Aug. 2, 1966 S. R. PORWANCHER ETAL 3,263,933

DUCT SYSTEMS

Filed July 29, 1964 3 Sheets-Sheet 1

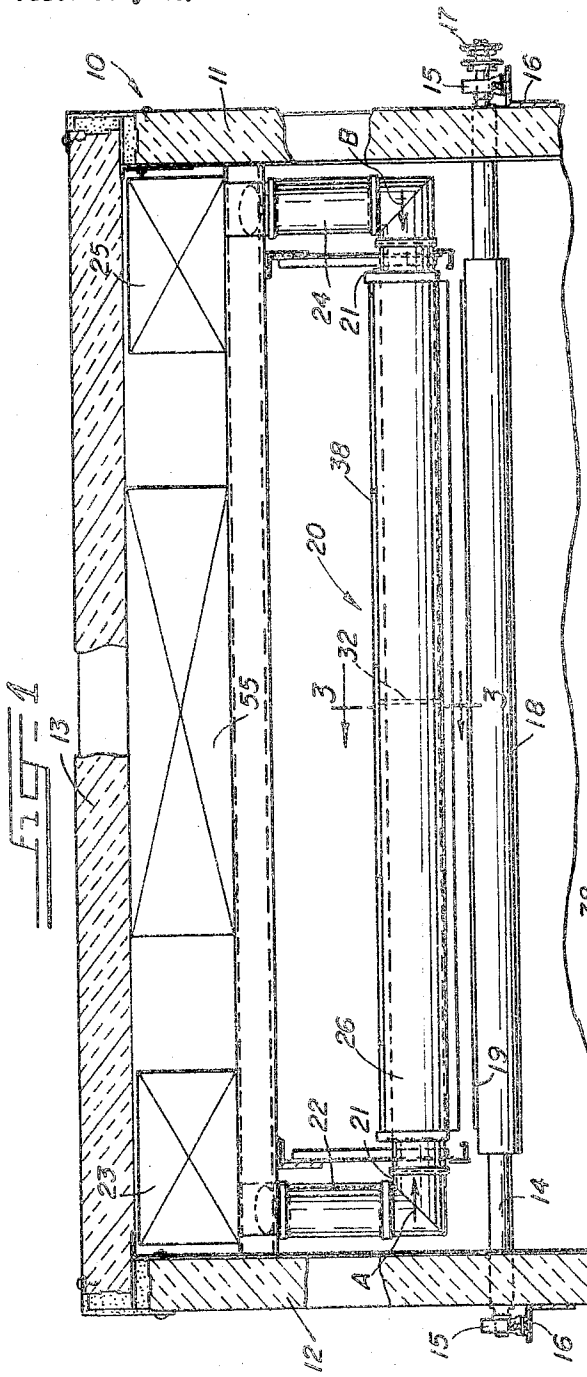


FIG-1

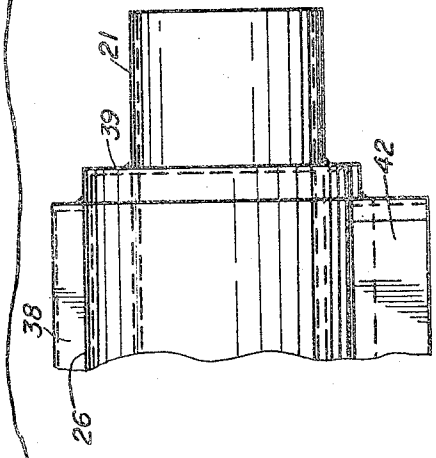


FIG-2

INVENTORS.
KENNETH W. PATTERSON
SAMUEL R. PORWANCHER
BY
Wallace, Kinzer & Ford
Attys.

Aug. 2, 1966 S. R. PORWANCHER ETAL 3,263,933

DUCT SYSTEMS

Filed July 29, 1964 3 Sheets-Sheet 2

FIG - 4

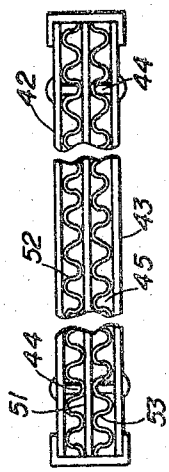


FIG - 5

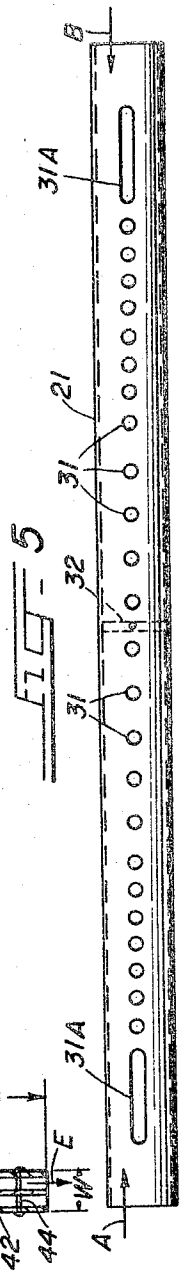
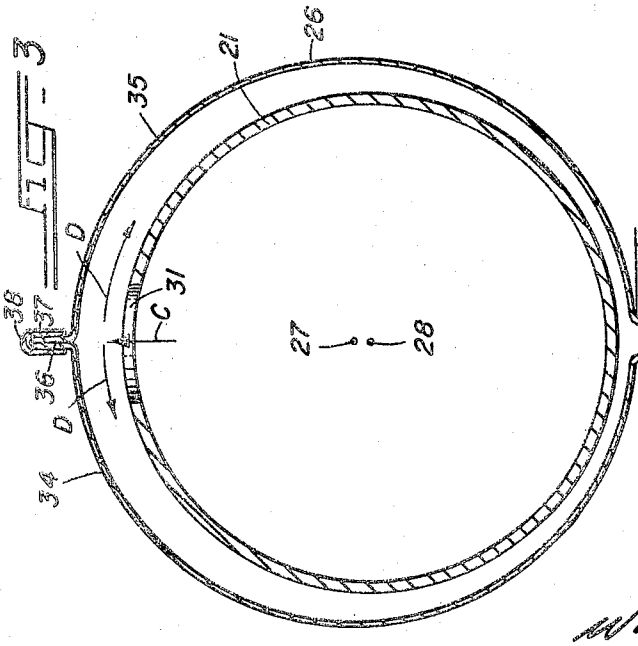


FIG - 3



INVENTORS
KENNETH W. PATTERSON
SAMUEL R. PORWANCHER
BY
Wallace, Kanzen & Ford
Attys.

Aug. 2, 1966 S. R. PORWANCHER ETAL 3,263,933

DUCT SYSTEMS

Filed July 29, 1964 3 Sheets-Sheet 3

Fig. 6

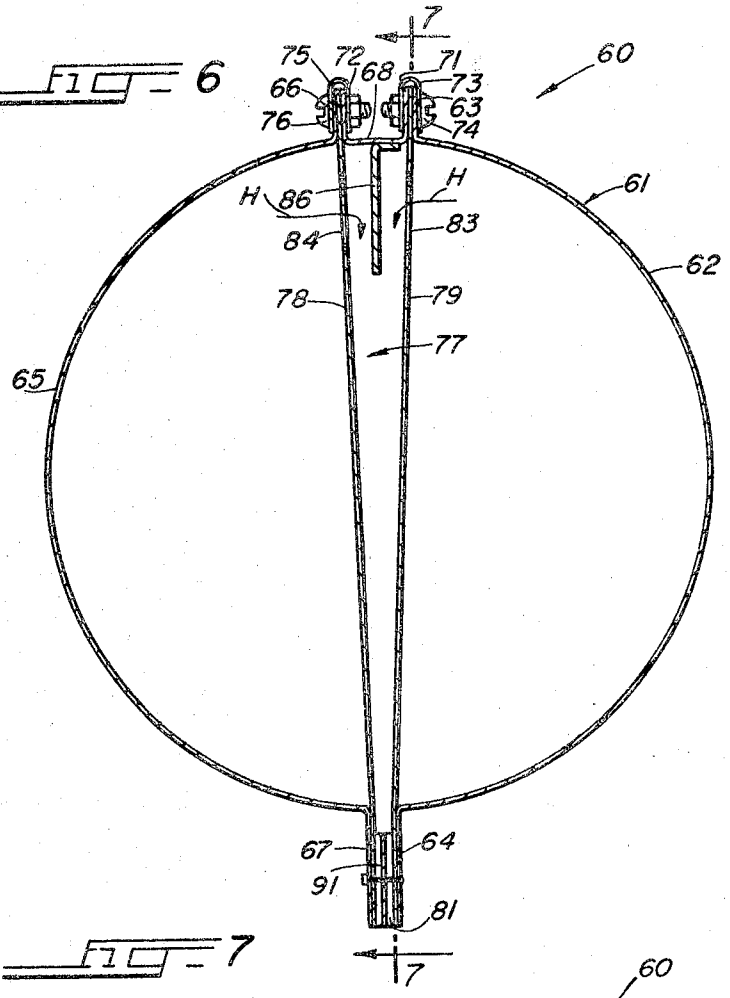
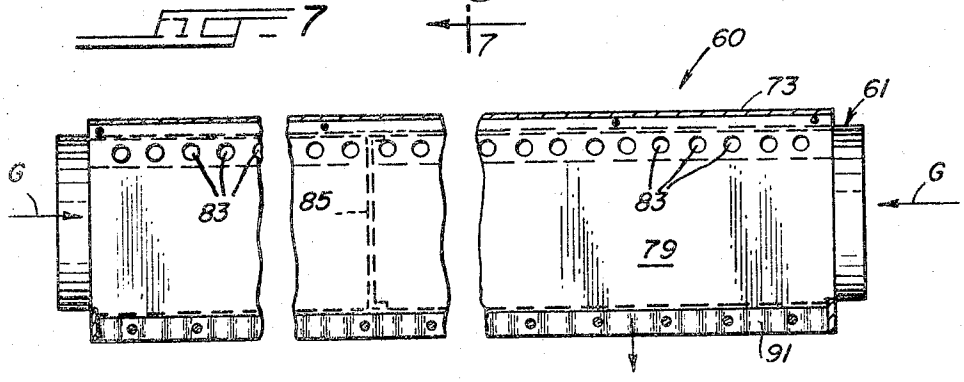


Fig. 7



INVENTORS.
KENNETH W. PATTERSON
SAMUEL R. PORWANCHER
BY
Wallace, Kinzel & Dowd
Attys

United States Patent Office 3,263,933 Patented August 2, 1966

3,263,933

DUCT SYSTEMS

Samuel R. Porwancher, Chicago, and Kenneth W. Patterson, Skokie, Ill., assignors to Michigan Oven Company, Detroit, Mich., a corporation of Michigan

Filed July 29, 1964, Ser. No. 385,864
12 Claims. (Cl. 239—552)

This invention relates to a new and improved duct system for developing a high velocity stream of air or other fluid of uniform velocity; the invention is particularly advantageous as applied to the drying of a coated web, but may also be utilized to advantage in other applications.

In many industrial processes, it is necessary to apply a liquid or semi-liquid coating to a flat sheet or continuous web, which coating must be dried or set to afford a usable product. Currently, the trend in industrial practice is to dry such coated surfaces by blowing heated air onto the coated surface at velocities substantially higher than even customary in the past. The air velocity employed may vary considerably with different installations and different processes; however, a range of approximately five to twenty thousand feet per minute may be taken as generally representative of modern installations.

At these high velocities, a large quantity of air can be passed through a relatively narrow slot. The volume of air required to carry out a given drying process on a continuous basis can ordinarily be calculated from available engineering data. This volume affords the basis for determining the number of delivery slots and the width of the slots required to furnish the necessary amount of air on the basis of a given delivery velocity.

In high velocity fluid systems of the kind with which the present system is concerned, it is frequently difficult to obtain the required uniformity of velocity over the full physical range required for the drying or other processing system. Thus, in a given application, it may be necessary to supply drying air to dry a continuous web of substantial size as, for example, a web six feet or greater in width. With an air outlet duct or nozzle of this width, it has been quite difficult to achieve uniform flow while maintaining the desired high velocity, at the same time, previously known duct systems tend toward relatively low efficiency, in many instances. Moreover, there may frequently be a substantial tendency to develop a transverse flow longitudinally of the delivery slot, rather than normal to the product, which may disrupt the drying process and prevent uniformity of drying across the width of the web or other sheet.

It is a principal object of the present invention, therefore, to provide a new and improved duct system for developing a high velocity stream of air or other fluid of uniform velocity that is applicable to applications requiring a stream of substantial width.

Another object of the invention is to afford a new and improved high velocity duct system capable of developing a uniform high velocity stream of air or other fluid that operates at high efficiency from a supply source that delivers the air or other fluid at a relatively moderate velocity.

A particular object of the invention is to provide a high velocity duct system that is compact in size and adaptable to a wide variety of industrial and other installations, yet produces output velocities comparable to those achieved by previously known systems of substantially greater size.

Another object of the invention is to afford a new and improved high velocity duct system for developing a uniform fluid stream which eliminates shock losses in the acceleration of the fluid stream yet which is adaptable to feeding of the duct system from either one end or both ends of the duct.

A particular object of the invention is to preclude the development of transverse velocity components in the output of a duct system that develops a high velocity fluid stream by effectively collimating that stream as the stream flows outwardly of the duct system.

Other and further objects of the present invention will be apparent from the following description and claims and are illustrated in the accompanying drawings which, by way of illustration, show preferred embodiments of the present invention and the principles thereof and what is now considered to be the best mode contemplated for applying these principles. Other embodiments of the invention embodying the same or equivalent principles may be made as desired by those skilled in the art without departing from the present invention.

In the drawings:

FIG. 1 is a sectional elevation view of an oven or like apparatus for drying a continuous web, incorporating a high velocity duct system constructed in accordance with one embodiment of the present invention;

FIG. 2 is a detail elevation view on an enlarged scale of one end of the duct system of FIG. 1;

FIG. 3 is a sectional view of the central portion of the duct system of FIG. 1 taken along line 3—3 therein;

FIG. 4 is a detail bottom view of the delivery slot of the duct system;

FIG. 5 is a detail plan view of the interior supply duct employed in the duct system of FIG. 1;

FIG. 6 is a sectional elevation view, similar to FIG. 3, illustrating another embodiment of the present invention; and

FIG. 7 is a sectional elevation view of the duct system of FIG. 6 taken approximately along line 7—7 therein.

FIG. 1 illustrates a drying system comprising an oven **10** in which a high velocity duct system constructed in accordance with one embodiment of the present invention is incorporated. The oven **10** includes enclosing insulated side walls **11** and **12** and an insulated top wall or roof **13**. A shaft **14** extends across the oven enclosure between the side walls **11** and **12**. The ends of the shaft **14** are extended into suitable bearings **15** mounted upon supporting brackets **16** on the exterior sides of the side walls **11** and **12**. The right-hand end of shaft **14**, as seen in FIG. 1, extends beyond the bearing and is provided with a pulley **17** or other suitable means for rotating the shaft.

The central portion of shaft **14** carries a roller **18** that is a part of a conveyor system employed to move a continuous web **19** through the oven **10**. The processing oven may be relatively long and may include a number of different processing stations. Furthermore, the conveyor mechanism for moving the web **19** may be relatively elaborate, depending upon the length of the oven and the particular processes carried out therein. Moreover, it should be understood that the web **19** may also be taken as representative of a separate sheet of material. The present invention is concerned only with a drying station or similar station within the oven **10** at which a high velocity stream of air or other compressible fluid is to be directed against the web **19**.

The duct system **20** illustrated in FIG. 1, which comprises one embodiment of the present invention, includes an elongated central supply duct **21**. As best shown in FIG. 3, the supply duct **21** is of circular configuration in cross-section. The left-hand end of the supply duct **21** is connected through a vertical duct **22** to a first input duct **23** that is located in the upper left-hand corner of the oven **10** as viewed in FIG. 1. The right-hand end of supply duct **21** is similarly connected through a vertical duct **24** to an input duct **25** positioned in the upper right-hand corner of the oven. The two ducts **23** and **25** are connected to a suitable supply of heated air or other desired compressible fluid; the particular apparatus em-

ployed to furnish air to the inlet ducts 23 and 25 is not critical to the present invention, so long as it is capable of supplying the two inlet ducts with essentially equal quantities of air at equalized pressures and velocities. Accordingly, the primary air supply has not been illustrated in the drawings.

An elongated acceleration duct 26 is mounted in encompassing relation to the supply duct 21. Acceleration duct 26, like duct 21, is of circular cross-section. However, the two ducts are not mounted in concentric relation. Rather, and as best illustrated in FIG. 3, the acceleration duct 26 is disposed eccentrically with respect to the supply duct 21, the center 27 of the acceleration duct being located above the center 28 of the supply duct. This eccentric orientation of the two ducts 21 and 26 with respect to each other affords a construction in which the effective width of the acceleration duct 26 is at a maximum at the top of the acceleration duct and progressively decreases, around the two sides of the duct system, to a minimum width at the bottom of the acceleration duct.

Supply duct 21 is interconnected with acceleration duct 26 by means of a plurality of individual openings such as the opening 31 shown in FIG. 3. The openings interconnecting the two ducts are not uniform along the length of the supply duct. Rather, these openings are graduated to afford decreasing interconnection between the two ducts from the outer ends of supply duct 21 to the center of the supply duct. Moreover, a barrier or bulkhead 32 is mounted at the center of supply duct 21, as shown in FIGS. 1 and 5. This central barrier 32 prevents head-on collision of the two streams of fluid flowing into supply duct 21 from the left and right-hand ends respectively, as indicated by arrows A and B. A typical arrangement for the inter-duct openings, graduated in size and in spacing from the ends of the duct toward the center, is shown in FIG. 5.

FIGS. 2 and 3 illustrate a typical construction that may be adopted to afford a practical and relatively economical means for erecting the acceleration duct 26 and mounting the same in encompassing relation to the supply duct 21. In the illustrated construction, the external acceleration duct wall is constructed in the form of two semi-circular wall members 34 and 35. The upper ends of the wall members 34 and 35 terminate in a pair of flanges 36 and 37 respectively. A U-shaped connecting strip 38 is mounted over the two flanges 36 and 37 and is spot-welded or otherwise suitably joined to the two flanges to join the top edges of the two duct wall members 34 and 35.

As shown in FIG. 2, the end of acceleration duct 26 is provided with a cap 39 having an opening through which the central supply duct 21 extends. Of course, the opening in the cap 39 for the acceleration duct is eccentric with respect to the center of the cap to afford the required eccentricity between the two ducts discussed hereinabove. Cap 39 may be tack-welded or otherwise suitably secured to the end of acceleration duct 26 and to the outer surface of supply duct 21, affording a rigid duct assembly.

Referring again to FIG. 3, it is seen that the two acceleration duct wall members 34 and 35 terminate at their lower ends in a pair of lip or flange members 42 and 43 respectively. The flange members 42 and 43 are secured in parallel relation to each other by suitable means such as a plurality of nails, screws, or bolts 44 extending between the two flanges. If nails are employed, these may be welded to the two flanges to assure equal spacing between the flanges. The two flanges 42 and 43 comprise a discharge means for the duct system, as described more fully hereinafter, affording an elongated narrow discharge slot 45 leading outwardly from the lower end of acceleration duct 26. FIG. 4 illustrates a delivery slot 45 as seen from below.

In considering the operation of the duct system 20 of FIGS. 1–5, the starting point is the two supply ducts 23 and 25. These ducts, together with the air blower or other supply means (not shown) connected thereto and the feeder ducts 22 and 24, afford a means for supplying air or other compressible fluid under pressure and at moderate velocity into both ends of supply duct 21. The inflow of air into supply duct 21 is indicated by arrows A and B in FIGS. 1 and 5. As noted above, the central barrier 32 within the supply duct prevents head-on collision of the two streams of fluid at the center of the duct.

From supply duct 21, the air or other fluid flows out of this duct and into acceleration duct 26 through the openings 31 in the supply duct. The graduated spacing of openings 31 illustrated in FIG. 5 equalizes the flow from the supply duct to the acceleration duct, assuring a substantially uniform supply of fluid throughout the length of the acceleration duct. If ungraduated openings were employed, or if more and larger openings were provided at the central portion of the supply duct rather than at the end portions, there would be a greater flow of air from the supply duct to the acceleration duct at the center of the duct system, producing a substantial non-uniformity in the output from the duct system. In most processes, uniformity of output throughout the length of the duct system is highly important, so that the illustrated graduated spacing of the openings 31 is frequently critical insofar as effective operation of the system is concerned. The spacing requirement for the outlet openings has not been reduced to mathematical formulation, but must be determined empirically for any given duct system. However, this determination is not unduly difficult once it is realized that the openings must be graduated, decreasing in number or in size, or both, from the inlet end of the supply duct, to the center thereof. Of course, in a duct system in which the supply duct is fed with fluid from only one end, the graduation is from the inlet end to the opposite end of the supply duct.

From supply duct 21, the air or other fluid flows outwardly through the openings 31 as illustrated by arrow C in FIG. 3. As the fluid moves into the annular acceleration duct 26, the stream is divided and the fluid flows peripherally around the acceleration duct. The two air streams are again combined at the entrance to slot 45 between flanges 42 and 43. Moreover, the progressively decreasing width of the annular acceleration duct produces a progressive increase in the velocity of fluid flow. Thus, the velocity of the fluid at the outlet portion of acceleration duct 26, which is the fluid entering delivery slot 45, is substantially greater than the velocity at the inlet portion of the acceleration duct, indicated by arrows D. The fluid is discharged from slot 45 as indicated by arrow E at a high velocity; moreover, this velocity is quite uniform along the full length of the delivery slot. Thus, duct system 20 produces a high velocity stream of air or other compressible fluid, a stream of uniform velocity, that impinges upon web 19 and produces the desired drying or other process effect.

In the duct system 20, there may be some tendency for the air stream to develop some velocity in a direction parallel to the length of slot 45 and thus parallel to the width of web 19. In most applications, the resulting lateral movement of the air stream would be undesirable. To correct this tendency toward undesired movement of the air stream impinging upon the web, and to collimate the air stream in a direction normal to the web, slot 45 may be provided with a series of baffles extending through the delivery slot in the direction of desired outward flow.

One construction that may be utilized for this purpose is illustrated in FIG. 4. As shown therein, the slot 45 is effectively divided into two slots by a central flat strip 51 extending longitudinally of the slot. A corrugated baffle member 52 is mounted in the one side of slot 45 between strip 51 and flange 42. A corresponding corrugated baffle member 53 is mounted in the other half of the delivery slot between strip 51 and flange 43. The corrugated baffle members 52 and 53 may be fabricated from relatively light gauge sheet metal by any suitable means for bending the

sheet metal to afford the required transverse corrugations or baffles. One simple method of producing a usable corrugated baffle member is simply to pass a strip of light gauge sheet metal between a pair of gears which are slightly out of mesh. The corrugated baffle members **52** and **53** and the central divider strip **51** are held in place by the nails, bolts, or similar members **44**. It is not essential that two corrugated baffle strips such as strips **52** and **53** be utilized in the delivery slot; a single corrugated member affording the desired multiplicity of transverse baffles may be utilized, or three or more such strips may be employed, depending upon the required open area in the delivery slot.

To complete the processing apparatus in oven **10**, it is usually necessary to provide a suitable exhaust duct. In the construction illustrated in FIG. 1, an exhaust duct **55** is disposed immediately below the top wall **13** of the oven, extending over the processing station that includes the duct system **20**. The exhaust duct may be connected to a suitable exhaust fan (not shown).

The duct system **20** of FIGS. 1 through 5 affords a highly uniform high velocity stream from the discharge slot **45**, the high velocity stream being effectively collimated and directed almost solely along a path normal to web **19**. The configuration of acceleration duct **26** affords a gradual increase in the fluid velocity from the openings **31** to the discharge slot. This gradual increase in velocity of the fluid stream within the acceleration duct, which effectively creates a nozzle effect throughout the length of the acceleration duct, avoids sudden and restrictive changes in velocity. Consequently, shock losses due to abrupt velocity changes in the system are materially reduced, so that a relatively high efficiency can be maintained. At the same time, the duct system is quite compact, particularly because the acceleration duct is disposed in encompassing relation to the supply duct rather than being constructed as a separate and independent member. The small size of the duct, more clearly illustrated in the specific example furnished hereinafter, makes it possible to incorporate this system in a wide variety of different installations. This inherent design flexibility is also aided by the fact that the duct system can be fed from both ends or from one end and thus may be fitted to the particular supply arrangements available in a given oven or other processing apparatus.

In order to afford a more complete example of the embodiment of the invention illustrated in FIGS. 1 through 5, certain specific data with respect to duct dimensions and air velocities are set forth hereinafter for a given air drying system. It should be understood that these data are furnished solely by way of illustration and in no sense as a limitation on the present invention.

Supply duct 21

	Inches
Inside diameter	4.06
Outside diameter	4.25
Openings **31**, diameter	1.00
Slots **31A**, length	6.00

Acceleration duct 26

	Inches
Inside diameter	4.78
Eccentricity, **27** to **28**	0.125
Delivery slot length L	1.00
Delivery slot width W	0.225

Velocities

	Ft./min.
Inlet velocity (arrows A, B)	2290
Inter-duct velocity (arrow C)	2000
Initial acceleration duct velocity (arrow D)	1180
Discharge velocity (arrow E)	5680

FIGS. 6 and 7 illustrate a duct system **60** that is in many respects essentially similar to the duct system **20** discussed hereinabove in connection with FIGS. 1–5, but which is modified in other respects and constitutes a second embodiment of the present invention. Duct system **60** may be incorporated in a processing apparatus such as the oven **10** illustrated in FIG. 1; no environmental apparatus has ben shown with respect to system **60**.

Duct system **60** comprises an elongated supply duct **61** of generally circular cross-sectional configuration. Supply duct **61** is constructed in three pieces. Thus, the supply duct comprises a first substantially semi-circular duct wall member **62** terminating in an upper flange **63** and a lower flange **64**. The opposite side of the supply duct comprises a similar duct wall member **65** having an upper end flange **66** and a lower flange **67**. The supply duct is completed by a relatively small spacer channel **68** that is interposed between the upper ends of wall members **62** and **65**. That is, the two flanges **71** and **72** of channel member **68** are aligned with and disposed between the flanges **63** and **66** on the main wall members for the duct.

The assembly of the supply duct **61** is somewhat similar to that employed for the acceleration duct **26** of the previously described embodiment. Thus, a U-shaped sealing strip **73** is mounted over flanges **63** and **71** and is clamped to the two flanges by suitable means such as a series of bolts **74**. A similar sealing strip **75**, secured by bolts **76**, clamps the flanges **66** and **72** together.

Duct system **60** is of inverted construction as compared with the previously described duct system **20** in that the acceleration duct in system **60** is disposed within the supply duct **61** whereas in the first described embodiment the supply duct is mounted within the acceleration duct. In duct system **60**, the acceleration duct **77** is formed by a pair of partition members **78** and **79** that extend longitudinally through supply duct **61**. The upper end of partition member **79** is clamped between flanges **63** and **71** and the upper end of partition member **78** is clamped between flanges **66** and **72**. The lower end of partition **79** is spot welded or otherwise affixed to the flange **64** of the supply duct. Similarly, the lower edge portion of partition **78** is secured to the inner surface of flange **67**.

In duct system **60**, the requisite interconnection between supply duct **61** and acceleration duct **77** is provided by a plurality of openings at the inlet portion to the acceleration duct. In the illustrated construction, the inlet to the acceleration duct is at the top of the duct. This is the widest part of the acceleration duct. Thus, the spacing between partition members **77** and **78** at the top or inlet edges thereof, determined by the width of channel **68**, is substantially greater than the spacing between the partition members at the discharge slot **81** defined by the extensions of the partitions between the parallel flanges **64** and **67**. Thus, and as in the previous embodiment, the acceleration duct progressively decreases in width from the upper or inlet portion to the lower or outlet portion of that duct.

There are two series of openings from the supply duct **61** to the acceleration duct **77**. Thus, there is a first series of air holes or openings **83** distributed along the upper portion of partition member **79** and there is a similar series of openings **84** near the top edge of partition member **78**. The openings **83** and **84** may be of uniform size and substantially uniform spacing as shown in FIG. 7. On the other hand, these openings may be graduated from the inlet ends of the supply duct **61**, gradually increasing in spacing so that there are fewer effective openings near the center of the supply duct as in the previously described embodiment. Again, a central barrier **85** is provided in the supply duct so that the two air streams do not impinge upon each other at the center of the supply duct. However, and as in the case of the first described embodiment, it is equally possible to feed the supply duct from one end only. Because the openings **83** and **84** are located directly opposite each other, substantial turbulence may occur in the inlet portion of

acceleration duct **77**. The head-on collision of the two air streams entering the acceleration duct could thus produce a substantial energy loss with resultant reduction in efficiency of the system. To prevent this, a baffle **86** is mounted upon channel member **68** and projects down between the inter-duct openings **83** and **84**.

The outlet slot **81** from acceleration duct **77** is essentially similar in construction to the discharge slot utilized in the previously described system. Preferably, one or more corrugated baffle members, like baffle members **52** and **53** (FIG. 4) are mounted in delivery slot **81** to collimate the output from the duct system. In FIG. 6, only a single such corrugated baffle member **91** is shown, but it should be understood that a multiple baffle construction as described hereinabove may be employed, depending upon the width of slot **81**. The corrugated baffle again affords a plurality of individual transverse baffle elements that assure uniform direction in the stream of fluid flowing outwardly of slot **81**.

The operation of duct system **60** is essentially similar to that of previously described duct system **20**. Air or other processing fluid enters supply duct **61** at the two ends thereof as indicated in FIG. 7 by the arrows G. The fluid flows longitudinally of the supply duct, but the two air streams are prevented from head-on collision by the central barrier **85**.

As shown by the arrows H in FIG. 6, the air flow from supply duct **61** into acceleration duct **77** comes from both sides of the supply duct through the openings **83** and **84**. The fluid flows downwardly through acceleration duct **77**, progressively increasing in velocity due to the progressive decrease in width of the acceleration duct. Fluid is discharged through slot **81** at a substantially higher velocity than that at which it was admitted to supply duct **61**. Moreover, the outlet velocity from slot **81** is quite uniform throughout the length of the duct system. Duct system **60**, like duct system **20**, may be extended to a substantial length, such as a length of eight to ten feet or even more, while still maintaining a uniform high velocity output.

Like system **20**, duct system **60** is highly compact and can be utilized in virtually any application. On the other hand, the system exhibits relatively high efficiency, since abrupt changes in velocity are avoided and shock losses are thus held to a minimum. Thus, duct system **60** shares the advantages of system **20** noted hereinabove. In addition, duct system **60** is somewhat less expensive than duct system **20** because only one complete duct housing is required, the second duct, acceleration duct **77**, being provided by partitioning the central portion of supply duct **62**. Furthermore, system **60** does not require the provision of a self-supporting central duct such as the supply duct **21** of the first described embodiment.

Both duct systems described herein have the flexibility of being rotatable about the longitudinal axis of the duct. This makes it possible to deliver high velocity fluid, not only at right angles to the product but also angularly to the product, either in the direction of product travel or opposing product travel and at any angle tangential to product flow and including parallel to product flow. Where the product has generally been mentioned in the previous description as a coated web or sheet, and the application mentioned as drying, the invention has other important applications not restricted to drying, such as cooling, moisture removal, or blow-off; the product is not confined to web or sheet applications.

Hence, while preferred embodiments of the invention have been described and illustrated, it is to be understood that they are capable of variation and modification.

We claim:

1. A duct system for developing a high-velocity stream of fluid of uniform velocity comprising:
- an elongated supply duct;
- means for supplying fluid under pressure at moderate velocity into one end of said supply duct;
- an elongated acceleration duct, having an inlet portion along one side and an outlet portion along the opposite side, said acceleration duct progressively decreasing in width from said inlet portion to said outlet portion to progressively increase the velocity of fluid flowing therethrough;
- one of said ducts being mounted within the other, the innermost duct having opening means interconnecting said supply duct with the inlet portion of said acceleration duct;
- and discharge means affording an elongated narrow delivery slot connected to said outlet portion of said acceleration duct to deliver a uniform high-velocity stream of fluid outwardly of said acceleration duct along the length of that duct.

2. A duct system for developing a high-velocity stream of fluid of uniform velocity comprising:
- an elongated supply duct;
- means for supplying fluid under pressure at moderate velocity into one end of said supply duct;
- an elongated acceleration duct, having an inlet portion along one side and an outlet portion along the opposite side, said acceleration duct progressively decreasing in width from said inlet portion to said outlet portion to progressively increase the velocity of fluid flowing therethrough;
- one of said ducts being mounted within the other, the innermost duct having opening means interconnecting said supply duct with the inlet portion of said acceleration duct;
- discharge means affording an elongated narrow delivery slot connected to said outlet portion of said acceleration duct to deliver a uniform high-velocity stream of fluid outwardly of said acceleration duct along the length thereof;
- and at least one series of baffles extending through said delivery slot in the direction of desired outward flow, for effectively collimating the fluid flow from the delivery slot.

3. A duct system for developing an elongated high-velocity stream of fluid of uniform velocity comprising:
- an elongated supply duct;
- means for supplying fluid under pressure at moderate velocity into both ends of said supply duct;
- a transverse barrier extending across the central portion of said supply duct to prevent direct collision of the two streams of fluid flowing into said supply duct;
- an elongated acceleration duct, having an inlet portion along one side and an outlet portion along the opposite side, said acceleration duct progressively decreasing in width from said inlet portion to said outlet portion to progressively increase the velocity of fluid flowing therethrough;
- one of said ducts being mounted within the other, the innermost duct having opening means interconnecting said supply duct with the inlet portion of said acceleration duct;
- and discharge means, affording an elongated narrow delivery slot connected to said outlet portion of said acceleration duct and having parallel walls, for delivering a uniform high-velocity stream of fluid outwardly of said acceleration duct along the length thereof.

4. A duct system for developing a high-velocity stream of compressible fluid of uniform velocity comprising:
- an elongated supply duct;
- means for supplying fluid under pressure at moderate velocity into one end of said supply duct;
- an elongated acceleration duct, having an inlet portion along one side and an outlet portion along the opposite side thereof, said acceleration duct progressively decreasing in width from said inlet portion to said outlet portion to progressively increase the velocity of fluid flowing therethrough;

one of said ducts being mounted within the other, the innermost duct having a plurality of individual openings interconnecting said supply duct with the inlet portion of said acceleration duct;

and discharge means affording an elongated narrow delivery slot connected to said outlet portion of said acceleration duct and having parallel walls, for delivering a uniform high-velocity stream of fluid outwardly of said acceleration duct along the length thereof.

5. A duct system for developing a high-velocity stream of compressible fluid of uniform velocity comprising:

an elongated supply duct;

means for supplying fluid under pressure at moderate velocity into one end of said supply duct;

an elongated acceleration duct, having an inlet portion along one side and an outlet portion along the opposite side thereof, said acceleration duct progressively decreasing in width from said inlet portion to said outlet portion to progressively increase the velocity of fluid flowing therethrough;

one of said ducts being mounted within the other, the innermost duct having a plurality of individual openings interconnecting said supply duct with the inlet portion of said acceleration duct, said openings being graduated to afford substantially more inter-duct access at said one end of said supply duct than at the opposite end;

discharge means affording an elongated narrow delivery slot connected to said outlet portion of said acceleration duct and having parallel walls, for delivering a uniform high-velocity stream of fluid outwardly of said acceleration duct along the length thereof;

and a series of transverse baffles in said delivery slot for collimating the outward flow of fluid from said slot.

6. A duct system for developing a high-velocity stream of a compressible fluid, of uniform velocity, comprising:

an elongated supply duct having a plurality of outlet openings along one side thereof;

means for supplying fluid under pressure at moderate velocity into one end of said supply duct;

an elongated acceleration duct mounted in eccentric encompassing relation to said supply duct so that the effective width of said acceleration duct is at a maximum along one side immediately adjacent said supply duct outlet openings and progressively decreases to the opposite side of said acceleration duct to progressively increase the velocity of fluid flowing peripherally of said acceleration duct;

and discharge means affording an elongated narrow delivery slot connected to said opposite side of said acceleration duct to deliver a uniform high-velocity stream of fluid outwardly of said acceleration duct along the length thereof.

7. A duct system for developing a high-velocity stream of a compressible fluid, of uniform velocity, comprising:

an elongated supply duct of circular cross-sectional configuration having a plurality of outlet openings along one side thereof;

means for supplying fluid under pressure at moderate velocity into one end of said supply duct;

an elongated acceleration duct of circular cross-sectional configuration mounted in eccentric encompassing relation to said supply duct so that the effective width of said acceleration duct is at a maximum along one side immediately adjacent said supply duct outlet openings and progressively decreases to the opposite side of said acceleration duct to progressively increase the velocity of fluid flowing peripherally of said acceleration duct;

discharge means affording an elongated narrow delivery slot, having parallel walls, connected to said opposite side of said acceleration duct to deliver a uniform high-velocity stream of fluid radially outwardly of said acceleration duct along the length thereof;

and a series of parallel baffles extending across said delivery slot to reduce any longitudinal component of flow in said slot to a minimum and thereby collimate said high-velocity stream.

8. A duct system for developing a high-velocity stream of a compressible fluid, of uniform velocity, comprising:

an elongated supply duct having a plurality of individual spaced outlet openings along one side thereof, said openings being graduated to decrease the effective outlet opening area progressively from one end of said supply duct to the other;

means for supplying fluid under pressure at moderate velocity into said one end of said supply duct;

an elongated acceleration duct mounted in asymmetrical encompassing relation to said supply duct so that the effective width of said acceleration duct is at a maximum along one side immediately adjacent said supply duct outlet openings and progressively decreases to the opposite side of said acceleration duct to progressively increase the velocity of fluid flowing peripherally of said acceleration duct;

and discharge means affording an elongated narrow delivery slot connected to said opposite side of said acceleration duct to deliver a uniform high-velocity stream of fluid outwardly of said acceleration duct along the length thereof.

9. A duct system for developing a high-velocity stream of a compressible fluid, of uniform velocity, comprising:

an elongated supply duct of circular cross-section having a plurality of spaced outlet openings along one side thereof, with progressively fewer openings from the ends of said duct to the center;

means for supplying fluid under pressure at moderate velocity into both ends of said supply duct;

a central barrier within said supply duct preventing head-on collision of the two streams of fluid flowing into the duct;

an elongated acceleration duct of circular cross-section mounted in eccentric encompassing relation to said supply duct so that the effective width of said acceleration duct is at a maximum along one side immediately adjacent said supply duct outlet openings and progressively decreases to the opposite side of said acceleration duct to progressively increase the velocity of fluid flowing peripherally of said acceleration duct, said acceleration duct having a narrow discharge opening extending continuously along said opposite side;

discharge means affording an elongated narrow delivery slot, having parallel walls, connected to said discharge opening of said acceleration duct to deliver a uniform high-velocity stream of fluid outwardly of said acceleration duct along the length thereof;

and at least one corrugated member mounted within said delivery slot to afford a multiplicity of transverse baffles for collimating the outward flow of said high-velocity fluid stream.

10. A duct system for discharging a high-velocity stream of fluid at uniform velocity comprising:

an elongated supply duct;

means for supplying fluid under pressure at moderate velocity into one end of said supply duct;

an elongated acceleration duct, having an inlet portion along one side and an outlet portion along the opposite side, said acceleration duct progressively decreasing in width from said inlet portion to said outlet portion to progressively increase the velocity of fluid flowing therethrough;

said acceleration duct being mounted within said supply duct and having a plurality of openings interconnecting the inlet portion of said acceleration duct with said supply duct;

and discharge means affording an elongated narrow

delivery slot connected to said outlet portion of said acceleration duct to deliver a uniform high-velocity stream of fluid outwardly of said ducts along the length thereof.

11. A duct system for discharging a high-velocity stream of fluid at uniform velocity comprising:

an elongated supply duct;

means for supplying fluid under pressure at moderate velocity into one end of said supply duct;

a pair of partition members extending longitudinally within said supply duct and defining an elongated acceleration duct, having an inlet portion along one side and an outlet portion along the opposite side, said partition member being so positioned that said acceleration duct decreases in width from said inlet portion to said outlet portion to progressively increase the velocity of fluid flowing therethrough;

said partition members each having a plurality of openings interconnecting the inlet portion of said acceleration duct with said supply duct;

a baffle member mounted in and extending longitudinally of the inlet portion of said acceleration duct between said partition members to preclude direct collision of fluid streams entering said acceleration duct through said openings;

and discharge means affording an elongated narrow delivery slot connected to said outlet portion of said acceleration duct to deliver a uniform high-velocity stream of fluid outwardly of said ducts along the length thereof.

12. A duct system for discharging a high-velocity stream of fluid at uniform velocity comprising:

an elongated supply duct of circular cross section;

means for supplying fluid under pressure at moderate velocity into one end of said supply duct;

an elongated acceleration duct, having an inlet portion along one side and an outlet portion along the opposite side, said acceleration duct progressively decreasing in width from said inlet portion to said outlet portion to progressively increase the velocity of fluid flowing therethrough;

said acceleration duct being formed by a pair of elongated partition members mounted within said supply duct and closing off the central portion thereof, at least one of said partition members having a plurality of openings interconnecting the inlet portion of said acceleration duct with said supply duct;

discharge means affording an elongated narrow parallel-wall delivery slot connected to and projecting outwardly of said outlet portion of said acceleration duct to deliver a uniform high-velocity stream of fluid outwardly of said ducts along the length thereof;

and a series of transverse baffle members within said slot for collimating said high-velocity stream.

References Cited by the Examiner

UNITED STATES PATENTS

1,186,226	6/1916	Parker	239—553
1,751,960	3/1930	Veenstra	239—561
1,759,231	5/1930	Feldmeier et al.	239—552
2,624,559	1/1953	Hyde	239—560
2,624,625	1/1953	Magos et al.	239—590
2,919,861	1/1960	Meek	239—561

EVERETT W. KIRBY, *Primary Examiner.*