connecting arrangements which coact with the pinned-chain drive. For instance, a power cable “reciprocating-connector” is provided as shown in FIG. 8 to flexibly-couple conduit means (such as a power cable) leading from a fixed frame (of a particular traverse frame) to a relatively movable carriage reciprocating thereon-long, this connector system taking the form, generally, of a rolling-sprocket/support chain arrangement mounted in a raceway, with the cable wrapped, with the chain, about the sprockets, the chain being pinned to the main frame.

Yet another feature of novelty comprises a “chain suspension” arrangement for connector segments, whereby, using an “endless chain-paired sprocket” arrangement as above, conduit-supporting brackets may be mounted between opposed sections of the chain pairs and carried thereon as the sprocket pairs are translated, so as to support a set of aligned conduits (e.g. fluid-supply hoses, electric cables, flexible connectors and the like), threaded along the plane joining the two chains, and disposed between them. Such a conduit set can be so strung from a frame fixture (where the chains are pinned) along the chain path, and concentric therewith around their sprocket, to extend to the reciprocating load pinned between the chains, being operatively connected to apparatus carried on the load.

As will be seen, two or more continuous lengths of such conduits may be strung in succession in different translation-directions; e.g. so as to “follow” a first load (reciprocated along a first chain arrangement on an “upper traverse frame”) as well as extending beyond, to be threaded between a second (transverse) chain arrangement, being carried therealong, to be coupled to a second load (reciprocated along this second chain array, on a “lower traverse frame”).

The foregoing suspension arrangement will be seen as acting to maintain a constant conduit length, avoiding the typical difficulties of slack, stretching, and storage. This provides a “minimum-bend-radius” suspension following the radius of the chain sprockets and subjects the conduits to very little bending stress.

Yet another novel feature comprises a “skew” shaft arrangement especially useful in instances where a reciprocated load (e.g. on the described pinned-chain arrangement) must be simultaneously, and synchronously, whipped across the reciprocation path in a controlled manner. The load frame is engaged by a prescribed skew shaft (mechanical bar cam roller/follower guide) to control this transverse movement, being mounted to be freely translatable therealong.

SUMMARY OF DESCRIPTION KEYED TO FIGURES

The invention features will be described as embodied in a particular coating machine indicated, generally, in FIG. 1, a top perspective view of a foam application machine 10 and supporting elements.

FIG. 2 is an upper perspective general view of the two orthogonal “traverse” systems of machine 10, indicating the framework of each, together with the chain-driven carriers reciprocated along each frame.

FIG. 3 is a rather schematic view of the perspective chain-driven carrier LC with parts of the lateral traverse LTR, being indicated rather sparsely to suggest element functions; for instance, the pair of drive chains C, the motor-drive M therefor, carriers with the two wheels coupled engaging guide rails, the array of conduits cd supported between the chains, with the reciprocated mount DM (for dispensing unit DU) load on its trolley LLC (exploded away from the carrier LC) and shown generally mounted on rails 11r and associated wheels w", together with a functional indication of its engagement with “skew-bar” means S-T.

FIGS. 4A and 4B are (opposite) phase diagrams illustrating the extreme positions defining a “half-cycle” of operation for the “pinned-chain” drive; 4A showing the chain (schematically) with its load L in a first extreme (or “out”) position; 4B showing the load in the opposite extreme (“in”) position, having been carried there via coupling (pinning) to the chains threaded on the sprockets 62, 63.

FIGS. 5A and 5B are very schematic, propaedeutic plan views of a to-be-foamed substrate with over-laid
foaming tracks, which (taken together with FIG. 3) indicate the characteristics and operation of the “skewbar” SB, means for mechanically importing a “compensating skew” motion to dispenser unit (DU) as it is reciprocatingly driven (unit DU being mounted on load carriage LLC so as to freely reciprocate in a direction transverse to the path of “lateral carriage” LC, itself reciprocating along horizontal axis H—H). A “captured cam” arrangement imports this skew mode while a limit switch and indexing means at each extreme position along lateral axis H—H.

FIGS. 6 and 7 are upper perspective views of the novel conduit mounting arrangement for meeting the problem of conducting a number of conduits from a fixed station of origin to a succession of relatively movable, reciprocating units while maintaining them in constant alignment and free moving elements, conveniently mounting them between drive-chain pairs; FIG. 7 indicating this arrangement exemplarily for a single conduit segment.

FIG. 8 is a rather schematic, partial perspective showing a novel reciprocating conduit connector/guide arrangement cooperating with a reciprocating unit and adapted to connect a conduit thereto in a compact, reciprocable arrangement following the unit without interference therebetween.

FIGS. 9, 10 and 11 illustrate in schematic perspective view a modified form of the coating machine and associated support vehicle shown in FIG. 1.

EMBDIMENT DETAILS

The features of invention will now be described as embodied in a particular coating machine 10 designed for dispensing urethane foam so as to coat substrates therewith in a controlled manner over one or several passes. FIG. 1 shows machine 10, very schematically, as comprising a main frame 12 (forward portion shown) extending from an operator cab 11 to a tow coupling TC, and on which is hung a windscreen arrangement 13. Machine 10 is mobile, being mounted on a pair of large wheels 15 and adapted to be towed from one coating site to another by a support module/tractor 21 or the like. This particular machine is especially adapted for the application of urethane foams and related materials in multiple layers successively overlaid upon a ground-surface substrate to form a foam “pad”. One such pad is indicated at plot 1, (over which the machine’s wheels have just passed) over-sized tires being provided to facilitate this. Machine 10 will be particularly understood as especially adapted for applying foam coatings to roadways, gravel embankment substrates or the like in a frigid, Arctic environment where the extreme cold and frequent high winds, plus the snow and ice prevalent, make such sites especially hostile and difficult to service.

FIG. 2 illustrates machine 10 in greater enlarged detail in a somewhat schematic isometric top view eliminating and simplifying many elements for clarity and propaedeutic discussion. Thus, it will be understood that the main frame 12 of machine 10 comprises a fixed, “forward”, or longitudinal traverse, section FTR extending along the direction of vehicle travel (machine path L—L) from a forward tongue portion 17—A of tow-coupling TC along an open, somewhat rectangular, box-like “primary” frame 17 (here about 30 feet long by about four feet high and three feet wide) to terminate at cab 11. The entire unit is adapted to be towed by a truck 21 as indicated in FIG. 1, from the tongue 17—A in trailer fashion with the load rolling on a pair of large tractor wheels with (oversized) low-pressure tires 11B mounted rotatably to support cab 11 on substrate 1. In FIG. 2, however, the machine will be understood as assuming its stationary mode, being fixedly stationed over a given coating site 1 with the tongue resting upon a height-adjustable forward stance 16 and the cab end similarly resting upon a pair of height-adjustable cab stanchions 11—C, to form, with wheels 11—B, a relatively firm, stable (tripod) support for the unit in working position over the subject terrestrial substrate plot to be spray-coated. A tent framework 13—A is projected symmetrically outboard from both sides of primary frame 17 a prescribed distance (here about 14 feet each side); this length may be adjustable and in any event will span the width of the substrate plot contemplated. This screen-frame 13—A is, of course, adapted to be covered along the side (and preferably also the top) portions, including the front and rear, with a suitable tenting material, including adjustable lower flap (or drag lines) sections 13—B (see FIG. 1).

The object is to completely surround the spray plot with a tent wall and provide a protective “coating enclosure” and a favorable environment for coating operations, being relatively wind-free and somewhat controllable as to temperature, humidity, etc. The top of frame 13—A is similarly covered preferably; for example so the enclosure air may be heated as an aid in coating operations. Heaters such as infra-red lamp unit IR may be provided for this purpose. FIG. 1 shows this tenting arrangement and indicates, schematically, an exhaust arrangement 11—A which will be understood as comprising an air-duct means extending from the top of the framework 13—A to project well beyond cab 11, being adapted with exhaust fan means, etc. in the art to exhaust the tent enclosure and thereby withdrawing surplus spray materials, excess heat, moisture and the like for better control over coating operations. During coating operations (as noted below), one or more operators may be stationed inside cab 11 to observe (through the indicated window 11—W) and usually will monitor and manually control various functions, being provided with a number of remote controls such as for spray material supply, heating (materials, air and/or substrate), exhausting, conduit flush, etc.

The second major structural portion of vehicle 10 comprises a lateral traverse section LTR comprising an open box-like “secondary” frame 18, similar to frame 17 and suspended therefrom on a “turnbuckle” (or related pivot) structure T—B (not shown, but well understood in the art). Lateral traverse LTR is adapted to define a coating axis H—H along its length, being movably (and pivotably) suspended from a “secondary” or forward carriage FCC reciprocated along a pair of rails 10 for forward traverse PTR. Traverse LTR as normally (during coating) disposed extends transverse to “machine path” L—L and is reciprocated along L—L, being carried by cart FCC. Cart FCC is, in turn, carried and (according to a feature of novelty) translated by a “pinned chain-driven” (longitudinal) “primary” carriage FC. A similar “primary” or “secondary” lateral carriage arrangement is illustrated in FIGS. 3 and 4 (described below) and will be understood as, in turn, carried by this “forward” carriage array.

Primary forward carriage FC (very schematically shown but generally analogous to primary lateral car-
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FIG. 3 indicates a particular embodiment of the "pinned-chain drive", and related features of novelty, such as the chain-driven load, the chain-supported conduits and the "skew bar" feature. Here the reciprocable primary lateral carriage structure LC will be generally understood as comprising a pair of drive chains C, each threaded in "endless loop" fashion about an associated pair of sprockets (62/63, 62'/63'), so as to be driven thereby. Chains C are pinned and affixed to a main horizontal traverse frame 18 at a fixed "tie point", indicated as tie bar TB. Opposed drive sprockets 62/62' are affixed on a drive shaft 61-D to be synchronously driven thereby, while opposed idler sprockets 63/63' are similarly affixed on an idler shaft 61-I to be rotated in synchronism thereon, (being driven by chains C in synchronism with driving shaft 61-D). The ends of each shaft are affixed to a pair of flanged wheels (or rollers) w, disposed outboard of the respective chain-sprocket array and preferably being adapted to include a concave rolling surface of the type indicated to fit upon and engage a respective convex guide rail lr, whereby wheels w can roll freely along the rails while being kept aligned and constrained from movement in the transverse direction. Sprocket shafts 61-D, 61-I are rotatably mounted in a prescribed carriage frame 66 (only portions being shown and very schematically, such being well-understood in the art) so as to be translated as an integral carriage assembly LC when driven by the associated sprockets and chains, to roll along guide rails lr. Carriage frame 66 also supports a prescribed power unit carried on a platform 51 and comprising an electric drive motor 52 adapted to be energized by a suitable power source (not shown) through a power cable PC (see also FIG. 8) and related motive means including a drive shaft having manual speed-adjust means 53 (known in the art) affixed thereon and being adapted to drivingly engage a belt linkage 54 which (with appropriate gearing, etc. as known in the art and only schematically indicated) drives a gear reduction means 55 (adapted to gear down the drive train for increased power and lower rotational velocity) which is, in turn, linked through a belt or the like drivingly to drive shaft 61-D.

Thus, it will be appreciated that, in operation, carriage LC may be driven reciprocatingly along guide rails lr in the "coating direction" H→H upon energization of motor 52. That is, when motor 52 is energized to drive shaft 61-D and sprockets 62, 62', carriage LC is pulled along rails lr in "endless winch" fashion, the sprockets being coupled to the main frame 18 (at tie point TB) through chains C (pinned thereto). Thus, rotation of the drive sprockets in a first direction will cause them to "take up" on one half of the chain and pull themselves toward tie bar TB (with the companion idler sprockets "letting out" that half of the chain and moving away from TB); while rotation in the reverse direction will cause the drive sprockets to pull themselves along the other chain-half in the opposite direction — the net effect being to pull carriage LC along rails lr and path H→H, reciprocatingly, the reciprocating motion being controlled according to the (alternating) directions of rotation of drive motor 52. This chain-drive translation is schematically illustrated for one half-cycle (full excursion in one direction) in FIGS. 4A and 4B as follows.

In FIG. 4A the elements of FIG. 3 are only diagrammatically indicated, i.e., one endless chain c is indi-
cated as wrapped (drivingly) about drive sprocket 62 (driven, in turn, by drive shaft 61-D) and also about idler sprocket 63, being pinned to the main frame 18 of the lateral traverse LTR at tie bar TB as indicated before. Load L is schematically indicated as affixed to chain c at the right extremity of its lower segment to be driven thereby (by the associated chain pair; only one chain here indicated) to roll cart LC along its associated rails Ir. Chain c may be represented as comprising a first (upper) half segment cs-a extending between tie bar TB and load L plus a second, complementary half-segment cs-b connected with segment cs-a to complete the chain-loop about sprocket 63. As noted below, the path H-P of the conduits cd shown in FIG. 3 (and also in FIGS. 6 and 7, described below), is shown in phantom extending between tie point TB and load L, relatively along the plane between th chains c.

Turning now to FIG. 4-B, the same arrangement is shown as in FIG. 4A with the sprockets and load, howeyer, now located at the opposite ("extreme left") position. Operation of the indicated "pinned-chain" drive will now be functionally described; i.e. starting at the "extreme right" position (FIG. 4A), sprockets 62, 63 will be understood to be chain-driven through a "half-cycle" of cyclic operation to the "extreme left" position (FIG. 4B) carrying load L with them, "through" its "center" position (below bar TB). Chain segment cs-a wrapping sprocket 62 thus acts as the linkage pulling carriage LC when drive shaft 61-D rotates (in the direction indicated by the arrow in FIG. 4-A). When shaft rotation is reversed (as indicated in FIG. 4B), sprocket 62 will be rotated (by sprocket 62 through linkage cs-a) to "take up" along segment cs-b (pinned at TB) and complete the reciprocation cycle by pulling load L back to "start" position (as in FIG. 4A). Thus, it will be apparent that driving the motor (and the drive train therefrom) to rotate a drive sprocket for a half-cycle will pull carriage LC a prescribed (carriage-travel) distance X (this corresponding to the travel of idler shaft 61-D). This chain mounting will, in turn, cause load L to shift a prescribed (load-translation) distance x-dx, corresponding to the travel of "load-travel" x-dx will, here be understood as the sum of "carriage-travel" x plus an increment dx corresponding to the span between sprocket shafts along segment cs-b. Viewed otherwise, while sprocket 62 is rolling along the rails a sprocket-separation distance X and is pulled down the chain to "take-up" along segment cs-a and "bottom" below tie point TB, it will be simultaneously releasing an equal-length chain segment along cs-b and around sprocket 63 to establish new (reversed) segments cs-b' (from cs-b) and cs-a' (from cs-a) — shifting load L by this same incremental length. Of course, certain variations of this may be worked as those skilled in the art will recognize. For instance, in some cases it may be preferred not to pin the load on the chain but establish intermediate cam-drive means, driven by the chain to push the load, left free. In other variants, the chain length may be wrapped repeatedly about either or both sprockets to establish multiple strands in pulley-fashion. In certain cases, a friction belt/friiction wheel arrangement may be suitable instead of the chains and sprockets. Alternatively, a single "take-up pulley" arrangement might be used with load L mounted from carriage LC along with a single pulley-sprocket-take-up arrangement provided on the shaft (e.g. of 62), eliminating the endless loop configuration; i.e. deleting "re-turn segments cs-b, without, of course, deriving all the same results.

As suggested above, and indicated particularly in FIGS. 3 and 5, the dispenser unit DU (e.g. a foam dispenser, shown only in phantom in FIG. 5B, mounted on platform 45 — see FIG. 3) is mounted on its cart LLC to be controllably translated in compound "skew fashion" both along the "spray direction" H-H (lateral movement) but also having an orthogonal translation-component, sufficient to compensate for the cart's forward motion during a spray pass (between limits S, S' FIG. 5A). This compound bi-directional, or skewed, translation mode will also be advantageous for many other coating applications beyond this embodiment as will be readily understood by those skilled in the art.

FIG. 5B is a plan view of the elements in the embodiment of FIG. 3 effecting this controlled skew. Here, the main forward-oriented frame 17 of machine 10 may be understood as aligned along forward axis L—L (i.e. the direction of movement for lateral frame LTR, this traverse frame LTR, carrying dispensing unit DU (indicated in phantom), being understood as aligned, transversely along the spray path H—H. The dispenser platform 45 portion of cart LLC carrying unit DU is indicated in conjunction with the slide bars SS along which it is freely reciprocable (in forward direction L—L) along with the spaced pair of rotatable cam rollers 35, 35' engaging skew bar 31 (see also FIG. 3). Skew bar 31 comprises an elongate metal tube suspended from the frame 18 of lateral traverse LTR between a pair of index pistons units 33, 34 disposed respectively at either end of frame 18 at the limits of the spray-path. Units 33, 34 are adapted to support tube 31 so as to be disposed just above platform 45, and be captured between paired rollers 35', 35' rotatably engaging 31 to guide platform 45 and unit DU therewith along the prescribed skew-path as load L is reciprocated back and forth along frame 18. Each index unit 33, 34 is similar, comprising an hydraulic cylinder, the driven-piston portion of which includes an elongate piston shaft affixed to the associated end of skew bar 31. The driving portions of each indexing arrangement are hydraulically linked to an hydraulic control unit 37 arranged to selectively inject hydraulic fluid into a respective piston cylinder so as to drive its piston "home" to the "extended position" (in a known conventional manner) this, in turn, thrusting the associated end of bar 31 a prescribed (adjustable) "indexing distance" at selectable, controlled times (e.g. point 2 to point 3 in FIG. 5A). To control this hydraulic indexing action, a pair of limit switch means LS-1, LS-2 (schematically shown, but generally understood in the art), are arranged along the path of carriage LC and adapted to be energized upon the passage of "throw portion" thereof (e.g. a wheel w) can throw it either switch when dispenser DU reaches a respective end of the coating pass. Of course, the switch position along the pass travel may be adjustable. In response to this energizing event (and after a predetermined delay, if desired), the energized switch will impress a corresponding (left or right) "index signal" upon hydraulic control unit 37 which will, responsively, activate the associated indexing unit into its "index cycle". Thereupon, the associated, connected end of bar 31 will be advanced the prescribed "indexing distance" (to define the origin of the next reverse pass), carrying with it slidable platform 45 and dispensing unit DU suspended therefrom.
The functioning of this index operation, as well as the general plan for translating load L (with dispensing unit DU) across a subject substrate plot will be better understood by reference to FIG. 5A, a schematic, plan view of such a plot, the lateral boundaries of which are defined by segments S—S and S'—S'. Here, as in FIG. 5B, the forward direction L—L is also shown, being understood as generally parallel with these boundaries. In general, the mode of dispenser manipulation will be understood as operating to effectively translate dispensing unit DU (or platform 45, effectively) in a straight-line path across the plot, such as from point 1 to point 2, in FIG. 5A, along spray direction H—H normal to axis L—L. Unit DU is then indexed (i.e. advanced the unit the prescribed "indexing distance"; cf from point 2 to point 3); thereafter to retrace in a return pass parallel to and abutting (preferably overlapping) the first pass but oppositely; e.g. from point 3 to point 4. Thus, successive parallel abutting passes will lay down foam coating material onto plot 1, these passes building up the contemplated coating length (see the two cross-hatched swaths sw–1, sw–2 along centerlines "1–2" and "3–4", respectively). For instance, in a horizontal traverse along sw–1, a typical urethane foam dispensing unit can be controlled to lay down a relatively uniform coating as is characterized in U.S. Pat. No. 3,741,482 by James R. James and Kay E. Eliason, filed Sept. 17, 1971, and incorporated herewith.

Now referring to FIG. 2, it will be apparent that during a given pass of dispensing unit DU across lateral direction H—H, the entire traverse unit LTR will be understood as being continually and gradually advanced (along forward direction L—L) and thus a "skew" problem will be presented. That is, this forward motion gives dispenser DU a forward velocity component resulting in a skew divergence from its planned coating path — e.g. instead of proceeding from point 1 to point 2 in FIG. 5A, DU would skew-forward somewhat (e.g. to point 1'). A skew problem would likewise arise if apparatus 10 were, instead, to be continually towed along a road or other long "plot" (such as by a truck 21). However, it will be apparent that this skew may be compensated-for according to a feature of novelty by providing a compensating "reverse skew" in the opposite direction (e.g. nominal heading from point 1 to point 1' but so correlated to the rate of forward motion that the resultant motion is "straight", along direction H—H, namely from 1 to 2). As will be explained, skew apparatus ST including skew bar 31, establishes just that sort of compensation so that the rate of "reverse skew" equals the forward velocity during a given swath-coating period, or half-cycle. Thus, for a particular speed of carriage VLC (carrying LTR) along forward direction L—L, a particular angular orientation of skew bar 31 (established by controlling the extended-piston position of cylinders 34, 33 as known in the art) will be exactly compensatory and yield a resultant "straight run" along direction H—H. However, it will be apparent that the return run (e.g. between points 3 and 4, or swath sw–2) will require an advancing (indexing) of the dispensing unit a prescribed amount (roughly corresponding to the selected swath width plus any "overlap" margin added). Moreover, this "skewed" translation mode obviously required a reversal of the skew direction; thus, a reversal of the operative states of hydraulic cylinders 33 and 34 (from "piston extended" as with piston 34, FIG. 5B to "piston retracted" as with piston 33). As afore-mentioned, the limit switch and hydraulic control arrangement will be understood as adapted to provide such an indexing automatically; e.g. stepping (the center of) dispensing unit DU from a first swath (centerline — e.g. point 1 to point 2) to the next adjacent swath (e.g. point 3 to point 4); while at the same time reversing skew bar 31. While details implementing this control mode are only suggested, workers will appreciate how it may be implemented. For instance, limit switch means LS–1 may be thrown by passage of (a selected portion) of the dispenser platform to activate this hydraulic indexing at one end of pass while like switch means LS–2 provides the same at the other end. This indexing is indicated functionally by the arrow between points 2 and 3 (or points 4–5; next indexing) in FIG. 5A. Those skilled in the art will appreciate that equivalent means may likewise be provided to effect the functions according to this novel feature.

Another feature of the invention may be best understood by reference to FIG. 3, together with FIGS. 6 and 7, and relates to the arrangement of hoses or other conduits, carried on the chain drive mechanism (of one or both) of the afore-described "pinched-chain" traversing arrangements. Referring, for example, to the lateral carriage LD in FIG. 3 it will be seen that a number of conduits cd are (very schematically) indicated as fixed in parallel alignment on tie bar TB, being threaded therethrough to be entrained between, as well as carried by, the opposed adjacent segments of drive chains (C.C.). Conduits cd may comprise any elongate flexible structure for supplying chemicals, liquids, heat, power, hydraulics or other energy to various portions of the translated (e.g. dispensing) apparatus. For example, in the subject embodiment, they are adapted to supply: air, solvent, LNG, control circuits, electrical power and foam materials. The functional arrangement of the conduits may best be understood from considering FIG. 7 (in conjunction with FIGS. 3 and 6), where a prototypical conduit segment h—a is shown as originating from cab 11 being entrained (along with several other like, parallel conduits in the set) to a fixed alignment bar TB–1, affixed on frame 17 of the forward traverse arrangement FTR, being functionally analogous to tie bar TB in FIG. 3. From TB–1, a second continuous segment h–b of the same line will be understood as entrained between the opposing chain segments CC of the forward primary traverse carriage FC (travelling along rails fr, see FIGS. 2,3 also) being suspended between the opposing chain segments by prescribed separator bars SB. Bars SB are affixed to the chain segments and adapted to carry the prescribed (set of) conduits in alignment. Bars SB preferably include separator means, such as resilient separators SB–2 affixed thereon so as to resiliently engage the conduits, being spaced to admit them in proper position. According to this novel feature of the invention, the conduits are, moreover, entrained relatively concentrically with the chains carrying them about the sprockets along the involved chain-length — e.g. in FIG. 6 see sprockets SP in primary carriage FC. The conduits so mounted and entrained along the drive chains CC may be led to a fixture on a relatively movable array — e.g. conduits cd are conducted to engage a second tie bar TB–2 (FIG. 7) understood as mounted on secondary forward cart VLC (not shown in FIG. 6) so as to be reciprocated in conjunction therewith, along forward axis L—L.
Workers in the art will appreciate that according to this feature of novelty, a subject conduit segment (or set) may be advantageously supported by, and aligned between a pair of chain segments to be led from a source structure to contact a reciprocating carrier without complications or fouling of the conduits with any intermediate gear, with minimal danger to attendant personnel or equipment, and with no undue strain or twisting distortion of the conduits — such as might well result with conventional contemporary arrangements for connecting such conduits to a reciprocating carrier.

The described conduit length (segments h—a, h—b — to h—c) may be extended further to be conducted, in any convenient fashion, (along a transition segment h—c) from the forward traverse FTR unit to the lateral traverse unit LTR (primary lateral cart LC) where it engages alignment bar TB (mentioned above FIG. 3) or a like positioning structure affixed on horizontal frame 18. The conduit (segment h—a) may then be further conducted, entrained between outboard segments of drive chains C,C and about associated sprockets 62, 62’ (FIG. 3 as well as FIG. 6, FIG. 7), being mounted on these chain segments and positioned therebeneath by separator bars as afore-described. The conduit may next be conducted to a second mounting bar TB’ affixed on reciprocable secondary lateral cart LLC and affixed therein to be translated in conjunction therewith along horizontal axis H—H. A final terminal section (h—e) of the hose is led from bar TB' to dispensing unit DU where each conduit will be connected to an associated operative portion. Dispensing unit DU will, of course, be understood as translatable in the lateral direction, H—H, as well as transverse thereto to the extent the skew bar displaces it in forward direction L—L.

Thus, it will be apparent to those skilled in the art that this feature of novelty provides a unique and advantageous arrangement for conducting one or several conduit lengths from a fixed source to a relatively movable terminus; along a sprocket and chain arrangement suspending the conduits between appropriate opposed chain segments so as to entrain them relatively along the plane described by these segments, the lengths to be “taken-in” and “let-out” as the chains and the terminus are reciprocated. Of course, the afore-described embodiments, while being illustrative of this concept, may be modified as understood by those skilled in the art to perform this function in other ways, while still lying within the general intent of the subject invention. For instance, a single chain arrangement or triple chain array could be used in certain circumstances; also the chain means need not drive (translate) the terminus structure in all cases.

Another feature of novelty is indicated in FIG. 8 and comprises a reciprocable transitional conduit coupling, or “moving loop” guide means, i.e. a means for conveniently linking a power cable, or like conduit, between a relatively movable reciprocated terminus and a relatively fixed, separate station which is fixed to a stationary frame adjacent the path of reciprocation. In particular, and referring to FIGS. 3 and 8, a power cable type flexible conduit means 101 is shown and will be understood as adapted and connected to energize motor 52 on carriage LC, being understood as extending between motor 52 and a power-control source PS (not shown) affixed on the main frame 18. The problem is to effect the connection of flexible cable 101 between the fixed frame and the relatively movable terminus (carriage) without snaring, tangling or damaging the cable or otherwise interfering with any mechanism. The solution, according to this novel feature, is a chain- and sprocket carrier arrangement 83, affixed on carriage LC and adapted to reciprocate cable 101 along a raceway portion of frame 18 in the indicated manner, moving a sinusuous intermediate section of the cable 83—S, while keeping the ends fixed at reference points on the frame and carriage respectively. More particularly, a support bar 85 is affixed to frame 66 of carriage LC, being projected out from the side thereof in cantilevered fashion, and comprising a bar of predetermined length (corresponding to a contemplated reciprocation distance) carrying a pair of spindles on either end, these spindles projecting downwardly to slidably support a pair of associated chain sprockets (83—S) for rotation thereon. The sprockets 83—S are arranged to be linked by a relatively conventional endless-loop coupling (cf. chain 83—C), this being threaded around the spindles and pinned (at appropriate segment thereof) to fixed frame 18 as indicated functionally at 86. A raceway 81 is formed to define and enclose the reciprocating path of this sprocket/chain array as it follows the reciprocating translation of carriage LC. Raceway 81 is disposed on a part of frame 18, just below the excurision path of the chain-sprocket array 83 and including a “floor” or base 82 disposed between two side walls defining the path to be taken by this “moving loop” guide means during the reciprocation of carriage LC. Base 82 is adapted to support these sprockets rotatably (for a compound rotating, rolling motion thereon), the sprockets each being fitted with a set of like roller bearings 84 (here three), or the like. Thus, each sprocket rests upon three bearings 84 confined in respective pockets so that with the sprockets loosely fitting (to accommodate some vertical play, or “jounce” in LC) on the spindles of bar 85 they will engage the associated bearings and be journaled thereby as they glide, rotatingly, along raceway base 82. The intermediate transition length of cable 101 between frame 18 (tie 86 thereon) and its point of attachment to carriage HC (motor 52 thereon) is threaded along an appropriate section of chain 83—C to form a sinusuous transition cable length. It will be apparent that the described reciprocation of the carriage may evidently be better accommodated by such a transition cable length without danger of harming the cable or of adverse contact with any intervening mechanisms, this being effected in a very simplified manner, using a few conventional components. Of course, similar conduit lengths may likewise be coupled between a relatively reciprocating terminal and a relatively fixed reference structure; such as a length of conduit for supplying electrical signals to the dispensing unit DU. Likewise, differential segments of such cables may be strung successively between successively-movable structures of course, using this same “moving loop” coupling arrangement.

FIGS. 9, 10 and 11 illustrate modified versions of the mobile spray coating rig described above (e.g. see FIG. 1). Here, a support vehicle 121 will be understood as adapted to both support (e.g. supply components, power, living quarters) and propel a coating structure 141 (or alternate 131, FIG. 10). Vehicle 121 includes a set of low-pressure tire arrangements 123 fore and aft, plus an operations control cab (see door 125) in
the forward section and, preferably, tow coupling means aft. Supplies and storage space is provided amidships (cf. cargo door 127). Thus, in operation vehicle 121 may propel itself across the frozen tundra, self contained with all supplies necessary for a predetermined spray-coating tour, towing its coating module 141 (cf. tow-coupling 145) behind, on low pressure tire arrangements 143. Module 141 may comprise a pair of orthogonal traverse sections (146, 144) generally constructed in the manner of embodiment 10 above, except for wheel placement, lateral traverse placement and, obviously, the arrangements for operator control. Vehicle 121 may not only transport the module 141 as indicated in FIG. 11 but also so tow it during "moving coating" sequences (e.g. along an arctic roadway section). Moreover, with certain appropriate adjustments in design, the elements of module 141 may be arranged to be broken down during transit (between coating jobs) and stowed in vehicle 121. Otherwise, during transit, the tent and tent frame would be removed and stowed (e.g. in 121) and the lateral traverse pivoted 90° the nest into alignment with the forward traverse one of the wheels 143 being preferably pivoted around to support the towed module but the other being either pivoted out of the way or removed and stowed.

FIG. 10 illustrates an alternate module embodiment 131 (shown in "coating condition"); generally like module 141 except for having two lateral traverses 134, 132, each supported on an "outrigger" wheel unit 135, 133 and no forward traverse. The tenting is understood as rolled out from a roll 135 mounted along the side of (modified) vehicle 121'. During (relatively high speed) transit, the elements of module 131 will be understood as stowed in vehicle 121'. Those skilled in the art will appreciate how the foregoing features of invention, both separately and in combination, can provide the indicated advantages and results (as well as others) especially in embodiments like those described. It will be apparent, for instance, that the "pinned-chain" drive mechanism described provides a simple, advantageous technique for reciprocating elements in a controlled fashion along a pre-scribed track; that such a mechanism is optimized when much of its working mass is carried on a "primary carriage" with only the few necessary "head-end" components being carried on, and translated separately with, a "secondary carriage" which can readily be translated in conjunction with the drive chain at a relatively faster rate than the "primary carriage"; (this mode of operation being further optimized in cases where one contemplates indexing and related operations which are relatively mass-sensitive). It will be further appreciated that a "load-skewing" arrangement provided in conjunction with the foregoing, or related, reciprocating mechanisms may provide a mode of translation along a first direction which is advantageously adapted to accommodate conjunctive advancement in a second, non-parallel, direction. It will be further appreciated that, in conjunction with the aforementioned "pinned-chain" drive mechanism, conduit lengths associated with a driven load may be advantageously mounted upon, and entrained between driving chain segments to be conducted from a fixed origin to the moving load, or to several, successive relatively-movable loads, in a convenient manner; and it will be further appreciated that, in instances where a conduit means is to be connected between a reciprocating load and a fixed frame, a "moving loop" coupling arrangement of the type described may be particularly advantageous.

Referring now to the particular embodiments described it will be appreciated that the subject features of invention and the described mechanisms are particularly adapted for spraying layers of urethane foam (or like coatings) onto terrestrial surfaces or similar substrates. In such cases, it will be evident to those skilled in the art that the dispensing unit employed may be adapted to dispense polyurethane foam or a similar plastic foam where, for instance, the liquid foam, as sprayed upon the substrate, will expand many times the delivered thickness, e.g. expanding a fractional-inch liquid layer to about 30 times its thickness when foamed. Such foaming is optimized in many instances when the foam ingredients (such as the subject polyol, isocyanate and blowing agent) are heated and/or where the substrate is heated either before, during and/or after application of the foam. Heating of this sort can be optimised and hasten curing of the resultant foam coating, especially in cold environments. For this reason, the apparatus 10 may be provided with various kinds of heating means such as infrared lamp means IR indicated functionally as mounted upon the trailing edge of horizontal frame 18 (FIG. 2). Other heaters of the infrared or similar sort may also be provided such as means to heat the ambient air within the tent. Exhaust means, such as system 11--A may further be provided to remove air and suspended matter from the tent.

Although certain embodiments have been given by way of example and illustration, it is obvious that various modifications of the structures and/or techniques taught may be made without departing from the spirit of the invention as defined in the appended claims. For example, equivalent elements and steps may be substituted for those described, parts may be reversed and various features may be used independently of other features, all without departing from the spirit of the invention.

What is claimed is:

1. A "crawler arrangement" for automatically controlling the velocity (i.e., speed and direction of travel) of at least one load unit relative to fixed frame means, while reciprocating the unit in a controlled manner along a prescribed "forward to aft axis", the arrangement comprising:
Carrier means mounted on the frame means including at least one pair of sprockets, each mounted on the carrier means to be rotatable therein and linked by an associated endless-loop means adapted to couple sprockets for synchronous rotation thereof; motive means adapted to controllably rotate an associated one of the sprockets in each pair, doing so in both the "forward" and "reverse" rotational senses according to a prescribed driving program; guide means comprising part of the fixed frame means being disposed along said "forward to aft axis" and including guide rail means adapted to engage wheel means rotably attached to said carrier means for guiding thereof and of said carrier means along said "forward to aft axis"; fastening means arranged to fixedly pin said loop means to said fixed frame means at an origin point along said loop means; load means mounted on said carrier means to be reciprocated therewith in a prescribed manner said load means comprising secondary carrier means movably mounted on secondary guide
Means adapted to guidingly engage portions of said secondary carrier means for guiding thereof along an axis non-parallel to said "front to aft axis"; secondary fastening means fixedly coupling said secondary carrier means to said loop means at a load point thereof, so that the secondary carrier means is translated in conjunction therewith, said load point being spaced from said origin point.

2. The combination as recited in claim 1 wherein said secondary carrier means includes material dispensing means mounted thereon and arranged to dispense material along prescribed portions of a substrate as the load unit is reciprocated along said "working direction".

3. The combination as recited in claim 2 wherein said fixed frame means is arranged to be translated at a prescribed speed along a prescribed "translation direction" angularly displaced from said "working direction" by a prescribed "forward angle"; and wherein said carrier means includes skew compensation means adapted to impart to the load means a sufficient reverse velocity component opposing said "forward velocity" to said dispenser means as to compensate for and cancel out the latter, and thereby maintain orientation of the load unit effectively along the prescribed "working axis".

4. The combination as recited in claim 3 wherein said skew compensation means includes a rolling "rack/pinion" engagement means mounted on the secondary carrier means; skew bar means mounted from said fixed frame to extend across the path of said dispensing means, while guidingly engaging said skew engagement means, such as to effect said compensatory reverse velocity component.

5. The combination as recited in claim 3 wherein said carrier means includes a carrier frame; wherein said sprocket means comprise two pairs of rotatable sprockets each linked by a respective chain/web means, each web-linked pair being mounted for synchronous rotation on a pair of respective sprocket axle means; each of said sprocket axle means being mounted for rotation on the carrier frame and including guiding means adapted to engage said secondary guide means for guiding translation of the carrier frame.

6. The combination as recited in claim 5 wherein at least one conduit means is arranged to be carried by, and "taken-in" and "let-out" in conjunction with the translation of, said carrier means, being carried by and suspended between said pairs of web means, being threaded relatively along at least a portion of the plane defined therebetween.

7. The combination as recited in claim 6 wherein said conduit means comprise an aligned set of flexible conduits mounted and suspended between said web means on at least one separator means, each separator means comprising a plurality of spaced positioning slots, one for engaging each conduit and positioning it, these slots being separated by resilient positioning means.

8. The combination as recited in claim 1 wherein said fixed frame means also includes a forward carrier means (FC) comprising at least one chain/sprocket means including web means adapted to drive this carrier means along a prescribed forward direction, such forward carrier means being coupled by transition means to carry said carrier means and forward guide (FG) means adapted to engage said forward carrier means for directing thereof along said forward direc-

tion; plug forward fastening means adapted to pin said web means to said fixed frame means.

9. The combination as recited in claim 8 wherein said FC means comprises forward secondary carrier (FSC) means coupled to said transition means to carry said carrier means along said forward direction; wherein at least one conduit means is arranged to be carried by, and "taken-in" and "let-out" in conjunction with the translation of, said carrier means, being carried by and suspended between said pairs of web means, being threaded relatively along at least a portion of the plane defined therebetween; said conduit means being arranged to eminate from a fixed origin remote from the subject arrangement to be mounted upon, engaged by and "taken-in"/"let-out" in conjunction with: in sequence, said FC means and said associated FSC means; as well as said carrier means and said secondary carrier means, in that order, being entrained between the respective web means thereof in respective succession and in the manner aforesaid.

10. The combination recited in claim 1 wherein said fixed frame means includes conduit-origin means; and wherein said carrier means includes conduit-attachment means plus chain/sprocket/linkage (C-S-L) means carried thereon; said C-S-L means being mounted to project from frame means so that reciprocation thereof along the prescribed "working axis" sweeps this C-S-L means along a prescribed "C-S-L-path" adjacent a prescribed reference frame portion of said frame means; said C-S-L including linkage web means and being so arranged that said C-S-L web means will be "let-out" and "taken-up" as said carrier means is so reciprocated; and flexible coupling conduit means extending between said conduit-origin means and said conduit attachment means being mounted along at least a segment of said web means relatively along the length of this segment so as to be "let-out" and "taken-up" therewith as said carrier means is reciprocated.

11. The combination as recited in claim 1 wherein said frame means comprises a portion of a foam dispensing machine adapted so that dispensing means may be reciprocated along its working path and across a relatively moveable substrate disposed in operative relation therewith.

12. The combination as recited in claim 11 wherein said machine comprises a foam dispensing vehicle adapted for use with terrestrial substrates and including dispensing means and arranged so that said carrier means may be controllably translated in a given "forward direction" while also being reciprocated in the working direction; said directions being non-parallel.

13. The combination as recited in claim 12 wherein said vehicle includes a pair of like respective "forward crawler" and "lateral crawler" arrangements, said lateral crawler being suspended from said forward crawler to be translated thereby in the forward direction while also reciprocating the dispensing means in the lateral working direction.

14. The combination as recited in claim 13 wherein said "forward crawler" arrangement comprises primary and secondary forward carrier means (PFC and SFC respectively) mounted on a primary, forward frame means; and wherein said "lateral crawler" arrangement comprises primary and secondary lateral carrier means (PLC and SLC respectively) arranged and mounted along an associated lateral frame means,
said lateral frame means being suspended from said forward crawler to be reciprocatingly translated therewith in said forward direction.

15. A foam dispensing machine for automatically and controllably applying foam spray to terrestrial substrates, said machine comprising main frame means, extending along a prescribed "forward axis" between a prescribed forward end and a prescribed aft end of said machine; carrier means movably mounted on said main frame means and adapted to travel along said main frame means between said forward and said aft end; lateral reciprocating means mounted on said carrier means and adapted to controllably reciprocate a prescribed load in a prescribed "working direction" relatively non-parallel with said "forward axis"; said load means including foam dispenser means mounted on said reciprocating means to be reciprocated thereby, means attached to the main frame means to compensate for travel of the lateral reciprocating means along the main frame means and directing the lateral movement of the foam dispenser means so as to apply a prescribed foam coating to a respective strip portion of a subject terrestrial substrate in a direction substantially perpendicular to said forward axis.

16. The combination as recited in claim 12 wherein

said vehicle comprises a machine adapted to be towed by a prescribed self-propelled "support-vehicle".

17. The combination as recited in claim 16 wherein said support-vehicle is adapted to tow said machine in a first operating mode and is also adapted to be selectively positioned adjacent said machine in a second operating mode so as to support and control static coating operations at a particular coating site.

18. The combination as recited in claim 16 wherein the features of said support-vehicle and of said machine are adapted to be consolidated and used in a single self-propelled "combination-vehicle", the dispensing and related elements of said machine being adapted to be stored within this combination-vehicle during transit and adapted to be removed and/or projected therefrom in operative working relation during coating operations.

19. The combination as recited in claim 14 wherein are also included forward secondary fastening means adapted to fixedly attach said SFC means to the associated web means; and secondary forward guide (SFG) means adapted to engage said SFC means for directing thereof along said "forward direction".

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