The Type "21" U-Boat

(By Our Naval Correspondent)

No. II—*(Continued from page 5, July 6th)*

The Schnorkel

THE type "21" U-boat has no gun armament for surface work against ships, but built into the streamlined structure of the bridge, both fore and aft, are power-worked turrets, each mounting twin 28 mm. cannons. Here is aircraft practice adapted to form the anti-aircraft armament of a U-boat. It may be very effective, but the turrets are difficult of access and the gunners must stand a very good chance of being drowned if the U-boat has to dive in a hurry.

In the after part of the bridge on the starboard side is the "schnorkel." This is of the latest telescopic type, comprising a tube for the air intake when submerged and also an exhaust pipe. It is smaller in section and much less cumbersome than the earlier types of schnorkel, which were pivoted at the foot of the conning tower and were lowered like an arm into a slot in the fore casing when not in use.

The top of the schnorkel in the type "21" U-boat is dome-shaped, about 1ft. wide and between 2ft. 6in. and 3ft. in length fore and aft. Within this top casing is the anti-flood valve, which is operated by a floating ball. This is exactly the same ball valve principle that is used in the ordinary sanitary arrangements, except that in this case the ball has inclined planes fitted on each side to make it more sensitive to the wave motion when the U-boat is travelling through the water at the normal "schnorkeling" speed of about 7 knots. In any sea, of course, the valve would be "chattering" all the time, but even so, water does not pass down the schnorkel into the submarine.

The system of a valve directly controlled by a ball float is ancient and is simplicity itself. Yet the whole principle of the schnorkel was for long deemed to be impossible because it was thought that any form of air intake from an orifice thrust above the surface of the water must inevitably be subject to flooding by every wave.

The top of this latest type of schnorkel as fitted to the type "21" U-boat is made of a light alloy. The actual valve is under a metal dome and the ball float trails astern and is protected by an extension of wire mesh against weed or wreckage. The solid part of the dome has a surface made of intersecting raised ribs, between which there are recesses about $\frac{3}{4}$in. square. These are filled with rubber insertions. This form of surface is an anti-radar device.

On the top of the schnorkel dome there is a small wire cage, about 8in. in diameter and some 4in. high. This contains the radar to give warning of the approach of aircraft so that the schnorkel can be lowered below the surface to avoid detection.

Torpedo Compartment

When one goes down into the type "21" U-boat through the fore hatch the first impression is of the enormous size of the torpedo compartment. It certainly is very big, but the absence of internal frames makes it appear even larger. Moreover, there is no bulkhead immediately in the wake of the rear ends of the torpedo tubes.

Considering the size of this type of U-boat and the size of the torpedo compartment, the type carries a very small armament. There is the usual nest of six 21in. torpedo tubes, but the total number of torpedoes which can be carried, including those in the tubes, is only twenty-three. This seems quite out of proportion, for it means that if the submarine can remain at sea for nine months an average of only one attack every ten days can be carried out, and then only if a single torpedo is used in each attack.

The small number of torpedoes that can be carried seems the more curious since the U-boats of this type must have been built some time after the system of sending special supply U-boats to sea with fuel, stores, and torpedoes for the attacking U-boats, had been proved to be a costly failure.

The torpedoes carried are driven by electricity. They have a short range and are slightly slower than our "heater" torpedoes, but they have the merit of being entirely trackless. The Germans did, of course, use ordinary torpedoes as well as electric torpedoes, these being interchangeable.

The torpedo tubes of the type "21" U-boat are interesting. In the first place, they are remarkably accessible for the bow tubes of a submarine, and they are fitted with external angling gear, so that the torpedo gyro can be angled without pulling the torpedo back from the tube. This is not an innovation, but the arrangement is simpler than that in most British submarines, chiefly owing to the greater accessibility of the whole lay-out of the tubes. Other adjustments can also be made to the settings of the torpedo after it has been loaded into the tube.

There is a very neat little arrangement which makes it impossible to load the torpedo into the tube with the stop valve shut. Failure to open the stop valve of the torpedo before loading it is, of course, one of the major sins, for it not only prevents the torpedo from running, but leads to its loss, since it will sink as soon as it is clear of the tube. It should never happen with properly trained men, but these things do happen sometimes, and it is just as well to make it impossible.

In the centre of the rear door of the torpedo tube there is a small rubber pad piece. This is another good refinement, for it closes the exhaust in the tailshaft of the torpedo when it is loaded and the rear door of the tube is shut. Thus the torpedo engine and gearing does not become flooded when the tube is flooded up, as is normally the case. The tubes, of course, have to be flooded up as soon as a target is sighted, and circumstances may make it impossible to attack and fire torpedoes. In such an event the torpedo in the ordinary tube without this fitting will remain flooded. This may continue for quite a long time, in which case it is apt to lead to erratic running of the torpedo when it is eventually fired. This small rubber pad piece in the German tubes is a very simple way of guarding against this.

Interlocking

The torpedo tubes in the type "21" U-boat have on them an interlocking device, which makes it impossible to open the rear door of a tube when the bow cap is open. In other words, it would be quite impossible for a submarine of this type to meet with disaster in the same way as the ill-fated H.M.S. "Thetis," which was lost on trials in Liverpool Bay with so many valuable lives before the war.

This interlock is one which has for some time been deemed impracticable, because it is a direct contradiction of the requirement that both the bow cap and the rear door of a torpedo tube must be open at the same time when the tube is gauged and when the clearances of the torpedo on passing the bow cap are checked. Both these operations are, of course, carried out when the submarine is in dry dock.

In the type "21" U-boat the rear doors of the torpedo tubes are of the bayonet joint type, so that the first movement of opening them is a turning movement. On the edge of the rear door there is bolted a piece of steel plating. Attached to the operating gear of the bow caps and working with them is a threaded steel rod, which moves aft as soon as the bow cap operating gear begins to move. In coming aft, this rod projects over the edge of the rear door in the wake of the piece of plate, so that, with the rod aft the rear door cannot begin to rotate. The piece of plating attached to the rear door of the torpedo tube is only bolted on so that it can be easily removed when the vessel goes into dry dock and it is necessary to open the bow caps and rear doors at the same time in order to take the clearances.

Protosorb

The central gangway through that part of the submarine which contains the living quarters—that is, between the torpedo compartment and the control room—is almost lined with racks in which rectangular tins are strapped into place. These are the tins of protosorb—an air purifying substance which absorbs the carbon dioxide and the humidity from the air. One is impressed by the great quantities of this substance carried, but this is probably only in proportion to the length of time these craft were expected to remain at sea and without coming to the surface. The schnorkel, of course, does not produce ventilation comparable to a "blow through" on the surface. On the other hand, the U-boats of this type have two air cooling and conditioning plants.

In the lower part of the hull are the four batteries. The cells are stowed in tiers on either side of a central gangway and are of the ordinary acid electrolyte type. They are fitted with separate cell ventilation. In the lower part of the hull, too, there are three large refrigerated store-rooms.

Control-Room

The control-room is utterly different from that of any British submarine. The most striking difference is the absence of periscopes and periscope wells, for in German practice the attack is not carried out from the control-room, but from the "attack kiosk," which is really the lower part of the conning tower. Thus the control-room is free of periscopes, but the centre of the compartment is filled with a circular structure reminiscent of a barbette between decks in a surface ship fitted with gun turrets. This is the periscope well, which passes right through the control-room.

This is not the place to argue the merits and demerits of the German system of having an "attack kiosk" in the conning tower against the British system of carrying out the attack from the control-room. Suffice to say that the Germans appear to prefer the commanding officer to be free from other distractions and to gain the advantage of the greater safety with a given length of periscope which is provided by the eyepiece being above the pressure hull, while we prefer our commanding officers to know what is going on in the submarine even while carrying out an attack.

Without periscopes and attack instruments the German control-room is much less important than the British, and in the type "21" U-boat it is small and inconvenient. Tucked away behind the shaft of the periscope well, are the controls for the hydroplanes and the steering position, the Anchuss gyro-compass, and the panel of levers for the telemotor-controlled main ballast tank vents. Steering and hydroplane control is not by wheel, as used to be normal practice, but by a horizontal lever pivoted in the middle, rather like the rudder bar of an aircraft, and having direct telemotor connections with the steering gear or the hydroplane operating gear. This system certainly has the merits of simplicity and silence.

The "attacking kiosk" in the lower part of the conning tower is chiefly remarkable for the enormous power-operated periscope. This is an astonishing instrument, with a seat for the officer using it and hand and foot control of the telemotor system, which raises and lowers the periscope and trains it in azimuth. It is an instrument which has made the mouths of those who have seen it, water. The officer using it does not have to shuffle round a well, pushing the periscope round to look round the horizon. Nor does he have to bend double as the periscope is being raised and get his eye to the eyepiece almost at deck level to follow the periscope up in order to avoid showing too much of it above the surface. With this German instrument the eyepiece remains at the same level and in front of the officer on the seat, whether the periscope is up or down, being raised, or being lowered. And all the time the focus remains perfect. There seems almost to be some form of black magic in an engineering system and an optical system which will preserve focus while the optical length is changing and allow the eyepiece to move only in azimuth, while the object glass can be raised and lowered as well as trained in azimuth. So interesting is this German periscope that it will form the subject of a separate article in THE ENGINEER.

ENGINE-ROOM

Abaft the control-room is the engine-room, and here,again, the main impression is one of spaciousness, for the engines by no means fill the compartment.

The engines are two six-cylinder, two-stroke diesels, developing 1200 H.P. They drive the submarine at a full speed on the surface of 12 knots. It is of interest that these U-boats were fitted with superchargers which gave them a full speed on the surface of about 14 knots. In "U.3008," however, the superchargers had been removed, which seems to indicate that they were not entirely satisfactory or that the extra 2 knots of surface speed was not considered to justify their retention. It is not known whether the superchargers had been removed from all the U-boats of this type which had been completed.

The full stowage of oil fuel is in the nature of 270 tons, carried in fully self-compensating external tanks. The normal method of propulsion is to use the schnorkel and work on a system which is tantamount to diesel-electric drive. This gives a speed of rather over 6 knots submerged, with a load of 600 amperes. It was stated that the fuel consumption was in the nature of 150 litres per 1000 ampere-hours.

The diesel-electric drive system is possible because of the complicated clutch system, involving a layshaft on each side. When "schnorkeling," the diesels are driving the main motors as dynamos and charging the batteries. At the same time the submarine is being driven through the water by silent motors driving the tail shafts by belts. Belt drives are greatly used in these U-boats because of their silence. This method of "schnorkeling" has the great advantage that if the schnorkel has to be lowered suddenly on an alarm, the diesels are stopped and the propulsion of the submarine is not interrupted while clutches are being taken out. The U-boat simply continues to be driven by the silent motors, and all that happens is that the charge is broken, so that the batteries begin to sustain a discharge instead of "floating."

In the engine-room there is also an evaporator for producing fresh water, so that a great deal of this need not be carried in tanks. The phenomenal endurance of these craft is, in fact, due to this evaporator more than to any one other factor.

Abaft the engine-room is the usual motor-room, but there is only one main motor on each shaft, and abaft the motor-room a "tail end" which is a very efficient little workshop with lathe and drilling machine. It is curious to find that even in this after end there is plenty of headroom, and the compartment seems comparatively spacious and airy.

The type "21" U-boat is fitted with an asdic in the casing, but its main listening gear consists of no less than fifty-two hydrophones. Forty eight of these are in one nest around the perimeter of a circular structure below the torpedo tubes. This "nest" of hydrophones is highly directional and its position ensures that it suffers from the minimum of water noises. "U.3008" also has radar equipment and directional wireless. Her crew consisted of seven officers and fifty-two men.

CONCLUSION

This type of U-boat is of great interest, and it certainly contains innovations and developments. The general impression is, however, that in spite of all these advantages the Germans have not made the best possible use of their technical ability. One cannot escape the impression that the type "21" U-boat has too small an offensive armament, considering her other capabilities. Nor can one close one's eyes to the fact that a very high proportion of the new developments in this type of U-boat have been evolved as defensive measures, and have been dictated by the efficiency of our anti-submarine measures. The very deep diving depth and the very high emergency underwater speed are only two manifestations of this. There are many others. There is the obvious stress that has been laid upon silence and which has led to all the auxiliary machinery, even down to a small hand pump, being mounted on rubber blocks, 2in. thick. There is the fact that no less than two anti-asdic "foxing" devices are fitted. These are ejectors through which an effervescent substance can be forced out into the water, which will give a false echo to the asdic operators of the hunting craft while the U-boat uses its high underwater speed to get away. Even the schnorkel had been made necessary by reason of the efficiency of our system of anti-U-boat warfare.

An Engineer Looks at Brazil

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No. II—(*Continued from page 7, July 6th*)

CATTLE AND AGRICULTURE

THE structure of Brazilian agriculture is based on sound foundations. According to the 1945 edition of "The South American Handbook," the census of the animal population is as follows:—Cattle, 47,767,000; horses, 7,814,000; asses and mules, 4,529,000; sheep, 10,000,000; goats, 6,668,000; pigs, according to a 1942 estimate, number 25.827.000. It is interesting to note that Brazil is the third largest pig-breeding country in the world.

Cattle and horses abound in most parts of the country, with about half the total number located in the States of Minas Geraes and Rio Grande do Sul; mules and asses are employed for a great deal of transport and sheep are bred almost entirely in Rio Grande do Sul. In the northern part of the country goats are bred in large numbers, their skins being exported in considerable quantities. Successful poultry farming is carried on near Rio de Janeiro and São Paulo, superior breeds having been introduced to compensate for the poor quality of local fowls.

In recent years a great deal of chilled beef has been exported, but it is difficult to arrive at exact statistics of the trade owing to security reasons in wartime. About one-quarter of the cattle raised in Brazil come from Rio Grande do Sul, now the main exporting centre for chilled beef; more than half a million head of cattle are fattened each year on the open ranges of São Paulo and Rio Grande do Sul, where European breeds flourish. Of the total number of cattle in the country, 10,000,000 are in Rio Grande do Sul and 11,250,000 in Minas Geraes; they are fattened in the Barretos district in the State of São Paulo, where more than 300,000 head of cattle are fattened each year.

There are a number of fattening camps located on the Sorocabana and Noroeste railways, which supply the demands of the *frigerificos* in São Paulo and Santos. Every year cattle fattening in the State of Minas Geraes grows apace, particularly in the north-western part; slaughtering in Government inspected establishments is about 2,500,000 cattle and 1,500,000 pigs each year.

A trade which has increased by leaps and bounds in recent years is the production of jerked (sun-dried) and fresh meat for home consumption. It is interesting to note that a British concern is trying to overcome prejudices against zebu meat, which is said to be appetising when chilled. The zebu is a humped race of horned cattle originating from India, but found in many tropical countries.

Before the war the greater part of Brazilian meat products was sold on Continental markets, particularly in Italy. Some idea of the importance of this trade to Brazilian economy is shown by the following statistics, which apply to the year 1941 :—

	Tons.
Frozen and chilled meat	54,129
Conserved meat	64,228
Lard	345
Meat extract	2,310
Frozen tongue	90
Preserved tongue	867
Frozen offal	3,581
Wool...	3,735
Chilled beef	39,314
Frozen pork	4,834
Canned beef	62,883
Canned pork	451
Hides and skins	58,994
Sundry	13,388
Tallow and grease	595

The Brazilian wool clip, the greater part of