~~Patent c~~Claims

1. A ~~P~~process for cryogenic air separation in a distillation column system which has at least one single column ~~(12)~~, the process comprising~~wherein~~:

— cooling a compressed feed air stream ~~(6, 8) is cooled down~~ in a main heat exchanger ~~(9)~~ in counter-current to a first return stream ~~(16, 23)~~ from the distillation column system,

— introducing the cooled feed air stream ~~(11) is led~~ into the single column ~~(12)~~,

— removing a nitrogen-rich fraction from~~(15) is produced in~~ the upper region of the single column ~~(12)~~,

— condensing at least part ~~(16b)~~ of the nitrogen-rich fraction ~~(15) is condensed~~ in a top condenser ~~(13)~~, which is constructed as a condenser-evaporator,

— introducing at least part ~~(54)~~ of the condensed liquid nitrogen-rich fraction from~~(52) produced in~~ the top condenser-evaporator ~~(13) is led~~ into the single column ~~(12)~~ as reflux,

— withdrawing an oxygen-containing recycle fraction ~~(18a) is drawn off~~ from the single column ~~(12)~~ in liquid form,

— cooling the oxygen-containing~~liquid~~ recycle fraction ~~(18a) is cooled down~~ in a counter-current subcooler ~~(100)~~,

— evaporating the cooled oxygen-containing recycle fraction ~~(18b) is evaporated~~ in the top condenser-evaporator ~~(13)~~,

— re-compressing the evaporated oxygen-containing recycle fraction ~~(29) is re-compressed~~ in a re-compressor ~~(30)~~, and

— introducing the re-compressed recycle fraction ~~(31, 32) is fed~~ into the lower region of the single column ~~(12)~~,

wherein~~characterized~~ ~~in that~~

— the main heat exchanger ~~(9)~~ and the counter-current subcooler ~~(100)~~ are formed as~~by~~ an integrated heat exchanger ~~(101)~~,

— the integrated heat exchanger ~~(101)~~ having a first group of passages for the first return stream ~~(16, 23)~~, which extend~~goes through~~ from the cold end of the integrated heat exchanger to the warm end of the integrated heat exchanger,

— the first return stream ~~(16, 23)~~ being introduced~~led~~ into the first~~this~~ group

of passages ~~(102)~~ at the cold end of the integrated heat exchanger, and flowing through the integrated heat exchanger to~~(101) as far as its~~ the warm end of the integrated heat exchanger and, ~~in the process,~~

— during passage through the integrated heat exchanger, the first return stream is~~being~~ brought into indirect heat exchange ~~both~~ with both the liquid recycle fraction ~~(18a)~~ and ~~with~~ the feed air stream ~~(8)~~,

— the cooled feed air stream is~~(11) being~~ withdrawn ~~off~~ from the integrated heat exchanger ~~(101)~~ in completely gaseous form and is fed~~being led~~ into the single column ~~(12)~~ in completely gaseous form, and

— the re-compressed evaporated oxygen-containing recycle fraction is cooled in the subcooler of the integrated heat exchanger before being introduced into the lower region of the single column.

2. Process according to ~~C~~claim 1, wherein~~characterized in that~~ the integrated heat exchanger is ~~formed by~~ a single plate-type heat exchanger block.

3. Process according to ~~C~~claim 1 or 2, wherein~~characterized in that~~ the single column is~~constitutes~~ the only distillation column of the distillation column system.

4. Process according to any one of ~~C~~claims 1 to 3, further comprising~~characterized in that~~:

— withdrawing a further oxygen-containing fraction ~~(14a) is drawn off~~ from the single column ~~(12)~~ in liquid form,

— cooling the ~~liquid~~ further oxygen-containing liquid fraction ~~(14a) is cooled down~~ in the integrated heat exchanger ~~(101)~~,

— evaporating the cooled further oxygen-containing liquid fraction ~~is evaporated~~ in the top condenser-evaporator ~~(13)~~,

— warming the evaporated further oxygen-containing fraction ~~(19) is warmed~~ in the integrated heat exchanger in counter-current flow to air, and

— expanding the warmed evaporated further oxygen-containing fraction ~~is expanded~~ in an expansion machine to~~(21),~~ produce~~ing~~ work,

wherein

— the temperature of the ~~liquid~~ further oxygen-containing liquid fraction ~~(14a)~~ as ~~it is~~ introduced into the integrated heat exchanger is~~(101) being~~ higher than

the temperature of the cooled feed air stream ~~(11) as it is~~ withdrawn off from the integrated heat exchanger ~~(101)~~.

~~5. Process according to Claim 4, characterized in that, before its work-producing expansion, the evaporated further oxygen-containing fraction is warmed up in counter-current to air in the integrated heat exchanger.~~

5~~6~~. Process according to ~~either of C~~claims ~~4 and 5~~, wherein~~characterized in that~~ the oxygen-containing recycle fraction is removed from the single column at an intermediate point which is located at least one theoretical or practical plate above the point at which the further oxygen-containing fraction is removed from the single column.

6~~7~~. Process according to any one of ~~C~~claims 4 to 5~~6~~, wherein~~characterized in that~~ the expansion machine ~~(21)~~ is coupled mechanically to the re-compressor ~~(30)~~.

7~~8~~. Process according to any one of the preceding ~~C~~claims ~~1 to 7~~, wherein~~characterized in that~~ the re-compressor ~~(30)~~ is constructed as a cold compressor.

8~~9~~. Process according to any one of the preceding ~~C~~claims ~~1 to 8~~, wherein~~characterized in that~~ the re-compressed recycle fraction ~~(31)~~ is cooled in the integrated heat exchanger ~~(101)~~ before being introduced into the lower region of the single column ~~(12)~~, and the re-compressed recycle fraction is~~(32) being~~ withdrawn ~~off~~ from the integrated heat exchanger ~~(101)~~ in completely gaseous form and fed~~led~~ into the single column ~~(12)~~ in completely gaseous form.

9~~10~~. Apparatus for cryogenic air separation in a distillation column system, comprising ~~which has~~:

~~—~~ at least one single column ~~(12)~~,

~~—~~ ~~having~~ a main heat exchanger ~~(9)~~ for cooling a compressed feed air stream ~~(6, 8)~~ in counter-current flow to a first return stream ~~(16, 23)~~ from the distillation column system,

~~—~~ ~~having~~ means for introducing~~leading~~ a~~the~~ cooled feed air stream ~~(11)~~ into the single column ~~(12)~~,

— ~~having~~ means for removing~~producing~~ a nitrogen-rich fraction from~~(15) in~~ the upper region of the single column ~~(12)~~,

— ~~having~~ a top condenser-evaporator ~~(13)~~ for condensing at least part of the nitrogen-rich fraction ~~(15, 16b), the top condenser being constructed as a condenser-evaporator~~,

— ~~having~~ means for introducing~~leading~~ condensed~~the liquid~~ nitrogen-rich fraction from~~(52) produced in~~ the top condenser-evaporator ~~(13)~~ into the single column ~~(12)~~ as reflux,

— ~~having~~ means for withdrawing ~~off~~ an oxygen-containing liquid recycle fraction ~~(18a)~~ from the single column ~~(12) in the liquid state~~,

— ~~having~~ a counter-current subcooler ~~(100)~~ for cooling down ~~the~~ liquid recycle fraction ~~(18a)~~,

— ~~having~~ means for introducing ~~the~~ cooled recycle fraction ~~(18b)~~ into the top condenser-evaporator ~~(13)~~,

— ~~having~~ a re-compressor ~~(30)~~ for compressing ~~the~~ evaporated recycle fraction ~~(29)~~ from the top condenser-evaporator ~~(13), the re-compressor (30) being constructed in particular as a cold compressor~~, and

— means for introducing re-compressed evaporated oxygen-containing recycle fraction into the subcooler, and

— ~~having~~ means for introducing~~leading the~~ cooled, re-compressed recycle fraction from the subcooler~~(31, 32)~~ into the lower region of the single column ~~(12)~~,

wherein~~characterized~~ in that

— the main heat exchanger ~~(9)~~ and the counter-current subcooler ~~(100)~~ are formed as~~by~~ an integrated heat exchanger ~~(101)~~,

— the integrated heat exchanger ~~(101)~~ having a first group of passages ~~(102)~~ for the first return stream ~~(16, 23)~~, which extends~~goes through~~ from the cold end of the integrated heat exchanger to the warm end of the integrated heat exchanger,

— the cold end of the integrated heat exchanger ~~(101)~~ being connected to means for introducing~~leading~~ the first return stream ~~(16, 23)~~ into the first~~this~~ group of passages,

— the warm end of the integrated heat exchanger ~~(101)~~ being connected to means for withdrawing the first return stream ~~(16, 23) off~~ from the first~~this~~ group

of passages,

— the integrated heat exchanger ~~(101)~~ being constructed in such a way that, during the operation of the apparatus, the first return stream ~~(16, 23)~~ is brought into indirect heat exchange ~~both~~ with both~~the~~ liquid recycle fraction ~~(18a)~~ and ~~with the~~ feed air stream ~~(8)~~, and

— the passages in the integrated heat exchanger are arranged~~(101) being laid out~~ in such a way that, during ~~the~~ operation ~~of the plant~~, the cooled feed air stream ~~(11)~~ is withdrawn ~~off~~ from the integrated heat exchanger ~~(101)~~ in completely gaseous form and is fed~~led~~ into the single column ~~(12)~~ in completely gaseous form.

10. Process according to claim 2, wherein the single column is the only distillation column of the distillation column system.

11. Process according to claim 1, wherein the top condenser is as a forced-flow evaporator.