

FIG. 6.

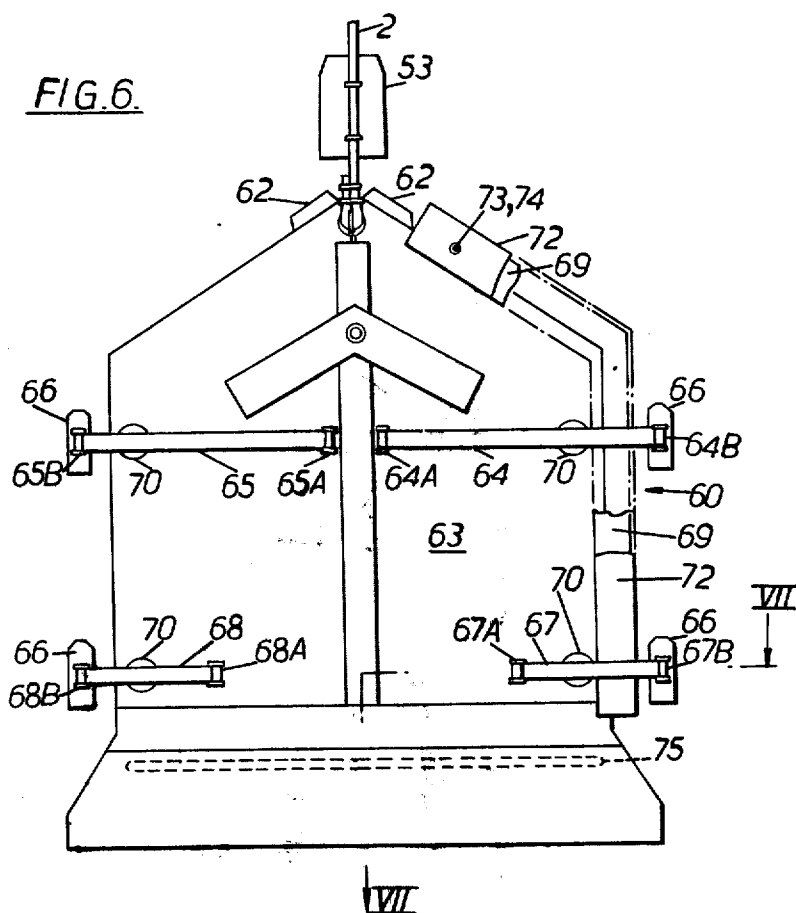


FIG. 7.

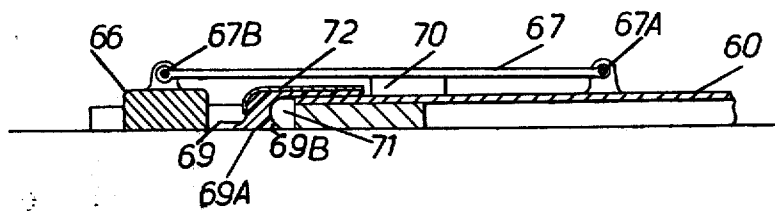
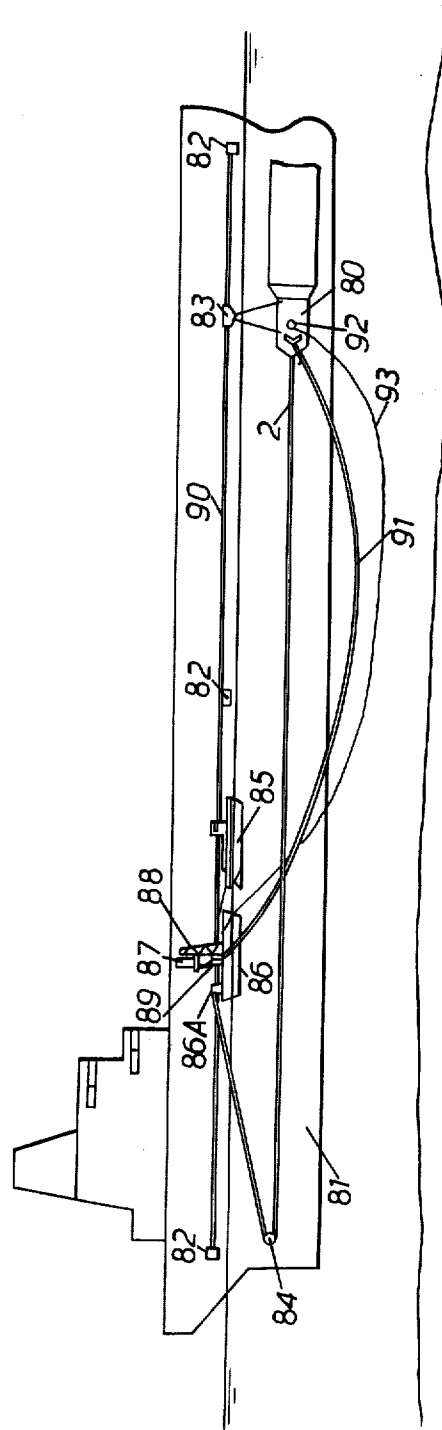


FIG. 8.



SURFACE TREATMENT

This invention relates to methods and apparatus for applying to a surface a substance such as paint for example and, in particular, substances for controlling and preventing growth of marine organisms, such as Enteromorpha for example, on the immersed surfaces of ships, boats and the like.

Enteromorpha, which is the prevalent and most troublesome marine fouling organism reproduces by means of motile zoospores which can become attached to a wetted surface, such as a ship's bottom or sides for example, and develop into a small but complete plant within four days. Such growth usually occurs upon the immersed surfaces of ships when moored, such as when loading or unloading for example, up to depths of around 14 ft. below which there is insufficient light penetration to promote the photosynthesis necessary for development of the organisms.

Furthermore, at relative speeds of water to immersed surfaces of about four knots and greater, the zoospores are unable to become attached to the surfaces so that no growth occurs. A ship, or boat, is therefore most vulnerable to attack when moored, and in the case of large vessels such as oil tankers, the time taken to discharge or take-on the cargo is sufficient to permit a strong growth of weed on the ship's sides below the water line, which considerably adds to the power required for normal cruising speeds.

It has therefore been proposed to continuously scrub or wash the sides of such vessels when moored, in order to prevent fouling, which methods are costly, cumbersome and tend to remove protective films such as anti-fouling paints or ordinary paints.

Aims of the invention are to provide apparatus whereby a surface may be coated with a paint-like substance and particularly whereby the immersed surfaces of a hull may be coated with fluid substances which inhibit and prevent marine growth, the use of which apparatus is simple, considerably reduces the time taken to coat a surface or to treat a vessel and are economically advantageous.

A further aim is to use such apparatus for underwater painting of a ship's hull.

To those familiar with the art it will be apparent that a ship's hull, or comparable structure to which the invention may be applied, is seldom completely flat. Usually there are major changes of contour (such as near bow or stern) and also minor changes such as lap welds, rivets, patches, or permanent fittings which extend from or intrude into an otherwise fairly uniform surface. The invention makes allowance for such third-dimension variations in that the subject applicator is so constructed as to be in effect sufficiently flexible to accommodate itself to the probable variations.

The growth inhibiting substances, hereinafter called "inhibitors", may be pastes, paints and the like, all such fluids are generally referred to hereinafter as "paint", and may be either of a temporary nature or more permanent and durable.

A temporary inhibitor may conveniently be a soluble paste containing chlorine or chlorine compounds, or other known growth-inhibiting agents, which paste will give protection for a suitable period whilst a vessel is stationary, but which is washed off by the slip-stream when the vessel is under way.

By the invention there is provided a paint applicator whereby a coat of paint may be applied to a surface, comprising:

an open sided chamber the periphery of which is defined by a leading margin, two side margins and a trailing margin, the elements forming the margins, or at least those forming the side margins, being longitudinally flexible so that they accommodate to a non-flat surface to be painted, some or all of the elements (which define the margins of a chamber to receive and deposit paint when juxtaposed to the recipient surface) being provided with polarized magnetic means to attract the applicator to the surface, which for this purpose is of course deemed to be of magnetically responsive material, such as the ordinary mild steel used in hull construction;

at least one paint inlet connection in fluid communication with said chamber;

means for delivering paint under pressure to said inlet connection;

at least one attachment point so positioned that when sufficient force is, in use, applied thereto generally in the plane of said surface, said chamber is caused to slide relative to said surface with said leading margin in advance and said trailing margin in the rear;

in which said trailing margin is of such dimensions, and urged into contact with said surface with such pressure that, when in use and sliding relative to said surface, said trailing margin acts to spread as a film upon said surface, paint delivered to said inlet connection.

The trailing margin of the applicator may be provided with at least one groove extending laterally between the two said side margins and facing said surface when the applicator is in contact therewith. The groove acts to distribute the paint evenly across the underside of the trailing margin thus ensuring that as even coating of paint is spread by the trailing margin.

The magnetic means to attract the applicator to the required surface may comprise an array of individual polarized magnets arranged so that the lines of force pass through said margins and react attractively with the magnetic surface. Alternatively, said peripheral margins may be formed from preferably flexible magnetic material permanently polarised so that a series of alternately polarised poles are presented to said magnetic surface and react attractively therewith.

In order to improve contact between the peripheral margins and a magnetic surface, there may be provided at least one arm having an inner end attached to said applicator and extending over and outwards from said peripheral margins towards an outer end thereof to which said extra permanent magnet is hingedly attached; spring means joining said arm to part of said peripheral margins so that when the extra permanent magnet is attracted to said surface, the arm acting through said spring means urges said part of said peripheral margins into contact with said surface. Such an arrangement is particularly useful when the magnetic surface is rough or uneven, in which case it is preferable to make the peripheral margins of flexible material which will conform to the surface irregularities.

The seal between peripheral margins and surface may be improved by providing a flexible sealing member which extends around and is sealedly attached to said side margins and said leading margin, and which seal is arranged to sealedly and slidably contact said surface when said peripheral margins are in contact

with said surface. The sealing member may be of such cross-section and so arranged that a channel is provided between said sealing member and said side and leading margins, including: a fluid connection to said channel; purging means whereby said channel may be

The purging means may conveniently comprise a suction pump.

The applicator may also be provided with one or more cavities in the peripheral said margins which cavities face said surface in use and are bridged thereby; pump means for providing suction; connector means leading from said cavities for fluidly connecting said pump means thereto. In such a case the suction (being understood to mean sub-ambient pressure) may contribute to the magnetic forces in holding the applicator against the surface.

According to a further aspect of the invention, a paint applicator is provided comprising: a sheet of flexible magnetic material having a periphery comprising a leading margin, two side margins and a trailing margin, at least which peripheral margins of said sheet are permanently magnetically polarised so as to present on a face thereof a series of alternate poles which are attracted to said surface when said sheet is placed thereon; at least one inlet connection for paint extending sealedly through said sheet so that when said sheet is placed upon said surface and held thereon by said magnetic poles, paint may be introduced between said sheet and said surface; means for delivering paint to said inlet connection at such pressure as to urge away from the underlying said surface an area of said sheet without causing any part of the peripheral margins to lift from said surface, thereby creating a paint-filled chamber; at least one attachment point so positioned that when sufficient force is, in use, applied thereto generally in the plane of said surface, said sheet is caused to slide relative to said surface with said leading margin in advance and said trailing margin in the rear; in which said trailing margin is of such dimensions and urged into contact with said surface with such pressure that, when sliding relative to said surface, said trailing margin acts to spread as a film upon said surface paint delivered to said inlet connection.

As before, magnets may be attached to the upper surface of the peripheral margins and said trailing margin may be provided with at least one groove extending thereacross between said side margins, which groove faces said surface when the applicator is in use.

A scraper may be attached to the leading margin of an applicator so as to scrape clean said surface when the applicator is operated.

The means for delivering paint to said inlet connection may, in a simple and convenient form, comprise a header tank with a hose leading therefrom to the inlet connection of the applicator, thus affording gravity feed at substantially constant pressure. In order to adjust the pressure of paint within the applicator, the height of the header tank may be varied, and pressure sensing means may be included in the invention, being attached to the applicator, which sense the difference in pressure between the paint within the applicator and the fluid surrounding the applicator. The height of the header tank may be caused to vary according to the signal output of the sensing means.

Further according to the invention, the spreading apparatus may be provided with means which scrape clean the surface in advance of the paint spreading.

Examples of the invention will now be described with reference to the accompanying drawings which are as follows:

FIG. 1 shows the underside of a paint applicator which is held on to a ship's hull by magnetic forces;

FIG. 2 shows a section II — II through the applicator of FIG. 1;

FIG. 3 shows a section III — III through the same applicator;

FIG. 4 shows the underside of a similar applicator;

FIG. 5 shows a section V — V through the applicator of FIG. 4;

FIG. 6 illustrates in plan a modification of the applicator of FIGS. 4 and 5, whilst

FIG. 7 shows a section VII — VII through the applicator of FIG. 6;

FIG. 8 shows a paint applicator according to the invention in use on the hull of a ship; and

FIG. 9 is a section through "Ferriflex" (Trade Mark) flexible sheet magnetic material showing the pattern of magnetic polarisation.

Referring to FIGS. 1, 2 and 3, the spreading apparatus or applicator, comprises a sheet 1 of flexible rubber impregnated with particles of magnetic material polarised such that when one side of the sheet is applied to a steel or iron surface, it is held thereon by the magnetic forces generated by the particles, whereas the reverse side of the sheet is not attracted to the steel surface at all. An example of such material, known by trade name as "Ferriflex sheet" is available from Magnetic Application Limited, 323, City Road, London, EC1V 1LL, and which when attached by magnetic attraction to a surface, may be caused to slide thereover, remaining at all times in contact therewith, by exerting a pull on the sheet in the plane of the surface. Although the forces acting to hold such a sheet onto a steel or iron surface are considerable, the sheet may be readily removed therefrom by simply peeling it off, very little force being required so to do. The sheet is polarised as illustrated in FIG. 9 so as to present a series of alternately polarised magnetic poles on one side of the sheet, being of substantially neutral polarity on the opposite side thereof.

Sheet 1, therefore, the magnetised underside of which is shown in FIG. 1, may be placed upon an immersed surface, surface 10 of FIGS. 2 and 3 for example, to which it will adhere.

In order to form a chamber 8 between surface 10 and sheet 1 for the purpose of receiving inhibitor, paint or whichever substance is to be applied to surface 10, an echelon shaped strip 3 of similar material to that of sheet 1 is bonded to the underside thereof as shown. Five inlets for the substance extend sealedly through sheet 1 from a manifold 5 to communicate fluidly with chamber 8. Manifold 5 is supplied with the substance under pressure through a flexible hose 6.

The chamber 8 is sealed on three sides by edges 1D of sheet 1 and the strip 3, which strip is tapered towards the ends thereof approaching sides 1D, in order to improve such sealing.

A cable 2 may be attached to the leading edge 1B of sheet 1, engaging with an eyelet 10 therein, whereat the applicator may be dragged across or along surface 10. A groove 7 extends across the underside of sheet 1 in

advance of the trailing edge 1A thereof, which groove, as will be seen, materially improves the spreading action of the applicator.

In an anti-fouling operation, the applicator 80 is laid upon the submerged surface of a ship hull (such as 81 see FIG. 8), adjacent the stern or stem, hose 6 being connected to a pressurised supply of inhibitor (such as a tank 82 which affords gravity feed at substantially constant pressure), whilst cable 2 (preferably of polypropylene rope which has slight positive bouyancy and the weight of which will not therefore modify the path of the applicator in use) is passed through a pulley attached to the hull by clamps (such as 84) at the opposite end thereof and then to a winch on the deck of a workboat alongside.

Inhibitor is forced through hose 6 and into chamber 8 as cable 2 pulls the applicator along the hull. Inhibitor is forced by the combined action of the supply pressure (for example, governed by the height of header tank 87 and the forward movement of the applicator, towards the trailing edge 1A before which it encounters groove 7. The groove acts to distribute inhibitor evenly across the width of sheet 1 so that trailing edge 1A leaves an even coating 9 of inhibitor upon surface 10 in a band at least the width of sheet 1.

The height of a header tank (such as 87) may be either manually, adjusted, or the tank moved vertically by a powered elevator, the height being governed by a signal from a pressure sensor attached to the applicator so as to sense the pressure differential between the paint and immediately surrounding water.

This coating process may be repeated as often as required so that a series of parallel and slightly overlapping bands of inhibitor are applied to the hull.

In order to remove the applicator at the end of a run, the workboat alongside the vessel, either using a separate cable (not shown) also attached to leading edge 1B, or by picking up cable 2, exerts a pull away from the vessel and somewhat towards the trailing edge 1A, whereupon the applicator is peeled off the hull.

Buoyancy aids (not shown) such as air filled chambers attached to the applicator in order to give it slight positive buoyancy, prevent the now free applicator from sinking, and at the same time may serve to maintain it in a suitable attitude for re-attachment to the hull.

Inflation of the buoyancy chambers may if so desired, be controlled so that the applicator can be manoeuvred in a vertical plane, the plane of the applicator remaining substantially parallel with that of a ship's hull.

Alternative apparatus for spreading an inhibitor is shown in FIGS. 4 and 5. The applicator 40 illustrated is an open-sided chamber having a top wall 41 of rigid sheet material divided longitudinally into two halves 41A and 41B, hingedly joined together by a strip of flexible material 42, such as rubber sheeting for example, bonded to each half. Side walls 43 and 44 of flexible sheet magnetic material such as "Ferriflex" for example, are bonded to the underside (i.e. that side facing upwards in FIG. 4) of the top wall so that the exposed underside surface of the walls 43 and 44 presents a series of alternately polarised magnetic poles.

The leading edge 45 of the side walls is suitably rounded or chamfered as at 45A so that the applicator will pass over small surface projections and irregularities.

Hingedly attached to the end 41C of the top wall 41 is a trailing panel 47, also of flexible sheet magnetic material having its operative magnetic poles also on the underside thereof. A strip of flexible material 48 bonded to both the trailing panel and top wall 41, serves as a hinge, whilst pads 49 of flexible material such as closed-cell sponge rubber for example, prevents leakage of paint past the junctures of panel 47 and side walls 43 and 44.

A paint inlet manifold 46, similar to manifold 5 of FIG. 1 but of flexible material such as polyvinylchloride, is attached to the upperside of top wall 41, a number of openings 46A in top wall 41 permit paint from the manifold 46 to enter the chamber. A hose 54 connects with the manifold 46 and delivers paint thereto when in use.

A cable 2 may, as before, attach to "eyes", such as 51, integral with the applicator 40 and positioned so that the leading edges 45 will take up the foremost position when the cable 2 pulls the applicator 40 along a surface.

In order to prevent the applicator 40 from lifting off a surface or breaking away therefrom, additional magnets, such as 50 for example, may be attached to the upper surface of the top wall 41 adjacent the edges thereof, so as to reinforce the magnetic field of the side walls 43 and 44, and the trailing edge of panel 47.

A magnetic shoe 53, having a well chamfered leading edge 53A, may be clamped to the cable so that the pull of the cable 2 upon applicator 40 is, in operation, always substantially in the plane of the surface being painted.

Where particularly uneven, or rough surfaces are to be painted, the applicator 60 illustrated in FIGS. 6 and 7 may be used. Applicator 60 is the same as applicator 40 but with extra additions, which are leading-edge magnets 62 bonded to the leading edge 61, poles downwards, outrigger magnets 66, and a seal member 69.

The outrigger magnets 66 are each hingedly attached to the respective ends 64B, 65B, 67B and 68B of respective rigid arm 64, 65, 67 and 68. Respective ends 64A, 65A, 67A and 68A of the arms are hingedly attached to the upper side of the top wall so that the arms extend transversely outwards beyond the edges of the applicator 60. The arms 64, 65, 67 and 68 are each joined to the top wall 63 in the vicinity of the edges thereof by spring members 70 which, as illustrated, are rubber pads. When the applicator is attached to a magnetic surface, magnets 66 pull into contact with the surface, compressing rubber pads 70 in so doing and thus exert a downward force on the edges of top wall 63, whilst permitting a degree of vertical movement of the side walls beneath the rubber pads 70.

A sealing member 69 extends around the leading edge 61 and side walls of the applicator, being bonded thereto and reinforced with a rigid backing piece 72, the sealing member 69 extending downwards slightly beyond the underside surfaces of the applicator so that, when the applicator 60 is held upon a surface, the sealing member 69 is compressed, flat face 69A contacting the surface being painted. A channel 71 is formed between the sealing member 69 and the applicator, thus providing a facility for either purging the channel 71 of any paint which may leak past the applicator walls, or for supplying fluid under pressure into the channel in order to improve the seal between face 69A and the surface being painted. Lips such as 69B on the sealing

member 69, are responsive to pressure differentials and can be forced into intimate contact with a surface when such a pressure differential is provided. An inlet pipe 73 fluidly communicates with the channel 71. A hose 74 extends therefrom to a source of suction for purging purposes, or to a source of pressure fluid for improving the seal. However, such pressure should not exceed that of the paint within the applicator.

The sealing member 69 may, if so desired, be hollow and expandable, by internal pressure from a compressor for example, into improved contact with the surface being painted.

Referring to FIG. 8, an applicator 80, such as any of those described herein, is shown attached by its magnetic poles to the hull 81 of a ship. The applicator 80 is suspended from a pulley 83 which runs freely along a cable 90, attached to the hull 81 by and stretched tautly between two limpet type magnetic clamps 82 which are removable.

A cable 2 extends from the applicator towards and over a pulley 84, magnetically attached to the hull distant from the applicator 80, the cable 2 passing to a winch 86A situated upon a floating lighter 86 alongside the hull 81. A powered boat 85 is used to move and position the lighter 86.

A hose 91 extends from the applicator to a small header tank 87 of paint situated upon a powered elevator 88 whereby the height of the tank may be varied. A pump 89 maintains a constant level of paint in header tank 87. A pressure sensor 92 attached to the applicator 80, monitors the pressure differential between the paint within the applicator and the surrounding water, and produces a corresponding electrical signal which is transmitted to control equipment (not shown) on lighter 86 via cable 93. The control equipment controls elevator 88 so that the height of tank 87 is varied according to the signal from sensor 92 thus maintaining a constant pressure differential between the paint within the applicator and the surrounding water.

In operation, winch 86A draws the applicator along hull 81 until it reaches pulley 84, whereupon the applicator is peeled off from the hull, lowered relative to pulley 83, and reattached to the hull immediately below its initial position. Pulley 84 is thus repositioned and the procedure repeated so that a series of overlapping bands of paint are produced upon hull 81.

So that the painting of a hull side may be completed in one operation, a number of applicators may be used simultaneously, linked together in echelon fashion and pulled along together by a single cable so that a number of overlapping bands of paint are produced simultaneously.

Referring again to FIGS. 1 and 2, a flexible blade 11 is shown bonded to leading edge 1B so that the blade 11 contacts and scrapes clean the surface 10 when the applicator is in use. A similar scraper blade 55 is provided in the embodiment of FIGS. 4, 5, 6 and 7, but is only notionally illustrated in FIGS. 4 and 5.

A groove 75 is notionally illustrated in FIG. 6 and may be included in the trailing margin of any of the illustrated embodiments in order to improve the paint spreading action. In the embodiments of FIGS. 4, 5, 6 and 7, the juncture of trailing panels (such as 47) and the top walls (such as 41) provide a natural groove.

Referring once more to FIGS. 1 and 2, strip 3 may conveniently be omitted, and the pressure of the paint

relied upon to urge the sheet 1 away from surface 10, without causing the edges to lift from the surface, thus creating a paint filled chamber.

We claim:

1. A paint applicator whereby a coat of paint may be applied to a surface comprising:

a chamber open at a side to be juxtaposed with said surface and having two longitudinally flexible marginal side elements, a third marginal element leading in an intended sense of direction of movement of said chamber over said surface and extending transversely between said side elements, and a fourth marginal element extending transversely between said side elements rearwardly of said leading marginal element and constituting spreading means;

polarized magnetic means arranged to hold at least said side elements close to and slidable over said surface;

means for attaching said chamber in the region of its leading marginal element to towing means effective generally parallel with said surface; and

means to enable paint to be supplied into said chamber.

2. A paint applicator according to claim 1 and in which the cross-dimensions of said chamber parallel to said surface are substantially greater than the cross-dimensions perpendicular to said surface.

3. A paint applicator according to claim 1 in which said fourth element is constructed so as to be flexible in its length.

4. A paint applicator according to claim 1 in which magnets are attached to the upper surface of said marginal elements so as to react attractively with the said surface underlying said marginal elements.

5. A paint applicator according to claim 1, in which at least some of said marginal elements comprise sheet magnetic material permanently polarized so as to present a series of alternately polarized magnetic poles to said surface there-underlying.

6. A paint applicator according to claim 5 in which at least one extra permanent magnet is attached to at least part of said marginal elements so as to reinforce the magnetic attraction between a margin and the underlying said surface.

7. A paint applicator according to claim 6 in which is provided:

at least one arm having an inner end attached to said applicator and extending over and outwards from said side marginal elements towards an outer end thereof to which said extra permanent magnet is hingedly attached;

spring means joining said arm to part of said side marginal elements so that when the extra permanent magnet is attracted to said surface, the arm acting through said spring means urges said part of said side marginal elements into contact with said surface.

8. A paint applicator according to claim 1 in which said fourth element is provided with at least one groove extending laterally between the said two side marginal elements and facing said surface when the applicator is in contact therewith.

9. A paint applicator according to claim 5 in which said sheet magnetic material is flexible.

10. A paint applicator according to claim 1 in which is provided:

one or more cavities in at least some of said marginal elements which cavities face said surface, in use, and are bridged thereby;

pump means for providing suction;

connector means leading from said cavities for fluidly 5 connecting said pump means thereto.

11. A paint applicator according to claim 1 in which a flexible sealing member extends around and is sealedly attached to said side elements and said third 10 element, and which seal is arranged to sealedly and slidably contact said surface when said side and third elements are in contact with or very close proximity to said surface.

12. A paint applicator according to claim 11 in which a channel is provided between said sealing member and 15 said elements, including:

a fluid connection to said channel;

purging means whereby said channel may be purged of any paint which may leak past said elements.

13. A paint applicator, whereby a coat of paint may 20 be applied to a surface of magnetic material, comprising:

a sheet of flexible magnetic material having a periphery comprising a leading margin, two side margins 25 and a trailing margin, at least which peripheral margins of said sheet are permanently magnetically polarised so as to present on a face thereof a series of alternate poles which are attracted to said surface when said sheet is placed thereon;

at least one inlet connection for paint extending 30 sealedly through said sheet so that when said sheet is placed upon said surface and held thereon by said magnetic poles, paint may be introduced between said sheet and said surface;

means for delivering paint to said inlet connection at 35

such pressure as to urge away from the underlying said surface an area of said sheet without causing any part of the peripheral margins to lift from said surface, thereby creating a paint-filled chamber;

at least one attachment point so positioned that when sufficient force is, in use, applied thereto generally in the plane of said surface, said sheet is caused to slide relative to said surface with said leading margin in advance and said trailing margin in the rear;

in which said trailing margin is of such dimensions and urged into contact with said surface with such pressure that, when sliding relative to said surface, said trailing margin acts to spread as a film upon said surface paint delivered to said inlet connection.

14. A paint applicator according to claim 13 in which said trailing margin is provided with at least one groove extending thereacross between said side margins, which groove faces said surface when the applicator is in use.

15. A paint applicator according to claim 1 in which is provided a scraper attached to said leading marginal element so as to scrape said surface when said applicator is operated.

16. A paint applicator according to claim 13 in which is provided a scraper attached to said leading margin so as to scrape said surface when said applicator is operated.

17. A paint applicator according to claim 1 and in which said means to enable paint to be supplied comprises a header tank so provided that the effective height governing its hydraulic head in respect of said chamber is variable, and flexible duct means connecting said tank to said chamber.

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