FREE FLIGHT HOT AIR BALLOON

FLIGHT MANUAL

ISSUE 7
1992

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This handbook provides a flight manual for the Cameron range of free flight hot air balloons ranging from 20 000 to 530 000 cu.ft. (590 to 15 000 m^3)

While all the information presented in this manual has been compiled in good faith, and is believed to be accurate, no responsibility can be accepted for the consequences of any inaccuracies which it may contain, whether due to negligence or otherwise.

Sections 2 to 6 of this manual are approved by the Civil Aviation Authority.

The balloon shall be operated in accordance with the limitations in section 2 and any additional limitations in section 6.

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SECTION 1 - GENERAL DESCRIPTION

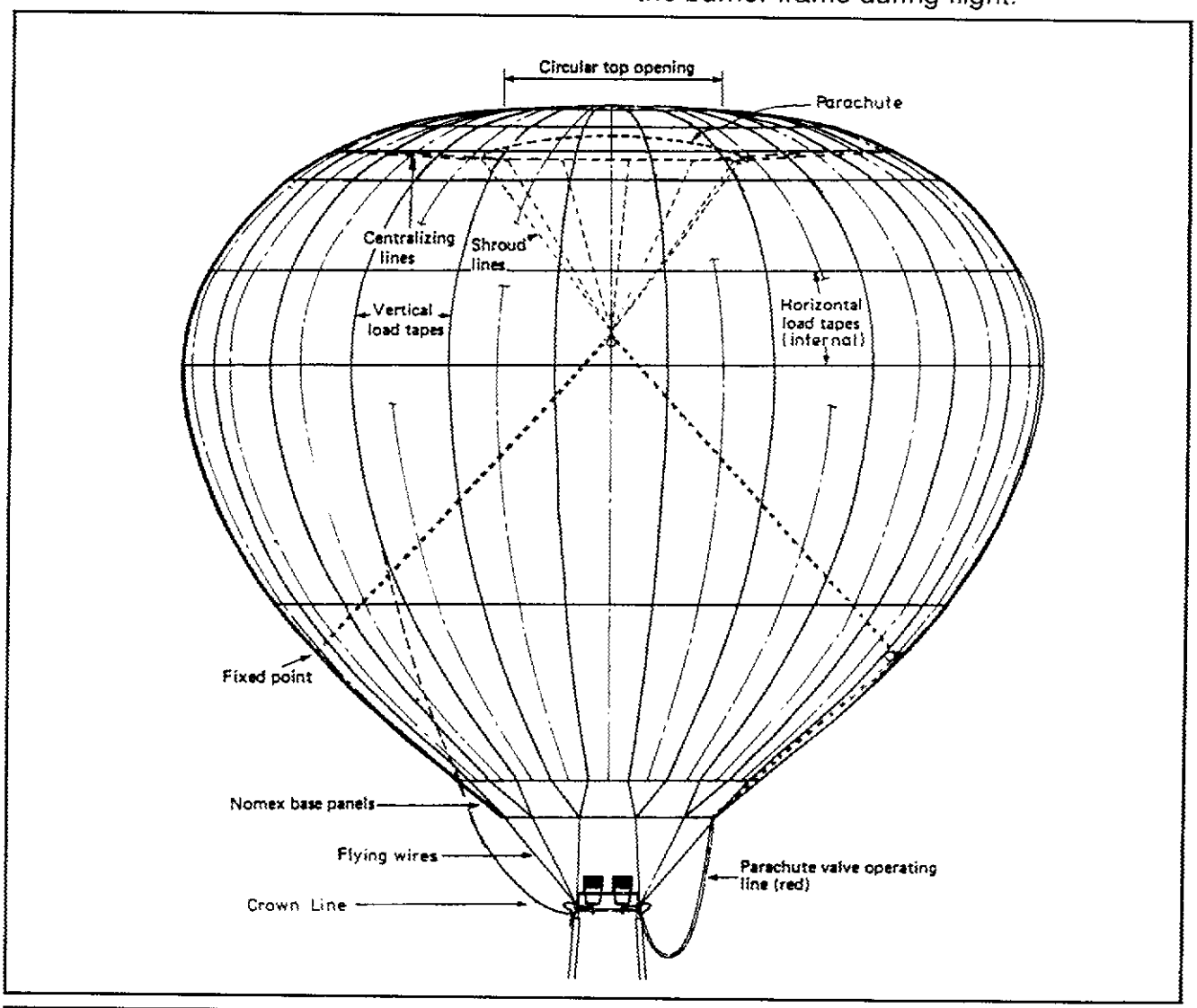
1.1 ENVELOPE

Envelopes are of sewn construction, and are made of high-tenacity nylon fabric. The fabric is coated to make it imporous and to protect it from the effects of sunlight. The gores are designed to a "natural" mathematical form which gives zero stress in the fabric in static conditions, leaving all the main envelope loads to be carried by nylon load tapes. The design stresses allow an extremely high factor of safety.

Horizontal tapes act as rip stoppers so that any damage to the envelope will be limited in extent.

The base panels of the balloon are made from "Nomex" heat-resistant fabric so that the nylon is kept at a great enough distance from the flame to prevent most melt damage. The lower ends of the load tapes are formed into rigging loops to which stainless steel or kevlar cables, called flying wires, are attached.

There is a handling line attached to the crown, for use during inflation (two on very large envelopes). It is long enough to control the envelope during the whole inflation, and is clipped to a karabiner on the burner frame during flight.



At the base of the balloon the patented Cameron pressure scoop can be optionally fitted. This is an asymmetrical extension of the base of the balloon which acts as an air intake scoop, and very much improves the performance of the balloon when taking off or tethering in wind, and in flight in turbulent conditions.
Tapered, edge-reinforced flight skirts can be optionally fitted

1.1.01 Concept

The concept is a 12-gore vertically-cut envelope of 60 000cut ft (1700m^3), designed expressly for economy of construction, with a parachute deflation system. It has twelve flying wires, rigged in threes to the corners of the burner frame.

1.1.1 'O' Type

The O Type has twelve moderately bulbous gores. Sizes range from 31 450 to 160 000 cu.ft. (890 to 4530 m^3). The normal deflation system is the parachute valve but sometimes, usually on large sizes, a velcro rip panel or the combination velcro/parachute is specified. The twelve flying wires are rigged in threes to the corners of the burner frame.

1.1.2 'A' Type

The 20-gore A Type was designed for larger balloons not requiring a smooth surface. Standard sizes range from 105 000 to 530 000 cu.ft. (2970 to 15 000 m^3). The deflation system can be parachute valve, velcro rip panel with side vent, or combination. Five flying wires rig to each corner of the burner frame.

1.1.3 'V' Type

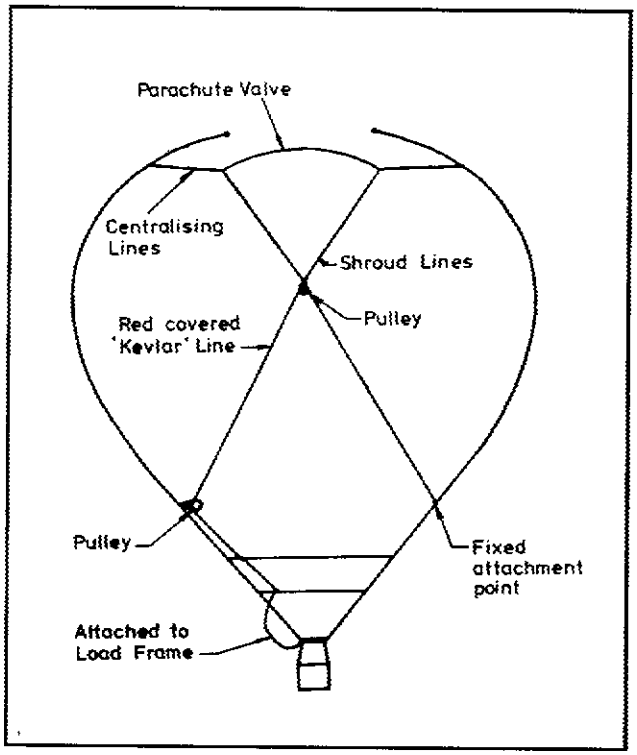
The V Type has eight bulbous gores. The normal deflation system is the parachute valve. Sizes range from 20 000 to 90 000 cu. ft. (590 to 2550 m^3). There are eight flying wires (two to each corner of the burner frame).

1.1.4 'N' Type

In the N Type envelope the closely spaced load tapes and narrow gores of vertically-cut panels give a near-smooth surface. The normal deflation system is the parachute valve. Sizes range from 31 450 to 180 000 cu.ft. (890 to 5100 m^3). There are twelve flying wires (three to each corner of the burner frame) on balloons up to 133 000 cu.ft. (3770m^3), and sixteen on the larger sizes (four to each corner).

1.1.5 Parachute Valve

The parachute valve combines the functions of venting and total deflation, and is used on most balloons. It takes the form of a parachute-style panel inside the top of the balloon, sealing an opening in the envelope. The parachute is held in position by the internal pressure and by centralising lines which join its edge to the inside surface of the balloon. It is opened by a pull on a red rope which runs through a pulley attached to the shroud lines, giving mechanical advantage.
The fixed attachment point may be replaced by a third pulley, usually attached by a length of rope, to give 3:1 ratio for the biggest envelopes.



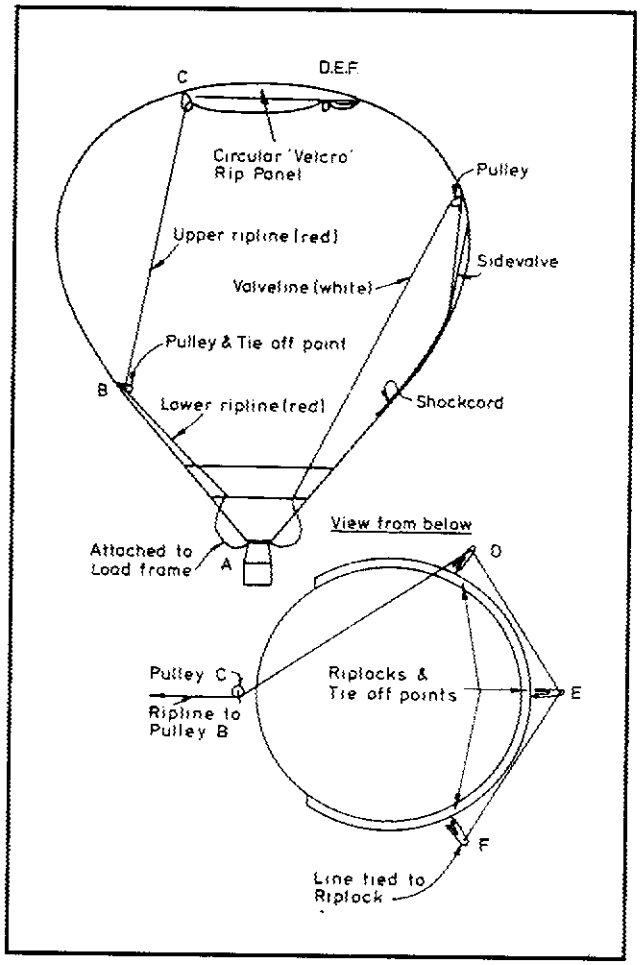
For in-flight venting the parachute is slightly opened for a few seconds, and for deflation it is pulled right in and held.

1.1.5.1 Lock Top

To achieve faster deflation for large balloons, the parachute may be centralised by longer lines, attached further down the envelope. To prevent the pilot over-venting, the centre of the parachute is linked by a releasable shackle to the crown ring. On final approach, the shackle is opened by a pull on a release line, confirmed by the appearance of a flag on the line inside the envelope.

1.1.6 Velcro Rip Panel

The Velcro Rip consists of a panel at or near the top of the balloon, permanently sewn in over part of its circumference, but mostly held in place by Velcro. It is operated by a red rope from the basket



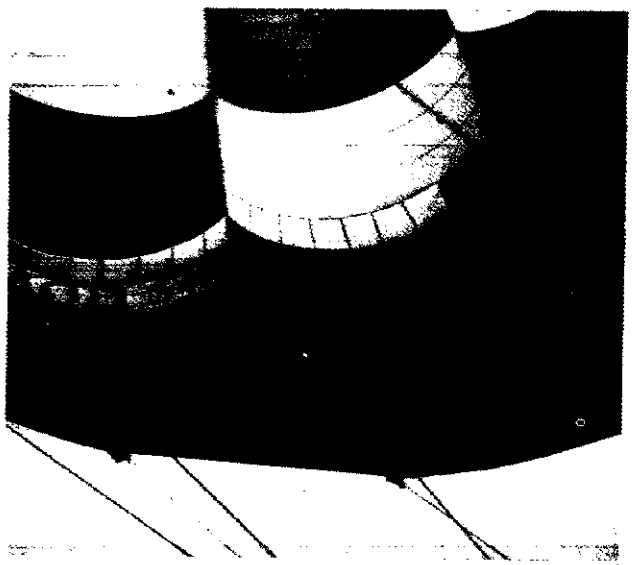
and when opened allows a rapid escape of the air from the balloon. As it will not re-close automatically it is never to be used until the balloon is committed to a landing. Normal balloons have a circular rip panel, but rectangular or other configurations may be used for special shapes. The panel is restrained against the internal pressure by free tapes across the opening, and the length of these is set to keep the hole smaller than the rip panel, so that the Velcro is not subjected to tension.

As a further safety device, riplocks consisting of aluminium hooks and tape loops are fitted at intervals across the velcro and the action of pulling the ripline releases these before the velcro can open. The line passes through pulleys 'B' and 'C', riplock hooks 'D' and 'E' on the edge of the ripping panel, and is then permanently attached to riplock hook 'F'.

Some larger balloons have more riplock hooks. The ripline is of excess length to accommodate distortion of the envelope in turbulence, and this excess is held in a loop inside the envelope by a tie-off at a pulley near the mouth of the envelope. This tie-off must be broken and the slack taken up shortly before the final deflation.

The velcro rip is normally used in conjunction with a recloseable means of discharging air in flight.

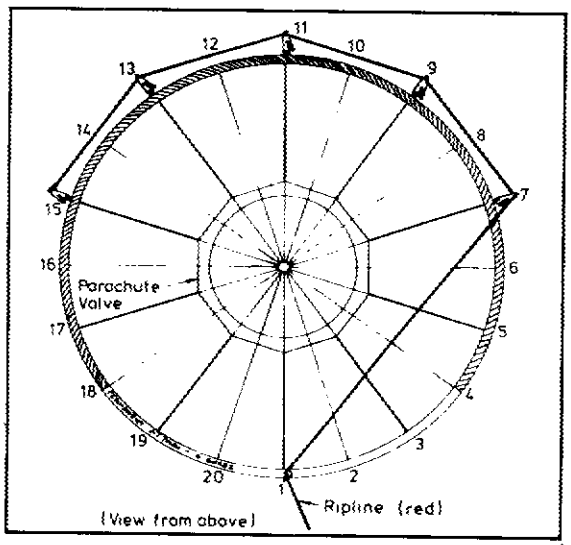
1.1.7 Side Vent



When a Velcro rip is fitted, a vent is usually situated in the side of the envelope and can be opened and reclosed in flight to provide a means of discharging a controlled amount of hot air. This vent may be omitted on small or special shape balloons whose natural cooling characteristic is rapid.

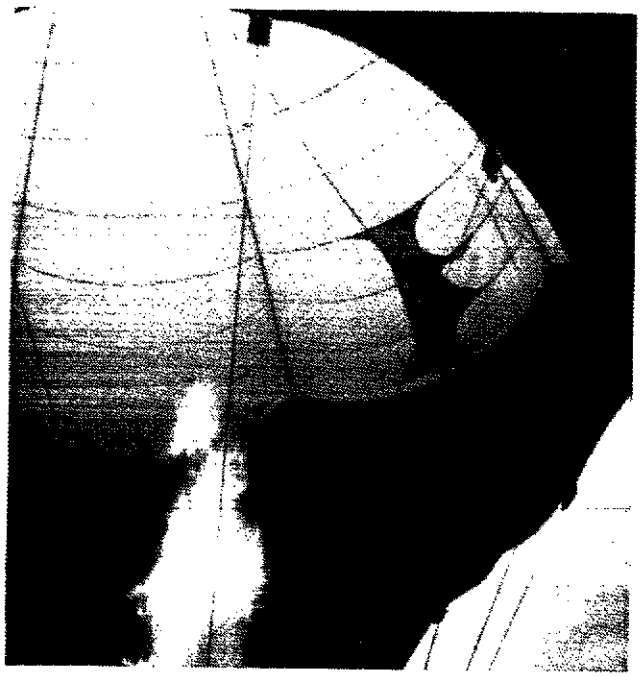
1.1.8 Combination Rip Panel/ Parachute Valve

The combination top is a deflation system in which a small parachute valve is positioned in the centre of a large circular velcro rip panel. It is used mainly for larger balloons.



The parachute is used for in-flight venting, and for deflation after a stand-up landing, while in faster conditions rapid deflation is achieved by opening the velcro panel.

1.1.9 Turning Vent



Turning vents may be optionally fitted to cause the balloon to rotate about its vertical axis while airborne. These can be used on larger balloons to align the basket into the safest position for landing and can assist the effective display of advertising. They consist of a flap arrangement at the equator which ejects air tangentially when activated by a line from the basket, and are self-closing on release of the line.

1.2 BURNER

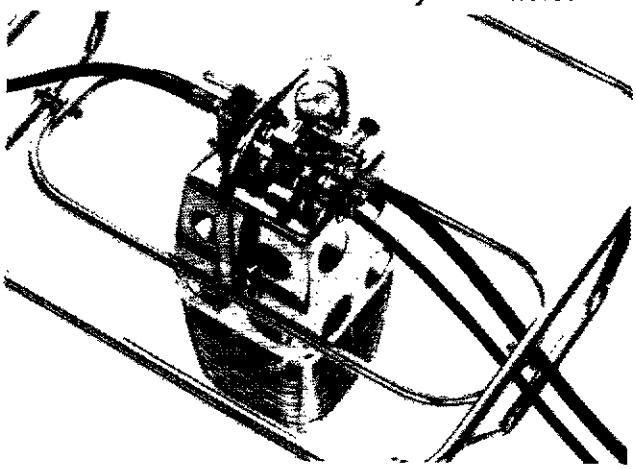
The heat source is a high-output burner fed by liquid propane. The burner unit itself consists essentially of a stainless steel vapourising coil and jets through which the vapour passes to form a flame, pivoted in a frame which is gimballed in the load frame of the balloon. Linked to the corners of the load frame are karabiners which connect the basket to the envelope wires. Optionally, the height of the inner frame in relation to the outer may be adjustable. The supply of propane is controlled by quick-acting on/off valves,

and a gauge gives an indication of the fuel pressure. High-pressure armoured hoses ending in self-sealing, hand-operated couplings conduct the liquid propane from the fuel tanks to the burner valves. Ignition is by a pilot flame with its own shut-off valve and piezo-electric igniter. A single burner is certified for balloons of under 105,000 cu ft (2970 cu m), a double for those under 210,000 cu ft (5950 cu m), and a triple for those under 315,000 cu ft (8920 cu m).

The whisper burner comprises a liquid propane feed through a valve directly to a jet for use when it is necessary to burn close to livestock. The power output is about 3/4 full burner, which is more than adequate to maintain height, but the noise is much reduced and less sudden, minimising the risk of disturbing the animals.

1.2.1 Mark 4 Burner

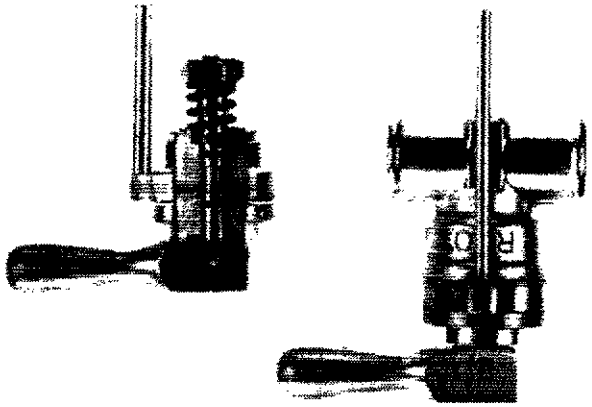
The single burner consists of one coil unit fed by duplicated fuel systems, so that in the event of any failure of the fuel supply in use, a reserve is immediately available.



The normal valve is the Rego 7553T or 7901T, but Worcester 44 series ball valves may be used.

1.2.1.1 Bonanno Modification to Rego Blast Valve

The stem of the standard Rego blast valve carries a single O-ring, so that any failure causes a potentially dangerous leak to atmosphere. This modification consists of a complete new centrebody with a thicker valve stem carrying two O-rings.



The first performs the normal sealing function, but is manufactured to closer tolerances. If a leak does occur, the propane enters a chamber which is vented to the combustion area. Beyond this chamber the second O-ring prevents a propane leak at the handle.
This modification may be fitted to any new or existing Rego blast valve 7553S or 7553T type.

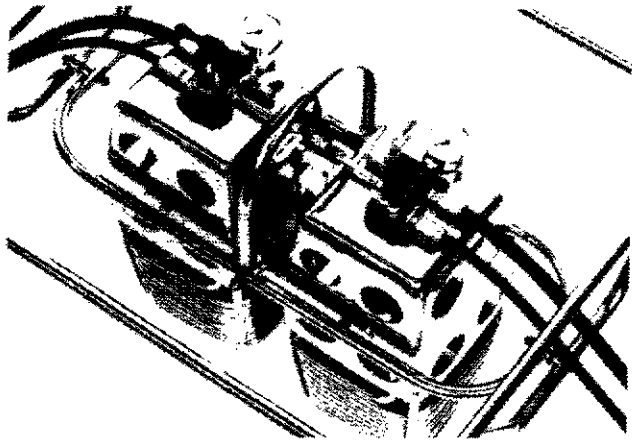
1.2.2 Mk 4 Super Burner

The Mk 4 Super burner differs from the Mk 4 in the arrangement of connections and controls.

A manifold block incorporates the main valve and the pilot light with cutoff and piezo-electric igniter, and has tappings for a main fuel supply, pilot supply, pressure gauge, whisper burner and crossflow. The block mates with corresponding holes in the base of the burner can, and is secured by three Allen screws and the main fuel connection.

The main valve stem carries two O-rings with between them a gallery which is vented to the combustion area. If the first O-ring leaks, a stem leak is prevented by the second seal, and the leaking propane vents safely into the can.
With the pilot light switched off the piezo button is covered, preventing accidental sparking (e.g. during refuelling). The supply is turned on by rotating the handle until it locks onto the peg protruding from the manifold body. This exposes the piezo button to allow ignition, or re-ignition at any

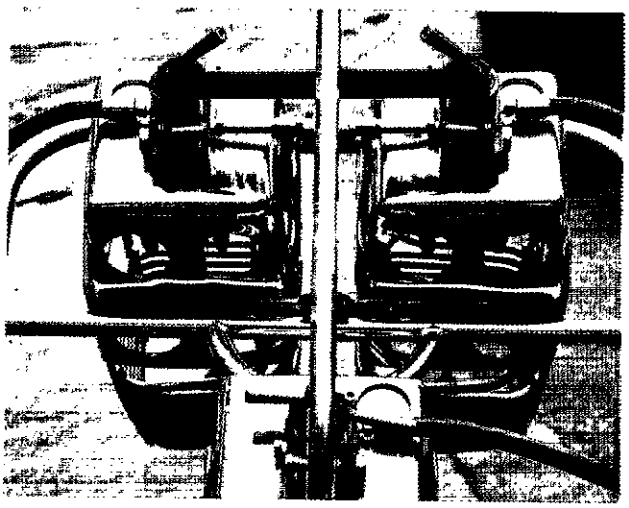
time. To shut the pilot light off it is necessary to depress the lever slightly before turning it, so preventing inadvertent cutting off during flight.



The pressure gauge accurately reads tank pressure while the tank valve is open and burner valves closed. When the burner is on the pressure indication drops due to the flow past the gauge inlet.

The whisper burner is controlled by a high-pressure ball valve which bypasses the vapourising coil and delivers over three quarters of normal burner output with a low noise level.
The Mk 4 Super burner was first designed with the double unit in mind. Two coil units are mounted together in gimbal frames, each functionally independent of the other except for a crossflow pipe which allows both burners to operate off one fuel supply.

1.2.2.1 Triple Burner



For large balloons, three coils can be mounted together with a single handle in a large pair of gimbal frames. Two of the coils are mounted as a normal double burner, except that the pilot lights are ganged together, and the third coil has one main fuel feed with whisper burner and a pilot light supply.

1.2.2.2 Quad Burner

This is the most powerful burner in the standard range. Two double burners are mounted together with a single handle in a large pair of gimbal frames. Each double burner has ganged pilot lights but is otherwise normal.

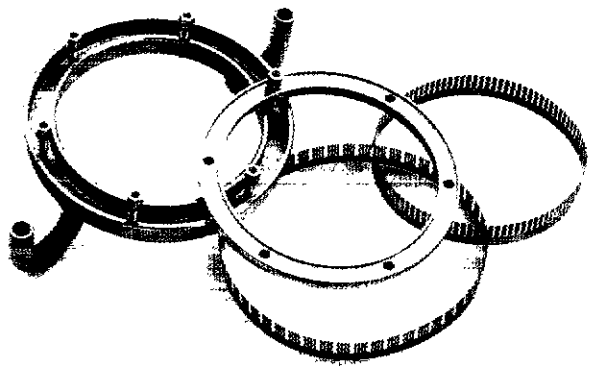
1.2.2.3 Liquid-feed Pilot Light

This option on the Mk4 Super burner removes the need for vapour hoses and master tanks. A small tube leads from the liquid inlet of the manifold block, through the pilot light cup to a needle valve adjustor, which screws directly into the original vapour port.

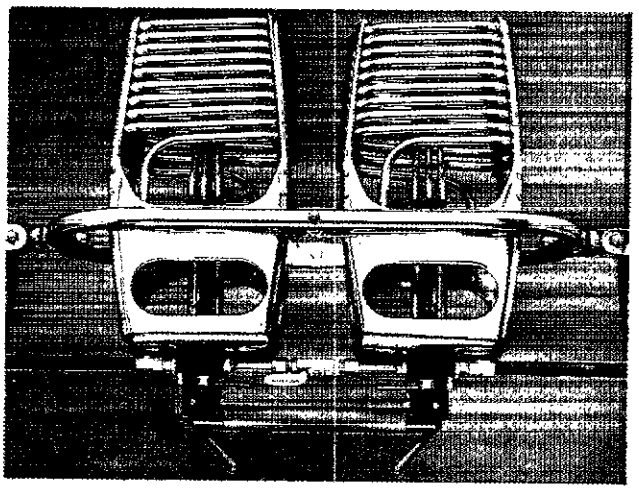
In operation, the propane initially vaporises spontaneously, and ignition within a few seconds provides a heat source to balance the evaporative cooling. The needle valve allows adjustment of the pilot flame for varying temperature conditions.

1.2.3 Stealth Double Burner

The Stealth burner achieves a considerable reduction in noise thanks to a jet ring consisting of two photo-etched stainless steel foils, precisely located inside a stainless steel housing to produce in effect 300 high-precision holes.



The Stealth has a 'soft start, soft finish' burn, resulting in a gradual build up and decay of noise. This may lead to some sooting of the can and coils if burner use consists of many very short burns. This has no detrimental operational effect and can easily be cleaned from the coils. Cleaning of the jet ring may be required after using dirty propane (see maintenance section). If dirty propane is suspected a fuel filter should be incorporated in the refuelling hose.



The Stealth blast valve is internally similar to the Mk4 Super, but the valve handles can now be operated with a squeeze action against the cross-handle. If traditional operation is required the handle is moved through 180° and operated as normal from the outboard side. The burner should be stored with handles in a straight line with the cross handle.

The Stealth whisper valve is built into the manifold. The valve handle is rotated to open a shutter similar to the main blast valve by means of two cams. Some bedding down of the seal and cams may occur, necessitating an easy adjustment of the valve. Instructions for adjustment and lubrication are given in the maintenance section. The whisper burner should not be left on continuously, as prolonged restricted opening of the valve can result in the liquid propane not being atomised correctly so that droplets of propane are produced at the nozzle with a potential build up of liquid fuel in the can and risk of fire.

The Stealth pilot lights are available as either filtered, regulated liquid pilot lights or vapour pilots. To considerably reduce the possibility of the pilot jet becoming blocked a sintered filter is located in the manifold block. The filter is easily removed for cleaning or replacing. (See maintenance section.) The pilot light cup has been further improved to protect against gusty conditions. If the pilot light jet becomes blocked it is easily cleaned or replaced (see maintenance section).

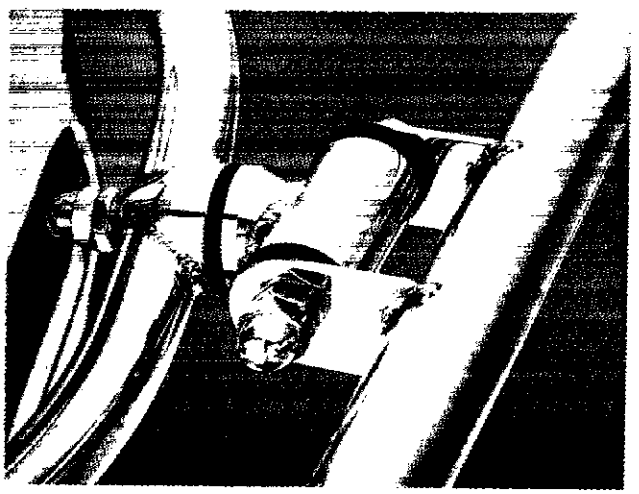
The regulated liquid pilot is operated like the Mk4 Super, but with an improved handle design. The liquid propane is converted to vapour in a small cylinder which incorporates a fixed regulator at the base of the pilot light assembly.

In the vapour pilot the regulator is replaced by a spacer tube, and an adaptor to take a vapour hose is screwed into the filter housing.

To make a triple burner, a Stealth double burner is mounted with a third coil which looks like a Stealth coil, but has a jet ring which carries eight multi-hole jets, and a single central inlet feed pipe like the Mk4 burner (this version is called the Mark 5 burner coil).

The quad burner consists of two Stealth double burners mounted together with a single handle in a large pair of gimbal frames.

The Stealth double burner can be mounted

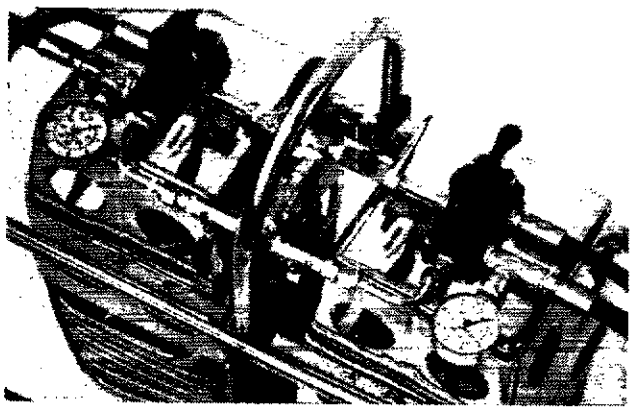


in the existing rectangular load frame, or a new design consisting of a hoop at each end of the inner frame which locates on two support poles and links to the karabiners joining the basket and envelope wires in the usual way. In either case the outer pivots incorporate a limiter which restricts burner rotation to 95° each way. The hoops pack flat with the burner for transportation.

With the Stealth frame it is particularly important to use a quick release when preparing for flight, and two V-bridles for tethers. For commercial tethering, the rectangular load frame is recommended until experience in field trials has confirmed the suitability of the Stealth frame.

1.2.4 Electric Remote Actuation of Burner Valve
(Double Burner Only)

A solenoid-operated valve is fitted in a line which bypasses one of the normal burner valves, feeding into the burner via the crossflow pipe. In case of malfunction an isolating valve is fitted. The solenoid is activated by a hand-held push button, and powered by a sealed dry-cell battery which is contained with a charger unit in a small padded Cordura case in the basket.



A double-sided version may be fitted by adding a bypass with isolating valve to the second burner valve, teeing into the first bypass upstream of the solenoid valve. In this case a second valve is fitted in the crossflow pipe, so that either fuel supply can feed either burner (or both).

1.3 FUEL TANKS

The propane is carried in liquid form under pressure in tanks which are either 'standard', supplying the main liquid fuel feed only, or 'master' with an additional valve supplying vapour through an adjustable pressure regulator for vapour - feed pilot lights.

To preserve a duplicated fuel supply, the minimum number of tanks for flight is two, with an appropriate supply for each pilot light. The usual valves for both main and pilot fuel feeds are of the handwheel type, but a lever-operated ball valve is an option for the main feed. All tanks have a contents gauge which indicates through the last 33% of capacity. A combined bleed valve and full level indicator is fitted for filling, and a safety blow-off valve protects against excess internal pressure.

The tanks are normally strapped vertically inside the basket. Padded tank covers with map pockets are available to give a measure of passenger protection.

1.3.1 Worthington Aluminium 10 U.S. gallon

The Worthington tank was almost universal in ballooning for many years. It was originally designed for horizontal use on forklift trucks, and for this reason the boss marked 'vapor' is not ideal for ballooning use where the tank is vertical.

Instead, the master tank vapour offtake is screwed into the unlabelled boss adjacent to the two round holes in the guard ring, and these should be uppermost when the tank is lying down during inflation - a label to this effect will be found in the top rim of the guard ring.

The liquid offtake boss has a long dip tube which is either kinked to end near the lowest side (as used on forklift trucks) or almost straight from the boss to a point just above the centre of the tank bottom.

A straight dip tube is indicated by a label in the guard ring. If the dip tube is kinked, it is important for the round holes in the guard ring to point down if the tank is being used for liquid supply during inflation. A label to this effect will be found in the top rim of the guard ring.

1.3.2 Cameron Stainless Steel 40 litre (CB497)

This tank was designed as an exact replacement for the Worthington, having the same height, diameter and usable volume. It has a straight dip tube, but no extraneous vapour boss.

1.3.3 Cameron Stainless Steel "Big 40" (CB599)

This size supercedes the CB497 tank, having the same diameter but slightly greater height.

1.3.4 Cameron Stainless Steel "60" (CB426)

This tank differs from CB599 only in having a slightly larger diameter, and still fits neatly in the normal basket. All fittings are identical to the smaller tanks.

1.3.5 Cameron Stainless Steel "80" (CB959)

This tank has the same diameter as CB426 but is taller, and is designed for the higher baskets of large,paying-passenger balloons.

1.3.6 Tank Volumes

Type	Total Vol.		Usable Vol.	
	litres	imp. gals.	litres	imp. gals.
Worth'ton	47.0	10.3	38.6	8.5
CB497	46.0	10.1	38.3	8.4
CB599	52.0	11.4	42.6	9.4
CB426	66.0	14.5	54.1	11.9
CB959	87.2	19.2	71.3	15.7

1.4 BASKET

Baskets are constructed of willow and cane, woven around metal tube frames which carry the four burner support rods and give the appropriate measure of stiffness to the shape. Stainless steel cables are also contained within the weave, passing down one wall, across the floor and up the opposite wall, and forming a cradle of slings in which the basket hangs.

Holes are provided for the straps which secure the fuel tanks, and rope handles are woven in on the outside for carrying, and internally as passenger handholds. The top and bottom edges are reinforced with rawhide, and the top upholstered with foam and suede.
The floor is reinforced by internal and external hardwood battens, bolted together through the weave. One or more stepholes are provided for ease of entry or exit.

For safety and a tidy appearance, the basket cables, burner support rods and fuel hoses are contained within zip-up padded suede covers.

A fire extinguisher is fitted inside the basket.

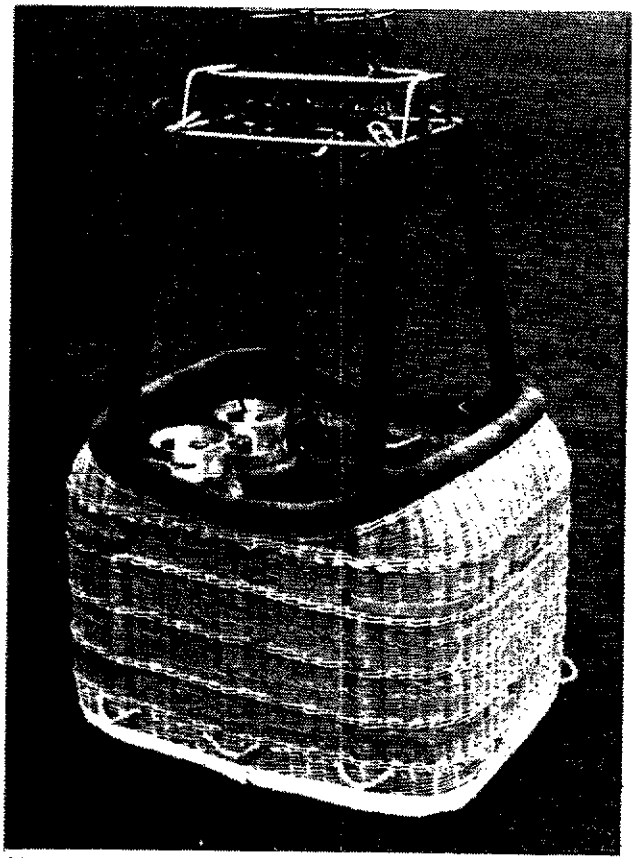
1.4.1 Aristocrat, 2-tank Width

For balloons of 1-4 person carrying capacity, there is a range of baskets which are designed to take fuel tanks in each corner, leaving room for instruments and storage between the tanks. The metal frames are in the form of two aluminium U-tubes incorporated in the walls and floor of the basket, and the ends of the basket are swept up.

1.4.2 Aristocrat, 3-tank Width

Balloons of carrying capacity 5-7 normally use a basket which can take three 10-gallon or 40-litre tanks across the ends.

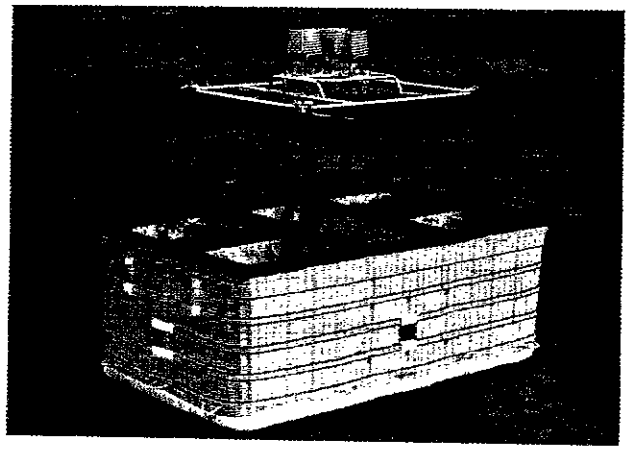
There are two designs in this range, one of which is similar in construction and shape to the smaller baskets.



For larger models a stainless steel tube frame is woven in all round the flat top edge, with four stubs pointing up to carry the nylon rods, and four pointing down which fit over thick cane U-frames.

1.4.3 Partitioned Baskets

For the largest balloons, extra rigidity is built into the baskets by internal partitions woven into the walls and floor and around extra tubes in the flat top edge frame. As such baskets are commonly used for passenger carrying the walls are made slightly higher than in sporting balloons and the passenger compartments are padded.



The pilot and fuel tanks occupy a separate compartment from the passengers. The biggest baskets use load frames with two rigging points per corner, so that each basket cable end has its own karabiner, and the envelope wires are divided as evenly as possible between them (if an odd number, put the extra one adjacent to the long side).

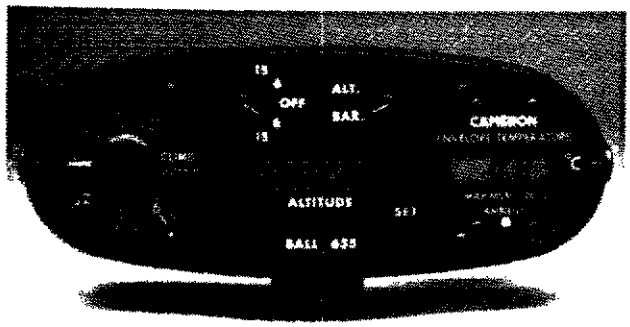
1.5 INSTRUMENTS

Instruments are not essential for normal sport ballooning, but an instrument pack is a requirement in some countries (currently USA, Canada and West Germany). The standard balloon instruments comprise an altimeter, variometer and envelope temperature gauge.

1.5.1 Ball 655 Instrument Pack

This instrument pack contains a variometer, a digital altimeter and a digital pyrometer. Power is derived from two 9V batteries inside the back cover, one battery being for back-up. For normal use, alkali type 9V

batteries are highly recommended for longer life.



If operated below -18°C (0°F), then rechargeable Ni-cad batteries should be used. Alkali batteries last about 20 hours each and the Ni-cads about 7 hours per charge. Operating current is 15 mA. The variometer has two gains, 600 and 1500 fpm (3 and 6 m/s in the metric version). The upper left switch selects either gain, on battery 1 in the upper positions and battery 2 in the lower. When first turned on, the variometer will peg and return to zero in about 10 seconds.

The altimeter reads from about 2000 feet (600 m) below sea level to 19 999 feet (6095 m) in 1 foot increments (1 m in the metric version). To set the altimeter, turn the upper right switch to "BAR" and set the barometric pressure on the liquid crystal altimeter. Set the switch on "ALT" to read the altitude. The "SET" knob adjusts barometer or altitude reading. One can also set the altimeter to read zero at takeoff altitude. Above about 2500 feet (750 m) the SET knob adjustment may reach its limit.

The pyrometer reads envelope temperature with a sensor located at the top end of the long Teflon-insulated cable. An ambient sensor is located inside the casing (in older instruments, it is outside on a short sensor cable). Pushing the "AMB" button will read out ambient temperature. The sensor cable has a disconnect at the instrument and at the level of the Nomex.

The instrument will operate in ambient temperature from -40°C to +70°C (-40°F to +160°F) with reasonable accuracy. When the battery in use falls below 6.5 volts, a "LO BAT" sign will appear on the altimeter window. Switch to a fresh battery if this occurs.

1.5.2 Other Instruments

Flytec 3040. This combined balloon instrument includes an altimeter, variometer, stopwatch and wireless thermistor. Separate versions are available with the variomer in metric or imperial units and temperatures in °C or °F, but all versions can display altitude in feet or metres.

The thermistor sender unit remains attached to the envelope, and is automatically switched on and off by the envelope temperature reading. Manufacturer's instructions are supplied with the instrument.

Alibi. This instrument incorporates an electronic altimeter, variometer, stopwatch and ambient thermometer, but no envelope temperature, in Imperial and Metric units. Manufacturer's instructions are supplied with the instrument.

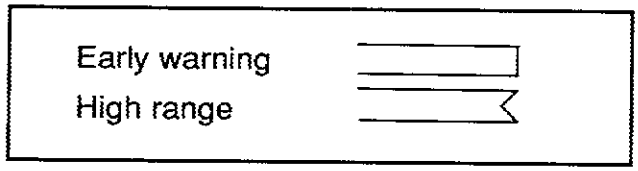
A standard aneroid aircraft altimeter is perfectly good for ballooning use.

The Ball type 400 or type 502 electric variometers are extremely sensitive. The aeroplane rate-of-climb instrument is much less accurate but adequately records prolonged climbs and descents.

The AE envelope pyrometer consists of an analogue gauge reading from -20°C to +140°C with dual batteries mounted on the back. Mounted on the face are a pointer setting screw, and switches to select OFF or either battery, and envelope or ambient temperature. The envelope lead plugs into a short lead from the instrument. These instruments may be mounted in an oak case with a plexiglass lid.

The envelope temperature may be registered on a large dial thermometer, hung in the crown and legible from the basket.

A melting link attached to a streamer (fitted to all balloons near the top thermistor tie, usually on load tape 2) provides security against over-heating. Should an error be made in the loading calculation, the streamer will fall warning the pilot. The pilot should reduce weight before taking off if still on the ground, or if airborne, should reduce altitude and avoid rapid climbs or descents. Melting links are available for two levels of warning: early, at 104°C (220°F), and high range - 124 or 129°C (255 or 265°F). The streamers may be of any colour, preferably contrasting with the balloon, but the temperature of the link is identified by the shape of the tail as shown below.



Near the top of tape 3 is fitted a telltale consisting of a number of spots of temperature-sensitive paint, which change colour irreversibly at temperatures from 90-150°C (200-300°F).

1.6 WEIGHTS AND VOLUMES

1.6.1 Envelope Data

The table on the facing page contains comprehensive information concerning all current standard balloon envelopes manufactured by Cameron Balloons Ltd.
Please note the following -

** The number of occupants is a guide only; limitation is by weight.*

*** Typical envelope weight includes carrying bag and scoop, but makes no allowance for artwork, banners or optional heavier fabric (eg: hyperlast, metallised).*

**** For use with a harness in place of basket.*

Model	Volume		Max AUW		Normal* Max. Occupants	FAI class AX	Typical env. weight**	
	cu.ft.	cu.m.	lb	kg			lb	kg
V -20***	20850	590	400	181	1	3	93	42
O -31 V -31 N -31	31450	890	629	285	1	4	115 110 128	52 50 58
O -42 V -42 N -42	42000	1190	840	381	2	5	134 128 148	61 58 67
O -56 V -56 N -56	56000	1590	1120	508	3	6	159 148 170	72 67 77
Concept	60000	1700	1200	544	3	7	152	69
O -65 V -65 N -65	65000	1840	1300	590	3	7	176 165 187	80 75 85
O -77 V -77 N -77	77500	2190	1550	703	4	7	194 191 203	88 87 92
O -84	84000	2380	1680	762	4	8	205	93
O -90 V -90 N -90	90000	2550	1800	816	5	8	214 214 227	97 97 103
O -105 N -105 A -105	105000	2970	2100	953	6	8	238 247 247	108 112 112
O -120 N -120 A -120	120000	3400	2400	1089	7	9	260 276 276	118 125 125
N -133	133000	3770	2660	1207	7	9	287	130
O -140 A -140	140000	3970	2800	1270	8	9	291 309	132 140
N -145	145000	4110	2900	1315	8	10	317	144
O -160 N -160 A -160	160000	4530	3200	1451	9	10	324 340 340	147 154 154
N -180 A -180	180000	5100	3600	1633	10	10	370 370	168 168
A -210	210000	5950	4200	1905	12	10	408	185
A -250	250000	7080	5000	2268	15	11	452	205
A -300	300000	8500	6000	2722	18	11	496	225
A -375	375000	10620	7500	3402	22	12	606	275
A -530	530000	15000	10600	4808	33	13	772	350

1.6.2 Component Weights

Burner (including Karabiners)	lb.	kg.
Concept	33	15
*Mk 4 single	37	17
*Double (Mk. 4, Super, 5, Stealth)	53	24
Triple (Mk. 4, Super, 5, Stealth)	97	44
Quad (Mk. 4, Super, 5, Stealth)	115	52

*In adjustable height outer frame, add 7lb/3kg.

Baskets

Description	Dimensions: Internal LxWxHmin/max External LxWxHmax (cm)	Weight* lb.	kg.
31/42	97 x 97 x 104 112 x 112 x 114	132	60
Concept	101 x 84 x 95 116 x 99 x 108	101	46
56/65	114 x 97 x 98/114 124 x 112 x 120	137	62
77/84	137 x 97 x 98/114 147 x 112 x 120	146	66
90/105	47 x 107 x 98/114 157 x 122 x 120	154	70
120 Open	175 x 107 x 110 190 x 122 x 132	174	79
120 Partition	180 x 120 x 110 195 x 135 x 132	247	112
140T	215 x 129 x 110 230 x 144 x 132	368	167
160/180T	221 x 155 x 110 236 x 170 x 132	406	184
180/210TT	252 x 155 x 110 267 x 170 x 132	425	193
210/250T	267 x 155 x 110 282 x 170 x 132	397	180
210/250TT	290 x 155 x 110 305 x 170 x 132	518	235
210/250TT (12 pax, Germany)	290 x 170 x 110 305 x 185 x 132	540	245
300TT	332 x 155 x 155 347 x 170 x 143	736	334

*Includes poles, covers, fire extinguisher.

Tanks (full, with cover and 2 straps)

Worthington (contents 43 lb/20 kg)	Master Standard	75 73	34 33
Stainless Steel '40' CB497 (contents 43 lb/20 kg)	Master Standard	79 77	36 35
Stainless Steel 'big 40' CB599 (contents 48 lb/ 22 kg)	Master Standard	85 83	39 38
Stainless Steel '60' CB426 (contents 61 lb/28 kg)	Master Standard	109 107	50 49
Stainless Steel '80' CB959 (contents 82 lb/37 kg)	Master Standard	139 137	63 62

SECTION 2 — LIMITATIONS

2.1 WEATHER

The balloon must not be flown free or tethered in winds greater than 15 knot (surface) nor if there is any extensive thermic or cumulo-nimbus activity. Tethering with passengers must not be carried out in winds over 10 knots and is limited to conventionally-shaped balloons. Inexperienced pilots should not fly in winds over 8 knots, nor in any thermic activity.

2.2 FUEL

Normal commercial propane must be used. If aluminium cylinders are used the fuel must be caustic-free. In cold weather avoid mixtures containing high proportions of butane as its lower vapour pressure causes reduced burner output.

Minimum burner pressure is 40 psi (2.8 bar) and care should be exercised below 80 psi (5.5 bar).

The minimum requirement for takeoff is two tanks, each containing fuel, including a supply for each pilot light, arranged so that two independent fuel supplies are available.

2.3 PERMITTED DAMAGE

The balloon must not be flown if there is any suspected damage other than small amounts of damage to fabric below the first horizontal load tape. The balloon may not be flown if there is any damage to other load carrying parts, or to any part of the fuel system.

Kevlar flying cables - no visible burn damage (slight stiffening of the rope assembly is acceptable). If there is any break in the outer cover the assembly must be replaced.

2.4 SAFETY EQUIPMENT

Protective gloves must be available to the pilot.

Matches or other means of ignition must be carried, in addition to any igniters built into the burner.

A means of extinguishing fires must be carried.

2.5 CREWS

The minimum crew in all free flight balloons is one, and the maximum number of occupants is determined by 1.6 below.

2.6 ENVELOPE TEMPERATURE AND LOADING

Envelope temperature must not exceed 120°C, 250°F.

Temperature must be controlled either by use of the envelope thermometer, or by loading according to the loading chart in Section 5.

The weight in any event must never exceed the maximum All-Up-Weight, which is equal to the Maximum Permitted Lift of 20lb. per 1000 cu. ft. of envelope volume (see 5.1, Note 3).

When tethering with passengers, the weight is limited to 75% of maximum AUW.

2.7 RATES OF CLIMB

Unless an envelope temperature gauge is fitted, extreme rates of climb, sufficient to cause a relative wind at basket level, should be avoided.

2.8 OPERATION OF PARACHUTE VALVE

Except when landing, discharges through the parachute valve must not exceed 3 seconds duration each. The envelope must be allowed to reinflate fully between activations of the parachute valve. This limitation is based on a pull of about 1.5 m (5 ft) on the parachute line. If the parachute line is pulled farther than this, the duration of the pull must be shortened.

2.9 RIP PANEL

Operation before final deflation is prohibited, except in an emergency.

2.10 TETHER HEIGHT

The maximum height for tether operation is 30m to the bottom of the basket.

SECTION 3 — EMERGENCY PROCEDURES

3.1 AVOIDANCE OF DANGEROUS OBSTACLES AT LOW LEVEL

The pilot must decide whether to climb, or to make an emergency landing.

Emergency landings can be made by partially opening the rip panel or parachute valve at heights of 50 feet (15 m) or less.

3.2 CONTACT WITH ELECTRIC POWER LINES

Contact with electric power wires is extremely dangerous and has resulted in fatal injuries. It should be avoided at all costs. If contact with power lines is inevitable, pull parachute or ripline to ensure that the basket is as close to the ground as possible before contact. Turn off fuel.

Leave the basket without touching metal parts or placing the body in contact with the ground and any part of the balloon at the same time.

Do not attempt to recover the balloon until the electricity authority has been contacted, and has indicated that it is safe to do so.

3.3 FIRE — IN THE AIR

Turn off the fuel.

Put out fire with extinguisher.

Identify the cause of the fire and decide if it is possible to relight the burner. If not, the procedure for a hard landing (3.6) must be followed.

3.4 FIRE — ON THE GROUND

Turn off fuel and send all unnecessary persons to a safe distance.

Put out fire with extinguisher.

If this is not attained within approximately 20 seconds ensure that all remaining persons retreat to a safe distance, as there will be an explosion if the fire continues and causes rupture of the tanks.

3.5 DAMAGE TO ENVELOPE IN FLIGHT

Heat to replace lost lift while maintaining a steady rate of descent. Remain at very low altitude and land as soon as possible. Do not burn if the air loss from the balloon is sufficient to cause the mouth to close, as damage to suspension tapes could be disastrous.

If the rate of descent cannot be controlled, consider jettisoning all disposable ballast including fuel cylinders, if safe.

3.6 PREPARATION FOR A HARD LANDING

Advise all passengers to brace themselves, hold firmly onto the basket's internal handles or the tank rims (not to the suspension wires, fuel hoses or basket edge), and keep low but watch the progress of the landing. Remind passengers not to leave the basket until told to do so.

Shut the fuel off at all tanks in use, empty the lines if time permits, and extinguish the pilot light(s).

In balloons with partitioned baskets passengers may adopt a rearward-facing position at the landing, bracing against the padded surface.

On flexible suspension systems the pilot should have one hand on the burner, and should deflect it forward on landing, away from the occupants. The parachute or rip line should be firmly gripped before touchdown in high wind speeds.

3.7 ENVELOPE OVER-TEMPERATURE

Descend to the minimum practical altitude and keep to low rates of climb and descent. If the temperature remains too high, land as soon as possible.

Note — if the balloon is not overloaded for the altitude and ambient temperature it is extremely unlikely that the envelope temperature limits will be exceeded in normal flight.

3.8 BURNER VALVE FAILURE

If a double burner is fitted, or if the fault is not an external leak on one valve of a single burner, then simply transfer control to the other burner or other valve and shut down and vent the faulty side. Land as soon as possible.

Note that the hoses have been made long enough to reach tanks at the other end of the basket when the padded pole covers are unzipped.

If the fault is an external leak on one of the valves of a single burner, do not operate that valve, but use either the opposite valve or the whisper burner, with the other side shut down. If the leak continues shut off all fuel and the pilot light and prepare for a hard landing (see 3.6).

If any blast valve is stuck open, its flow can be controlled from the cylinder valve.

3.9 PILOT FLAME FAILURE

If the pilot light should go out for any reason, it should be relit if possible.

If all else fails, the following procedure should be adopted:

- shut off main fuel at cylinder
- lock one burner valve open
- permit a small amount of fuel to enter the line by fractionally opening the cylinder valve
- light main burner with a match or other igniter
- open tank valve to full flow to obtain normal burn
- close tank valve to a fractional setting to turn burner off but to maintain a pilot setting.

Do not use one cylinder as a pilot, with main fuel taken from another, unless the pilot cylinder is giving vapour only, as prolonged restricted flow of liquid will cause freezing of the valves.

A whisper burner can also be used, not shutting it off completely between burns to provide a built-in pilot light.

Make a landing as soon as possible.

SECTION 4 — NORMAL PROCEDURES

4.1 FLIGHT PLANNING

Before starting to prepare the balloon for flight, the pilot should analyse the weather and flight area to determine their suitability for flight.

Balloons are very affected by air turbulence generated by sunlight heating the ground and the ground heating the air. The best time to fly a balloon is the period beginning at sunrise and extending up to about 2-3 hours after sunrise. Flight time can be extended beyond this window if the air is basically stable (not very humid, or there is a solid overcast with no associated storm activity). If the surface winds begin to increase or become gusty, then the calm conditions best for ballooning are deteriorating and the pilot should land before the surface wind or turbulence exceeds his level of skill.

Evening flying is also possible, beginning about 2 hours before sunset and extending to sunset. The air becomes more stable as the direct heating of the sun is reduced. Evening flights may start off with some thermic activity or stronger winds, but often conditions will be quite calm by sunset. If take-off is in thermic or gusty conditions, it is best to fly at least 500 feet above ground or obstacles until stable air develops later in the flight.

Near large bodies of water, there is also a morning and evening breeze generated by the large temperature difference between the land and the water. This breeze may be quite strong from the water to the land in the afternoon, but usually drops towards sunset.

When planning the flight, the pilot should consider the intended load, the fuel usage per hour and the direction of flight. The launch point should be chosen to avoid making the final landing in a congested or inaccessible area.

Weather	Expected to be suitable throughout the flight.
Turbulence	Minimal expected during flight.
Wind Direction and Speed	Predicted flightpath - airspace restrictions.
Flight Duration	Passenger and fuel weight appropriate (see Section 5).

4.2 PREPARATION AND RIGGING

4.2.1 Site

The site chosen for inflation should be towards the upwind side of the available space, and, if possible, at a point which gives some shelter from the wind. The downwind path which the balloon will take must be free of powerlines or high obstacles. There should be no powerlines close enough on any side for the balloon to touch them should it sway or drag during inflation. The area for laying out should ideally be a smooth grass surface.

4.2.2 Weather

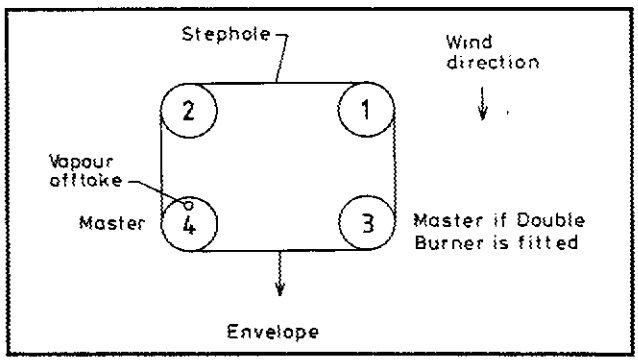
The balloon must not be flown in winds greater than 15 knots (surface) or if there is likely to be any extensive thermic or thunderstorm activity. Inexperienced pilots should not fly in winds greater than 8 knots or with any thermic activity.

4.2.3 Basket Rigging

Place the basket at the take-off point, near the upwind boundary of the field but far enough away from powerlines or other obstacles to allow adequate clearance for the envelope when fully inflated to sway completely in any direction without contact. Place the envelope, in its bag, about 5 m downwind of the basket.

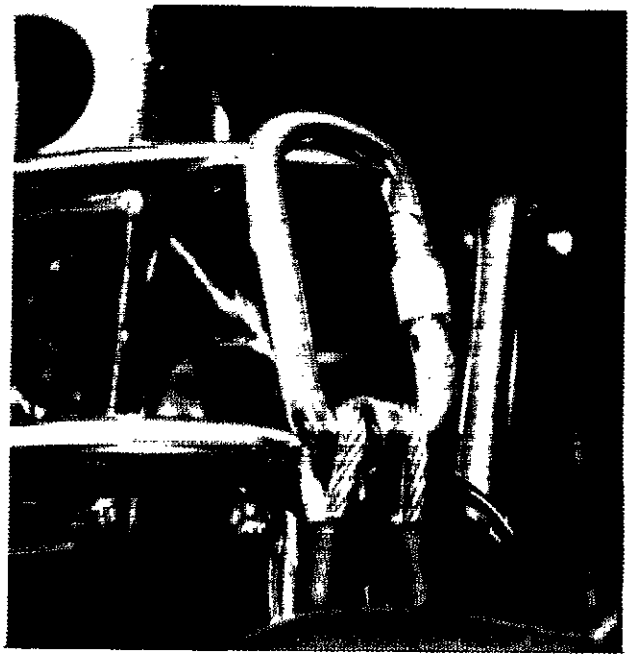
The stephole of a non-partitioned basket should be on the side farthest from the envelope; the pilot compartment of a T-partitioned basket should be on the right, looking from the basket towards the envelope.

Strap tanks as required into the basket, checking the contents and ensuring that there is a master tank on the downwind (envelope) side positioned so that the vapour offtake will be at the top when it is lying on its side for inflation. With a double burner both 'downwind' tanks should be masters. The tanks should be used in the order shown so that the master is connected last. Where fewer then four tanks are used they should be omitted starting with position 1.



Insert the nylon rods in the basket sockets, lift the burner up and locate the corner sockets onto the top of the support rods, ensuring that the pressure gauge(s) will face up when the basket is laid down for inflation. Take each karabiner in turn and, holding a pair of basket cables, one either side of the lug on the burner frame, pass the karabiner through one cable end, the lug, and the second cable end. Work the karabiners round until these are at the end nearest the gate hinge, so that the karabiners are ready to accept the envelope wires.

Fit the padded covers, enclosing a hose in each - liquid hoses to the upwind side, vapour hose(s) adjacent to the master tank(s). (T-partitioned baskets have a different arrangement - all the hoses fit into the two covers at the cockpit end of the basket.) Start the zips at the top and close downwards. Ensure that the hoses have sufficient slack at the top to allow the burner to gimbal.



The fuel hoses should now be connected to the tanks. To ensure a tight fit on the main connectors, hold the hose near the end and wiggle it as the joint is tightened up. The hose should not be able to rotate when properly connected.

Approved Tee manifolds may be used to connect tanks to the burner hoses, but only one tank at a time should be open to each burner, and fuel management must still observe the rule of at least two

Site	Free of obstacles and powerlines in relation to wind direction.
Weather	Suitable for flight.
Fuel	Tank contents checked. Masters and standards in correct positions in basket and secure. Hose connections tight.

independent feeds available to the burner at all times. A manifold must not be used in such a way as to leave a bare connector (e.g. only two tanks on a three-tank manifold).

Turn the basket onto its side, the burner towards the envelope.

4.2.4 Envelope preparation

Pull the nomex base of the envelope out of the bag, and connect the appropriate flying wires to each karabiner on the burner frame (see diagram). Take care that wires are not crossed and that the scoop is outside all the wires.

Pre-Flight check of Kevlar flying ropes.

Prior to each inflation, inspect each rope. There must be no visible burn damage. Slight stiffening of the rope assembly is acceptable, but if there is any break in the outer cover, even if the kevlar inner is not damaged, the assembly must be replaced. It should be remembered that, apart from the direct effects of heat, exposure of the kevlar inner to daylight has the potential to cause gradual loss of strength due to UV radiation.

Any rope which is damaged during the inflation must be replaced before take off.

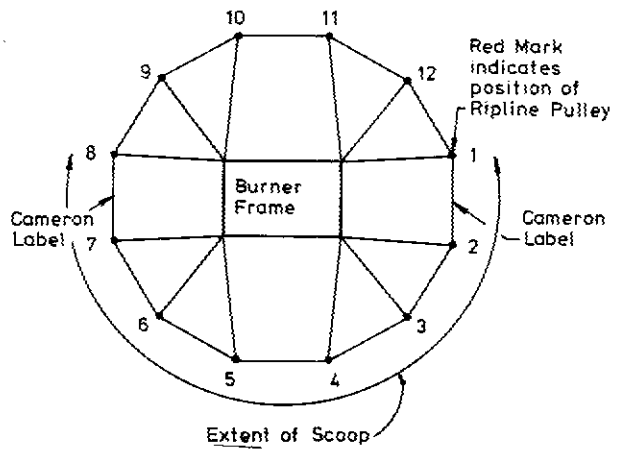


Diagram of wire connections, viewed from the basket (12-wire rigging shown, but 8, 16, and 20-wire systems are similar, having 2, 4, and 5 wires per corner).

If a restraint, such as the Bonanno release, is being used, connect it to the uppermost corners of the burner frame and attach the tether line.

Close all karabiner screwgates.

Pull the envelope from the carrying bag by taking hold of the bag handles and walking away downwind. Unless the envelope has been rolled up during packing it will emerge easily all the way to the crown ring. Stow the envelope bag in the basket.

Two crew members should control the mouth during the inflation.

Mouth Crew Briefing

(1) Full body cover, with clothing of natural or heat-resisting fibre, is safest for this position.

(2) The object is to offer the pilot a big round mouth directly in front of the burner.

(3) Hold the mouth of the envelope so that the nomex gives you protection from the heat of the flame, and trap the fabric on the ground with a foot so that it is fairly taut and cannot billow up between the crew members. This should be done without stepping inside any of the flying wires.

(4) The crew member on the pilot's right may need to hold the ripline to prevent it dangling in the burner flame.

(5) As the envelope fills with hot air the mouth will rise, and it is necessary to change grip down the sides towards the bottom edge of the mouth. Do not hold on by the scoop, but as the envelope finally rises catch the scoop attachment hooks and clip them onto the karabiners.

One strong person is sufficient for the crown line of a normal-sized balloon in good conditions. It is very important for a safe, smooth inflation, that the crown crew is well briefed and understands the job.

Crown Crew Briefing

(1) Refuse all offers of help from onlookers.

(2) Inform the pilot if anything looks wrong at the top of the envelope.

(3) Stout gloves and footwear are an advantage.

(4) Always stay at the end of the line - do not attempt to feed out the rope.

(5) Do not loop the crown line around your body or arm. The strongest technique is to face the balloon with the rope passing over one shoulder, diagonally across the back and down the outside of the arm, with the four fingers of that hand through the end of the loop. In this position the arm is in compression and as the body leans back against the tension, the legs resist the pull.
The free hand grips the rope in front of the body as a steady.

(6) The object is to prevent the envelope oscillating too much during inflation, and to prevent it rising until it is buoyant enough to pull the basket upright as it rises. Let the envelope up until the whole parachute valve is visible, then hold fast until the pull can no longer be resisted, and finally give way steadily, step by step until the balloon is vertical.

(7) On the pilot's instruction, clip the end of the line to a karabiner on the burner frame, away from the ripline.

The most important instruction for all the crew is to let go immediately if you are lifted off the ground.

Spread the envelope out, preferably by using the inflator fan at a part-throttle setting, with the crew just helping to remove any twists. If the spreading is done manually, ensure that crew do not pull too hard, or unseen internal parts, such as parachute loops or a thermister wire, may be damaged. Untangle the bottom of the ripline and feed it into the mouth of the balloon, and attach the end to either of the karabiners on the pilot's right (at the bottom of flying wire 1 or 2). If a thermistor is being used, bring the wire down from its pocket inside the nomex at tape 2 and plug it into the instrument. It may be convenient to leave the bottom right hand pole cover off until this moment so that the wire can be enclosed within it.

Tab the parachute valve into position matching the numbers near the velcro tabs on the parachute and envelope, and ensure that there are no folds of fabric lying on the ripline which could pull off the parachute during the inflation.

Complete the cold inflation with an appropriate fan throttle setting.

Karabiners	Basket and envelope wires correctly attached. Screwgates closed.
Instruments (if used)	Plugged in. Switched on. Set.
Ripline	Attached to burner frame. No tangles. (Velcro rip - tied off at bottom pulley, riplocks engaged and tied off, valve line attached).
Quick Release (if used)	Connected to tether.
Ground Crew	Fully briefed. Gloves issued. Retrieve number established. Keys in retrieve vehicle.

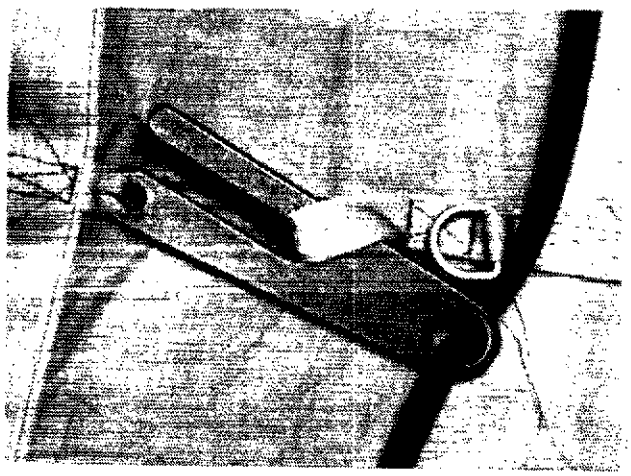
4.2.4.1 The Velcro Rip Panel.

Unlike the parachute panel, this needs to be carefully closed before starting to put air in the envelope.

The strength of the velcro seal depends very much on how firmly it is pressed together, so make sure that it is well pressed down. It is also important to ensure that it is completely dry and free of grass etc.

The panel should be closed by first correctly positioning the ends of each straight section, and then stretching the section by pulling from each end. The velcro seal can then be closed neatly. This should be repeated for each section of the edge.

Nylon thread of about 10 lbs (5 kg) strength or knitting wool should be used for the breaking points. Four turns should be used to secure the top of the lower section of ripping line to the D-ring under pulley "B" and one turn to secure the riplock hooks to the D-rings, at points D, E and F.



It is necessary to enter the base of the balloon to tie the thread at the bottom pulley, but the riplocks should be joined and tied off by opening the velcro at a point about one foot (30 cm) away from the lock.

Pull enough slack ripline up into the top of the envelope to prevent drag on the line opening the end riplock during inflation.

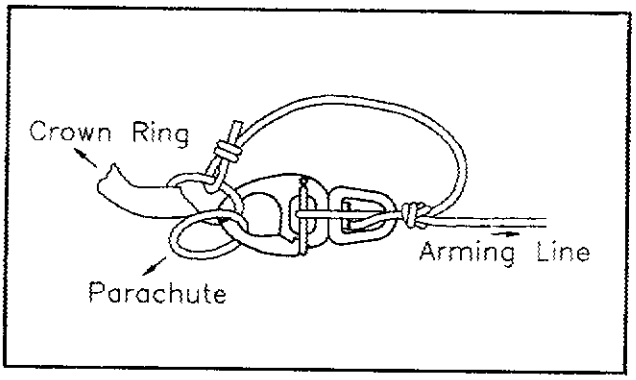
Care must be taken to ensure that the ripline does not pass inside the slot of the riplock hooks, and this is rechecked at the time of take off by inspecting from the basket.

4.2.4.2 The Combination Rip Panel/Parachute Valve.

To prepare this type of envelope for flight, simply follow the instructions already given, first for the velcro rip, and then for the parachute.

4.2.4.3 The Lock Top

After tabbing the parachute as usual, locate the quick release shackle. Ensuring that the cord is not tangled, pull up the slack from inside the envelope until the indicator flat is visible. Lock the stainless steel rings attached to the parachute and the crown ring together with the quick release shackle.



Attach the end of the release line (white with red fleck) to the burner frame. Follow up the release line to the lower tie-off point. Use four turns of nylon thread of about 10lbs (5 kg) strength or knitting wool to secure the release line tie-off to the lowest cord guide.

4.3 INFLATION

When the envelope is nearly full of cold air, warn the crown crew that hot inflation is about to begin, and take up position behind the burner

Check that both burner valves, whisper jet valve and pilot light cutoff(s) are closed.

With a double burner, also check that the crossflow valve is closed and use only one burner for inflation.

Turn on and ignite the pilot light, and turn on the main fuel at the tank to be used for inflation, checking for leaks at each stage. In general, tank valves should be opened no more than is necessary to attain full flow. In an emergency, they can then be closed quickly. Two hand twists (about one full turn) is usually sufficient.

Check that everyone is ready to start inflation.

Ask the helpers to hold the base of the balloon as wide open as possible, holding all suspension wires out of the way of the flame. Aim at the lower half of the opening and give a short puff of flame. Continue, always with short puffs, and the balloon will slowly fill.

When the lift in the balloon is approaching the weight of the crown crew, it should be allowed to rise. It is important at this point that there should be plenty of helpers putting full weight on the basket as it is quite possible for the momentum of the rising balloon to lift the basket temporarily off the ground. Never allow too many people on the crown line as this would allow excessive lift to build up, and could lead to the basket leaving the ground in an uncontrolled manner.

As the balloon rises to the vertical position, step backwards into the basket, and continue heating to fully inflate the balloon.

While completing the inflation, the second tank and fuel system (and burner, if a double is being used), and the whisper burner, can be tested.

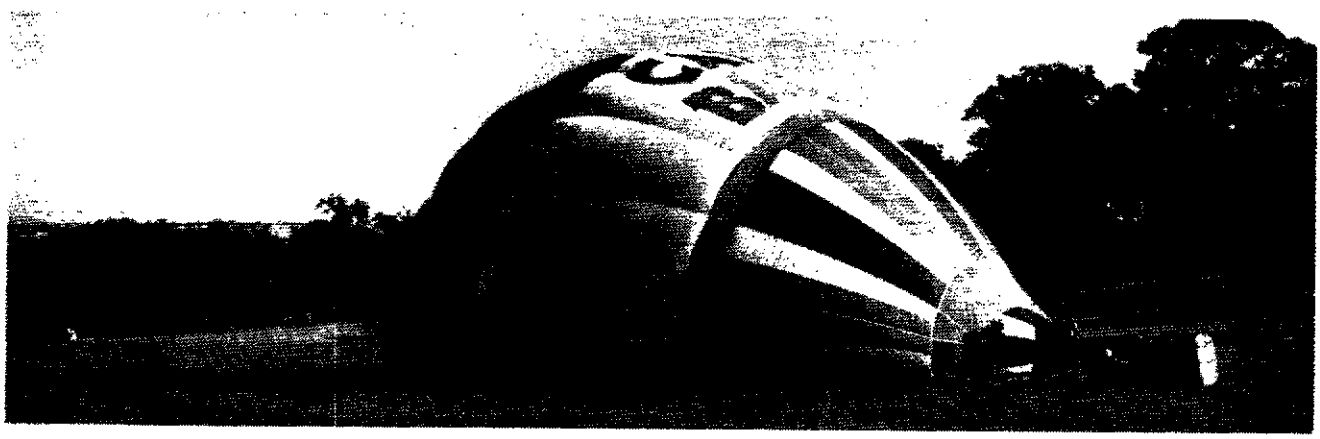
The parachute line should be pulled until the velcro untabs, and the appearance checked after reclosing.

Passengers should now be loaded. The pilot should ensure that they have sufficient room, and that each has a handhold available. Normal clothing for the prevailing weather is suitable for ordinary ballooning, although waterproof footwear is a worthwhile precaution. If the weather is not ideal, it may be advisable to carry helmets.

When passengers are aboard, they should be briefed.

Passenger Briefing

- Do not hold on to hoses, valves or control lines.
- Hold on to rope handles, tank rims or (except when landing) burner supports.
- On landing, brace and watch the touchdown.
- Do not leave the basket without pilot's permission.
- Wear helmet (if conditions dictate).



4.4 TAKE-OFF

Pre-take-off Checks

Envelope	General condition — free of damage, other than permitted base damage; tapes appearing correct without sign of undue strain; rigging wires correctly connected; karabiners closed. Parachute valve — test operation; appearance normal; line attached to load frame (and/or ripping panel — appearing correctly closed; line clear of riplock hook slots; tie-offs unbroken; line attached to correct point on load frame. Side valve — test working; line attached to load frame). Lock top - release line attached to load frame; indicator flag not hanging inside envelope.
Pilot Light(s)	Burning satisfactorily; normal appearance and sound; no freezing at offtake.
Burner Test	Note pressure from cylinder in use. It will vary from about 40 psi (2.75 bar) in winter to 120 psi (8.3 bar) in summer. Test also the second cylinder to be used and the other blast valve. It is not necessary to test cylinders beyond the first two, unless a flight over very difficult terrain is intended where one cylinder would not be an adequate landing reserve.
Fuel	Have contents been checked? Memorise cylinder in use; check all others off. (With double burners, two cylinders will normally be on).
Equipment	Matches, or strikers; maps, with up-to-date information on airspace restrictions and sensitive areas; instruments switched on and set (if used); envelope bag in basket.
Loading	Passengers aboard and briefed; have weight calculations been made? (or monitor envelope temperature as lift builds up to take-off).
Retrieve	Keys in vehicle. Telephone number agreed.

4.4.1 Take-off — Calm Conditions

Take off by building up lift with intermittent burning, all helpers standing clear of the basket. The balloon will lift off, and the burner can be shut off a short distance above the ground; the balloon will continue to climb in silence.
Be ready to burn again at the top of the climb to prevent a descent.

4.4.2 Windy Conditions — Sheltered Take-off

When conditions are windy (say above 8 knots) special care is necessary on take-off. When the balloon rises out of a sheltered area and hits the full wind speed, there is a tendency for the wind force to slightly deflate the balloon, losing some of its lift, and also to deflect the flame, and so prevent the replacement of the lift.

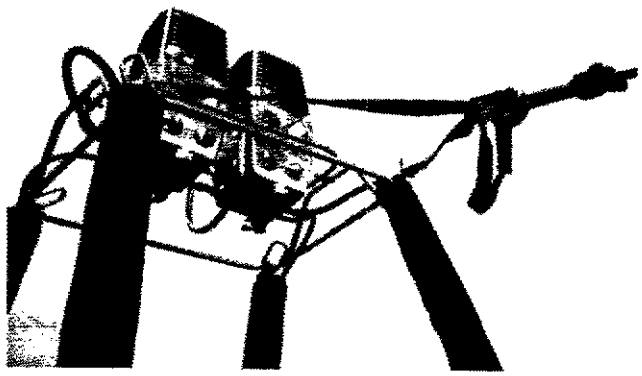
This only applies for the first few seconds until the balloon picks up the speed of the airstream, but it can lead to a dangerous situation.

In these conditions, build up an excess lift before leaving the ground by using helpers in a "hands on" and "hands off"drill, or a restraining device. Burn while ascending, and use the angle control on the burner to counteract the deflection of the flame by the wind. If a scoop is fitted ensure that the balloon is launched with the open side of the scoop facing the oncoming wind.

4.4.3 The Bonanno Release

This optional device is designed to restrain the balloon during inflation and heating up for take-off. Use of the release is recommended as a way of ensuring that the balloon will not drag during inflation or leave the ground prematurely.
It consists of a webbing yoke and an aluminium latch with a safety pin.

The ends of the yoke connect to the two uppermost karabiners during inflation, either directly or through extra karabiners which allow it to be stowed during flight. A short tether line (about 5 m) is best for the maximum control, and is looped through the jaws of the release.
When take-off is imminent, the safety pin is withdrawn ready for the final release, which should be performed by the pilot, holding the latch release lever firmly to prevent recoil



4.4.4 Windy Conditions — Take-off without Shelter or Restraint

If no shelter or restraining device is available in windy conditions, a take-off may sometimes be made by inflating the balloon as far as possible, and then carrying the basket down-wind. Only the pilot should be aboard at the beginning and the passengers should enter one by one as the lift builds up. This method is seldom used nowadays, and is less necessary if a scoop is fitted.

4.5 CONTROL IN FLIGHT

4.5.1 Burner Control

The flight path of the balloon is controlled by the use of the burner, which is either full on or full off. When the atmosphere is stable, and the pilot is sufficiently practised, the height can be controlled to an accuracy of a few inches.

The characteristics of the balloon will vary with temperature,which affects the propane vapour pressure, and hence burner power. They are also affected by loading. When a balloon is flying heavily loaded in winter conditions it can take much longer than usual to arrest a descent.

4.5.2 Parachute Valve

The parachute valve provides a very powerful means of reducing lift, and care must be taken to avoid unintentional descents. Use sparingly until you have become practised in its use. When using large amounts of parachute opening in flight always watch the envelope to observe the amount of deflation occurring. Parachute operation in flight should not exceed 3 seconds. Under very lightly loaded conditions it is sometimes possible that the parachute does not reclose itself automatically, but it will do so if the burner is operated — this also requires a visual check.

4.5.3 Side Valve

The discharge valve provides a way of losing lift at a faster rate than normal cooling. It is fitted to velcro rip balloons

only and is less effective than the parachute valve.

4.5.4 Fuel Management

In flight two tanks at opposite ends of the basket are connected. With a single burner, one will normally be in use and the other turned off but tested and ready for use.

There are two exceptions to this for low flying. When the tank in use is nearly empty the next tank may be turned on ready for a rapid changeover, and if the whisper burner is on the opposite side to the tank in use the second tank should be on in case it is needed.

When a double burner is in use there will be two masters, and both pilot burners will be lit. The sequence of using cylinders is the same except that both sides of the system will be turned on. One side should be used preferentially to ensure that there is never a run-out on both sides at once.

When a tank is empty, the sound of the flame will change and the pressure will fall on the gauge.

Tank Change Procedure

- Open new tank and test burn (unless it is already open to supply double burner or whisper burner).
- Check safe flight path.
- Close empty tank.
- Burn off line and close burner valve.
- Disconnect and connect to next full tank.
- Check secure connection.
- Open next tank and test burn.
- Close next tank and burn off line (unless supplying double burner or whisper burner).

In this way there is always one complete tested cylinder in reserve.

When only two tanks remain, transfer control to the last one when 25% or so remains in the other. This ensures a dual fuel supply at all times.

Some pilots prefer to use the master cylinder first as the withdrawal of vapour reduces the pressure after a time. This is particularly worth while in cold conditions. When a tank with a straight dip tube is being used in this way, care should be taken to change over when at least 5% liquid remains, to provide a vapour supply for the pilot light during the remainder of the flight.

The vapour pressure of cold propane may be increased to normal operating values by pressurising with a more volatile, non-flammable gas such as nitrogen. The vapour offtake of a pressurised tank should not be used to supply a pilot light.

Care should be taken not to bring pressurised tanks back up to normal temperature without safely relieving the pressure.

4.5.5 Climbing

Climbing is achieved simply by burning for relatively longer periods.

Rates of climb should not exceed 600 ft/min (3 m/sec) unless an envelope temperature gauge is fitted, because the loading chart method of controlling temperature does not make allowance for the down load due to aerodynamic forces at high rates of climb. When a temperature gauge is fitted 120°C, 250°F should not be exceeded.

Special shapes should observe the limitation given in the flight manual supplement and noted on the limitations plate in the basket. During rapid climbs a crosswind will be felt at the basket. This is due to the "Coanda effect" of airflow passing around the balloon, and is no cause for alarm. It is a useful means of judging a high rate of climb when instruments are not in use.

4.5.6 Descending

To descend the burner is left off for relatively longer periods.

For descents from high altitudes, it is satisfactory to leave the burner off completely for a long period. The balloon will then enter a stable cold descent whose speed is around parachute speed, but varies greatly depending on the loading of the balloon and the temperature lapse rate of the atmosphere. On cold descents the balloon may swing a little, or slowly rotate, and light buffeting will be felt. None of these effects need cause concern.

Cameron balloons remain very stable in cold descents, but this cannot be assumed with every type of balloon. Long cold descents should also be avoided when a scoop is fitted. If the base of the balloon shows any tendency to close, a short blast of heat should be given to stabilise the descent. Recovery should be initiated with plenty of height in hand (say 2000ft) and should be achieved with a number of burns rather than a single long burn which could overheat the balloon.

4.5.7 Flight at Higher Altitudes

When flights are being made to a considerable altitude (say more than 3000 feet) the weight calculations should be rechecked in the light of the actual temperature encountered at altitude. It is therefore necessary to have a loading chart, an altimeter and a thermometer in the basket.

The alternative is to carry a direct reading envelope thermometer, of the thermistor or dial type.

Oxygen should be carried for flight above 10 000 ft. Some countries have specific regulations on oxygen and radio aids required at high altitude.

4.5.8 Gusts and Crosswinds

When a wind is felt in flight it means that the balloon has entered an airflow of a new speed or direction, and this relative airflow will act on the balloon until it has taken up the new velocity. Gusts tend to cause the balloon to lose lift by forcing some of the hot air out of the envelope, and also prevent its replacement by blowing away the heat of the flame. When a gust is felt it is best to start burning early, as an instinctive reaction, and to use the angle control on the burner to counteract the deflection of the flame by the wind. Gusts and crosswinds are to be expected during thermic conditions, after take-off from shelter, and near ground features such as hills, woods or buildings.

4.5.9 Flight in Thermic Conditions

Thermic conditions make control difficult, and they should be avoided by inexperienced pilots. Thermals produce strong horizontal gusts, and can also cause the balloon to climb, against the pilot's will, up to a few hundred feet. When caught in a thermal at low level, it is better to ride up with it, keeping the balloon hot until the altitude is greater than, say, 500 ft. Otherwise there is a risk that the balloon which has been allowed to cool will leave the thermal and hit the ground before it can be reheated.

As the balloon continually changes direction in thermic conditions it becomes more difficult to plan a landing approach and great care is necessary.

Flight near to cumulo-nimbus or thunderstorm clouds should be rigorously avoided. Such clouds often generate areas which are deceptively calm, but contain in other parts 'cells' of convection which produce vertical currents of speeds above 50 mph (80 km/hr) and extend to many thousands of feet.

If a balloon were drawn into one of these rising currents there would be no means open to the pilot to leave it and it is likely that turbulence levels sufficient to destroy the balloon would be found, or the balloon would be carried to such heights that the occupants would die from oxygen starvation or exposure.

4.5.10 Lock Top Operation

The lock top parachute valve is similar in operation to a parachute valve. However, there is an additional control - the Release Line (white with red fleck). The release line should only be pulled when a final landing is almost imminent. The release line unlocks the parachute from the crown ring and causes the indicator flag to appear inside the envelope. In the unlocked state an extended pull on the rip line, beyond the limits in section 2.8, may cause the parachute to "stall". The parachute will then NOT re-close.

4.6 LANDING

Pre-Landing Checks

Powerlines	Well clear of approach path and overshoot.
Passenger Briefing	Silence during landing. Brace, hold on, keep low, watch, do not leave until told.
Fuel	Enough on line for landing and overshoot.
Loose Items	Instruments, cameras, radios, etc, securely stowed.
Lock Top Release Line	Break tie-off on release line; pull to release lock; check for indicator flag to confirm top is unlocked.
Ripline	In hand during approach (velcro balloons: break bottom tie-off and take in slack).
Main Fuel	Off at tank, and burnt out if possible, before touchdown in high winds.
Pilot Light	Turned off or popped before touchdown in high winds.

4.6.1 Approach to Land

For landing, a field must be chosen in the line of drift. It should be free of animals, and there should be adequate space, bearing in mind the speed of travel, which is free of crops or electric or telephone wires. There should be no high obstacles on the approach or overshoot.

4.6.2 Touchdown

The balloon should be stabilised at about twice the height of trees or other obstacles. As the boundary of the field is crossed the balloon should be allowed to descend, valving if necessary, and a further burn should then be given to check the descent. In a final landing, all fuel should now be turned off. Ground level should be reached with zero vertical velocity. The parachute is pulled right in and held when it is intended to deflate the balloon.

With a velcro rip, the side vent should be held open from about five feet (1.5 m) above ground level until some time after the landing. If conditions are windy, and there is a risk of dragging, the rip panel should be operated instead of the vent to fully deflate the balloon. This applies also to the combination rip panel/parachute valve.

4.6.3 Landing Large Balloons

Large balloons, often used for sightseeing flights with novice passengers, require particular care in landing. The size of the basket makes it undesirable that it should touch down on a corner or short end in any appreciable wind. This can be prevented by the use of turning vents (see 1.1.9) during the approach to land.

4.6.4 Action after Landing

Turn off and empty any fuel lines not already shut down. With the Mk 4 burner it is advisable to return the pilot light cutoffs to the ON position when fuel has been disconnected to avoid damaging the handles during transport.

Switch off instruments.

If some air remains in the envelope it may be possible to pull the ripline slack up to the top of the envelope without danger of a tangle or ropeburn, to allow the parachute to be tabbed in, or the velcro rip to be closed, ready for the next flight.

Empty the envelope of air by folding it into a long sausage, starting from the base and kneeling on it to expel the air towards the crown. On wet or dirty ground a cleaner but less effective method is to stand astride the envelope at the nomex and gather it in the arms. Then walk to the crown squeezing with the arms and legs.

Coil the crown line and stow it in the bottom of the envelope bag, taking care not to tangle it in the crown tapes. With two or three people holding the bag open and walking down one side of the envelope, it is easy to feed the fabric into the bag, roughly folding it zig-zag fashion and tucking it down the sides. Do not detach the envelope from the burner frame until at least half of it is safely in the bag.

National practices vary with regard to landowner relations, but in the UK the National Farmers Union code should be adhered to and, in particular, no vehicle should enter private land to pick up the balloon until permission has been granted. If no permission can be obtained the balloon should be carried out.

Enter the flight in the balloon and pilot's logbooks.

4.7 TETHER OPERATION

Hot air balloons, although designed for free flight, are frequently flown tethered, either before or after a free flight, or as an alternative when weather conditions are not suitable for free flying. All Cameron balloons are suitable for tethering.

Safety in tethering depends very much on the wind speed. On a calm morning or evening there is little to go wrong, but in turbulent windy conditions it is common for a balloon to generate surprisingly large forces. Ropes have been broken, metal karabiners have been prised open, and even vehicles have been lifted off the ground by hot air balloons.

Any aerodynamic force depends on the square of the windspeed, and this means that higher speeds cause forces to increase surprisingly rapidly. For example if it takes one man to hold a balloon at 5 knots, it would take sixteen men each exerting the same force at 20 knots.

Unfortunately it is seldom possible to know the windspeed exactly when about to tether a balloon, and often conditions depend as much on the character of the turbulence as the exact speed of the wind. Exact limits are therefore impossible to specify, but pilots should understand that tethering in windy conditions requires some experience (despite the absence of a legal requirement for a licence in most countries). The behaviour of the balloon during inflation and the first few moments of tethering is the best guide, and the attempt should not be continued if gusts are producing forces which are likely to be near to the maximum which the tether lines, attachment points or crew can withstand.

Despite the impossibility of quantification, some rough guide can be given:-

1) Light Airs (perhaps 0 to 10 knots): Tethering is easy, and only the usual precautions at take-off need be observed. The tether line can be a single line attached to any shackle or karabiner at the burner load-frame level.

2) Windy Conditions (10 to 15 knots): Tethering must be carried out with the precautions outlined below.

3) Higher Winds (over 15 knots): The balloon is not certified for tether operations above 15 knots. Higher winds can generate forces which will break any tethering system. If large forces are appearing in gusts, abandon the attempt and deflate.

Tethering in Windy Conditions

The main tethering load should be taken by a V-bridle attached to the two adjacent

corners of the load frame on the side opposite the scoop. Two strong tether lines should be attached by 5 tonne karabiners to the V-bridle, and attached to strong points on the ground, spaced apart in the upwind direction. Vehicles are usually the most convenient anchorage point.

When rigging the balloon it is recommended that a second set of 2.5 tonne karabiners be added, above and linked to the first set by means of 'tether rings'. The V-bridle should then be attached via 2.5 tonne karabiners, linked onto the tether rings, thus ensuring a straight pull from the tether point to the envelope.

A third line should be attached to one of the downwind corners of the load-frame and should be held by a team led by an experienced crew member. Children should never be allowed near this line. The pilot, by use of the burner, and the chief crew man on the line should, between them, attempt to stabilise the balloon, anticipating and reducing sudden movements due to gusts.

Some pilots prefer other methods, and it is only important to ensure a high strength in the whole tethering load path. In particular, care must be taken never to apply a tether load to a karabiner in its transverse direction, as it will fail far below its rated load in this condition.

Ropes used for tethering should have a quoted breaking strength of at least four tonnes, and should be inspected before each tether flight.

When tethering it is important to keep all people away from the attachment lines and out of the way of the basket during landings or bounces. The lines can snap taut and injure a spectator, and the basket could suddenly descend onto people.

There should be no obstacles which might cause injury to anyone within the arc of possible movement of the balloon.

4.8 REFUELLING

Because propane is a flammable, heavy vapour refuelling should only take place in a well-ventilated place out of doors. Particular care must be taken to keep the vapour away from cellars, drains or any other low-lying place where it might accumulate, especially in flat calm conditions.

There must be no smoking, naked lights or live electrics, and no unnecessary movement of steel articles which might generate a spark. A fire extinguisher should be readily available.

Tanks should be removed from the basket and placed on the ground to reduce the chance of spark discharge of static electricity, and to facilitate isolation of tanks in the event of a fire. Gloves are recommended.

Connect the propane supply hose to the tank valve, turn on the propane supply, open the bleed valve and then open the tank valve to receive propane. Fill until the bleed valve begins to squirt liquid propane instead of vapour. Close the tank valve, the bleed valve, shut off the propane supply and disconnect the tank. The tank is now 82% full, leaving a safe volume for thermal expansion. Tanks should not be overfilled, nor subjected to extreme heat when full, as the pressure may rise until the pressure relief valve opens and releases vapour. The relief valve is set at 375 psi (25.9 bar). Tanks should be stored vertically, or if it is necessary to store them horizontally, with the pressure relief valve pointing upwards so that vapour, not liquid propane, will be ejected in the event of overpressure.

If 47 kg (104 lb) cylinders without dip tubes are being used as a supply, it is necessary to partially invert them to ensure liquid (not vapour) flow. Other users do not do this — they use vapour with the tank upright, so dirt and water collect in the bottom. To minimise the amount that gets into the flight cylinders, the 104 should be rested at an angle of about 45° so that dirt collects

in the "shoulder". It is also worth noting that most refuelling connectors have a left-handed thread.

4.9 STORAGE

The balloon is best stored in a clean dry place. The envelope should not be stored wet for long, as residual moisture can result in fabric deterioration due to mould or mildew. A wet envelope should be gently dried by keeping it cold-inflated with a fan until most moisture has evaporated, before hot inflating it.

Water soaking into the basket base hide will deteriorate the hide and wicker.

Tanks should be stored in a well-ventilated place with no sources of ignition, or excessive heat which could cause over-pressure leading to propane venting.

4.10 LAUNCHING HANG GLIDERS

There is considerable experience in launching hang gliders and, with care, the procedure is safe and practical.

4.10.1 Suspension.

The weight of the glider should be taken by two adjacent karabiners. A good suspension has been a length of 4,000 lb balloon load tape knotted in a loop around the shackles and tied to the attachment at the top of the glider king post. It should be long enough to allow the balloon to be inflated on the ground alongside the hang glider.

The ability of the glider king post to withstand lifting is the responsibility of the hang glider pilot who should check this with his manufacturer.

4.10.2 Release Mechanism.

Many systems have been proposed, some rather complicated. Purpose-made mechanisms should be avoided as these tend to need development, and it is lucky if they work first time. A simple system is to cut the nylon tape with a knife at the balloon basket.

The cutting method is extremely simple and reliable, and experience has shown that the length of tape which remains streaming from the glider king post has no noticeable effect on its flying qualities. It is important to stand back at the moment of release to avoid injury if the taut nylon springs back, and to make sure that a spare knife is available in the basket.

It is better that the release should be under the control of the balloon pilot, and not the glider pilot, as an incorrect release after the first fifty feet or so would be more dangerous to the balloon than to the glider.

4.10.3 Take-Off.

To carry out a smooth take-off the weather must be close to ideal from the balloonist's point of view. The load-carrying ability of the balloon for the ambient temperature should be checked on the loading chart.

The balloon, once inflated, should be allowed to lift off slowly, and be gently controlled by the suspension tape for as long as possible. Helpers should apply plenty of weight to the hang glider pilot to prevent a premature lift-off. It is very important to avoid jerking the hang glider off the ground as the extra load on the balloon would simply make it descend again, probably into the downwind obstacles. Instead, a hands-on, hands-off routine should be tried with helpers holding the hang glider pilot's shoulders.

It is the balloonist's responsibility to ensure a clean climb out as the glider is very vulnerable to any collision with obstacles. Once over 100 ft or so the glider is safe, even if released, and attention can be given to the climb.

4.10.4 Climb.

During the climb the glider pilot cannot see the balloon, but he can hear everything the balloon pilot says. It is good, therefore, to keep him informed of progress.
One can call out the instrument readings for altitude and rate of climb at approximately 250 ft intervals. A climb rate of about five knots (500 ft/min, 2.5 m/sec) seems satisfactory.

4.10.5 Release.

It is important that the balloon slows its rate of climb and actually descends before releasing the weight of the glider, otherwise a dangerously fast rate of climb could occur. This is particularly important for Velcro rip balloons. A descent rate of 5 knots seems adequate before release. With the standard hang glider this declines to two knots descent after release, but after releasing a heavy two-seater it can change to four knots climb despite prolonged use of side vent.

4.10.6 Personal Parachutes.

It is advisable to use parachutes, both on the balloon and glider pilots, and it is probably good to do this until experience is gained with this relatively new technique. In the long term, however, they should not be necessary.

4.11 DROPPING PARACHUTISTS

All Cameron balloons of "O", "A", "V", "N" type are approved for the dropping of parachutists but only when fitted with a conventional basket.

The use of the balloon by parachute jumpers is approved subject to the following conditions being satisfied:-

a) Parachutists to sit on the sides of the basket away from the fuel lines and balloon parachute/rip operating lines.

b) Before releasing the parachutists, the balloon pilot should stablish a rate of descent appropriate to the number of parachutists jumping simultaneously as follows:

1 jumper	200 ft/minute
2 jumpers	400 ft/minute
3 jumpers	700 ft/minute

c) Parachutist only to exit on an agreed signal from the pilot when he is satisfied the required conditions are established.

d) Balloon pilot to ensure before flight that all balloon lines are safely secured, so that a clean exit can be made by the parachutists.

e) Free fall parachuting only is permitted, static line releases are not used.

f) A suitable instrument for measuring the rates of ascent and descent must be fitted and be operating satisfactorily.

g) The maximum number of occupants listed in paragraph 1.6 of this manual is not to be exceeded. Due allowance is to be made for the weights of the occupants and their parachutes.

4.12 NIGHT FLYING

All models of Cameron balloons are suitable for night flying, subject to minimum equipment as follows:

(i) Lights satisfying national regulations.
(ii) Instruments: an altimeter is essential, and a variometer and compass are useful.
(iii) Maps and an adequate reserve of hand lamps.

Flight planning, including timing and weather information, should be made carefully so that the balloon will be able to remain airborne until sunrise. Adequate fuel reserves are essential.

Night landings are not a normal procedure. Although they have been done using strong lights, they must be regarded as experimental at present.

SECTION 5 — WEIGHT CALCULATIONS

5.1 Loading Chart

Before each flight the all-up weight must be calculated, and a check made to ensure that this does not exceed the safe limit. Otherwise the fabric can easily be overheated.

The load which can be carried safely depends on:

(i) the temperature (°C) of the surrounding ambient air;
(ii) the pressure altitude (feet a.m.s.l.)

Instruction for Use of Chart

(i) Find permitted lift per 1000 cu.ft. for actual altitude and temperature, using graph opposite.
(ii) Use Ready Reckoner to find Total Permitted Lift, using column appropriate to the balloon size, interpolating if necessary.
(iii) Disposable Lift = Total Permitted Lift minus Balloon Empty Weight (from logbook).
(iv) Ensure that the combined weight of passengers and fuel tanks does not exceed Disposable Lift.

Notes

1) The dotted lines show typical temperature variations with height (I.S.A. = International Standard Atmosphere) but these cannot be relied on for any particular day. For flights high above take off altitude, an ambient thermometer and altimeter must be carried, and the loading rechecked in flight. Alternatively a direct reading envelope thermometer may be used.

2) Loading chart is based on static lift, 100°C internal temperature, thus allowing for moderate rates of climb within the temperature limitation.

3) Total permitted lift is limited to 20 lb per 1000 cu.ft. by maximum permitted stress loading.

4) Empty Weight includes envelope, carrying bag, burner, karabiners and basket including poles, pole covers and fire extinguisher. (Not included are tanks, accessories or occupants). Consult your aircraft logbook for the main component weights of your balloon.

5) Full Tank Weights: see overleaf.

5.2 SLIDE CHART LOAD CALCULATOR

The result of the loading chart calculation has been produced in slide chart form, giving total permitted lift very simply.

5.3 WINTER CONDITIONS

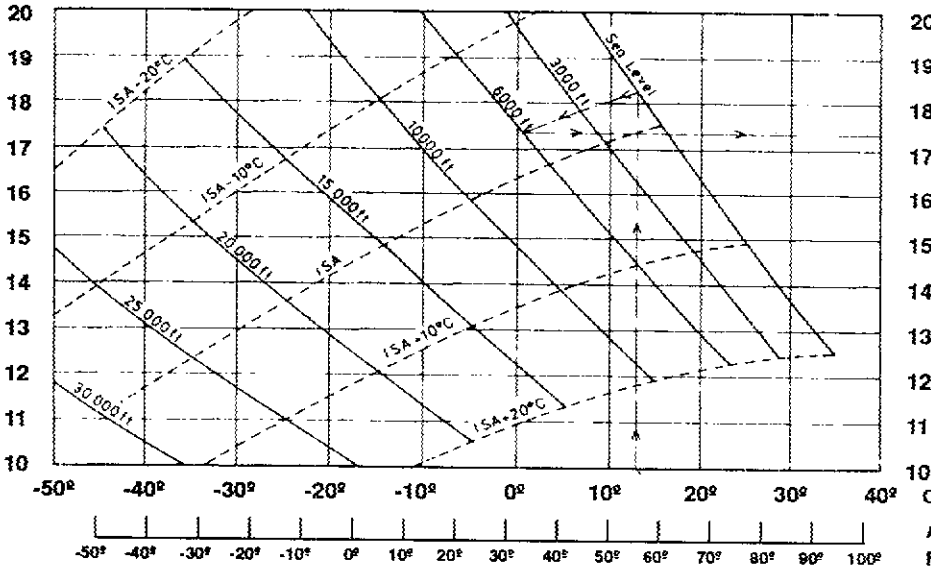
The loading chart is not the only limitation on weight. In cold conditions (below 10°C) the vapour pressure of propane falls markedly, reducing the output of the burner. This makes the balloon less responsive to attempts to arrest a descent, especially when heavy.

Experience is the only guide here. Until you know your balloon, fly well below the recommended load, especially in cold weather.

5.4 INVERSION CONDITIONS

When the temperature of the atmosphere increases with height, loading according to the temperature of the cool ground layer can lead to an overheating after the initial climb.

On cool, early morning flights use the expected mid-day temperatures for the calculations, or simply leave a good margin below the calculated maximum permitted weight.



LOADING CHART

Lift per 1000 cubic ft.

(e.g. ambient temperature 13ºC, flight up to 6000 ft., the lift per 1000 cu.ft. is between 17 and 18)

Lift per 1000 cu.ft	BALLOON SIZE																			
	20	31	42	56	65	77	84	90	105	120	133	140	145	160	180	210	250	300	375	500
10	200	315	420	560	650	775	840	900	1050	1200	1330	1400	1450	1600	1800	2100	2500	3000	3750	5000
11	220	346	462	616	715	852	924	990	1155	1320	1463	1540	1595	1760	1980	2310	2750	3300	4125	5500
12	240	378	504	672	780	930	1008	1080	1260	1440	1596	1680	1740	1920	2160	2520	3000	3600	4500	6000
13	260	409	546	728	845	1007	1092	1170	1365	1560	1729	1820	1885	2080	2340	2730	3250	3900	4875	6500
14	280	441	588	784	910	1085	1176	1260	1470	1680	1862	1960	2030	2240	2520	2940	3500	4200	5250	7000
15	300	472	630	840	975	1162	1260	1350	1575	1800	1995	2100	2175	2400	2700	3150	3750	4500	5625	7500
16	320	504	672	896	1040	1240	1344	1440	1680	1920	2128	2240	2320	2560	2880	3360	4000	4800	6000	8000
17	340	535	714	952	1105	1317	1428	1530	1785	2040	2261	2380	2465	2720	3060	3570	4250	5100	6375	8500
18	360	567	756	1008	1170	1395	1512	1620	1890	2160	2394	2520	2610	2880	3240	3780	4500	5400	6750	9000
19	380	598	798	1064	1235	1472	1596	1710	1995	2280	2527	2660	2755	3040	3420	3990	4750	5700	7125	9500
20	400	630	840	1120	1300	1550	1680	1800	2100	2400	2660	2800	2900	3200	3600	4200	5000	6000	7500	10000

TOTAL PERMITTED LIFT (lbs)

Lift per 1000 cu.ft	BALLOON SIZE																			
	20	31	42	56	65	77	84	90	105	120	133	140	145	160	180	210	250	300	375	500
10	91	143	191	254	295	352	381	408	476	544	603	635	658	726	816	952	1134	1361	1701	2268
11	100	157	210	279	324	387	419	449	524	599	663	699	723	798	898	1047	1247	1497	1871	2495
12	109	171	229	305	354	422	457	490	572	653	724	762	789	871	980	1143	1361	1633	2041	2722
13	118	185	248	330	383	457	495	531	619	707	784	826	855	943	1061	1238	1474	1679	2211	2948
14	127	200	267	356	413	492	533	571	667	762	844	889	921	1016	1143	1334	1588	1905	2381	3175
15	136	214	286	381	442	527	572	612	714	816	905	953	987	1088	1225	1429	1701	2041	2551	3402
16	145	228	305	406	472	562	610	653	762	871	965	1016	1052	1161	1306	1524	1814	2177	2722	3629
17	154	243	324	432	501	597	648	694	810	925	1025	1080	1118	1234	1388	1619	1928	2313	2892	3856
18	163	257	343	457	531	633	686	735	857	980	1086	1143	1184	1306	1470	1715	2041	2449	3062	4082
19	172	271	362	483	560	668	724	776	905	1034	1146	1207	1250	1379	1551	1810	2155	2585	3232	4309
20	181	285	381	508	590	703	762	816	953	1088	1206	1270	1315	1451	1633	1905	2268	2721	3402	4536

TOTAL PERMITTED LIFT (kgs)

Tank Weights (full, with cover and 2 straps)		lb.	kg.
Worthington (contents 43 lb/20 kg)	Master	75	34
	Standard	73	33
Stainless Steel '40' CB497 (contents 43 lb/20 kg)	Master	79	36
	Standard	77	35
Stainless Steel 'big 40' CB599 (contents 48 lb/ 22 kg)	Master	85	39
	Standard	83	38
Stainless Steel '60' CB426 (contents 61 lb/28 kg)	Master	109	50
	Standard	107	49
Stainless Steel '80' CB959 (contents 82 lb/37 kg)	Master	139	63
	Standard	137	62

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6.1 THE SMART VENT RAPID DEFLATION SYSTEM.

6.1.1 General description.

The Smart Vent is a rapid deflation system, fitted as an alternative to a Parachute Valve or Lock Top.

For in-flight venting the red & white vent line is used; this opens the panel in a manner similar to a parachute valve. For final deflation the red rip line pulls the centre of the panel down towards the basket, collapsing the parachute into a column in the centre of the parachute aperture. The parachute panel can be reopened by pulling on the red & white venting line.

The ability to re-close the parachute once collapsed allows the system to be tested as part of the preflight checks, and reduces the dangers of inadvertent operation.

USE OF THE RED RIP LINE IS NOT PERMITTED AT HEIGHTS GREATER THAN 2m (6 FEET) ABOVE GROUND LEVEL.

6.1.2 Preparation

Attach the Rip Line (red rope) to the burner frame & the venting line (red & white rope) to the ring on the Smart Vent bag installed in the basket.

There are no mechanical locks or tie-offs associated with the Smart Vent. As cold air is blown into the balloon simply tab the parachute into position matching the numbers on the parachute edge to the numbers on the envelope. Care should be taken to ensure that no cords are wrapped around the velcro tabs.

6.1.3 Pre takeoff checks

Test the venting action of the system (red/white line) and ensure all the velcro tabs are detached.

Ensure that the balloon is fairly hot and test the deflation action of the system. As soon as the parachute has collapsed pull on the venting line to reopen the panel, then release the venting line to allow the panel to reseal. A second operation of the vent line may be needed to obtain a good seal.

The excess venting line should be stuffed into the Smart Vent bag to prevent any possibility of it becoming entangled.

6.1.4 In-Flight

In-Flight release of Hot-air.

For in-flight release of hot-air the red & white venting line should be pulled. The vent should not be held open for more than three seconds. The envelope must be allowed to reinflate fully between activations of the valve.

USE OF THE RED RIP LINE IS NOT PERMITTED AT HEIGHTS GREATER THAN 2m (6 FEET) ABOVE GROUND LEVEL.

Inadvertent operation of the Smart Vent

If the rip line is accidentally pulled the smart vent will start to operate. The pilot will be warned by the difference in feel and sound as the panel starts to open. The rip line should immediately be released, and the panel closed by pulling on the venting line.

6.1.5 Landing & final deflation.

Pre-landing checks

Rip line Available.

Valve line available & free to pull out of Smart Vent bag.

Landing Procedure

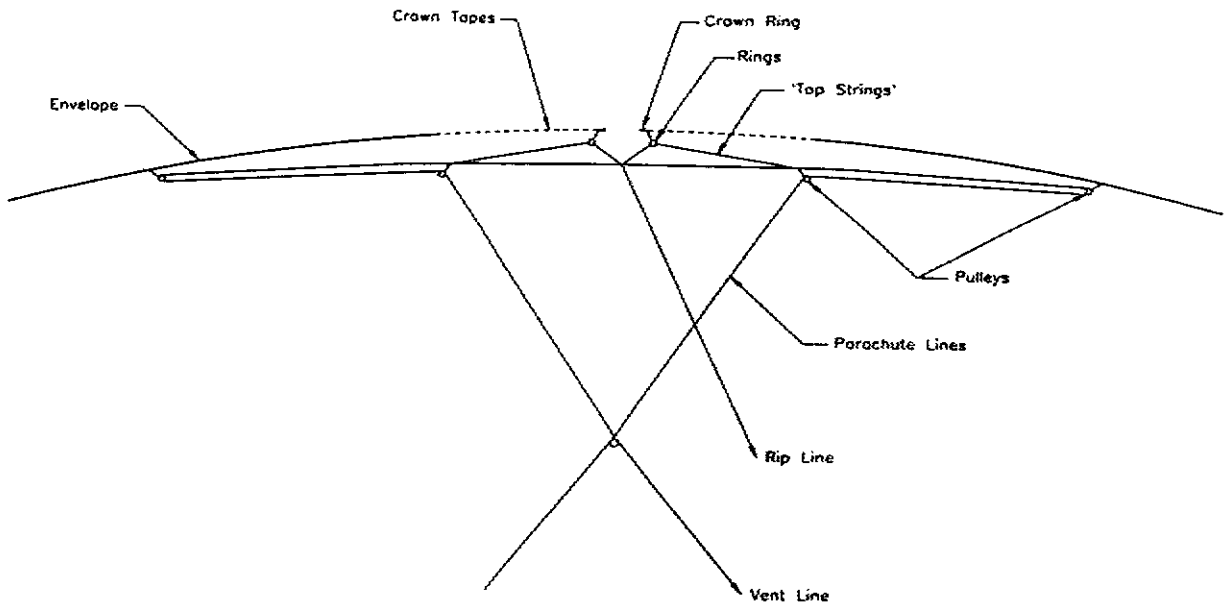
The red rip line may be pulled immediately before touchdown (less than 2m, 6 feet). For final deflation the panel should be pulled fully open. If it is wished to keep the balloon inflated the panel may be opened, then closed by pulling on the venting line once sufficient air has been released.

In light winds it is possible to land & deflate using the venting action (red & white line). However deflation will be slower than with a conventional parachute.

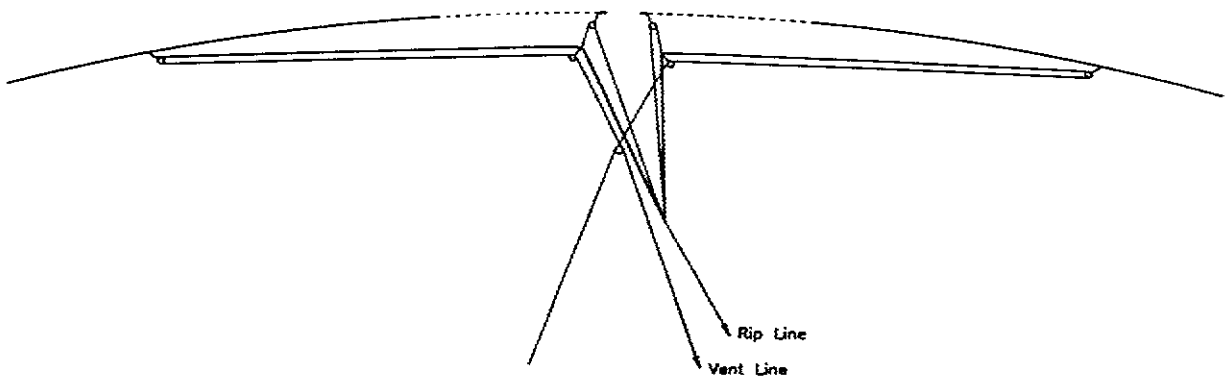
6.1.5 Limitations.

Use of the red rip line is not permitted at heights greater than 2m (6 feet) above ground level.

In flight release of hot air (red & white line) must not exceed three seconds. The envelope must be allowed to reinflate fully between activations of the valve.


Crown Tapes
Crown Ring
Rings
'Top Strings'
Envelope
Pulleys
Parachute Lines
Rip Line
Vent Line

CLOSED


Rip Line
Vent Line

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6.2 THE SUPER SHADOW BURNER.

6.2.1 General description.

The Super Shadow Burner is similar to the mark IV Super burner but fitted with the Stealth Burner manifold block. The Super Shadow burner is available with squeeze action or toggle valves, and can be fitted with either regulated liquid pilot lights or vapour pilot lights.

The Super Shadow burner may be used with Stealth burner units to make combination systems of double triple and quadruple Burners.

6.2.2 Maintenance.

The manifold assembly may be maintained according to the instructions for the Stealth Burner (Section 1.6.6).

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6.4 THE SINGLE SHADOW & SINGLE STEALTH BURNER.

6.4.1.1 General description. Single Shadow Burner.

The Single Shadow burner consists of a Shadow burner coil with all the burner controls incorporated into a single manifold block. Two independent fuel supplies, pilot lights and whisper burners are fitted so that is impossible for any single failure to prevent the use of the burner. The positions of the controls and their operation are identical to the Shadow Double Burner.

Two options are available for the main blast valve controls. The "lever action" controls are mounted below the handgrip, and can be operated either by squeezing the lever towards the handgrip, or by pulling the lever downwards. The "Squeeze action" controls are triggers mounted in the top of the handgrip. The burner is operated by squeezing the trigger into the handle.

In an emergency situation the main burner can be operated together with the whisper burner connected to the second fuel supply. This will provide 1.8 times the power output of the ordinary single burner.

The Single Shadow burner can be fitted with either regulated liquid pilot lights or vapour pilot lights.

6.4.1.2 General description. Single Stealth Burner.

The Single Stealth burner uses an identical manifold to the Single Shadow burner, but combined with a Stealth burner coil.

The Single Stealth burner can be fitted with either regulated liquid pilot lights or vapour pilot lights.

6.4.2 Emergency Procedures.

6.4.2.1 Pilot Flame Failure.

If the pilot light should go out for any reason, it should be relit if possible.

If all else fails the following procedure should be adopted:

Shut off main fuel at cylinder.

Lock one main burner valve open or fully open one whisper valve Burners with "Squeeze Action" blast valves should have the whisper valve fully opened.

Permit a small amount of fuel to enter the line by fractionally opening the cylinder valve.

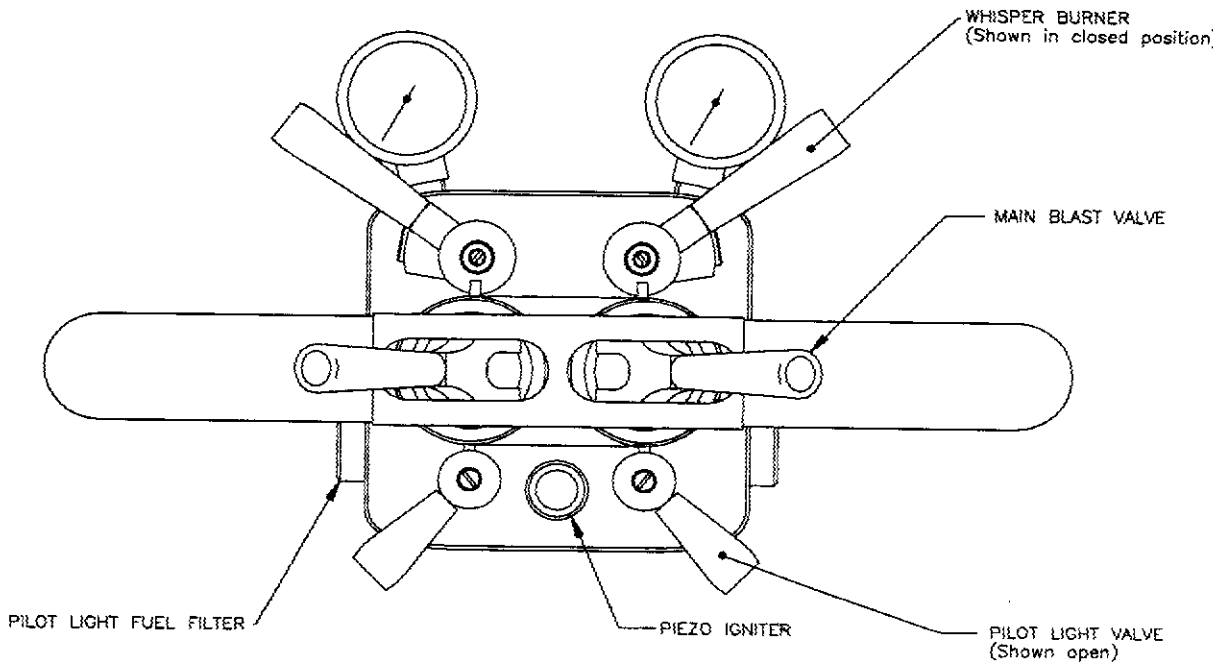
Light main jets or whisper jet with a match or other igniter.

Open tank valve to full flow to obtain a normal burn.

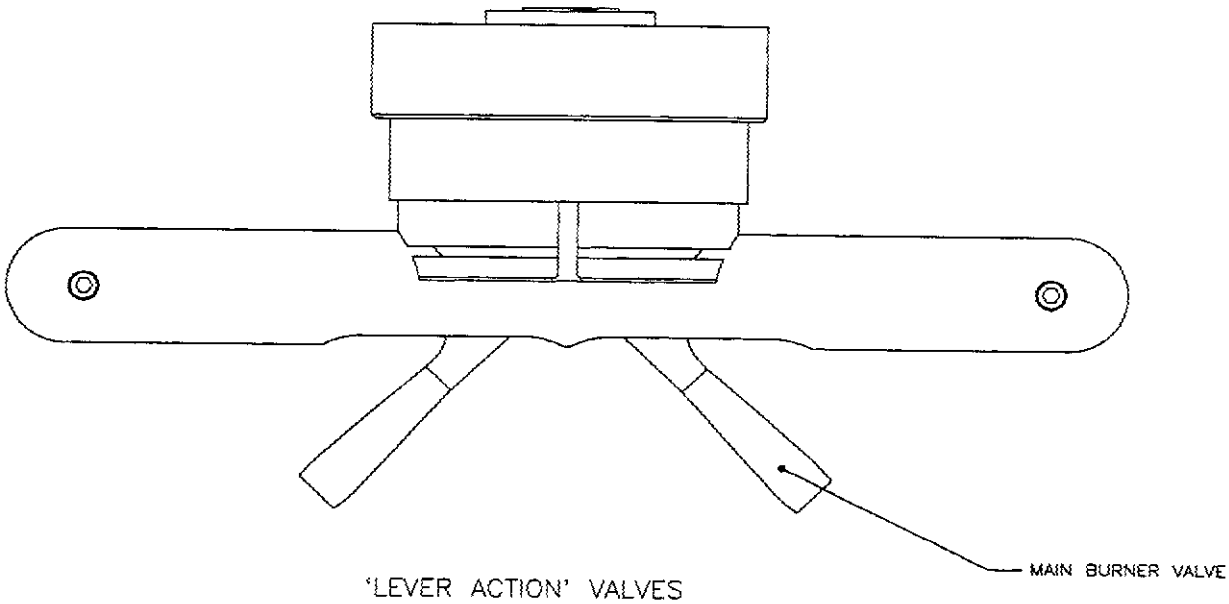
Close tank valve to a fractional setting to turn burner off but to maintain a pilot setting (flame 2-3 feet, 0.5 to 1m long).

Do not use one cylinder as a pilot, with main fuel coming from another, unless the pilot cylinder is giving vapour only, as prolonged liquid flow will cause freezing of the valves.

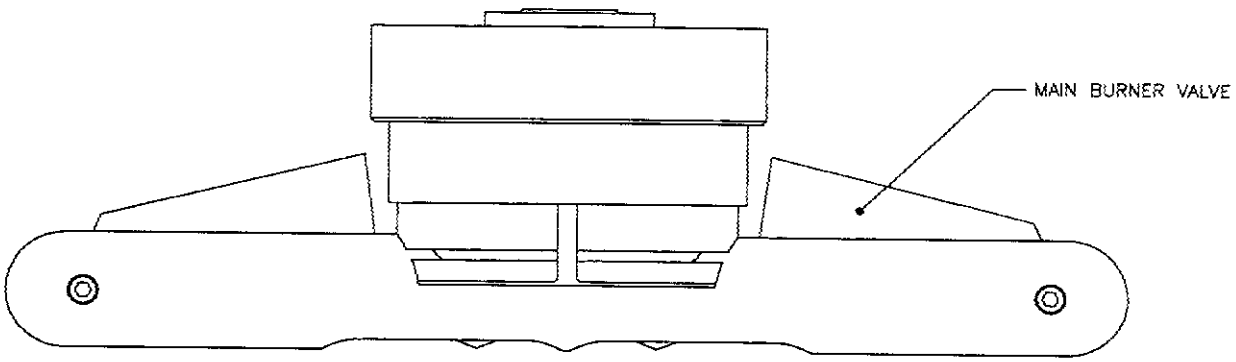
Make a landing as soon as possible.



Layout of controls.



'LEVER ACTION' VALVES



'SQUEEZE ACTION' VALVES

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6.5 RIGGING OF WIRES TO AN EIGHT POINT BURNER FRAME.

For large passenger carrying balloons which utilise a burner frame with eight (8) rigging points, the preferred wire connections are as per the following diagrams. This type of burner frame is generally used with an A type (20 gore) envelope. Three wires are attached to each of the corner rigging points and two wires are attached each of the remaining rigging points. This arrangement gives a smoother envelope mouth shape.

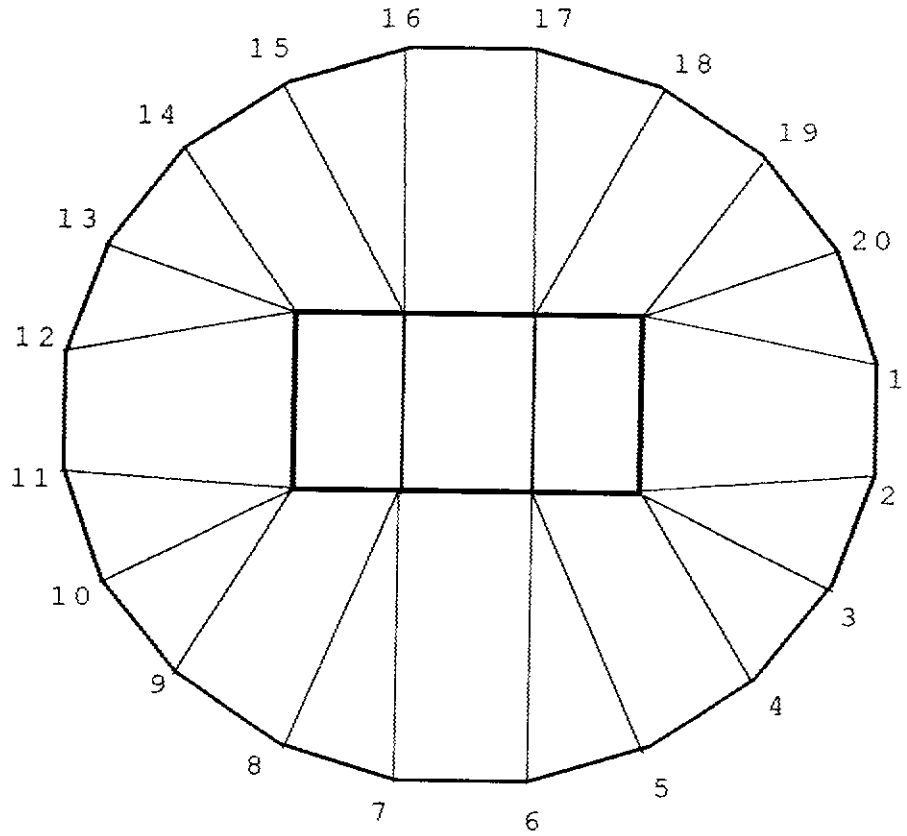

Diagram of wire connections viewed from the basket.
(20 Wire rigging shown)

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6.7 BURNERS

6.7.0 General Description

The Double, Triple and Quad versions of the Shadow and Stealth burners are now mounted with a central Gimbal block. This block allows movement in two axes and features integral limit stops on the Gimbal angle. Gimbal friction may also be adjusted independently in both axes.

Versions of these burners are now also available fitted with an adjustable height burner frame. These frames use a pneumatic strut to give a quick and easy setting of the burner at any height within the maximum and minimum limits of the frame. Adjustment may be made at any time during the flight.

6.7.0.1 Burner Height Adjustment

To adjust the burner height, squeeze the lock release lever located on the side of the burner frame at the end of the strut. Using the other hand move the burner to the required height, then let go of the lever to lock the frame.

Note that the frame is intended for adjustment with the burner mounted upright, if the lock is released when the burner frame is on its side then the burner may move rapidly.

Please take care not to put hands around the moving parts of the frame when the lock is released.

The strut contains Nitrogen gas at high pressure. At no time should the burner flame be directed at the pneumatic strut as this will cause rod seal failure allowing the pressure to escape.

At no time should any attempts be made to take the strut to pieces as this will be hazardous.

If the strut requires replacement a new strut must be fitted as a complete unit.

6.7.0.2 Gimbal Friction Adjustment

To adjust Gimbal friction two of the bolts at each end of the Gimbal block can be tightened or loosened. At each end only the two bolts adjacent to the side of the block where there is a gap at the body joint should be used to adjust the friction. (The other two bolts have been fully tightened and should not be disturbed).

The following procedure should be used:-

1) Remove the two adjusting bolts with their spring washers.

2) Apply fresh Loctite thread locking compound to the bolts.

3) Refit the bolts (and washers) and adjust tightness to give the desired friction.

4) Allow time for the Loctite to cure before regular use of the burner.

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6.8 FUEL TANKS

6.8.1 General Description - 'Tall 60' Stainless Steel Tank (CB 2088)

The 'Tall 60' tank has been made available as a more space efficient tank for high sided baskets. This tank has the same diameter as CB599 and the same height as CB959.

6.8.2 General Description - Titanium Tanks

The titanium tanks are identical in appearance to the current stainless steel tanks. Each current stainless steel tank has a titanium equivalent as follows:

Stainless Type	Empty Weight (kg)		Titanium Equivalent	Empty Weight (kg)
CB599	19.2		CB2385	11.2
CB2088	21.6		CB2387	12.6
CB426	21.3		CB2380	12.4
CB959	24.7		CB2383	14.4

6.8.3 Maintenance

The new tanks are similar in arrangement and have identical fittings to the current tanks, and may be maintained according to the instructions for fuel tanks (Section 1.7).

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6.9 FUEL TANK NITROGEN PRESSURISATION

6.9.1 General Description

The burner has an operating pressure range of 45 - 145 psi (2.8 -10 bar). However flying with a fuel pressure below 80 psi (5.5 bar) requires care due to the reduced burner power. In order to provide increased fuel pressure during cold conditions fuel cylinders may be pressurised with nitrogen.

6.9.2 Procedure

The nitrogen used must be from a regulated supply, providing a pressure of between 0 and 10 Bar to the fuel cylinder, and this nitrogen supply must be operated in accordance with the suppliers instructions.

Nitrogen is added to the cylinder through its liquid feed valve until the desired pressure level is reached.

The maximum tank pressure must not exceed 145 psi (10 bar).

The maximum tank pressure must not exceed 100 psi (7 bar) if the tank is to be stored in a pressurised state.

A cylinder that has been pressurised with nitrogen becomes unusable for vapour withdrawal, as the nitrogen occupies the vapour space at the top of the fuel cylinder, so always leave sufficient master cylinders nitrogen-free for vapour pilot light operation and ensure they can be easily identified.

When fuel cylinders that have been pressurised with nitrogen are warmed the fuel pressure will rise much more rapidly than that of an unpressurised tank. Care must be taken to ensure that the tank maximum safe working pressure is never exceeded. This may be achieved either by pressurising tanks to a maximum of 7 bar if they are to be stored, or by pressurising tanks to 10 bar immediately before a flight and venting the nitrogen from any unused or partially used tanks after landing.

The nitrogen is vented from a fuel cylinder by opening the Fixed Liquid Level Gauge (FLLG) and allowing vapour to vent for a minimum of 10 minutes. This will allow a considerable amount of nitrogen and propane vapour to escape, reducing the internal pressure of the cylinder.

Propane vapour is flammable and heavier than air. Do not vent cylinders in the basket (unless an external vent kit is fitted), in enclosed spaces or near hollows or drains in which the vapour could accumulate. All potential sources of ignition should be removed. There should be no naked lights, smoking or live electrical equipment in the vicinity. Avoid performing activities that might create a spark (e.g. moving steel fuel cylinders or starting a vehicle). The fuel cylinders should be electrically earthed during the venting process. Protective gloves must be worn. A fire extinguisher must be available. Never vent more than one cylinder at a time.

Cameron Balloons Ltd.

Supplement to Flight Manual Issue 7

6.10 Overboard Venting of Pressurised Fuel Cylinders

6.10.1. Introduction

To allow pressurised fuel cylinders to be safely refuelled in the basket, an overboard vent system has been developed to allow the removal of excess vapour from the cylinder fixed liquid level gauge (bleed valve), via a hose, to an area remote from the cylinder.

The systems operate in the same way as the existing bleed valves in the cylinders. When the cylinder is full, liquid appears in the hose adjacent to the bleed valve.

6.10.2. Equipment - CB2481 - 'Fuel Safe II'

This system uses a modified bleed valve with a threaded outlet to allow direct fitting of the vent hose and couplings.

The bleed valve on the cylinder is fitted with a female coupling which incorporates a shut off valve. The cylinder cannot be filled without the hose being attached. The detachable hose is fitted with a silencer (see Figure 6.10.1.).

The cylinder is fitted with a warning placard to ensure that the vent hose is fitted prior to refuelling (see Figure 6.10.2.).

If the vent hose is not present, the thread on the outlet is blanked off using a brass blanking nut.

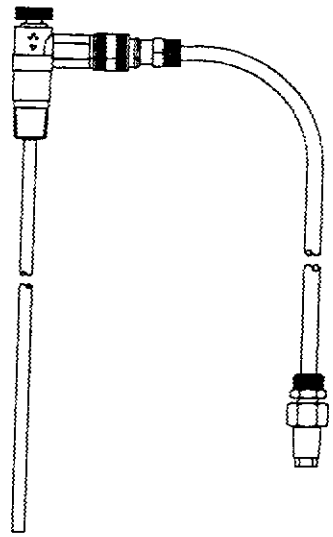

Figure 6.10.1. CB2481 FuelSafe II

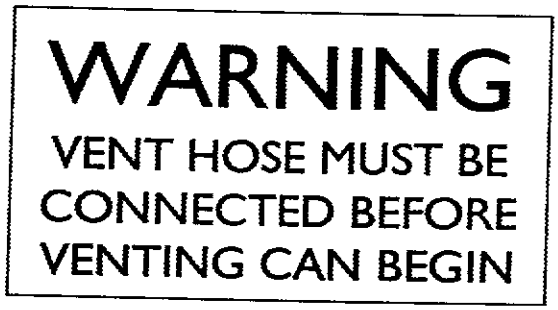

Figure 6.10.2. CB8405 FuelSafe Label

APPENDIX 1

NOTES ON PROPANE FUEL

At atmospheric pressure and temperature propane (C_3H_8) is a vapour and its boiling point is -42°C. It is normally stored in liquid form in cylinders under pressure, and its vapour pressure depends on the temperature as follows:

Temperature	Pressure (gauge)
-15°C	30 psi (2.1 bar)
0°C	56 psi (3.9 bar)
15°C	90 psi (6.3 bar)
30°C	140 psi (9.7 bar)

This pressure is a very useful feature, as it means that a pump or other means of propelling the fuel to the burner is not necessary. The variation with temperature is a disadvantage however, as it means that a lower burner power is obtained in winter.

The main burner uses liquid fuel which evaporates in the vapourising coil before emerging from the jets to form a flame. To obtain this, a dip tube passes from each main tank valve to the bottom of the cylinder. Liquid must be used, for if vapour were drawn off at the high rates required, the cylinder would refrigerate and lose pressure within a few seconds.

The pilot burner works from a vapour supply, either piped from the space at the top of the tank or tapped off the liquid feed to the burner and evaporated. The pressure is adjustable to give a suitable flame. Occasionally when the tank is on its side, liquid will be fed to the regulator and frost will form on the outside and it may run erratically. This should be prevented as far as possible.

Since the vapour pressure of propane is the same whether the cylinder is full or nearly empty of liquid, contents gauges are not based on pressure but use a system of floats.

Propane liquid has a high coefficient of thermal expansion and when it expands in a tank, it forces a little of the propane vapour to condense so that the pressure in the tank only rises by a small amount with increase in temperature. if, however, there is no vapour space, and a closed compartment is filled with liquid completely, a rise in temperature can cause very dangerous pressures — quite enough to split a steel or aluminium tank causing a serious explosion.

It is for this reason that the fuel tanks are protected by a controlled vapour space and a safety relief valve. The vapour space is controlled by a small dip tube extending downwards from the vent valve. When filling, this valve must always be open, allowing a discharge of vapour, and filling must be stopped as soon as liquid appears. if filling has taken place beyond this point, some propane should be drained out again at once.

APPENDIX 2

THE U.K. PILOT'S LICENCE REQUIREMENTS (at November 1989)

The Civil Aviation Authority requirements for the issue of a Private Pilot's Licence (Free Balloons, Hot Air) are as follows:

(i) The applicant must make a declaration that he has no medical defects which could be a danger in piloting a balloon, and must obtain his doctor's counter-signature.

(ii) A minimum of six flights totalling at least 16 hours under instruction, including at least two flights with a BBAC instructor.

(iii) Students must have attained their 17th birthday before presenting themselves for flight examination.

(iv) A dual test flight with a C.A.A.- appointed B.B.A.C. examiner.

(v) A solo flight under the supervision of the C.A.A. examiner, or a delegated supervising pilot.

(vi) Written examinations must be passed in the following subjects:

Aviation Law and Flight Rules

and Procedures

Navigation

Meteorology

Airmanship and Balloon Systems

Human Performance and Limitations

Further Reading

In addition to this manual, the following textbooks will be found useful:

C.A.P. 85
A GUIDE TO AVIATION LAW, FLIGHT RULES AND PROCEDURES FOR APPLICANTS FOR THE PRIVATE PILOT'S LICENCE
(C.A.A.)

METEOROLOGY FOR GLIDER PILOTS
C.E. Wallington (John Murray)

THE WEATHER GUIDE
A.G. Forsdyke (Hamlyn)

FLIGHT BRIEFING FOR PILOTS, VOL.4
N.H. Birch & A.E. Bramson (Pitman)

BALLOONING HANDBOOK
Don Cameron (Pelham)

FREE FLIGHT HOT AIR BALLOON

MAINTENANCE MANUAL

ISSUE 7
1992

This handbook provides a maintenance manual for the Cameron range of free flight hot air balloons ranging from 20 000 to 530 000 cu.ft. (590 to 15 000 m^3)

While all the information presented in this manual has been compiled in good faith, and is believed to be accurate, no responsibility can be accepted for the consequences of any inaccuracies which it may contain, whether due to negligence or otherwise.

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CONTENTS

AMENDMENT LIST

Amendment No.	Description	Paragraphs	Date	Signature
1	Viva parachute lines	2.2.5	Jan 1993	

SECTION 1 — MAINTENANCE NOTES

1.1 GENERAL

The maintenance of a modern hot air balloon is relatively simple compared with other types of aircraft. Balloons constructed by Cameron Balloons Limited have a very high factor of structural safety and the fuel system and burner are simple and robust.

All servicing of these balloons can therefore be carried out by any person with a suitable mechanical or engineering background after a short course of training. Some repair work can be carried out by completely untrained labour.

In the U.S.A. all work on load bearing or fuel system parts must be made only by an F.A.A. approved repair station.

These notes set out the standards which should be observed in the maintenance of hot air balloons.

The inspection standards which determine the need for maintenance or repairs are laid down in Section 2.

1.2 FABRIC (excluding Load Tapes)

The treatment of fabric damage must be considered in two parts. The area below the first horizontal load tape above the top of the Nomex can be treated more casually than the fabric higher in the envelope.

1.2.1 Fabric below the First Horizontal Load Tape above the Nomex.

It is possible for the fabric in this region to be damaged by the flame during inflation, although this is infrequent with experienced pilots.

Provided that no damage has been done to the load tapes it is perfectly safe to fly the balloon with holes in this lower area of fabric.

Repairs can be carried out by any convenient method — this may be sewing, sticking, by adhesive tape — or by the more thorough methods below.

1.2.2 Fabric above the First Horizontal Load Tape.

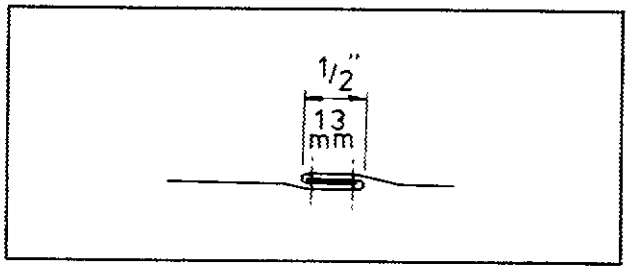
The fabric above the first horizontal load tape is an essential part of the balloon structure, and, if it is damaged, the balloon is not airworthy, and must be repaired according to the standards set out below.

1.2.3 Repair Techniques.

For all repairs a three strand, 210 denier, nylon or polyester thread should be used, and it should ideally have a contrasting colour to the work. A lockstitch sewing machine should be used with a sharp needle and a setting of 6 to 10 stitches per inch (3-4 per centimetre).

1.2.3.1 The Balloon Seam.

The seam used in manufacture is known as a balloon seam and is shown below in cross section.



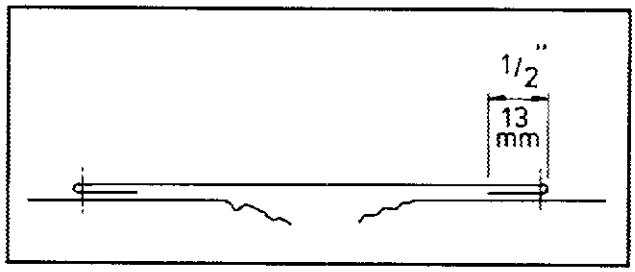
To produce this seam correctly, it is essential that the folded over edge of fabric is penetrated by both rows of stitching.

When whole panels of the balloon are to be replaced this type of seam must be used. If load tapes are present, they should be carefully unpicked, and sewn back again when the seaming is complete.

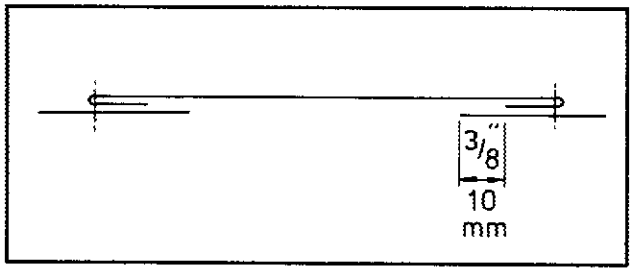
1.2.3.2 Sewn Patches.

Patches may be used to make repairs to panels and should be made as follows.

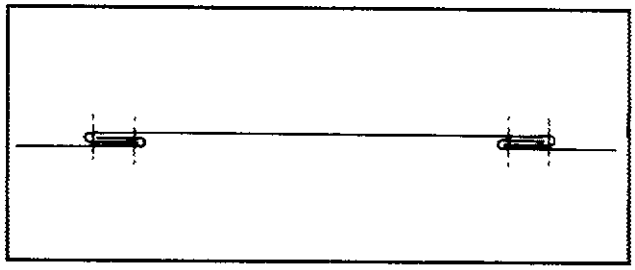
(i) Cut patch to shape, fold edges over 1/2 inch (13 mm) and sew to damaged area of balloon;



(ii) cut out damaged area from inside surface, leaving a further 3/8 inch (10 mm) excess as shown;



(iii) fold this excess under (making small cuts at corners) and sew like this.



This is the approved method of making patches. It will be noticed that the seams are not quite balloon seams as the outer row of stitches penetrates only three layers of fabric.

1.2.3.3 Adhesive Patches.

Adhesive patches may be used at any point on the balloon for very small holes, say under 1 inch (25 mm) diameter. A circular patch giving 1 inch (25 mm) clear overlap all around the damage, made from an identical material, may be attached using a contact adhesive (e.g. "Evo-Stik" or "Plio-Bond").

1.2.3.4 Adhesive Strip Repairs.

Adhesive strip repairs using the repair strip commercially available from sailmakers is acceptable provided the strip is at least 1.5 inches (38 mm.) wide and is oversewn with two lines of stitching each side of the tear.

1.3 LOAD TAPE REPAIRS

The load bearing tapes are an essential part of the balloon structure and the balloon is not airworthy if any of them are damaged.

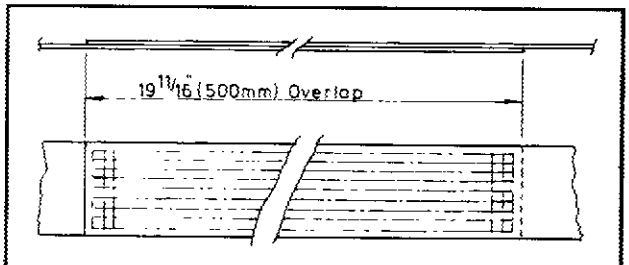
Load tape repairs should generally be made with tape of the same specification as the original, obtainable from Cameron dealers or direct from Cameron Balloons Limited. Tape ends should be singed with a flame to prevent fraying, and joints should generally be made to the same specification as existing joints subjected to the same load.

1.3.1 Vertical (Load-bearing) Tapes

Two types of tape are in general use:

25 mm (1 inch) tubular nylon, breaking load 1810 kg (4000 lb);
20 mm (3/4 inch) tubular nylon, breaking load 1020 kg (2250 lb).

The standard joint is 50 cm (20 inches) long, and consists of a number of parallel rows, with three rows of single or double needle stitching across each end.



1"(25mm) Flat Tape, 9 Rows, 3 Rows across each end.
3/4"(20mm) Tubular Tape, 8 Rows 3 Rows across each end.
1"(25mm) Tubular Tape, 14 Rows 3 Rows across each end.

If a tape is damaged near to one of its ends, it may be best to replace the section from the damage to the end. If the damage is in the middle a new section should be spliced in. To avoid excessive puncturing of the fabric, it is best to start making the splice on the tape alone, using just the last two rows of stitching to attach the repaired tape to the fabric.

1.3.2 Horizontal Tapes

25 mm (1 inch) flat nylon, breaking load 680 kg (1500 lb).
In normal balloon use these carry no permanent load, but act as rip-stoppers. The standard joint is 50 cm (20 inches) long with two rows of stitching, either backstitched at the ends, or continuing about 5 cm (2 inches) beyond the overlap.

1.4 RIGGING LINES

A distinction can be drawn between the deflation system, which is the only critical component of rigging, and anything else.

Damaged side vent or turning vent lines can be repaired with any comparable materials, retaining any existing colour coding. Crown line can be repaired with anything comfortable to hold.

The red parachute line, which has a fire-resistant kevlar core, is installed with a reserve length stored in a long loop at the fixed attachment point inside the envelope. If any shrinkage or burn damage close enough to the free end should occur the correct length can be restored by slackening the knot at the long loop and feeding the required amount from the loop into the line. If more length is needed, an extension can be added at the fixed attachment, but no knot should be more than 3 m (10 ft) from the attachment loop. The security of knots is of paramount importance. Cut off the burn-damaged section and tidy the end by pulling back the red covering 2-3 cm, cutting off the protruding kevlar core, and heat-sealing the red cover over the end.
A damaged parachute valve centralising or shroud line can be repaired by cutting out the damaged section and knotting in a length of new cord so that the total length is unchanged (compare with another cord between similar points). Knots should preferably be taped flat and smooth to prevent tangling.

The ripline of a velcro balloon is in two sections, divided at the point which is tied off at the bottom pulley. Most burn damage will happen to the lower section which can easily be replaced. It is important to use fire resistant kevlar-cored line for replacement.

1.5 SUSPENSION CABLES

1.5.1 Flying Wires.

If any of the envelope rigging wires is damaged it must be replaced. Unpick the protector and sewn turnback, thread on a new wire and protector assembly, and re-sew the turnback and protector. If swaging facilities are available the old wire can be removed by sawing or shearing between the thimble and ferrule (taking care not to damage the loop of the load tape) and replaced by a new wire which has only been finished at one end.

If any kevlar envelope flying rope is damaged it must be replaced. The end of the rope is looped through the turnback and back on itself so the old rope can be removed without any unpicking. The replacement rope is fitted in the same way.

1.5.2 Basket Wires.

A damaged basket wire may be repaired by swaging or splicing a new section of 6 mm, 6x19 stainless steel wire rope. The essential criterion is the full strength of the wire slings which pass down through the wall of the basket, across the floor, and up the opposite wall.

1.5.3 Swaging of Wire Ropes.

Swaging must be carried out only by a qualified and experienced person. The correct size of swage is critically important

to the strength of the joint and only wires and swages obtained from Cameron Balloons Limited must be used.

1.6 BURNER AND FUEL SYSTEM

1.6.1 Coil Unit.

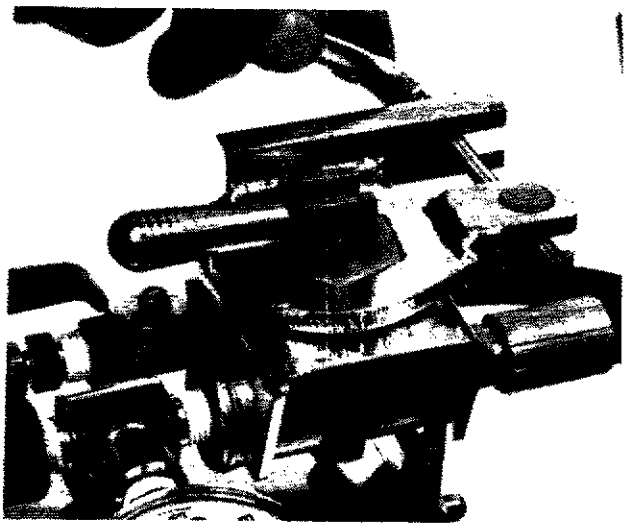
If the stainless steel burner coil is damaged, it should be returned to Cameron Balloons Limited for inspection and repair. If damage is suspected, the jets may be removed and replaced with blanking screws, and the system connected to a tank of propane and pressure tested. Any small leaks will then be visible, whereas they might escape notice when the burner is operating. On replacement, ensure that jets are fitted with a shake-proof washer and tightened to 1.7 kg.m (150 lb.in.).

1.6.2 Burner Components.

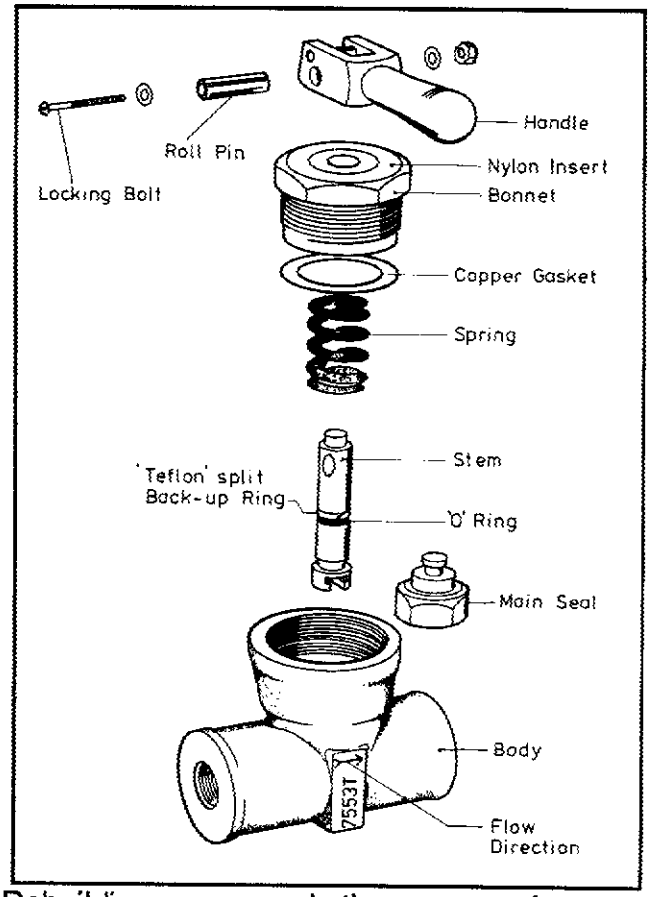
1.6.2.1 Rego 7553T.

The Rego blast valve may be overhauled by renewing the stem 'O' seal and/or the main seal in its housing. If damage has been caused to the bore of the bonnet, a new bonnet is needed.

To dismantle, first open the valve and, gripping the valve body securely to minimise stress on the tee-piece, just loosen the bonnet. A special tool is available to facilitate this operation. Close the valve, and cut off the rollpin locking bolt. Knock out the rollpin and remove the handle. Before unscrewing the bonnet remove any sharp edges around the hole in the stem, using fine emery cloth or a file, to prevent damage to the bore.



If renewing the stem 'O' seal, fit the new part manually without using tools which may damage the 'O' seal. The white Teflon split ring fits on the "handle" side of the 'O' seal.



Rebuilding sequence is the reverse of dismantling.

Lubricate the stem with a little (preferably low temperature) silicone grease.

Carefully refit the stem in the bonnet and refit the handle with rollpin and a new bolt (size M2.5x20 mm). Open the valve and screw the bonnet down onto the copper washer in the body.

The bonnet should be tightened (but not excessively) while gripping the body with a right-angled adjustable spanner (eg. King Dick type).

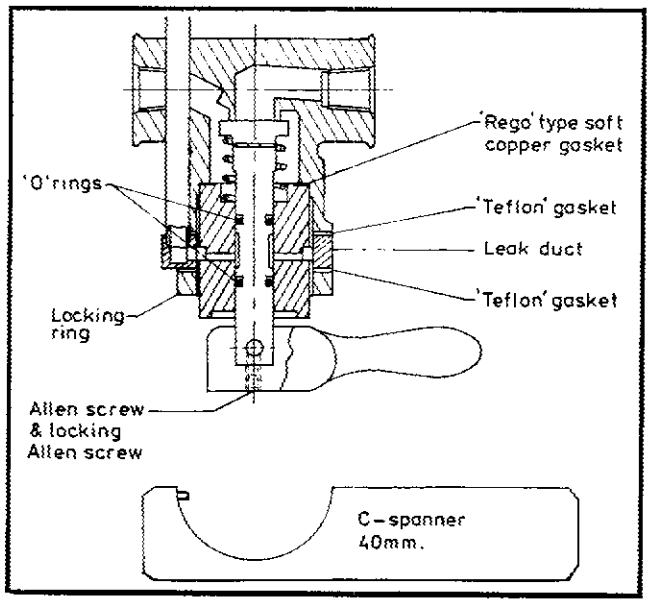
If a blast valve has been removed from the burner, note the direction of flow arrow when refitting.

The Rego 7901T valve is basically similar, but the 'O' ring is larger and is retained in a recess in the valve bonnet, and seals against a plain stem.

1.6.2.2 Bonanno-modified Rego 7553 Valve

To dismantle, open the valve, remove the locking ring with the special C-spanner and withdraw the leak duct. The bonnet can now be removed with an open spanner. The handle pivot screw is secured by two 'lock-nutted' Allen screws. Remove the first and slacken the second before unscrewing the pivot pin. Check the hole in the stem for sharp edges before withdrawing it from the bonnet.

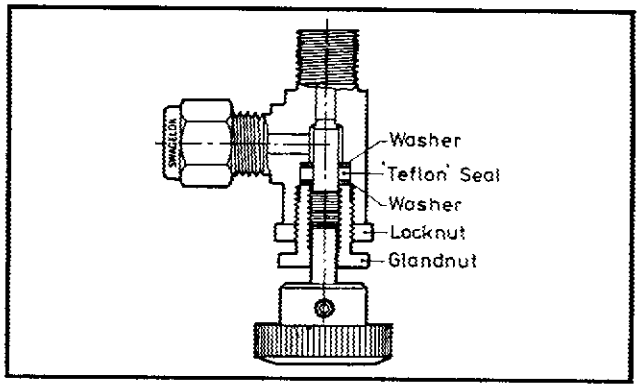
The 'O' rings should be lubricated with just the leak duct removed, using silicone spray (not grease) through the vent holes about every 20 hours. On reassembly, it is not necessary to tighten the locking ring greatly.



1.6.2.3 Nupro Needle Valve. (Whisper burner control on Mk4 & earlier burners)

The gland nut is secured with Loctite Stud Lock 270 to prevent inadvertent removal of the whole stem. If in use the stem loosens in the body, the gland nut should be removed and refitted with new Stud Lock 270. The gland nut controls the ease of valve operation and should not be overtightened. Tighten the lock nut when the correct feel is obtained.
The knob is fixed to the stem with Araldite as well as the grub screw, and should not be removed. (Earlier knobs were not glued).

If the valve will not shut off the flow completely, a replacement stem unit should be fitted.



1.6.2.4 Waverley Ball Valve.

(Mk 4 pilot light cut-off) (see also 1.6.3.3)

To remove, hold the valve body in one spanner and loosen the hose with another. Next, hold the nut at the other end of the valve and slacken the compression fitting. The valve can now be removed and unscrewed from the compression fitting. Note which end (relative to the handle) takes the compression fitting for correct reassembly to the burner.

1.6.2.5 Dynaquip Crossflow Valve.

(Mk 4 double burner)

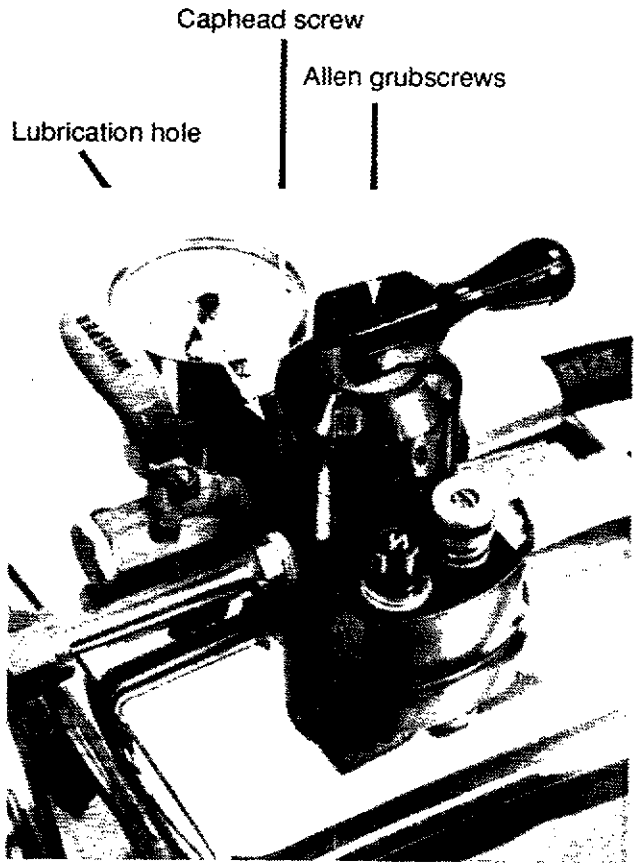
To remove the valve from the burner, slacken the adjacent compression fitting and remove the four screws which hold the burner unit in the handle. This gives clearance for the crossflow valve to be unscrewed from the burner unit once the valve handle has been removed. A refurbishing kit is available if time is more plentiful than the cost of a new valve. Refitting is the reverse of the removal.

1.6.2.6 Piezo-electric Igniter.

The electrode may be adjusted by slackening the screw clamp and moving it until the spark occurs correctly. If any component of the igniter is defective it must be replaced.

1.6.3 Bonanno Manifold (Mk 4 Super)

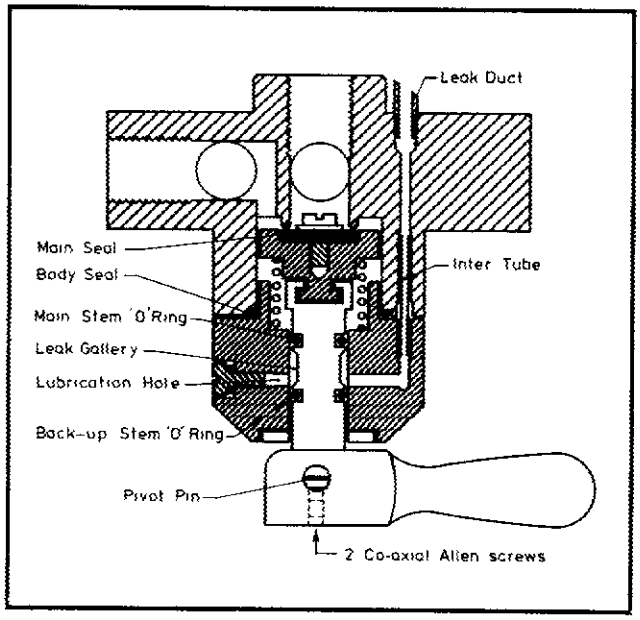
Silicone spray (not grease) should be sparingly applied to the lubrication hole after removing the blanking screw (approximately every 20 hours use).



1.6.3.1 Internal Seals.

To replace the stem 'O' seals, remove the four cap head screws and withdraw the bonnet. Next remove the first Allen grub screw from the handle pivot, and slacken the second. The handle can now be removed by unscrewing the pivot pin. Check that the pivot hole is free of sharp edges before withdrawing the stem.

New O-rings should be fitted with a little silicone grease after ensuring the stem is perfectly clean. The fitting should be done manually, without using tools which might damage the seal. The main stem O-ring must be worked past the back-up groove and leak gallery to reach its own groove.



The main seal is held in its carrier by a screw which is fixed with thread locking compound. If the seal face suffers damage, carefully grip the carrier and loosen the screw. (It is not necessary to remove the stem from the bonnet unless the carrier itself is to be replaced.) The seal is a flat disc, so simply reversing it should expose a new, serviceable face. The screw should be treated with thread locking compound (eg. Loctite 270) before replacement.

On reassembly of the valve, take care to locate the body seal in the groove in the body before offering up the bonnet, and orientate the bonnet so that the leak duct fits over the inter tube.

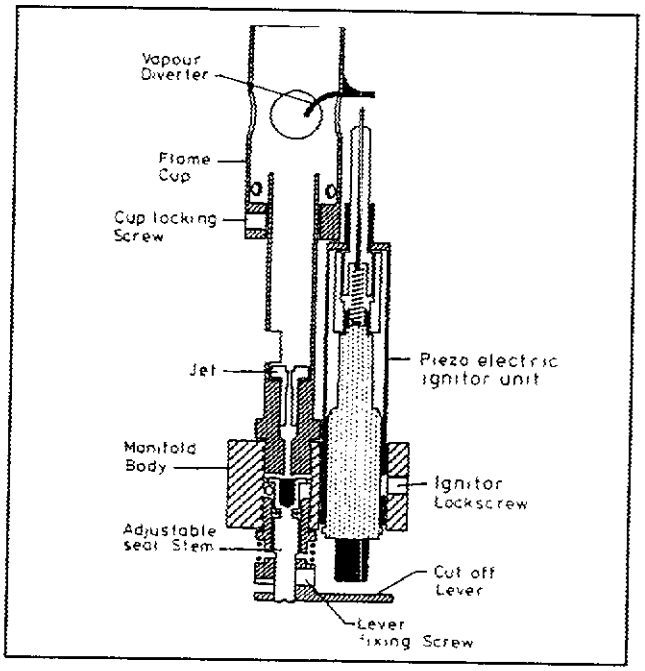
To remove the manifold from the burner, disconnect both hoses, and the compression fitting between the crossflow pipe and valve. Remove the piezo igniter and pilot light flame cup (see 1.6.3.2) and the end fitting from the whisper burner. Undo the compression fitting and the three

Allen screws inside the base of the can (it may be necessary to unscrew the leak duct, which has a slotted end, for access), and slacken the two bolts holding the can to the handle, so that the burner can be swivelled to free the crossflow pipe.

The manifold can now be removed.

1.6.3.2 Pilot Light and Piezo-electric Igniter.

If the pilot jet should become blocked, it can be unscrewed after the flame cup has been removed by loosening the cup locking screw.

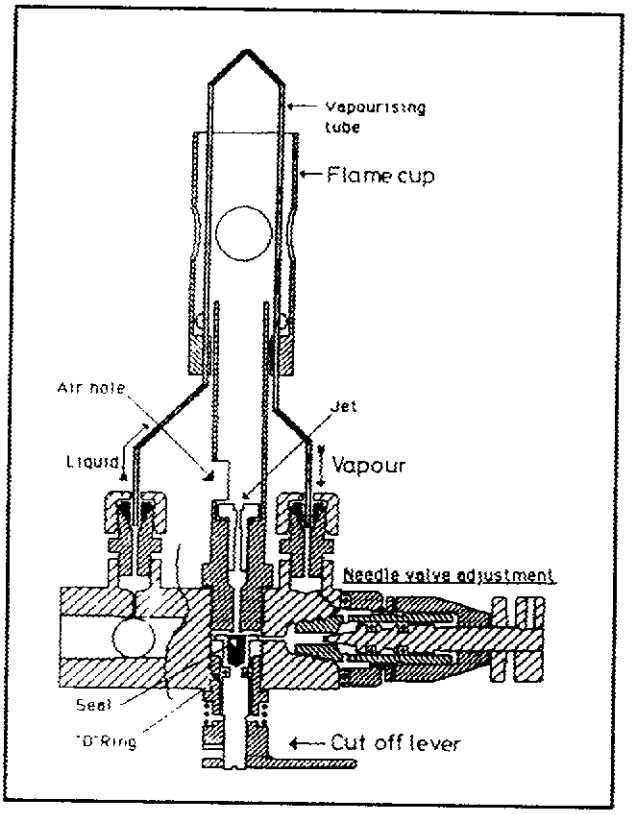


If the pilot light cutoff fails to function correctly, it can be adjusted by loosening the lever fixing screw, screwing the seal stem in or out until correct operation is achieved and re-tightening the fixing screw.

In the event of failure of the piezo igniter, loosen the igniter lockscrew and replace the unit complete. The lockscrew locates in a hole in the outer sleeve of the unit and should not be overtightened as this can jam the button. The spark gap is set by locating the flame cup in contact with the shoulder of the igniter unit, and the flame cup may need adjustment to achieve this, taking care that the vapour diverter is positioned directly over the piezo electrode.

Liquid-feed Pilot Light

To dismantle, the flame cup is removed first, and then the vaporising tube.
There are no further additional maintenance or inspection instructions.



1.6.3.3 Whisper Burner.

The whisper burner is controlled by a Waverley ball valve. If this part needs renewal, the manifold must be removed from the burner (see 1.6.3.1). Note that these valves are 'handed' by the operation of the lever.

To cure a leak at the handle, remove the Nyloc nut, add a drop of Nutlock, and re-tighten the nut.

1.6.3.4 Crossflow Valve.

To remove this valve, undo the adjacent compression fittings and slacken the bolts holding one burner unit to the handle. Clearance can now be obtained to enable replacement of the valve.

1.6.3.5 Pressure Gauge.

Replacement lenses can be fitted in situ. To replace the gauge it is necessary to remove the manifold from the burner (see 1.6.3.1). It is important that the gauge stem incorporates a flow restrictor in case of breakage as the gauge is always 'live' to tank pressure.

1.6.4 Hoses

If any section of fuel hose is damaged it should be unscrewed from the adjacent parts and a replacement obtained from Cameron Balloons.

PTFE tape or sealing compound must be used when re-assembling the threaded end fittings.

1.6.4.1 Self-Sealing Couplings

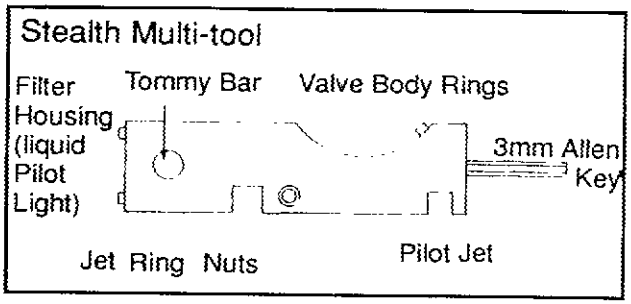
There are no repairable parts in these couplings. If a fault develops the coupling should be replaced. A regular, light application of silicone spray to the threads is the only maintenance action required.

1.6.5 Electric Burner Valve

A fully charged battery should last for about 8-10 hours of normal operation. The battery should not be left completely discharged. Full charging time is about 10 hours, and full charge is indicated by illumination of the LED on the charger. The battery should give 14.5 V when fully charged.

In the event of any other problem, please refer to your dealer, or Cameron Balloons Ltd. direct.

1.6.6 Stealth/Mark 5 Burner



Silicone spray (not grease) should be sparingly applied to the lubrication hole after removing the blanking screw in the blast valve body in the same position as the Mk4 Super (approximately every 20 hours of use).

1.6.6.1 Stealth Internal Seals

To replace the stem 'O' seals remove the body of the valve from the manifold as follows:-

1. Remove lower ring using 'C' spanner (Multi-tool); this also releases the cross bar assembly. Note position of components to facilitate re-assembly.

2. Remove blast valve handle by pushing out dowel.

3. Remove second part of valve body using 'C' spanner.

4. Withdraw the valve stem and replace 'O' rings (see 1.6.3.1).

The main seal can be replaced as described in 1.6.3.1. If the Stealth manifold assembly has a cross bar the valve stem and seal carrier will be a one piece assembly. If the manifold has revolving toggle handles the main seal is held in a carrier as described in 1.6.3.1.

1.6.6.2 Stealth Pilot Light and Piezo Electric Igniter.

If the pilot light becomes blocked, loosen the grub screw (3mm Allen key) in the side of the gold-coloured body and remove the body. The jet can now be removed (Multi-tool), cleaned and the whole reassembled. Make sure the tag at the side of the flame cup is directly over the piezo electrode.

If the pilot light cut off fails to function

See supplement 3.4

3.4.3

If the piezo igniter fails, loosen the locking grub screw (3mm Allen key) in the side of the manifold block and withdraw the igniter through the block. Insert a replacement igniter and carefully tighten the lockscrew in the recess on the side of the body. Correct location sets the spark gap. Do not over-tighten the lockscrew or it may jam the action of the button.

1.6.6.3 Stealth Whisper Valve

The whisper valve should be lubricated occasionally (approximately every 20 hours of use). To lubricate the valve the grub screw in the centre of the stem should be removed (2.5mm Allen key),silicone grease should be squeezed into the hole and the grub screw replaced and tightened fully. The action of tightening the grub screw forces grease into the space between the two 'O' rings on the valve stem.

If the valve fails to turn on/off satisfactorily, it can be adjusted as follows:

See supplement 3.4

3.4.2

1.6.6.4 Stealth Jet Ring

Reduced burner power may be caused by contaminated fuel causing jet blockage. The jet ring may be partially disassembled for cleaning by unscrewing the six brass nutes (Multi-tool) retaining the inner ring. The inner ring and two jet foils can now be lifted clear to allow cleaning. Complete removal is not possible because of the central column and foils should be handled carefully. After cleaning, re-assemble in reverse order, taking care to tighten the brass nuts evenly.

1.6.6.5 Pressure Gauge (Stealth Burner)

To replace the glass, or the whole gauge, slacken off the compression fitting connecting the 3mm stainless steel tube to the pressure gauge. Unscrew the two nuts retaining the pressure gauge in the burner can. If the gauge is to be replaced remove the plastic backing plate from the new gauge and discard it. Replace this plate with the stainless steel plate from the faulty gauge and reassembly in reverse order.

1.7 FUEL TANKS

Damage to an upper or lower guard ring can be tolerated as long as it has not affected the tank body and the necessary protection is still provided, and distortion can be straightened out on the same basis.

Otherwise maintenance and repair action is limited to the tank fittings, which are common to Worthington aluminium and Cameron stainless steel tanks. Before removing any fitting which screws into the tank itself, it must be completely emptied of liquid propane and vented to atmospheric pressure in safe outdoor surroundings.

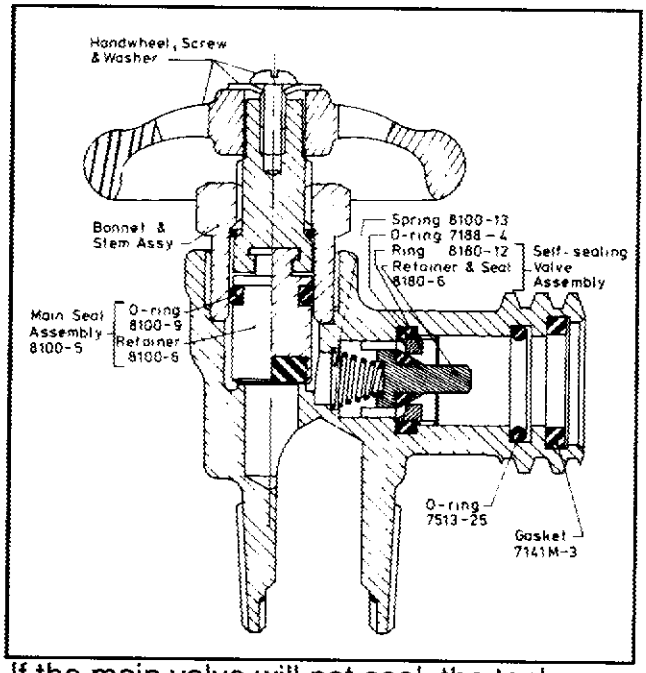
1.7.1 Liquid Withdrawal Valve.

Normal maintenance consists of an occasional light application of silicone spray to the threads and outlet.

If the outlet fails to seal against the hose end connector, the outlet O-ring should be changed, and probably the square section gasket as well.

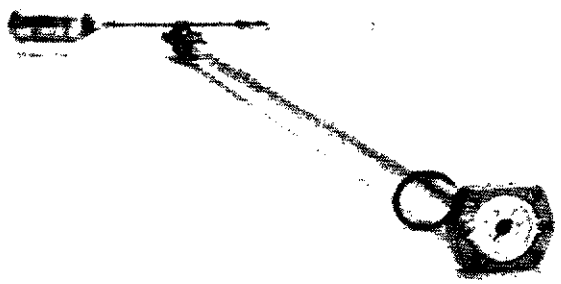
If the self-sealing valve fails to seal even after it has been "popped" a few times, it is advisable to fit a replacement centrebody (although this is not mandatory as some older valves were deliberately modified to have a slight leak). A special 'cutaway screwdriver' is available to ease replacement. With the valve closed, it is not necessary to empty the tank to change the self-sealing valve.

(Rego 8180 shown - BMV 344 is similar in principle)



If the main valve will not seal, the tank must be drained (see 1.7) although the bonnet and stem can be removed after unscrewing the handle without removing the valve from the tank. When reassembling, the handwheel screw should be treated with thread locking compound.

1.7.2 Contents Indicator.



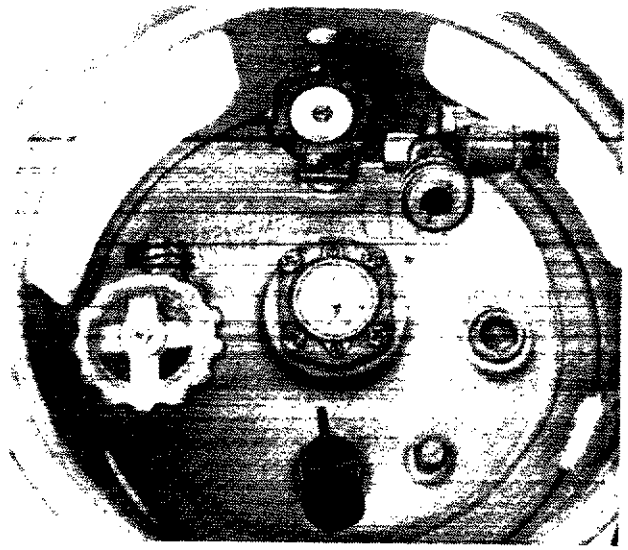
The dial is an independent part, activated by magnetism from inside the tank. If the needle sticks, first loosen the two screws which hold the dial and check if freedom of movement is restored. If so, the trouble lies inside, and the tank must be emptied (see 1.7). When the tank is empty, remove the four screws of the float gauge and withdraw the gauge.

1.7.3 Vapour Valve (901 P5H).

If this valve fails to seal the stem can be changed in situ after emptying the tank (see 1.7). Note that the bonnet has a left hand thread. Treat the handwheel screw with thread locking compound when refitting.

1.7.4 Regulator and Quick-Release Socket.

To adjust the pilot flame, slacken the locknut and screw the handscrew in or out until the flame is firm, but not tending to lift off the cup. The ear soon gets used to the sound of a normal pilot flame. Set the screw with the locknut (finger-tight).



To dismantle the regulator, first disconnect it from the vapour valve. With a metal point prise out the lead seal in one of the screw recesses, and undo the three screws. Trap the diaphragm against the body with a finger, and unscrew the spindle. The diaphragm is the only replaceable component.

The Dynaquip quick-release socket should be lightly sprayed with silicone from time to time. In the event of any unserviceability, it should be replaced.

1.8 BASKETS (Basket wires — see 1.5.2)

An aluminium U-tube which is bent out of

shape may be restored to the correct shape by controlled application of a steady force (eg jacking, or pushing with a motor vehicle against a suitable restraint).

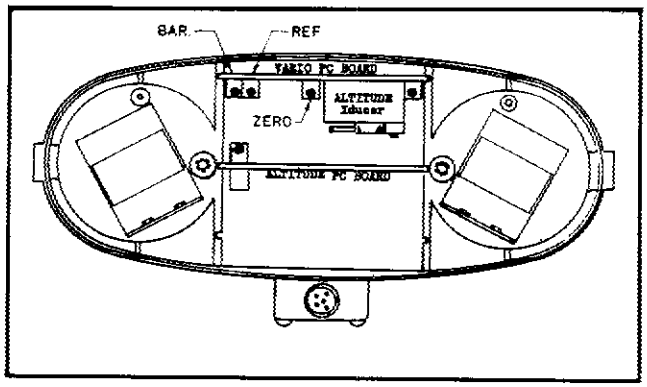
A broken floor batten may be replaced with commercial timber; the original material is either ash or beech. Knotty timbers should not be used. The throughbolts are peened over the nuts, and so not normally reusable. Take care that the finished nut does not protrude significantly above the inner batten, as there have been cases of damage to the base of a fuel tank.

If a basket becomes caked with mud, it can be emptied and cleaned with a pressure hose, provided the top edge padding is not wetted. It should be gently dried without delay.

1.9 INSTRUMENTS

Apart from fitting new batteries (see Flight Manual, para. 1.5.1) when necessary, the only actions advisable on the Ball 655 are to reset the barometric pressure/altitude relationship should this prove to be incorrect, and to adjust the zero position of the variometer needle.

Use a well-calibrated sensitive aircraft altimeter to obtain readings of altitude for 980 and 1050 mbar (or 29" and 31" Hg). Remove the back of the Ball 655; the adjusters are labelled BAR and REF.



Set the altimeter to the calibration altitude for 980 mbar and switch to the barometric pressure reading on the 655. If it does not read 980, adjust the REF potentiometer until it does.

Switch back to altitude and set the calibration reading for 1050 mbar. Back on pressure the reading should be 1050; if not, use the BAR potentiometer to make it read 1050.

Switch back to ALT, reset the 980 mbar altitude, and repeat the sequence until the instrument is adjusted.

The variometer null position is adjusted by means of the ZERO potentiometer. Other adjustments or repairs are best left to the official agents:

A E Supplies
Slates Farm
Glentham
Lincs LN2 3AW
UNITED KINGDOM.
Tel. 067 37334

Ingenieurburo Werner Ackermann
Am Lohnberg 15
D-6109 Muhltal/Nd. -Ramstadt
Germany
Tel. 061 51/148093 Fax. 061 51/144247

or, of course, the makers:

Ball Variometers Inc
4747 Pearl Street
Boulder
Colorado 80301
UNITED STATES OF AMERICA
Tel. 303 449 2135

1.10 LOGBOOK ENTRIES

Every time work or an inspection is carried out on the balloon, whether by a qualified inspector or not, an entry should be made in the logbook. It should comprise the date, brief details of what was done, and signature and identification of the person responsible for the work.

1.11 ADVISORY SERVICE

If in doubt about any maintenance question, do not hesitate to consult Cameron Balloons Limited. Advice is always available, free of any charge.

SECTION 2 - INSPECTIONS

2.1 QUALIFICATION

This inspection is the minimum required for annual/100 hour renewal of the UK Certificate of Airworthiness. Validity of the C of A is subject to the log book having a BBAC inspection certificate (IR4) less than one year old and the balloon having fewer than 100 hours since the date of that inspection. Some countries require variations to take account of differing national requirements (eg. obligatory instruments).

Inspections for official purposes must be carried out by suitably qualified inspectors - in the UK, a BBAC category 1, 2 or 3, or for validating repairs, category 5.

In some countries regulations require officials experienced in aeroplanes, but not in balloons, to carry out the annual inspection. Where this happens, it is strongly recommended that the owner should also carry out this inspection for himself.

Short training courses in balloon inspection are available at the factory.

2.2 SCHEDULE OF INSPECTION, ISSUE 7

2.2.1 Logbook.

- ❑ Present at time of inspection.
- ❑ Conforms to requirement (UK - CAP 398, CAP 408, CAP 27 or Cameron Balloons Flight & Maintenance Log).
- ❑ Examine log for maintenance entries, number of hours, flights and tethers and modifications since last inspection. Verify as far as possible that all entries are correct and up to date.

After inspection

- ✍ Complete form IR4 in accordance with the notes thereon. If repair is needed and can be carried out within 30 days, leave the IR4 sheets together after signing, for the repairs to be signed off on completion.

2.2.2 Envelope.

- ❑ Temperature link in place (tape 2, near top).
- ❑ Tempilabel - add new label alongside if overheating (over 120°C) indicated (tape 3, near top).
- ❑ Stitching of vertical load tapes at crown ring, at free ring tapes over the parachute aperture, and at the top edge tape secure.
- ❑ Top pulley free, but no axle wear, and shroud and centralising cords undamaged.
- ❑ Length of centralising lines (see 2.2.5).
- ❑ Long loop tapes on parachute (to beyond velcro tabs).
- ❑ Condition of fabric at parachute outer edge.
- ❑ Reinforcing tape one panel above and below centre-gore loops in envelope.
- ❑ If envelope has over 250 hours, or fabric seems suspect or is known to have been overheated, perform grab test (see 2.2.7) near top on original fabric. Test each colour.
- ❑ Try to blow through fabric. If substantial porosity is suspected, perform a flight test (see 2.2.8).

Velcro rips:

- ❑ Visual appearance and performance of velcro.
- ❑ Condition of fabric adjacent to velcro.
- ❑ Length of free load tapes (see 2.2.6).
- ❑ Riplocks installed/condition.
  (triangular velcro rips - replace velcro every 100 hours. Contact Cameron Balloons).
- ❑ Side vent - check panel tape grid, shock cord, line stop (Mod 11), pulley free.

- ❑ Lock top - check security of rings, witness flag, condition of arming line.
- ❑ Turning vents - check stitching, tapes, line and pulley.
- ❑ Check bottom rigging loops for chafing or heat damage, and protectors in place.
- ❑ Check bottom ripline pulley free, and parachute line fixed attachment secure.

- ❑ Control lines undamaged.
- ❑ Cable-cored lower ripline - red tubular tape cover securely stitched, especially at top.
- ❑ Kevlar flying cables — no visible burn damage (slight stiffening of the rope assembly is acceptable). If there is any break in the outer cover the assembly must be replaced.
- ❑ Flying wires — must be stainless steel, no broken strands, thimbles and ferrules good, no annealing (brown appearance and loss of spring on bending).
- ❑ Inspect for holes, tears or abrasions, either panel-by-panel or by an inflation test. Special shaped balloons must be inflated. Small holes or low quality repairs are acceptable below the first horizontal tape above the nomex, but all other damage must have been repaired using approved methods.

2.2.3 Burner and Basket (structural).

Karabiners :

- ❑ Correct type (aluminium 2000kg not approved over 84000 cu.ft.). Free from distortion, hinges lubricated, screwgates working.

Load Frame:

- ❑ Security of welds, any sign of fracture, especially if bending damage has occurred at any time, no bending apparent.
- ❑ Pivots correct tightness, no nuts missing.
- ❑ Shackles - no distortion, locknuts (Mod 10) fitted.

Burner:

- ❑ No externally visible damage.

Hoses:

- ❑ Look and feel end-to-end for damage or distortion.

Nylon Rods:

- ❑ These are not load-bearing, but should be checked generally for length relative to wires, freedom from fractures, condition of sockets and end fittings.

Basket Wires:

- ❑ No broken strands, thimbles and ferrules good.

Basket:

- ❑ No excessive damage to weave, especially in base.
- ❑ No excessive dryness, dampness or fungal attack.
- ❑ No breaks or major cracks in battens, inside or out.
- ❑ Metal frame - no significant cracks or distortion visible.
- ❑ Protective hide at bottom edge substantially undamaged.
- ❑ Internal handles serviceable.
- ❑ (Paying passenger balloons) Fire extinguisher serviceable according to maker's information.
- ❑ Tank straps undamaged, buckles functioning.

Tanks:

- ❑ Check correct numbers entered in logbook.

- ❑ Check correct orientation labels for type of tank
- ❑ Check for external damage, including base.
- ❑ Internal inspection is required after 10 years and thereafter every 5 years, or if damage is suspected. Date of manufacture is stamped on the guard ring. As this requires an empty tank, which would prevent the functional check, it is recommended that this inspection be carried out in advance and entered in the logbook.

2.2.4 Burner and Fuel System (functional test).

- ❑ Dual fuel system (Mod 6) incorporated.
- ❑ Burner jets secure.
- ❑ Check blast valves for sign of wear or leakage.
- ❑ All connections and joints secure and leak-proof.
- ❑ Pilot light(s) — check by appearance and sound of flame.
- ❑ Carry out burner test on each tank, observe function of burner jets, pressure gauge(s), all burner valves and tank valves.
- ❑ Check for leaks, particularly at blast valve stems. (Note : tanks must be vertical to test dip tubes).
- ❑ Check self-seal on tank valves. It is not a requirement that these are a perfect seal on 8180 valves; in fact some older valves are deliberately modified so that they have a slight leak.
- ❑ Check freedom of movement of tank contents gauges.

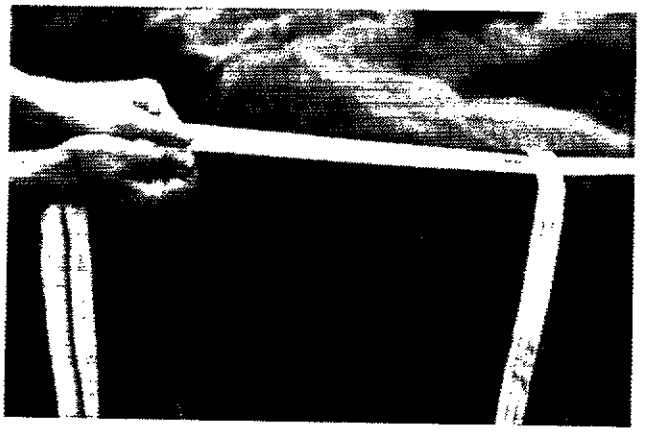
2.2.5 Parachute Centralising Lines.

(If fuel consumption is normal, and the parachute appears normal when inflated, there is no need to check line lengths).

1) Cords along vertical tapes :

have one person hold the load tape just below the parachute attachment loop. Hold the free load tape just above the envelope top edge in one hand, and the parachute in the other, both pulled just taut. The velcro tab on the parachute (measuring between corresponding edges) should lie **nearer** the crown ring by the following distances:

N-type	1 cm ± 2 cm
A-type (cushionseal)	27 cm ± 2 cm
(flat)	14 cm ± 2 cm
O-type (cushionseal)	27 cm ± 2 cm
(flat)	8 cm ± 2 cm
V-type	10 cm ± 2 cm
V-type (after July 1990)	16cm ± 2cm



2) Centre-gore cords (Viva only):
hold the centre of the gore as described above.

Pre-1980 balloons: overlap from top edge tape to loop at parachute edge - 63cm ± 6cm.

1980-1986: D-shaped panel added at top of gore. Distance measured as above should be107cm ± 6cm.

1986-July 1990: use centre-gore velcros to check overlap. The parachute velcro lies inside the envelope, 48cm ± 6cm from the velcro at the top edge tape.

After July 1990: parachute tab lies outside envelope, 12cm ± 2cm from top edge velcro.

2.2.6 Crown Tape Dimensions — Velcro Rips.

✍ Mark the centre point of the circular patch in the centre of the ripping panel.

✍ From this point, in the direction of each load tape mark out the radius "R", using the appropriate value from the table.

	R	
O-31	8"	20 cm
O-42	8.5"	22 cm
O-56	9.5"	24 cm
O-65	11"	28 cm
O-77	12"	30 cm
O-84	12"	30 cm
O-105	13"	33 cm
O-120	13"	33 cm
O-160	14.5"	37 cm
A-105	13"	33 cm
A-120	13"	33 cm
A-140	14.5"	37 cm
A-160	14"	36 cm
A-180	13"	33 cm
A-210	14"	36 cm
A-250	14"	36 cm
A-300	14"	36 cm

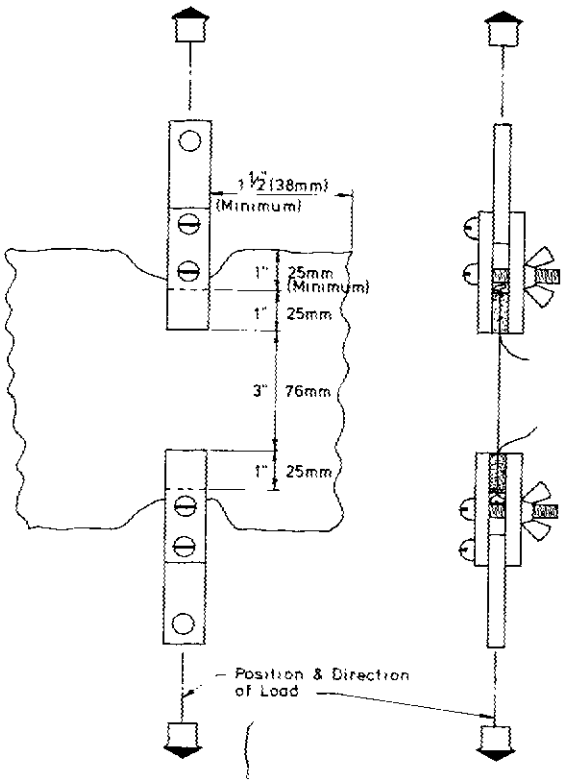
✍ These points should be permanently marked with a felt tip pen or other means.

With the velcro correctly in place ask an assistant to hold each load tape on the balloon side of the velcro. Ensure that it is not held at the velcro in a manner which distorts the relative lengths of the panel and the free load tapes.

Hold the free load tape and the panel straight together, with no slack, but no excessive tension. The inside edge of the metal crown ring should match the radius mark made in para. 2. Repeat for each load tape.

If the free load tape is too long by more than 10% of "R", it must be unstitched and resewn. Free load tapes which are too short represent no danger, although amounts greater than, say, 0.5 "R" would merit investigation.

2.2.7 Grab Test.



The fabric must be gripped with the jaw edges aligned so that the same fibres are being pulled from each end. The clamps should be tightened so that the fabric does not move in the jaws.

If the fabric withstands a 30 lb (13.6 kg) pull, it is fully airworthy.

If it fails between 21 lb (9.5 kg) and 30 lb it may be passed as airworthy within the following limitations:
(i) Max loading 14 lb/1000 cu.ft.
(ii) Not to fly in turbulence
(iii) Grab test to be repeated every 50 operating hours, or annually, whichever is the more frequent.

If it fails below 21 lb (9.5kg), all the weak fabric must be replaced and the envelope reinspected before renewal of the C of A.

2.2.8 Flight Test.

Flight tests must be conducted only with careful measurement. Experience has shown that it is a complete waste of time to try to subjectively estimate flying qualities from the pilot's impression of control response. Differences large enough to be noticed are easily found simply by looking at and blowing through the fabric.

A flight test should be made in stable air conditions, at a precisely known weight near to the permitted maximum. Inflation and all preheating should be made from an external tank, and the time to consume a complete tank in flight immediately after take-off should be found.

The data required are:
- all-up weight of balloon at lift-off
- all-up weight at end of first tank
- weight of test tank (full)
- weight of test tank (empty)
- time to consume test tank
- outside air temperature.

From this, a rate of fuel consumption can be calculated, and compared to the average of the two all-up weights.

2.2.9 Instruments (not required for C of A in UK).

Although instruments are not mandatory in the UK, it is obviously important, if they are being used, that they be serviceable.

Note: Never blow or suck at the static pressure inlet of any flight instrument.

Altimeter:
Set the altimeter to the current barometric pressure. If the altitude registered is within 50 ft (15 m) of the actual altitude there is no need to calibrate it (if a Ball 655 - see 1.9) or send it away for adjustment (if mechanical).

Variometer:
The Ball 655 and Ball 502 have no user-applicable means of calibration. For a Ball 400, with the variometer off, zero the needle using the knob in the centre of the face. Switch on to high gain, and re-zero with the red adjustor on the back.

Aeroplane rate-of-climb meter:
Has no user adjustment.

Thermistor:
Check by using ice water or a comparison reading of ambient temperature, and boiling water (note variation of boiling point with altitude). To avoid direct immersion, use a plastic bag or toy balloon to contain the sensor.

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3.1 THE REGULATED LIQUID PILOT LIGHT.

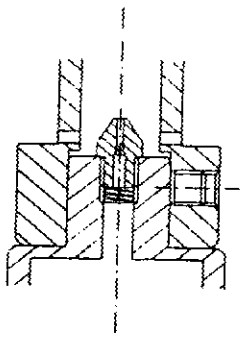
3.1.1 General description.

The Regulated Liquid Pilot light is fitted to Super Shadow and the Stealth burners. The pilot light cup fits above a pressure regulator mounted on top of the Bonanno manifold block. The regulator automatically maintains a constant pilot light flame size regardless of fuel pressure. There are two standards of regulator in service at the present time :-

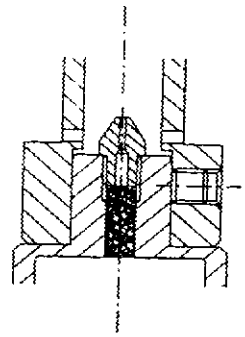
1) Early type. These regulators have no filter other than the inlet filter.

2) Late type. These regulators have an additional filter located underneath the pilot light jet. This increases reliability and reduces the need for Maintenance.

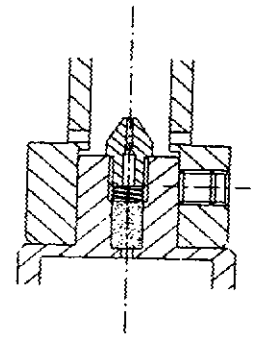
In addition to these two new production standards, a retrofit wire filter is available for the early type regulator.



Non-Filtered Regulator



Wire-Filtered Regulator retrofit only.



Current Standard Sintered Filter

A vapour pilot light is available as an option.

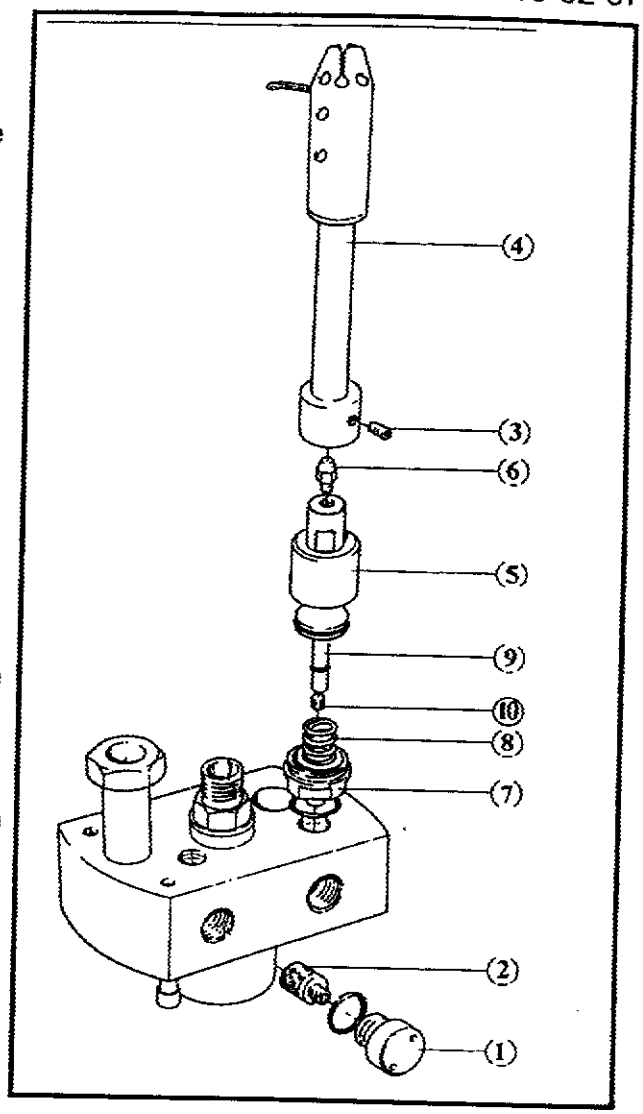
3.1.2. Maintenance Instructions.

Any contamination of the liquid pilot light system usually manifests itself as a progressive reduction in pilot flame size. If the flame size decreases then the regulator and jet should be dismantled and cleaned before the next flight, rather than waiting for total failure.

It is essential that any burner maintenance is carried out in clean conditions as the presence of dirt may impair the function of the seals or cause blockage of the jets.

3.1.2.1 Removal of the Inlet Filter.

The liquid propane is filtered by a replaceable filter before passing into the pilot light regulator. The filter can be reached by unscrewing filter housing (1) from the side of the block using the stealth multi-tool. The filter (2) can then be removed and inspected. If contamination is suspected the filter should be replaced.



3.1.2.2 Stripping and cleaning of the regulator unit.

To clean the regulator assembly and jet proceed as follows.

1. Loosen the grub screw (3) in the side if the pilot light body (4) and remove the pilot light body.

2. Unscrew the regulator upper body (5) using a 12mm spanner on the flats just below the jet (6). This will either separate the regulator upper body from its lower half (7) or remove the entire regulator body from the manifold block.

3. Unscrew the regulator upper body from its lower half (if necessary) and remove the spring (8) and piston assembly (9).

4. Remove the jet (6) using the Stealth multi-tool. Invert the regulator body and remove the filter and spring. Inspect the jet for any sign of blockage and replace or clean (if no replacement available). The filter should replaced. See Note 1.

5. Carefully clean the inside of the regulator and the piston assembly using a soft lint free cloth and silicone spray. If the regulator housing and / or piston are heavily soiled, the following generic cleaners may be used:-

   i) Chlorinated solvents e.g. trichlorethylene (ICI "Triklone").

   ii) Hydro Carbon solvents eg. petroleum fractions, or citrus based oil.

   iii) Aqueous based detergents.

5. (Cont'd)

NOTE

The 'O' rings and rubber seal must be removed prior to the application of any of these cleaners. The piston / regulator body must be dried thoroughly before reassembly. Inspect the "O" rings for wear and damage and replace if necessary.

6. Check that the rubber seal (10) on the end of the piston does not project more than 0.5mm below the metal housing. If the seal should project excessively it should be pushed back into its housing. If it still projects by more than 0.5 mm the excess may be trimmed off with a sharp knife.

7. Lubricate lightly with silicone spray DO NOT GREASE and reassemble in reverse order.

   Take care to keep the regulator assembly clean of any contamination as the jet is small and easily blocked.

8. Test run the pilot light system when completed.

3.1.2.3 Stripping and cleaning of the pilot light jet only.

To clean the pilot light jet proceed as follows.

1. Loosen the grub screw (3) in the side of the pilot light body (4) and remove the pilot light body.

2. Unscrew the pilot light jet using the Stealth multi-tool.

3. Inspect the jet for any sign of blockage and replace or clean (if no replacement is available). See Note 1.

4. Replace the filter if fitted.

Note 1.

I) It is always preferable to replace jets and filters rather than clean them.

ii) Earlier burners will not have spring and filter.

iii) Installation of the retrofit filters must be carried out in accordance with CBL/TN/JD/1016.

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3.2 THE SINGLE SHADOW & SINGLE STEALTH BURNER. MAINTENANCE INSTRUCTIONS.

The manifold should be maintained as described in supplement 3.1 and section 1.6.6 of the Maintenance Manual EXCEPT for replacement of the main seals.

3.2.1 Replacement of Main Seals.

To replace the stem "O" seals remove the body of the valve from the manifold as follows:-

1. The handle retaining rings should be removed by inserting a pin punch with the end ground round into the spanner recesses and tapping gently with a small hammer. This will release the handle assembly. Note the position of the components to facilitate re-assembly.

2. Remove the blast valve handle by pushing out the dowel.

3. Remove the main part of the valve body using a "C" spanner (Stealth Multi-tool) or pin punch and hammer.

4. Withdraw the valve stem & replace the "O"-rings and/or main seal (See 1.6.3.1 of the Maintenance Manual)

5. Re-assemble and test run the burner.

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3.3 GRAB TEST

The grab test instructions as pre section 2.2.7 of the maintenance manual should be maintained EXCEPT the following paragraph should be added:

3.3.1 GrabTest of Parachute Edge.

If the fabric of the Parachute overlap (between the Velcro Tabs and the edge of the parachute) withstands a 21 lb (9.5 kg) pull is full airworthy.

Supplement to Maintenance Manual Issue 7

3.4 The Stealth / Shadow Burner lubrication and Valve Adjustment.

3.4.1 Regular Maintenance.

The main blast valve and the whisper valve should be lubricated after each 20 hours of flight.

The valve maybe lubricated with Cameron KSP125 (recommended) or silicone grease.

Lubrication of main blast valve seals.

Remove the blast valve lubrication screw.

Squeeze Cameron KSP125 or silicone grease into the lubrication hole. The recommended quantity is approximately 0.5 ml.

Ensure that the O-ring is still present and replace the lubrication screw. This will squeeze the grease into the gap between the main O-rings.

Clean off excess grease.

Lubrication of whisper valve.

Use a 2.5 mm Allen key to remove the lubrication blank in the centre of the whisper valve stem.

Squeeze Cameron KSP125 or silicone grease into the lubrication hole.

Replace the lubrication blank.

Clean off excess grease.

3.4.2 Adjustment of Whisper Valve

If the whisper valve fails to shut off satisfactorily then it can be adjusted as follows:-

Turn the whisper valve to the **open** position.

Remove the grub screw from the side of the black lower cam (3 mm Allen key). The threaded stem has four flats, one of which can be seen through the grubscrew hole.

Using a large screwdriver (8 mm blade) turn the stem of the whisper valve ¼ turn clockwise (in) to adjust the action of the valve.

One of the flats in the valve stem should now be lined up with the grubscrew hole.

3.4.2 Adjustment of Whisper Valve (cont'd)

Replace and tighten the grubscrew.

Check action of the whisper valve and repeat the procedure if necessary.

Note:- the whisper handle should move through approximately 15° before the valve opens.

Note:- adjusting the valve action with the valve in the closed position may damage the valve.

3.4.3 Adjustment of Pilot Light Valve

If the Pilot Light valve fails to shut off satisfactorily then it can be adjusted as follows:-

Turn the Pilot Light valve to the **open** position.

Loosen the valve handle (5 mm Allen key)

Using a large screwdriver (8 mm blade) turn the stem of the valve ½ turn clockwise (in) to adjust the action of the valve.

One of the flats in the valve stem should now be lined up with the valve handle.

Tighten the valve handle.

Check the action of the pilot light valve and repeat the procedure if necessary.

Note:- adjusting the valve action with the valve in the closed position may damage the valve.