INSTRUCTION BOOK

No. 1507.

B T-H

ELECTRIC INERTIA STARTERS

TYPES FA, FA1, FB, AND FB1

AS USED ON

"CIRRUS" AERO ENGINES.

THE BRITISH THOMSON-HOUSTON CO., LTD.,

COVENTRY, ENGLAND.

IMPORTANT.

The apparatus described in this Instruction Book was designed, manufactured, and tested with care and, with proper attention, should give the purchaser the service which he may reasonably expect.

The purpose of this Instruction Book is to explain the functions of the apparatus, and the manner in which it should be adjusted and maintained.

If these instructions are not clear, or appear incomplete in any particular, and you desire further information, this will be promptly furnished upon request.

Please address such enquiries to The British Thomson-Houston Co., Ltd., Alma Street, Coventry, England, mentioning the particulars stamped upon the apparatus.

BTH ELECTRIC INERTIA STARTERS

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FOREWORD.

These Electric Inertia Starters have been designed for the easy starting of aircraft engines not exceeding 200 H.P.

The fundamental principle of operation is that of first storing up energy in a small flywheel by rotating it electrically at high speed, and then applying this energy to the crankshaft of the engine through the medium of a reduction gear train incorporating a torque overload release or clutch.

This principle permits energy to be drawn from a battery at a relatively low rate, so that it is only necessary to use a comparatively small battery and small diameter cables. The energy stored in the flywheel is applied at a high rate, causing the engine to be rotated quickly—the ideal condition for certain starting.

The advantages of this method of starting are :—

(1) **Low total weight** in relation to the energy provided, since the battery and cable sizes are very small.

(2) **Rapid rotation of engine** resulting in certain starting and making booster magnetos or trembler coils unnecessary.

(3) **Excellent operation in low temperatures**—an engine that is very stiff due to low ambient temperature will start at the second application of the starter after the first attempt has obtained the few slow revolutions necessary to "break the engine away."
The current taken from the battery is unaffected by engine stiffness as the starter does not engage with the engine crankshaft until the flywheel has attained operating speed. Consequently, the battery can never be overloaded.

CLASSIFICATION.

The Type FA Starter has a horizontal electric motor, the motor shaft being in line with the engine crankshaft.

The Type FB starter has a vertical electric motor, the motor shaft being at right-angles to the engine crankshaft.

On both the above types of starters engagement with the engine crankshaft is effected by means of an electro-magnetic solenoid which is energized by hand operation of a separate switch.

CLASSIFICATION (CONTINUED).

The numeral 1 after the Type letter (Types FA1 and FB1) indicates that engagement with the engine is effected automatically at a predetermined speed of the flywheel. In all other respects Types FA1 and FB1 starters are identical with Types FA and FB starters.

Particulars of the different Forms of starters are given in the following table. All types and forms are arranged for flange mounting.

NOMENCLATURE		MOTOR	Position of Terminals	Dog	Outline Fig. Ref.
TYPE	FORM				
FA or FA 1	A	Horizontal	On top	6 jaw	Fig. 3
	B	,,	,,	8 jaw	Fig. 3
	B1	,,	Underneath	8 jaw	Fig. 3
FB or FB1	A	Vertical	On top	6 jaw	Fig. 4

ENGINE RATINGS, TECHNICAL DATA, ETC.

TYPE	FORM	Max. Engine Rating (H.P.)	Weight of Starter (lb.)	Recommended Size of Battery	Recommended Size of Cables
FA or FA1	A, B, and B1	150	17·75	12 volts, 21 ampere-hour	195/0·010″ not exceeding 20 yards.
FB or FB1	A	200	22	12 volts, 25 ampere-hour	195/0·010″ not exceeding 14 yards. 37/0·036″ not exceeding 30 yards.

CONSTRUCTION.

TYPES FA AND FA1 STARTERS (Horizontal motor).

The construction of these starters is shown in Fig. 1.

The armature A of the D.C. series motor is built up on a hollow shaft B which is integral with the flywheel C. Keyed to the shaft is a sun pinion D which engages with a double planetary gear

CONSTRUCTION (CONTINUED).

system E. The planet gears also engage with an internal gear F—normally held stationary between the " ferobestos " plates G—and also with an internal gear cut on the inside of a bell casting H. This bell casting therefore is driven at a reduced speed, the overall speed reduction being 200·7 to 1. The nominal speed of the armature and flywheel at the time of engagement is approximately 15,000 R.P.M., thus the speed of the bell casting is 75 R.P.M. The bell casting is carried on two ball-bearings J, and is splined at K to drive the engaging dog L.

The motor field system is indicated at M and the brush-gear at N.

The engagement of the starter dog with the engine dog is effected by means of a solenoid mounted at the back of the starter. The solenoid consists of a winding P, a pole piece Q, and a plunger R, to which is attached the operating rod S carrying the starter dog L.

TYPES FB AND FB1 STARTERS (Vertical motor).

The construction of these starters is similar to the Types FA and FA1 except that in each case the motor is built as a separate assembly mounted at right-angles, Fig. 2. The motor drives the planetary gear system through a bevel gear, a construction which shortens the overall length of the starter. Types FB and FB1 starters have 25% more energy than Types FA and FA1.

OPERATION.

The starter motor is energized by pushing and holding in the starter switch knob for 30 seconds during which time the motor speeds up the flywheel to 15,000 R.P.M. When the starter switch is released, the bell-gear and dog are running at 75 R.P.M.

For FA and FB starters the solenoid switch knob is then pulled out, energizing the solenoid P, Fig. 1, causing the pole-piece Q to attract the plunger R. The operating rod S thus moves towards the engine, engaging the starter dog L with the engine dog. The solenoid switch should be released as soon as the engine fires.

Should the jaws of the dogs clash at the moment of engagement, the spring Y will be momentarily compressed until the starter dog turns to such a position that it will engage properly with the engine dog. The spring T returns the plunger and starter dog to the normal position when the solenoid is de-energized.

In the event of a back-fire, as soon as the load reaches the predetermined value of the torque overload release (clutch) setting,

the internal gear F slips round, relieving the starter and the engine crankshaft of undue stress.

When the engine is warm it will be found that the starter motor need not be energized for as long as 30 seconds.

For Types FA1 and FB1 starters, in which the engagement of the dogs is effected automatically, the sequence of mechanical operation is the same as for Types FA and FB starters ; but, the solenoid winding P is connected across the starter motor terminals, and only one switch is used. On closing this switch, the current is applied to both the motor and the solenoid ; but, the latter does not operate immediately, since the initial current taken by the motor causes a voltage drop in the battery and cables.

As the flywheel speeds up, the current decreases and the voltage increases, until, at a predetermined voltage value, the solenoid operates and engages the starter with the engine. The energy already stored in the flywheel " breaks the engine away ; " and, thereafter, the starter acts as electrical turning gear, the motor being energized until the engine fires. The switch should then be released. With this arrangement, starting time is reduced.

MAINTENANCE.

An electric inertia starter requires no attention during service beyond occasional cleaning of the commutator by wiping with a clean cloth. The commutator is accessible after removing the cover strap O, Fig. 1.

The bearings are packed with grease on assembly and no provision is made for lubrication in service as this is not necessary.

DISMANTLING.

Should it be necessary to dismantle a starter the following procedure is essential :—

STARTER WITH HORIZONTAL MOTOR.

(1) Remove screws EE and nut Z, Fig. 1, and withdraw dog L and spring Y.
(2) Remove cover U and solenoid leads X and take off solenoid body V.
(3) Pole-piece Q can then be removed after taking out screws W.
(4) Withdraw the brushes from their holders.
(5) The starter must then be placed in a special jig, which clamps the castings AA and BB together, while nuts CC are removed. **These nuts must not be removed unless the starter is in a jig, since the total pressure of the springs, tending to part the castings, is more than a ton.**

If it is necessary to make up the jig, the dimensions and other particulars given in the outline Fig. 5, should be carefully followed.

(6) On removing the starter from the jig, the body casting can be removed, leaving the armature and planet gears as a unit. After removing the locknuts DD, the armature and flywheel can be withdrawn from the planet gears.

STARTER WITH VERTICAL MOTOR.

Dismantling of this type of starter is simpler as the motor can be removed as a separate unit after unscrewing the four flange nuts. If it is necessary to dismantle the gears, the instructions given for a starter with a horizontal motor should be followed.

RE-ASSEMBLY.

Re-assembly of the starter is carried out in the reverse order to dismantling, but the following points must be carefully noted :—

(1) The clutch plates must be quite dry and free from grease or oil.

(2) The bearings should be lightly greased with " Belmoline " or its equivalent. No oil should be used.

(3) If the planet gear cage has been removed from the armature, when replacing, make certain that the planet gears engage with the sun pinion in such a position that the scribed lines (one on each planet gear) are diametrically opposite. This ensures correct meshing of the gears.

(4) The jig must be used to hold the body and flange castings together while the nuts CC are tightened.
The nuts must not be used to pull the castings together.

BTH ELECTRIC INERTIA STARTERS.

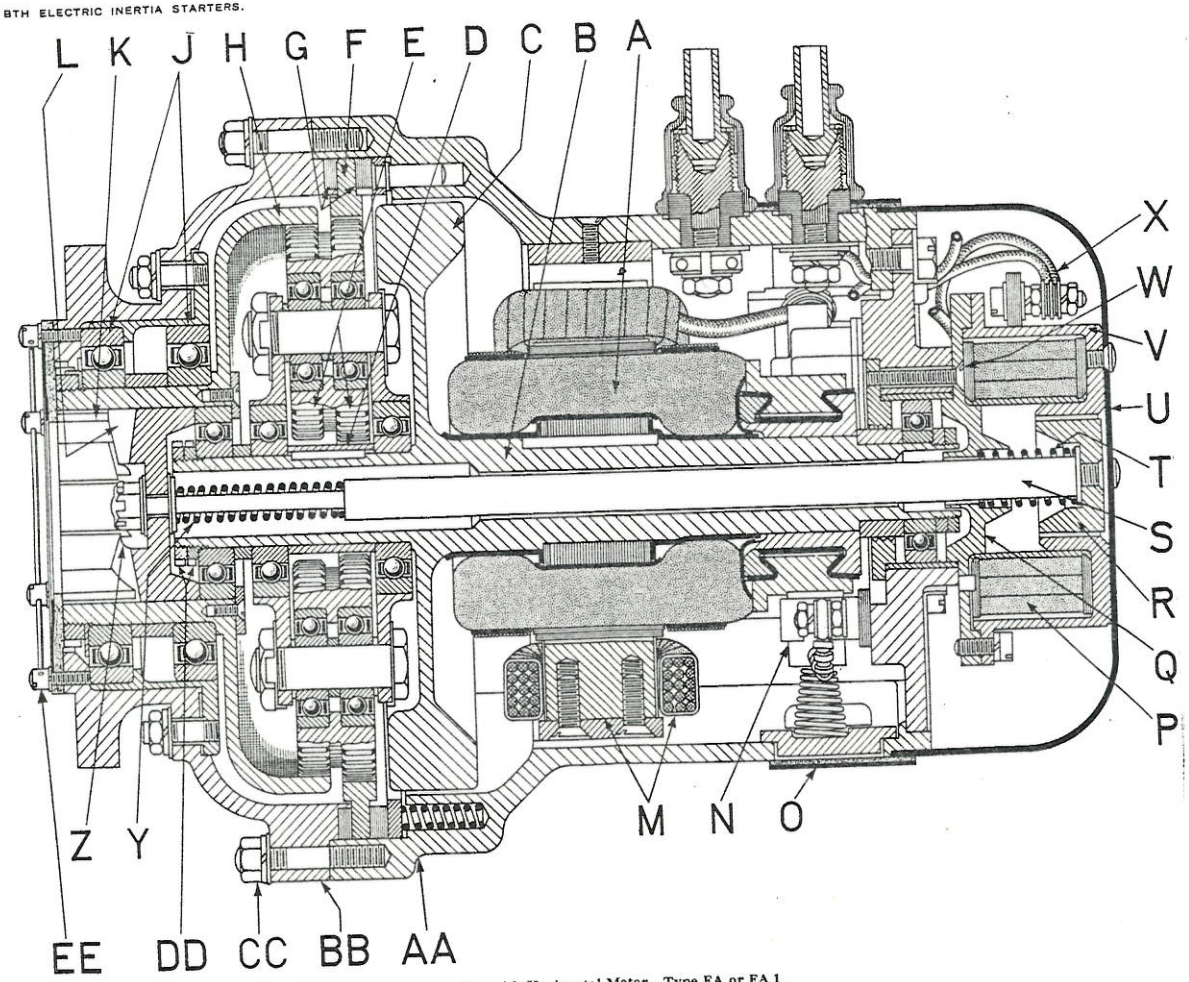


Fig. 1. Section through Electric Inertia Starter with Horizontal Motor—Type FA or FA 1

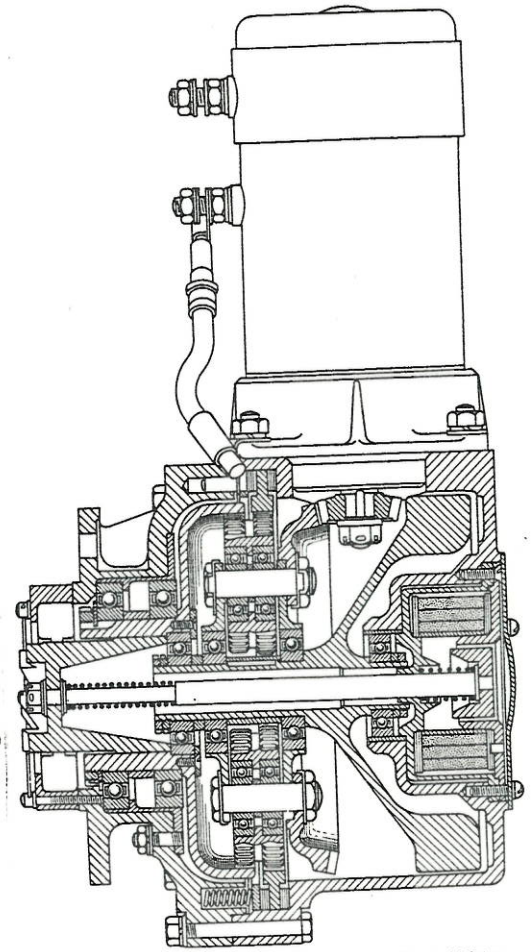
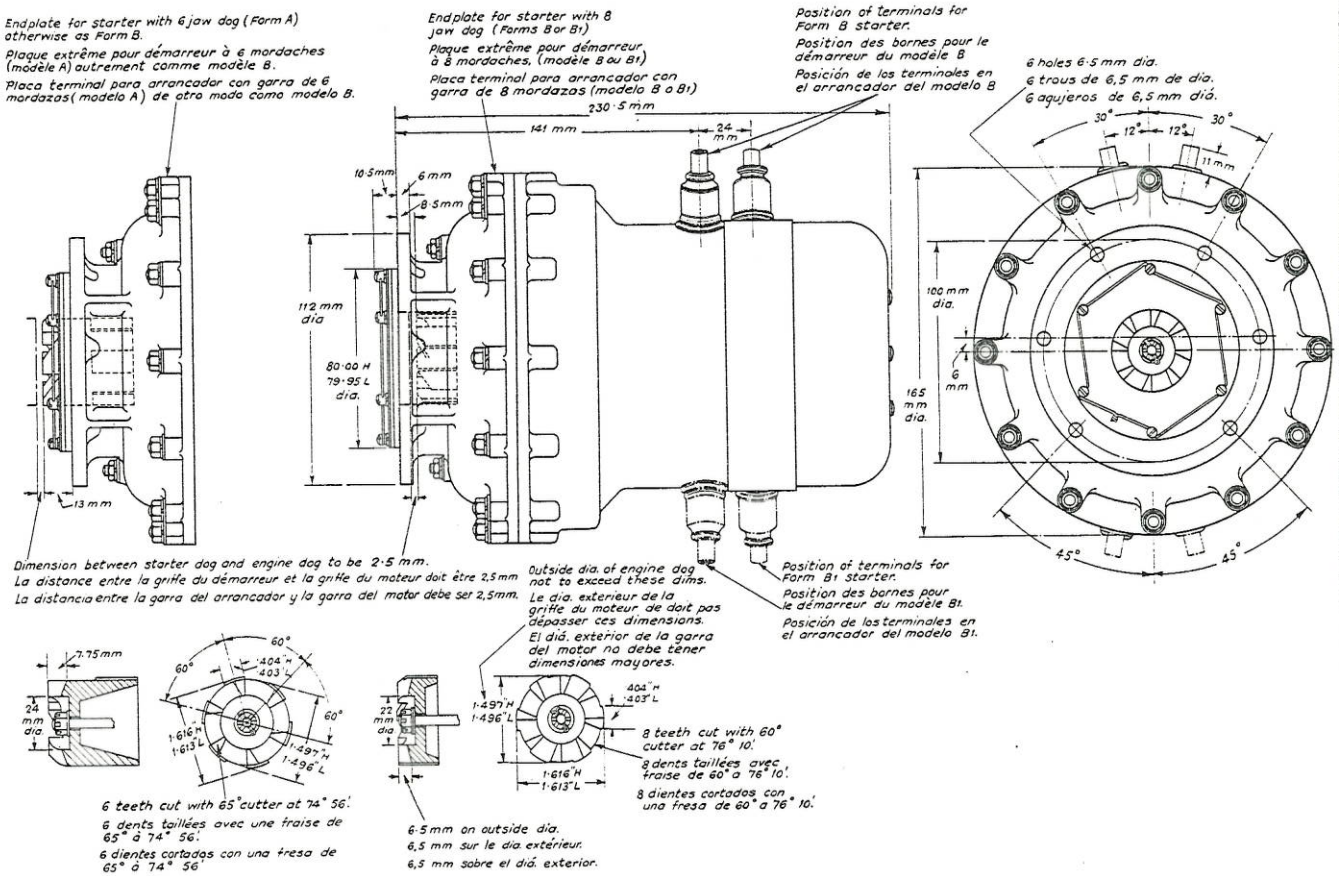


Fig. 2. Section through Electric Inertia Starter with Vertical Motor—Type FB or FB 1.



3. Outline and Dimensions of Electric Inertia Starter, with Horizontal Motor—Type FA or FA 1.

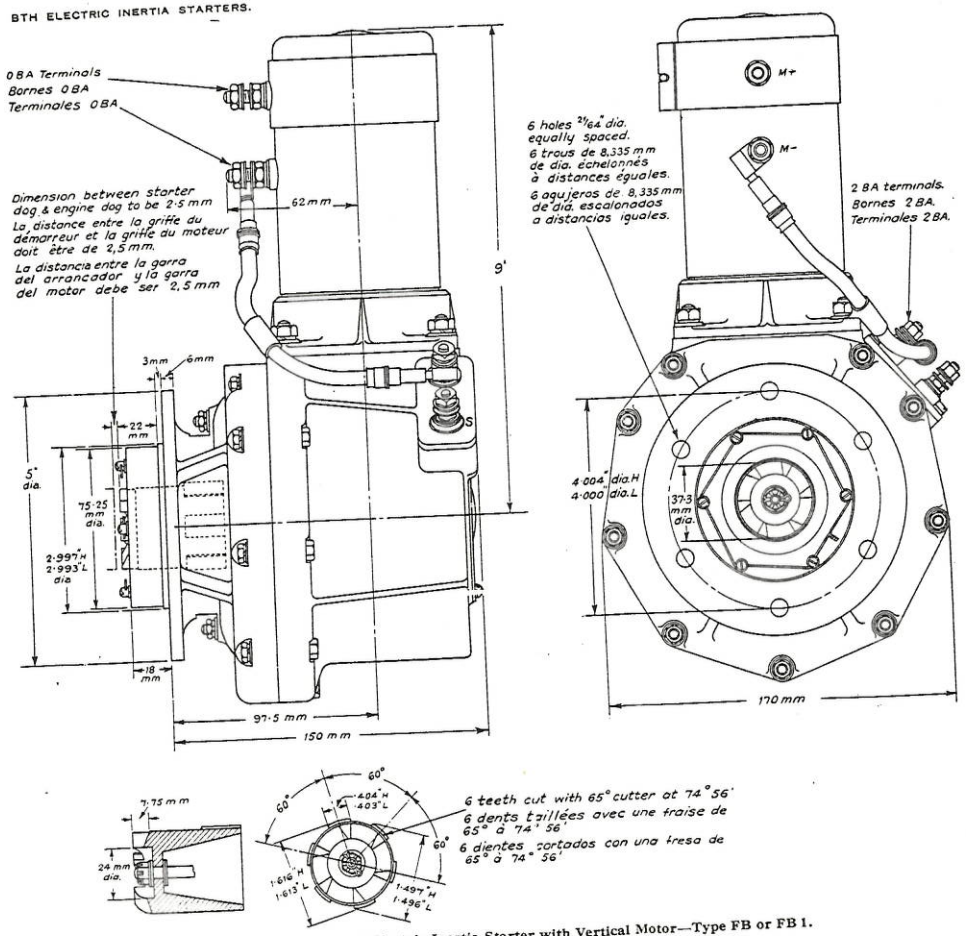
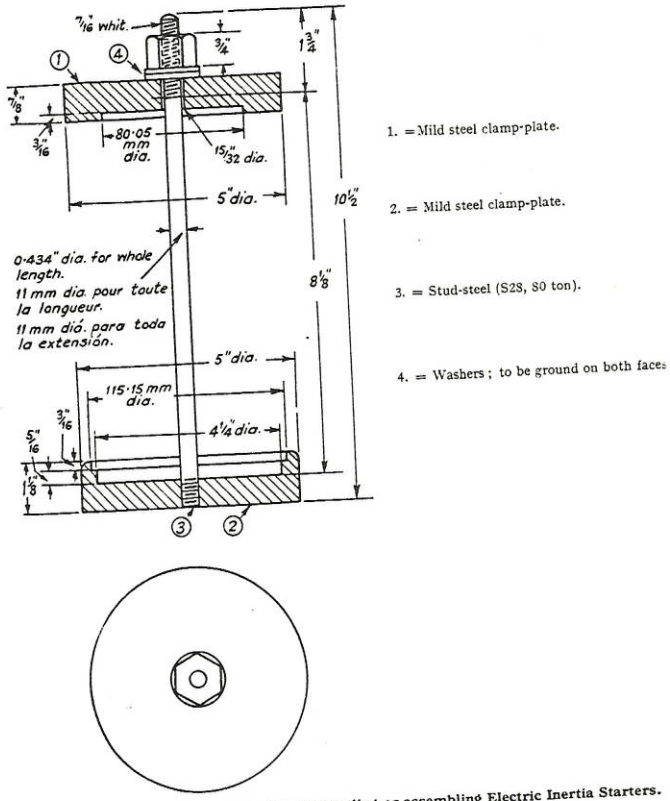


Fig. 4. Outline and Dimensions of Electric Inertia Starter with Vertical Motor—Type FB or FB 1.



1. = Mild steel clamp-plate.

2. = Mild steel clamp-plate.

3. = Stud-steel (S2S, 80 ton).

4. = Washers; to be ground on both faces

Fig. 5. Jig for use when dismantling or assembling Electric Inertia Starters.