

easy. In fact, the writer believes that, up to the present, no theoretical solution has been discovered. The case for the combination put forward in his own memorandum (cited above) is far from convincing and in no sense final.

Beyond this a further unknown factor is introduced when account is taken of the loss of rotational wake energy due to the residuary turbulence in the rotational wake. As a problem to be settled by experiment, one method of approach is to take the individual propellers, as designed for ordinary duty, and mount them coaxially a sufficient distance apart to avoid direct interference. Then the leader will be running under normal conditions and show normal efficiency. The follower will be subject to two opposite influences, one tending towards a higher revolution speed due to the sternward wake being already established; the other tending towards a lower revolution speed due to the air on which it operates having opposed rotational momentum. It being assumed that the combination is driven through a balance gear, equality of torque takes care of itself. The combination is then tested in the wind tunnel and the results recorded and plotted.

The whole process is then repeated, using propellers designed on the same system but with a higher value of P/D (coarser pitch), and then again with a higher P/D ratio still. If the main contention in the memorandum is correct, there will be an increase in efficiency with increased P/D ratio till an optimum value is reached, which may be regarded as the practical solution. A falling efficiency associated with an increase in the P/D ratio would betoken that the optimum condition has been passed.

The gain to be anticipated from the use of a higher

P/D ratio would be due to the lower blade-velocity for a given flight speed and, incidentally, a reduction in the propeller noise. Such higher ratio is permissible because a portion at least of the rotational wake energy is conserved. The procedure suggested above does not tell us how much, or what proportion of the rotational wake energy is conserved (that will depend upon the extent to which the action of the propellers on the air coming within their grasp is homogeneous), but it means that we reach a practical solution for optimum condition without such knowledge.

The experimental campaign would not be quite so simple as it might appear from the above description. Not only would the tests on each combination require to be repeated for many variations of velocity and thrust, the results being analysed in the form of plotted graphs, but side issues arise which would require independent examination. For example, owing to the contraction of the slipstream as and after passing through the leading screw, it is necessary that the follower should be of somewhat smaller diameter than the leader, in order that both should act on the *same column of air*. Then again the whole programme might need to be repeated with different numbers of blades, or with propellers based on different formulæ of design. Also there would be a preliminary enquiry to establish the minimum distance of separation consistent with non-interference.\* Such work is worthy of the renewed attention of the staff of the N.P.L. with the equipment they have at their command.

\* The following references may be given as relating to early investigations of the present problem: Technical Reports of the Advisory Committee for Aeronautics, 1918-19, pp. 642 *et seq.*, and p. 655, paragraph (4). Also (quoted on p. 643) R. & M., 421, 385 and 429. But as these latter do not appear in any index they are difficult to locate. These are additional to the writer's contribution, ref. pp. 634 *et seq.*

## AUXILIARY SQUADRONS in the WAR

*More than 200 Enemy Aircraft Accounted for : First to Fly Several New Types*

**P**ILOTS of R.A.F. Auxiliary fighter squadrons have already accounted for more than 200 enemy aircraft in offensive operations this year. This is over a quarter of the total number of German aircraft destroyed by Fighter Command in raids over the Continent and the enemy's seaboard since January.

In addition, members of Auxiliary squadrons have been pioneer pilots of new types of aircraft now being used against the enemy. It was an Auxiliary Hurricane squadron which opened the fighter campaign against enemy shipping in the Channel. An Auxiliary squadron was the first to be equipped with American Airacobra fighters, and pilots of another Auxiliary squadron made the first raids over France with bomb-carrying Hurricanes.

### War of the Roses

The West Riding of Yorkshire Squadron and the West Lancashire Squadron have each destroyed more than 50 enemy fighters on offensive operations this year. In one week in June the West Lancashire Squadron shot down 17 Me 109s for the loss of only one of their own pilots. In one sweep they accounted for seven of the enemy. In July they shot another 17 German machines out of the French skies, including five in one day. Their brilliant fighting won them the congratulations of the Secretary of State for Air.

Like its colleagues from Lancashire, the West Riding Squadron was in at the start of the offensive. Until August the pilots were led across the Channel by a pilot who now commands a Spitfire Wing and has 17 German machines

to his credit. Airmen from many nations have contributed to the success of this squadron. The personnel includes Belgians, Canadians, New Zealanders, Frenchmen and Poles.

Among other Auxiliary squadrons which have gained distinction in fighting over enemy territory are the South Yorkshire, County of Chester and City of Edinburgh Squadrons.

### Attacks on Shipping

Early in September Fighter Command took a hand in the war against enemy shipping in the Channel. In new-type Hurricanes, pilots of one county squadron opened the campaign with low-level attacks on *flak* ships, patrol boats, minesweepers and tankers. This new form of attack was an immediate success, and within a few weeks the squadron had definitely sunk eleven vessels and damaged many others.

Pilots of the county squadrons fly at mast-head height to gun enemy ships and sweep in over tree-tops to release bombs on airfields, factories and gun posts. Once the bombs, which are fitted with delayed-action fuses, are dropped, the Hurricanes become fighters again, and the pilots seldom return until they have used up their machine-gun ammunition against enemy fighters or ground targets.

While the daylight offensive has been going on, other Auxiliary squadrons have been engaged in the night defence of this country. Although "customers" have been fewer lately, one squadron has now bagged more than 60 night raiders.