Arresting RN Aircraft . . .

sheave the tension in the rope at the first impact will rise to $2.62 \times v^{\frac{4}{3}}\left(\frac{K}{2}\right)^{\frac{2}{3}} \frac{m}{g}$ and this will be increased to $3.75 \times v^{\frac{4}{3}} \left(\frac{K}{2}\right)^{\frac{2}{3}} \frac{m}{g}$ when the transverse wave returns to the impact point and is reflected there. Experimental results show close agreement with the former figure. The latter tension is not achieved in practice because the rope begins to move other than by rope stretch when the moving crosshead of the gear yields.

The longitudinal tension wave travels on from the deck edge sheave, around various leading sheaves, and arrives at the first pulley of the moving crosshead. It will be recalled that the discharge orifice is large at the beginning of the arrest in order that the ram may be accelerated rapidly and therefore the moving crosshead begins to move and this movement takes place before the tension wave has arrived at the second sheave, i.e. while the wire is still slack for a certain distance ahead of the stress front. This slack wire is therefore brought home on to the second sheave with a jerk and another impact is engendered. This process continues until on the last pulley the maximum slack is encountered and the maximum impact from this cause is impressed on the system. The longitudinal stress wave travels at approximately 9,000ft/sec and the transverse wave at speeds up to 600ft/sec for modern gears depending upon the rope tension. These tensions occur during the first $\frac{1}{10}$ sec after impact and are normally the maximum tensions experienced. In the later stages of the arrest the energy-absorbing quality of the fluid is brought into play and is the main factor in determining rope tensions, and the geometry of the wire on the deck becomes more favourable as the pull-out increases and the angle of pull to the middle line decreases.

Main Cylinder Pressure. The pressure is normally measured at one point on top of the spline valve. At high energies this is of the order of 10,000lb/sq in and a Langham-Thompson barrel type pressure transducer is used. For a given weight the pressure record is an indication of the spline valve performance. If the pressure diagram shows a reasonably flat top throughout approximately two-thirds of its length then energy is being absorbed efficiently; but if the spline profile is fautly this can be revealed by, for example, a hump at the end of the diagram.

Ram Stroke. This is recorded by a rotating segmental commutator actuated by a wire passing over a grooved drum with its free end attached to the moving crosshead. Together with pressure it is a measure of the energy absorbed by the unit, and integration of the pressure diagram on a stroke base will give the energy at the unit.

Retardation. The accelerometers used have been developed in the department and are of the direct reading, moving weight spring type. Frequent calibration is necessary to ensure consistency and the mounting must be firm and as close to the c.g. as possible.

This is the critical record as far as aircraft and pilot are concerned. The impact g in the early part of the arrest is the maximum. A high g at the end of the arrest usually means that the full stroke of the gear is not being used, assuming that the energy limit is not being exceeded.

From these recorded measurements the first task of the arrester gear section is to ensure that maximum value is being obtained for money, i.e. that the retardation imposed by the gear throughout the weight and speed range is as nearly uniform as possible. Having established this the next, and principal, function is to recommend performance curves to DGS for issue to the Fleet. These performance curves take the form of a family of iso-g curves drawn against axes of entry speed and weight. For an aircraft at a given weight, maximum approach air speed and permissible retardation are known. Using the landing weight and retardation, the entry speed which the gear can accept is determined from the curves. The difference between aircraft approach speed and entry speed into the gear establishes the wind over the deck which must be contributed by ship and/or natural wind.

It is of interest to note that ideally the iso-g curves should be horizontal straight lines if the same max/mean ratio can be achieved throughout the range covered by the gear.

During the period when this performance is being established, the reliability of the gear is proven and mechanical improvements to make the unit acceptable operationally are suggested and tested. This is the third major contribution of this department to the finished article as used in the Service.

Modifications after Trial

Trials of a recent gear have produced modifications to most of the spline barrel groove profiles. Generally these have consisted of axial movement of the groove down the spline so that cut-off, or minimum orifice, occurs earlier in the arrest and the working ram stroke is not exceeded.

Mechanical troubles which have arisen have mainly concerned the sheaves, both those on the unit and the deck edge sheaves which lead the wire from the deck to the unit below deck.

The crosshead pulley bearing is subjected to a high wire load which is slightly offset because of the lead of the wire to the pulley on the other crosshead. The side load caused heavy bearing pressures of the outer race against the thrust washer and the ensuing high temperatures caused cracks in the outer races. It is hoped that a spheroidal cast-iron thrust washer will reduce the heating caused by side load.

The bursting load of the wire in the pulley groove opened out the rims of the unit sheaves until a foul occurred which led to seizure. The sheaves are now manufactured in a high tensile material.

At high speeds modern aircraft lift the wire to an appreciable height at the instant of pick-up and these up loads were taken on the rim of the deck edge sheave which sighed and dished like a saucer. The deck edge sheave pulleys are now made in a high tensile material.

Two mechanical problems are still with us. As designed, the gear pays out equal lengths of wire rope from each deck edge sheave. If an aircraft hook strikes the wire some distance off centre the aircraft path stays sensibly straight and hence the wire must move through the hook. This movement under load together with the bending round the small radius of the hook imposes high temperatures and stresses on the wire, which result in the rate of wear of centre spans under off-centre conditions being logistically unacceptable. A programme of tests is being pursued which it is hoped will determine the effect of various wire and hook materials and constructions and wire/hook interface materials on centre-span life.

The other problem is the picking up of the wire by the hook. The design of a hook to scrape a wire from the deck at high entry speeds presents a major problem. For example the hook must collect a wire striking high on the sting and yet it must at no time be able to hold two wires, which would put an excessive load on the installation. If the aircraft taxies into the wires the wire is laid flat to the deck and a step wave is put into the rope. This wave moves outboard until it strikes an obstruction, normally the bowspring, when it is reflected and returns inboard. The wire remains grounded until the reflection returns and if the time taken for this to happen is greater than the time taken for the aircraft hook to arrive at the wire after the nose-wheel has passed, the hook will attack a grounded wire and may miss. Efforts are being made to induce a false reflection by obstructions on the deck which will reflect the tension wave and not interfere with aircraft landing or with the various trollies used for storing and arming aircraft.

Sea Trials

When the gear is first installed in the ship and after major refits a flying trial is carried out at sea. Records are taken of main cylinder pressure, ram stroke and aircraft retardation, and the gear performance checked against that established under test conditions. Additional problems may arise at this stage or after experience under the more exacting and intensive operational conditions, and it is only after this stage has been passed that the unit is considered fully proved and the cycle of conceiving, designing and producing a new arrester gear is complete.

THE LATEST "JANE'S"

RECENTLY published, the 1960-61 edition of *Jane's All the World's Aircraft* is the first to be compiled and edited by John W. R. Taylor, FRHistS, ARAeS, well known to readers of *Flight* as a contributor to this journal and formerly the assistant compiler of *Jane's*.

In his preface, Mr Taylor pays generous tribute to his editorial predecessors, Fred T. Jane, C. G. Grey and Leonard Bridgman, and remarks on changes in the aircraft industry during the past twelve months and their reflection in the 574 pages of this new edition. Despite some gloomy predictions about the future of the aircraft industry, there were more new aeroplanes than ever to be included this year (the aircraft section totals 413 pages, compared with last year's 403); and the newcomers are of such variety and potential that, in Mr Taylor's words, the 1960s "should prove to be the most interesting, challenging and rewarding decade in aviation history."

Mr Taylor remarks on the width of coverage, from manpowered aircraft and airships (a section which has grown this year) to supersonic deltas and ICBMs, and points out that the total of 1,176 illustrations—702 of them new—is 45 more than last year. As a result of many requests, the list of officially recognized aviation records has been reinstated. *Jane's* is published by Sampson Low, Marston & Co Ltd, Potter Row, Great Missenden, Bucks, at £5 5s net.