TABBY TALES

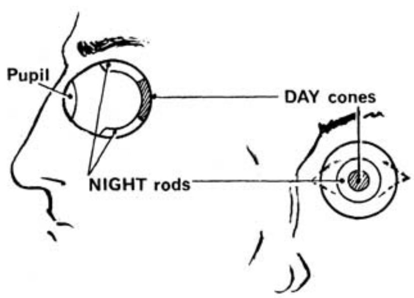
Clive Elliott reviews some of the early British ideas that have been used to assist night vision, including the wartime 'Tabby' systems.

Since the war there have been considerable advances in night vision systems but they still are expensive, relatively bulky, and tiring to use. It is unlikely that all troops would ever be individually equipped with night vision systems and those that are suitably equipped may in the heat of battle become parted from their equipment. But certain skills can be acquired that allow the human eye to cope with vision in near darkness.

USING YOUR EYES

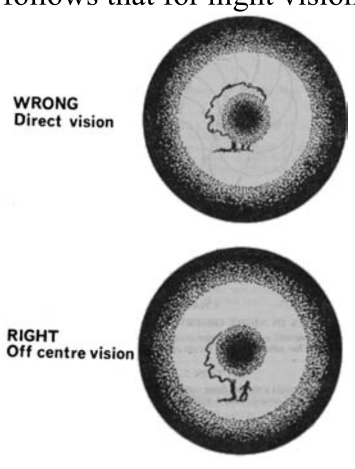
Unfortunately the wartime belief that eating carrots could enhance the night vision of aircrew, was merely propaganda to boost the morale of the nation. The night vision of a healthy individual with a balanced diet would not benefit from carrots or vitamins, but with an appreciation of the workings of the human eye and some practice, additional powers of vision can be achieved after dark.

It has been claimed that some people have especially sensitive eyes suitable for night vision, but the more likely reason is that they have learnt how to use their eyes in a different manner at night and to avoid situations that hinder night vision. Humans have two types of light sensitive cells in the retina at the back of the eye, which are used for either day or night vision. The day cells are called *cones* and are mostly arranged in the central portion of the back of the eye, whereas the night cells called *rods* are mostly around the edge of the central portion. Hens and many birds only have cones, whereas animals that specialise in night operations like cats and owls have only rods.

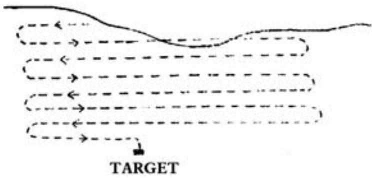


The human eye

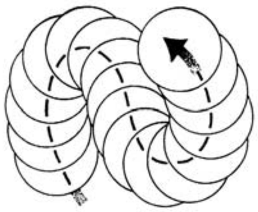
The day cells need strong light. The pupil is the aperture of the eye that contracts so that the central portion of the retina responds. This means that during daylight the night cells are protected from light. As the light level is reduced to moonlight, the pupil enlarges allowing light to spread over more of the retina, which allows the night cells to be stimulated. With lower levels of light, the night cells provide the vision; the day cells are useless. It follows that for night vision an object is best observed by looking slightly to one side.



The night cells are weak and become tired quickly, after 10 seconds of staring at an object it will become blurred. To help overcome the tiring and off set vision, a different technique needs to be adopted for scanning for objects.



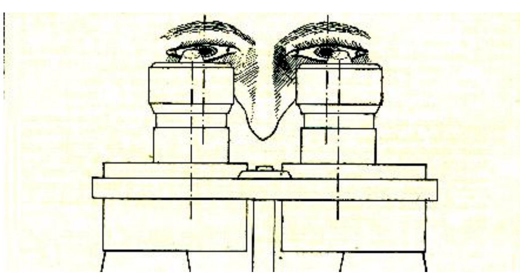
In daylight a horizontal scanning is used.



But for scanning at night a figure-of-eight technique needs to be used.

On going from sunlight to dim light such as inside an AFV, day cells only need a few seconds to adapt to the new conditions. But night cells take 30-45 minutes to adapt to darkness, but seeing light will rapidly destroy this adaptation. It is therefore very important not to spoil this adaptation by the inappropriate use of light. Dim red light spoils dark adaptation less than dim white light, but has disadvantages that red markings on maps become invisible. The problem is not so bad with orange light, but of course orange markings such as contour lines are then invisible. It was found that wearing deep red goggles in a white light area did largely preserve the dark adaptation, but in many situations repeatedly changing to goggles would be impractical. When interior vehicle lights have to be used, they should be used on the dimmest setting, and arranged so as not to shine in the eyes, nor allow the object to be in a shadow otherwise more light is needed. When interior vehicle lights have to be used, they should be used on the dimmest setting, and arranged so as not to shine in the eyes, nor allow the object to be in a shadow otherwise more light is needed.

Additional problems occur when viewing through windscreens, periscopes, telescopes and binoculars. Dust, rain, mist, condensation, mud and grease smears which may have no perceptible effect on day vision, may totally obscure an object at night, without the observer realising there is a problem. It is very important that viewing surfaces are polished with a clean cloth, a dirty cloth will make matters worse and even anti-misting compound can cause streaking. Not all binoculars will perform well in poor light. No. 2 prismatic has x6 magnification but is very poor at night. But some binoculars, such as No.5 prismatic with x7 magnification, are designed to be particularly effect at night as well as day. These glasses may have up to five times the range of the naked eye at dusk; even so it is important that they are adjusted correctly. What may seem to be satisfactory settings during daylight may be sub-optimal for night use. It is important that the interocular distance is set correctly so that all the light reaching the binoculars is passed through the pupils and into the eye.

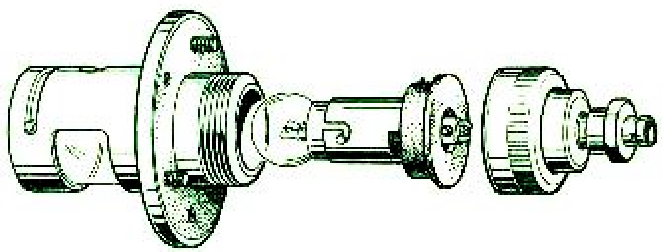


Interocular setting is too wide, some of the light passing through the binoculars does not pass through the pupil and enter the eye, this makes the target appear dimmer or it may not be seen at all.

Rather than relying on what was assumed the optimal daylight focus, it is important to set it up for night vision by focussing on a faint distant star with the eyes relaxed. Night vision cells are weak and tire quickly. Blurring will occur if an object is starred at for more than 10 seconds, this can result in false alarms that an observed target is moving. But the most crucial factor of all night vision is to have an observer who has learnt how objects, however familiar in daylight, have special characteristics at night.

CONVOY NIGHT DRIVING

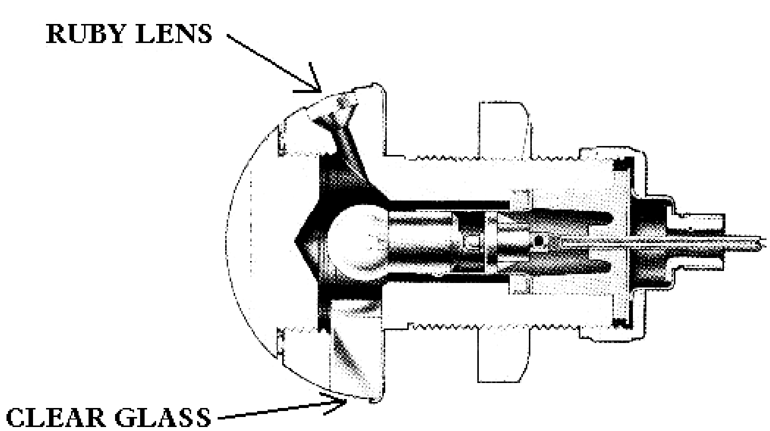
It is now common practice for military vehicles to have a low power light at the rear or underside of the vehicle. This allows the driver of the following vehicle to keep on course under blackout conditions when all other lights are extinguished. In a similar way some animals such as rabbits have white fur around their bottoms presumably to aid members of the group to keep together. In the case of post-war British ‘B’ vehicles the lamp used is the Convoy Light No.1, which is the same as the Number Light No.1. Its dual role is attributable to the ability of the front cover to be rotated through 180º allowing the choice of two levels of light.



Convoy Light No.1 with the larger aperture exposed facing downwards.

When used as a registration number light, the cover is set to the larger aperture. When fitted underneath the vehicle as a convoy light there is the option of the larger aperture or a hole 3/8-inch in diameter. The convoy light is mounted under the chassis, often near the rear differential which when painted white can be illuminated. Where the vehicle has a differential that is obscured from rear vision, (or in the case of a trailer does not have one at all) then a square, rectangular or round plate painted white is fixed close to the convoy light underneath the vehicle where it can be seen from the rear. The required setting of the light level would depend on the distance from enemy lines and the intended proximity of the individual vehicles in the convoy.

Post-war British ‘A’ vehicles are fitted with a more sturdy light, the Convoy Light No.2. The central part of the dome is made of brass and is threaded to allow access to the bulb, a ruby lens faces upwards to emit a red light whilst beneath a domed window allows illumination of the convoy markings. There was no provision for varying the light intensity to suit the circumstances.



Convoy Light No.2

INFRA-RED

Infra-red is that part of the spectrum that extends beyond red light that is invisible to the human eye. The part that is nearest to visible light is called "near infra-red" and vision systems that use this require a beam of infra-red energy to illuminate an image i.e. it is an "active system". Moving further along the spectrum systems using "far infra-red" detect the heat energy emitted from the target itself i.e. it is a "passive system".

British far infra-red

In 1927 Admiralty experiments at Farnborough in the use of far infra-red were abandoned. The idea had been to try to detect heat from aircraft engines. But the concern was that any detector would be ineffective because engine heat could be screened off, and the clouds would shield even what little heat might escape this anyway. Besides if a system could be made to work it would only give direction whereas radar would give range as well. However the Admiralty was not the only interested party, in 1935 the Tizard Committee considered the various means of providing air defence for Britain. The committee sanctioned the start of work on a receiving system into the far infra-red spectrum for the detection of heat from enemy aircraft. It was considered that heat energy would come not just from the engine but also as aerodynamic heating from the wings and fuselage, so even screening the engine would not hide the presence of an aircraft. By April 1937 an airborne detector had been made and tested, plans for an image converter were in hand to view intruding aircraft. But infra-red was not the only option under consideration, there were bitter personal clashes within the Tizard Committee, and some political ambitions too. One of the more forceful members of the committee saw the airborne defence issue in terms of aerial mines, although when these were tried in 1940 they were a failure, another scheme considered was to floodlight the whole of southern England. But the major challenge was from radar, although it was accepted that enemy aircraft could use jamming transmitters and lay down reflective chaff. The additional use of infra-red particularly for short-range use was dismissed. The frustration was not knowing how advanced the Germans were at applying science to warfare, however all major efforts were then diverted to radar.

British near infra-red

Again it was interest from the Admiralty that stimulated research, but this time into near infra-red. In 1938 there was a requirement for the development of image converter tubes that could be incorporated into telescopes for signalling, beacons for clandestine operations, friend or foe recognition etc rather than a need for an observation system. A simple glass converter tube was devised that when supplied with at least 3,000 volts allowed a photosensitive cathode to glow when infra-red energy hit the cathode. The tube was originally designated RG4, but in production became CV144. The image was green and inverted but this was corrected by the lens system.

Two converter tubes type CV144 either side of £1 coin. The converter tube on the left shows the viewing screen (the cathode) at the far end of the tube, the fixing of the screen to the tube is particularly delicate, although the outer glass tube is more resilient. The other vulnerable part is the cathode connection from the tube to the HT supply; it consists of a paper ring painted with graphite. Removing the tube, particularly after many years, can easily pull the paper away.

But it was realised that the real potential for this system lay in night driving. The idea in June 1942 was that this viewing system, known as "R.G. Equipment", would be used typically with a scout leading a column on a Lloyds Carrier. But the concept changed to fitting this equipment to the lead and every third vehicle in large formations, which could then be moved at night at speeds of up to 30 mph. As it was not originally intended that this would be close to enemy lines, it allowed the design of the infra-red filters to pass some red light as well. This extra energy improved sensitivity, but even so, filtered headlights were not visible beyond 200 yards.

Tabby

The term R.G.Equipment probably is based on the fact that the system relies on dark filters made of "Red Glass". I assume there might be too much of a give-away in the title. So in 1943 it was replaced by the code name "Tabby", this was a general name for a number of types of night vision systems based on these converter tubes. Tabby was not some clever acronym, but merely because a Tabby cat can see in the dark! Not too clever as one of the German systems was named after the tom-cat, which can also see in the dark!

Churchill was keen that Tabby should be deployed as widely as possible, and then put into operational use at the same time. Large-scale production of the tubes started in 1942, a vast amount of Tabby equipment must have been made, as 100,000 of the CV144 converter tubes had been made by the end of the war. As the installation kit provided for one spare tube per pair of binoculars, this would suggest 33,000 sets. But the actual figure would be higher than that because a large number of monoculars were produced. Not only did these have a single tube, but also the viewer was hermetically sealed and tubes could not be replaced.

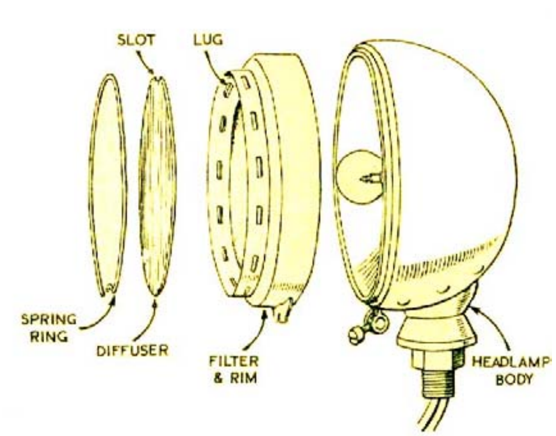
Tabby Type E

Type E was the most famous of the Tabby devices, but up until December 1942 the designation was "R.G.Binoculars Type 6".

An underside view of Type E binoculars, on the right the webbing fits over the head to support a rubber face mask. On the left side a lens shield is shown removed to fit the converter tube. The lens shield screens against stray light, and houses the object lens and an infra-red filter. The high voltage is fed through the cable below, another cable supplies 12 volts to run a de-misting heater. The equipment seen here is still in working order after 58 years and is complete with its Ministry of Supply label.

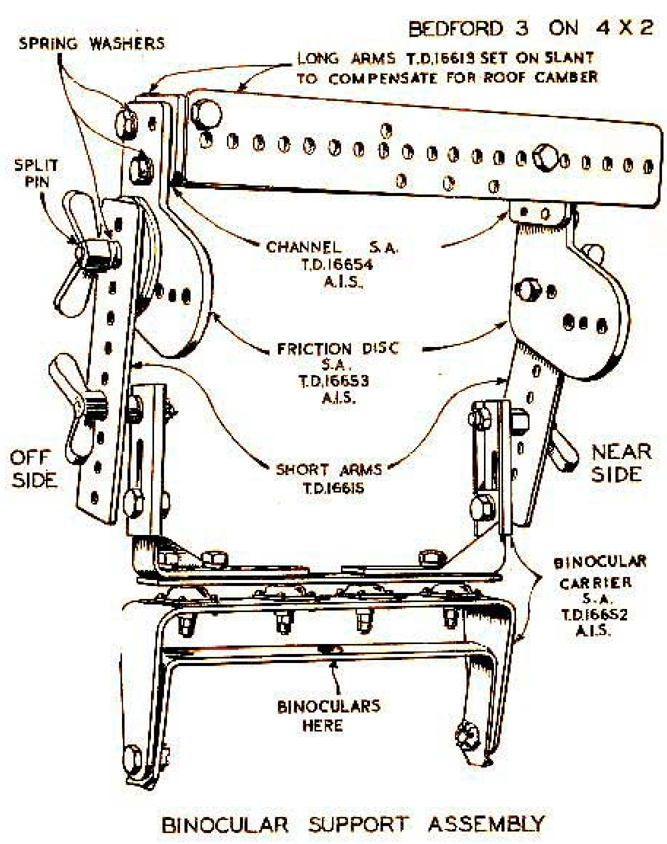
At the beginning of 1943 an order was placed for 3,000 sets, of which 2,000 sets were for fitting to tanks. In August 1943 trials at Chobham investigated various combinations of infra-red headlights. It was soon realised that spotlights of infra-red gave no appreciation of the surrounding ground, and headlight diffusers were needed. It was also found that it was better to have narrow diffusers than wider diffusers even with double the power. It was also better to have two headlights rather than a single headlight of twice the power.

This shows a Tabby headlight, the infra red filter can be seen obscuring the reflector, the clear plastic diffuser is not fitted here.

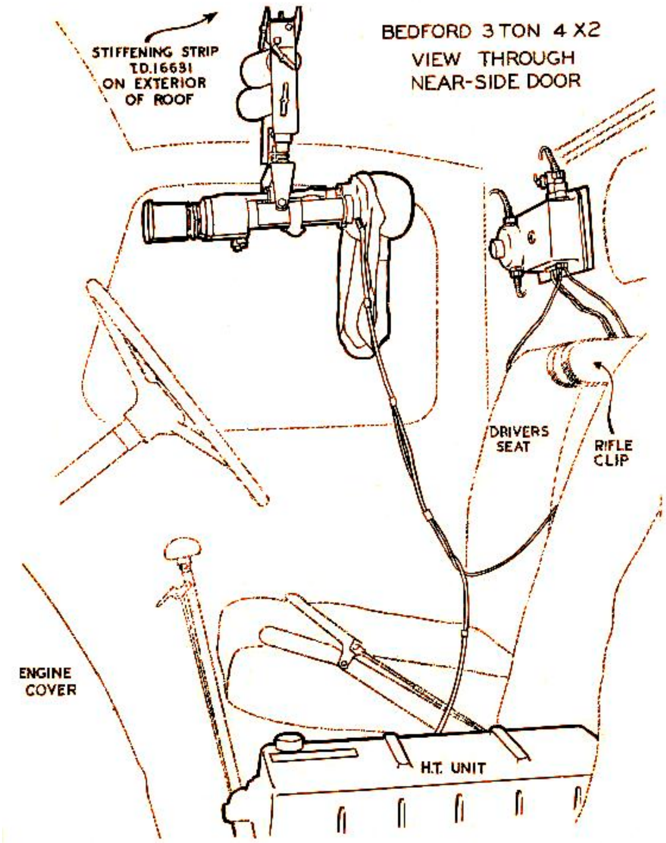


The filter gets hot, as it has to absorb all the white light energy. To avoid the plastic diffuser from melting, it is spaced from the filter by means of lugs. The holes, from which the lugs are formed, allow for some cooling unfortunately the lack support from behind the diffuser, means it can easily break.

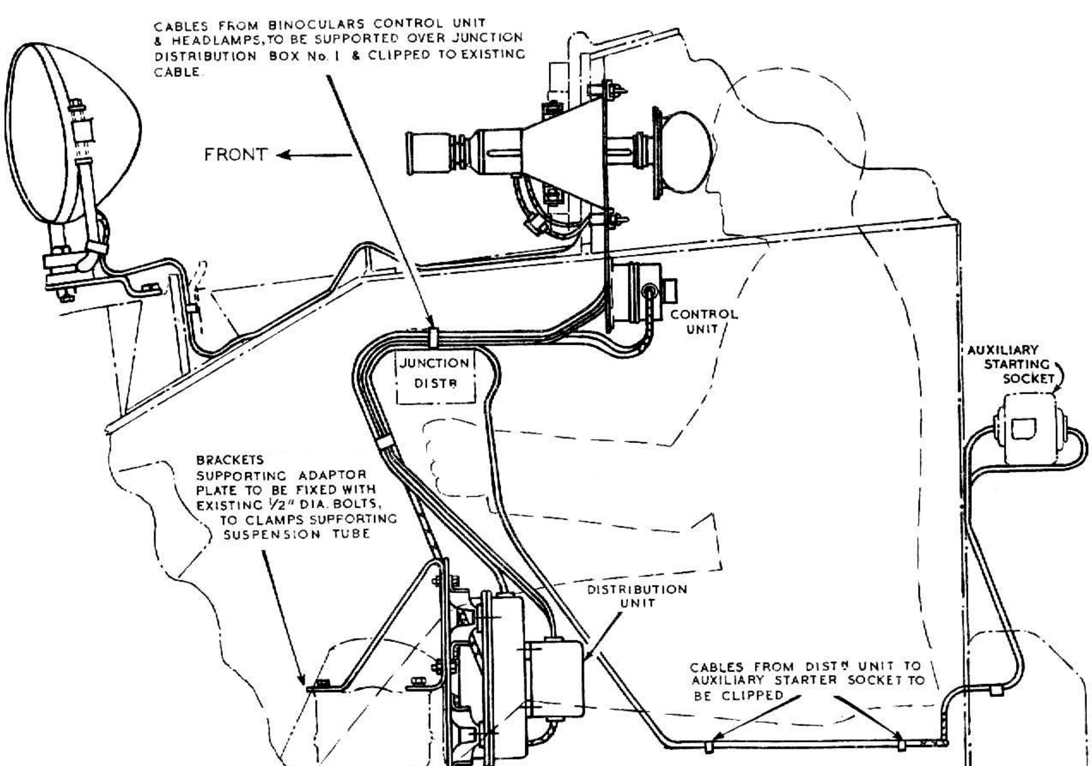
With a weight of nearly 4-kg it was essential that the binoculars were firmly supported. Fitting Tabby equipment to a wide range of AFVs and trucks, presented great problems in accommodating not only the binoculars in a cramped interior, but finding enough room to accommodate the power unit, and control box where it can be reached easily. The installation kits where specific to vehicle type and comprised, a frame resembling a Meccano outfit to support the binoculars, a pair of filtered headlamps with frame, power unit, control box, junction box, cabling and clips.

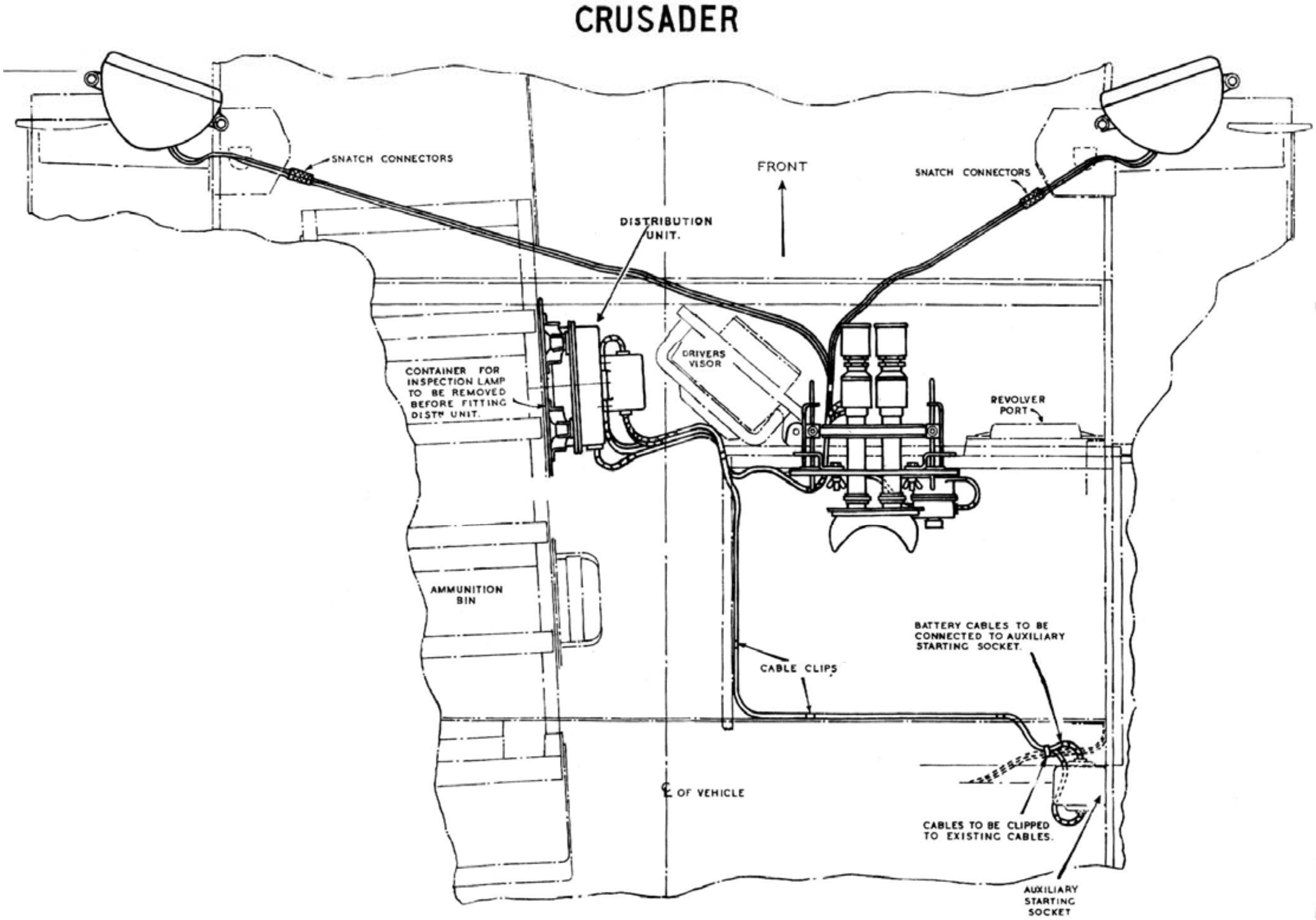


A typical support frame for a truck.



Generally in trucks, the binocular supporting frame was secured to the cab roof.





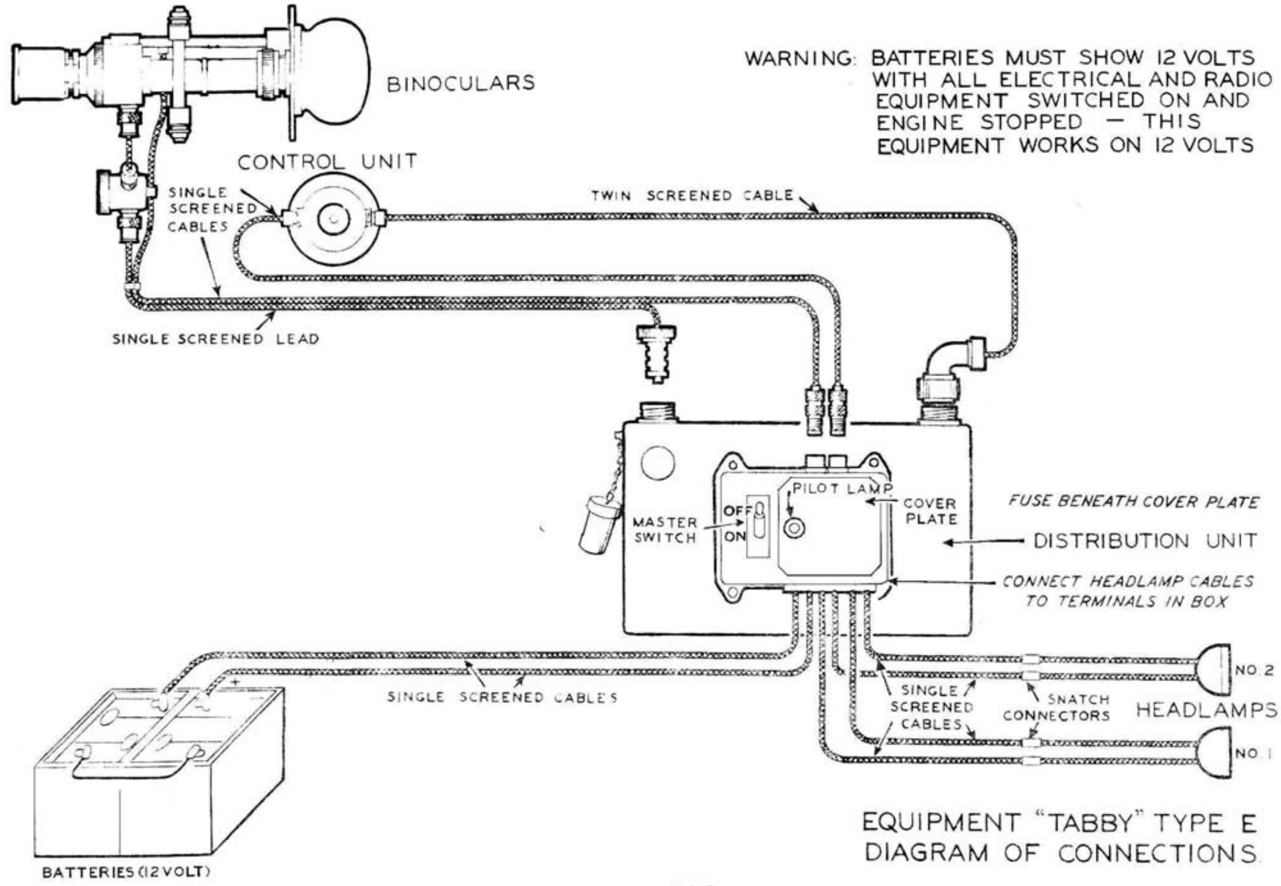
Generally in an AFV, the binoculars were clamped in a frame around the driver's visor:

Tabby power units

The current required to supply a converter tube was minimal, being in the order of a micro-amp, but at least 3,000 volts was needed to make the screen glow. Experiments were conducted to see if the vehicle ignition system could supply the necessary voltage. Unfortunately the converter tubes could not withstand the inverse voltage, and attempts to rectify the high voltage to produce DC fell below 3,000 volts, which was inadequate. The other problem was the cabling of this high voltage, and suppressing it. So a power unit was developed that used a vibrator to produce AC, which was then stepped up in voltage with an ignition coil, and with valve rectifiers this was converted into DC, to supply the converter tubes. This power unit required 12 volts, so when used in a Jeep it required its own set of batteries, which took up valuable space in a small vehicle. The other problem was the need to independently charge up these additional batteries. It must be remembered that, as intended, infra-red headlights are invisible to the eye, and it is easy to accidentally leave them switched, the only indicator is the warmth that can be felt by a hand in front of the headlight.

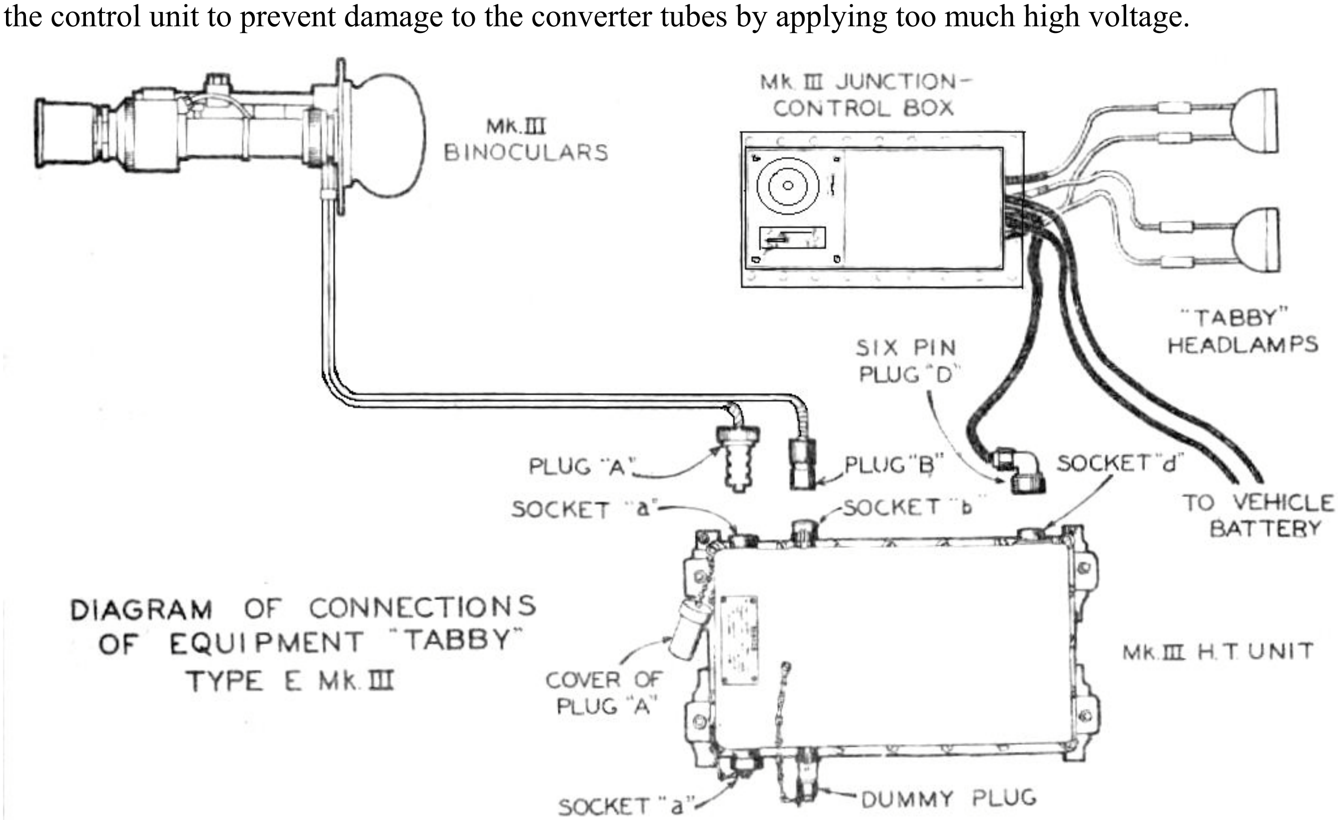
Tabby Type E Mark II

This was the first production system and was available in 1943. The power unit could only operate from the vehicle batteries if the system was 12 volts negative earth, in all other cases separate batteries must be fitted. The control unit provides a means of setting the high voltage for the binoculars correctly, it must always be rotated slowly. Too high a voltage will cause the screen to glow to brightly or be damaged. Too low a voltage will give insufficient glow and sensitivity. The control unit must always be placed within reach of the driver.



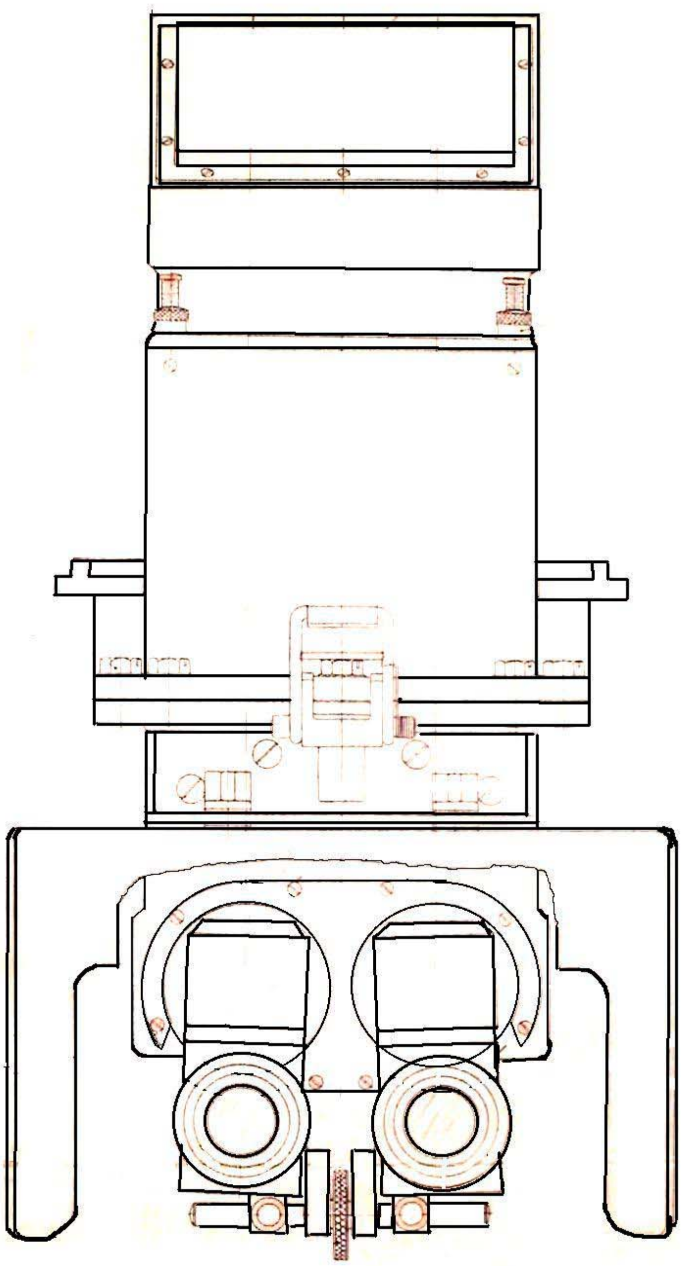
Tabby Type E Mark III

This system was introduced in 1945; the main feature was an improved power supply. Not only was it lighter but it could operate from 6 or 12 volts, positive or negative earth. The other main change was combining the control unit with the junction box, as it turned out that many installations with the Tabby Mk II required an adapter plate to mount the two components together anyway. A useful refinement was a REME set, end stop to the control unit to prevent damage to the converter tubes by applying too much high voltage.



Tabby Type M

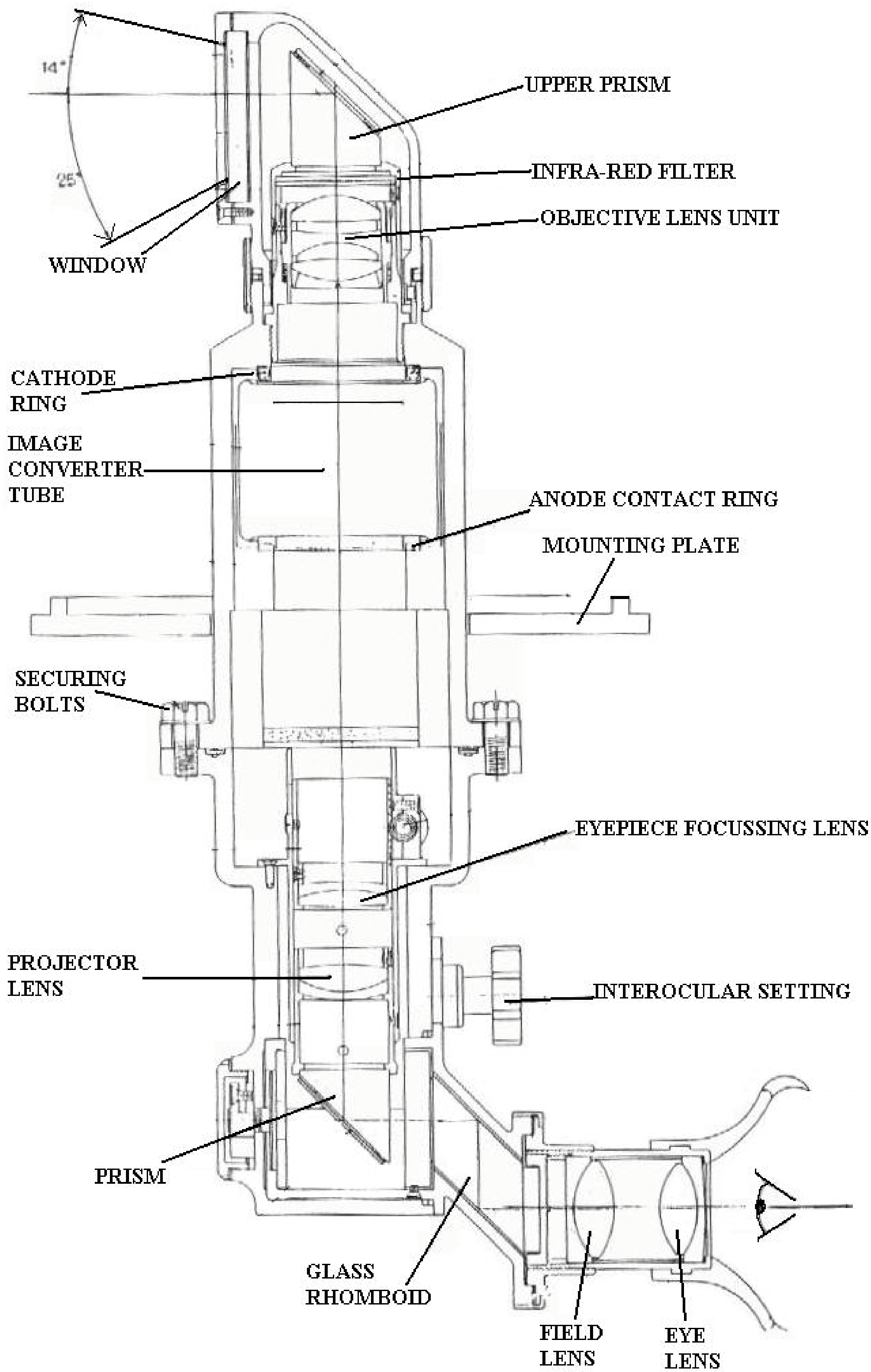
In December 1943 a Tabby system was described for drivers of bulldozers. A feature of the system was that the front part of the viewer could be detached whilst the driver, still wearing the mask part, could take a look around. What he would be able to see in the dark, must have been limited, in fact night vision for bulldozers would seem to have limited applications. However I have an original Barr & Stroud drawing dated April 1945, which details a Tabby tank periscope designated as Type M. This possibly may have been for Shermans, which unlike the British tanks, had to have their Tabby binoculars mounted largely outside the tank on a "Meccano" type frame.



Note that the periscope window is, for the purpose of the diagram, shown facing in reverse.

Tabby Type E Periscope No 1

Again an original Barr and Stroud drawing illustrates a further design for a Tabby periscope. It is dated July 1945 and may represent simply an improved design. Although there are vernier settings for focussing and inter-ocular adjustment, the 1x magnification suggests its purpose was for driving. Indeed the substantial mounting plate suggests it was for a tank.



Tabby Type K

Unlike the rest of the Tabby system, Type K was clearly not intended for driving. It was a hand held monocular with a self-contained power unit. The fact that it was tropicalised indicates Churchill's desire that Tabby should be issued to all theatres and only used when stocks permitted a simultaneous deployment. As the 3,000 volts required to activate the image converter tube is at a negligible current, it permitted the use of batteries that were permanently sealed into the monocular case. There were three of these batteries were called Zamboni piles, they consisted of thousands of thin disc cells packed in plastic tubes. The viewer was turned on by pressing a button on the side of the case. The eyepiece could be adjusted; all the other focussing was factory set. The whole unit was carried in a very sturdy leather case, but when the batteries deteriorated or the tube failed mechanically or damaged by too much light then the complete unit was discarded.

Tabby Type K with its leather carrying case. The viewer was activated by pressing the button on the unit.

Tabby Type F

This was a monocular for RAF use. The converter tube was sealed within the plastic body; there was no provision for replacing the tube. There is no eyepiece focus adjustment, although the object lens has a means of alignment during manufacture. Unlike some viewers used for signalling the image is the correct way up, but the viewer is not very portable, as there is only a short screened cable to carry the high voltage from the bulky power unit. Night fighters and bombers of the RAF were fitted with Tabby, principally as a friend or foe system. The tails of friendly aircraft could be identified by their infra-red beacons.

Tabby Type F, a converter tube is shown for comparison.

Tabby Type B

This was not a viewer but a battery powered beacon with a range of up to 100 yards, intended for signalling and covert operations by identifying friendly vehicles or personnel. The beacons could also be used as a route marking beacons, being active markers they were far more effective than the use of markers painted with just infra-red sensitive paint. A further use was for testing and aligning Tabby equipment. An active beacon would give a far better range than trying to align equipment by using the beam from the vehicle's own infra-red headlights. There were two more powerful models of beacon, B2 and B3. Their effectiveness and that of Tabby Type K and E viewers can be compared:

"Small" IR reflectors are visible with Tabby Type E & K at:

40 yards with IR spotlight
30 yards with IR headlamps

"Large" IR reflectors are visible with Tabby Type E & K at:

80 yards with IR spotlight
50 yards with IR headlamps

Beacon B2 is visible at:

400 yards with Tabby Type K
500 yards with Tabby Type E

Beacon B3 is visible at:

500 yards with Tabby Type K
500 yards with Tabby Type E

Cluster of IR headlights (4) is visible at:

1 – 1½ miles with Tabby Type K
2 – 2½ miles with Tabby Type E

Operational use of Tabby

Despite all this research and development it is quite disappointing there are so few records of the operational use of Tabby. The first record of operational use by any of the services was in the Mediterranean in 1941, when Commandos, equipped with infra-red signalling sets, maintained contact with parent ships offshore. In September 1943 midget submarines attacked the German battleship Tirpitz, using infra-red equipment, and again when they cut the submarine cables at Hong Kong and Saigon.

LVTs for crossing of the Rhine were equipped with Tabby; in fact the previous table comes from a document for installing Tabby on LVTs. The purpose was to provide not only night vision for landing and climbing river banks more easily, but also as homing beacons for returning craft. In the event a network of No 19 wireless sets provided the homing system, and artificial moonlight provided widespread night vision for all. Artificial moonlight is created by illuminating clouds by anti-aircraft searchlights, which had become a much used technique by the British in Italy.

The RAF also used Tabby Type F to detect enemy infra-red equipment, extensive night-time reconnaissance was carried out over enemy occupied territory to no avail. It was later discovered that the Germans had never deployed infra-red on the Western Front. Not only was there a shortage of operational equipment but the Germans believed the Allies were more advanced with infra-red systems than we really were. This belief was deliberately fuelled through double agents after code breakers had found that the Germans believed our detection of submarines was due to advanced infra-red systems. In fact it was due to microwave radar, but it kept the Germans busy trying to develop infra-red screening systems for their submarines, which of course would make not the slightest difference to their radar silhouette.

Organisations

The Ministry of Supply co-ordinated the development of Tabby. The main participants were the Admiralty Research Laboratories at Teddington and A.S.E. at Hazlemere, with The Gramophone Co Ltd at Hayes who manufactured the image converter tubes and viewers. C.A.V. at Acton produced the lamps, switchbox and installation kits. The glass for the filters was manufactured by Spintex Glass Co. who supplied The Gramophone Co Ltd to make the filters for the viewers and to Joseph Lucas Ltd. who made the larger filters for the headlamps.

Summary of British Tabby Systems

Tabby Type B	Battery powered beacon
Tabby Type C	Simple monocular with open sight
Tabby Type D	Simple monocular with open sight, superseding Type C
Tabby Type E	Binoculars for night driving
Tabby Type E	Periscope No.1. Tank periscope with binocular aperture
Tabby Type F	Monocular for RAF use
Tabby Type K	Monocular for Army use, in hermetically sealed unit
Tabby Type M	Binoculars for bulldozer drivers, not successful was redesignated:
Tabby Type M	Binocular tank periscope with single window aperture
Tabby Type N	Personal binoculars with head harness, lamp & battery pack
Tabby Type O	Personal monocular with lamp & battery pack

ULTRA-VIOLET

During the First World War, the British observed that the movement of supplies after dark was more effective with horse drawn wagons than with vehicles. It was thought that the successful negotiation of the route was more to the credit of the horse than to the driver of the wagon, and this gave an advantage over the driver of a vehicle. Subsequently the marking routes for night driving exercised military thinking for the next twenty years. Experiments were conducted using a wide variety of luminous paints that were becoming commercially available, but their performance for military purposes was unsatisfactory. The exception was radioactive paint, but this was ruled out, not for safety reasons, but on grounds of cost.

With the outbreak of the Second World War, consideration was given to using ultra-violet energy to assist night vision. Just as infra-red energy is “below red” visible light, at the opposite end of the spectrum, ultra-violet energy is “above violet” visible light.

In Paris in August 1939, it was demonstrated that ultra-violet could very effectively activate certain materials and paints to make them fluoresce. This is because ultra-violet being a higher frequency than visible light has more energy, when this energy strikes certain surfaces some energy is absorbed; the rest is converted into visible light making it appear brighter. Although the photoreceptors of the human eye can respond to some degree to both infra-red and ultra-violet, it is filtered out by the lens of the eye, which then defines what we know as visible light. Butterflies have good ultra-violet vision, which no doubt means their wing markings are even more distinctive, than they appear to us.

As with infra-red the British notion was the assistance of night driving rather than night fighting, three main requirements emerged for ultra-violet illumination (UV):

1. Route marking for vehicles to proceed along roads or cross-country under the cover of darkness.

2. Illumination of bridges in forward areas at night to avoid the use of vehicle lights.

3. Production of maps that could be illuminated by UV but remain invisible 50 yards away.

1. Route marking

At the time, the only effective UV source was from a mercury vapour lamp, which required as a minimum 110 volts. Such a voltage is not easily obtainable in a vehicle, so approaches were made to British Thomson Houston Co Ltd to see if it was feasible to make a low voltage UV bulb. Within four weeks a 12-volt bulb had been produced that would provide a suitable source of UV illumination when placed behind a special filter. The bulb had to tolerate up to 14 volts, to allow for the variations in vehicle charging systems, although continued use at this voltage would reduce bulb life by 50%. The UV filter was manufactured by Chance Bros. from a special glass developed by Wood Bros. of Barnsley. The 12 volt UV bulb, although only 36 watt rating, was nearly as effective as the traditional mercury vapour lamp at producing UV energy. But the 12-volt version did produce a bit more visible light, but was thought not to be a problem as it was barely visible a few hundred yards away.

Experiments with vehicles commenced, using illuminous paint on wooden boards 12 inches by 4 inches, these were spaced at 10 yard intervals either side of the tracks. Drivers could cope with these well, more complex routes were devised utilising signs that indicated turns and deviations, again these were negotiated with no difficulty. The use of these rather large signs gave way to experiments with illuminous tape. This tape was available in widths from 6 inches to ¼ inch, although they all suffered from the problem of being obscured by mud splashes; surprisingly the narrow tape was just as effective as the wider tape. Concerns were raised about the possibility of the headlight filters getting smashed allowing white light to become visible. With some difficulty a 12 volt 60 watt bulb was produced that was made of the special “Woods glass”, this had the additional advantage that there were no filters to fit, and the only modification to convert the vehicle for night driving was to fit the special bulbs.

The system received great acclaim from various branches of the War Office. But the enthusiasm waned as it became realised that drivers could drive very well between the fluorescent markers but were quite oblivious to all else, such as other vehicles, personnel, pot holes, tree stumps etc. Although there was some usage by tanks for harbouring vehicles by night, but the system was soon abandoned. Even the Home Office toyed with the idea of using UV for marking Civil Defence personnel, but didn’t seem to develop the idea. In contrast IR being lower in frequency than visible light, has less energy and much less energy than an equivalent power of UV. This explains the poorer results obtained when IR was used with reflective markers to define routes.

2. Bridge lighting

Discrete illumination of a bridge with conventional lighting, requires a number of low intensity sources, but this has the problem of needing much wiring which can be subject to damage by passing traffic or enemy action. The advantage of using UV is that fluorescent markers can be illuminated by perhaps a single source at one end of the bridge. It also means that it is no longer a requirement of the vehicle to provide the UV source, so a generator could provide the power for a mercury vapour lamp which anyway is more effective than the headlight UV bulb. The noise of a generator is unwelcome in the tranquillity of the night, so Lucas developed a battery operated power unit using a vibrator that was sufficient to power a 40-watt mercury vapour lamp. In this application the UV lamps were not filtered and were just as visible to the naked eye as a normal light source of equal intensity. The advantage of the UV was to use a lower level of illumination, which is compensated by the fluorescence of the markers. If a bridge was to carry two-way traffic it must be arranged so that there is an UV source at each end of the bridge, and alternated so that a driver is not looking into the UV source. Although the oncoming brightness is distracting, UV light has the effect of making the eyes seem out of focus, which is particularly dangerous when driving over bridges in the dark. It was a worry that the fluorescent signs may be visible from the air, so “Cats Eyes” were developed with 1-inch reflectors, but they were more difficult for drivers to follow. But it was found that from the air, the reflections from the fluorescent signs were minimal, and besides pilots were quite skilled anyway at identifying any bridge over water at night.

The requirement for this type of bridge illumination lapsed following the evacuation from France, and besides there was a certain lack of bridges in the Middle East. But with air supremacy, even the shielding of vehicle headlights was abandoned.

3.Flourescent maps

Whilst developing fluorescent materials for use in paint, the Metal Box Company were able to produce three types of ink that would produce three contrasting colours when illuminated by a low level UV source. This would allow night patrols to consult maps without giving away their position. A torch was developed with a special bulb rich in UV component, with the white light largely obscured by a special filter. The system worked well, being invisible at 20 yards, but the problem was the complexity of overprinting maps in large quantities.

The breakthrough was the development of a clear fluorescent liquid which, when painted over a map, would dry to appear normal under white light, but would fluoresce in the dark with an UV source. A considerable number of maps were thus treated and sent over to France for trials, but the maps failed to arrive in time for the evacuation from France. The Army then abandoned the system.

However the Air Ministry considered utilising the system by marking maps for bomber crews to just identify those features, which would be visible at night. It would also mean that enemy fighters could not identify map-reading lights from within the bomber. The Air Ministry were not impressed with the UV torch and wanted to use an UV light powered by a transformer from the instrument panel supply. However development ceased when it was found that studying a fluorescent map disturbed the navigator's dark adaptation, and it was more satisfactory to continue to use the existing low level orange light system. It is curious that the dark adaptation problem had not been identified in the Ministry of Supply experiments.

Some sixty years on, it is interesting to note that Ford and several other car manufacturers have developed headlights that emit UV energy to improve night visibility. There is excitement that a special pigment has been developed in Sweden, which when applied to road signs and lane markings make them appear brighter under ultra-violet illumination. So nothing really new there! At the other end of the spectrum, Jaguar working with Pilkington Glass and GEC Marconi Avionics are developing a driving system using near IR to improve night driving safety. Filtered headlights will be used in conjunction with an IR camera, to provide a head-up display interfaced into a holographic element on the windscreen. This is certainly an improvement on rather tunnelled vision from peering down binoculars.