RESTRICTED

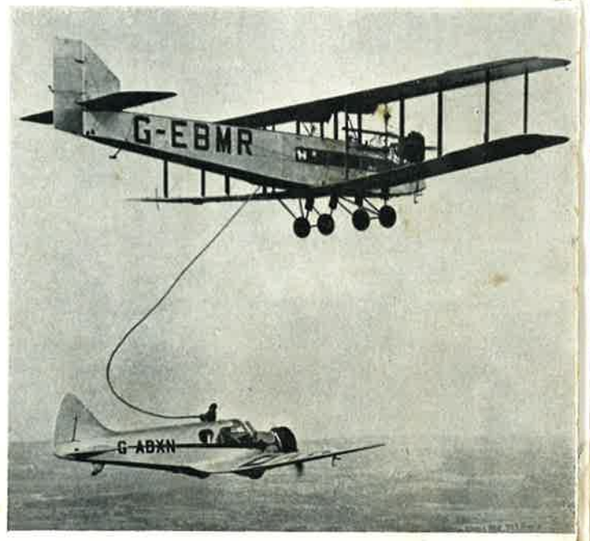
Contents

Cover Picture

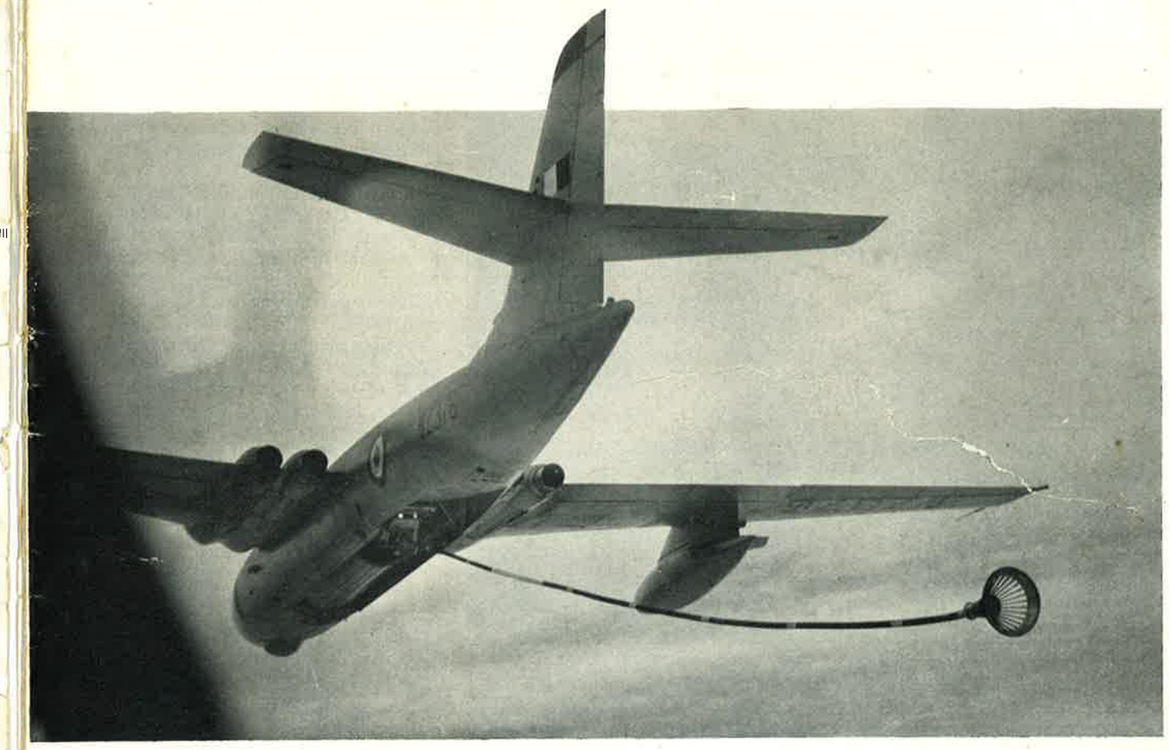
One of the 'founder' aircraft of the recently formed Battle of Britain Flight, Spitfire PS.853, in formation over Kentish cloud with a Hunter 5 of No. 41 Squadron. The Spitfire, a Mk 19, was one of the three that were formerly used by the Woodvale met flight. When this picture was taken both aircraft were based at Biggin Hill. Since then, however, the Battle of Britain Flight – two Spitfire 16s, one Spitfire 19, and one Hurricane 2C – has moved to North Weald, and No. 41 Squadron has ceased to exist as a day fighter unit: its numberplate was transferred to a Coltishall Javelin squadron, No. 141. Wing Commander P. D. Thompson, D.F.C., was flying the Spitfire, Flight Lieutenant R. Irish, the Hunter. Incidentally, the latter's attitude is not truly indicative of the Spitfire's speed potential; PS.853 is still a remarkably fast aeroplane in its own right.

★ **All correspondence and contributions to The Editor, *Air Clues*, Air Ministry, Room 27, Richmond Terrace, Whitehall, London, S.W.1. Telephone: Trafalgar 8811; exts 6662 & 6848.**

BOMBER COMMAND *is on the threshold of an era of infinitely greater flexibility than it has ever previously enjoyed – it is about to introduce flight refuelling for the V-force. Unlike the American Strategic Air Command system which employs special boom-lowering tanker aircraft, the R.A.F's refuellers are ordinary squadron Valiants which can be converted to the tanker rôle at short notice after certain basic modifications. Squadron Leader Bardon who has sent AIR CLUES this fascinating guide to the new art was engaged on Valiant-to-Valiant flight refuelling trials at A. & A.E.E., Boscombe Down, where he has flown both as tanker and receiver pilot.*



The beginnings of flight refuelling in England. The Airspeed Courier, in which Sir Alan Cobham made an unsuccessful attempt to fly non-stop from Ford, Sussex, to India in September, 1934, being refuelled from a Handley Page W.10 tanker. After successful in-flight refuelling over Portsmouth and in the Mediterranean, throttle trouble compelled a landing at Malta. Further along the route R.A.F. tankers had been waiting for Sir Alan – a Victoria at Alexandria and a Valencia at Basra. The hose was hauled down by a weighted light line which a passenger standing up through a hatch in the Courier caught with a hooked stick!



Above: The drogue "looms up outside the cockpit windscreen, like some vast speaking trumpet, roaring abuse and jeers". – An R.A.F. Valiant tanker during A. & A.E.E. trials early this year.

Left: A Valiant-to-Valiant hook-up. The receiver aircraft normally finds itself about 10 to 15 feet below and 15 to 20 feet behind the tanker. If the connexion is inadvertently broken the fuel flow is automatically cut off.

Flight Refuelling the V-bombers

by Squadron Leader P. J. BARDON, D.F.C.

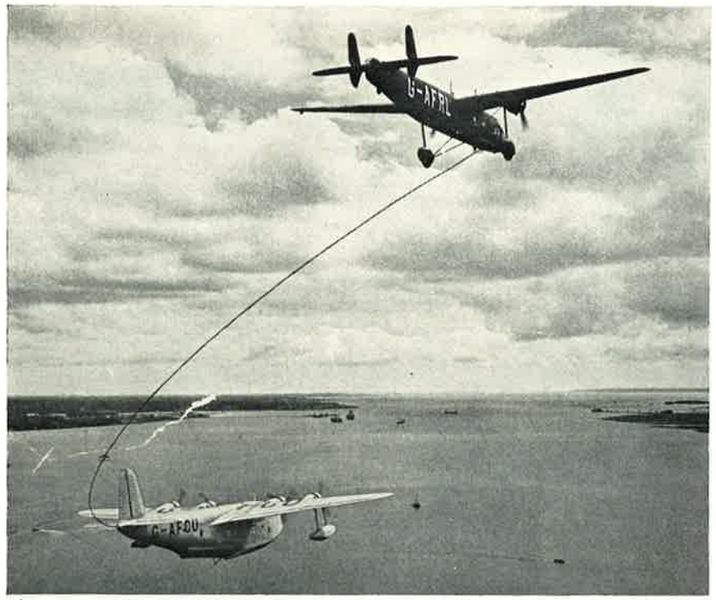
('B' Squadron, A. and A.E.E., Boscombe Down)

AS OUR OVERSEAS BASES become less dependable, or cease to be available at all, our bomber force is going to rely more and more for its flexibility and radius of action on the ability to refuel in flight.

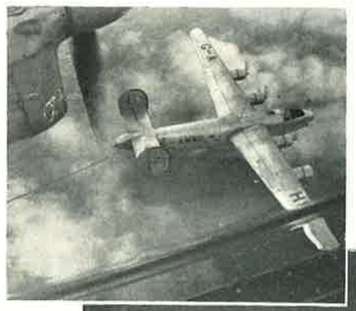
To this end, the R.A.F. has adopted for its V-Force, the probe and drogue method of flight refuelling. It has many advantages, not least of which is its simplicity compared with other systems. It is easy to use and operate, and it does not require specially built tankers such as the American KC-135. After certain basic modifications, any Valiant can be converted at short notice to the tanker rôle – and, equally quickly, back again.

The intention of this article is to provide a potted guide on how to become a competent flight refueller. It is therefore written chiefly for those who will be directly concerned with the system – in fact, an amplification of *Pilots' Notes*, which, though perfectly comprehensive in their own way, do not and cannot refer to the human element in quite the same way as is possible here.

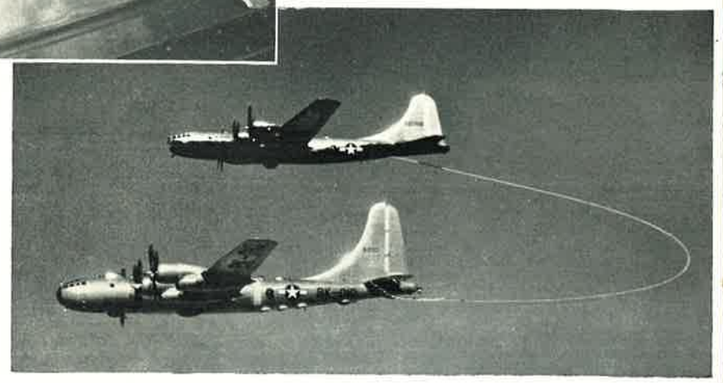
The history of flight refuelling goes back to 1923. In that year two U.S. Army Air Service officers remained airborne for more than 37 hours in a D.H.4b which they refuelled in flight by dangling a hose from another aircraft and passing fuel direct to the tanks via a suitably positioned funnel. This method, with many refinements, was used until the



Above: Flight refuelling, 1939. A Harrow refuels an Imperial Airways Empire flying boat over the Solent at the start of a trans-Atlantic flight. This was known as the looped hose technique: the receiver trailed a grapnel line which was picked up by another line fired by a gun from the tanker. The tanker operator then winched in the receiver's line and attached the hose, which the receiver winched down. The fuel flowed by gravity. Other Imperial Airways in-flight refuelling points were at Shannon (Ireland) Gandar (Newfoundland) and Goose Bay (Labrador). *Below:* Flight refuelling, 1948. A B.O.A.C. Liberator in the process of being refuelled by a Flight Refuelling Ltd Lancastrian during trans-Atlantic trials.



Above: Lancaster-to-Lancaster looped hose trials conducted by Flight Refuelling Ltd in 1946. Because this system called for an operator in the receiver aircraft it could not be used for fighters. The probe and drogue method overcame this limitation and the looped hose technique is no longer used.



Right: "Lucky Lady II", the U.S.A.F. B-50 which, in 1949, sustained by flight refuelling, made a non-stop round-the-world flight of 94 hours continuous flying. In this picture, taken on a training flight beforehand, "Lucky Lady" is being refuelled over Arizona by a B-29 tanker – again the looped hose method.

introduction of the looped hose method for the Imperial Airways flying boat trials in 1939; the latter system never enjoyed continuous commercial use although it saw military service with the U.S.A.F. in Korea.

Sir Alan Cobham, who founded Flight Refuelling Ltd in 1934, had, in the same year, made an unsuccessful attempt to fly non-stop to India using the looped hose method. Unfortunately, over the Mediterranean he was foiled by a mutinous split pin in the throttle linkage. – "For the want of a nail..." However, the Company persevered with the development of the system, perfecting many features, including the means of receiving and coupling up the hose. In 1939, eight successful return services were flown across the North Atlantic by the Empire flying boats *Cabot* and *Caribou* using in-flight refuelling, without which the flights would have been impossible.

All then seemed set for flight refuelling to come into its own as a world-wide commercial proposition when along came the Second World War. For the time being it looked as though all the hard work had been for no purpose. But, in 1944, the greatest opportunity of all presented itself. Without in-flight refuelling, the task of bombing Japan seemed impossible. Accordingly, the conversion of 600 Lancasters to the tanker rôle was begun, the scheme being to refuel Lincolns on their way to the targets. However, in the event, the acquisition of a piece of terra firma within range of Japan cancelled the project and the R.A.F. was to hear no more of flight refuelling for another 10 years.

Atlantic trials

After the war, British South American Airways Corporation, in conjunction with Flight Refuelling Ltd, began a series of experiments involving non-stop flights between the U.K. and Bermuda with Lancastrians. The success of these experiments encouraged B.O.A.C. to conduct their own trials over the North Atlantic with Liberators and these were also extremely successful. But, regretably, the system never came into permanent use.

The Americans were also busy with the same looped hose technique, and the circumnavigation of the world by a B-50, *Lucky Lady*, in 1949, with a non-stop flight of 23,108 statute miles, was a demonstration of their successful use of the equipment.

The limitation of one pair of hands

The previous year the ability to refuel fighters in the air became an American operational requirement and Flight Refuelling Ltd were consulted. It was obvious that the looped hose idea could not be applied to single seaters, where the only pair of hands was needed for other matters. And so was born the probe and drogue method. The U.S. Navy and the U.S.A.F. Tactical Air Command have since made extensive use of this technique with their fighters and light bombers. The R.A.F. experimented with it some years ago on a small scale using Meteors, but did not then bring it into general use. It has since been tried out by both the R.A.F. and the U.S.A.F. with a variety of aircraft, but only now has the R.A.F. introduced the system as an operational proposition, undertaking, initially, Valiant-to-Valiant refuelling.

That is indeed a very brief history of British flight refuelling endeavour. I only wish I had space to discuss the use made of it by Strategic Air Command, the great champion of flight refuelling, who went their own way with Boeing's flying boom system, and have, as all the world knows, reduced the whole thing to the finest of fine arts, thereby creating the most flexible and effective strategic bombing system of all time.

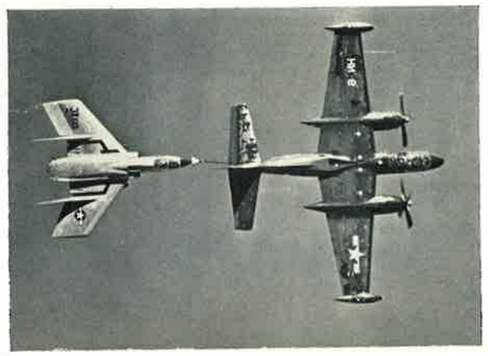
Tanker conversion

Though it is my intention to avoid excessive detail, it is nevertheless necessary to say a little more than the fact that one aircraft has a probe which is poked into a drogue trailed by another aircraft. First, the tanker. The contents of a certain number of the Valiant's normal fuel tanks are made available for transfer to the receiver. When this fuel is not to be transferred, it can still be used in the normal way. In each of these tanks there is an air turbine fuel pump, which takes its air supply from the poor overworked engine compressors. These deliver fuel at the required pressure to the main flight refuelling pump, also air driven, which is part and parcel of the hose drum unit (H.D.U.). So the basic modification is the installation of the tank turbine pumps, associated plumbing, and electrical supply. All that is then required to make a Valiant B.1 into a tanker is to hoist the H.D.U. into the bomb bay with its fairing, and connect up.

The hose drum unit, very briefly, consists of 90 feet of flexible hose wound on a rotatable drum. One end is connected to the tanks via the main turbine pump, and the free end is fitted with a coupling and a drogue. The hose drum is coupled to an electric motor through a variable torque fluid drive coupling. The motor is always attempting to wind the hose in, but by varying the amount of fluid circulating in the coupling (and hence the torque transmitted to the drum) the drag of the hose and drogue can be made to exceed the

Above: In 1951, 16 Meteor 8s of No. 245 Squadron, Horsham St Faith, were fitted with flight refuelling nose probes for R.A.F. evaluation trials. While they were proceeding, Flight Refuelling Ltd began three-point trials for the U.S.A.F. with a B-29, and the 245 Squadron Meteors co-operated – as is shown in this picture taken over the Norfolk coast near Cromer.

Above: One of the Lincoln tankers used in the 1951 trials with 245 Squadron's Meteors. *Right:* An eagle's eye view of a United States Navy A.J-1 Savage, a carrier borne tanker, refuelling an F-7U fighter. The U.S.N. has adopted probe and drogue refuelling. So has Tactical Air Command.



Above: A United States Air Force B-47 about to hook up for a drink from a tanker of the same type.

wind-in load, which will allow the hose to be trailed and stay trailed. By balancing the wind-in load against the drag load, the hose drum will then become sensitive to changes in the relative speed of the two aircraft when in contact. If the receiver flies a little faster than the tanker, the pressure of the probe nozzle against the drogue will oppose the drag and the hose will be wound in at the same rate as the overtaking speed. The reverse will apply as the receiver falls back. The hose tension will therefore remain constant throughout the contact.

Probe and drogue

The receiver is equipped with a probe which is attached to the nose of the aircraft. It is fitted with a special nozzle, and a fuel pipe runs away from it inside the probe body, around the canopy and into the normal ground refuelling lines. When the probe nozzle enters the coupling at the end of the hose, it is gripped by rollers mounted on spring loaded toggle arms. The load required to make contact is a good deal less than that required to break it so, therefore, the chances of an inadvertent disconnect are reduced. Floating valves in the probe and drogue coupling act on each other at the moment of contact and fuel can then flow as soon as the main fuel cock in the H.D.U. is opened. This, together with the start up of the main pump, occurs automatically as soon as seven feet of hose is wound in.

Above: The drogue reels back from the hose drum unit of a Valiant tanker during trials from Boscombe Down.

Signalling lights are fitted to the H.D.U., which enables the operation to be conducted without the use of R/T. An amber light will indicate that a contact may be made, and when seven feet is wound on the drum, this will change to green, indicating that the fuel cock is opened. A pressure gauge tapped off the flight refuelling lines in the receiver will indicate that fuel is being transferred. The third and last light is a red one, which will indicate that a contact must not be attempted, or if already in contact, that it must be broken off without delay.

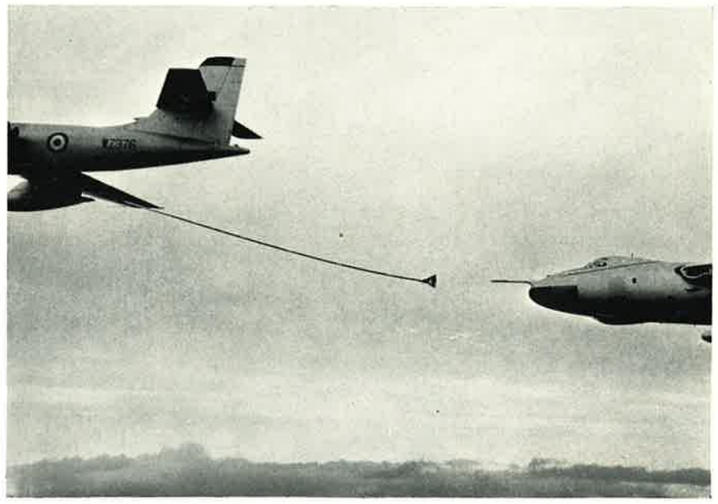
The equipment is under the control of an operator seated at a special panel in the crew compartment of the tanker. At this panel he can control the hose and the tank pumps and observe the rate of transfer and the quantity of fuel that has flowed. Panel operation is very straightforward, and only a short course is necessary to understand its mysteries.

Flying the receiver

A nice balance has to be struck when describing how one should make contact with the drogue. On the one hand, it can be made to sound so easy as to incur the risk of being asked why it is necessary to describe it at all; and on the other, it can be made to sound like a piece of high drama of which certain death would be an inevitable though only a minor feature. As one would expect, it is neither of these things. The best way to approach the subject, perhaps, is merely to give a calm account of the whole business, just hinting delicately here and there at the odd pitfalls, and allowing the reader to draw his own conclusions.

A tanker is essential. How and where one is found is beyond the scope of these pages. But before leaving the subject, one recalls to mind the odd occasion when the navigator has been hard pushed to locate a permanent and static feature of the earth's surface under ideal conditions. So it is therefore permissible to ponder awhile on the implications of that same gentleman attempting to find an object which is moving as fast as he is, and in a direction he knoweth not. The usual magic box will be there to help, but it will boil down in the end to a good pair of eyes, unclouded by age or alcohol.

Above: "The tanker has been found, flying in a steady and purposeful straight line, with the drogue trailing peacefully behind . . ."
Right: "Apply a small amount of power and the probe will sail into the coupling and connect up with a most satisfying CLUNK."



So let it be assumed that the tanker has been found, flying in a steady and purposeful straight line, with the drogue trailing peacefully behind, undisturbed either by rough air or random twitchings of the tanker pilot on his controls. It is rarely that one manages to find both these conditions fulfilled at one and the same time. Before charging uncouthly into contact, one should first examine the tanker to establish first, that it is one of ours and, second, is the particular one briefed. Using someone else's tanker would be on a par with drinking someone else's grog.

Then it should be noted from the signal lights whether or not the tanker crew are ready for contact. When they are, one can move in directly astern, still keeping the signal lights in view in case somebody changes his mind at the last moment. Twenty to 30 yards behind the drogue is sufficient; and roughly in line with it. It is an advantage to fly for a moment or two at the same speed as the tanker and note what that speed is. The correct closing speed can then be established. Still watching the signal lights out of the corner of one's eye, apply a small amount of power and allow the aircraft to approach the drogue at certainly not more than five knots closing speed. Try and keep the probe boring remorselessly towards the centre of the drogue, and overcome a tendency of one's limbs to approach a condition of complete rigor mortis.

When only a few feet from the drogue, the slightest unnecessary movement on the controls is sufficient to send the probe away to one side or the other, or above or below. It is very easy to believe that these spasmodic movements are in fact the drogue thrashing about, and before long one is exhausting one's repertoire of curses on the head of the tanker pilot. Humility is a great virtue for a receiver pilot, and more successful contacts will be made if he considers everything that happens to be his fault.

When the probe nozzle is really close to the drogue, a dull roaring sound will be heard and a mild buffet felt. This may be ignored, as it is only the drogue trying to produce the amount of drag required from it to balance the H.D.U. motor. But the effect of its turbulent wake will be to reduce the closing speed: so when the nozzle is just outside the drogue periphery, and pointing in the right direction, apply a small amount of power and the probe will sail into the coupling and connect up with a most satisfying *CLUNK*.

"When a contact has been made . . . a little power may be applied to move sedately and under perfect control up into the refuelling position."

A jeering trumpet

If however, the excitement becomes too great, it is possible (and usual) that at the moment of applying that last little burst of power, one's arm may give an involuntary twitch on the controls. The effect of this is sufficient to deflect the probe so that it misses the drogue altogether, with the result that it looms up outside the cockpit windscreen, like some vast speaking trumpet, roaring abuse and jeers. One can only reduce power and allow the receiver to fall back to square one, and start again. When this has happened half a dozen times and more, a certain tension may be discerned in the cockpit of the receiver, and a look of glassy desperation will be observed in the eyes of the first pilot. For his own peace of mind, and the immediate safety of the aircraft and its crew, he should make every effort to adopt an Oriental and inscrutable calm. As an absolutely last resort, it might be necessary and wise to let the second pilot make the contact – provided he can be relied upon to keep his mouth shut afterwards.

This unhappy situation of never quite making contact can be continued more or less indefinitely, especially if the receiver pilot hovers just a foot or two outside the drogue making wild darts at it, whenever it pauses for a tantalizing second or two. The only thing to do, and it is the quickest way to success, is to fall back a good few yards and start again. This is sound advice for several reasons.

Perils of the hose whip

First, hovering about upsets the drogue. A straight-in approach to contact, with possibly the merest pause, will not worry the drogue at all, but wavering on its doorstep will subject it to fluctuating bow wave effects which will make it dance about. Second, the actual speed of contact will not have time to reach the necessary value from a standing start from only two or three feet behind, and all that will happen will be a partially locked contact which will not open up the fuel valves in the coupling and probe. Third, making frantic digs at it, will probably result in the drogue being clouted in a direction not along its axis. In the worst case, the drogue is carried away from its natural trailing position and a great loop develops in the hose. This loop travels down the hose and flicks like a whip at the end, and

one is treated to the alarming spectacle of the drogue tearing the nozzle off the end of the probe like an angry pair of pliers. This is generally classed as a hose whip. In the course of time it may well come to be known as something more forcible and less polite. It can be achieved even more simply by making contact at a high rate of knots – that is, a lot more than five knots closing speed. In this case the H.D.U. cannot wind the hose in fast enough and, in quite a startlingly short time, the receiver is lighter by 7 lb of brass which the probe body delivers agonizingly to the accompaniment of a loud *BOING*. Chastened, the receiver then returns home. The pilot is not allowed for one single instant to forget his humiliation, as before his very eyes is the twisted and torn end of the probe body, strongly reminiscent of a 1914 howitzer whose shell has gone off prematurely in the barrel.

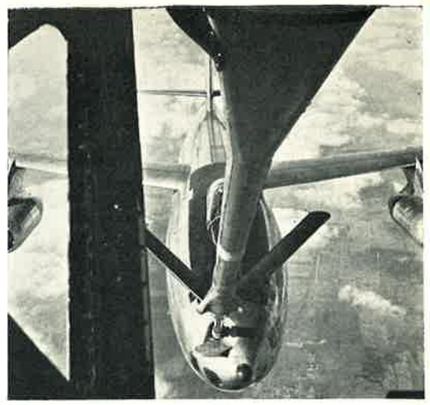
It is difficult to say categorically the precise speed at which the contact should be made, and in any case it is not of great value unless the average bomber pilot's eyes are so arranged that he is able to observe the ASI and the drogue at one and the same moment. One can only say that the correct speed of contact is something which comes to be recognized, in the same way as the correct hold off height for landing is occasionally recognized. If the contact is too slow the probe nozzle will not lock into the coupling and, if it is too fast, then the seekers of the spectacular will not go unrewarded.

Above: Valiant feeds Valiant. *Below:* Key man in the Valiant tanker, the panel operator. Lights on the panel give such a full picture of refuelling progress that R/T conversation is normally unnecessary. The operator here is Flight Sergeant K. Symonds.

After the *CLUNK*

When a contact has been made in the prescribed manner, the little burst of power necessary to achieve it should immediately be reduced. Ideally, a distinct pause should be made to enable one's thoughts to be re-orientated, and the urge to shout in triumph suppressed. A little power may then be applied to move sedately and under perfect control up into the refuelling position. This is marked quite clearly on the hose by a large yellow band which should be kept hovering half way into the H.D.U. The fuel will now be flowing as indicated on the pressure gauge in the receiver, and it is just a question of sitting there until the transfer is complete. The time that this takes will seem interminable. But provided that no exaggerated control movements are made, and the increase of weight is anticipated early enough on the throttles, station-keeping presents no problems. There is a wide latitude available in which to move around, though if one reaches the limits of range of this available movement an inadvertent disconnect may result, with all the attendant frustrations of having to re-establish contact. Likewise, if the station kept is well back from the recommended position, it requires only the slightest delay in correcting for a loss of speed again to result in an inadvertent disconnect.

If at any time a red light is signalled, an emergency disconnect must be made by closing the throttles. The receiver will then fall back rapidly, and when the hose reaches a speed of five feet a second, a brake on the hose drum will be applied and the contact will be broken. Every effort has been made to ensure that no fuel escapes from the coupling either during the transfer or on breaking contact. In any event, except during an emergency 'disconnect', it should be no more than the merest whiff. On an emergency break one may expect a little more.



A view from 'Clancy's' position in a U.S.A.F. KC-97 tanker of the refuelling boom lowered and in action. While the U.S.N. and Tactical Air Command have adopted the probe and drogue system, Strategic Air Command has opted for the celebrated Boeing boom.

The completion of transfer is indicated by the fuel transfer pressure gauge reading zero, by the tanks indicating full, and the refuelling valves in the receiver's tanks indicating 'closed' on the 11-lamp indicator.

Unhooking

As much care should be taken in breaking contact as in making it. Emergency breaks as a regular diet are not to be recommended as they throw a heavy strain on the hose and the rest of the equipment. When it is decided to break contact, the throttles should be closed just enough to start the hose slowly unwinding off the drum. By playing it on the throttles, the aircraft should be allowed to fall back slowly to full trail, the last seven feet being indicated by an amber light and a length of gaily striped hose. When the end is reached, the drogue will part from the probe gently and without fuss. If the point of parting is anything other than the natural trailing position of the hose, it will plunge off in that direction with astonishing haste. It will then reappear at odd intervals as it roars past the windscreen, and it is as well to keep out of its way.

The interlude is now over and each may now proceed on his way. It will no doubt cause a great deal of pain to the technicians that an aircraft has been refuelled without the appropriate entry in the Form 700 – but maybe one speaks too soon.

Incidentally, the problem of flight refuelling at night has been solved by the simple expedient of making it as bright as day by suitably positioned lights.

Receiver pilots can take heart, for the task of making contact is well within everyone's capability, and proficiency can be achieved in a very few trips. It speaks highly of the simplicity of the system.

Flying the tanker

One may variously describe the task of the tanker as vital, important, requiring judgment and skill, and more – all of which is indisputable and very true. Even so, at first sight, it might be thought that flying the tanker cannot be other than one of life's more humdrum occupations. I agree that it could hardly be one of its more exciting jobs, but it should not be scorned for that reason. Anyone capable of even the mildest enthusiasm will find many features of the tanker business which are challenging and interesting.

Like any well brought up lady, the tanker has to be sought and found, rather than be the seeker. But in the same way as the too well brought up lady may require the assistance of the age old custom of leaving a trail of "come hither" looks around the place, so too must the tanker indicate its willingness to give its all (or nearly its all) by leaving a trail of "come hither" radio waves around the sky. At the appointed time and place, and here there must not be any charming inconseqential feminine tardiness, the drogue must be trailing at the end of a placid hose, and the aircraft flying serenely in the right direction, at the right height and at the right speed. With the bomb doors open a very slight buffet will be felt with the H.D.U. equipment installed and, apart from the slight tug of the drogue being trailed, nothing should otherwise disturb the peaceful calm of the crew compartment.

When the panel operator has satisfied himself that everything is ready for contact, he informs the first pilot. This gentleman should by now have brought the aircraft to that magic, but hard won and easily lost state of straight and level flight. When he has approximated to this condition, he orders the red stand-off light to be turned off, thus informing the receiver that he is ready for contact.

As the flick of a wrist will lash a whip so, too, a jerk on the tanker's controls will lash the trailing hose many feet. Even the slightest control movements can cause the drogue to move about sufficiently to render the job of making contact difficult, if not impossible. For that reason rough air must be avoided.

Everything must be done to provide the receiver with the steadiest possible drogue. So one comes to the paradoxical situation, peculiar to tanker flying, that any changes of attitude must be made without moving the controls. This is of course difficult, but the point being that any necessary control movements should be made with desperate care and very slowly. If the tanker starts to drift off its appointed path, let it, and gradually try to nudge it back again. It is far better that the aircraft should be allowed slowly to wallow about the sky with infinite smoothness than be held rigidly to a straight path by continuous though small control movements. This may sound like absolute nonsense, especially to those who have the happy knack of being able to fly an aircraft as though it were on greased rails, but even they will agree that the presence of 70 tons of shiny aluminium bobbing about close astern cannot fail to make its presence felt in even the best regulated cockpits.

Trim changes after hook-up

The most difficult time is when the contact has just been made. The receiver has just relieved the tanker of the drag of the drogue which tends to increase the speed. Furthermore, there is a nose-down trim change caused by the change in the direction of the airflow over the tanker's tailplane due to the close proximity of the receiver. Both these phenomena can be anticipated with experience and practice, and on the rare occasion it is possible to hold the speed and attitude steady throughout the whole period of contact. If, however, the full effect of the contact is awaited before corrective action is taken, the JAS can increase by as much as 10 knots, which strikes one dumb with horror at the time. In the worst case, it could cause the receiver inadvertently to disconnect from his hard won contact.

However, as I have already explained, before contact a certain amount of sparring around is likely to go on down at the back. One must bear this with fortitude and patience. In the event of the drogue being clouted without a contact being made, it will usually be pushed in for a few feet and will require retrailing for a further assault. This provides an opportunity to relax for the moment and sort out the odd wayward deviation of the instruments.

When the contact has been made and the receiver moves up into the refuelling position, the tendency for the speed to increase is checked by throttling back. Whether or not the nose-down trim change is held or trimmed out, largely depends on the whim of the pilot. If the period of contact is likely to be short, as during training, it is hardly worth retrimming. But, if a full transfer is taking place, it will then be necessary to do so, and it is worth considering the use of the fine trimmer in the interests of smoothness. As fuel is being transferred and the weight decreases, frequent adjustments to the power settings and trim will be necessary. On the completion of the transfer, the tanker pilot will have no doubt forgotten the nose-up trim he applied at the beginning, and will be caught out as the receiver moves out to break contact – with the result that his aircraft will rear majestically up into the sky.

Close-up of the H.D.U. on a Valiant, showing the drogue and six signal lights by which the tanker communicates with the recipient.

Tanker/receiver pilot relations

In essence, then, the tanker pilot's main task is to provide a steady platform. But, of course, it is inconceivable that, in the course of a refuelling, the tanker will not, at some time or other, make an infuriating and unaccountable climb or descent, with its attendant changes of airspeed. To the tanker pilot, the sight of the ASI reading as little as five knots more or less than it should, and the VSI waving about, undisciplined, seems a most unforgivable

offence. His mind is filled with the image of a desperate receiver trying to make contact on a wildly thrashing drogue, and he is soon either devoutly wishing, or is glad that, the receiver crew belongs to an airfield a great geographical distance from his own. He prays that the chances of ever coming face to face with the apoplectic gentleman astern are infinitely remote.

It is, therefore, with positive disbelief that, where tanker and receiver share the same base, one hears oneself greeted by the receiver crew on their return with a friendly effusiveness and even cautious praises for providing them with such a steady platform. One allows the vivid and agonizing memory of the VSI reading 500 ft/min climb at the time of contact swiftly to fade. The feeling of furtiveness which had prevailed since landing is quickly replaced by a blithe and almost hysterical assurance, and the conviction that no one else would have managed at all.

In other words, provided that everything happens with a ponderous smoothness, slight displacements from the chosen path are not noticed at all, except by the gloom ridden figure of the tanker's second pilot. He will become more than ever convinced of the injustice of a system which relegates talent and ability to the obscurity of the right-hand seat, while the left-hand side is allowed to be occupied by a blatantly incompetent nitwit.

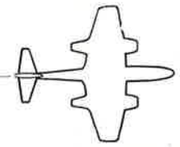
It has been said that any birdbrain can fly the receiver. But one can say with more certainty that tanker pilots have *got* to be smart customers. There is really no comparison between the two rôles, in the same way that there is no comparison between formation flying and the agony of accurate flying on an I.R.T.

Last, those in the airborne bowser business will find that it is an unusual and sobering experience to take off absolutely groaning with fuel and to find oneself not long afterwards making extremely meticulous and anxious calculations on the back of an envelope in terms of distance, fuel and consumption.

* * *

There can be no doubt that the ability to refuel in the air will be of immense value to Bomber Command. It will now enjoy a much greater flexibility, the true extent of which may not become apparent until practical experience is gained. And there are no tricks to using the system. Provided adequate and proper training is given initially, and crews remain in reasonable practice, one can count on flight refuelling.

Fighter Command's First Gunnery Meet



by Squadron Leader R. W. D. Evans (Fighter Weapons School)

WHEN, early last year, Headquarters, Fighter Command, told us that the finals of the Dacre and Ingpen trophy competitions were to be held at the Fighter Weapons School and would take the shape of a Command gunnery meet – the first ever held – we at the School were highly delighted.

The two trophies are presented annually, the Dacre to the day fighter squadron and the Ingpen to the night/all-weather fighter squadron achieving the highest standards in weapons efficiency.

All Fighter Groups – Nos 11, 12, and 13 – entered a team for each trophy and preliminary rounds took place in due course as part of normal weapons training within the groups. Air-to-air and ciné results were compared and, by mid-September, the teams had been chosen.

Meanwhile, rules for the competition had been drawn up by Headquarters, Fighter Command. Because of the need to apply the rules strictly, under competition conditions, it was decided to set up a panel of judges who would deal with objections and give impartial rulings. The panel was to be kept extremely busy.

A great deal of information on the methods of conducting a gunnery meet was obtained, it must be admitted, by studying brochures and reports of the U.S.A.F. Gunnery Meet held annually at Nellis A.F.B.

Each team was to comprise four pilots chosen to represent the squadron nominated by each group. One reserve pilot was to be allowed to each team (in the event this proved essential as the competition took place at the height of the Asian flu epidemic). Night/all-weather teams were to consist of four pilots with their navigators. Four aircraft per team were to be permitted, which in effect left two in reserve because the flying program allowed sufficient turn-round time to make the operation of only two aircraft necessary.

The finals were planned to cover five days during which 72 ciné and 72 air-to-air flights had to be completed. Each team member was required to fly three high altitude (40,000 feet) ranging and tracking ciné exercises, with the target aircraft taking set evasive action, followed by two countable and one practice air-to-air (banner target) exercises at 20,000 feet.

Marks

Marks for the ciné gun phase were to be allotted as the result of mechanical and visual assessing. Mechanical assessing marks were to be obtained as follows:

A hit was counted when the pipper was within .2° of the aiming mark (rear of target cockpit) provided the ranging error was less than 15 per cent. This formula then applied:

$$\frac{\text{Hits} \times 100}{\text{Frames Assessed}}$$

(Every 8th frame was assessed)

To this mark were added visual marks awarded for opening range, break-off range, closing speed, and steadiness; the result was divided by 2 as follows:

$$\frac{\frac{\text{Hits} \times 100}{\text{Frames Assessed}} + \text{Visual Mark}}{2}$$

The C-in-C Fighter Command, Air Chief Marshal Sir Thomas Pike, K.C.B., C.B.E., D.F.C., arrives at the Fighter Weapons School in a Meteor during the gunnery meet. Here he is being welcomed by the School's C.O., Group Captain R. Deacon Elliott, O.B.E., D.F.C.

The air-to-air marking system was to be more straightforward, being the number of hits on the banner multiplied by a weighting factor as follows:

Hunter (all Mks)	×2
Meteors N.F. 11, 12, 14	×3
Venom N.F. 3	×3
Javelin	×4½

A very important part of the competition was the re-arm and turn-round exercise which took place at the squadron home bases just before the finals; it was worth a maximum of 200 marks to each team.

Total marks obtainable by each team were: Cinégun, 1,200; air-to-air, 800; turn-round, 200.

Rules

During the flag-firing, automatic disqualification was fixed as the penalty for firing at below 15° angle-off and under 200 yards range; the use of flap by Hunters was prohibited. How were these rules to be enforced so that there could be no arguments later that one squadron had 'interpreted' them differently from another?

The only certain way was to 'chase' every competitor, and Fighter Weapons School pilots were used to the full for this purpose. Thus each Dacre trophy competitor in the air-to-air exercises was followed by a Hunter flying 50 to 100 yards behind; this unusual form of flying was thoroughly enjoyed by the staff and, fortunately, not objected to by competitors. F.W.S. Hunters also acted as target aircraft on all Dacre ciné exercises so that near standard evasive action could be presented to each competitor.

The Ingpen competitors, on the other hand, had an easier time as each team happened, by chance, to be operating vastly different types of aircraft, to wit Javelins, Meteor N.F. 14s, and Venom N.F. 3s. During ciné exercises in this competition an F.W.S. Hunter tagged along behind each pair of Javelins to keep an eye on evasive action taken. Likewise, the School's faithful Meteor 8s were, for a few glorious hours, relieved of their usual humdrum towing duties to 'chase' the Meteor N.F. 14s and Venom N.F. 3s. The Venom team had little mercy on the F.W.S. Meteors and many an anxious glance was directed towards jet pipe temperatures as our pilots attempted to keep their quarry in sight during the climb, and subsequent evasion, exercise. As competitors returned to base the chase aircraft formed up in close echelon for the run in and break; formating in a Hunter on a pair of Javelins looked, and felt, quite amusing.

If a competitor felt he had been unfairly penalized, his team leader submitted the objection in writing to the judges who, after due deliberation either upheld or overruled it. A firm, but fair, decision published by the judges avoided any major conflict and spirits remained, on the whole, commendably even. As was perhaps inevitable in such a competition, the odd sharp practice was discovered, rapidly pounced on by the judges, and the offender penalized.

Each squadron brought its own armament servicing teams and, where stoppages were found to be attributable to poor servicing, air-to-air scores were counted as a percentage of rounds carried, not of rounds fired. Thus, with the marks obtained by the pre-competition turn-rounds, it was clear that the whole squadron, rather than just the aircrew, contributed to the marks won.

The final result :- which gave No. 264 (now No. 33) Squadron 1216 marks to win the Ingpen trophy and No. 63 Squadron 790 to take the Dacre.

Ancient vehicles with long pedigrees

The night/all-weather teams – Nos 46, 89, and 33 Squadrons – arrived at the Fighter Weapons School on September 27, and the day fighter teams – Nos 34,