

### Introduction

Modern aircraft electrical systems demand considerable electrical power. Research has shown that constant frequency alternator systems are well suited for aircraft basic power supplies. When alternators are operated in parallel better reliability and flexibility are obtained. A distribution system in which there are a number of power sources, with one or more power lines to important load points and a means of isolating a section of the system under fault conditions, contributes to its reliability. Alternating power offers distinct advantages, among them being:-

- (a) Voltage can be stepped up and down by transformers.
- (b) Sparking and arcing problems are reduced.
- (c) A.C. motors are simpler, reliable, more compact and lighter
- (d) Dry plate rectifiers may be used for D.C. supply
- (e) Brush gear problems are greatly reduced.
- (f) Inverters can be made redundant.

### General Information

The introduction of this the Constant Speed Drive Unit has been followed by the production of a system consisting of one or more alternators driven irrespective of engine speed, at a constant speed by an automatically controlled continuously variable hydro mechanical transmission unit.

Basically the C.S.D.U. is a hydraulic transmission unit comprising a variable displacement pump, driven by the aircraft engine and a hydraulic motor coupled to the alternator. Pump and motor are combined in the same housing, and are arranged to operate as a differential.

### Operation

The diagram shows in schematic form the arrangement of the drive and its oil system. The drive comprises a variable displacement, axial piston type motor housed in a common cylinder block assembly and bolted together, with the port plate positioned in between to direct the oil flow between pump and motor. The cylinder block assembly is rotated by the engine through the input shaft.

Initial rotation of the input shaft causes the cylinder to rotate as well as the CHARGE and SCAVENGE oil pumps. The gear type charge oil pump is used to deliver oil to the pump and motor assembly and the governor system. This charge oil supplies the inlet of the pump and motor so that the pistons and push-rods will be held in contact with their swashplates at all times.

The variable displacement pump consists of the cylinder block assembly, the pump swashplate assembly, and the manifold assembly. As the charge  
/pressure

pressure holds the pistons against the swashplate assy. piston stroking is accomplished when the cylinder block is rotated. The displacement of the pump is regulated by the angle of the swash-plate which is determined by the governor system through a hydraulic signal. The manifold assy. serves to deliver charge oil to the pump and working pressure oil to the charge relief valve.

The fixed displacement motor consists of a cylinder assy. and the motor drive shaft. The motor cylinder block assy. receives working pressure oil which forces the pistons to move out against the fixed angled swash-plate, thus converting axial piston movement into rotary motion. The swash-plate is free to rotate independently of the cylinder block and hence can operate at speeds in excess of or below that of the rotating cylinder block assy. The offset of the motor valve plate is always in the same position with respect to the angle of the swash-plate, this position being such that the motor pistons are exerting a clockwise torque upon the swash-plate.

The speed signal for the governor system is taken from the output shaft. The alternator is driven through a clutch located in the output shaft of the transmission. This ensures that the drive and alternator will not transmit "Reverse Power".

#### Differential Speed

From the diagram the following points should be noted:-

##### (a) The Pump

- (i) The fixed valve plate and eccentric pin.
- (ii) The direction of rotation.
- (iii) The variable angle of the swash-plate.
- (iv) That oil pressure is constantly supplied to the centre of the valve plate through the manifold.
- (v) That any cylinder at B.D.C. or T.D.C. will be blanked off.

##### (b) The Motor

- (i) The eccentric pin and motor valve plate are part of the swash-plate shaft and rotate with it.
- (ii) The fixed angle of the swash-plate.
- (iii) The eccentric pin and valve plate rotate in phase with the motor swash-plate shaft.

##### (c) Oil Flow

It will be seen that some of the pistons are in communication with the centre of the valve plate and others with the working pressure annulus outside the valve plate rim. Charge pressure oil is supplied to the cylinder block by the manifold keeping the pistons in contact with their respective swash-plates. On being re-circulated the working pressure oil from the pump causes the motor pistons to exert a thrust on the motor swash-plate. This thrust is transmitted to the motor swash-plate drive shaft. The speed of the motor shaft relative to the cylinder block speed is governed by the quantity of oil

quantity of oil flowing through the motor per revolution, of the cylinder block. This is the DIFFERENTIAL SPEED. With oil flowing from pump to motor the differential speed will be positive as the action of the pistons in the motor are rotating the motor shaft in the same sense as the cylinder block. However, as the pump swash-plate changes so that its different angle now causes oil to flow from the motor to the pump, the motor shaft will be rotating in the opposite sense to the cylinder block and the differential speed will be negative. The resultant speed of the motor shaft will therefore be the sum of the differential speed and the speed of the cylinder block. In conclusion therefore the pump swash-plate angle determines the speed and direction of rotation of the motor shaft with respect to the cylinder block.

#### Overdrive

With the swash-plate in the maximum overdrive position the output shaft is over-speeding the input shaft. This over-speed is the ratio of maximum pump displacement to the fixed displacement of the motor. The swash-plate remains in this position until output speed reaches 6,000. With further increase in input speed, the normal tendency is to increase the output speed still further. At this point however, the governor regulates the control piston and swash-plate assy. to decrease pump piston stroke. Less oil then flows from the pump to the motor and therefore the differential speed between the motor shaft and the cylinder block assy. is reduced to retain constant output speed.

#### Underdrive

When the input speed exceeds the output speed the cylinder assy. will be turning faster than the motor shaft. relative motion between the cylinder block and the motor shaft will now be in a reverse direction, since it is now necessary to subtract from input speed to maintain governed output speed. due to the cylinder block overspeeding the motor shaft, the pump swashplate is held in an under drive position (negative angle) which permits an oil flow from motor to pump. In effect the pump is now metering the oil flow from the block.

#### Straight Drive

The pump swashplate is no longer at an angle and therefore does not cause any pumping action between pump and motor. The motor shaft will therefore rotate at the same speed as the cylinder block assy.

#### Governor System

The governor system performs two essential functions:-

- (a) Control of output speed for constant frequency.
- (b) Load equalisation for parallel operation.
- (c) In addition it is desirable that during starting the drag of the C.S.D.U. and the alternator on the engine is at a minimum. This is achieved when the C.S.D.U. is in the maximum under drive condition.

The control is handled by two separate governors, both being driven at the same speed from the output gear trains viz:- the BASIC GOVERNOR and the LIMITING GOVERNOR.

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During normal running the drive is controlled by two separate governors which is of the centrifugal type. This governor controls a hydraulic servo system which includes the overdrive and underdrive control pistons and cylinders, a trip valve and a pressure switch. The limiting governor gives both over and underspeed protection.

Load equalisation and precise frequency adjustment is accomplished electrically onto the biasing spring of the basic governor.

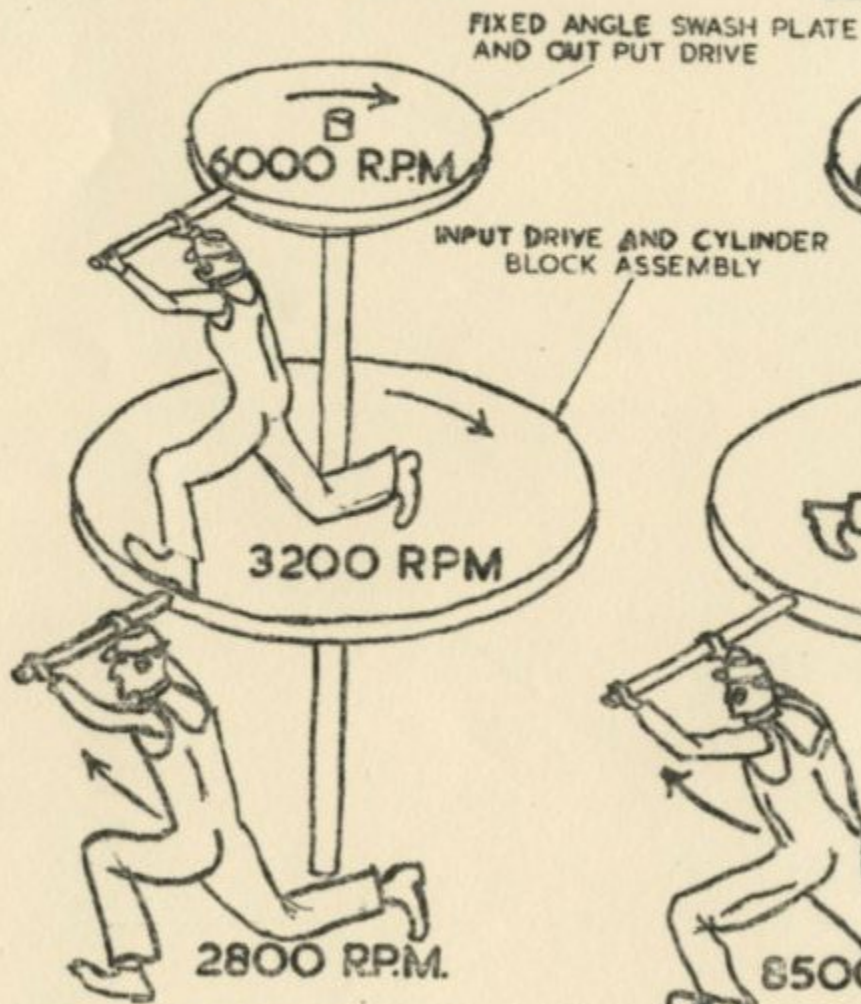
The underspeed protection is simply that the governor will not allow any load to be taken by the alternator until its frequency is above 365 C.P.S. This frequency is transmitted to the limiting governor as an indication by R.P.M. Below 365 C.P.S. the flyweight in the limiting governor cannot compress the spring and this the valve at the bottom of its stroke. The valve keeps the trip valve and pressure switch free from charge oil and therefore oil directed by the basic governor to the overdrive cylinder cannot pass the trip valve.

The overspeed protection is achieved by the limiting governor being lifted and allowing the charge pressure in the trip valve and pressure switch lines to drain away, so causing the contacts in the pressure to open. The oil in the overdrive cylinder can now drain through the trip valve and allow the C.S.D.U. to move into the maximum overdrive position. This action is permanent and can only be cancelled by shutting down the drive.

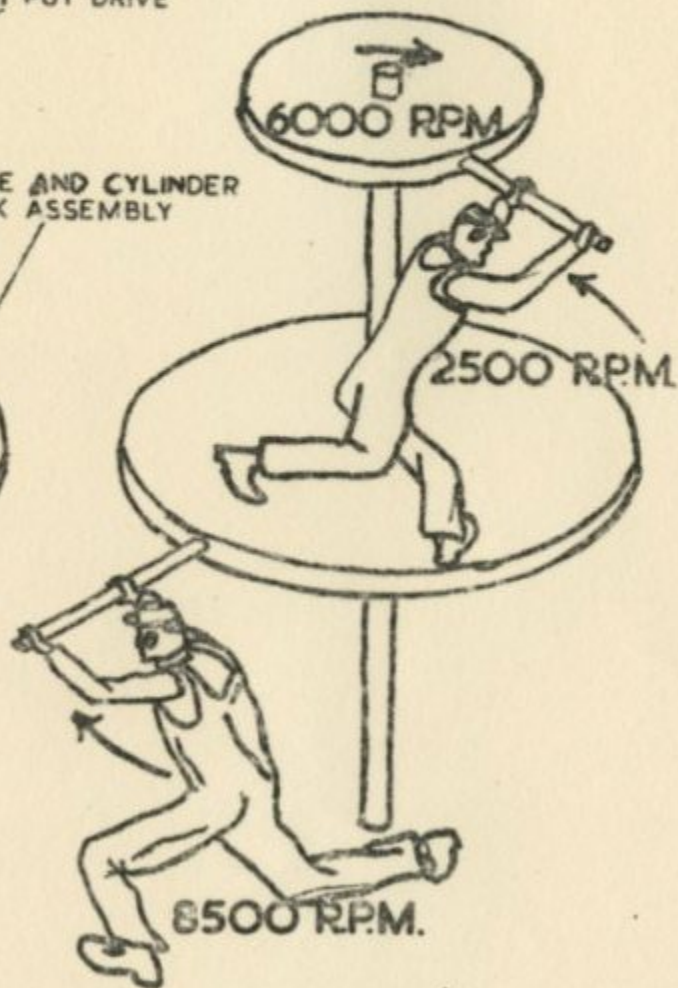
# CONSTANT SPEED DRIVE

## DIFFERENTIAL ACTION

### OVERDRIVE



### UNDERDRIVE



### STRAIGHT DRIVE



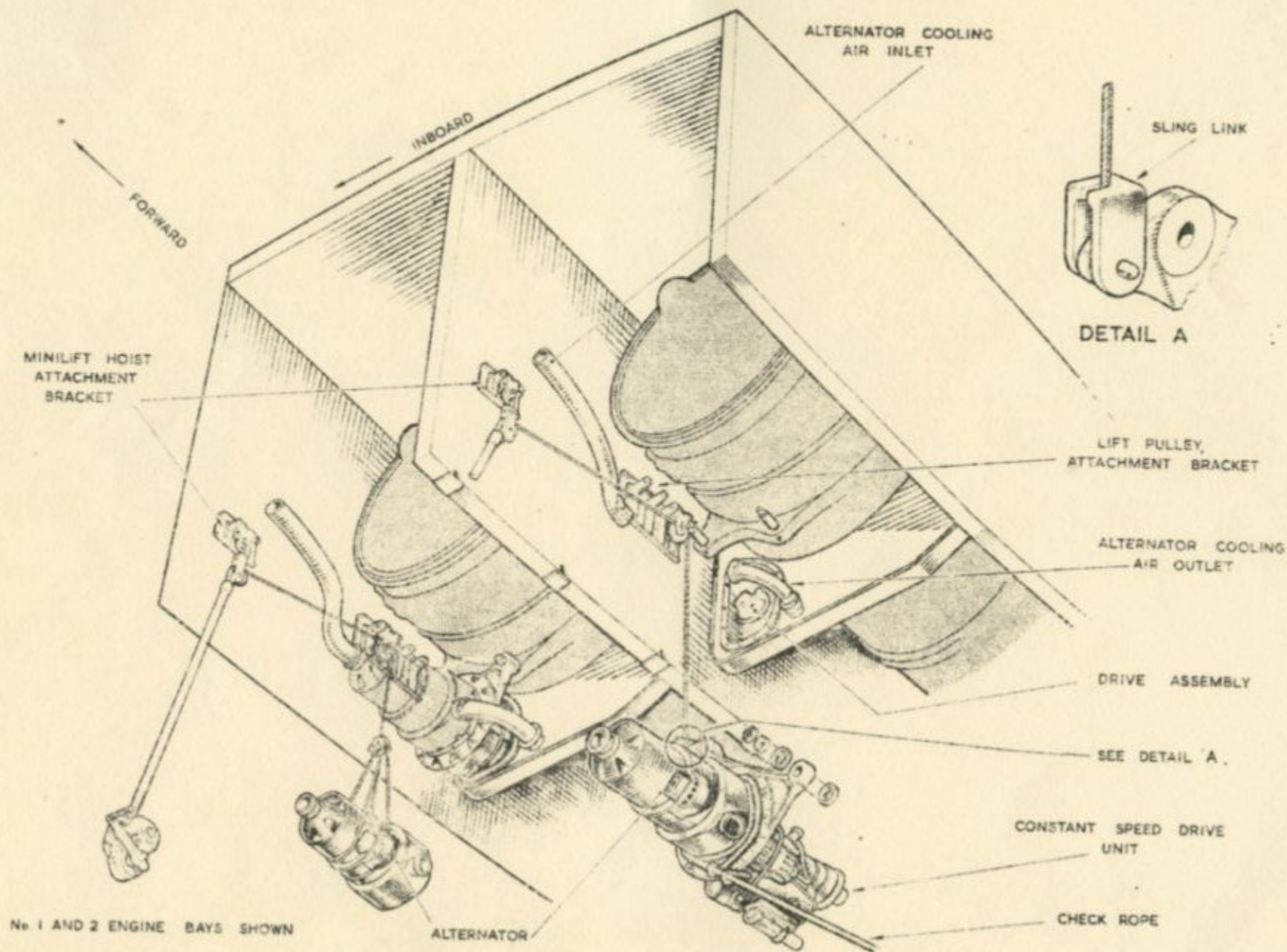


Fig. 11 Constant speed drive/alternator removal

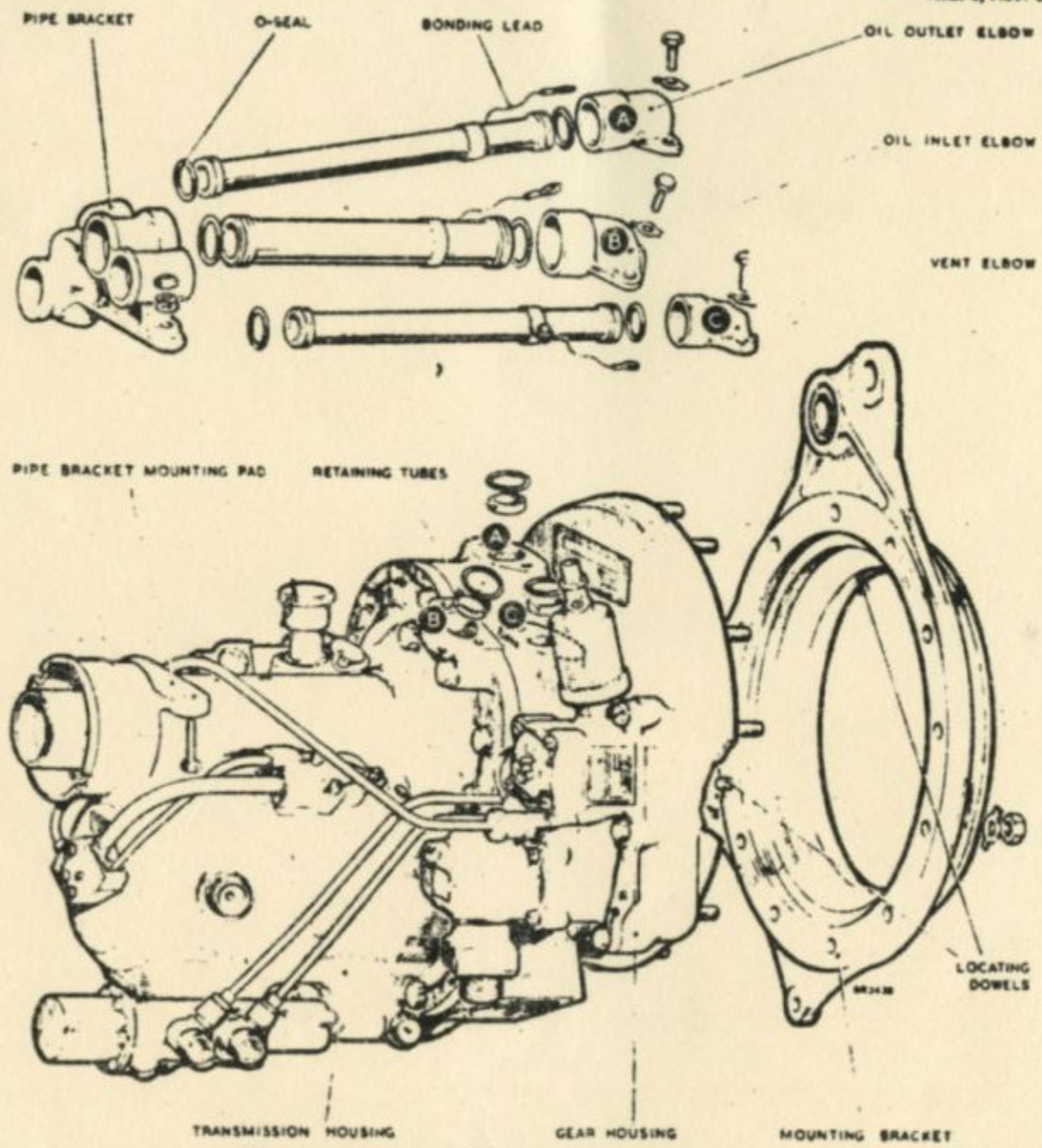
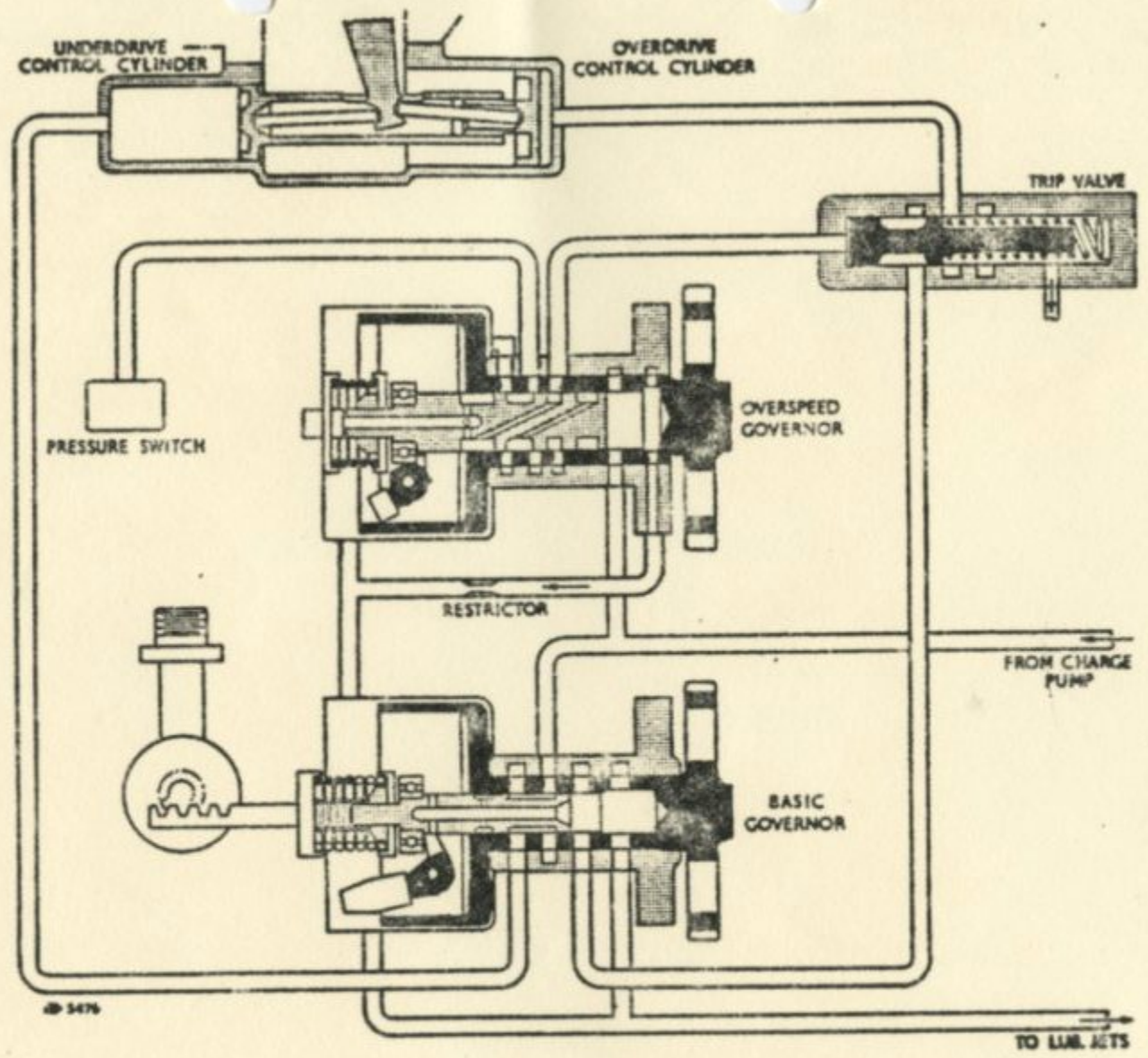


Fig. 2. Constant-speed drive unit—installation fittings



- CHARGE PRESSURE
- OVERDRIVE CONTROL PRESSURE
- UNDERDRIVE CONTROL PRESSURE
- LUBRICATION PRESSURE
- SCAVENGE

Fig.16 Governor system at overspeed

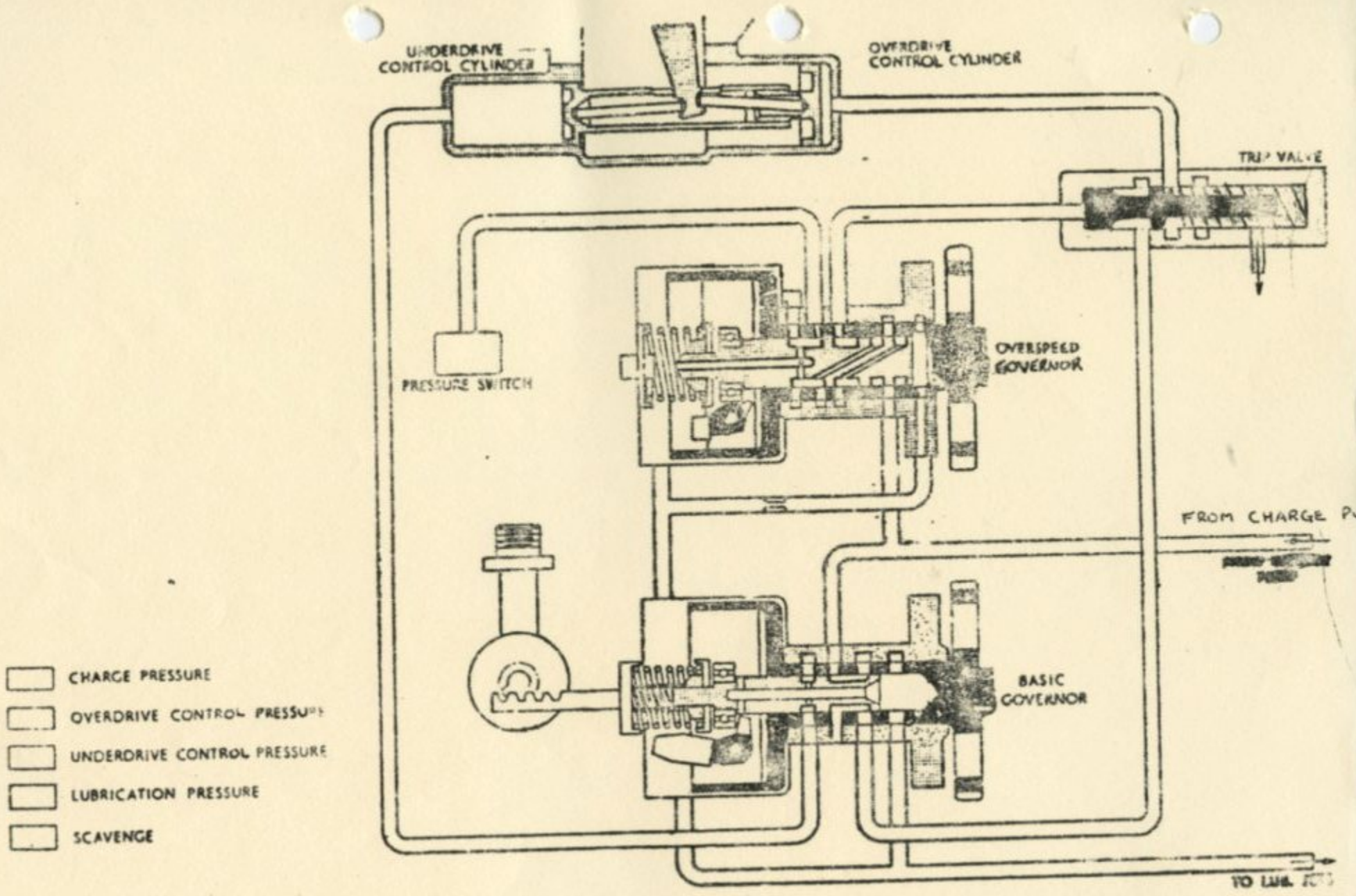
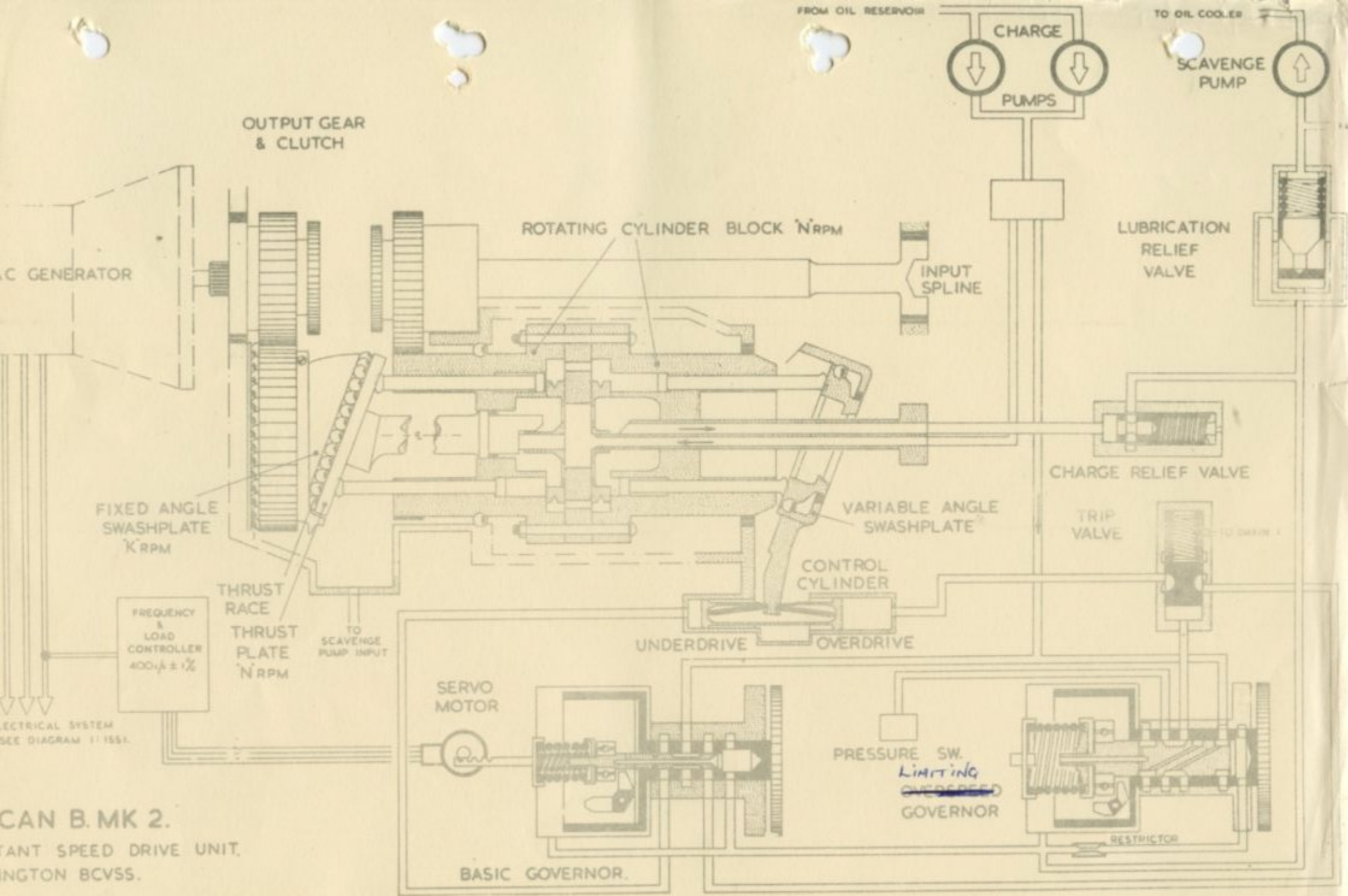


Fig. 15 Governor system at starting



CAN B. MK 2.  
 ANT SPEED DRIVE UNIT.  
 NGTON BCVSS.

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