PAMPHLET ON THE DISTANT CONTROL OF A TARGET SHIP.

(H.M.S. "AGAMEMNON").

D/C GEAR AS APPLIED TO H.M.S. "AGAMEMNON".

GENERAL REMARKS.

H.M.S. "AGAMEMNON" commenced fitting out as a target ship on December 10th, 1920.

As far as the D/C gear is concerned, H.M. Signal School, Portsmouth, supplied the W/T gear, A.T.M. Co., selector and all steering gear. Chatham dockyard fitted up the Signal School instruments and produced and fitted the gear, beyond the selector, for controlling the engines and oil fuel valves.

It was originally intended that the ship should be ready for first trials by April 8th. Owing to the strike, however, this date was not adhered to.

H.M.S. "AGAMEMNON" actually commissioned on July 12th and sailed for Portsmouth on July 25th. The first trials of the steering gear were carried out on the passage round, W/T not being used.

During the early part of August seagoing trials for the adjustment of gear were carried out, H.M.S. "ANTRIM" having been fitted for controlling. H.M.S. "ANTRIM" being, however, required for other services, H.M.S. "TRUANT" was fitted for transmitting and took her place.

On August 19th Admiralty decided aircraft bombing and machine gun trials were to commence on August 25th, the three weeks practical testing asked for by H.M. Signal School being dispensed with.

During

During the preliminary trials on August 23rd and 24th everything in H.M.S. "AGAMEMNON" worked well, a few "Pea" valves only failing. On August 25th, a few more valves went.

On August 26th, all valves failed and the cut-out panels required modification. The bombing trials were, however, successfully carried out.

Arrangements were then made to collect every available "Pea" valve and an alteration was made to the cut-out panels, which it was hoped would put these right. These were tried out on August 31st with some success. No further "Pea" valves being in existence, trials were commenced with a view to utilising and, if successful, producing Signal School valves.

On Sept. 7th and 8th H.M.S. "SNAPDRAGON" was fitted for controlling and tried out. Excellent results, as far as H.M.S. "SNAPDRAGON" was concerned, were obtained, but more "Pea" valves failed and trials had to be stopped in order to retain sufficient valves to carry out the two machine gun trials arranged for Sept. 9th.

On Sept. 9th the machine gun trials were successfully carried out. This was the first occasion on which H.M.S. "AGAMEMNON" was completely abandoned.

The work of producing Signal School valves and altering the panels to suit them was proceeded with, so that a seagoing trial could be carried out on Sept. 21st, on the results of which a report as to the condition of H.M.S. "AGAMEMNON" was to have been forwarded, with a view to her being sent north for the Atlantic Fleet firings.

On Sept. 20th the Commander-in-Chief, Atlantic Fleet, reported that he would not be ready for H.M.S. "AGAMEMNON"

until the beginning of November, so the trials of Sept. 21st were cancelled and the cut-out panels were still further improved.

In a demonstration which was arranged to take place on October 13th, the inner disc of the dummy rudder of the steering gear seized and the securing pin fractured on the first alteration of course. This put the steering gear out of action but the engine control was successfully operated from slow to full speed and down again.

The Signal School valves (D I X) were on the whole satisfactory, but owing to various circumstances, were very irregular in operation. A specification of the valve required was, however, produced, and the manufacture of the valves put out to contract. The first consignment of the contract made valves were tried out on October 18th and proved satisfactory.

As a result of the trials of October 18th, it was decided that H.M.S. "AGAMEMNON" was in a fit condition to go north to act as target ship for the Atlantic Fleet, and the Commander-in-Chief, Atlantic Fleet, was so informed on October 19th.

One point with regard to H.M.S. "AGAMEMNON'S" gear still remains to be decided - whether the W/T gear as a whole will stand the shock of shells bursting in the ship. No conditions approaching the shock to be expected from this cause can be manufactured for experiment, but the receivers and aerials have been subjected to a severe hammering with a sledge hammer without ill effects, and a 7.5-inch projectile (200-lbs.) was dropped several times on the deck over the control rooms, without showing the least sign of interfering with the operation of the gear.

It remains to be seen that the effect of the shells will be, but as there are eight aerials and receivers fitted, it is considered probable that control of the ship is unlikely to be completely lost, although it may be necessary for the controlling ship to circle round H.M.S. "AGAMEMNON", in order to find which aerials are still in working order.

With a view to reducing the chances of damage by shock to all the aerials, two have been fitted, one over the stem and one over the stern, the remainder being distributed to the best possible advantage over the midship portion of the ship.

An indicating device is being fitted which will show at a distance whenever a control signal is received. This device is of primary importance for testing purposes and is fitted in the conning tower.

REMARKS ON HANDLING THE SHIP BY THE COMMANDING OFFICER, H.M.S. "AGAMEMNON".

Steering. H.M.S. "AGAMEMNON" is undoubtedly a difficult ship to steer under the best conditions, taking a lot of steadying once she gets a swing on. The control gear is quite satisfactory and keeps the ship, once she has steadied, within about a degree of her correct course.

When altering course the ship will take a considerable time to finally steady; she will swing 5 to 8 degrees past the course and then comes back about 5 degrees past it, and continues yawing a gradually lessening amount until steadied, which takes anything up to five minutes.

With much wind on the bow, when the ship would ordinarily carry "weather helm", it is found that she steers a course about 5 degrees to windward of the course signalled.

Engine and Boiler Room Controls. The results of the various trials carried out with the engine and oil fuel pump W/T controls (5 in number) show that these controls are now satisfactory.

In regulating the engine and oil fuel pumps a gradual increase or decrease has been aimed at, so as to avoid, as far as possible, fluctuations in steam pressure and water level of boilers, and varying conditions for the auxiliary engines which are not under control and are unattended.

With steam in all boilers any delay between abandoning ship and commencing to work up the speed of main engines should, if possible, be avoided.

THE D/C GEAR AS APPLIED TO H.M.S. "AGAMEMNON".

THE SELECTOR. (Photo. No. S.S.309).

All controls are effected by operating by W/T a 100-line telephone selector. This is an instrument by the Automatic Telephone Manufacturing Company as used in the automatic telephone system on shore. It is operated by W/T impulses through a relay switch, or by a dial switch on the fore-bridge for local working.

The selector is built up to the required number, energises that contact and, for a steering control, remains there, although the sending switch is put to "OFF", until the circuit through the alter-course disc is broken. For the speed controls an additional relay has been inserted, which allows the selector to drop off on breaking the sending switch.

The numbers used for steering are from 00 to 35, corresponding to 360° of the compass in 10° steps. Thus 06 = 60° (true C°), 27 = 270° (true C°), etc.

The numbers from 50 to 99 control the speed of the ship or are used for testing purposes. There are 15 spare contacts not at present used.

The operations beyond the selector and the W/T gear for working the selector are as follows:-

(A) THE STEERING GEAR. (Figs. 1 and 2).

The alter-course disc (photo. No. S.S.431), is divided electrically into two halves and is surrounded by 36 fixed contacts, set 10° apart. Each contact is connected to a terminal on the selector board, so that the dialling of a number energises that contact on the alter-course disc. The current

flows through one half of the disc and operates through a reversing switch, a 30-volt motor, which rotates the disc until a segment of insulation comes under the energised contact, when the circuit is broken, the motor stops, and the selector drops off.

The steering disc (photo. No. S.S.431) has two brass contact rings on its surface. The outer ring is divided electrically into five small contacts and two large ones, over which works a contact finger. The inner strip and its fingers will be dealt with later.

The finger is driven, through differential gear by the 30-volt motor operating the A.C. disc, and by the gyro compass.

The outer ring contact segments are connected to corresponding contacts surrounding the dummy rudder.

The dummy rudder (photo. No. S.S. 429), which name includes all the gear mounted above the steering motor, consists of an inner and outer revolving disc. The inner disc is divided in half electrically and is driven by the steering motor, its movement being proportional to the movement of the steering wheel. The outer revolving disc carries seven "Officer-of-the-watch" contacts which bear on the inner disc, and it is rotated by a 30-volt hunting motor. Outside the outer ring are seven fixed "Quartermaster" contacts, which bear on a conductor round the periphery of the outer disc. This conductor is also divided in half electrically.

The electrical action of both these discs is a repetition of the electrical hunting gear already described for the alter-course disc.

The positions of both officer-of-the-watch and quarter-

master contacts are adjustable and are so arranged as to give a maximum of 15° of helm for altering course, while a combination of the two sets of contacts can give full helm (35°).

A safety arrangement has been fitted, which prevents the helm being jammed in an endeavour to put it over too far.

The steering motor (photo. No. S.S.429) drives, through a bicycle chain, a sprocket wheel which is connected to the ship's steering wheel in the lower conning tower, by inserting a pin. This pin is so arranged that it can easily be removed in case of emergency when testing the gear under-way at sea.

Various relay switches are employed. Reversing relays are fitted to the steering motor and to the two 30-volt motors operating the outer disc of the dummy rudder and the alter-course disc.

The action of the gear is as follows:- (Figs. 1 and 2)

Suppose the course steered to be 360° and it is desired to alter course to 90°. All discs and pointers are central and the helm is amidships.

(a) Switch on. This sets the selector ready to operate.

(b) Dial 09. This builds up the selector and energises the 90° contact outside the A.C. disc, which operates the relay and starts the motor driving the A.C. disc and the pointer over the steering disc, both of which commence to rotate.

(c) Switch off. This does nothing but prepare the way for the next signal, as the holding-on relay is keeping the selector in place.

Directly the pointer on the steering disc moves off the 0 contact, current flows in turn through contacts 2, 4 and 6 on to the corresponding officer-of-the-watch contacts. The dummy rudder inner disc hunts limits each in turn, finally putting on full port helm.

In the meanwhile the A.C. disc has limited the 90° contact and stopped the 30-volt motor. This allows the selector to drop off.

15° port helm being on, the ship starts to swing to starboard, and the gyro compass, through the step by step motor, begins to replace the steering disc pointer in the central position. As the finger passes over contacts 4 and 2, the corresponding officer-of-the-watch contacts are energised and the helm is eased. When the ship reaches her new course the helm is amidships and directly she passes it, opposite, or meeting, helm is applied to bring her back.

This arrangement would cause a very sinuous course and it would take a long time for the ship to settle down on any new course. To overcome this and to steady the ship more quickly, the anti-swinging gyro is introduced.

The Anti-swinging gyro (photo. No. S.S.302) is fixed with the axis of rotation of the wheel in the fore and aft line of the ship. It is rigidly held from precessing in a horizontal direction, consequently, when the ship alters course, the gyro tends to precess about its horizontal axis or to "topple". This toppling is restrained by carefully adjusted springs, so that the rate of swinging of the ship can be approximately measured by the amount of movement of the axis of rotation of the wheel in the vertical plane. A pointer is attached to this axis and works over three electrical contacts on each side of a central contact. Each of these is connected to a corresponding quartermaster contact of the dummy rudder.

The smaller finger attached to the large pointer working

working over the steering disc is so arranged, with its contact strip, already mentioned, that current is only allowed to flow through the anti-swinging gyro pointer when the ship is within 36° of her course. This angle can be varied by using fingers having a different spread.

The effect of the anti-swinging gyro is this:- (Figs. 1 and 2)

As the ship approaches her new course (90°) and arrives within 36° of it, the 5th. quartermaster contact is energised. The hunting motor then causes the outer ring to hunt this contact, thereby carrying the officer-of-the-watch contacts clockwise. The inner disc still hunts the No. 6 officer-of-the-watch contact, and consequently the helm is reduced.

As the other contacts in the steering disc are energised and the rate of swinging of the ship is reduced, the effective helm used becomes a compromise depending on the energisation of both officer-of-the-watch and quartermaster contacts, but meeting helm can only be put on when the ship has reached her new course. By a suitable adjustment of the position of these contacts, it can be arranged that the over swing beyond the new course is limited to about 5° or 6°.

The course steered when steady may vary as much as 3° or 4° each side of the true course, but this must be accepted.

(B). SPEED CONTROL GEAR. (Photos. Nos. S.S.630 and 631).

The principle by which the control of engine speed is obtained is similar to that employed for working the steering wheel already described.

There are five valves to operate, the two main steam regulating valves in the engine rooms (photo. No. S.S.631)

and the spring-loaded by-pass valves on three oil fuel pumps, one in each boiler room, (photo. No. S.S.630). Each valve is fitted with a disc, similar to the inner disc of the dummy rudder, having ten contacts around it each energised by a separate line from the selector through a relay. The disc hunts the energised contact, the control motor opening or closing the valve to the corresponding position.

It will thus be seen that 50 controls are employed.

In the case of the regulating valves, the control motor is geared by sprocket and chain, to a worm-wheel which may be clutched to the valve spindle.

The control motor on the oil pumps works directly through a worm on to the adjusting nut and thus varies the pressure on the spring. The "stop" position of the disc corresponds with the minimum pressure on the spring.

The electrical system is shown diagrammatically in Fig. 3.

The holding-on coils in the relays keep the relays on until the disc has turned to its proper position.

SAFETY ARRANGEMENTS.

The following safety arrangements are fitted:-

1. In the event of failure of the W/T gear, to stop the ship.

This is obtained by means of a clockwork mechanism which, at the end of 15 minutes, will close a circuit energising the "stop" position contact of the two regulating valve discs. This closes off the steam from the main engines.

Every W/T signal that is received resets the clockwork so that the safety gear will operate 15-minutes after the last signal is received.

2. In the event of failure of the main electrical supply, to stop the ship.

When the main current is cut off, a local battery is automatically brought into play which again energises the "stop" position contact of the two regulating valve discs.

(C) W/T TRANSMITTING GEAR.

SHORT WAVE W/T GEAR.

General.

The wavelength utilised for W/T control of H.M.S. "AGAMEMNON" is 10 metres and, although the apparatus for the production and reception of these waves is still in its infancy and a matter of laboratory research, one particular condition which is a vital necessity to the operation of the control system is, at present, satisfied only by the employment of these short waves. This is the immunity from interference, either from longer wave transmitting sets or from atmospherics, without which no reliable control can be maintained. Hence the use of an undeveloped W/T system in preference to one of the standard types.

The chief disadvantage which make satisfactory control

by means of short waves a matter of some difficulty, lies, from the point of view of reception, in the extremely directional properties of the waves. This makes it necessary that receivers should be arranged so that signals may be received by some combination, irrespective of the direction whence the latter may emanate. From the point of view of transmission, special apparatus is necessary and the position chosen for the transmitter must be well clear of the iron of the ship. Also, from both points of view, the limited ranges obtainable (1 to 3 miles) and the unexpected effects due to screening by, or reflection from, stays, funnels, casual awning stanchions and the like, all go to make the selection of positions for both transmitter and receiver a matter for very careful consideration.

The diagrams (Figs. 4 and 5) are reproduced here as an example of these latter effects. Fig. 4 is a polar diagram showing the received current in H.M.S. "AGAMEMNON", while H.M.S. "SNAPDRAGON" astern of her, turned through 32 points. The pecked circle shows the limit (1 milliampere) below which the relay will not operate. The curious dips which occur at 40° and 300° of swing are apparently due to stays on the reciprocal bearing behind the transmitter, while the decrease from 150° to 220° is due to almost complete screening by the funnels. The range in this case was about 1-1/2 miles.

Fig. 5 shows a polar diagram of H.M.S. "AGAMEMNON'S" first swing round 32 points with various aerial deficiencies noted.

This will serve to show how necessary it is to have a maximum number of aerials available for any particular

bearing, quite apart from the question of having a reserve in case a number get shot away.

The ships in this case started in single line ahead, H.M.S. "ANTRIM" (the transmitting ship) being about 1-1/2 miles astern.

The pecked circle as before shows the limit of operation of the relay, and it will thus be seen that under these conditions H.M.S. "AGAMEMNON" would not have been under the control of the transmitting ship except when the latter was bow on to her and bearing from red 50° through right ahead to green 100°.

This is a situation which quite possibly might arise during firing.

Transmitting gear. Power is supplied from an alternator of the type fitted for Fessenden sound signalling apparatus. This gives about 220 volts at 500 cycles. A Type 9 transformer is employed to give the necessary voltage for the spark gap.

In H.M.S. "SNAPDRAGON" the alternator is fitted down below aft, and the transformer on the forecastle at the foot of a wooden platform upon which is placed the transmitter box with the gap and aerials. (Photo. No. S.S. 650).

The pressure gap contains the whole oscillating circuit. The actual spark passes internally between the base plate and one plate of the condenser, which is formed by concentric cylinders inside. The necessary inductance is provided by the flat strip outside to which the aerials are attached. The length of strip between the points at which the aerials are connected compared with the whole length of the strip governs

the

In this form of gap it is necessary that the spark length should not be more than 1 mm., and as it only requires about 5000 volts to break this down, the internal pressure is raised to 250 lbs. per square inch to increase the energy of discharge which at this pressure takes place at about 25 000 volts.

Experiment has shown that the best results are obtained with an "L" shaped aerial. The legs are telescopic and have to be adjusted in length for best radiation. Their length does not affect the transmitted wavelength but only the energy radiated.

The aerial current in this set, as fitted in H.M.S. "SNAPDRAGON" is about 1.5 amperes, and the range of reliable control about 2 miles.

Operating. The ultimate effect of the transmitter is to operate the telephone selector, and a dial switch, identical with those used with the automatic telephone on shore, is employed to control the current. On the dial board is a small tumbler switch which is switched on before making any signal; this operation completes the transmitting circuit and corresponds to lifting the receiver off the hook in the telephone. Two numbers must be dialled successively for each control signal, and, as the dial runs back after the dialling of each number it breaks the transmitting circuit a corresponding number of times. At the receiving end these breaks operate the receiving and intermediate relays which in turn build up the selector until the required line is energised and the main steam valve, oil fuel valve or course gear is operated accordingly.

(D) W/T RECEIVING GEAR.

The form of the aerials may be seen from the photographs Nos. S.S. 626 and 467.

There are eight of these, one on the fore turret, one at either side of the fore superstructure, one on either beam on boat deck, one on either quarter in main top and one on the after turret. There are also alternative positions for the foremost and after aerials over the stern walk and over the stem.

The signals are actually detected by the small valve in the ~~aerial~~ and are amplified to work a receiving relay in the W/T control room.

The aerials are all in parallel and their leads are taken as far away from each other as possible, until they get below armour. One aerial is sufficient for control.

To avoid damage to one aerial interfering with the working of the others, a special cut-out panel is fitted to each aerial. These panels are so designed that a burnt-out valve filament, a short-circuit, or a break in any of the aerial leads will cause disconnecting switches to break and thus entirely to isolate the damaged aerial.

Below the disconnector switches the panels are paralleled and the received current is stepped up by a three-~~valve~~ amplifier, rectified through two parallel valves, and made to work the receiving relay. (See photo. No. S.S.469). This requires a change of current of 1 milliampere.

The receiving relay in turn works an intermediate relay which deals with the larger currents necessary for operating the selector in the control room.

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ADDENDA TO PAMPHLET NO.M.129 ON THE DISTANT CONTROL OF A TARGET SHIP (H.M.S."AGAMEMNON").

Page 4. "Pea" valves have now been replaced by D1 valves manufactured by Messrs.Cossor. Despite the failure on test of the last consignment of these valves, "AGAMEMNON" will be provided with a reasonable percentage of spares.

Page 6. New indicating gear has been fitted right aft on the Q.D., which, if damaged by the firing, will not effect the remainder of the D/C gear.

Page 7. When altering course, the overswing is usually not more than 3° - 5°.

Page 12. The overswing beyond the new course is now about 3° - 5°.

The course steered when steady may vary up to 3° or 4° each side of the true course, but in fine weather this is generally under 2°.

Page 14. The safety gear to stop the ship in the event of failure of the W/T gear is now arranged so that after about 15 minutes from the last W/T signal being received, the oil pressure to the boilers is reduced to a minimum. Two minutes later a Very's light is fired and after a further three minutes the main steam regulating valves to the main engines are closed

Page 15. Diagrams 4 and 5 were taken in 1921, "SNAPDRAGON"

being fitted with a S/W spark transmitter 7F.

Diagram 4 (a), taken in August 1922, shows a very similar state of affairs, but worked out on a basis of control range instead of strength of signals. "SNAPDRAGON", for this diagram, was fitted with a 1.5 KW. S/W transmitter 7H.

Page 16. The transmitter 7H now used in "SNAPDRAGON" consists of a Fessenden alternator supplying power at 200 volts to a transformer fitted in a box in the wooden platform forward. The transmitter box contains a T21C valve and the aerials used are the same as with the spark set.

The aerial current is now 5 to 6 amps., but the range of reliable control is still found to be much reduced on certain bearings, see diagram 4 (a). It is up to, or over, 2 miles on either beam, about 1-1/2 miles right ahead, while there is an arc on either bow when it is down to less than 1000 yards.

This effect is much more pronounced than was expected, it having been anticipated that the extra radiation would minimise the effect of the "blind arcs" by a greater all-round increase in the strength of signals.

Page 18. With a view to making possible the tracking down of the cause of any failures in control which may occur, a recorder has been fitted which records every movement of the receiving relay. All stray "clicks" which reach this relay are shown as well as all proper signals. If a failure occurs, the recorder shows whether it was due to an incorrect W/T signal, or whether the fault lies in the selector or beyond.

An additional safeguard against stray interfering noises has been added in the "click trap". This is a delay relay which requires a definitely persistent signal before it will operate and allow any following signal to go on to the selector.

In all the preliminary trials, only once has a stray click got through to the selector, and this was made possible because the click happened to coincide with a control signal. The recorder showed the effect very clearly.