United States Patent

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[33] **Denmark**
[31] **2687/67**

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[54] **DRYING CONVEYOR**
2 Claims, 8 Drawing Figs.

[52] **U.S. Cl.** **198/126,**
198/195; 118/313
[51] **Int. Cl.** **B65g 21/00,**
B65g 15/30
[50] **Field of Search** 198/196,
195, 185, 204; 134/72, 131; 118/313

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Primary Examiner—Richard E. Aegerter
Attorney—Beveridge & De Grandi

ABSTRACT: Drying Conveyor for use in combination with an automatic painting plant for plate-shaped objects, said objects being carried in the painting plant by means having points of contacts cooperating with edges of said objects, said points of contacts defining a horizontal plane for the movement of the object; said drying conveyor having a carrying frame being provided with lifting means which are displaceable and adjustable in vertical direction in relation to the support of the carrying frame in dependence of the width of the plate-shaped objects and their position in the drying conveyor for bringing the moving plate-shaped objects to flush with said horizontal plane.

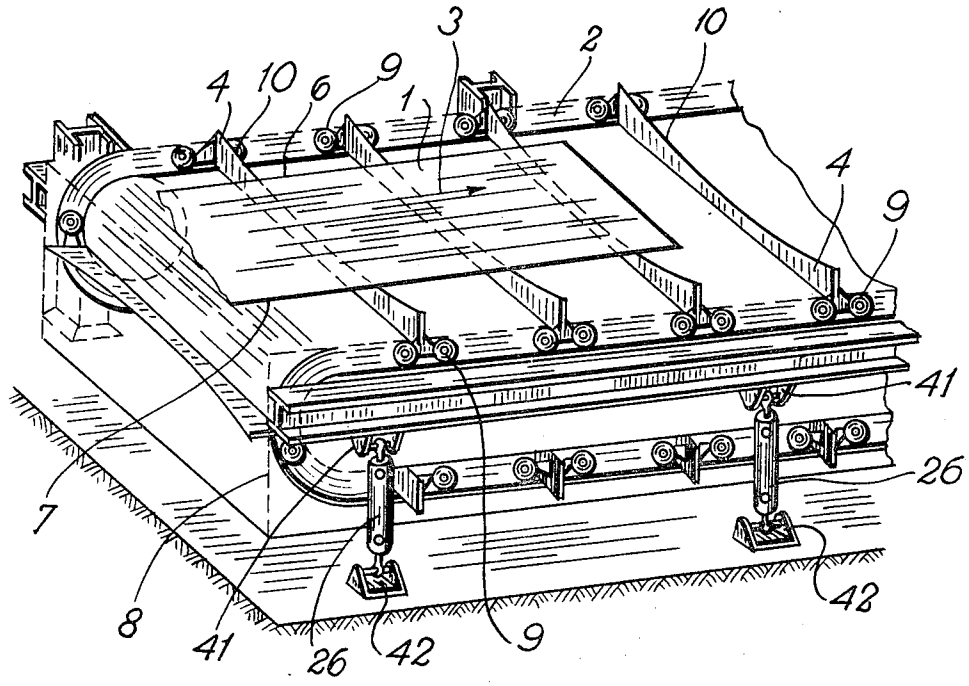

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Fig. 1

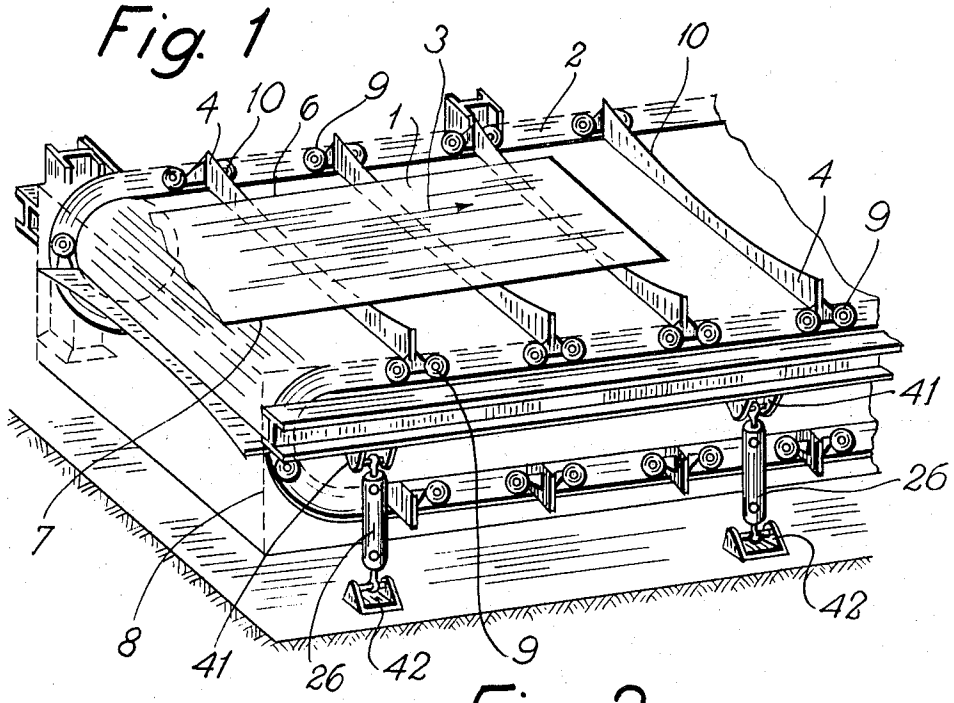

Fig. 2

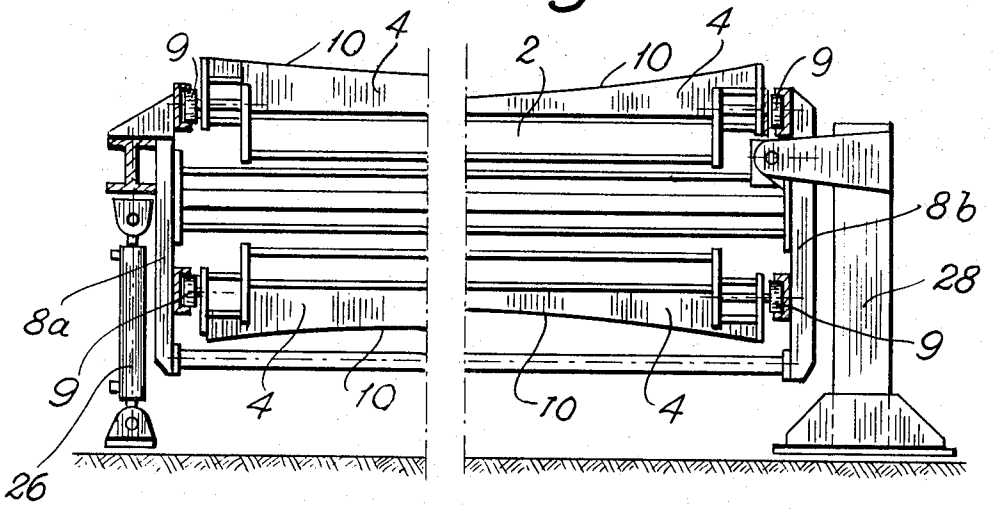

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Fig. 3

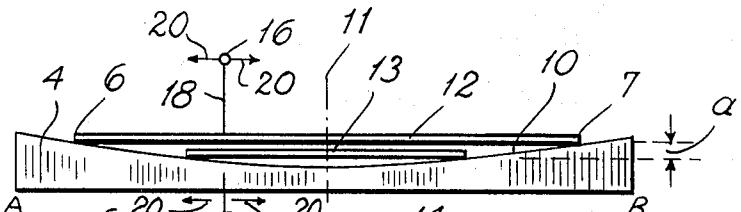
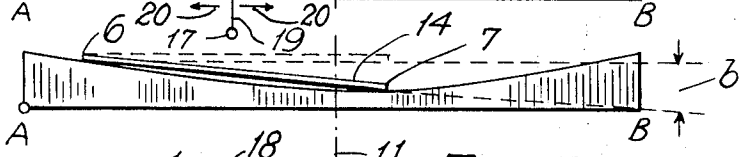


Fig. 4



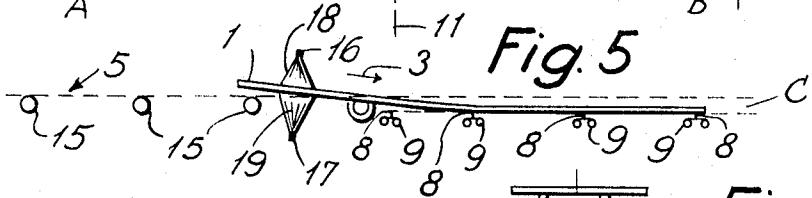


Fig. 5

Fig. 6

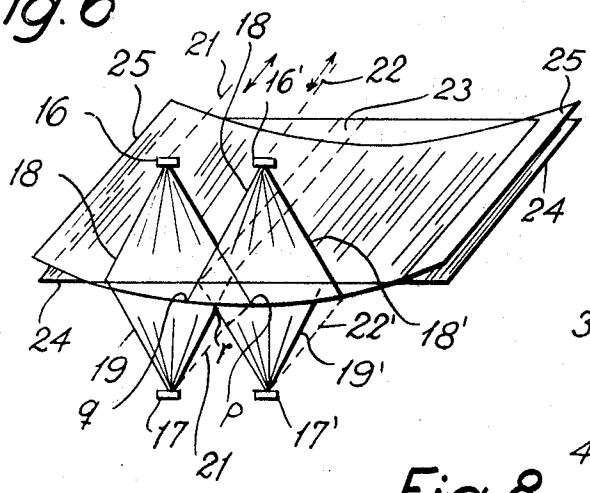


Fig. 7

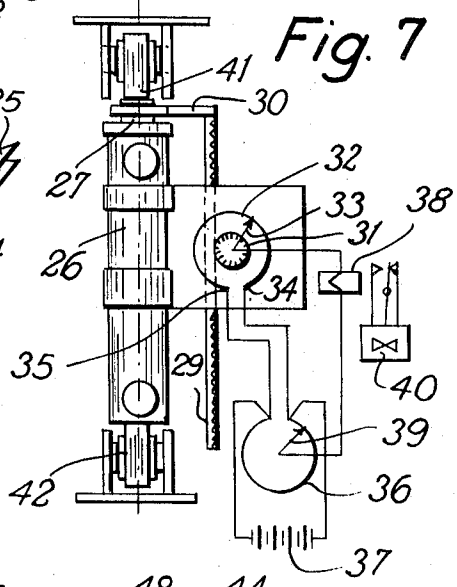
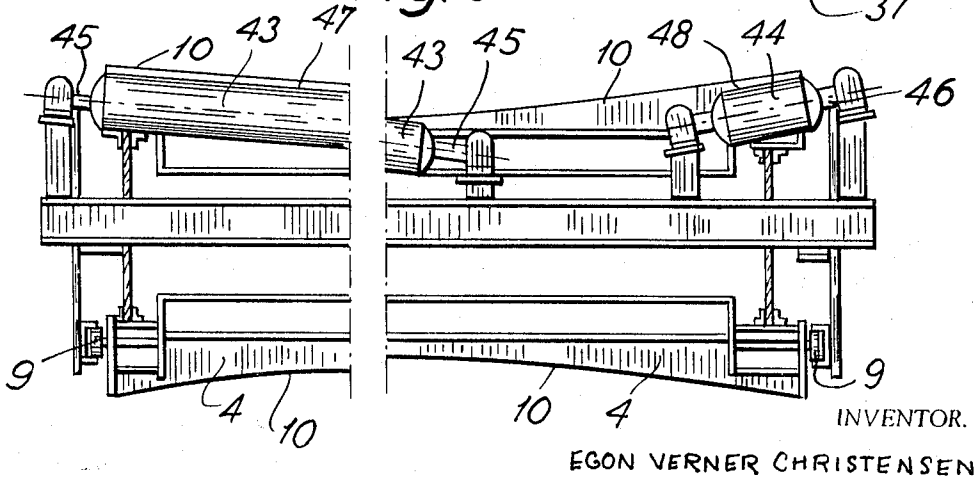


Fig. 8



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DRYING CONVEYOR

BACKGROUND OF THE INVENTION

1. Field of the Invention

Automatic painting plants for coating plate-shaped objects having at least one spray gun which is moved at right angles to the path along which the plate-shaped objects are advanced in a substantially plane conveyor carried by means having points of contacts cooperating with edges of said objects in order to avoid destruction of a coating already applied to such side of the objects as is facing the conveyor.

2. Description of the Prior Art

Drying conveyors of known art are generally mounted in such manner that the points of contact of the carrying means are flush with the plane determined by the advancement means of the painting plant to ensure a predetermined vertical distance from the spray guns in the painting plant to the object while this is being coated, in particular at the transfer of the object from painting plant to drying conveyor. Said vertical distance has to be observed rather carefully to ensure that the successive painting strokes do not overlap each other beyond what is necessary to avoid the formation of stripes on the surface of the object at the transition from one painting stroke to another.

SUMMARY OF THE INVENTION

It is the object of the invention to devise a drying conveyor in which the contact points of the carrying means of the drying conveyor always will flush with the plane determined by the advancement means of the painting plant and thereby preventing any discontinuity in the forward movement or any tilting of the object by its transfer from painting plant to drying conveyor.

Since the painting plant and the drying conveyor alike are to treat plate-shaped objects which are now of one width, now of a different width in the transverse direction of the conveying path, and since the carrying means, in order to avoid destruction of a coating already applied to such side of the plate-shaped object as is facing the conveyor, may only support the object along its side edges, the carrying means of the known plants are designed in such manner that the points of contact of the carrying means cooperating with said edges of the object are located along a curve which in a vertical plane is located transversely of the direction of conveyance. This involves, however, the drawback that a relatively narrow, plate-shaped object will be located deeper than a broader, plate-shaped object in relation to the horizontal plane which is determined by the advancement rolls of the painting plant, and the narrow object will therefore be inclined to tilt at its transfer from the said advancement rolls to the drying conveyor. As a result, the rear part of the object, which has not yet left the painting zone of the plant, may happen to be located closer to the spray guns than normally, which involves the formation of stripes on that part of the surface of the object which is treated after any such tilting.

It is the object of the invention to devise a drying conveyor in which the said drawback is wholly relieved, and a drying conveyor according to the invention has the essential feature that the carrying frame is provided with lifting means which are displaceable and adjustable in vertical direction in relation to the support of the carrying frame in dependence of the width of the plate-shaped objects and their points of contact with the supporting edges of the carrying means.

As a result, the contact points of the carrying members may be adjusted manually, or preferably automatically, until, irrespective of the width of the object, they are flush with the horizontal plane which is determined by the advancement rolls of the painting plant, thus securing the fixed distance between the flat surfaces of the object and the spray nozzles.

In a suitable embodiment of the drying conveyor according to the invention each of the lifting members consists of a mechanical, hydraulic or pneumatic lifting cylinder with a displaceable pressure rod.

As a result, the points of contact between the carrying members and a plate-shaped object which is moved with its longitudinal centerline located in the middle of the conveying path may be given such a height that the points of contact are flush with the plane of the advancement rolls of the painting plant, independently of the width of the object in the transverse direction of the conveying path.

In another embodiment of the drying conveyor according to the invention at least one set of the lifting members is placed against each of the side girders of the carrying frame and symmetrically in relation to the longitudinal centerline of the conveyor. As a result, such part of the conveying path as follows the inlet side of the conveyor may be given the same lifting or, if desired, a greater or smaller lifting dependent upon the tendency of the object to curve, for example upwards, owing to any existing mechanical bias in the longitudinal direction of the object, or tendency to be bent downwards owing to gravity.

In certain cases it is convenient in practice that the plate-shaped object is placed unsymmetrically in the transverse direction of the conveyor, so that one side edge of the object extends close to one side edge of the conveyor. In one embodiment according to the invention suitable for this purpose the lifting members are provided in such side of the carrying frame as is parallel with the direction of movement of the conveyor, the other side of the carrying frame being pivotally mounted in posts attached to the support. As a result, the other side edge of the object may be lifted to the same height as the first side edge of the object, so that any torsion of the object at its transfer from the painting plant to the drying conveyor is avoided.

It will be appreciated that the lifting members may be adjusted manually and individually, but for automatic adjustment of the lifting cylinders in one embodiment of the drying conveyor according to the invention at least one of the said cylinders is provided with a rack mounted parallelly with the direction of displacement of the pressure rod, one end part of the said rack being attached to the displaceable pressure rod of the lifting cylinder, while a gearwheel engaging the rack is rotatably mounted in the stationary part of the lifting cylinder and is mechanically coupled to an electric potentiometer which has a tap that may be rotated by the gearwheel and the position of which tap is an indication of the height to which the lifting cylinder is adjusted, the outer terminals of the said potentiometer and the said tap being connected to another potentiometer incorporated in an electric bridge circuit which has a source of current and a zero indicator, the said other potentiometer having a rotatable tap which in a manner known per se determines the height to which the lifting cylinder is adjusted, the zero indicator in the bridge circuit being connected to control means for the lifting cylinder. As a result, the zero indicator of the bridge circuit, such as a relay, may be used for controlling a driving means such as a hydraulic pump the pressure of which displaces the lifting cylinder until the taps of the two potentiometers have attained the identical angular position, in which case the displacement of the lifting cylinder is stopped in the height fixed by the adjustment of the other potentiometer, the said height corresponding to the two side edge portions of a plate-shaped object being located in the identical horizontal plane.

In a suitable embodiment of the drying conveyor according to the invention at least one of the carrying members of the drying conveyor, and preferably that carrying member which is leading in the direction of movement of the plate-shaped object, consists of at least one driven or freely rotating roller whose shaft is adjustable in a vertical plane at right angles to the direction of conveyance and is lying obliquely in such manner that the upper generatrix of the roller is located in the identical plane as one of the tangents to the supporting edge of the remaining carrying members.

As a result, the plate-shaped object is caught by a rolling support at the entrance of the drying conveyor; and the said rolling support will assist in equalizing any downward bending of the leading edge of the plate material.

BRIEF DESCRIPTION OF THE DRAWING

The invention will now be further described with reference to the drawing, in which:

FIG. 1 is a perspective view of a drying conveyor according to the invention,

FIG. 2 is the same, in a section taken at right angles to the direction of conveyance of the conveyor,

FIG. 3 shows a carrying member for the drying conveyor according to the invention in combination with plate objects of two different widths, placed symmetrically in the conveyor and viewed in their direction of movement,

FIG. 4 is the same in combination with a relatively narrow, plate-shaped object, placed unsymmetrically and with one of its side edges guided in fixed distance from one side edge of the conveyor path,

FIG. 5 shows schematically the drying conveyor according to the invention in connection with an automatic painting plant which is feeding treated, plate-shaped objects to the drying conveyor, viewed from the side and transversely of the direction of movement of the plate-shaped object,

FIG. 6 shows schematically the variation in the overlapping of successive painting strokes in case of a flat and a curved, plate-shaped object,

FIG. 7 shows a lifting member of the drying conveyor according to the invention, and

FIG. 8 a special embodiment of a carrying member for the drying conveyor.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIGS. 1 and 2 illustrate a drying conveyor for use in combination with an automatic painting plant for plate-shaped objects 1 and with an endless conveyor 2 which is provided with a number of parallel carrying members 4 for the plate-shaped objects 1, the said carrying members 4 being disposed at right angles to the direction of movement of the conveyor, indicated by an arrow 3. At least that side of the plate-shaped objects 1 which is facing the carrying members 4 of the painting plant 5, which is shown schematically in FIG. 5, has a coating of paint. The carrying members 4 are supported in a substantially horizontal carrying frame 8 and are, while the objects 1 are being conveyed, resting in local contact with such side edge portions 6 and 7 of the objects as are located in the direction of movement of the conveyor. The carrying members 4 consist of edgewise positioned plates projecting at right angles to the conveyor path 2 and mounted on rolls 9, the supporting edge 10 of the said plates being preferably formed symmetrically about the vertical center plane of the conveyor and being curved or inclined in relation to the plane of the conveyor path in such manner that the supporting edge 10 is at its greatest distance from the said plane at the side edges of the conveyor path and is lowest at the central part of the conveyor path; this prevents damage to the still unhardened coating of the plate-shaped object 1 at the advancement of the objects through the drying conveyor. Owing to the form of the supporting edge 10, which is indicated in FIG. 3, the distance of the objects 1 from the conveyor will depend in part upon the width of the objects transversely of the conveyor path as indicated in FIG. 3 where a broad object 12 placed symmetrically in the conveyor path is at a greater distance from the conveyor path, that is, in a higher horizontal plane than a narrow, plate-shaped object 13; this has certain disadvantages in the form of formation of stripes in the coating produced by the painting plant transversely of the direction of advancement of the object. In special cases it is convenient that a relatively narrow object 13 is placed unsymmetrically in relation to the center plane 11 as indicated in FIG. 4, in which one side edge 6 of the plate-shaped object is guided in a predetermined distance from one side edge of the conveyor path 2, but in that case the object 14 adopts as indicated in the FIG. an inclined position so that the other side edge 7 of the object is lying substantially lower than the first mentioned side edge 6; this involves also the formation of stripes transversely of the direction of advancement of the object.

FIG. 5 illustrates schematically a painting plant in which a plate-shaped object 1 is moved in the direction of the arrow 3 on carrying rolls 15 past spray nozzles 16 and 17, of which the former is disposed above and the latter beneath the object 1, so that paint may be applied to the upper side and to the underside of the object 1. The nozzles 16 and 17 produce fan-shaped jets 18 and 19, respectively, the planes of which are parallel with the direction of movement of the conveyor, and they perform reciprocating painting strokes at right angles to the path of movement as indicated in FIGS. 3 and 6 by arrows 20. At the transfer from the painting plant to the drying conveyor, which is indicated in FIG. 5 at the carrying members 8 and the rolls 9, the object 1 will tilt if the points of contact between the carrying members and the object 1 are not located in the same plane as that determined by the carrying rolls 15 of the painting plant. This tilting will involve the formation of stripes in the surface of the object, since the upper surface will get closer to the upper spray nozzle 16 and the lower surface be removed more from the nozzle 17 as indicated in grossly enlarged size in FIG. 5.

The distance from the nozzles 16,17 to the surface of the object is very critical 17 indicated in FIG. 6, since the edges of the material applied by the fan-shaped jets, 18, 18′ and 19, 19′, respectively, in the successive painting strokes 21 and 22 of the nozzle 16 have to overlap each other in a zone 23 as indicated in FIG. 6 when a flat object 24 is lying exactly in the predetermined distance from the two nozzles 16 and 17. The overlapping is necessary, since the fan-shaped jets 18 and 19 give a smaller amount of coating at the outer edges of the jets than at the central part of the jets, and this difference is equalized thereby that the zone 23 receives material at both painting strokes 21 and 22. A corresponding overlapping occurs on the underside of the flat object 24 by the action of the nozzle 17, 17′ respectively, which reciprocates in the direction 21′ and 22′, and their fan-shaped jets, 19 and 19′ respectively, produce a zone corresponding to the zone 23. If, however, the object on being transferred from the rolls 15 of the painting plant to the carrying members 8 of the drying conveyor is exposed to a curving, for example as indicated in FIG. 6 by a curved object 25, the jet 18 will spread to a point p and correspondingly the jet 18 will spread to a point q, so that the overlapping will be substantially greater than the zone 23, that is extending from the point p to the point q, which will result in a stripe having a coating of paint substantially thicker than the normal coating of the zone 23, and such a stripe of thicker coating will be produced at each painting stroke if the distance from the nozzle 16 to the object is greater than normal. Simultaneously the jets 19 and 19′ will be of reduced width and the overlapping of the painting strokes 21′ and 22′ will be less than normal; for example, as shown in FIG. 6, there will be no appreciable overlapping at a point r on the underside of the object 25, and here there will therefore be produced a stripe of inadequately low thickness of the coating.

If the nozzles, for example, are mounted at a distance of 30 cm. from the surface of the object 1 and the thickness of the coating aimed at is 30 μ, of which 15 μ has to be applied solely to cover the surface roughness of the object, than a simple geometric observation discloses the following variation in thickness of coating at variation in the distance x from the nozzles 16 and 17 to the surface of the objects.

x cm.	Thickness of coating on a flat, smooth surface, yμ	Thickness of coating on a flat, rough (sandblown) surface, y−15μ	Deviation in thickness of coating on an sandblown surface, percent
20	45.0	30.0	200.0
25	36.0	21.0	140.0
30	30.0	15.0	100.0
35	25.7	10.7	71.4
40	22.5	7.5	50.0

As will be seen from the table above, an alteration of 5 cm. of the location of the flat object in relation to the normal distance $x = 30$ cm. involves that the thickness of the coat of paint varies from +40 percent to b −30 percent which will be quite unsatisfactory. In addition, there is the formation of a stripe as explained with reference to FIG. 6, which stripe may be of a thickness varying from 0 μ at the point r in FIG. 6 to double the normal, that is 30 μ at variation in the distance x of ± 10 cm.

It will be appreciated from the above that to obtain a specified uniform thickness of the coating, any tilting of the plate-shaped object at its transfer from the painting plant to the drying conveyor has to be prevented. This is achieved in a drying conveyor according to the invention thereby that the carrying frame **8** is provided with lifting means **26** which are displaceable and adjustable in vertical direction in relation to the support of the carrying frame and in dependence of the width of the plate-shaped objects and the location of their points of contact with the supporting edges **10** of the carrying members **4**. The lifting members **26** may according to the invention each consist of a mechanical, hydraulic or pneumatic lifting cylinder **26** with a displaceable pressure rod **27**, as disclosed in FIGS. **2** and **7**. In one embodiment of the drying conveyor according to the invention at least one set of the lifting members is arranged against each of the side girders **8***a* and **8***b* of the carrying frame as indicated in FIG. **2** and symmetrically in relation to the longitudinal center plane of the conveyor path, as a result of which the carrying frame **8** may be lifted as a whole to such height that the contact points **6**, **7** of the object will be lying in the plane which is determined by the rolls **15** of the painting plant, so that any tilting of the object at its transfer from the painting plant to the drying conveyor is prevented.

If the broad object **12** lying symmetrically in the conveyor path and indicated in FIG. **3** indicates the maximum width of the objects, the carrying frame has thus to be lifted by means of the lifting cylinders **26** until the side edges **6**,**7** of the object are in the plane of the rolls **15**. If, however, a narrow object **13** is to be conveyed, the carrying frame **8** has to be raised a further distance *a* as indicated in FIG. **3**, by which the ends A and B of the carrying members **10** have both to be lifted a distance *a*, after which the side edges **6**,**7** of the object will be lying flush with the roll **15**. If a relatively narrow object **14** is to be conveyed with one of its side edges lying in the same contact point to the left in FIG. **3** as the broad object **12** shown therein, one end B of the carrying member has to be displaced a distance *b* as indicated in FIG. **4** and the carrying member **10** is thus to be given an angular turn about its other end A. In one embodiment of the drying conveyor according to the invention the lifting members are arranged in one side girder **8***a* of the carrying frame, the said side girder being parallel with the direction of movement of the conveyor, and the other side girder **8***b* of the carrying frame is, as indicated in FIG. **2**, rotatably mounted in at least one post **28** which is attached to the support.

In one embodiment of the lifting cylinder **26** according to the invention, shown in FIG. **7**, the lifting cylinder is provided with a rack **29** mounted parallely with the direction of displacement of the pressure rod **27**, the other end portion **30** of the rack **29** being attached to the displaceable pressure rod **27** of the lifting cylinder, and a gearwheel **31** engaging the said rack is rotatably mounted in the stationary part of the lifting cylinder and mechanically coupled to an electric potentiometer **32** which has a rotatable tap **33** which may be turned by the gearwheel and the position of which determines the level to which the lifting cylinder may be adjusted, the outer terminals **34** and **35** of the said potentiometer **32** being together with the said tap **33** connected to another potentiometer **36** which is incorporated in an electric bridge circuit which has a source of current **37** and a zero indicator **38**, the adjustment of the rotatable tap **39** of the said potentiometer determining in known manner the height to which the lifting cylinder is adjusted as the zero indicator **38** of the bridge circuit is connected to control means **40** of the lifting cylinder **26**. The lifting cylinder **26** is connected to the carrying frame and the support by means of bearings **41** and **42** for equalizing the angular turn of the carrying frame **8** at the unilateral lifting movement.

In one embodiment of the drying conveyor according to the invention, illustrated in FIG. **8**, at least one of the carrying members, and preferably that which is leading in the direction of movement of the plate-shaped object, consists of at least one driven or freely rotating cylindrical roller **43** and **44**, whose shaft, **45** and **46**, respectively, is adjustable in a vertical plane at right angles to the conveyor path **2** and arranged obliquely in such manner that the upper generatrix of the roller, **47** and **48**, respectively, lies substantially in the same plane as one of the tangents to the supporting edge **10** of the carrying member next succeeding, by which a uniform transfer of the plate-shaped objects from the painting plant to the drying conveyor is obtained.

I claim:

1. Drying conveyor for use in combination with an automatic painting plant for plate-shaped objects, the said conveyor having an endless conveying path provided with a number of parallel carrying members for the plate-shaped objects, the said carrying members being supported at right angles to the direction of movement of the conveyor by a horizontal carrying frame, and while the objects are being conveyed, said carrying members are resting in local contact with the side edge portions of the objects parallelly with the direction of movement of the objects, said carrying frame is provided with fluid-operated lifting cylinders which are displaceable and adjustable in vertical direction in relation to the support of the carrying frame and at least one of the lifting cylinders has fluid control means and being provided with a rack mounted parallelly with the direction of displacement of the pressure rod, one end part of the said rack being attached to the displaceable pressure rod of the lifting cylinder, while a gearwheel engaging the rack is rotatably mounted in the stationary part of the lifting cylinder and is mechanically coupled to an electric potentiometer which has a tap that may be rotated by the gearwheel and the position of which tap is an indication of the height to which the lifting cylinder is adjusted, the outer terminals of the said potentiometer and the said tap being connected to another potentiometer incorporated in an electric bridge circuit which has a source of current and a zero indicator, the said other potentiometer having a rotatable tap which is adjustable in dependence of the width of the plate-shaped objects and their points of contact with supporting edges of the carrying members to determine the height to which the lifting cylinder is adjusted, the zero indicator of the bridge circuit being connected to the fluid control means for the lifting cylinder.

2. Drying conveyor as claimed in claim **1**, in which at least one of the carrying members of the drying conveyor, and preferably that carrying member which is leading in the direction of movement of the plate-shaped member, consists of at least one rotatable cylindrical roller whose shaft is adjustable in a vertical plane at right angles to the direction of conveyance and is lying obliquely in such a manner that the upper generatrix of the roller is located substantially in the identical plane as one of the tangents to the supporting edge of the remaining carrying members.