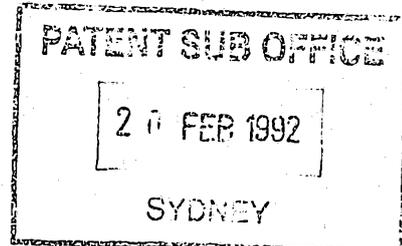


623115

P/00/008
Section 29(1)
Regulation 3.1(2)

AUSTRALIA
Patents Act 1990

NOTICE OF ENTITLEMENT



We **SOIL MACHINE DYNAMICS LIMITED**
of **Beaumont House, Stocksfield, Northumberland NE 43 7TN, ENGLAND**

Being the Applicant and nominated person, request the grant of a patent in respect of Application No. 30835/89 entitled **Aircraft Ground Handling Vehicle** state the following:

The applicant is the assignee of the invention from the inventors Dr T.W. Grinsted and Dr A.R. Reece.

The basic application was the first application made in a Convention country in respect of the invention the subject of this application.

Our address for service is: **GRIFFITH HACK & CO.**
168 WALKER STREET
NORTH SYDNEY NSW 2060

Dated this 18th day of February 1992.

**SOIL MACHINE DYNAMICS
LIMITED**
By their Patent Attorney

A handwritten signature in black ink, appearing to read "G. Carew".

GRIFFITH HACK & CO.

[GH&Co. Ref.] P20711-A:CLC:JM

(12) PATENT ABRIDGMENT (11) Document No. AU-B-30835/89
(19) AUSTRALIAN PATENT OFFICE (10) Acceptance No. 623115

- (54) Title
AIRCRAFT GROUND HANDLING VEHICLE
- International Patent Classification(s)
(51)⁴ B64F 001/10
- (21) Application No. : 30835/89 (22) Application Date : 28.02.89
- (30) Priority Data
- (31) Number (32) Date (33) Country
8805133 03.03.88 GB UNITED KINGDOM
- (43) Publication Date : 07.09.89
- (44) Publication Date of Accepted Application : 07.05.92
- (71) Applicant(s)
SOIL MACHINE DYNAMICS LIMITED
- (72) Inventor(s)
DR T.W. GRINSTED; DR A.R. REECE
- (74) Attorney or Agent
GRIFFITH HACK & CO. , GPO Box 4164, SYDNEY NSW 2001
- (56) Prior Art Documents
US 4658924
GB 157017
AU 68270/87 B64F 1/10
- (57) Claim

1. An aircraft ground handling vehicle, comprising:
a chassis;
front and rear wheels mounted on said chassis and
defining a wheelbase of said vehicle;
means on said chassis for driving said front and rear
wheels;
a platform means mounted on said chassis for
supporting a nose wheel of an aircraft;
means for moving said platform means axially of said
chassis relative to said front and rear wheels between a
first position wherein said platform means is adjacent
said rear wheels for receiving said nose wheel of an
aircraft, and a second, retracted position remote from
said rear wheels, to enable said nose wheel to be
received within the wheelbase of the vehicle;
and lifting means mounted on said chassis and adapted
to engage and raise said nose wheel whereby to enable
movement of said platform means into said first position
to receive said nose wheel.

COMMONWEALTH OF AUSTRALIA

PATENTS ACT 1952

Form 10

COMPLETE SPECIFICATION

FOR OFFICE USE

Short Title:

Int. Cl:

Application Number:
Lodged:

623115

Complete Specification-Lodged:
Accepted:
Lapsed:
Published:

Priority:

Related Art:

TO BE COMPLETED BY APPLICANT

Name of Applicant: SOIL MACHINE DYNAMICS LIMITED
Address of Applicant: Beaumont House, Stocksfield,
NORTHUMBERLAND NE 43 7TN, ENGLAND
Actual Inventor: T.W.Grinsted and A.R. Reece
Address for Service: GRIFFITH HACK & CO.
71 YORK STREET
SYDNEY NSW 2000
AUSTRALIA

Complete Specification for the invention entitled:

AIRCRAFT GROUND HANDLING VEHICLE

The following statement is a full description of this invention,
including the best method of performing it known to me/us:-

Title: Aircraft Ground Handling Vehicle

The present invention relates to an aircraft ground handling vehicle (AGHV) and in particular to an AGHV which is suitable for use with different types of commercial aircraft.

Aircraft are conventionally handled on the ground by attaching a tow bar to the nose wheel assembly and using a vehicle to pull or push the tow bar. This system has many disadvantages:

- a) labour intensive and slow;
- b) each type of aircraft requires a different tow bar type, the tow bar including shear pins to prevent damage to the aircraft;
- c) the tugs have to be relatively heavy to generate sufficient traction as there is no weight transfer from the aircraft to the tugs;
- d) a wide range of tug sizes is required. It is not permissible to use a large tug on a small aircraft due to the risk of imposing large forces on the aircraft nosewheel assembly;
- e) there is a risk of jack-knifing;
- f) the combined length of tug and tow bar dictates large turning circles and poor manoeuvrability;
- g) considerable time is wasted by the tug in moving tow bars around to and from the tow bar store;

- h) the method is unsuitable for use at higher speeds, see paragraph e) above;
- i) the steering gear of the aircraft nosewheel has to be freed to enable the wheels to follow the tug. This is done either by disconnection of the steering linkage, which is labour intensive and unattractive, or by switching the steering hydraulics to float which permits only a limited steering and risks accidental reversion to fixed steering.

Various designs of AGHV have been proposed in an attempt to overcome these disadvantages by dispensing with the need for a tow bar by lifting the front wheels of the aircraft and supporting them in a cradle on the AGHV for transport. This leads to weight being transferred to the AGHV (typically 10% of the total aircraft weight) thus increasing the available traction and so allowing the weight of the AGHV to be reduced.

Of the previously proposed AGHV designs, the following four are considered as the most practical examples:

Secfer/Tracma (GB 1579017)

This vehicle loads the aircraft by forcing a retractable ramp under the front wheels of the aircraft. For this operation the rear aircraft

wheels must be braked or chocked and the front wheels free to rotate. The aircraft front wheels are forced up the ramp and onto a platform which is then lifted off the ground. The wheels are locked in position on the platform and the ramp is closed. This system overcomes some of the problems associated with the tow bar system but the loading method is considered rather brutal. A turntable has been provided in one version of this vehicle although it is difficult to incorporate this feature in the lifting platform and so is generally absent, thereby necessitating the disconnection of the aircraft steering system.

Krauss Maffei PTS (DE 3616807)

This vehicle is U-shaped in plan, having a large rear cut-out. The vehicle is backed up to the aircraft until the aircraft front wheels engage against a ramp. A lifting device is then swung out from each side against the wheel and this pushes the wheel up the ramp, while supplying some lift. During this movement the tractor is pulled back. The lifting equipment is then locked for transport. This method overcomes the objections to tow bars with the exception of point i). It is not possible to incorporate a turntable in this system and so the requirement to disconnect the aircraft steering

linkage is a disadvantage.

With this design, it is not possible to make a single vehicle which is capable of lifting the largest aircraft while remaining sufficiently small to fit beneath a small aircraft and so different sizes of vehicle are required.

Echtman-Hamalchim (Engineering Incorporated
EISID1220)

This vehicle has been developed for small military aircraft with hollow front wheel shaft ends. The vehicle is U-shaped and provided with opposed jacking pegs which locate the shaft ends and lift the front of the aircraft. This technique requires the steering gear to be disconnected. However, this system cannot be applied to commercial aircraft having front double wheels.

Air Traction Industries Asset (US 4658924)

The Asset lifts the front of the aircraft on the lift ball between the wheels (this is a universal feature on all commercial aircraft). The lift is applied using a telescopic jib pushing against the ground without loading the vehicle chassis. Once the aircraft is lifted a turntable which is fixed to the chassis is slid back under the wheels and the aircraft lowered onto the turntable. To achieve

this, the chassis is telescopic and the whole rear end of the chassis with the turntable assembly located thereon is slid back. This concept leads to an intrinsically weak chassis and a long vehicle with poor turning circle.

5 Again, as with the Krauss Maffei PTS, it is not possible to make a single vehicle to this design which is capable of lifting the largest aircraft while remaining small enough to pass beneath smaller aircraft.

10 It is an object of the present invention to provide an AGHV which can obviate or mitigate the problems associated with previously proposed designs.

According to the present invention there is provided an aircraft ground handling vehicle, comprising:

a chassis;

15 front and rear wheels mounted on said chassis and defining a wheelbase of said vehicle;

means on said chassis for driving said front and rear wheels;

20 a platform means mounted on said chassis for supporting a nose wheel of an aircraft;

means for moving said platform means axially of said chassis relative to said front and rear wheels between a first position wherein said platform means is adjacent said rear wheels for receiving said nose wheel of an aircraft, and a second, retracted position remote from said rear wheels, to enable said nose wheel to be received within the wheelbase of the vehicle;

25

and lifting means mounted on said chassis and adapted to engage and raise said nose wheel whereby to enable movement of said platform means into said first position to receive said nose wheel.

30



It is an advantage of the present invention that the support platform is movable on the chassis and so allows the provision of a fixed length chassis.

In a one embodiment, the loading means and the first position are all within the wheelbase of the AGHV.

Preferably, the support platform comprises a turntable so obviating the need for disconnection of the aircraft steering.

It is particularly preferred that the first position (loading position) is ahead of or between a pair of rear wheels. The means for loading the aircraft wheels onto the platform is typically movable such that after loading or unloading the nose wheels, the means can be moved away from the first position.

It is particularly preferred that the AGHV comprises a chassis having front and rear wheels thereon, the supporting platform being mounted on the chassis, means being provided for loading the nose wheels of a aircraft onto the platform and arranged such that the weight of the aircraft is supported directly on the chassis when being loaded, the arrangement being such that the nose wheels of the aircraft can be loaded via the means onto the platform where the

means can be disengaged from the wheels.

The ability to support the weight of the aircraft directly on the chassis is an advantage in that it is not necessary to provide a further supporting mechanism to engage directly onto the ground to support the weight of the aircraft during the loading procedure hence simplifying the design of the loading means. Furthermore, the risk of damaging the ground surface or any lights mounted therein is reduced.

In one embodiment, the loading means comprises a lifting jib mounted on the chassis, the lifting jib typically being telescopic so as to be adjustable in length. The jib can be conveniently arranged for movement in both vertical and horizontal planes and may include a pivotable end section. The end of the lifting jib is typically engagable with a lifting ball provided between a pair of nose wheels on an aircraft.

In another embodiment the lifting means comprises one or more sets of wheel engaging means which are pivotably mounted on the rear portion of the chassis and can be swung into position behind the nose wheels of the aircraft, loading being effected by

moving the platform backward so that the aircraft nose wheels are wedged up onto it between a ramp on the platform and the wheel engaging means on the chassis.

In this embodiment, the wheel engaging means are preferably sets of rollers or the like.

It is also preferred that the AGHV should be provided with hydraulic variable height suspension so that the rear portion of the chassis can be lowered to reduce the overall height of the platform so as to minimise the lift height required, particularly for small aircraft.

The present invention will now be described by way of example with reference to the accompanying drawings in which:

Figure 1 is a plan view of an AGHV according to one embodiment of the present invention;

Figure 2 is a side view of the AGHV shown in Figure 1;

Figure 3 is a rear view of the AGHV shown in Figure 1;

Figure 4 is a view of the rear section of the AGHV shown in Figure 1 in an alternative position;

Figure 5 is a detailed view of the lifting jib of the AGHV shown in Figure 1;

Figure 6 is a detailed view of the jib end shown in Figure 5;

Figure 7 shows a detailed view of an alternative mechanism for slewing the lifting jib of the AGHV shown in Figure 1;

Figures 8-12 show the procedure for lifting and transporting an aircraft; and

Figures 13 and 14 show an alternative feature for lifting and transporting a smaller aircraft than shown in Figures 8-12.

Figures 15-18 show an alternative arrangement for locating the nose wheels of an aircraft on the turntable.

Referring now to Figures 1 to 4, the AGHV shown therein comprises a generally U-shaped chassis, the base of the U comprising a front portion 10 of the vehicle having a pair of steerable wheels 11, 12 and the side arms of the U comprising a pair of side booms 13, 14 each having a wheel 15, 16 at the outer end thereof.

The front portion 10 comprises the main body of the vehicle and includes front and rear control cabs 17, 18, a main power plant 19 and a ground power unit 20

for supplying auxiliary power to an aircraft. Both cabs 17, 18 have controls for driving the vehicle in either the laden or unladen state, the rear cab 18 additionally including controls for a lifting jib and turntable.

The main power plant 19 drives all wheels 11, 12, 15, 16 via hydrostatic drive transmission, the wheels preferably being of an appropriate size to take large aircraft tyres.

A turntable unit is mounted on rails 21, 22 between booms 13, 14 so as to be slidable in the fore and aft directions, the position of the unit being adjusted by means of a pair of hydraulic rams 23, 24. The unit is movable between a position which is just ahead of the rear wheels 15, 16 as shown in Figure 2 to a position immediately behind the rear cab 18. The unit comprises a sliding carriage 25 having a main turntable 26 mounted thereon, the main turntable 26 having a pair of hydraulically controlled front chocks 27, 28 and a hydraulically controlled rear chock and ramp 29. The rear chock and ramp has rollers provided at its free edge.

A hydraulically controlled, telescopic lifting jib 30 is mounted on the main body adjacent the rear cab

18 so as to extend between the booms 13, 14. The jib 30 is provided with hydraulic cylinders 31 for raising and lowering the jib and a hydraulic cylinder 32 for slewing the jib from side to side. The mechanism for extending and retracting the jib is enclosed within the jib and is not shown. An alternative arrangement for the slewing cylinder 32 is shown in Figure 7. The lifting point of the jib 30 comprises an arm 33 which extends downwardly and away from the end of the telescopic portion of the jib. A lifting socket 34 is pivotally mounted on the free end of the arm 33 and is provided with a cup-shaped recess 35 at the top thereof and a level indicator and adjuster (not shown) by which the jib can be extended to maintain the socket 34 in a generally vertical attitude. A load sensor (not shown) is also incorporated into the socket 34 to provide information regarding the weight of an aircraft being lifted.

The suspension system of the rear wheels 15, 16 on the respective booms 13, 14 is preferably adjustable so as to allow the rear portion of the chassis to be lowered relative to the ground (see Figure 4).

The operation of the AGHV described above will now be described in relation to Figure 8-12.

The unladen vehicle with the lifting jib 30 retracted and the turntable unit in its forward position is backed up to the nose wheels 36 of an aircraft (in this case, a large airliner such as a Boeing 747). When the vehicle is a few metres from the nose wheels 36, the rear chock ramp 29 is lowered to form a ramp up to the turntable 26, the roller supporting the ramp on the ground (see Figure 8).

The vehicle is backed towards the wheels 36 until the ramp is just ahead of the wheels which are between the booms 13, 14, just ahead of the rear wheels 15, 16. This position may be indicated by the braking of a light beam by the wheels 36 (Figure 9).

The lifting jib 30 is extended and the socket 34 engaged on the lifting ball which is provided between the nose wheels 36 of the aircraft. A television camera may be provided in the socket 34 with a display in the rear cab to assist in this. Once the socket and ball are engaged, the nose wheels 36 are lifted by raising the jib 30 until the wheels 36 are above the level of the turntable 26 (Figure 10). In this operation the main wheels of

the aircraft and the wheels of the AGHV are braked. As the wheels 36 and the jib end follow diverging arcs during lifting, the jib is extended and the socket adjusted to maintain a vertical lift and minimise horizontal forces applied to the nosewheel assembly.

The turntable unit is then slid rearwardly along the chassis until the centre of the turntable 26 is below the castor axis of the wheels 36. The jib 30 is lowered and the weight of the aircraft is taken on the turntable, the socket 34 being disengaged from the lifting ball and the jib retracted (Figure 11). The front chocks 27,28 and the rear chock ramp 29 are swung in to grip the tyres of the wheels 36, the position of the chocks also serving to give an indication of the type of aircraft (weight, size etc.) from the size of the front tyres (Figure 12).

The aircraft may now be towed or pushed back, and steered without the need to disconnect the aircraft steering due to the action of the turntable. This also allows a small turning circle and great manoeuvrability as the overall length of the AGHV is small.

The unloading procedure can be the reverse of the

loading procedure described above but a simpler method is also possible. In this latter case, the turntable is aligned for and aft for unloading. The AGHV and aircraft main wheel brakes are applied and the front and rear chocks are released, the rear chock being lowered to form a ramp. The turntable unit is then slowly pulled forward along the chassis so that the nose wheels 36 roll down the ramp onto the ground. The ramp may then be raised and the vehicle driven away.

Figures 13 and 14 show the procedures for a smaller aircraft (e.g. Boeing 737) having a lower ground clearance at the front. Before backing up to the wheels 36, the rear chassis is lowered such that the turntable is closer to the ground. This reduces the height of lift for the wheels 36. The chassis may be raised after the wheels are chocked on the turntable or alternatively, the chassis may remain in the lowered position for transportation. The chassis may be lowered for unloading.

The present invention has the advantage that a single vehicle is applicable to all sizes of commercial aircraft. This is particularly achieved by the use of special wheels and tyres which can incorporate powerful hydraulic motors which are useful for

moving larger aircraft while being of sufficiently small diameter for use with smaller aircraft having lower ground clearance. The lowering chassis arrangement described above is also useful for smaller aircraft.

Typically an AGHV of the type described above weighs about 20 tons and has a maximum turntable load of about 40 tons. Using a typical power plant and hydraulic drive system the vehicle can move at up to 20 kilometres per hour when laden and 30 kilometres per hour unladen. By controlling the pressure in the hydraulic transmission of the AGHV the maximum force applied to the nosewheel assembly can be limited to suite different types and prevent damage. Load measuring devices may be incorporated into the nosewheel support platform to maintain these forces.

When transporting the aircraft, the braking is achieved by braking the hydraulic transmission of the AGHV. However, if the pilot of the aircraft wishes to disengage the aircraft from the AGHV, for example to avoid a collision, he can do this by applying the aircraft brakes on the main aircraft wheels which will pull the aircraft back on the turntable against the rear chock and ramp. This is fitted with a pressure sensor and should the loading

on this chock become too great, it is lowered to form a ramp such that the aircraft wheels can roll off the turntable onto the ground.

It will be apparent that various features of the AGHV described above can be omitted while maintaining the essential principles of the invention.

Most of the advantages described can be achieved using other lifting means to raise the aircraft nose wheels onto the platform. One such means is shown in Figs. 15, 16, 17 and 18. The lifting jib described previously is replaced by a pair of arms 37 pivoting on the main frame of the vehicle, said arms each carrying roller assemblies 38 as shown on Fig. 15. The arms 37 pivot about an axis 39 inclined slightly to the vertical so that the rollers 38 move downward in moving from the stowed position 40 to the working position 41.

The operation of the AGHV when fitted with this lifting arrangement will now be described in relation to Figures 15-18.

The unladen vehicle with the arms 37 stowed, the turntable unit in its forward position and the rear ramp 29 lowered is backed up to the front wheels 36 of an aircraft (in this case, a large airliner such

as a Boeing 747). The vehicle is backed up until the roller assemblies 38 can be swung out to just engage with the rear of the aircraft wheels (see Fig. 16). The carriage 25 is then moved backwards while at the same time the rear ramp 29 is raised, to provide the lifting sequence shown in Figs. 16, 17 and 18.

While the roller assemblies in this case merely provide a fixed stop for the wedging action, it is possible that means could also be provided to achieve a gripping and lifting action on the wheels 36.

The aircraft wheels 36 are rolled right forward from the position shown on Fig. 18 by a combination of driving the vehicle backwards and raising the ramps 29.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. An aircraft ground handling vehicle, comprising:
a chassis;

front and rear wheels mounted on said chassis and
5 defining a wheelbase of said vehicle;

means on said chassis for driving said front and rear
wheels;

a platform means mounted on said chassis for
supporting a nose wheel of an aircraft;

10 means for moving said platform means axially of said
chassis relative to said front and rear wheels between a
first position wherein said platform means is adjacent
said rear wheels for receiving said nose wheel of an
aircraft, and a second, retracted position remote from
15 said rear wheels, to enable said nose wheel to be
received within the wheelbase of the vehicle;

and lifting means mounted on said chassis and adapted
to engage and raise said nose wheel whereby to enable
movement of said platform means into said first position
20 to receive said nose wheel.

2. A vehicle as claimed in claim 1, wherein the
lifting means and the first position are all within the
wheelbase of the vehicle.

3. A vehicle as claimed in any preceding claim,
25 wherein the platform means comprises a turntable.

4. A vehicle as claimed in any preceding claim,



wherein the first position is ahead of or between a pair of rear wheels.

5. A vehicle as claimed in any preceding claim, wherein the lifting means is moveable such that the means can be moved away from the first position after lifting.

6. A vehicle as claimed in any preceding claim, wherein the lifting means comprises a lifting jib mounted on the chassis.

7. A vehicle as claimed in any of claims 1 - 5, wherein the lifting means comprises one or more sets of aircraft wheel engaging means which are pivotably mounted on a rear portion of the chassis.

8. A vehicle as claimed in claim 7, wherein the wheel engaging means are sets of rollers.

9. A vehicle as claimed in any preceding claim, wherein a variable height suspension is provided such that the rear portion of the vehicle can be lowered to reduce the overall height thereof.

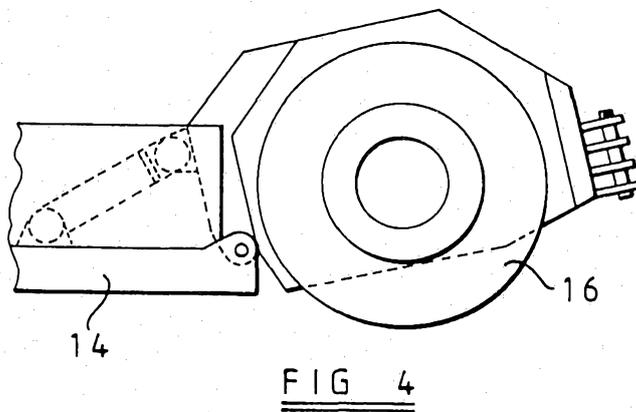
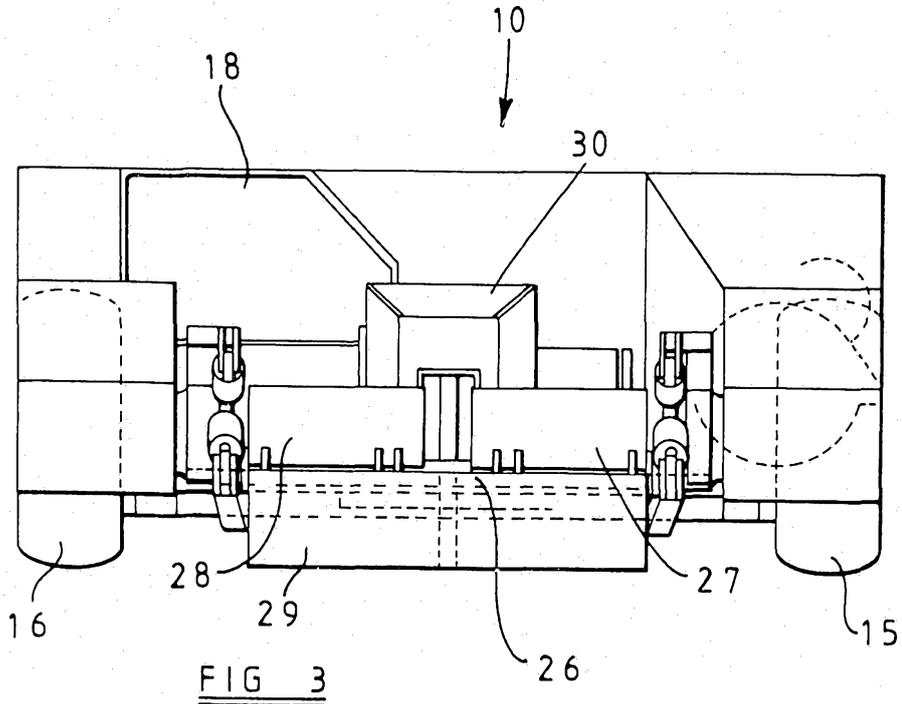


10
~~11.~~ A vehicle substantially as hereinbefore
described with reference to any one embodiment as shown
in the accompanying drawings.

Dated this 28th day of February 1989

SOIL MACHINE DYNAMICS LIMITED
By their Patent Attorney
GRIFFITH HACK & CO.





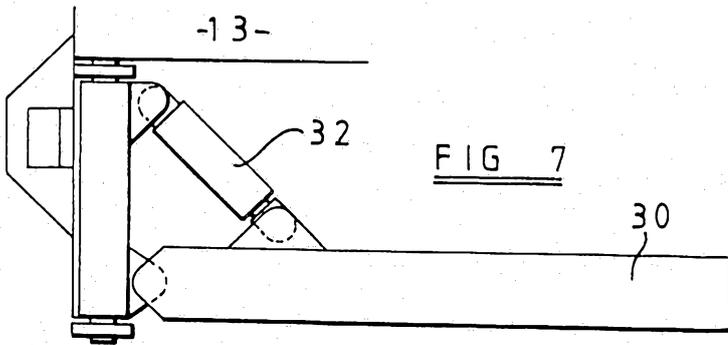
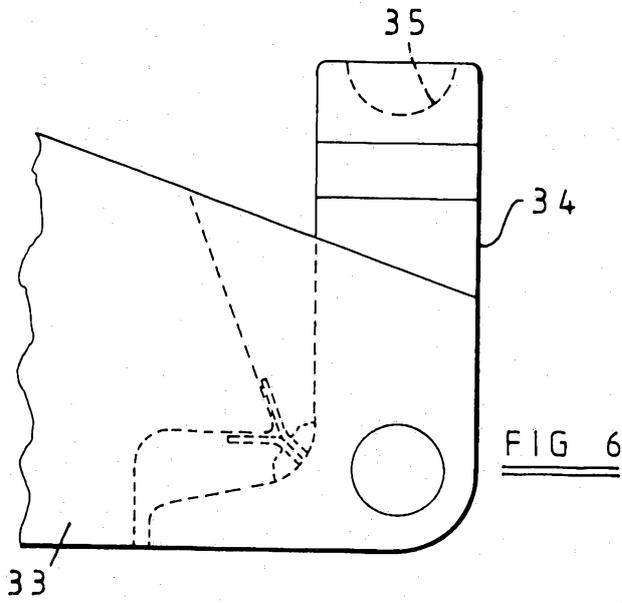
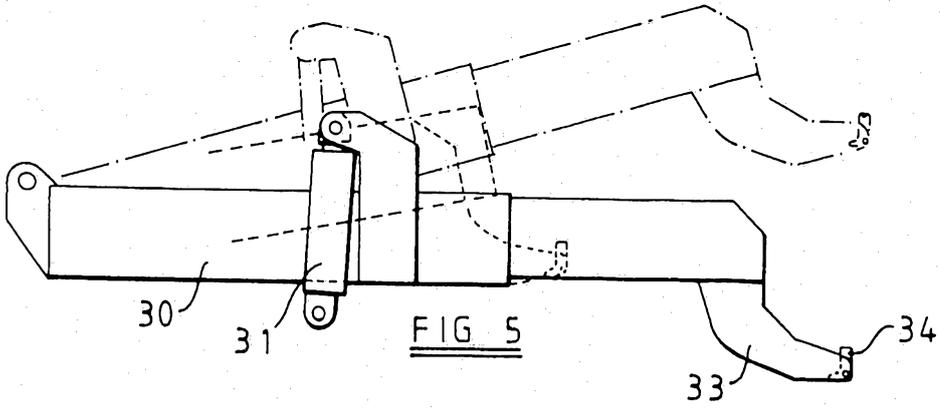
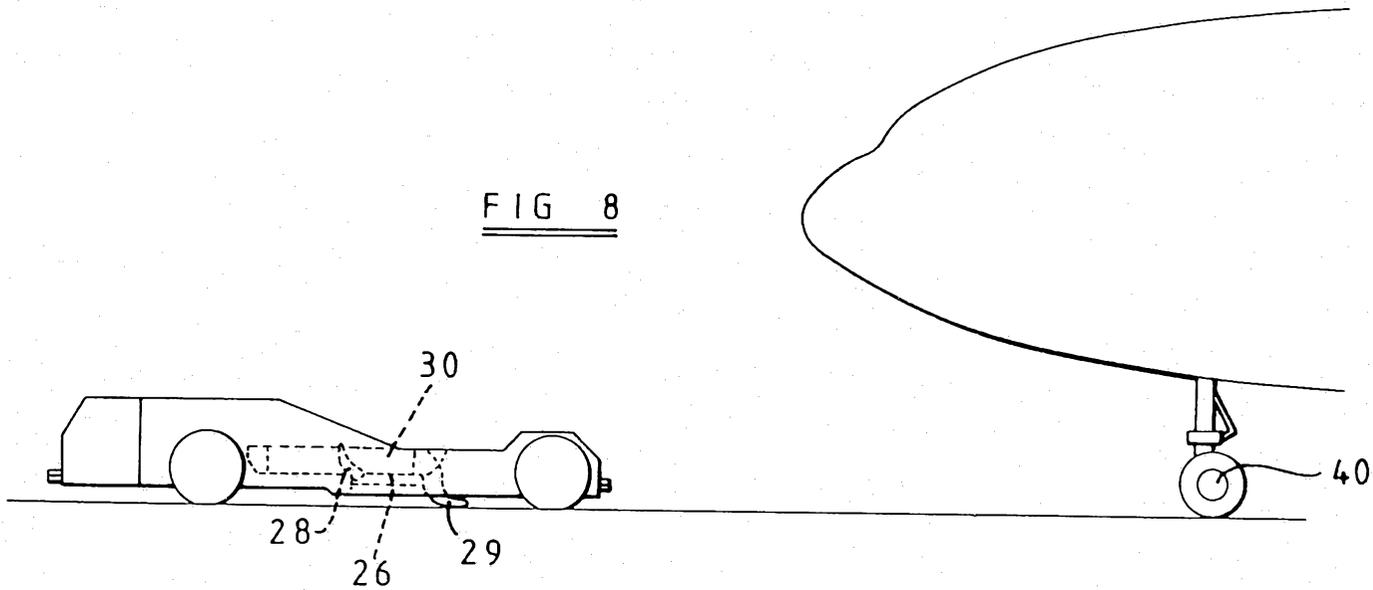
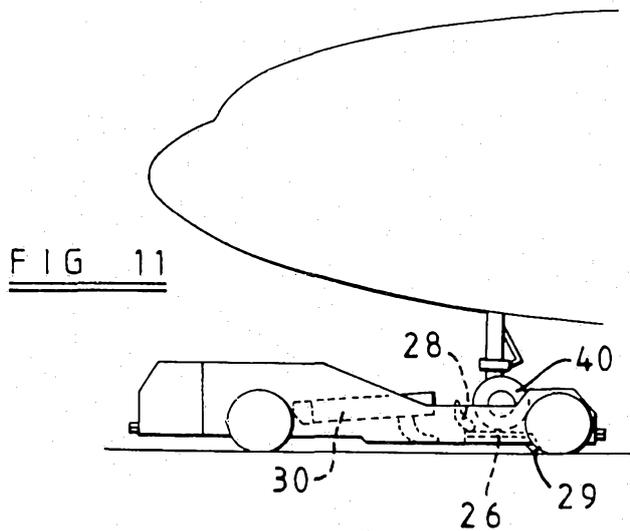
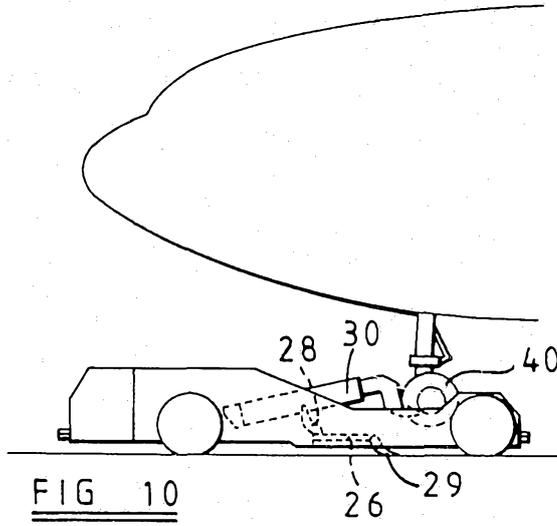
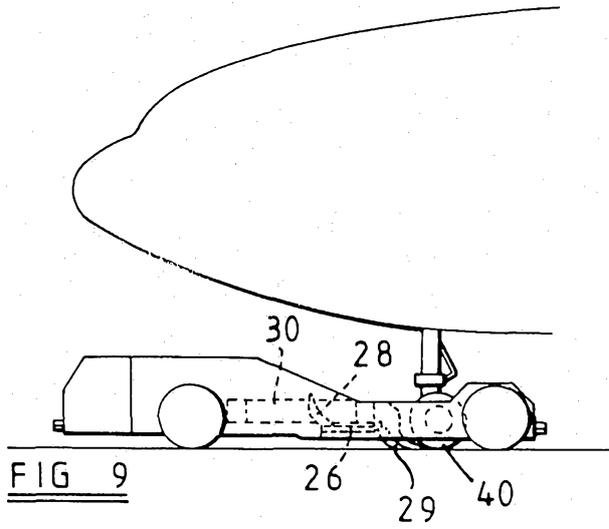
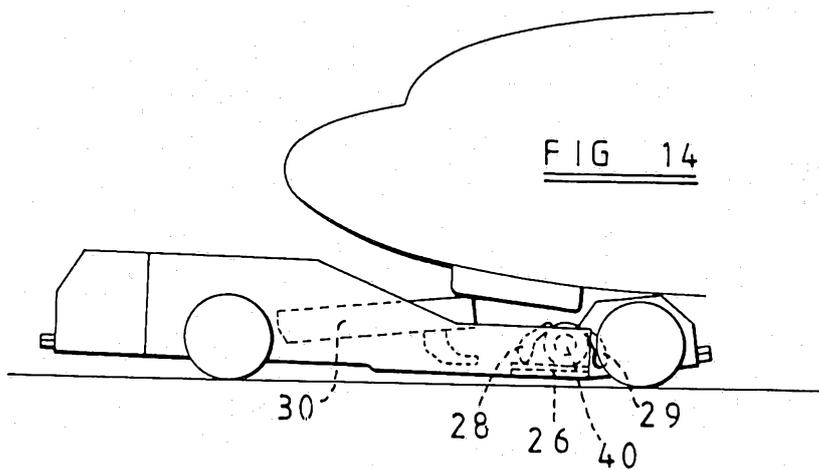
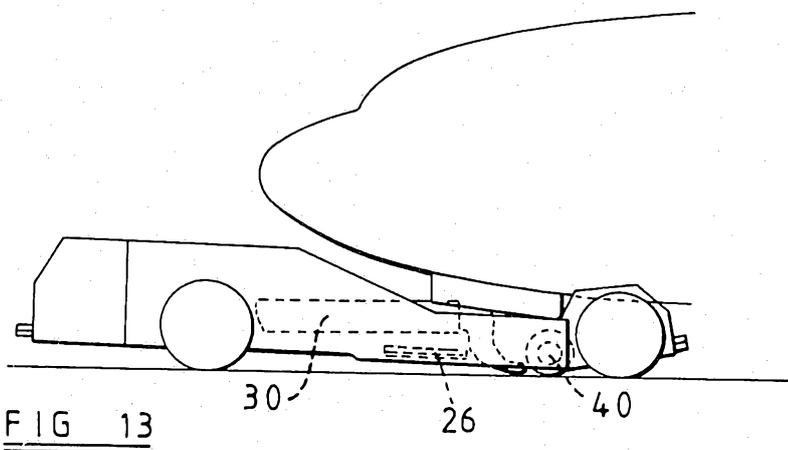
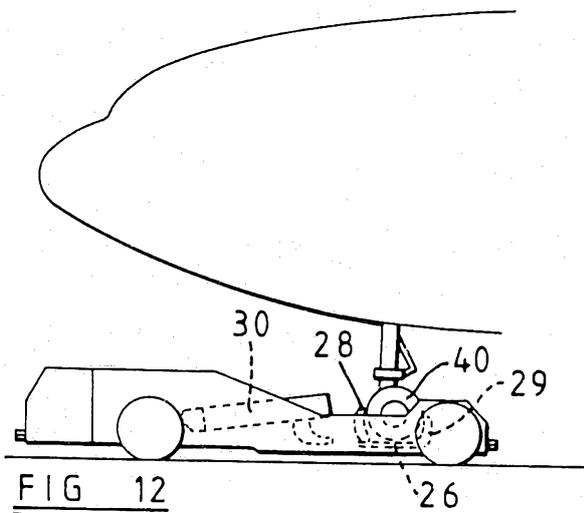


FIG 8



5 / 8





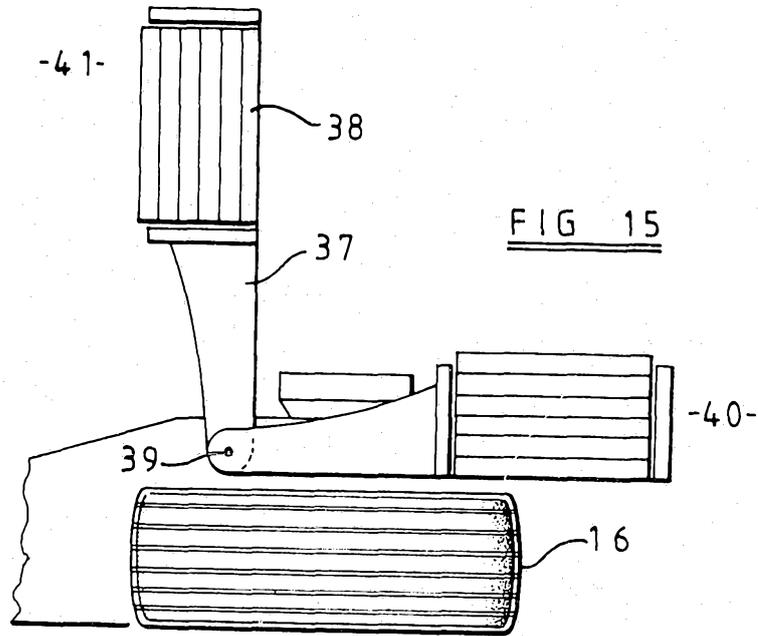
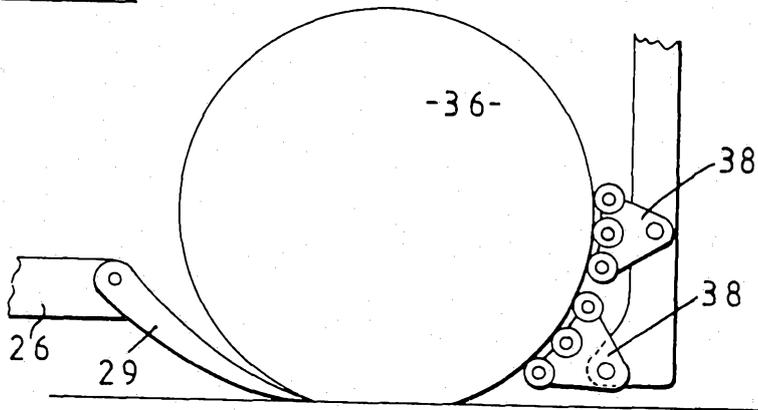


FIG 16



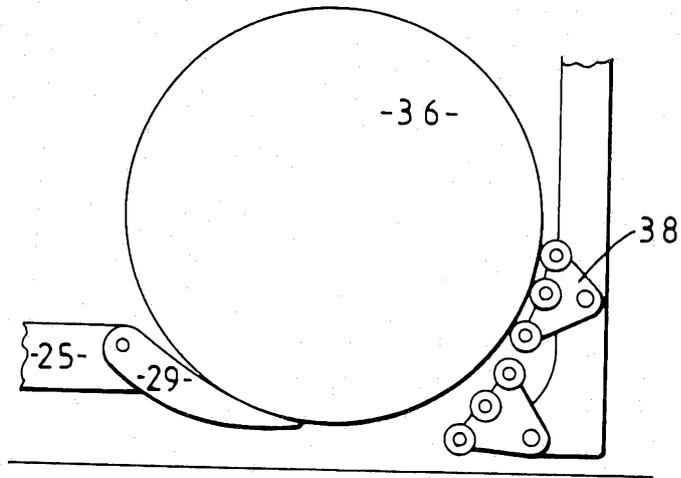


FIG 17

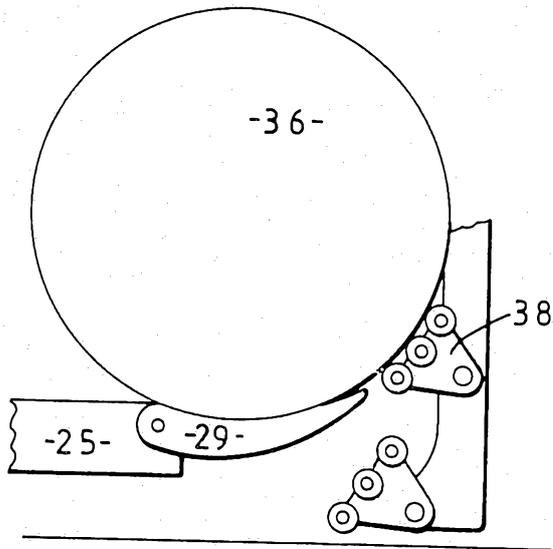


FIG 18