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REFRIGERATION APPARATUS AND METHOD OF REFRIGERATING

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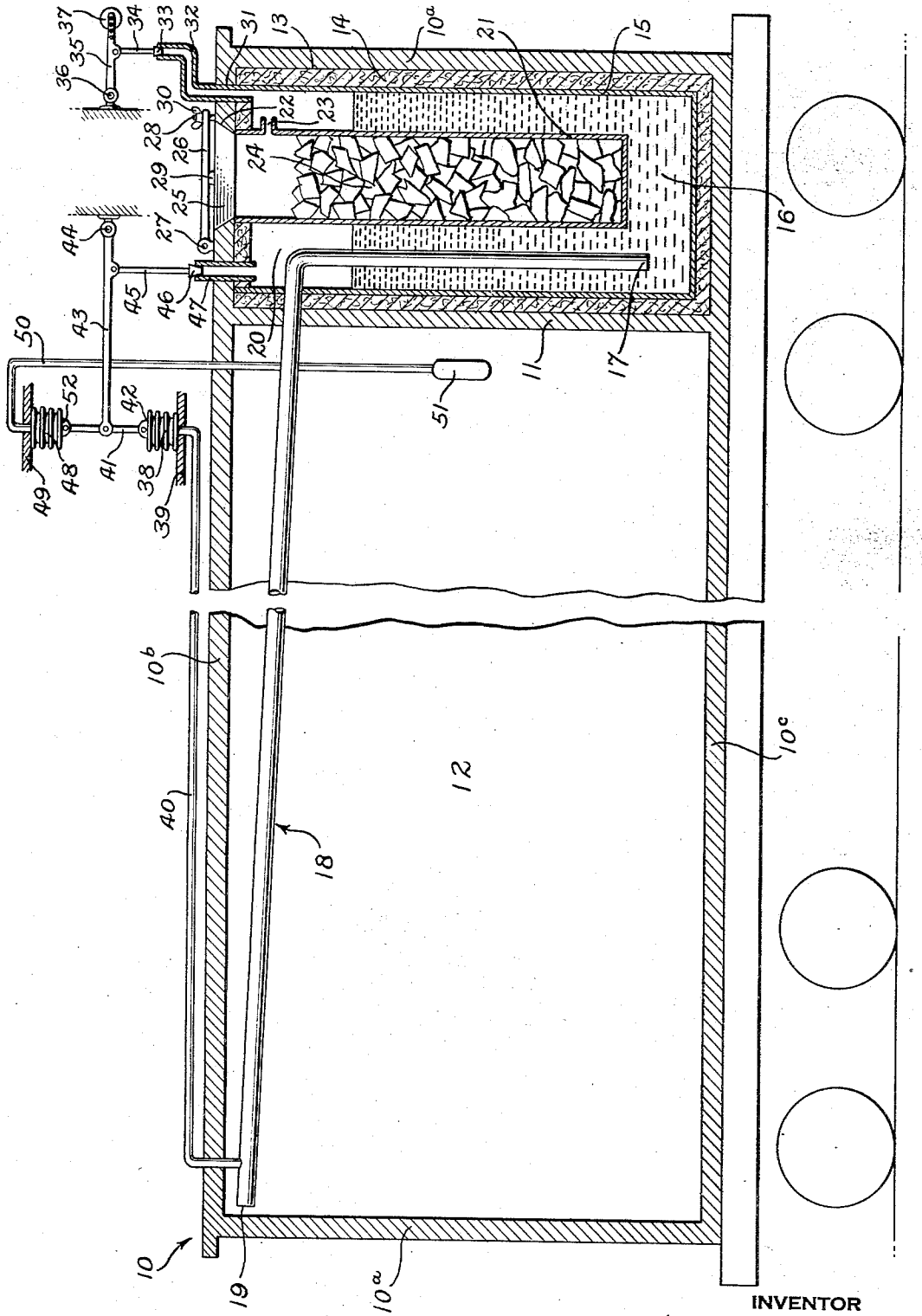

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REFRIGERATION APPARATUS AND METHOD OF REFRIGERATING

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This invention relates to refrigeration apparatus and a method of refrigerating.

One of the objects of this invention is to provide an apparatus which will be simple, practical and durable. Another object is to provide apparatus of the above character which will be efficient and dependable in operation. Another object is to provide apparatus of the above character which may be manufactured and installed with a minimum amount of labor and other expenses. Another object is to provide apparatus of the above character which will be comparatively free from mechanical complications and moving parts. Another object is to provide apparatus of the above character which will utilize certain properties of solid carbon dioxide for refrigerating purposes in an economical and dependable manner. Another object is to provide a method of refrigerating characterized by inexpensiveness and dependability of operation. Another object is to provide a method of the above character whose practice is so simple that reliability thereof is assured. Other objects will be in part obvious and in part pointed out hereinafter.

The invention accordingly consists in the features of construction, combinations of elements, arrangements of parts and in the several steps and relation and order of each of the same to one or more of the others, all as will be illustratively described herein, and the scope of the application of which will be indicated in the following claims.

In the accompanying drawing, in which is shown one of the various possible embodiments of this invention,

The single figure is a longitudinal sectional diagrammatic view of a railroad car with my refrigeration apparatus installed thereon.

Turning now to the drawing, there is shown a railroad car, generally indicated at 10, which may be of any suitable character but which is preferably a refrigeration car of the usual construction, having its walls 10*a* as well as its ceiling 10*b* and its floor 10*c* heat-insulated in any suitable manner. Extending across car 10 is a partition 11, thus dividing the car into compartments 12 and 13, compartment 12 being a storage space for perishable articles or the like which are to be transported.

Compartment 13 is lined with a suitable insulating material 14 and located within lining 14 is a tank 15 containing a supply of refrigerating liquid brine 16 of any desired character. Extending through partition 11, insulating material 14 and into tank 15 so that its end 17 is substantially near the bottom of the tank is a conduit generaly indicated at 18; conduit 18 extends about compartment 12 and its end 19 is closed. Brine 16 preferably does not fill tank 15 so that any pressure created in the space 20 in the tank above the brine tends to force the brine through open end 17 of conduit 18 and finally out into that portion of the conduit disposed within compartment 12.

Preferably secured to roof 10*b* in tank 15 in any convenient manner is a container 21 the upper end of which, as viewed in the drawing, faces an opening 22 extending through roof 10*b*, and an opening 23 in container 21 substantially near the top thereof leads into space 20 in the tank above brine 16. Container 21 holds a suitable supply of refrigerating material 24, solid carbon dioxide being best suited for this purpose under most conditions. Accordingly, when tank 15 is sealed in a manner to be described hereinafter, the gas emanating from solid carbon dioxide 24 in container 21 passes through opening 23 into space 20 thereby creating the pressure necessary to force a portion of the brine 16 into conduit 18 in the manner described above.

A hatch 25 is preferably hingedly attached to roof 10*b* and shaped to fit tightly within opening 22. Hatch 25 is substantially air-tight when in the closed position shown in the drawing, and, although I may use any suitable structure for this purpose, there is here shown a bar 26 pivotally secured to roof 10*b* as at 27 and adapted to fit over a threaded lug 28 extending from roof 10*b*. Accordingly when hatch 25 is closed down, bar 26 may be swung down upon it to rest upon a lug 29 extending from the top of the hatch thus to fit over lug 28. A winged nut 30 is preferably threaded upon lug 28 to force bar 26 against lug 29 thus securing the hatch in its closed and substantially air-tight position. When hatch 25 is in the closed position shown in the drawing, the gas evaporating from the solid carbon dioxide 24 has no means of escape from container 21 except through opening 23 leading to space 20.

Extending through roof 10*b*, insulating material 14 and into tank 15 preferably near the top thereof is an opening 31 and a conduit 32 is connected thereto. Any suitable safety valve mechanism may be connected to conduit 32 and, for this purpose, there is here diagrammatically shown a plunger 33 adapted to fit within the open end of conduit 32 and in turn connected to a rod 34. Rod 34 is pivotally connected to a rod

35 which is pivotally anchored in any suitable manner as at 36 and a weight 37 is connected to the other end of rod 35, this weight being capable of adjustment to various positions along rod 35. Accordingly if a pressure of damaging proportions is developed in tank 15, stopper 33 is displaced from the opening of pipe 32 to allow for the escape of some of the gas from tank 15 and thus reduce the pressure therein.

An expansible bellows 38 is suitably anchored at one end 39 and is connected to conduit 18 preferably near the end 19 thereof by a conduit 40. A rod 41 is connected to the free end 42 of bellows 38 and pivotally connected to rod 41 is an arm 43 which is pivotally anchored as at 44. Suitably attached to arm 43 is a rod 45 carrying a plunger 46 adapted to fit within the open end of a conduit 47 which extends through roof 10b and insulating material 14 into the top of tank 15 preferably adjacent space 20.

When car 10 is prepared for transit and a suitable supply of perishable goods have been stored in compartment 12 so that refrigeration of this compartment is desirable, a quantity of solid carbon dioxide or the like is placed in container 21, and hatch 25 is clamped down by way of bar 26 and winged nut 30 so that no gas can escape therethrough. As the solid carbon dioxide in container 21 cools brine 16, gaseous carbon dioxide given off by the cooling action passes through opening 23 into space 20. Plungers 33 and 46 being closed, a pressure is built up in space 20 which soon reaches proportions sufficient to force some of brine 16 into conduit 18 by way of its open end 17. As the pressure in space 20 continues to build up due to the continued evaporation of the carbon dioxide in container 21, more cooled brine is forced into conduit 18 and is gradually forced out into that portion of the conduit located in compartment 12, accordingly absorbing heat and cooling the compartment.

However, when the brine reaches a certain predetermined point in conduit 18, this point being preferably near end 19 thereof, it has forced a large portion of the air in conduit 18 through conduit 40 and into bellows 38 to increase the pressure in the bellows. Accordingly bellows 38 expands when this point is reached to force rod 41 upwardly, as viewed in the drawing, and pivot arm 43 about pivot 44 thus releasing plunger 46 from conduit 47. Gas may now escape from space 20 in tank 15 to reduce the pressure at this point and allow the brine to flow back from conduit 18 into tank 15, conduit 18 being so disposed in compartment 12 that the brine will flow therefrom into tank 15 by force of gravity when the pressure in space 20 is reduced.

However, as soon as brine 16 leaves conduit 18 the air pressure built up in bellows 38 is reduced and consequently this bellows snaps into its contracted position to force arm 43 downwardly or in a counter-clockwise direction, as viewed in the drawing, fitting plunger 46 into the open end of conduit 47. Continued evaporation of the carbon dioxide in container 21 due to the relative warmth of the brine in tank 15 builds up pressure again in space 20 to force the brine out into conduit 18 in the manner described above. Accordingly cool brine is forced into conduit 18 intermittently to remain there for sufficient periods of time to absorb quantities of the heat in compartment 12 and gradually bring this compartment down to the preferred temperature. I have found that by proportioning the relative dimensions of tank 15, container 21, conduit 18 and compartment 12, I am able to maintain compartment 12 at a substantially constant temperature indefinitely by these intermittent operations.

Railroad refrigeration cars and other vehicles of this general character are filled at different times with perishable articles requiring different degrees of refrigeration, according to their individual characteristics, in order to maintain them in most desirable condition. Also, these cars pass through a variety of climates and prevailing temperature conditions so that any standardized and continuous method of refrigerating is often impractical due to its inflexibility.

Therefore it is usually more convenient to control the action of the above-described apparatus thermostatically in accordance with the temperature requirements of compartment 12. Accordingly I provide an expansible bellows 48 suitably anchored in any convenient manner as at 49 and connected by way of a conduit 50 to a bulb 51 situated within compartment 12 and containing a suitable volatile liquid; the free end 52 of bellows 48 is connected to rod 41.

Assuming that car 10 is loaded with perishable goods and is to pass through such a variety of climates and that a suitable supply of solid carbon dioxide has been placed in container 21, the apparatus commences to operate as described above, conduit 18 being charged with brine intermittently. Continuation of this operation brings compartment 12, as well as the articles contained therein, down to the temperature best suited for maintaining the articles now stored. When this preferred temperature has been reached, the volatile liquid in bulb 51 condenses sufficiently to allow bellows 48 to contract and pull arm 43 in a clockwise direction about pivot 44, releasing plunger 46 from conduit 47. Pressure in space 20 is thus reduced and any brine in conduit 18 flows back into container 15. No further refrigeration of compartment 12 can take place now as long as plunger 46 remains free from conduit 47. However, when the temperature of compartment 12 rises above that preferred to cause expansion of bellows 48 to close conduit 47 by way of plunger 46, the intermittent charges of brine are again imparted to conduit 18 in the manner described above. Bellows 48 may have any suitable adjusting means associated therewith so that the character of its operation and consequently the temperatures at which it will expand and contract sufficiently to open and close plunger 46 may be determined.

It will thus be seen that this apparatus is designed to operate in a reliable manner to maintain a substantially constant temperature in a refrigeration vehicle or the like and, also, its efficiency is markedly increased due to the simplicity of its structure and operation. The apparatus utilized to promote this refrigeration is extremely simple in construction thus avoiding undue expense in manufacture and installation and also contributing toward the above-mentioned simplicity of operation. Accordingly I have provided an apparatus and a method of refrigerating in which the several objects hereinabove referred to are successfully accomplished in a practical manner.

As many possible embodiments may be made of the mechanical features of the above invention and as the art herein described might be varied in various parts, all without departing from the scope of the invention, it is to be understood

that all matter hereinabove set forth or shown in the accompanying drawing is to be interpreted as illustrative and not in a limiting sense.

I claim:

1. In refrigeration apparatus, in combination, a space whose temperature is to be regulated, a compartment containing a brine, a tank disposed within said compartment and having an opening into said compartment, said tank adapted to contain solid carbon dioxide, a conduit connected at one end to said compartment and closed at its other end, a valve-outlet connected to said compartment, conduit means connected to said conduit substantially near said last-mentioned end thereof, a pressure responsive bellows connected to said conduit means and operatively related to said valve-outlet whereby the evaporation of said solid carbon dioxide creates a pressure in said compartment to force said brine into said conduit to actuate said bellows and said valve-outlet thereby reducing the pressure in said compartment, and a thermostatic bellows responsive to the temperature of said space operatively related to said valve-outlet.

2. In refrigeration apparatus, in combination, a space whose temperature is to be regulated, a compartment containing a brine, a tank disposed within said compartment and having an opening into said compartment, said tank adapted to contain solid carbon dioxide, a conduit connected at one end to said compartment and closed at its other end, a valve-outlet associated with said compartment, conduit means connected to said conduit substantially near said closed end thereof, a pressure responsive bellows connected to said conduit means and operatively related to said valve-outlet whereby the evaporation of said solid carbon dioxide creates a pressure in said compartment to force said brine into said conduit to actuate said bellows and said valve-outlet thereby reducing the pressure in said compartment, and means responsive to the temperature of said space for controlling the pressure in said compartment.

3. In refrigeration apparatus, in combination, a space whose temperature is to be regulated, a compartment containing a brine, a tank disposed within said compartment and having an opening into said compartment, said tank adapted to contain solid carbon dioxide, a conduit connected at one end to said compartment and closed at its other end, a valve-outlet for said compartment, conduit means connected to said conduit substantially near said last-mentioned end thereof, and a pressure responsive bellows connected to said conduit means and operatively related to said valve-outlet whereby the evaporation of said solid carbon dioxide creates a pressure in said compartment to force said brine into said conduit increasing the pressure therein and in said bellows to open said valve-outlet and reduce the pressure in said compartment.

4. In refrigeration apparatus, in combination, means forming a space whose temperature is to be regulated, a container holding a liquid, a tank mounted within said container and holding a refrigerant capable of evaporation, said tank having an opening into said container, a conduit connected at one end to said container and closed at its other end, said conduit being in thermal contact with said space whereby the evaporation of said refrigerant creates a pressure in said container to force said liquid into said conduit, and means connected with said conduit responsive to changes in pressure in said conduit for controlling the pressure in said container.

5. In refrigeration apparatus, in combination, means forming a space whose temperature is to be regulated, a compartment containing a fluid, a conduit connected at one end to said compartment and closed at its other end, means holding a refrigerant capable of evaporating in said compartment to create a pressure therein, said pressure adapted to force said fluid into said conduit to create a pressure in said conduit, means responsive to the increase in pressure in said conduit for reducing the pressure in said compartment to allow said fluid to flow back into said compartment, and means coacting with said last-mentioned means and acting in response to the temperature of said space to control the pressure of said compartment.

6. In refrigeration apparatus, in combination, means forming a space whose temperature is to be regulated, a compartment containing a fluid, a conduit connected at one end to said compartment and closed at its other end, means holding a refrigerant capable of evaporating in said compartment to create a pressure therein, said pressure adapted to force said fluid into said conduit to create a pressure in said conduit, means responsive to increase in pressure in said conduit for reducing the pressure in said compartment to allow said fluid to flow back into said compartment, and means responsive to the temperature of said space for controlling the pressure in said compartment.

7. In refrigeration apparatus, in combination, means forming a space whose temperature is to be regulated, a compartment containing a fluid, a conduit connected at one end to said compartment and closed at its other end, means holding a refrigerant capable of evaporating in said compartment to create a pressure therein, said pressure adapted to force said fluid into said conduit to create a pressure in said conduit, and means responsive to the increase in pressure in said conduit for reducing the pressure in said compartment to allow said fluid to flow back into said compartment.

8. In refrigeration apparatus, in combination, means forming a space whose temperature is to be regulated, a compartment containing a fluid, a conduit connected at one end to said compartment and closed at its other end, and means holding a refrigerant capable of evaporating in said compartment to create a pressure therein, said pressure adapted to force said fluid into said conduit.

9. In refrigeration apparatus, in combination, means forming a space whose temperature is to be regulated, a compartment, a conduit connected with said compartment and in thermal contact with said space, means holding an evaporating refrigerant within said compartment, a fluid in said compartment in thermal contact with said refrigerant whereby the pressure in said compartment forces said fluid into said conduit, and means for reducing the pressure in said compartment after said fluid reaches a certain point in said conduit.

10. In refrigeration apparatus, in combination, means forming a space whose temperature is to be regulated, a compartment, a conduit connected with said compartment and having a closed end portion in thermal contact with said space, means holding an evaporating refrigerant within said compartment, and a fluid in said compartment in thermal contact with said refrigerant whereby pressure built up in said compartment

by said evaporation forces said fluid into said conduit.

11. The herein described art which consists in cooling a liquid brine in a container by evaporating solid carbon dioxide in thermal contact therewith, and intermittently utilizing the gaseous refrigerant evolved therefrom to build up a pressure sufficient to force said brine into a pipe leading into thermal contact with a space whose temperature is to be regulated.

12. The herein described art which consists in cooling a liquid brine in a container, intermittently building up pressures in said container sufficient to force said brine out of said container into conducting means in thermal contact with a space whose temperature is to be regulated, and controlling said pressures in accordance with the temperature condition of said space.

13. The herein described art which consists in cooling a fluid in a container with a solid refrigerant by evaporating the refrigerant to create a pressure in said container and utilizing the pressure to force a portion of said fluid into thermal contact with a space whose temperature is to be regulated, controlling said pressure in accordance with the amount of said fluid in thermal contact with said space, and also controlling said pressure in accordance with the temperature condition of said space.

14. The herein described art which consists in cooling a fluid in a container with a solid refrigerant by evaporating the refrigerant to create a pressure in said container and utilizing the pressure to force a portion of said fluid into thermal contact with a space whose temperature is to be regulated, and controlling said pressure in accordance with the amount of said fluid in thermal contact with said space.

15. The herein described art which consists in cooling a fluid in a container with a refrigerant evaporating in said container so that the pressure created by the evaporating refrigerant forces a portion of said fluid into thermal contact with a space whose temperature is to be regulated, and reducing said pressure in said container after a certain portion of said fluid is in thermal contact with said space.

16. In refrigeration apparatus, in combination, means forming a space whose temperature is to be regulated, a container partially filled with a heat absorbing liquid, conducting means disposed within said space and having an open end extending into said container and into said liquid, and a tank disposed within said container and in thermal contact with said liquid, said tank adapted to hold solid carbon dioxide and having a vent into said container whereby sublimation of said carbon dioxide increases the pressure above said liquid in said container to force a portion of said liquid into said conducting means in said space.

17. In refrigeration apparatus, in combination, means forming a space whose temperature is to be regulated, a container partially filled with a refrigerating brine, a conduit having a closed end in thermal contact with said space and an open end extending into said container and into contact with said brine, and a tank disposed within said container and holding solid carbon dioxide, said tank having a vent into a portion of said container above said brine whereby upon sublimation of said solid carbon dioxide to cool said brine pressure is created above said brine to force said brine into said conduit.

18. In refrigeration apparatus, in combination, means forming a space whose temperature is to be regulated, a container partially filled with a refrigerating brine, a conduit having a closed end in thermal contact with said space and an open end extending into said container and into contact with said brine, a tank disposed within said container and holding solid carbon dioxide, said tank having a vent into a portion of said container above said brine whereby upon sublimation of said solid carbon dioxide to cool said brine pressure is created above said brine to force said brine into said conduit, and thermostatic means responsive to the temperature of said space for regulating the pressure in said container.

19. In refrigeration apparatus, in combination, means forming a space whose temperature is to be regulated, a container partially filled with a refrigerating brine, a conduit having a closed end in thermal contact with said space and an open end extending into said container and into contact with said brine, a tank disposed within said container and holding solid carbon dioxide, said tank having a vent into a portion of said container whereby upon sublimation of said solid carbon dioxide to cool said brine pressure is created above said brine to force said brine into said conduit, means for reducing said pressure in said container to allow said brine to travel back to said container after said brine has reached a certain point in said conduit, and means responsive to the temperature of said space for controlling the pressure in said container.

20. In referigeration apparatus, in combination, means forming a space whose temperature is to be regulated, a container partially filled with a refrigerating brine, a conduit having a closed end in thermal contact with said space and an open end extending into said container and into contact with said brine, a tank disposed within said container and holding solid carbon dioxide, said tank having a vent into a portion of said container whereby upon sublimation of said solid carbon dioxide to cool said brine pressure is created above said brine to force said brine into said conduit, a valve for controlling the pressure in said container, a pressure-responsive bellows associated with said valve and adapted to open said valve upon expansion, and a conduit connecting said valve to said first-mentioned conduit.

21. In refrigeration apparatus, in combination, means forming a space whose temperature is to be regulated, a container partially filled with a refrigerating brine, a conduit having a closed end in thermal contact with said space and an open end extending into said container and into contact with said brine, a tank disposed within said container and holding solid carbon dioxide, said tank having a vent into a portion of said container whereby upon sublimation of said solid carbon dioxide to cool said brine pressure is created above said brine to force said brine into said conduit, a valve for controlling the pressure in said container, a pressure-responsive bellows associated with said valve and adapted to open said valve upon expansion, a conduit connecting said valve to said first-mentioned conduit, and means responsive to the temperature of said space for modifying the action of said bellows.

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