

GENERAL TECHNICAL SUMMARY

The following comments on some of the main technical details of the machines used on the Exercise are made solely from information collected during the exercise, and do not represent a full review from a design angle, nor do they deal with the machines from a tactical, gunnery, or wireless point of view.

A. Cromwell and Centaur Series1. Hull

Instances occurred on the exercise of hull floor plates buckling inwards and bulging downwards, but in no case did this result in mechanical failures. Stony or rock outcrop country has not been experienced, otherwise the buckling of floor plates might have been more severe, with consequent damage by impact to either gearboxes or engines, or the mis-alignment of these units.

Hull floor inspection plates are considered to be too small and numerous, they are a difficult and lengthy process to remove, and are also incorrectly placed for ease of certain maintenance and adjustment operations. Larger and quickly removed floor plates, placed with a view to easing maintenance and repairs are called for, and an escape hatch on the floor is also desirable, as in the case of Sherman.

2. Escape Hatches

The side escape door is very small and awkward. This door, and the top escape doors, are trapped by the turret in many positions. The evacuation of the front compartment is not considered to be satisfactory in its present form.

3. Driver's Vision

A simple detachable screen for the driver's vision aperture in the visor plate is necessary for long approach marches in dusty or wet weather conditions.

4. Engine and Gearbox Compartment Doors

The wire type handles are most unsatisfactory, and a re-design of general layout of doors to give maximum access to engine and gearbox compartments is necessary.

Larger area doors and loss of them would seem to be the method of approach. From a major repair angle, the complete top deck armour must be removed, and a scheme to simplify and speed up this work seems necessary.

5. Petrol and Oil Fillers

The filler cap deck cover plates need re-design. They are awkward and difficult to remove, and are easily lost and misfitted. The tank filler orifice should be at least 4" diam. for ease of filling, and might well incorporate a fixed telescopic funnel and efficient strainer combined. The loss of time, and risk of dirt and water, under field conditions, are great and also dangerous. This problem of quick and clean re-fuelling is one that needs urgent and definite action.

6. Hull Front Plates

On the tanks tested the re-designed nose and visor plates were not incorporated.

7. Tracks

The present track life is very satisfactory up to 2,000 miles running, but the quality and fixing method of track pins leave much to be desired. The track

life/

Details of the above mentioned guns are given at Annexure "B".

life and performance is definitely limited by the present Track Pins. Certain Valentino track pins were supplied in error during the Trials and they gave a good account of themselves, and the crews much prefer the simple type of fixing of this pin, as compared with current Cromwell type.

It is considered that the wider track of 15 $\frac{1}{2}$ " on Cromwell, will be a great advantage, but the fouling that was apparent, on a machine of this type at Farnborough, on the side armour fixing bolts and Allen screws, would make armour removal difficult, if not impossible. With unfortunate experiences of armour removal on the exercise, in order to repair shock absorbers, the problem of the fixing bolts is serious.

8. Track Tensioners

Cromwell - Satisfactory.

Cromwell X and Centaur. This system has proved itself useless from its inception and first use, and every effort should be made to cease fitting this unit, and at the same time provision should be made to change existing machines to Cromwell type tensioner at the earliest moment.

9. Road Wheels

A great improvement in road wheel fixing studs and locking nuts has been apparent. The known trouble of excessive road wheel tyre wear was experienced, especially rapid when axle arms become slightly bent.

10. Driving Sprocket

The main retaining bolts and nuts need constant tightening, as also the main hub cap, despite its locking device. These points need immediate attention, either from a drawing correction or re-design angle.

11. Shock Absorbers

These have given serious trouble, in the main through faulty assembly and an inefficient locking device for the top caps.

12. Suspension

There is ample proof that the system is working to the very limit of loading, and cases of bent axle arms have occurred. On certain cross-country terrain encountered, it is doubtful whether it offers any real tactical advantages over the sturdy and reliable American method of suspension, as proved on Shermans.

13. Hydraulic Controls

The record of troubles, constant attention and maintenance on this system of control seem to point to the obvious deletion of the system, and incorporation of simple mechanical controls - not - anchored to the hull floor - and it is felt that a driver would accept a certain amount of added manual effort in order to avoid the continuous attention to Hydraulic Systems. The question of blast on pipe lines and unions, and also the extreme cleanliness that is so vital, but often not present, on this form of operation of controls, must be considered.

14. Clutches

(a) Cromwell - Very satisfactory and only trouble experienced was a breakdown of Hydraulic clutch operation.

(b) Centaur - Improved, but still unreliable in the withdrawal mechanism, and cannot be considered satisfactory.

15. Radiators

In their present position, which seems fundamentally wrong, there appears no certain insurance against constant blocking of matrix, and immediate failure of machine when a sudden oil leak appears - which has occurred on occasions during exercise on both Cromwell and Centaur.

16. Brakes

(a) Steering Brakes - Persistent troubles in steering brakes appear in the full detailed reports of the exercise, and this item is by no means satisfactory in its present form. Attention to the system and application is obviously necessary, and it seems that the quality and limits on brake drums, shoes and liners will need careful study. Further, the geometry of the lay-out needs to be considered. At present adjustments are very difficult when cold, and almost impossible when hot.

(b) Main brakes - The foot brake is not sufficiently powerful to cope with the speed and weight of the machine, even with spring boxes welded up.

When used as a parking brake it is dangerous as it is apt to release itself when the braking system cools down.

17. Gearbox

Generally good and no failures, except to controls. The oil seals on output shafts gave certain troubles, but show marked improvement, and the future close watch on high oil levels when machines are new and delivered, together with a check on seal retainers for looseness, seems to be the only complaint on this unit. Gear levers on Centaur still broke at the stems, and are obvious cases of faulty and careless manufacture.

18. Final Drives

Generally satisfactory. A method of locking the filler caps is necessary - they work loose and get adrift, despite every care to lock them with normal tools.

19. Gear Ratios

A lower overall gear ratio on both machines will be a distinct advantage. It will give an increased performance on all cross-country work and the resultant drop in maximum road speed should not be missed - on Cromwell, its present maximum can very rarely be used, and demands a very high standard of driving to handle the machine at such speeds.

20. Petrol Tanks, Pipe Lines, Taps and Filters

A drive on cleanliness on manufacture, storage, and fitting is necessary on these items. A stop cock at each petrol tank outlet is very much required to permit of repairs and attention without having completely to drain off the Tanks. A lengthy and dangerous job. The petrol tap controls on Centaur, and the tap design and filter system leave much to be desired.

General quality and strength of petrol tanks, header tanks and radiator tanks need to be improved.

21. Engine Units

(a) Cromwell - Meteor

From the evidence of this exercise this engine has been a little disappointing. Troubles and breakages of an unexpected nature occurred, such as Failure of Spring drive to Starter, Camshaft Bevel gear adrift, Fan Gear case looseness in use, Dynamo clutch failures, etc. Further, serious oil leaks which developed and caused

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three out of five machines to be taken off the road, rather points to the fact that this famous and proved aero engine, is not yet adapted to the very different role of a Tank engine. It is established that Fan Bolts and Sparking Plugs should be renewed at each 1,000 mile check.

Lightness in aero design, and the use of alloy metals may have to be reconsidered for the changes of torque, extreme vibrations and shock loadings to which a tank engine must be submitted.

b) Centaur - Liberty

Whilst this engine unit is much improved from past experience, it is still unreliable from oil leaks at rocker gear and fan bevel gears. Star drive leakages and failures are also still apparent. It is not considered powerful enough to cope with present Centaur loads - and its average speeds are below present Sherman types, taken over all types of terrain. Water pump failure and several cases of governor failures are reported. One engine developed a very serious vibration which would have put the Tank off the road, had the clutch failure on this same machine not made this necessary.

22. Mudguards and Tool boxes

Rapid deterioration and breakages on cross-country going have given trouble. Without front extension the driver's conditions are appalling, and without rear extension quantities of dust, mud, etc., are thrown over the turret on to the top deck and thence are drawn into the engine compartment. It is suggested that if these items cannot be increased in weight and strength, then the extensions should be light and quickly replaced, and provision made in Squadron stores for ample replacements.

23. Rear Smoke Emitters

Badly positioned at present, and get rapidly damaged. Now that the Auxiliary Petrol Tank has been deleted, they could safely be positioned higher on the rear of the machine.

24. Tow Ropes

The triangular connecting link is too large for the jaws of the shackle, and the Barton hook is also too tight a fit for the Shackle.

25. General Crew Comfort details

These have been submitted in Squadron Leader's reports and are worthy of consideration from a Technical point of view.

26. Instruments, etc.

The position of speedometer and ammeter should be changed to enable the driver to have an easy and continuous view, and at the same time a Revolution Counter should be incorporated on the same panel.

The position of the Electric Starter switch button should be moved to avoid the collection of dirt and dust, thus causing failures in operation. The general question of dust exclusion on electrical components seems to need consideration.

B. Sherman Tanks

1. Tracks

Synthetic Rubber Tracks appear to be reliable up to 1,500 miles at the controlled speed of the exercise viz. 22 m.p.h. The chevrons in this synthetic

rubber/

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rubber wear very rapidly from new and are not so effective from the point of view of gripping at much above 1,000 miles. It is appreciated that metal spuds or grousers can be fitted, but the time factor of fitting and removal has to be considered and their effect on mobility on the road is also concerned.

2. Suspension

Proved very reliable. Volute spring breakages are small and the springs are easily replaceable. Bogie wheel changes after tyre collapses are simple if gudgeons are free. In practice it is reported that wheel gudgeons and trunnion arm gudgeons are often found to be seized. There is no form of lubrication and therefore lack of maintenance is not responsible. In these conditions correct tools as used by U.S.A. ordnance are vital and necessary with Squadrons.

3. Sprockets

These have proved very satisfactory and easy to change, but wedges below fixing nuts can be difficult to remove, and supplies of these wedges should be available to be fitted when sprockets are replaced. Worn wedges make it impossible to fix sprockets tightly. The necessary tool should also be available.

4. Track Tensioner Spanner

This should be provided with a longer handle, as more leverage is required.

5. Top Rollers

A locking device seems necessary for the adjusting ring for bearing end float.

6. Engines

(a) G.M.C. Diesel. Synchronisation of governors was required frequently on two machines.

(b) Chrysler. All electrical equipment could be improved in quality, and a number of non-essential electrical devices could well be eliminated - normal oil pressure and water temperature gauges would dispense with a series of electrical indicators.

Numerous cases of disintegration of crankshaft vibro-damper mountings occurred and the necessity for the dampers does not seem clear.

Fuel and Petrol filter systems appear very efficient, but to judge by the numerous occasions on which they required cleaning, it seems that they should be larger in size. Purolator oil filter elements and A.C. oil filter elements proved most satisfactory and completed the entire exercise without replacement.

Distributor rotors are too tightly fixed and cannot be removed without fracture in most cases.

Spark Plug life proved very long, up to 2,000 miles and it is established that, all plugs can be changed with engine "in Situ".

Water Pumps - No trouble.

7. Electrical

Automatic Voltage control proved uncertain in performance throughout - with consequent wireless interference.

Numerous cases of lamp bulb failure were experienced, and it is not understood why normal bulb replacement is not made possible on the Tail lamps, instead of complete lamp assemblies having to be changed.

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8. Transmission

Propellor shafts gave no trouble due to the fact that joint nuts were given daily maintenance check - though this check established that tightening was definitely required particularly in the early stages.

9. Clutches

Only one machine had the full 1,000 miles check and in so doing, with engine removed, the clutch withdrawal was repacked with grease.

It is interesting to note that the remaining machines were also free from clutch trouble though this maintenance operation was not given to them.

10. Gearbox

One failure was experienced (Gamma 9) - it has been troublesome from the start due to excessive end float on the secondary shaft necessitating removal of the parking brake to prevent binding. The remainder of the gear boxes gave a reliable performance, and the known trouble of the past, viz stiffness in gear change at high temperatures, would appear to have been cured.

11. Final Drives, Steering and Brakes

It is not considered that the method of braking by use of steering levers is up to the desired standard, and crews have expressed a desire for a separate foot brake operation.

12. Steering Brakes

Very satisfactory, but the fitter adjustment is somewhat complicated.

(Sgd.) F.S. BARNES.

Lieut.-Colonel.

Officer i/c Records,
Exercise "Dracula".

L.F.V.
Chislehurst
25.9.43.

EXERCISE DRACULADAILY REPORT

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MOST SECRET32ND DAY OF EXERCISEDATE: 15 SEP 43.ROAD AND CROSS-COUNTRY
RUNNINGTIME: 0830 HOURS

ROUTE: (a) Cross-country WORGRET HEATH - lap of approximately 4.5 miles.
 (b) Road circuit - CLOUDS HILL - ALFPUDDLE - TOLPUDDLE - PUDDLETOWN -
 BLANDFORD - SPETTISBURY - PARK CORNER - BERE REGIS -
 ALFPUDDLE (Lap of 30 miles).

ROAD CONDITIONS: Cross-country - dusty - a few fairly steep short hills. Good
 Cruiser going. Road - chiefly fast main road some narrow,
 winding and hilly sections.

WEATHER CONDITIONS: Fine and cool all day.

GENERAL REMARKS AND SUMMARY:

For the remainder of the trial the above combination of road and cross-country running will be used, mileages each day being so arranged as first of all to reach the intended 25% cross-country running, and then to maintain this by doing the first 30 miles in each hundred across country and the remaining 70 round the road circuit. As the circuits used will be the same every day it is not intended to refer to them in future in the headings. Due to breakdowns and delays on the cross-country days earlier in the trial the percentage of cross-country mileage to total mileage is well below the 25% target on ALPHA 3 and 4 and BETA 6 and 8. These tanks therefore will have to clear this deficit before they do any more road work.

A large mileage is required in the next few days and machines will therefore run from 0800 - 1900 hours each day. On fine nights, with the moon full as at present, some night running may be possible. If necessary crews will work in relays.

No further records are being kept for GAMMA 9 or BETA 7A and 8A and the daily returns will be left blank in future for these machines.

Today GAMMA and DELTA tps and ALPHA 3 and 5 were able to put in a day's work, the other machines being still engaged on the 2,000 mile check and other repairs.

No serious trouble occurred mechanically though there were two incidents worthy of note. GAMMA 10 towed a Rota Trailer all day and at one point the trailer turned completely over and was pulled a considerable distance like this, the crew being unaware of anything wrong except that engine power seemed unaccountably down. They were finally stopped by wireless. The trailer naturally sustained some superficial damage to brackets, etc., but was able to run on after being righted.

During the afternoon on the road circuit DELTA 12A had a narrow escape from a serious accident. The driver, who had not been on this road before came unexpectedly to a sharp descent on a narrow road down into a village. He attempted to change down but missed the gear and as the vehicle was rapidly getting out of control he very sensibly steered into the tank ran up this and stopped within an ace of turning over on to its side. The angle was measured and found to be 38°. With a rope from the Scammel to steady it the tank was driven off the bank without difficulty.

GAMMA 10 stripped the rubber tyres off two bogey wheels which were therefore changed by the crew, and DELTA 12 was delayed by an ignition stoppage. ALPHA 3 suffered from overheating and radiators were blown through on last parade. As this tank has quite a bad, but unidentifiable, oil leak this may not be successful but tomorrow's running will decide the matter.

It is of considerable interest to note that, although the rubber bogey tyres and tracks on GAMMA and DELTA tps have shown signs of wear for many miles now, they have stood up well so far and it was not until the sandy Bovington country was reached that the tyres finally broke up on GAMMA 10. The explanation seems to lie in the high quartz content of the soil here and no doubt trouble may be expected soon on the other machines.

(Sgd.) F.S. BARNES.
 Lt. Col.

(Sgd.) A.C. RICHARDSON.

MAJOR GENERAL.

MOST SECRET

EXERCISE DRACULADAILY REPORT33RD DAY OF EXERCISEDATE: 16 SEP 43ROAD AND CROSS-COUNTRYROUTE, ETC: As already detailed..WEATHER CONDITIONS: Fine - cool..GENERAL REMARKS AND SUMMARY:

This day saw a variety of troubles on the British machines and although the final decision has yet to be taken it seems likely that OMEGA 1 and ALPHA 3 and 5 have "shot their bolt". The Shermans with a reliability which we now take for granted put in a long day's running without trouble.

OMEGA 1, as the day went on, suffered more and more from overheating and finally had to come in, stopping to cool off every few miles. Radiators proved to be badly oiled up due to an oil leak which was later traced to the fan pulley housing where seals and races are thought to be passing oil. In addition the N/S steering drum has traces of oil inside, and the inner output shaft seal is suspect. Estimate of time required for repairs, if spares were obtainable, is 2 days. OMEGA 2 put in 124 miles, the only trouble being with the footbrake which failed apparently due to hydraulic trouble though the actual cause could not be discovered. This will be watched tomorrow. ALPHA 3 had to come in early with a bad oil leak from the rear end engine seal. Repair time here, again if spares were available, is a full 24 hours. ALPHA 4 had to replace 2 fan belts on last parade but otherwise put in a good day of 160 miles. ALPHA 5, which has had an oil leak for some time, had to stop with a large quantity of oil in the hull. Eight gallons were required to top up. The leak cannot be traced without removal of gear box, clutch and radiators.

Summing up the Cromwell position, three out of the five machines cannot continue without extensive workshop repairs, and a decision will be made tomorrow, as to whether these shall be undertaken, though in two cases the spares position seems likely to be the deciding factor.

BETA troop had a better day than OMEGA and ALPHA but experienced some trouble. On BETA 6 the governor housing burst and to enable the machine to continue the governor was removed from BETA 7A and fitted as no spare was available elsewhere. This is the second governor to burst in this tank. BETA 7 only managed 40 miles before a bad water leak developed in the pump necessitating a change of this unit. A new one was obtained from the Fd Park detachment. BETA 8 did 125 miles the only trouble being the starter button jammed with dust. This button is well placed to collect dust on cross country running and it is for consideration whether it should not be repositioned to obviate this trouble.

GAMMA 10 was the star performer of the day with 161 miles run. This is an outstanding effort after over 2,000 miles and this machine now leads the field on total and cross country mileage and is only a few miles behind ALPHA 4's road total. GAMMA 11 during 140 miles had to change 2 bogey wheels on which the tyres had broken up. DELTA tp ran steadily only stopping for occasional cleaning of petrol filters and put in 110 - 120 miles each. It is worth noting that DELTA 14 has not yet needed any additional water in the radiator since the start of the exercise and level is still O.K.

The leading machines, despite the day's considerable mileage, have still 600-700 miles to do to reach the target of 3,000 miles. Time is now short and a proposal to put in a continuous 24 hours running is being considered. This would be run with only the standard halts for maintenance and would of course be a severe strain on the machines and would involve working crews in relays. It seems to be the only hope however of reaching the desired total in the time.

(Sgd.) F.S. BARNES.

Lt. Col.

O i/c Records,
Exercise "DRACULA"

(Sgd.) A.C. RICHARDSON

MAJOR GENERAL.

EXERCISE LOGDAILY REPORTMOST SECRET34TH DAY OF EXERCISEDATE: 17 SEP 43ROAD & CROSS-COUNTRYTIME: 0800 hours.ROUTE, ETC: As already detailed.WEATHER CONDITIONS: Heavy rain to start with - cleared later - cool.GENERAL REMARKS AND SUMMARY:

Another long day's work was put in by those vehicles which could stay the course. The longest mileage was actually 140 by GAMMA 10, but DELTA 14 put in 138 which is an excellent performance for a slower machine.

OMEGA 1 and ALPHA 3 and 5 were non-runners, and it has now been decided that for these machines the trial has concluded, time and spares not being available to put them on the road again. OMEGA 2 had to be brought in on the transporter with one cam shaft drive out of action. The engine was examined by the Rolls Royce engineer resident here and no damage was discovered, the failure of the drive being due to the nut and tab washer which secure the bevel to the shaft coming off. With the assistance of the Rolls representative repairs were carried out and the tank will be on the road again tomorrow. ALPHA 4 put in 127 miles, all across country, which brings it near to the required percentage.

BETA 6, after 15 miles, again stopped with the governor burst. This unit is, of course, the one which was removed yesterday from BETA 7A. In order to continue the trial it was decided to replace this with that on BETA 8A but, before fitting, the governor was dismantled and examined. It was found that exactly the same trouble would without doubt have occurred again within a few miles, the pins scouring the centrifugal weights being loose and about to drop out. This fault on CENTAUR governors has of course been well known now for some months, and it seems a most extraordinary thing that no efforts have apparently been made to put it right. A state of affairs such as this naturally causes the user to lose all confidence in the tank and its erectors and designers. This vehicle has also again stripped the union on the fan drive return oil pipe. This defect occurred first at Farnborough and was repaired by using a second hand housing. It is now throwing out oil in considerable quantities and though it will start out tomorrow it seems unlikely to last much longer.

BETA 7 ran steadily to begin with but suffered later from continual petrol stoppages, a trouble which has beset this vehicle throughout the exercise. The vehicle was kept going only by having a man in the turret continually juggling with the petrol tap control. The machine will go out again tomorrow but could not be considered battleworthy in its present condition and tanks and tap would have to be stripped to put it right.

On both these machines valve rocker box oil leaks are much more apparent, and radiator degreasing is obviously near at hand.

BETA 8 did 110 miles across country with no more serious trouble than steering adjustment and a loose electrical connection.

GAMMA 10 put in another good day though 2 bogey wheels had to be changed and a volute spring has fractured, though fortunately at the lowest coil. GAMMA 11 lost the rubber from 3 bogeys and when it came to replacing the third the axle was found to be seized and quite immovable. The tank was brought in on a transporter but will be a later starter tomorrow as bogey arms will have to be changed and a new axle and wheel complete fitted, which fortunately can be obtained locally.

This trouble with bogey wheels is, of course, due entirely to the fact that the tracks have been run on long after they were worn out. Many rubber plates are missing, inside and out, on both tanks and in several cases even the pins are beginning to crack up. The suspension and bogeys were never intended to stand up to this treatment and the natural result is break up of tyres and overheating which has caused the seizure on GAMMA 11. Owing to their lower speed on the road, DELTA 14 tracks are standing the strain better and it is hoped that they will just last the course. Two pairs of second hand tracks have been borrowed from vehicles off the road in the D & M Wing, A.F.V.S., and will be fitted as soon as possible to GAMMA 10 and 11 as it would take too long to obtain new ones from Bicester.

DELTA/

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DELTA tp ran steadily all day with only minor halts for cleaning petrol filters, though on 12A an oil leak has developed at the valve inspection cover on No.1 engine, where a new gasket is required.

To achieve the necessary mileage in the time available it has now been decided that all vehicles which can manage it will run throughout Sunday night next 19th. This will mean 36 hours continuous running (i.e. a.m. Sunday to p.m. Monday) and will be a heavy strain on men and machines. The results of this severe finale, coming as they do with leading machines around the 2500 miles mark, should prove of great interest.

(Sgd.) F.S. BARNES.

(Sgd.) A.C. RICHARDSON.

Lt. Col.

MAJOR GENERAL.

O i/c Records,
Exercise "DRACULA".

EXERCISE DRACULAMOST SECRETDAILY REPORT35TH DAY OF EXERCISEDATE: 18 SEP 43.ROAD & CROSS-COUNTRYTIME: 0800 HOURSROUTE, ETC: As already detailed.WEATHER CONDITIONS: Cool - heavy rain at intervals during the day.GENERAL REMARKS AND SUMMARY:

This day saw several more machines reach the conclusion of the trial owing to mechanical breakdowns. Apart from those vehicles already off the road, GAMMA 11 did no running during the day owing to repairs to the suspension and change of tracks. This tank was reported fit at the end of the day and will start on time tomorrow.

OMEGA 2 put in a steady day's running of 129 miles. ALPHA 4 did 107 miles before meeting with a serious accident and overturning on the road circuit. By great good fortune no one was injured but of course this means the end of the trial for this vehicle. No mechanical investigation has yet been possible so the exact cause of the accident cannot be established, but it appears that on a slight downhill right hand bend the tank failed to steer to the right and the foot brake also failed to act in time to prevent the machine from running up a high bank with a brick wall on the top. The machine turned completely over on to the turret and blocked the road. It was recovered with the aid of the Scammell and Diamond T and brought into camp on the transporter.

BETA 6 managed 51 miles before the radiators become so fouled with oil that the machine overheated seriously. It was also found that the engine had developed a violent vibration and the tank was therefore returned to harbour on the transporter.

BETA 7 ran 36 miles and then seized the clutch withdrawal mechanism. This tank also returned on the transporter.

BETA 8 after 74 miles first developed misfiring - traced later to plugs - and then overheated suddenly. After being allowed to cool, the tank was driven - still overheating - back to harbour. An attempt will be made to run again tomorrow but it is thought that the trouble may lie in the water pump and it seems probable that time will not allow the machine to do any more running in the trial.

GAMMA 10 did 30 miles across country, came in to change tracks, and then managed 30 miles on the road before dark. This vehicle needs a plate removing from each track which will make it a late starter tomorrow, but is otherwise fit and its crew is determined to put in a record mileage during the next 36 hours.

DELTA 12 did 132 miles without trouble, but 12A became a "Z" casualty after 9 miles and had to call on the transporter. A nut has somehow got into the gear case which houses the 5 driving pinions of the engines, has been caught up in the gears and broken a hole in the housing. It is thought that something else has also stripped inside the engine but no full investigation has yet been possible. DELTA 14 did 133 miles and only stopped to clean filters.

The end of the day therefore sees the list for the 24 hours run considerably reduced.

Starters will be OMEGA 2, GAMMA 10 (late) and 11 and DELTA 12 and 14. The leading vehicle - GAMMA 10 - has 2607 miles on the speedometer tonight and thus stands a very good chance of reaching 3000 by the end of the 20th. DELTA 14 may just manage it (2555 tonight) but the task appears rather too much for anything else.

(Sgd.) F.S. BARNES

(Sgd.) A.C. RICHARDSON

MAJOR GENERAL.

EXERCISE DRACULA.

MOST SECRET.

FINAL REPORT OF MECHANICAL FAILURES: "DRACULA" EXERCISE.Centaur Clutches.

Another instance of seizure of the clutch withdrawal bearings occurred at 2234 miles on Tank No. 7. The only Centaur which has not yet failed in this way is No. 6 which has run 2197 miles, previous failures being Nos 7A at 664 miles, No. 8 at 1773 miles, and 8A at 740 miles. It is noteworthy that in all cases the clutch fabric plates have worn very little and in only one case (No. 8 at 1773 miles, after renewal of the withdrawal bearings) have the adjusting shims been removed. On no Cromwells have the clutch pads been removed.

Liberty Engine governors.

The engine governor of Tank No. 6 fitted new on the failure of the original governor at 714 miles, failed in the same way after 1724 miles (governor life), i.e. by loss of a split pin from the bob-weight swivel pin nut, resulting in release of the nut and withdrawal of the swivel pin, giving unrestrained movement to the bob-weight which smashed its casing. A second hand governor taken from Tank No. 8A which had already run 840 miles was fitted. This also failed the next day after 90 miles. The governor of Tank No. 7A (which had run 766 miles) was then removed but prior to fitting to No. 6 it was stripped for examination and was also found to be on the point of failure in the same way. It was repaired before fitting and has not failed since.

It would appear that machining tolerances on the length of the bob-weight swivel pin (to the shoulder against which the nut is to bear) and the overall width of the bob-weight carrier jaws should be reviewed or more carefully inspected, as the retaining nut is evidently bearing against the outer face of the jaw and not against the shoulder of the bolt and is being loosened by "breathing" of the jaws. The split pins should also be more substantial and a better fit.

Liberty Engine water pumps.

Two instances have occurred on Tanks Nos 7 and 8 at mileages respectively of 2120 miles and 2195 miles of failure of the water pump carbon glands, which have worn right away leaving only a black slime round the inside of the pump gland casing. The resulting end movement had caused the outer edge of the impeller to bear on and wear the volute chamber casting.

Centaur Fan Drive.

The offside fan drive upper bevel box oil drain pipe of Tank No. 6 which enters the crank case by means of a union screwed into the fan drive shaft bevel housing again caused the union to strip the threads in the housing after a further 239 miles, in spite of the presence of a single flexible element inserted in the pipe prior to the beginning of the Exercise. As previously reported, this had already happened at 1856 miles when a second hand bevel housing was obtained and fitted in place of the original.

Meteor Engine camshaft drive.

At 2399 miles the engine of Tank No. 2 failed with loss of power. This was found to be due to the R.H. bank camshaft failing to revolve as the driven bevel on its end had come loose. This was caused by failure of the key and loosening of the retaining nut caused by breakage of the tab of the tab-washer. The bevel wheel was "re-lapped" on to the taper end of the camshaft, a new key was fitted, and the engine and tank returned to service.

Centaur/Cromwell gear change lever.

Another instance of a broken gearchange lever occurred at 2404 miles, this time on Tank No. 8. The failure consisted of clean fatigue fractures,

/starting

EXERCISE DRACULA.

MOST SECRET.

SHEET 2.

starting simultaneously from opposite sides, just where the steel shaft enters the brass handle. A second hand lever was taken from Tank No. 6 which had already run 2197 miles and was fitted to keep No. 8 running, although it too was found to be cracked about $\frac{1}{4}$ of the way through at the same point.

Conclusions.

The outstanding feature of the Exercise from a design point of view so far as Cromwells and Centaurs are concerned is the unsatisfactory nature of their steering and brakage system, in that these require constant attention, their adjustment is very critical, and consequently they are not reliable; and until a great improvement is effected the machines cannot, in my opinion, be considered battle-worthy.

The other consideration of importance is the poor accessibility of components requiring frequent attention, such as the lower Lockheed pipe connections, the radiator and the petrol cocks. Larger and more numerous access plates should be provided. More thought should be given too, to the possibility of removing certain components such as the main and steering brake drums and the sparking plugs without extensive dismantling of the whole structure.

Gear boxes have given little trouble, suspension troubles have shown that the tanks are overweighted, and failure of the power unit (in some way or another) has been the cause of withdrawing three Cromwells and one Centaur from the trials.

22 Sep 43.

(sgd.) K.G.G. Hunter, Major,
D.T.D.

Followed by
Supplementary Report on Spare Parts
details of 8 vehicles used for Stores
2-8-43 → 16-9-43

EXERCISE "DR. GULL"

MOST SECRET

REPORT BY TECHNICAL ADJUTANT - PERIOD 5- 13 SEP 43.

The results of the trial to date are not, it is felt, which might have been expected.

The Shermans suffered few of the troubles normally experienced in operating this type of tank, while the Cromwells exceeded those normally experienced. Centaurs ran as expected except that the clutches on the original three were a marked improvement on the early type.

It is considered that the Sherman crews generally were superior in knowledge of their machines and enthusiasm.

CROMWELL.

Tracks. The new strengthened track plate is quite satisfactory but the pins were a constant source of trouble. One or two Valentine pins were found to have stood up infinitely better as well as being more workable and capable of being rivetted over several times.

Suspension. No. 1 axle arms are not strong enough. Shock absorber caps must be properly locked. Roadwheels should be changed (inside to out) at 1000 miles to even up the wear, or axle arms should be offset to equalise the loading on the 2 wheels.

Tensioner. Cromwell I tensioner is excellent but more care is necessary to ensure freedom from seizure.

Cromwell III tensioner appears to have no feature to commend it and should be withdrawn from service. A simple adoption of Cromwell I could be made to fit this tank.

Engines. These have proved generally satisfactory but spring drives seem dangerous in the hands of unskilled drivers.
Spark plugs must be cleaned or changed at 1000 and changed at 2000.
All belts and hoses should be replaced at every 1000.
Fan gear casing location seems inadequate.
Oil pipes are too inaccessible and make any oil leak a major defect.
Water drain pipes caused trouble through fractures and should be done away with in favour of evacuating pump.

Gearboxes. These late type boxes gave no unusual troubles. Output shaft seal housings were in many cases found loose which completely neutralized improvement in oil seals.

General. Gear-change levers are not strong enough.
Electrical equipment is not properly protected from dust.
Switch box should have detachable front and all connections soldered.
Radiators are quite inaccessible but larger foreign matter such as grass could be excluded by easily detachable grills on the intake louvres.

CENTAUR.

Engines. These proved subject to a variety of oil leaks and it is felt that the design of the Rocker gear makes this engine quite unsuitable for tank work unless it can be isolated from all other parts of the tank.
The fan drive does not appear up to its job and any repair is most difficult to carry out.

Oil change at 500 miles would be a great disadvantage operationally and a larger oil filter seems essential

CLUTCHES. These have worn much better, but the withdrawal mechanism seems as unreliable as ever.

Gearboxes. (C Type). These are quite unsatisfactory the output shaft bushes having too short a life, leading to oil leaks past the distorted oil seals.

/Suspension

- 2 -

Suspension etc

As Cranwell.

SHERMAN IIITracks and
Suspension.

The rubber tracks shed their treads complete causing hammering of the bogeys, which would lead to early failure of the tyres, if permitted to continue.

Tyres have to be 'nursed' in hot weather.

Volute springs appear to have little safety margin.

Engines and
Clutches.

These were satisfactory subject to regular attention to synchronisation of clutches and governors.

Electrical.

Equipment is not very reliable and does not appear up to British standard.

Gearboxes.

One failed due to pinions fracturing, but trouble was expected from synchronizers which are apt to get very stiff when box heats up.

Steering.

It is found almost impossible to carry out adjustment as laid down owing to inaccessibility, but good results were obtained in spite of this.

SHERMAN VTracks and
Suspension.

As above.

Engines.

These have been generally satisfactory.

Vibration dampers started to separate at rubber mounting from 1800 and were removed.

Electrical.

Equipment is unreliable.

Clutches.

Satisfactory. New type withdrawal is great improvement.

Gearboxes and
Steering.

As above. No failures.

(sgd.) J.H. CRASS, CAPT.

D & M Wing A.F.V.S.

Technical Adjutant,

Exercise "DRACULA".

14 SEP 43.

APPENDIX
SUGGESTIONS FROM TANK CREWS

CROWEELL AND CENTAUR.

Driver's Seat - Requires modifying for free movement and made easy to remove for cleaning purposes! should also be adjustable for height (on the lines of the Matilda?) as very few drivers find that they can use the periscopes when closed down without using a blanket or overcoat (which are not readily available) to raise them in the seat. The position when opened up is excellent and drivers do not wish to be any higher unless closed down. Alternatively can periscopes be made adjustable? Driver requires more support in back of seat.

Driver's Vision Port - Should have a detachable mica - glass (Triplex) or talc screen with a wiper. May not be used in battle but hours and days of acute discomfort and any amount of water and dust could then be avoided on training and approach marches.

Mud Flaps - On front should be shorter and the side valances stronger. Rubber (synthetic) should be the material for the larger half in front as metal becomes bent and torn in a very short time. Spare mudguard scale should be increased as most Tanks become an inferno of dust and wet mud after being driven across country for a short distance and having crossed a stiff obstacle and replacements are almost impossible to acquire.

Commander's Control Box - Must be placed where the Commander can reach it conveniently - e.g. half way up on the left hand side of the turret.

Bulkhead - between Driver and Hull Gunner should either be padded or done away with.

Stowage Bin - A large stowage bin should be fixed to the rear of the Turret.

Drivers and Hull Gunners Doors - Drivers doors should open forward in front so that he can get out with the turret and gun in any position; Hull gunner's door should be enlarged so that a full sized man in equipment can get in and out easily. Can handle on outside of present driver's door be fitted?

Head and Brow Padding - Required for both driver and hull gunner: top, back and front.

Dump Valves - Access plates under both driver and hull gunner would be an improvement.

Periscopes - Hull gunner requires a periscope.

Screen between driver and hull of Tank - Could a canvas screen be fitted (with press studs) so that the driver's compartment is screened from draught, cold and dust from the turret.

Hull Gun - Ball mounting with direct vision telescope is a vast improvement. Gun requires fitting further forward so that gun can be cocked more easily. Dust cover required for Hull gun.

Turret Guns and Turret - Can M.G. be on right side of main gun as hitherto. Turret Gunner requires an adjustable and more comfortable seat with back support.

Control Box Operator - Suggest that the relay switch on the operators control box be made a different shape (square?) to the other switch to avoid the oft made mistake of using the wrong switch.

Commander's Seat - Generally disliked. Commanders require a 6" adjustment for varying heights. At the moment the seat when up requires too much "fixing" to get it to the down or lower position. One must have an adjustable seat that will permit individual adjustment in both the up and down positions. Further the change from up to down must be able to be done in a flash. Suggest a spring loaded pillar with a foot pedal as being an improvement but not ideal.

/ Chain for Co-ax cover.

2 One gunner reported seat not high enough for him to use telescope (5' 3").
Details of the above mentioned guns are given at Annexure "B".

Chain for Co-ax Cover - At the moment the chain is only correct when the gun is in the horizontal position. Suggest lengthening the chain and have several rings to give required adjustment.

Gloves - Drivers require asbestos type gloves in kit so that they can make adjustments when components are hot.

Grease gun - As supplied not satisfactory. A much better one is required.

Racks - Required for spare track links. The only place for them at the moment is along the rear ventilator opening which tends to produce overheating by restricting free air exit.

Aerial Base - Requires sinking or having an armoured "lip" surrounding it. Very vulnerable at the moment.

Gunner's Periscope - At the moment prevents brow pad being in correct adjustment.

Operator's Periscope - Too far forward.

Microphones - Present capsules give a lot of trouble.

Speedometer - Can this be more accessible and better lit, and a Revolution Counter similarly fitted.

Rain Gutters - Better without unless they can be improved as at the moment they send a steady stream down commander's neck.

Loader's Seat - Most uncomfortable.

General.

1. Armoured covers for petrol and oil filters are very awkward and difficult to remove - a simple screw thread would be easier.
2. Larger trap doors instead of many small ones over engine would be easier. Could not hull access plates be larger and fewer.
3. Switchboard rather inaccessible.
4. Could petrol taps and ki-gas be fitted in drivers compartment.
5. Could revolver ports be made so that they would hold open on a catch.
6. Could not a full length cleaning rod be supplied for the 6 pdr.
7. Could the present holes in the hinges of turret flaps be obviated. Protection from the flaps is nullified by two quite sizeable holes often opposite the commanders eyes.

SHERMAN.

Commanders Position.

1. The seat should be larger and adjustable or fitted lower.
2. Foot rests required to prevent Commander kicking the gunner when travelling across country.
3. Two hand grips in Turret roof (as on Crusader) for travelling when standing up.
4. Turret flaps, without periscopes, to be flat giving all round vision when travelling with only top of head out of turret and front flap closed.
5. A map rack fitted to take map board when not in use (as on Crusader).

Gunnery Position.

1. A nose pad is required on the bottom of the gunners periscope to prevent grazing.

2. One gunner reported seat not high enough for him to use telescope (5' 3").

Details of the above mentioned guns are given at Annexure "B".

- 3 -

Operators Position.

1. Seat should be larger and padding is required for the operators back as there is nothing to prevent bruising when moving across country.

Co-Driver. - NIL.

Driver - Heel rest or cup for accelerator foot as the foot is frequently jolted from the pedal when going is rough and revs are consequently lost.

General.

- a) No magazine racks for Sten Gun - Sten mags won't fit into Tommy Gun racks.
- b) Most Tanks have only 2 75 mm. cleaning rods making the whole about two feet too short.
- c) All periscopes let water in. On latest type of tank a rubber wiper is fitted to the front of the periscope mounting. If this was fitted all round it should give a flexible seal.
- d) The three ventilators let water in badly. If the drain holes were larger (say $\frac{1}{2}$ ") rain would not collect in the quantity it does now with $\frac{1}{4}$ " holes.
- e) Brackets might be fitted on the front on Tank to take the six spare track plates and give more stowage room inside.
- f) Very few tanks arrive fully equipped and the straps for scouring the exterior tools and tarpaulin are missing, with consequent losses when gear is tied on with wire and rope.
- g) A bin for stowage on the back of the turret would be of great value.
- h) The brushes - 11" 11 $\frac{1}{2}$ " and 12" for cleaning the engine and turret are too clumsy and it is the practice of most Troop and Tank Commanders to buy out of their own pockets ordinary paint brushes, the most useful sizes being 1", 2" and 4".
- i) Could wooden battery covers be fitted?
- j) Is there a more convenient way possible for filling up with engine oil (Petrol.S).
- k) Can torsion bars be fitted on covers.
- l) Can a 2 pint oil can be included in the tool kit.
- m) Are two hatchways instead of one possible for engine covers.
- n) Spare capsules for microphones need increasing.
- o) Retaining lip required on wireless set platform to prevent gear from slipping forward.

MOST SECRET

EXERCISE DRACULA

To:- Lt Col F.S. Barnes,
Officer i/c Records,
Exercise "Dracula".

SUGGESTED IMPROVEMENTS ON SHERMAN TANKS.1. Commander's seats and vision.

- a) Both must be adjustable.
- b) The top seat should be no higher than to allow the commander to have his eyes above the level of the turret.
- c) The flaps for the turret should fold right back to allow for an all round vision.

2. Operator's seat.

- a) Should be larger. Suggest about same size as gunners.
- b) Should be adjustable.
- c) Should have a back rest to prevent his back being hurt when going across country.

3. Neither the commander nor the operator have much to hold on to. Suggest handles such as fitted for the commander in Crusaders.

4. When closed down the fumes from the gearbox become highly nauseating and even when not closed down the operator suffers from this complaint.

5. Drivers and Co-drivers flaps.

These are difficult to close from the inside and it is necessary for the men to rise partly out of the tank to do so. This I consider most undesirable. As suggested torsion bars would be suitable but if anything like those fitted to the Valentine will not last long.

6. Periscopes.

These need a handle so that they can be turned around easily and quickly.

7. Battery covers.

These are of metal and have no handles which makes them difficult to remove without causing a direct short across the terminals.

(Sd) D.M. HALL Lieut.
Troop Leader,
Sherman M4A4 Troop,
Exercise "Dracula".

Bovington Camp.
21 SEP 43.