

Sept. 15, 1936.

A. WEILAND

2,054,350

AIR CONDITIONING APPARATUS

Filed Dec. 1, 1933

6 Sheets-Sheet 1

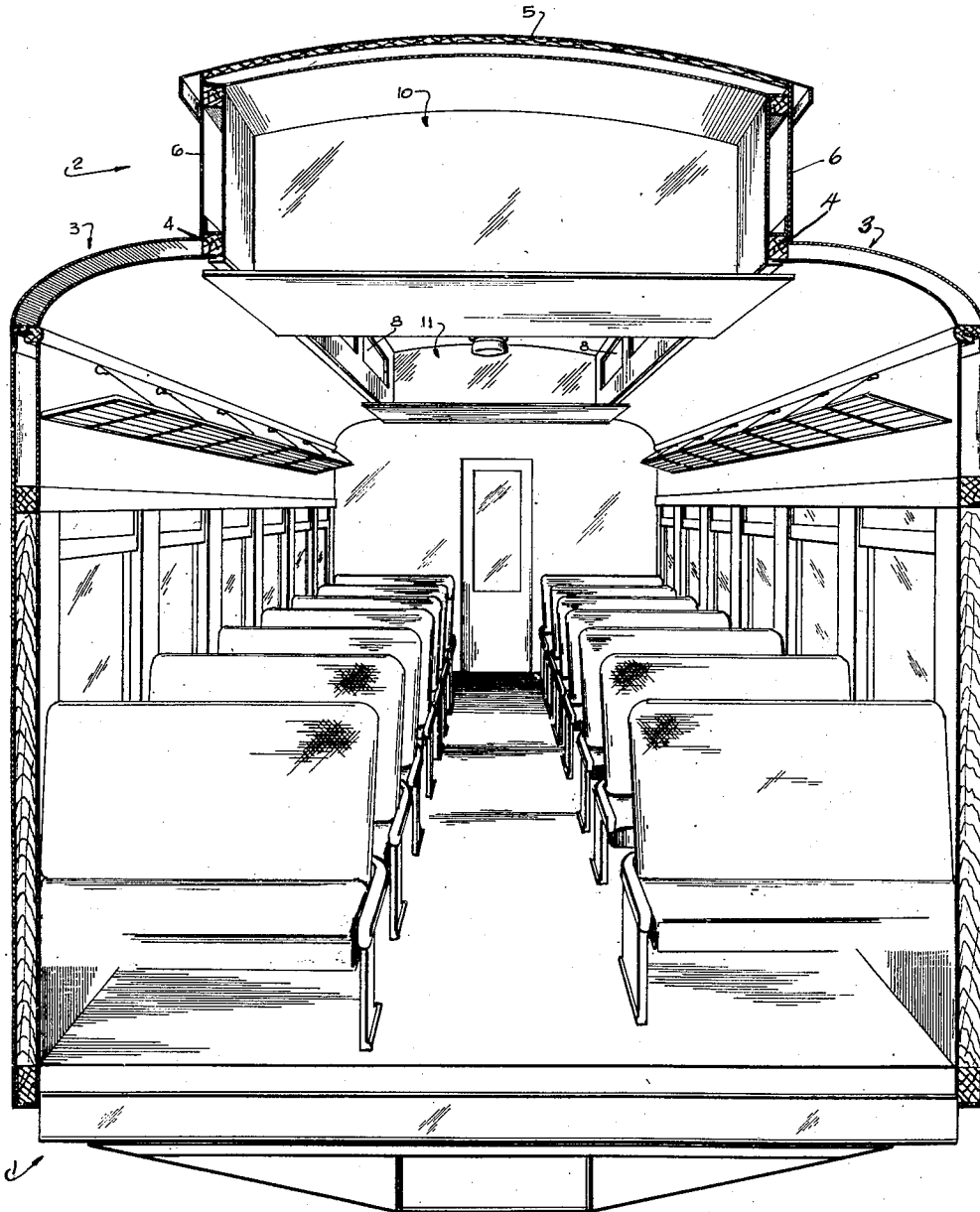


Fig. 1

INVENTOR

ALFRED WEILAND

BY

Charles E. Weiland
ATTORNEY

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A. WEILAND

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6 Sheets-Sheet 2

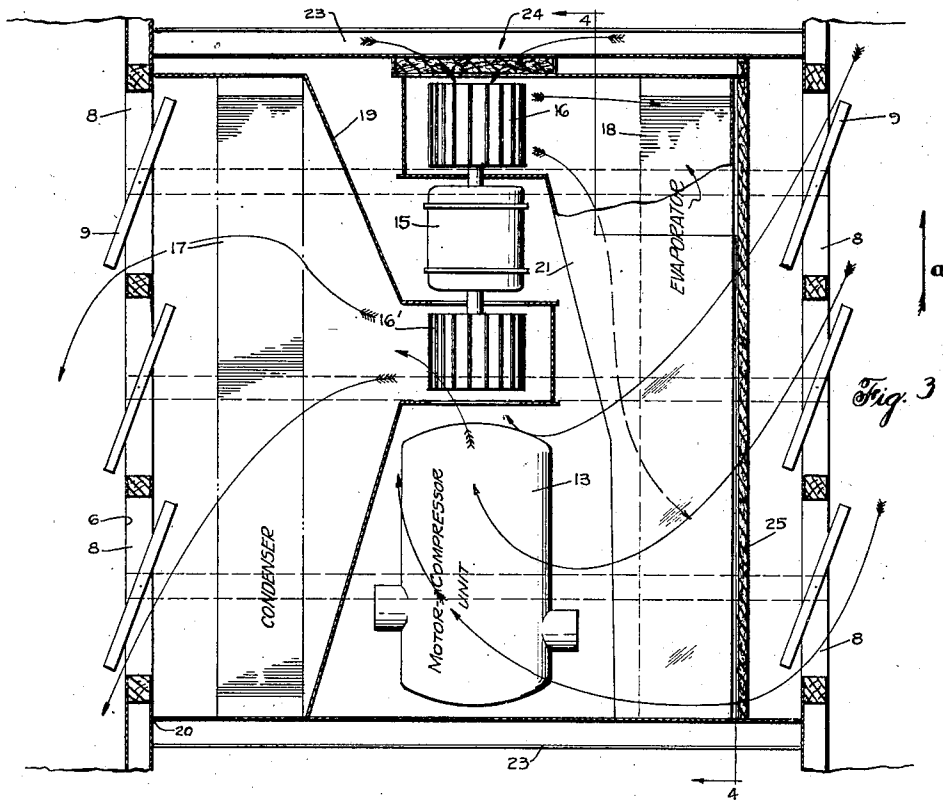
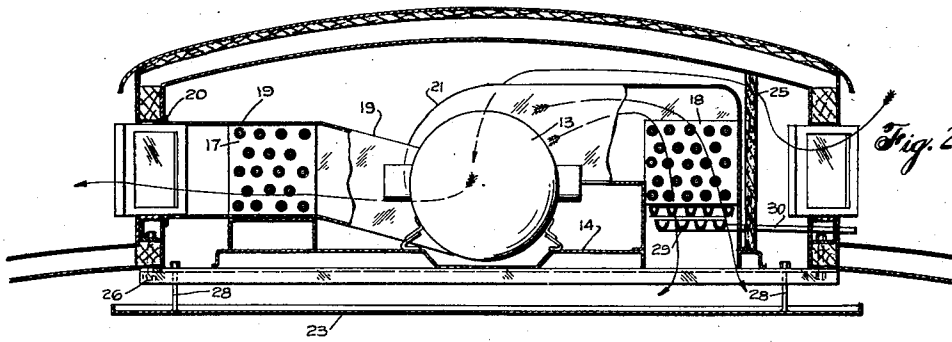
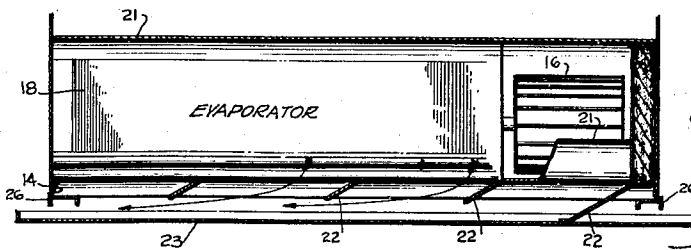


Fig. 4

INVENTOR
ALFRED WEILAND

BY *Charles F. McQuay*
ATTORNEY

Sept. 15, 1936.

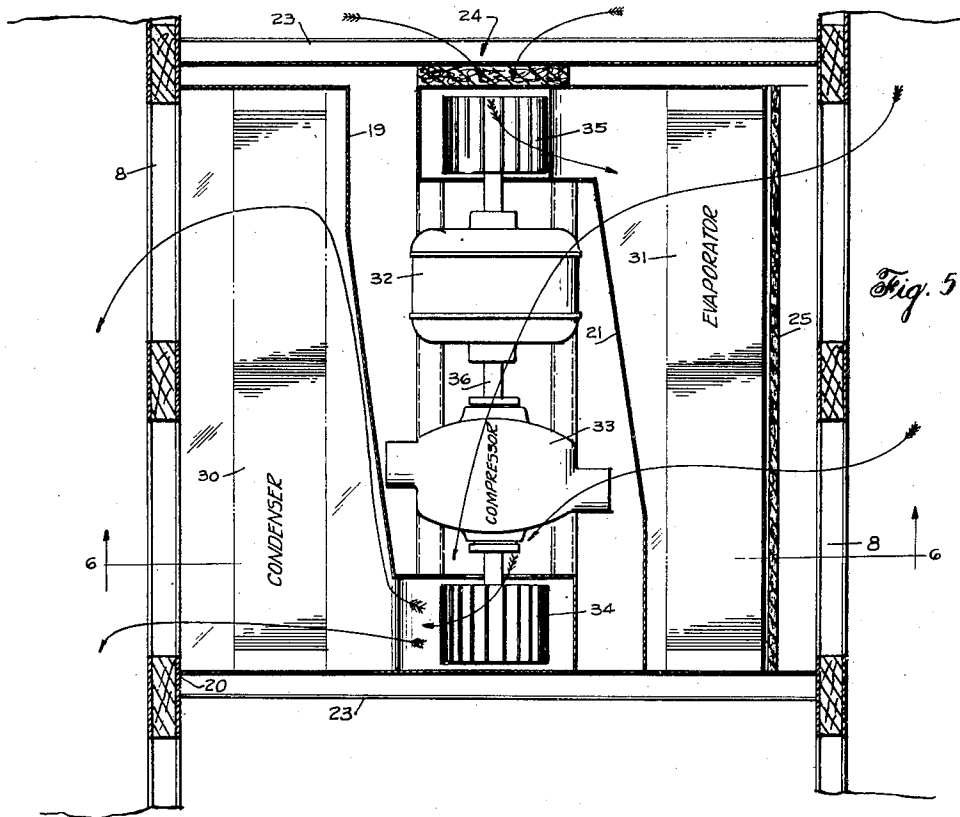
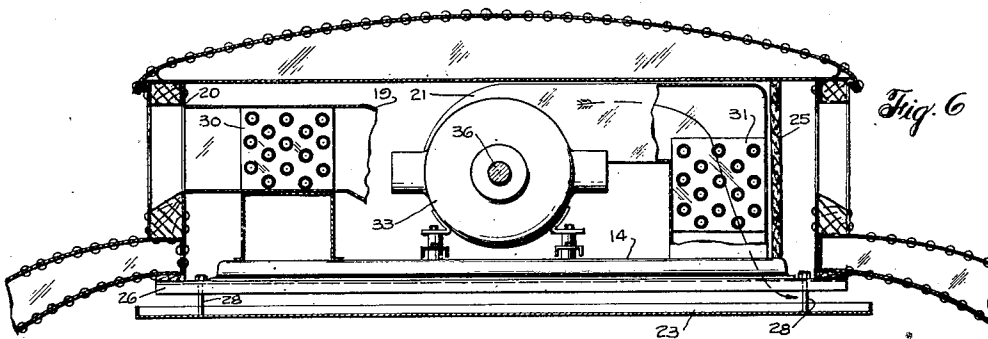
A. WEILAND

2,054,350

AIR CONDITIONING APPARATUS

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6 Sheets-Sheet 3



INVENTOR

ALFRED WEILAND

BY

Edward A. Weiland
ATTORNEY

Sept. 15, 1936.

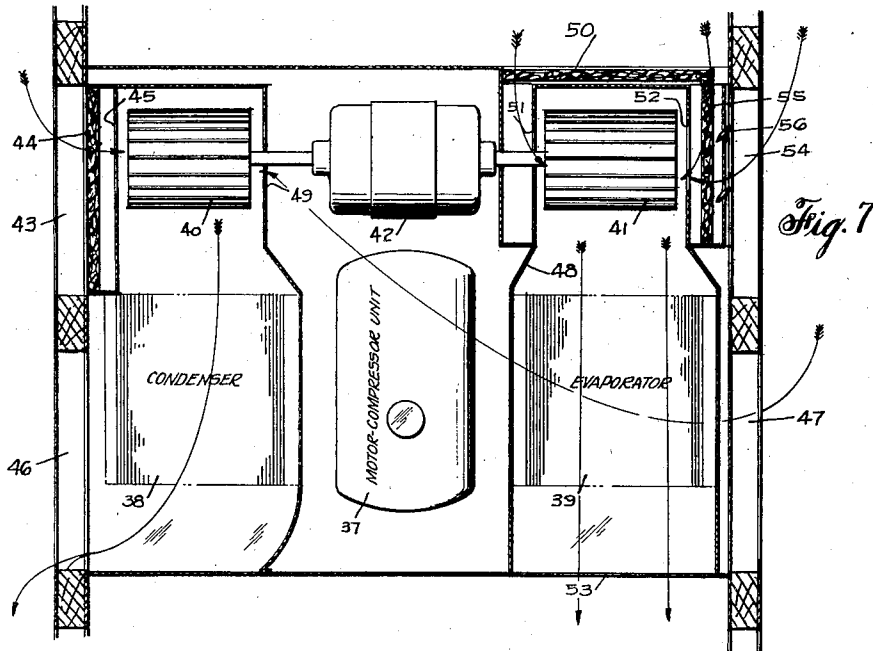
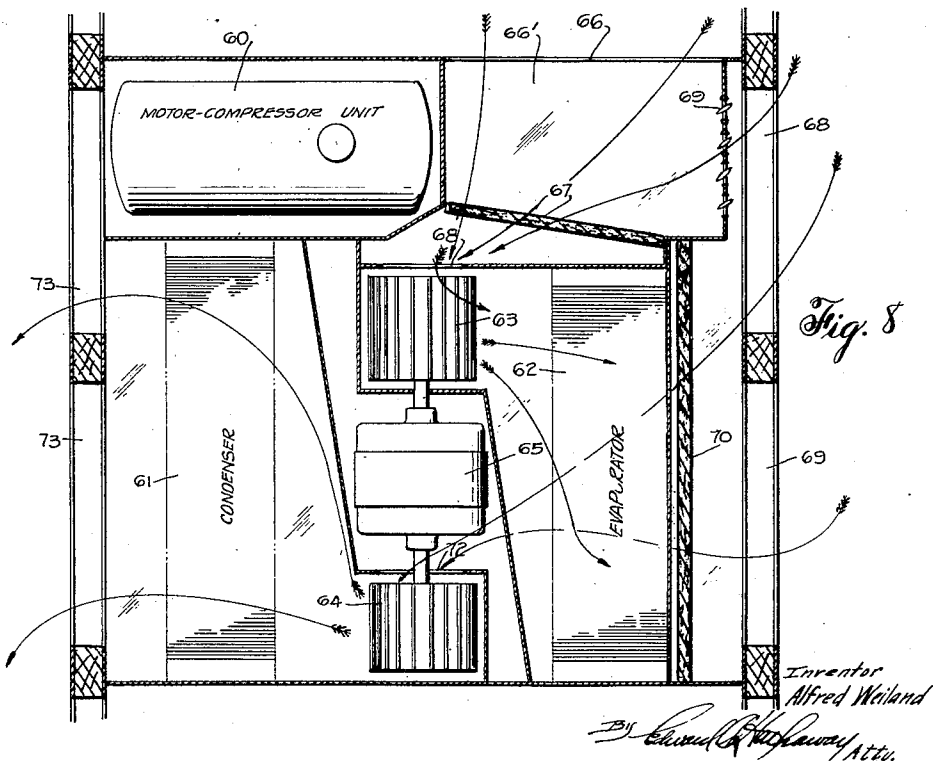
A. WEILAND

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AIR CONDITIONING APPARATUS

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Sept. 15, 1936.

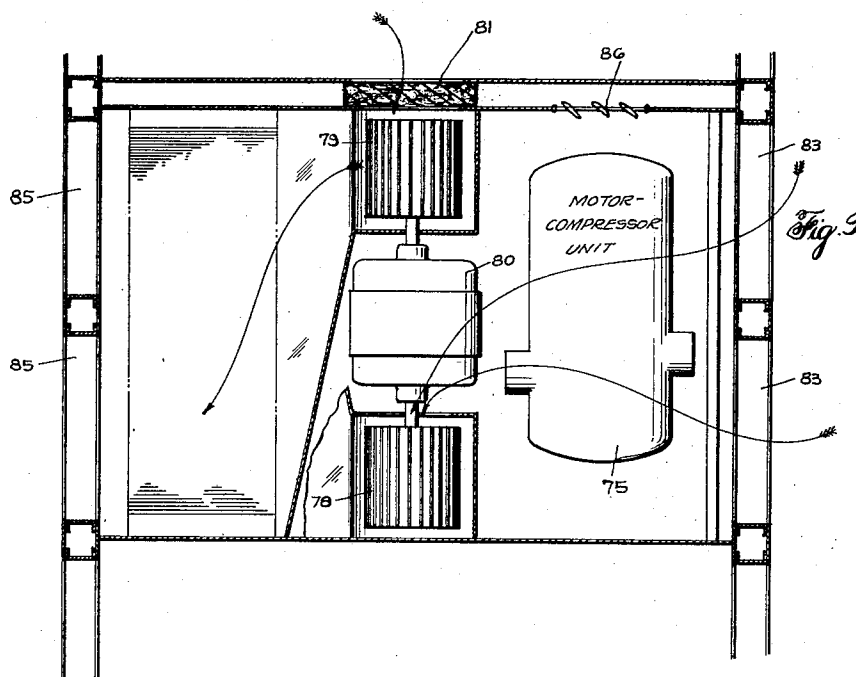
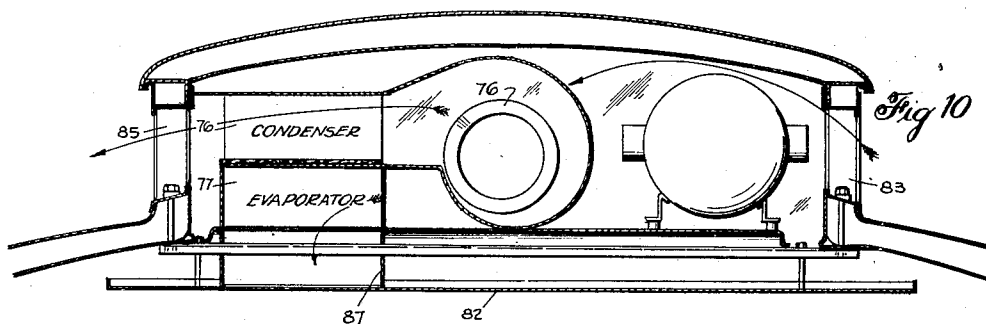
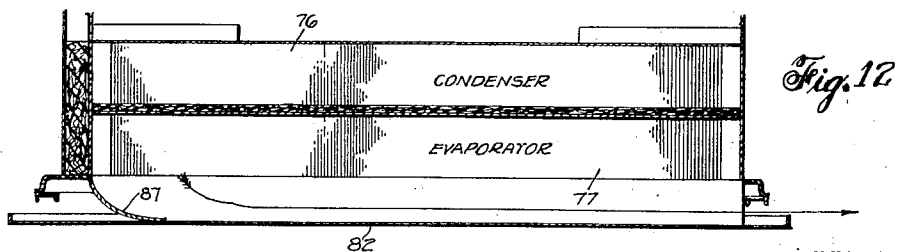
A. WEILAND

2,054,350

AIR CONDITIONING APPARATUS

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6 Sheets-Sheet 5



INVENTOR

ALFRED WEILAND

BY

Charles H. Sawyer
ATTORNEY

Sept. 15, 1936.

A. WEILAND

2,054,350

AIR CONDITIONING APPARATUS

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6 Sheets-Sheet 6

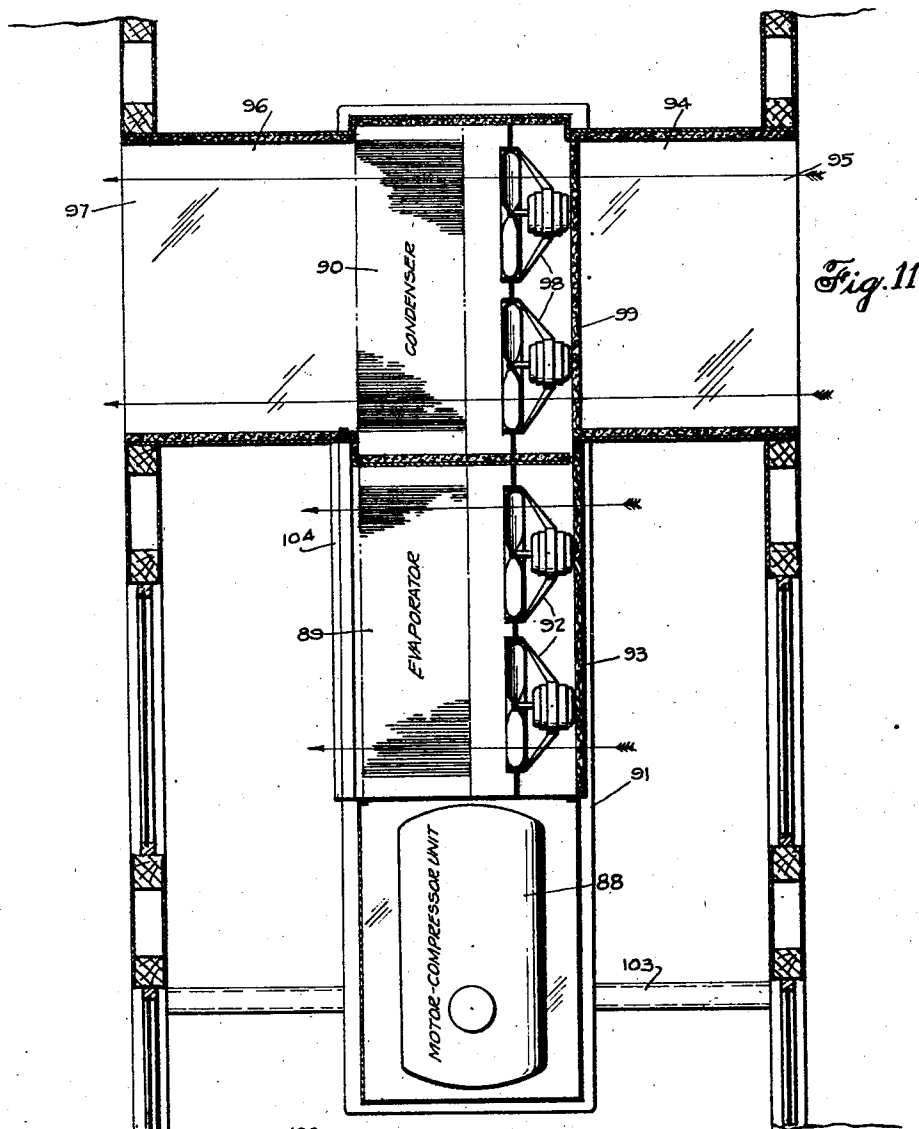


Fig. 11

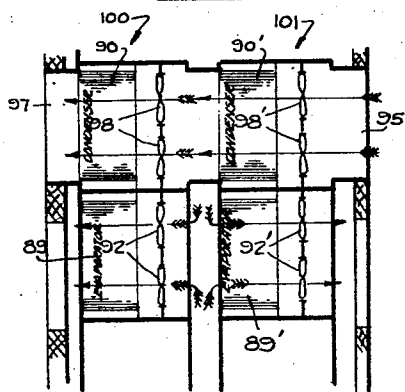


Fig. 11a

INVENTOR
ALFRED WEILAND.

BY

Charles H. McHenry
ATTORNEY

UNITED STATES PATENT OFFICE

2,054,350

AIR CONDITIONING APPARATUS

Alfred Weiland, Philadelphia, Pa., assignor to
Baldwin-Southwark Corporation, a corporation
of Delaware

Application December 1, 1933, Serial No. 700,526

10 Claims. (Cl. 62—117)

This invention relates generally to an improved air conditioning and cooling system for passenger cars and relates more particularly to an improved combination wherein an air conditioning unit of the refrigerating type is supported by the roof of a railway car.

Many air conditioning systems of the refrigerating type have been developed for railway cars some of which are in the nature of central unit systems having a large amount of the equipment carried in the car vestibule or beneath the car. This type of apparatus must be specially built and fitted for each particular car and special duct work must be installed to effect proper circulation of the air through the car and over the evaporator or equivalent cooling radiator. Hence this equipment and its installation are not only expensive but its characteristics are best adapted only for relatively permanent installation.

Other types of air conditioning apparatus in the nature of portable equipment involve the necessity of its installation beneath the car, thereby requiring special air ducts if it is desired to effectively distribute and circulate the conditioned air, and in addition such a system is disposed in an undesirable location where dirt and dust are constantly blown up from the road bed.

It is one object of my invention to provide an improved mechanical refrigerating air conditioning unit entirely locally supported by the car roof and so arranged in cooperation therewith that car air may be effectively cooled, dehumidified and circulated and the refrigerant condenser may be adequately air cooled. A further object is to provide an improved combination between such a unit and the car whereby the unit may be relatively easily installed for either temporary or seasonal use and yet will be unobtrusive in its appearance or location so that it may, if desired, be used permanently.

In one specific aspect of the invention, I support on the inside of the car roof an air conditioning unit of the type employing an air cooled condenser, and then utilize the ventilator openings in the roof, or special openings if so desired, for circulating outside air over the condenser to cool the same. In carrying out this specific aspect, I provide a self-contained unit including a condenser, evaporator, compressor and air circulating mechanism all arranged so that it may be placed as a unit in supported relation to the roof and in functional cooperation with the openings therein.

Hence it is seen that in providing my improved combination of a self-contained air conditioning

unit of the refrigeration type supported within the monitor top of a car roof, I am able to utilize a space which lends itself most advantageously to my improved type of unit while at the same time bringing the unit into cooperation with the openings in the deck sides of the monitor top, thus providing an extremely simple installation that is highly effective to cool the car, although it will of course be understood that various features of my invention may be employed with other types of systems.

As a result of my improved combination it is seen that I can install any number of air conditioning units at any desired points of the car roof and can circulate the cooled air downwardly through the car space without the necessity of expensive or permanent duct work.

Other objects and advantages will be more apparent to those skilled in the art from the following description of the accompanying drawings in which:

Fig. 1 is a perspective of the interior of a car with two air conditioning units embodied therein;

Fig. 2 is a vertical section of the unit taken cross-wise of the car;

Fig. 3 is a plan view of the unit shown in Fig. 2 with parts broken away to show details of construction;

Fig. 4 is a vertical longitudinal section taken substantially on the line 4—4 of Fig. 3;

Fig. 5 is a plan view of a modified air conditioning unit;

Fig. 6 is a vertical transverse section taken on the line 6—6 of Fig. 5;

Fig. 7 is a plan view of a further modified unit with the condenser and evaporator fans disposed transversely of the unit;

Fig. 8 is a plan view of another modification;

Fig. 9 is a still further modification with the motor-compressor mechanism disposed laterally of the unit;

Fig. 10 is a vertical transverse section taken on the line 10—10 of Fig. 9;

Fig. 11 is a modification with the condenser, evaporator and motor-compressor unit disposed in longitudinal alignment;

Fig. 11a is a modification showing diagrammatically two units, similar to Fig. 11, placed side by side;

Fig. 12 is a longitudinal vertical section taken on lines 12—12 of Figs. 9 and 10.

In the particular embodiments of the invention which are disclosed herein merely for the purpose of illustrating certain specific forms among possible others that the invention might

take, I have shown in Fig. 1 one preferred application wherein the air conditioning unit or units are placed in combination with a railway car 1 having a monitor roof 2. A roof of this type may be built in accordance with various structural designs but as this does not specifically enter into my present invention it will suffice to state in general that a usual lower deck 3 is preferably provided with customary deck sills 4, an upper deck 5 and deck sides 6, the upper deck and its sides hereinafter being referred to as the monitor. Any usual ventilator openings 8, Fig. 3, or special openings if so desired, are provided in the deck sides 6 together with ventilator windows or shutters 9. Preferably these shutters 9 are pivoted about vertical axes midway of their length, thereby being adjustable so as to deflect outside air inwardly and over the condenser of the air conditioning unit to be described presently and thence to be discharged to the outside through openings preferably in the opposite deck side which are similarly controlled by windows or transoms adjusted to a position for inducing withdrawal of air during movement of the car, although in accordance with the disclosure herein it will of course be understood that the inlet and outlet openings for the condenser cooling air may if desired be disposed in the same deck side.

In my improved combination I employ these structural and functional possibilities of a railway car by providing preferably a self-contained air conditioning unit having an air cooled condenser and at the same time I am able to utilize an extremely compact, unobtrusive and highly efficient location of the unit together with the ability to place a unit readily in position without material alterations, if any, to the cars. Such an air conditioning unit is generally shown in Fig. 1 at 10 which is specifically located midway of the length of the car, although further units 11 may be installed in the car at other locations such as at near the ends thereof. The number of units may, of course, be varied in accordance with the size or style of car.

One specific form of unit is shown in Figs. 2 to 4 wherein a motor-compressor unit generally indicated at 13 and preferably of the self-contained, hermetically sealed piston and cylinder type with the motor axis extending lengthwise of the unit 13, is suitably supported preferably on a base pan 14. This pan extends transversely for a substantial portion of the width of the upper deck or monitor and extends longitudinally for the full length of the air conditioning unit. As seen in Fig. 3 the motor-compressor is at one end of the unit while disposed at the other end thereof is an air circulating motor 15 whose longitudinally extending armature shaft carries at its two ends a car air circulating fan rotor 16 and condenser air fan rotor 16', these fans preferably being of the centrifugal type, although other types may of course be used.

The motor 15 is disposed centrally of the unit preferably in alignment with motor-compressor 13 while a condenser 17 and evaporator 18 are disposed lengthwise of the unit along the sides of the motor mechanism. A duct 19 provides a substantially horizontal passageway enclosing condenser 17 and also provides a scroll case for fan 16'. This duct is open at its side for communication with the openings in the adjacent deck side. Any suitable breakable joint 20 may be provided between the outer edges of duct 19 and the deck side.

A duct 21 encloses evaporator 18 on its two

sides and top and if desired may partially close the same at the bottom to provide as shown in Fig. 4 downwardly projecting outlets 22 for allowing air to be discharged through suitable openings in base 14 and then deflected laterally by a distributor plate 23. These downward openings 22 are preferably at one end of duct 21 and the scroll for fan 15 is at the other end, although if desired the downward openings 22 may extend for the full length of its duct. The inlet to this duct and fan is generally indicated at 24, Fig. 3, and may be provided with a filter if so desired. A longitudinally extending filter 25 is provided for the condenser cooling air, it being noted that this filter extends preferably for the full length of the air conditioning unit.

From the foregoing disclosure, it is seen that the air conditioning unit including the refrigerating elements as well as the air circulating mechanism is entirely self-contained on base 14, this base in turn preferably being supported on two or more cross beams 26 adapted to be either bolted as at 27 to the deck sills or if desired to be suspended from the upper deck roof. In either event it is seen that the air conditioning unit is wholly disposed within the upper deck or monitor while the distributor 23 entirely underlies the unit and slightly overlaps the lower decks 3 in spaced relation thereto. The distributor may be removably suspended from the unit as by a series of suspension bolts 28 and if desired this distributor may be used as a moisture collector pan. This moisture may be pumped by mechanical or ejector means into the outflowing stream of condenser cooling air or if desired a condensate collector pan having a series of longitudinal staggered troughs 29 may be disposed immediately below evaporator 18 and connected to a pipe 30 extending through one of the deck sides to be drained by gravity to the outside.

Operation.—Assuming the car to be moving in the direction of arrow *a*, Fig. 3, shutters 9 on the two deck sides are adjusted to the position shown thereby augmenting the flow of air inwardly through openings 8 on the right side, thence through filter 25 and over the top of evaporator duct 21 and into the coaxial inlets 31 of the casing of fan 16' which is driven by motor 14. This air is then forced over the condenser coil 17 and thence through the openings 8 on the left deck side. The shutters for these openings by being inclined rearwardly will cause a partial ejector action of the discharged air due to movement of the car. The car air is circulated by fan 16 which draws the air in through opening 24 and its filter, thence through duct 21 and over evaporator coil 18 to be cooled thereby and be discharged downwardly preferably toward the remote end. The air is then deflected by distributor 23 and flows horizontally over the edges thereof. The outlet 22 from evaporator duct 21 may extend for the full length thereof and register with suitable openings in base 14 without possibility of any appreciable portion of cooled air being short circuited or immediately recirculated into inlet 24, this possibility being minimized because of the relatively small size of inlet 24 compared to the large size of the distributor which will effectively spread the air out over a very large area. Hence it is seen that I have provided a self-contained air conditioning and air circulating unit that is highly adapted for cooperation with the upper deck and also may be readily installed so as to fully cooperate with the deck openings and yet will be conveniently and unobtrusively located.

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Figs. 5 and 6 illustrate a modification wherein a condenser and evaporator 30 and 31 respectively are disposed in parallel relation similar to the arrangement of Fig. 3. In this modification, however, a single motor 32 commonly drives a compressor 33, a condenser air blower 34 and a car air blower 35. These elements are centrally disposed on a common longitudinal axis and connected by a common shaft 36. This arrangement is particularly applicable to direct current motor actuation. The arrangement of ducts and the path of condenser cooling air and car air are the same as in Fig. 3 and similar elements are accordingly given the same reference numbers.

This modification has the advantage of using a single motor to drive all moving parts, tending thereby to maximum electrical efficiency and corresponding economic operation. Further, the use of a single drive shaft for both compressor and fans forms a simple and positive method of insuring condenser fan operation while the compressor is in operation, thereby avoiding the necessity of elaborate electrical or mechanical control devices to perform this function. To those skilled in the art it is apparent that the compressor could be placed at either end of the single drive shaft or that the fans could be belt driven without departure from the spirit of this modification.

Fig. 7 is a further modification which is highly adapted for certain installations. In this modification a motor-compressor unit 37 is disposed with its axis extending longitudinally of the car and centrally of the air conditioning unit. A condenser 38 and evaporator 39 are disposed on each side of the compressor while a condenser air blower 40 and a car blower 41 are disposed transversely of the car and driven by a common motor 42. As a result of this arrangement, condenser air flows inwardly through one of the deck openings 43 through filter 44 and blower inlet openings 45, and thence flows lengthwise of condenser 38 to be discharged outwardly through another deck opening 46. Condenser air may also flow inwardly through a deck opening 47 on the opposite side of the roof, thence over the top of the evaporator duct 48 and also over the motor-compressor unit 37 to a second blower inlet 49. The car air passes through a filter 50 and enters coaxial inlets 51 and 52 to be circulated over evaporator 39 and discharged into the car through opening 53. Fresh air may be admitted to the car through adjustable inlets 56 communicating with the outside air through a deck opening 54. The fresh air passes through a filter 55 and enters blower inlet 52.

From the arrangement of Fig. 7 it is seen that the conditioned air will be positively circulated longitudinally of the car in addition to other advantages inherent in the structure.

The positive discharge in a longitudinal direction, in relation to the car, has several definite advantages. By placing one or more pairs of such units, separated by either part or the whole of the car length, so that the direction of their cooled air discharge is toward each other in each pair, a rotary air motion is achieved which is highly desirable insofar as air circulation is concerned. Where an extreme drop in air temperature or humidity is desired (i. e., if the car is to be in service in particularly warm or humid localities), it is possible to place two or more units in such relation each to the other that the cooled air of one is discharged directly or substantially so into the evaporator suction of

the next unit, the temperature and humidity of the cooled air being lowered progressively in each.

Fig. 8 discloses a still further modification wherein the motor-compressor unit 60 is disposed transversely of the air conditioning unit. 5 and in one corner thereof, while the condenser 61 and evaporator 62 are disposed substantially parallel to each other with enclosing duct work therefor. A car air blower 63 and condenser cooling air blower 64 are commonly driven by 10 an electric motor 65. The axis of these elements extend longitudinally of the unit and permits a very compact unit. Car air enters through an inlet 66 and passes through a filter 67 to enter inlet 68 of blower 63, thence to pass over evaporator 62 and down into the car in the manner shown in Figs. 2 and 3. Fresh air may be admitted through deck opening 68 and thence through adjustable vane openings 69 of chamber 66'. Condenser cooling air is admitted 20 through deck openings 68 and 69 to flow through a filter 70 and thence over the top of the evaporator duct work 71 and into the inlet opening 72 to be circulated over condenser 61 and discharged to the outside through deck openings 73. 25

This modification possesses the advantage of having a relatively large plenum chamber for the mixture of car air and fresh air, and permits the use of a relatively large filtering area, thereby minimizing pressure drop through the same. 30 Further this arrangement permits, as shown, the complete enclosure of the compressor and motor unit for purposes of minimizing sound from the same.

Figs. 9, 10 and 12 illustrate another modification wherein the motor-compressor unit 75 has its axis extending lengthwise of the car and disposed adjacent one of the deck sides. A condenser 76 and an evaporator 77 are superimposed and disposed entirely to one side of the air conditioning unit. In this arrangement the condenser fan 78 and evaporator fan 79 are commonly driven by a motor 80, these elements being centrally disposed longitudinally of the air conditioning unit. The car air enters an inlet 81 45 to pass through any suitable filter, thence flows over evaporator 77 to be discharged downwardly against distributor plate 82, which may in conjunction with partition 87 form a duct discharging longitudinally with respect to the car, as in 50 Fig. 12. The condenser cooling air enters deck openings 83 to flow over and around the motor-compressor unit 75 and thence enter the axial inlet 84 to be circulated by fan 78 over condenser 76 and out through the other deck openings 85. 55 To admit fresh air into the car, an adjustable vane controlled opening 86 is provided whereby outside air may flow through openings 86 and 81 into car air fan 79 and thence be carried down over the evaporator into the car. 60

This modification possesses the advantage of compactness above all of the other modifications. The superimposing of the condenser above the evaporator utilizes the space allowed to the fullest advantage, so that the length of the evaporator or condenser becomes the determining size of the unit installation.

Fig. 11 is a further modification wherein the motor-compressor unit 88, evaporator 89 and condenser 90 are disposed lengthwise of the car 70 roof. These elements are of course commonly supported on an elongated base 91 and suitable cross supports 103 similar to the preferred form of Figs. 2 and 3. It will of course be understood that all of the other modifications herein de- 75

scribed are likewise provided with a suitable base and cross supports secured to the deck sills or to the roof by suspension rods if so desired. In Fig. 11, however, a fan or fans 92 circulate car air through a filter 93 and then directly across evaporator 89 to be discharged to the other side of the car. The cooled air will preferably impinge against the deck side and then gradually fall through the remainder of the car. In this respect the deck side serves as a deflector or baffle for breaking up any draft. In this modification the condenser air passage is adapted for a very simple arrangement as it will be noted that a transverse passage 94 extends from one deck opening 95 directly to the condenser and thence directly out through passage 96 to a deck opening 97 in the opposite side. Fans 98 may be employed for circulating this air. A filter 99 is likewise provided.

This modification possesses the advantage of having the simplest possible duct work and air passages, thereby minimizing any losses due to air friction and causing a proportionate reduction in both operating and initial expense. Further, this modification permits the disposal of condensate water directly into the condenser air discharge passage where the water may be carried off as a vapor, instead of objectionable dripping or jets. Condensate water produced by evaporator 89 is taken out of the car air stream by eliminators 104 and drained into passage 96 into the path of the warm condenser discharge air.

Fig. 11a is a diagrammatic amplification of Fig. 11 in that two units 100 and 101 are placed side by side. These units are of the same general construction and arrangement as shown in Fig. 11 except one is to discharge the evaporator air to the left and the other to the right with the circulated car air thus entering upwardly between the adjacent units. This may be accomplished by having the evaporator fans 92 and 92' rotate in opposite directions. This combination of units permits the condenser fan of one unit to act as a booster for the other, increasing the amount of air circulated over the condenser of both units and thereby increasing the coefficient of heat transfer of each in partial proportion to the increase in velocity of the air over the condenser surfaces. Such a combination of units would be particularly adaptable to abnormally warm climatic conditions.

In any of the modifications it will be understood that the condensate may be adequately taken care of as disclosed in the preferred form of Figs. 2 and 3 as by using trays 29'.

It is seen that in all of the modifications I have provided a very desirable system whereby cars may be adequately and effectively equipped with air conditioning equipment of the refrigeration type, this being accomplished in an economical manner together with such simplicity that the apparatus may be conveniently and relatively quickly installed, thus avoiding the necessity of withdrawing the car from service for an extended period.

If desired the condenser and evaporator may be functionally interchanged by suitable mechanism to permit car heating.

It will of course be understood that any or all of the ducts or casing and the compressor-motor of the several modifications may be insulated with either heat or sound insulation and may be arranged or changed in equivalent manners with-

out departing from the spirit of the invention as set forth in the appended claims.

I claim:

1. An air conditioning apparatus for a railway car having a roof provided with outside air openings comprising; in combination; a self-contained unit having a compressor, an air cooled condenser, an evaporator over which car air is passed, a blower for circulating car air over said evaporator, and means including passages adapted for communication with said openings for circulating outside air through one of said openings and thence over said condenser and back to the outside through the other of said openings; and means for supporting said self-contained unit at the under side of said roof to effect said communication with said outside air openings.
2. An air conditioning apparatus for a railway car having a roof provided with outside air openings comprising; in combination; a self-contained unit having a compressor, an air cooled condenser, an evaporator over which car air is passed, said condenser and evaporator being disposed in substantially parallel relation, a blower for circulating car air over said evaporator, means including a blower and passages adapted for communication with said openings for circulating outside air through one of said openings and thence over said condenser and back to the outside through the other of said openings, and a motor for commonly driving said car air and condenser air blowers; and means for supporting said self-contained unit at the under side of said roof to effect said communication with said outside air openings.
3. The combination set forth in claim 1 further characterized in that said condenser and evaporator are disposed in substantially parallel relation and said outside circulating means includes a blower and a motor for commonly driving said car air and condenser air blowers, and means for supporting said blowers with their axes extending substantially parallel to said condenser and evaporator.
4. An air conditioning apparatus for a railway car having a roof provided with outside air openings comprising; in combination; a self-contained unit having a compressor, an air cooled condenser, an evaporator laterally spaced from said condenser, a blower for circulating car air over said evaporator, and means including a blower and passages adapted for communication with said openings for circulating outside air through one of said openings and thence over said condenser and back to the outside through the other of said openings, said blowers being disposed between said laterally spaced condenser and evaporator; and means for supporting said self-contained unit at the under side of said roof to effect said communication with said outside air openings.
5. An air conditioning apparatus for a railway car having a roof provided with outside air openings comprising; in combination; a self-contained unit having a compressor, an air cooled condenser, an evaporator laterally spaced from said condenser, a blower for circulating car air over said evaporator, and means including a blower and passages adapted for communication with said openings for circulating outside air through one of said openings and thence over said condenser and back to the outside to the other of said openings, said blowers and compressor being disposed between said laterally spaced condenser and evaporator; and means for supporting said

self-contained unit at the under side of said roof to effect said communication with said outside air openings.

5 6. An air conditioning apparatus for a railway car having a roof provided with outside air open-
ings comprising; in combination; a self-con-
tained unit having a compressor, an air cooled
condenser, an evaporator over which car air is
passed, means including a blower and a passage
10 for circulating car air over said evaporator in a horizontal direction, and means including pas-
sages adapted for communication with said open-
ings for circulating outside air through one of
said openings and thence over said condenser
15 and back to the outside through the other of said openings; and means for supporting said self-
contained unit at the under side of said roof to effect said communication with said outside air
openings.

20 7. The combination set forth in claim 1 further characterized in that said outside air passages
terminate in lateral openings for communication
with deck side openings of a monitor type roof
within which said self-contained unit is disposed.

25 8. The combination set forth in claim 1 further characterized in that the outside air passage ter-
minates in lateral openings on opposite sides of
the unit for communication with deck side open-
ings in a monitor type roof within which the unit
30 is disposed whereby outside air enters from one
side of the car and passes over the condenser
and is discharged from the other side of the car.

9. An air conditioning apparatus for a railway car having a roof provided with outside air open-

ings comprising; in combination; a self-con-
tained unit having a compressor, an air cooled
condenser, an evaporator over which car air is
passed, a blower for circulating car air over said
5 evaporator, and means including a blower and
passages adapted for communication with said
openings for circulating outside air through one
of said openings and thence over said condenser
and back to the outside through the other of said
10 openings, and means for mounting said car air
and outside air blowers with their axes disposed
longitudinally of the self-contained unit; and
means for supporting said self-contained unit
at the under side of said roof to effect said com-
15 munication with said outside air openings.

10. An air conditioning apparatus for railway
car having a roof provided with outside air open-
ings comprising; in combination; a self-con-
tained unit having a compressor, an air cooled
20 condenser, an evaporator over which car air is
passed, a blower for circulating car air over said
evaporator, means including a blower and pas-
sages adapted for communication with said
openings for circulating outside air through one
25 of said openings and thence over said condenser
and back to the outside through the other of said
openings, means for supporting said car air and
outside air blowers upon a common axis, and a
common driving motor for said blowers; and
30 means for supporting said self-contained unit at
the under side of said roof to effect said commu-
nication with said outside air openings.

ALFRED WEILAND.