

Aug. 23, 1966

G. B. GERRISH

3,267,690

GASEOUS FLOW REFRIGERATING APPARATUS

Filed May 28, 1964

2 Sheets-Sheet 1

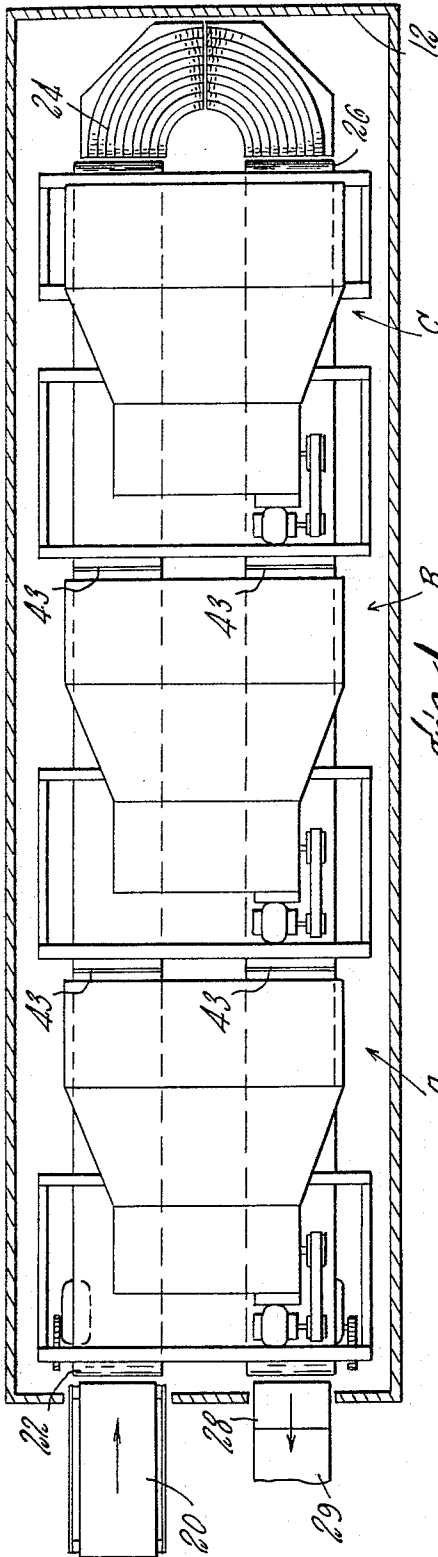


Fig. 1.

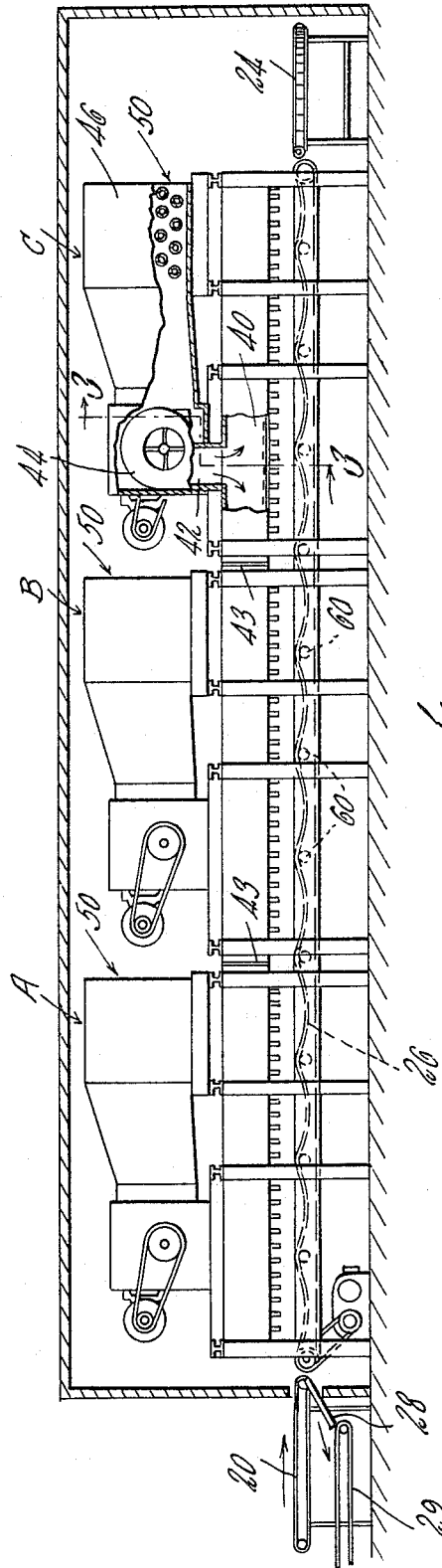


Fig. 2.

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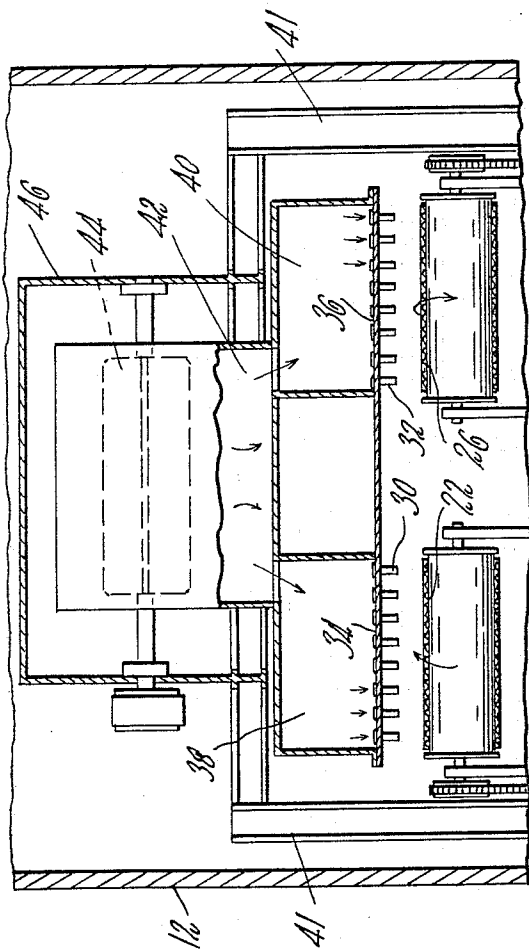


Fig. 3.

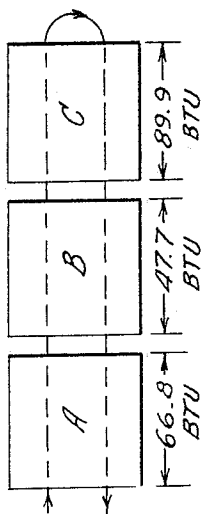


Fig. 4.

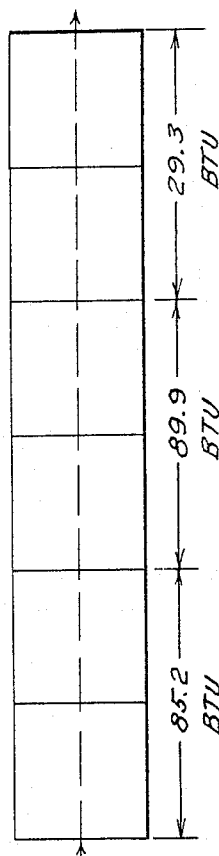


Fig. 5.

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GASEOUS FLOW REFRIGERATING APPARATUS
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Filed May 28, 1964, Ser. No. 370,800
1 Claim. (Cl. 62—380)

This invention relates to heat transfer apparatus and more particularly to the construction and operation of apparatus for freezing products advancing at a uniform rate along a continuous substantially horizontal path through gaseous cooling media circulating in the apparatus.

It has heretofore been proposed to construct such apparatus in such manner that the gaseous cooling media circulating through successive zones of the product advance are served by separate banks of cooling coils. In such equipment the path of travel of the articles to be frozen is commonly through successive separate streams of air circulating transversely to the path of movement of the advancing articles, rather than circulating in parallel, i.e. either concurrently or in counterflow, to the direction of article advance.

With the use of transverse compartmentalized or zoned flow of cooling media, such apparatus lends itself very well to modular construction, each contemplated zone having ducts forming a path for recirculation of its portion of the cooling media, after it has contacted articles advancing through its zone of the conveyor, through an independent refrigerating unit consisting of a bank of cooling coils and an associated blower.

Modular construction is of advantage since the number of modules utilized can depend upon the particular requirements of a particular customer for a particular product—two, three, four or more of the units can be placed end-to-end so that a continuous conveyor passes through all of the modules.

One of the great savings in module construction, however, depends upon all the modules having as much identical structure as possible, so as to adapt them to fabrication with modern day production line systems.

It has hence been usual to provide each module with identical but separate cooling units. The result has been in many cases that the required cooling capacity provided in an advance or middle unit is such that the same capacity in a trailing unit is entirely unnecessary for a particular application. For example, three units may not be sufficient to give adequate through-put dwell for a certain product, thus requiring the addition of a fourth unit to finish the job, but the fourth unit may not be required to operate anywhere near capacity. This constitutes an unnecessary capital expenditure.

It is thus an object of this invention to reduce the inequalities in the loads imposed upon independent cooling units assembled with a continuous conveyor system, whereby in many cases identical cooling units of less capacity may be used by reason of imposing part of the load which normally is imposed upon one unit onto a different

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unit which otherwise would not be called upon to operate at full capacity. Not only is initial capital expenditure decreased, but additionally, operation is more efficient where all the cooling units operate not too far below full capacity.

These and other objects of the invention will be more fully understood when taken in connection with the description of a typical refrigeration system embodying the invention as shown in the accompanying drawings, wherein:

FIG. 1 is a plan view partly in cross-section of a typical apparatus embodying the invention;

FIG. 2 is an elevational view partly in cross-section of the apparatus shown in FIG. 1;

FIG. 3 is an enlarged cross-sectional view taken along the line 3—3 of FIG. 2; and

FIGS. 4 and 5 taken together graphically illustrate the kind of load equalization accomplished in the use of the embodiment of the invention shown in the drawings.

FIGS. 1 and 2 illustrate an assemblage of modules, in this case three in number, A, B, C, each including a series of stanchions supporting blower, duct and cooling coil units for circulating air through separate closed paths into different zones within the over-all enclosure 12. The enclosure 12 is shown as being of integral construction but as may be understood, it may be sectionalized for ease of transportation with subsequent assemblage at the operation site.

In the embodiment shown the conveyor system for transporting the articles to be treated includes an input conveyor 20 abutting against the ingoing end of a conveyor 22 which extends down one side of the enclosure and carries articles onto a 180° turn-around conveyor 24 which then transfers the articles to another conveyor 26 which is parallel to the conveyor 22 but operates in the reverse direction back along the other side of the enclosure and abuts at its outgoing end a take-off chute 28, which can discharge articles onto a take-away conveyor 29. The turn-around conveyor 24 is well-known in the art, an example thereof being provided by using two 90° conveyors as shown in Greer Patent No. 2,862,602.

As best shown in FIG. 3 with respect to module C, a series of jet nozzles 30 are suspended over the conveyor 22, and a separate group of nozzles 32 are suspended over the conveyor 26, the nozzles being suspended from the bottom walls 34 and 36, respectively, of two ducts or plenums 38 and 40 suspended between the stanchions 41. Each plenum and its associated nozzles thus form conduits for conducting cooling media to one zone of the conveyor. The ducts 38 and 40 communicate in common with a central overhead duct 42 leading downwardly from a fan 44 positioned at the forward end of an intake duct 46, shown more clearly in the cross-section of module C shown in FIG. 2. The construction of each module is identical in the above respects with its ducts 38 and 40 extending in parallel but terminating at the extremities of its module length by virtue of end walls at 43.

Positioned within each duct 46 is a bank 48 of cooling coils around which all or part of the gases pass due to the

circulation caused by the pull of the fan 44. The banks may be supplied with circulating refrigerating media from separate compressors or a common compressor, as is well known.

The circulation of the gaseous cooling media in each of three zones of modules A, B and C may thus be summarized as follows: The fan 44 draws air from the enclosure into the intake end 50 of the duct 46 through the cooling coils and then into the downwardly extending duct 42 which separates the stream and directs the air into the two side-by-side plenums 38 and 40 and thence through the jet nozzles 34 and 36, respectively, into contact with articles on the respective conveyors. After contacting the articles, the gas is pulled back into the intake 50.

The result of this operation is shown diagrammatically in FIG. 4, wherein the center line of the path of travel of the conveyor system is indicated by the dash line. This path is in effect divided into six different zones, zone 1 being in module A, zone 2 in module B, zone 3 in module C, zone 4 in module C, zone 5 in module B, and zone 6 in module A. The zones are thus paired together, 1 and 6, 2 and 5, and 3 and 4, with one fan and coil bank serving zones 1 and 6, a second fan and coil bank serving zones 2 and 5, and a third fan and coil bank serving zones 3 and 4 in module C. Thus, the two end zones along the center line U-shaped path of the conveyor system are served by the same cooling unit in module A.

As is well known, in freezing, the withdrawal of the latent heat of fusion at the freezing point requires the greatest work. Thus, in the case of fish sticks it may be in the order of 100 B.t.u. per pound, in contrast with only .76 B.t.u. per pound per degree for removal of sensible heat above the freezing point and only .41 B.t.u. per pound per degree below the freezing point.

Accordingly, if it be assumed that, with identical modules, each handling 12,000 c.f.m. at -25° F. on the out-take side of the coils, the velocity and temperature of the air injected into the first of six zones is sufficient with respect to the speed of the conveyor to cool an article from 150° F. down to 74° F. during its traverse through zone 1, the total B.t.u. required per pound in zone 1 is 57.8. Zone 2 at the same air velocity and temperature conceivably could reduce the temperature down to 38° which would require an additional 27.4 B.t.u. per pound. However, in the last zone 6, where less work is required per degree, if it is desired that the outgoing temperature of the product be 0° F., there may be at the same velocity and temperature only a 22° reduction requiring only about 9 B.t.u. per pound. The load imposed during passage through zone 6 is therefore far less than that imposed in zone 1.

In accordance with this invention, these two sections are coupled together so that the gases exhausting therefrom are commingled in the intake duct to the same cooling unit and hence tend to equalize the load on this cooling unit as compared with what the load would be if it were required to handle the first and second zones. In fact, in the case aforementioned of fish sticks, the work input required by module A cooling unit is reduced to 66.8 total B.t.u. per pound as compared with 85.2 total B.t.u. per pound were it servicing the first and second zones, instead of the first and sixth zones.

The following table sets forth these figures, as well as the total B.t.u. which would be required if the cooling units were paired as in FIG. 5 for zones 1 and 2, 3 and 4, 5 and 6, rather than 1 and 6, 2 and 5, and 3 and 4, as in the embodiment of the invention shown in the drawing.

TABLE

Zone	Temp., ° F.			Required B.t.u. per ° F. per lb.	Total B.t.u. per lb.
	In	Out	Drop		
1-----	150	74	76	.76	57.8
2-----	74	38	36	.76	27.4
3-----	38	30	8	.76	5.9
Plus 24% of latent heat at 100 B.t.u. per lb.				24.0	29.9
4-----	30	30	0	0.0	0.0
Plus 60% of latent heat at 100 B.t.u. per lb.				60.0	60.0
5-----	30	22	8	.41	3.3
Plus 16% of latent heat at 100 B.t.u. per lb.				17.0	20.3
6-----	22	0	22	.41	9.0
					204.4

ZONES
(Fig. 5) 1 and 2=85.2
3 and 4=89.9
5 and 6=29.3
Total.....204.4

ZONES
(Fig. 4) 1 and 6=66.8
2 and 5=47.7
3 and 4=89.9
Total.....204.4

Utilization of the U-shaped conveyor path conserves duct length, although as can be understood, similar pairings could be made regardless of the configuration of the conveyor path, but at loss of the module construction, since the pair of zones served by a common unit would not be located side-by-side as in the U-shaped conveyor path travel.

The conveyors 22 and 26 shown in FIG. 1 are wire mesh endless belts supported transversely on the upper reaches by a series of transverse rollers 60. They are assembled in such manner that they dip between each roller on the upper reaches. The wavy path tends to prevent freezing of the products to the metal belts due to the flexing of the belts as they pass over the crest of each roller. This wavy path is less necessary with conveyor 26 because the articles are fairly solid before they start their return travel, but is very helpful with conveyor 22 to prevent the products from adhering to the wire belt as they are transferred onto turn-around conveyor 24.

What is claimed is:

In a gaseous flow refrigerating apparatus for freezing products comprising U-shaped conveyor means for advancing products at a uniform rate in a single horizontal path, a series of conduits for directing gaseous streams for downward flow in parallel vertical paths into contact with products supported by said conveyor means, each of said conduits serving a pair of zones lying side by side for directing gaseous streams downwardly in parallel vertical paths, duct and fan means for each of said conduits for collecting the gases separately from each side by side zone after they have contacted products in such zones and for mixing the gases after they have been separately collected from said zones for recirculating said mixed gases from said zones into the intake ends of the conduits leading to the same two zones from which they have been collected and mixed, and a separate cooling coil for each conduit for cooling the gases before they are directed through said conduits.

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