IMPORPANT:- No checks can be carried out without the use of the Special Bosch EF AW 228 Test Unit, which enables every part of the Electronic Fuel Injection system to be checked except for the Electronic Control Unit itself.

CHECKING THE ELECTRONIC FUEL INJECTION SYSTEM.

NOTE :-

Checks of the ignition system, and of the Basic settings and Clutch checks of the ignition system, and of the Basic settings and Clutch re-engagement Control on cars with hydraulic gearchange, before suspecting the Injection System.

In the event of trouble attributable to the Electronic Fuel Injection System, the following sequence of checks must be carried out in the order stated:-

1) Check the components of the injection system with the Bosch Test Unit.

- scrupulously following the sequence laid down.
 - All these components must be checked with the <u>Electronic Control Unit</u> <u>disconnected</u>.
- 2) If no fault is found during the course of the tests the Electronic Control Unit should not yet be pronounced faulty, the five earthleads should be carefully checked first:-
 - from the voltage regulator (a) to the battery;
 - from the injection system harness (b) to the regulator;
 - from the battery (c) to the water pump;
 - from the electric fuel pump (d) to the car body;
 - from the battery to the car body (e).
 - (Check the tightness of the bolts, and pull the leads gently to ensure that they are properly secured to their terminals. Use an ohmmeter to check continuity between terminals.)
- 3) If the earth-leads are in good condition, disconnect the field (excitation) lead (yellow sleeve) from the alternator and drive the car. If the trouble disappears, check the alternator and regulator; replace whichever is faulty.
 - If trouble persists, change the Electronic Control Unit.
- IMPORTANT:- Certain actions must be avoided at all costs, as they will damage the components of the Electronic Fuel Injection System, in particular the Electronic Control Unit:-
- 1) Never use a rapid charger, never carry out arc or spot welding on the car without first having disconnected both battery leads.

2) Never use a test lamp to check continuity of circuits (damage to microcontacts).

3) Never strike a spark to test whether a lead is alive.
4) Never start a vehicle with a voltage exceeding 12 volts.
5) Never force a connector onto the unit concerned, take note of the inhibitor chamfers on the connector.

TRAINING CENTRE - JUNE 1973

ELECTRONIC FUEL INJECTION DS 21 - DS 23 - SM

Test sequenceence using Bosch Tester E.F.A.W. 228

Check the following 5-earth connections:----

- 1/ at voltage regulator
- 2/ at fuel injection loom
- 3/ at battery lead
- 4/ at electrical fuel pump
- 5/ at chassis.

Before starting the test, ensure that the battery is well charged.

Disconnect E.C.U. (Electronic Control Unit) and electrical lead (s), ignition distributor to H.T. coil (s).

Connect the Bosch Tester without the E.C.U. for tests 1 to 15 and reconnect it (with the tester) for tests 17 to 19.

Switch on ignition.

	ITEMS TESTED	SWITCH "A"	SWITCH "B"	OPERATE BUTTON OR ACTION	READING REQUIRED	DS 21	DS 23	SM
1	Voltage to ECU (Term 16)	Measuring	Voltage I		11 to 12.5 V.			
2	Voltage to ECU (Term 24)	"	Voltage II		11 to 12.5 V			
3	Cranking voltage at starter motor relay	"	Starting Voltg.	Operate starter until pointer stabilises.	9 V. minimum			
4	Resistance, pressure sensor windings to earth	"	Adjust 00/ Pres. sensor	"Adjust 00" "Ground"	00 00			
5	Pressure sensor primary winding	"	Pres-sensor	Primary	0.8 to 1.2 Rx			
6	Pressure sensor secondary winding	"	"	Secondary	3 to 4 Rx			
7	Resistance, triggering contacts in distributor.	"	Distributor Contacts I Distributor Contacts II	Operate starter	0 to 00 then oscillates			
8	Engage clutch on hydraulic gearchange 'D' models. Acceleration contacts, throttle spindle switch.	"	Throttle valve Switch 1 Throttle Valve Switch II	Open throttle fully, slowly	8 to 10 oscillations from 0 to 00			

MODEL: REG. NO: MILEAGE: DATE:

	ITEMS TESTED	SWITCH "A"	SWITCH "B"	OPERATE BUTTON OR ACTION	READING REQUIRED	DS 21	DS 23	SM
9	Throttle spindle switch setting	Measuring	Throttle valve	Throttle closed	0			
		-	Switch III	.7 mm feeler at excentric	0			
				1.4 mm " "	00			
0	Resistance of air thermal sensor	"	Temp. Sensor 1		2 to 5 Rx			
11	Resistance of coolant thermal sensor	"	Temp. Sensor II		0.3 to 3.0 (Rx) falls with rising temperature			
12	Resistance cf injector windings.	"	Adjust 00	Adjust 00	00			
	Connect Citroën 1730 adaptor in white 6 way connector (157) on RH side of		Valves	1	2 to 3 Rx			Cyl 1 Cyl 2
	car electrical harness for SM cars.			2	2 to 3 Rx			Cyl 4 Cyl 5
				3	2 to 3 Rx			Cyl 3
				4	2 to 3 Rx			Cyl 6
3	Remove cold start injector and insert pressure gauge.	Valve check	Any	Pump	2kg/cm ² while pumping			$\overline{\searrow}$
				On release of button	Rapid fall to 1.2			
	Fuel pressure (Pump)			Pump	2kg/cm ² while pumping	\smallsetminus	\smallsetminus	
				On release of button	Rapid fall to 1.7	\square	\nearrow	
14	Injectors (delivery)	Valve check	Any	Touch 1	Pressure drop			$\frac{1}{2}$
	Do not test more than once or twice,			Touch 2	11 11			4 5
	or engine will flood.			Touch 3	" "			3
				Touch 4	" "			6
15	Cold starting injector (delivery) If coolant temp. above 25°C, earth tne grey female connector.	" "	"	Operate starter motor	Fuel spray while starter operating.			
16	Remove pressure gauge + 1780 adaptor, connect ECU coil(s) to distributor Lead(s).							
17	Triggering contacts in base of distributor,	Contact I Contact II		Run engine at 1500 rpm	Oscillates at both switch positions. The main point of oscillation must be within 2 divs. on the volt scale.			

	ITEMS TESTED	SWITCH "A"	SWITCH "B"	OPERATE BUTTON OR ACTION	READING REQUIRED	DS 21	DS 23	SM
18	Throttle spindle switch, throttle closed	Contact I or II	Any	Engine at idle, disconnect at manifold, hose to supplementary air control	Engine rpm rises and falls 1100 – 1800—1100—1800 and so on.		$\left \right\rangle$	
				Open throttle slightly	Engine rpm stabilises		\succ	\triangleright
19	Engage clutch on hydraulic gearchange	Contact IV	"	Engine stopped ign. on	0 to 4 V.	\succ	\succ	
	'D' models.	Pressure	"	Engine stopped ign. on	4 to 6 V.			\bowtie
	Full load switch.	Switch		Engine idling snap throttle open,	00 sudden drop towards 0			





General Feed Relay.

- Electronic Control Unit.
- Relay for Fuel Pump.
- Fuel Pump.
- Fuel-Pressure Regulator. 5)
- Thermal Switch (see "Cold-Starting" Diagram). 6)
- Throttle Spindle Switch. 7)
- Thermal Sensor. 8)
- Supplementary Air Control. 9)
- Impulse-Relay for cold-starting.Injector (see "Cold-Starting"-Diagram). 10)
- Injector (cold-starting) (see "Cold-Starting" Diagram). 11)
- Ignition distributor (Triggering Contacts). 12)
- Injector, (main). 13)
- Pressure Sensor. 14)
- 15) Full Load Switch.

NOTES :-

The following diagrams explain the operation of these items.

- The Cold Starting diagram includes items 6, 10 and 11.

The last diagram shows the general operation of the ECU

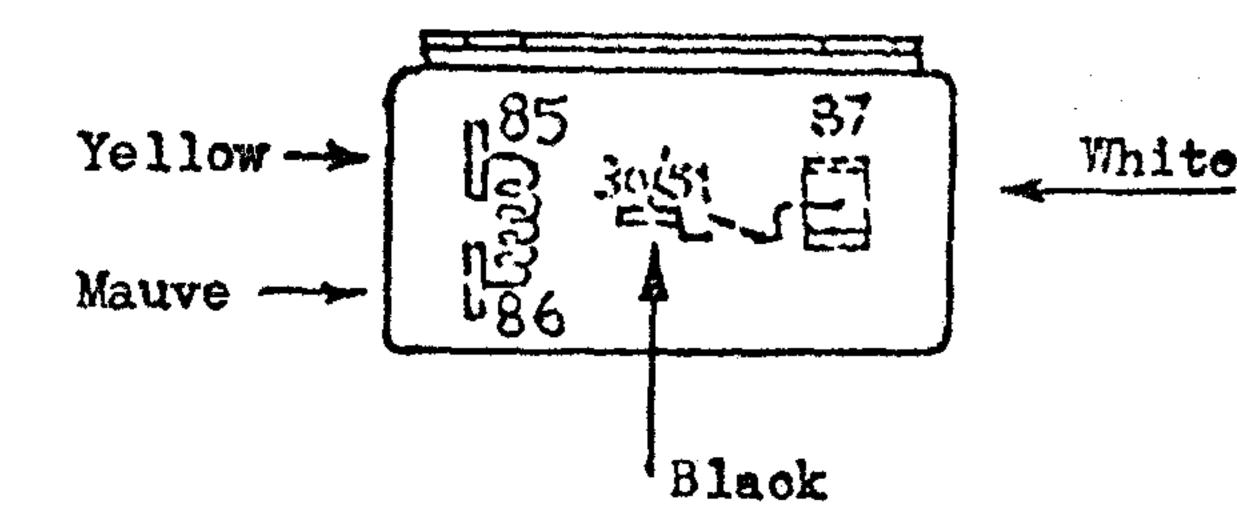
under acceleration and full-load conditions.



Relays (construction and fitting).

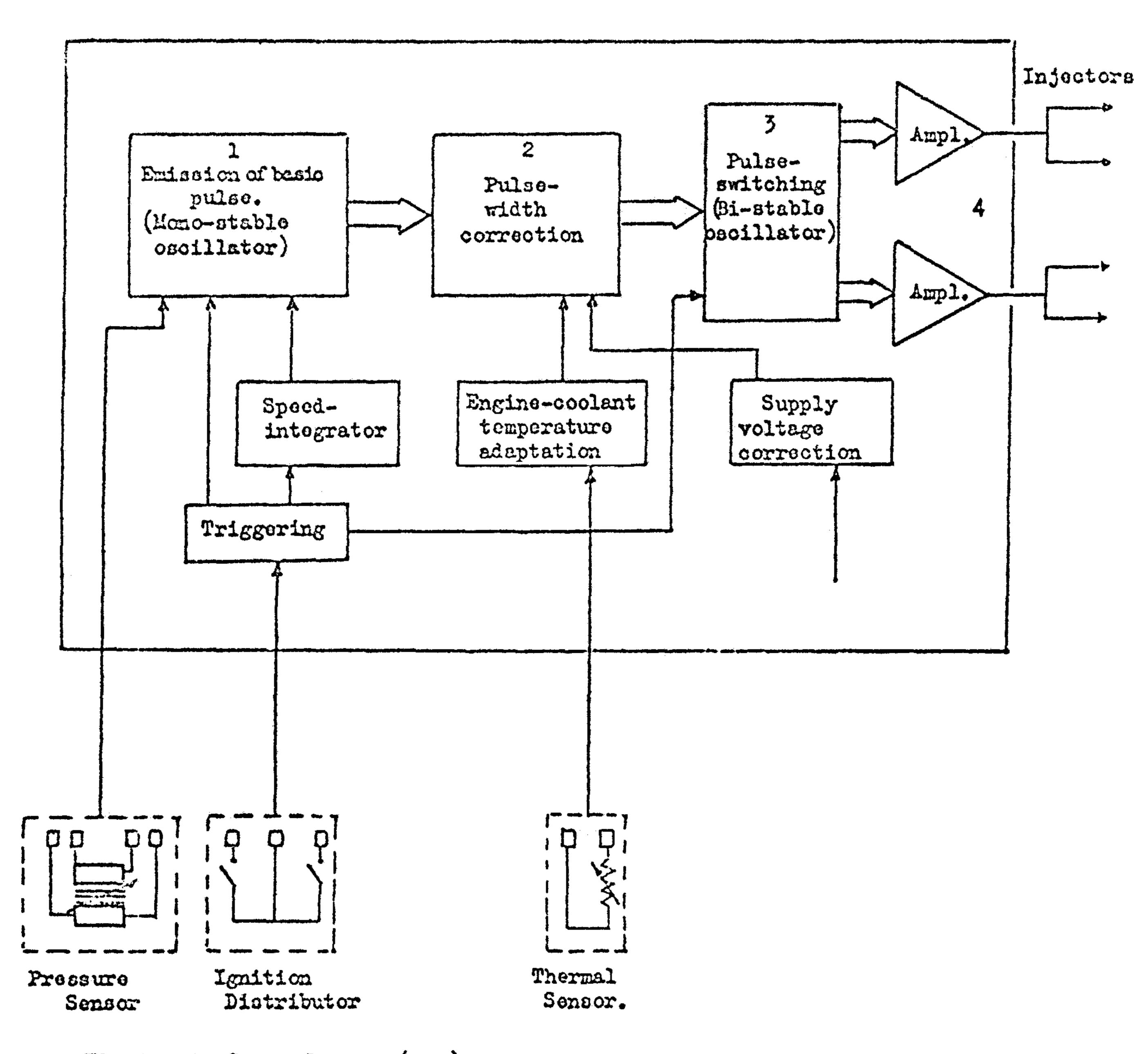
- The three Relays, fitted adjacent to the battery, are all of the same type; they have four blade-connectors (one double-bladed, no.87); two connectors (coded 85 and 86) are at the ends of the solenoid winding, the other two (coded 87 and 30/51) are the switching contacts; spring-loaded open, they close when the solenoid is energised.
- No. 30/51 is the live side of the switching contacts (feed from battery).
- The colour codings of the leads from the harness to these connectors are the same on all three relays:-
 - No. 85:- Yellow. No. 86:- Mauve. No. 87:- White. No. 30/51:- Black.
- As installed on the car, the forward relay is the General Feed Relay, the centre relay is the Fuel Pump Relay, the rearward relay is the Impulse Relay for the Cold-Starting Injector.

View from above.



ELECTRONIC CONTROL

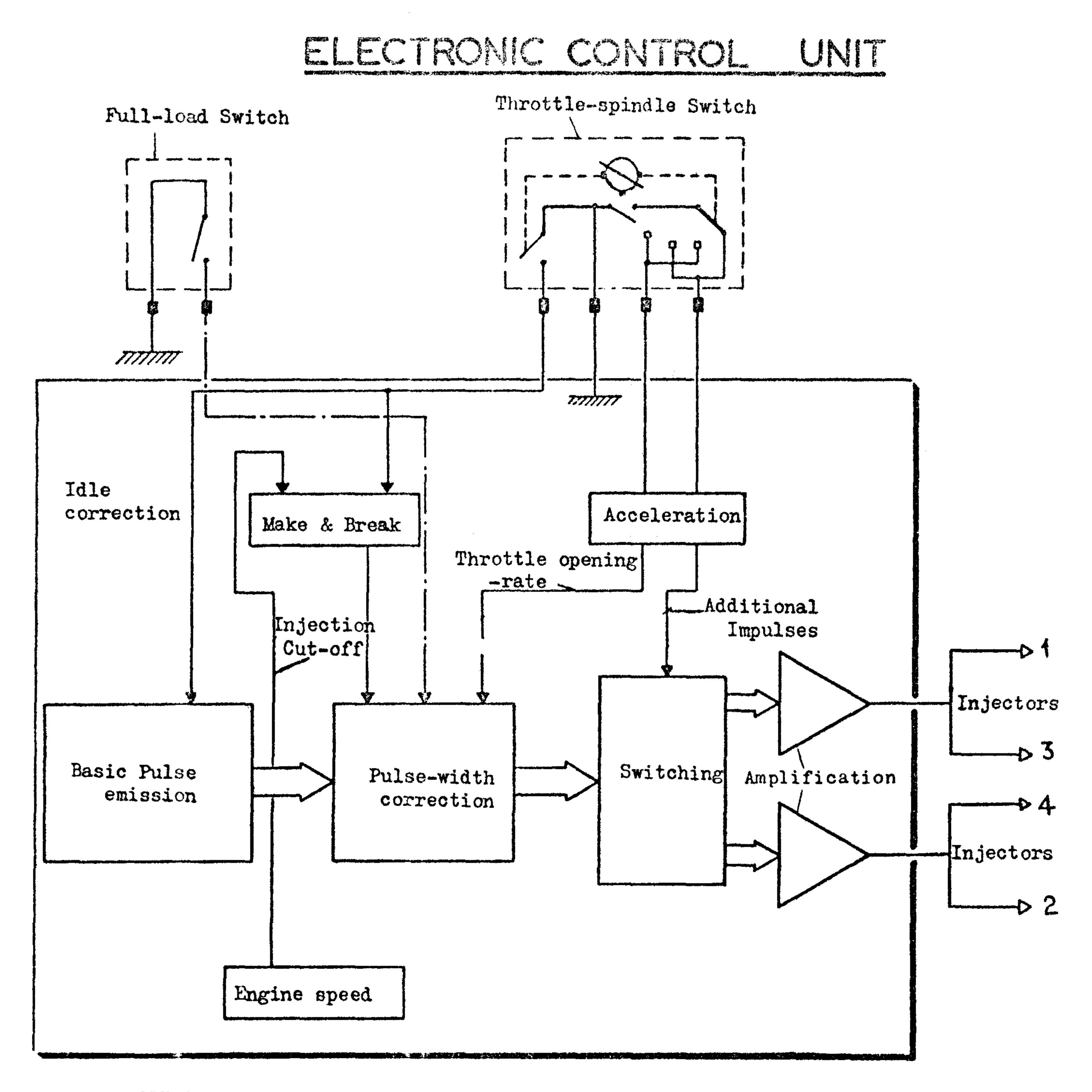




Electronic Control Unit (ECU):- receives signals from the various sensing clements, creates pulses, corrects the pulse-width, directs them to one cr other pair of injectors, amplifying them to operate the injector colenoids at 3 volts. Also controls operation of Fuel Pump when engine starts and stops.

Voltage compensation (inside Electronic Control Unit):- senses battery voltage and alters pulse width if necessary; e.g. if battery voltage is low, injector solenoid will open valve slowly, compensator increases pulse width.

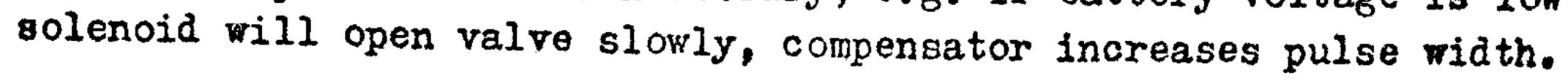


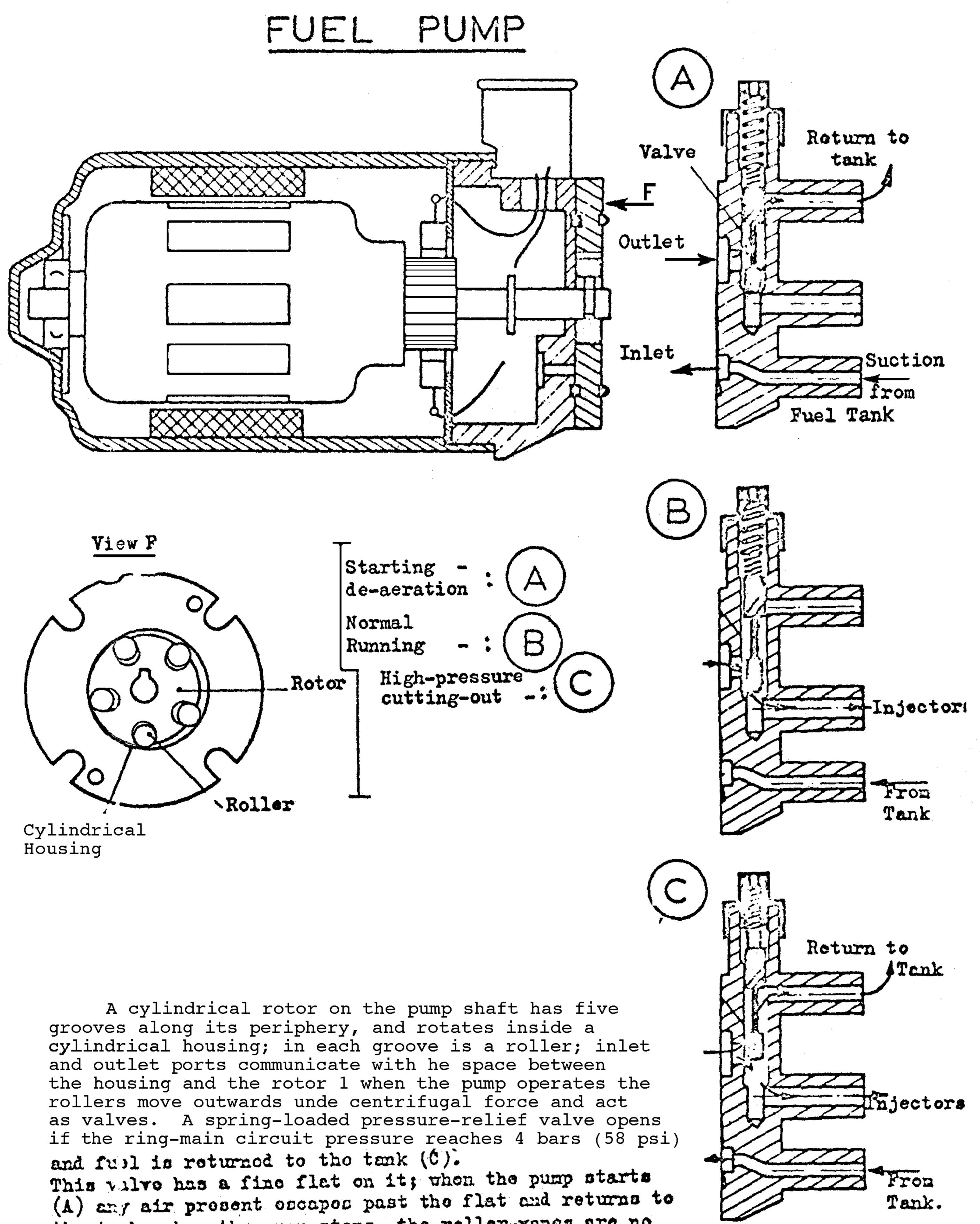


OPERATION OF ELECTRONIC CONTROL UNIT, ACCELERATION & FULL-LOAD

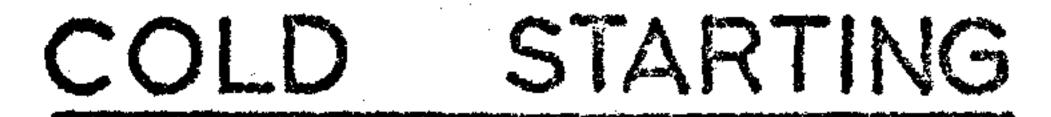
<u>Electronic Control Unit (ECU):</u>- receives signals from the various sensing elements, creates pulses, corrects the pulse-width, directs them to one or other pair of injectors, amplifying them to operate the injector solenoids at 3 volts. Also controls operation of Fuel Pump when engine starts and stops.

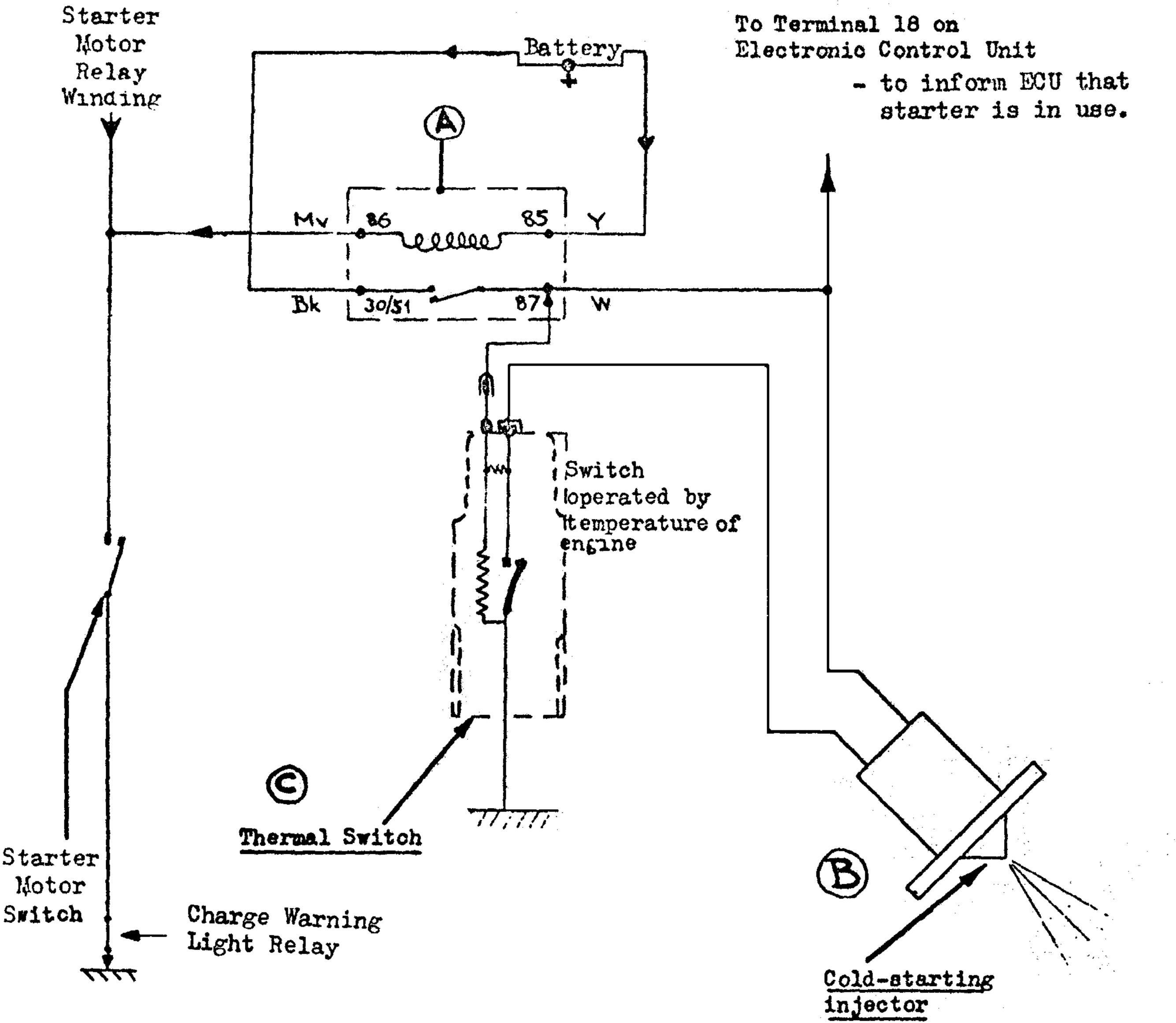
<u>Voltage compensation</u> (inside Electronic Control Unit):- senses battery voltage and alters pulse width if necessary; e.g. if battery voltage is low, injector





the trik; when the pump stops, the roller-venes are no longer held out by contrifugal force; fuel escapes from the ring-main along this flat until the line-pressure falls to 1.3 Kg/or2 (182 psi) at which point the valve closes. The pump is full of fuel at all times, eliminating shaft-leals and the friction they would introduce. The pump output of approx. 13 galls/hr exceeds the maximum requirements of the engine (92 galls/hr) and thus ensures that fuel circulates continuously.





Relay, Impulse:- for cold starting injector, energised only when starter motor is in use.

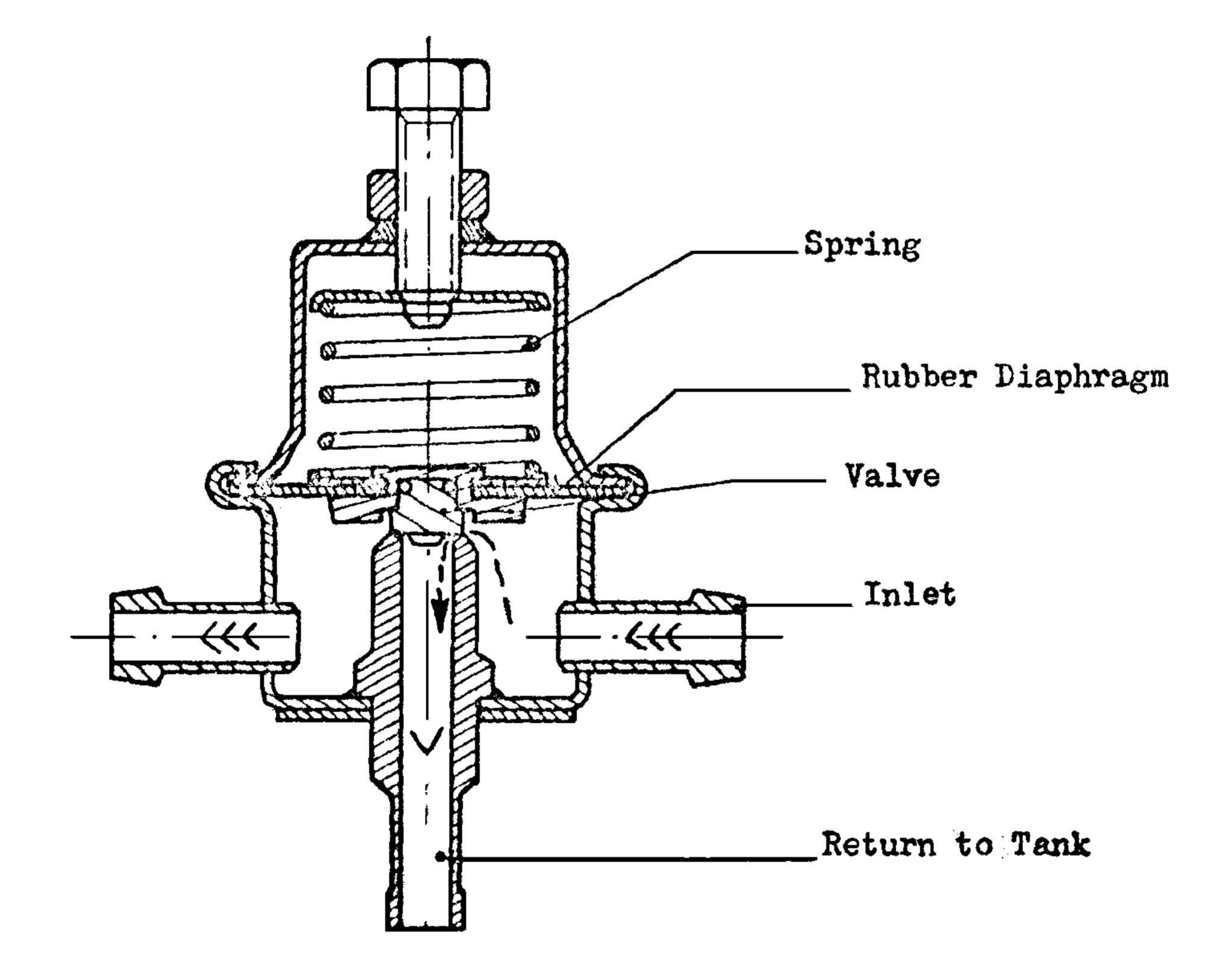
Inj ctor, Cold Start: - Energised by Impulse Relay, provided Thermal witch is closed (below 20°C to 30°C (68°F to 86°F); only injects hile Starter Motor is running. Operates at battery voltage, i.e. 9 - 10v while starter motor is in use.

.

The mal Switch:- responds to engine-coolant temperature if below 20°C to 30°C (68°F to 86°F), and allows cold-starting injector to open for the period of use of the starter motor; fuel condensed in manifold continues to evaporate giving reducing richness. Incorporates a resistance which heats the temperature-sensitive switch to avoid flooding engine if the starter motor is operated for long periods (timing 6 seconds at - 20°C, $1 \text{ second at } + 15^{\circ}\text{C}$).

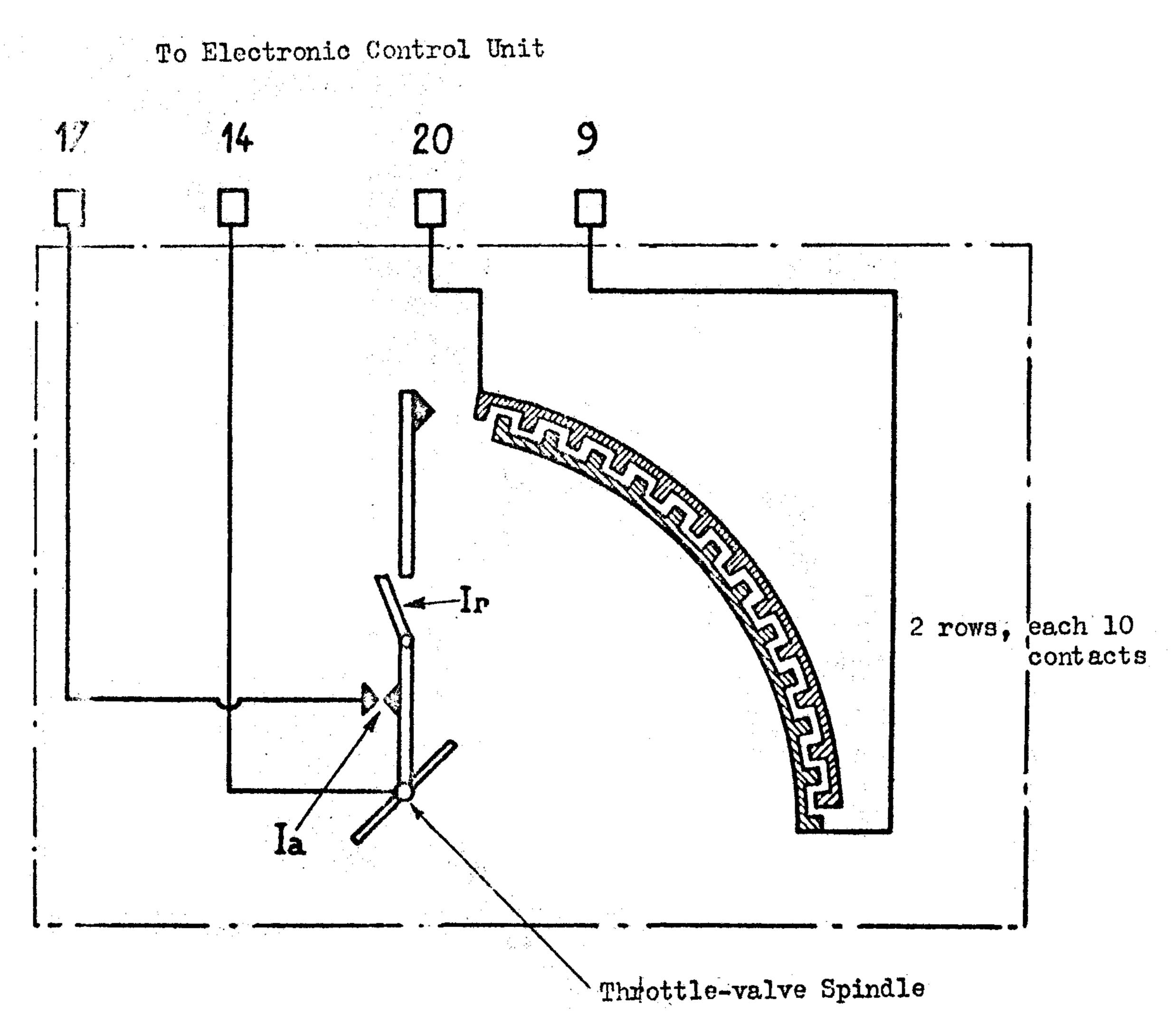


REGULATOR



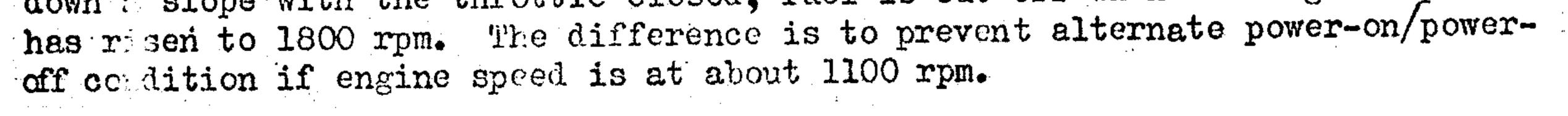
<u>Fuel-Pressure Regulator:</u> Fitted into the Fuel-supply Ring-Main. A spring-loaded rubber diaphragm holds a valve closed until the fuelpressure acting on the diaphragm is sufficient to compress the spring, lift the valve and allow fuel to return to the tank (2 kg/cm², 28.5 p.s.i.

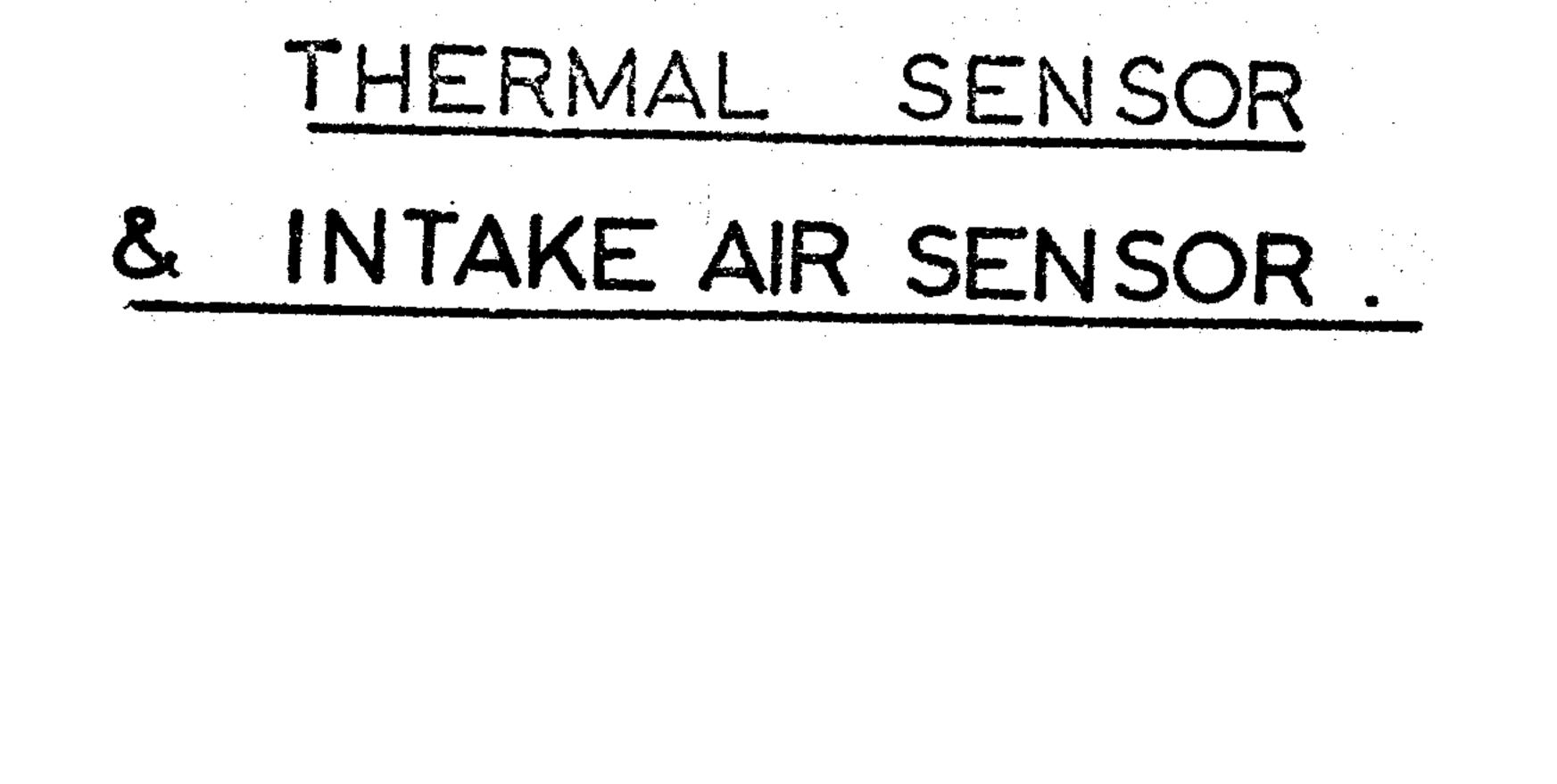
THROTTLE-SPINDLE SWITCH



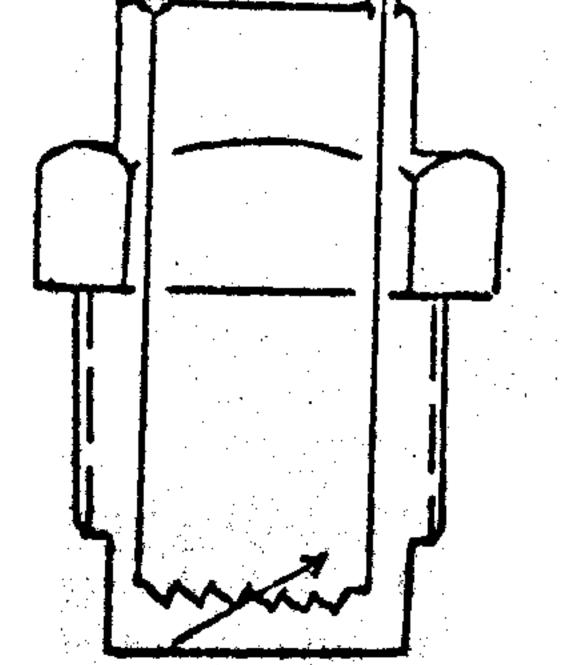
Throttle Spindle Switch:-

- Idlin (throttle olosed):- reduces length of pulse determined by Electronic Control Unit from Pressure Sensor Signal, otherwise mixture would be too rich. ("Thro tle-closed" Switch Ia).
- <u>Acceleration:</u> a slider rotating with the Throttle Spindle contacts alternate contacts and sends signals alternately to the bistable switching circuit and to the pulse-width correction circuit in the Electronic Control Unit. Those to the bistable switching circuit provide additional signals to the injectors, until the effect of the alteration of inlet manifold pressure on the Pressure Sensor results in a change of inductance (this is because the time lag of 150n/: at the Sensor would otherwise provoke a flat spot). The signals to the pulse width according to the ir frequency, i.e. as a function of the rate of opening of the throttle.
 <u>Throt le-closing:</u> when the throttle is being closed, the connection to the slider is open-circuited and no pulses are supplied (Switch Ir)
- Fuel out-off on over-run (engine-braking):- when the accelerator is released, Swite. Is causes fuel cutoff and the Electronic Control Unit recommences pulses when he engine speed has fallen to 1100 rpm; if the car then gathers speed down : slope with the throttle closed, fuel is cut off when the engine speed



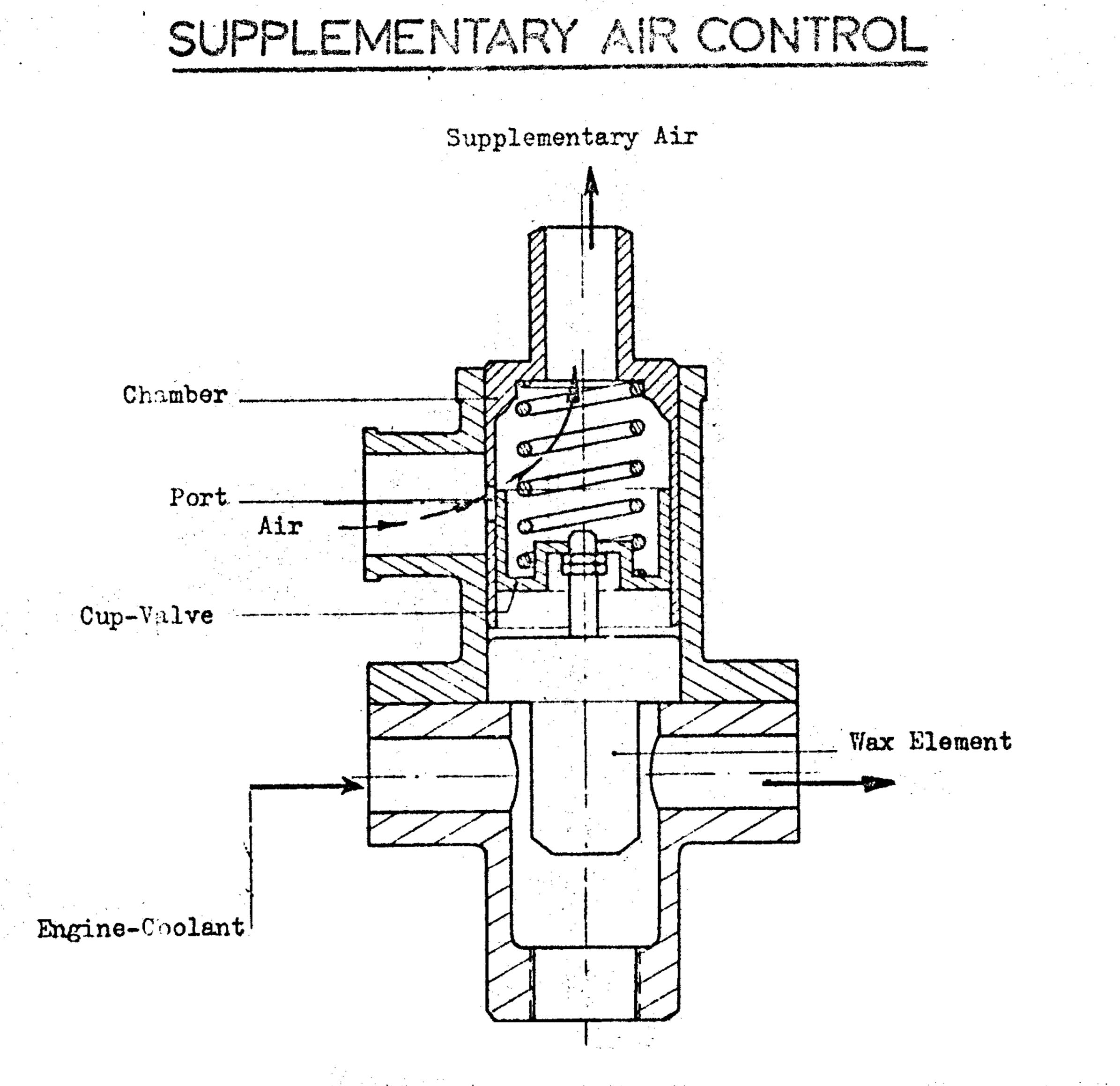


To Earth

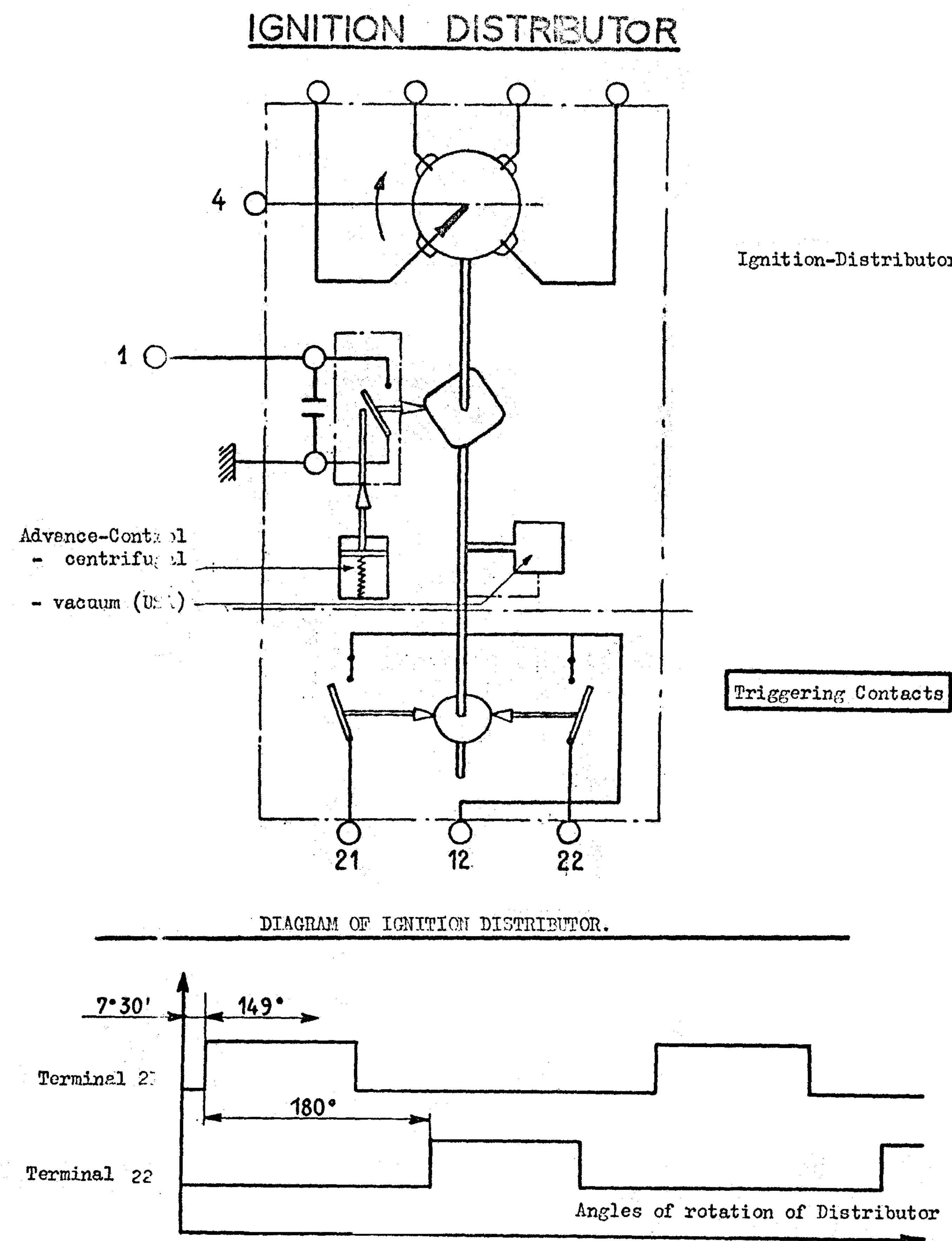


Thermal Sensor: - Resistance varies with engine coolant temperature; (<u>Warm-up control</u>) signal to Electronic Control Unit causes changes in pulse width (e.g. Temp. change from 50°C to 30°C causes pulse width to be multiplied by 2.5), until engine has reached normal operating temperature (70°C or above).

Intake Air Sensor: Resistance varies with intake air temperature; signal to ECU causes changes in pulse-width, balancing supply of fuel to mass (i.e. actual quantity of oxygen) of intake air.



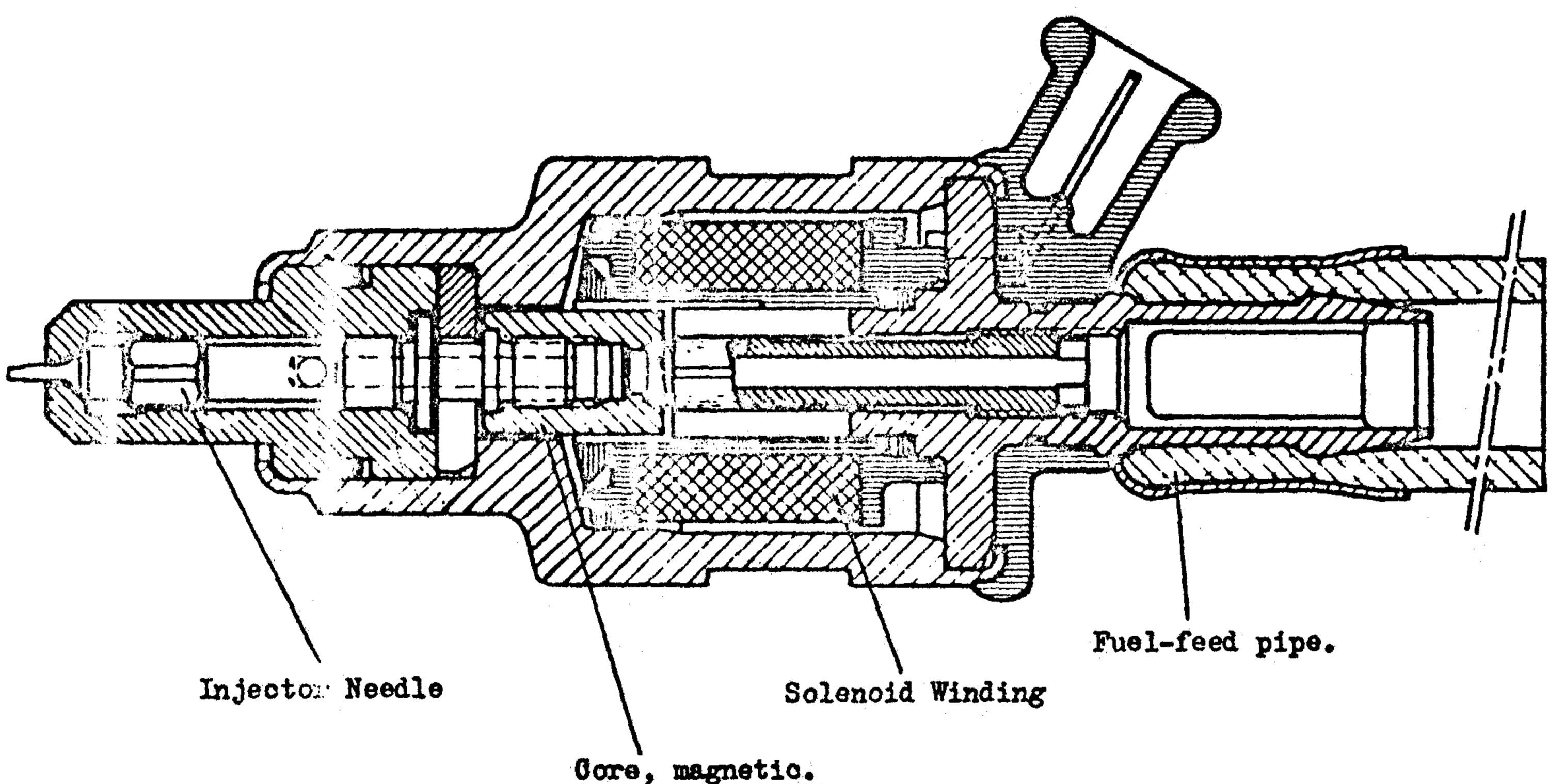
Supplementary Air Control (non-electrical):- in engine coolant circuit; a springloaded cup-valve operated by a temperature-sensitive wax element meters air passing through a port, reducing the volume of air as the coolant temperature rises; this supplementary air bypasses the throttle valve, and provides extra air during the warm-up period to balance extra fuel supplied in response to signal from Thermal Sensor. The air supply to this Supplementary Air Control comes from the engineside of the Air Filter. When the coolant has reached 70°C the supplementary air port is closed.



Ignition-Distributor.

ORDER OF PULSE-TRIGGERING

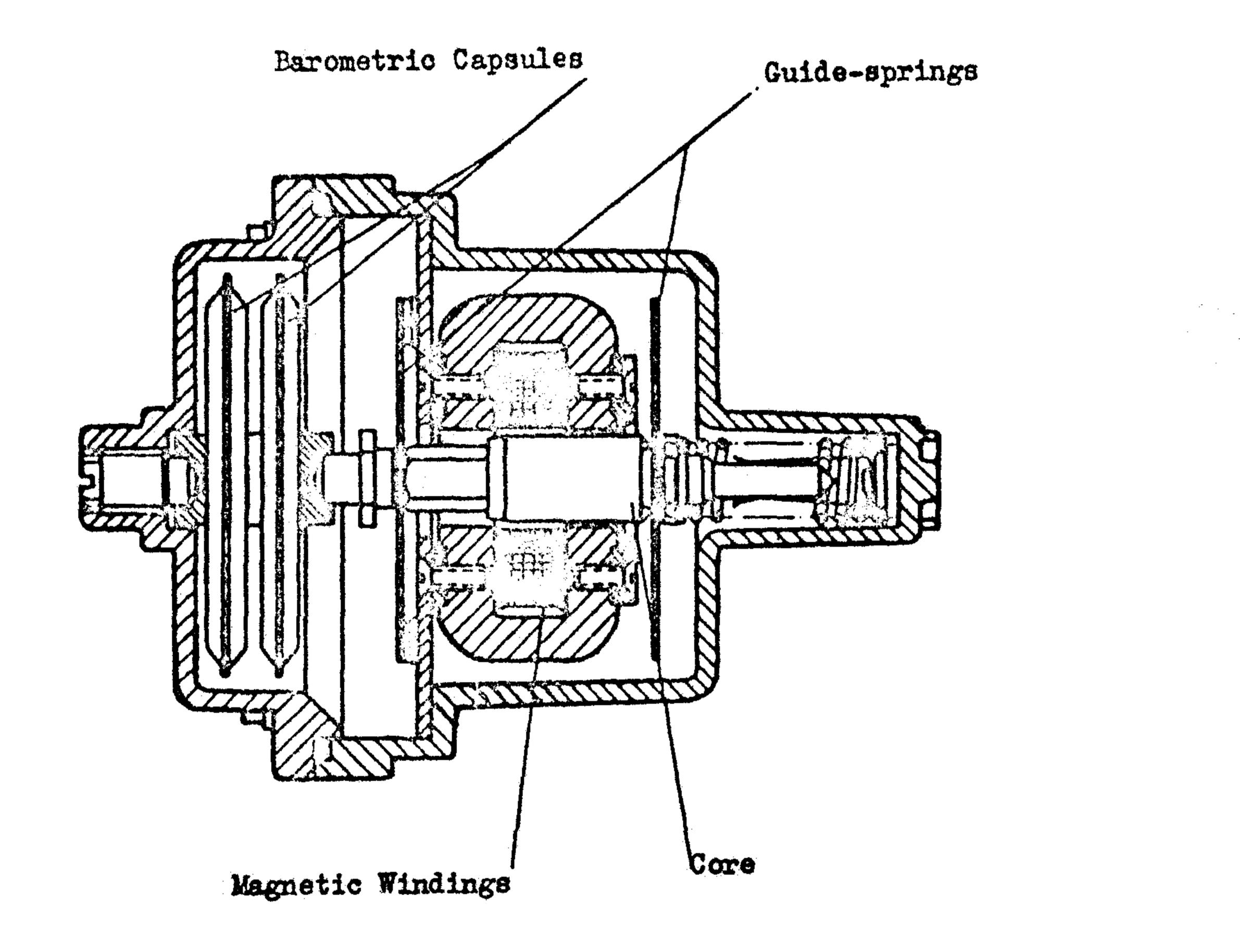
Ignition D. stributor: Includes an additional cam on the shaft, with two contactbreakers it 1800; these contact-breakers which each close through 1490 of rotation of the distributor shaft supply to the Electronic Control Unit, triggering pulses which are the signals for the commencement of the pulses supplied by the ECU to the injectors, and the switching of pulses to alternate pairs of injector; the freq ency of the pulses from the triggering contacts informs the ECU of the speed of the engine. The contects are non-adjustable.



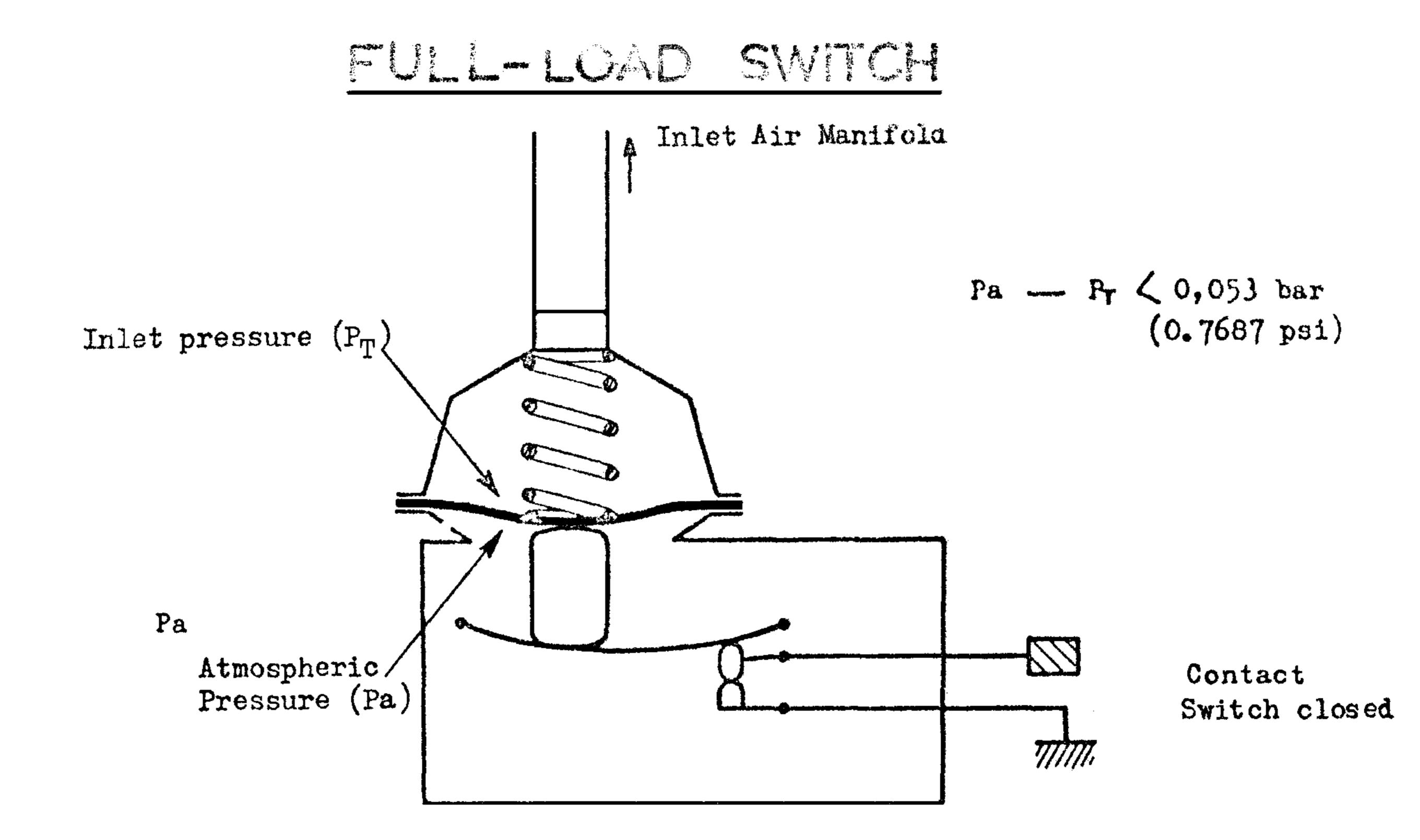
NJECTOR

- Soleno d-operated in pairs (1 and 3, 4 and 2) by pulses emitted by Electronic Control Unit. Fuel supply is at constant pressure (28.5 psi) and injector has constant lift; the only variable is the duration of opening (corresponds to the pulse ...idth). The solenoids operate at 3 volts, to avoid heating the fuel. Needle opening-time is approximately 1 millisecond. The duration of injection time v ries from 2.5 milliseconds at idling to 9.7 milliseconds at full load.

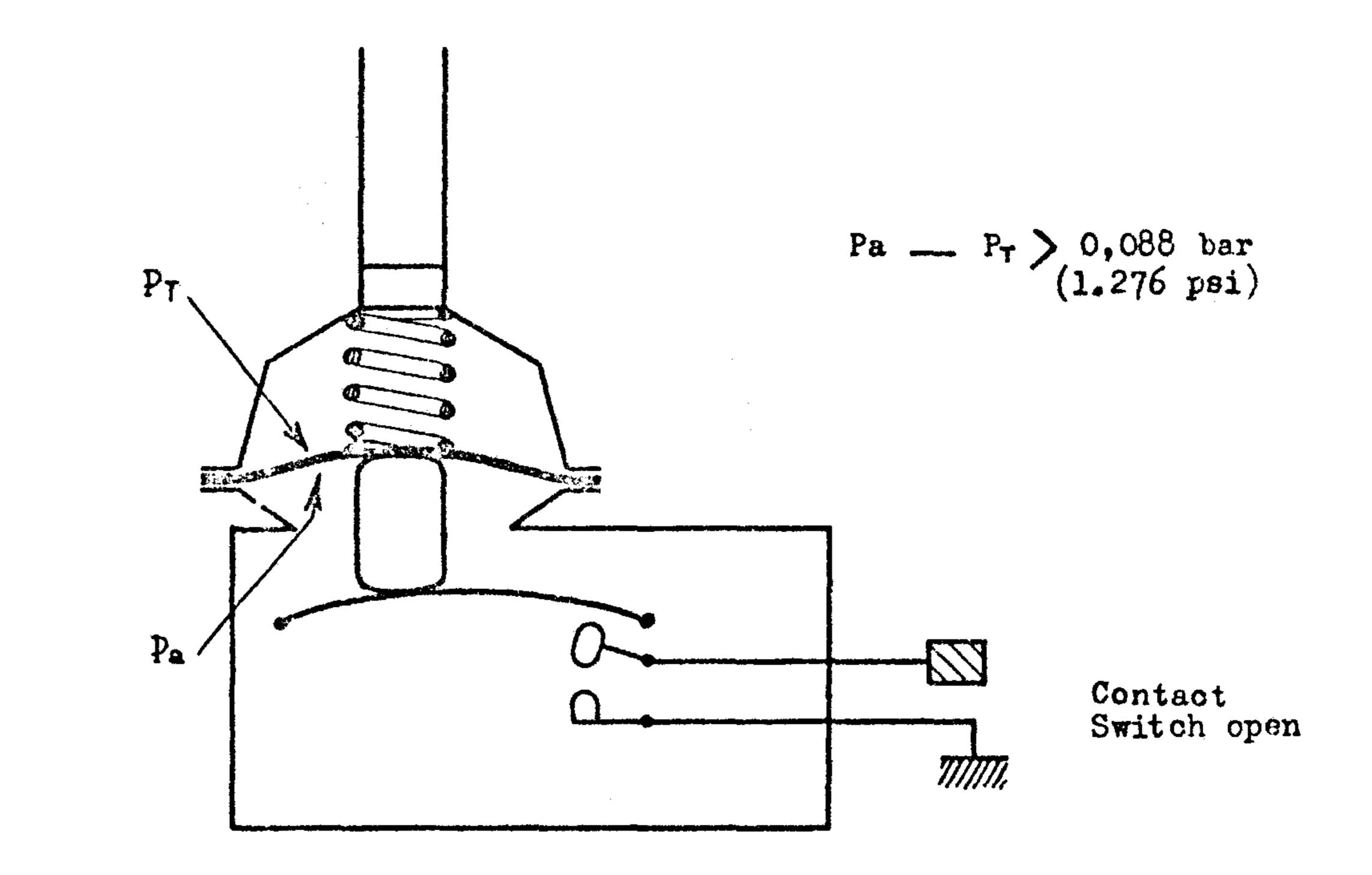




Pressure Sensor:- sends signals of varying inductance; controlled by inlet manifold pressure acting on two barometric capsules attached to a movable core in a choke of two windings (primary and secondary) which acts as a transformer. Value of inductance varies with the absolute pressure in the manifold; The ECU sends a signal through the primary and receives a response from the secondary, this response varies as the inductance changes. The Pressure Sensor is damaged by excessive vibration or by being dropped. On the car it is mounted on the Scuttle Panel by a bracket with rubber bushes.



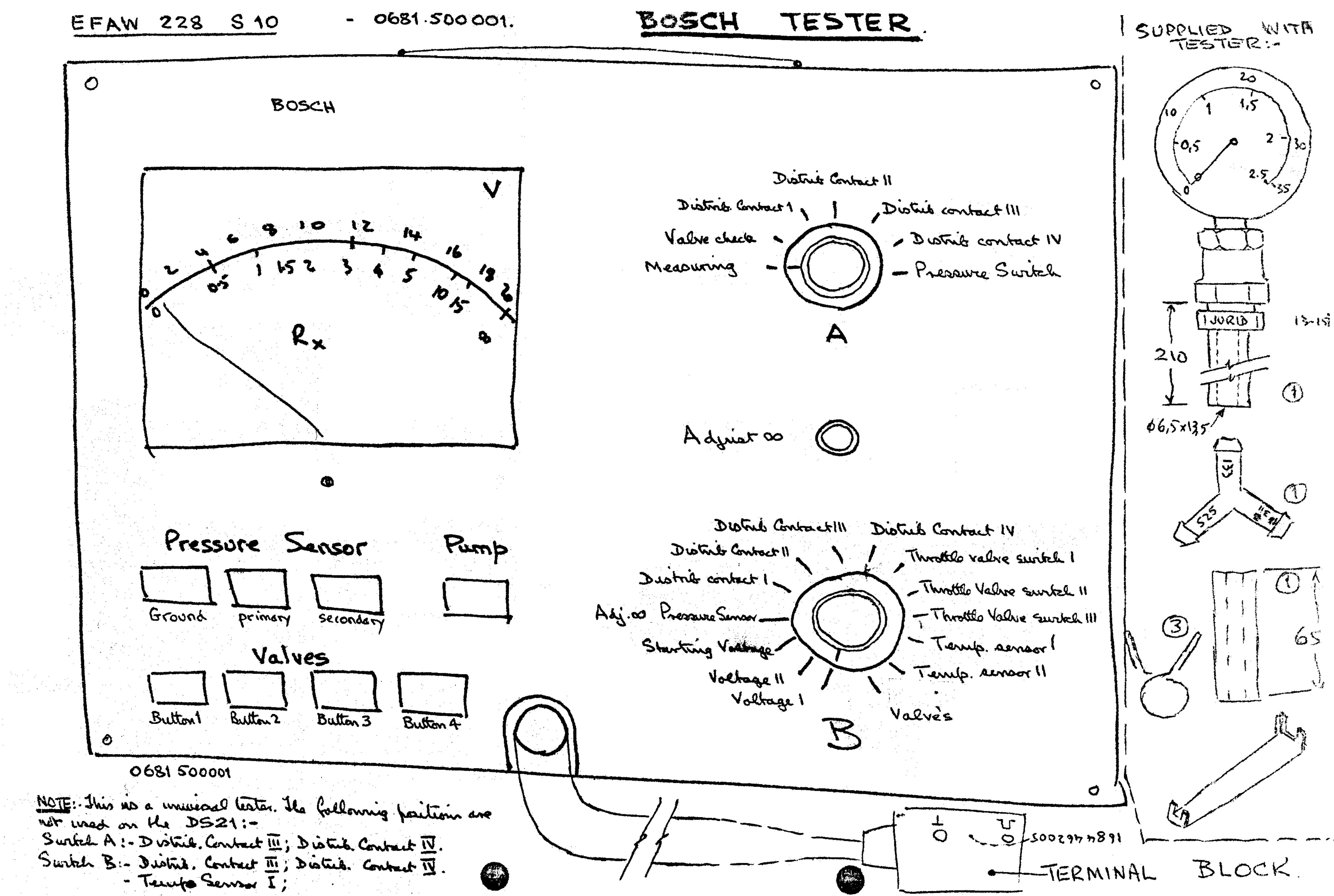
FULL-LOAD SWITCH CLOSED

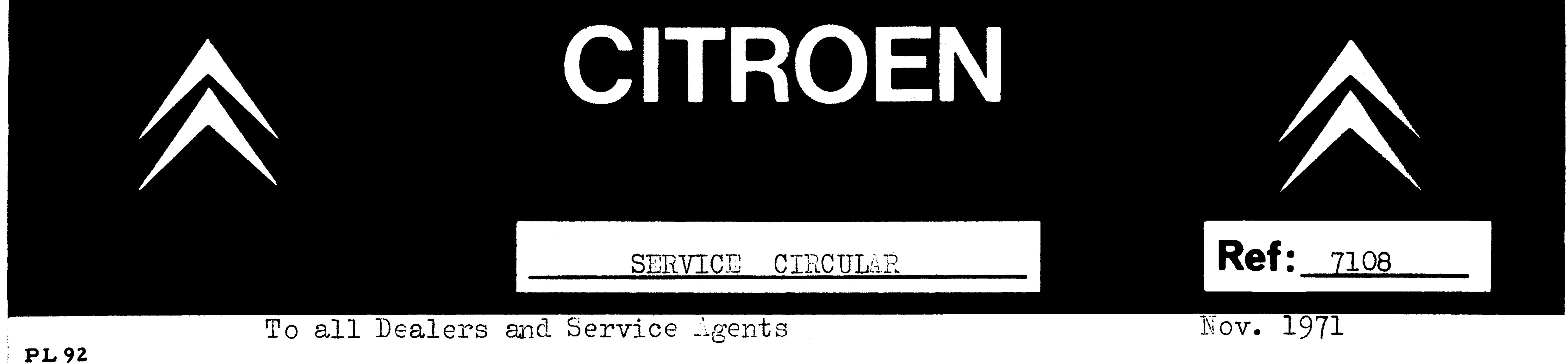


FULL-LOAD SWITCH OPEN

Full Load Switch:- Screes difference between absolute pressure in manifold and atmospheric pressure: when pressure differential is less than 0.053

Ler (0.7687 psi) i.e. when throttle is 2/3 open or more, a contact closes and sends a signal to the Electronic Control Unit which modifies the pulse width accordingly. An over-centre spring keeps the contact closed until the pressure differential reaches 0.088 bar (1.276 psi), to avoid fluttering and hesitation which could occur if the pressure oscillated slightly above and below a single operating level; the actual pressure of opening and closing varies with changes of atmospheric pressure, thus affording automatic altitude ompensation. When the <u>engine is stopped</u>, the pressure differential is nil, therefore the <u>switch closes</u>; as soon as the engine starts to turn, with the throttle closed, the switch opens, but in the closed position its signal to the ECU contributes to a slight increase of pulse-width each time the engine is started, whether hot or cold.





DS21 with ELECTRONIC FUEL INJECTION

ELECTRONIC CONTROL UNIT & PRESSURE SENSOR

1) Since the introduction of the DS21 EFI, several changes have taken place on the E.C.U. and on the Pressure Sensor. Since April 1971 an Air Temperature Sensor has been fitted to the Intake Air Filter.

2) Electronic Control Units

ZC9.851.101U

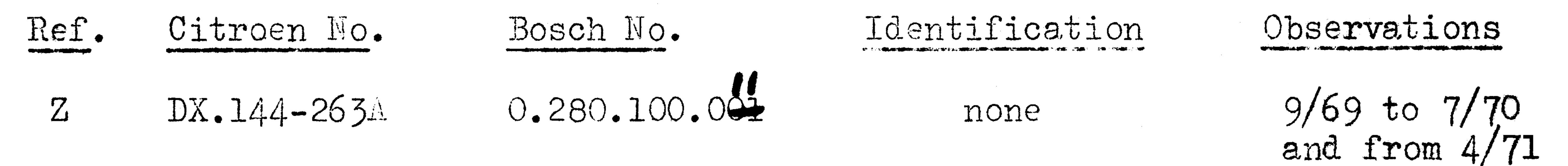
Ref		Bosch No.	Identification	Observations
	DX.144-906A	0.280.000.011	none	9/69 to 7/70
B	DX.144-906A	0.280.000.011	l yellow mark	7/70 to $12/70$
C	5D5.402.234K	0.280.000.011	2 yellow marks	1/71 to $4/71$
D	DX.144.906B	0.280.000.022	Potentiometer Knob	from 4/71
As :	replacement parts,	the three items A,	, B and C are being su	cceeded by:-

Potentiometer Knob

ON NO ACCOUNT MUST THE POTENTIOMETER SETTING BE ALTERED.

0.280.000.042

5) Pressure Sensors



Y DX.144-263B 0.280.100.023 Black spot 7/70 to 4/71

A Pressure Sensor DX.144-119A with a green marking was fitted as a replacement part on some cars; if one has to be changed, fit a Black Spot Sensor DX.144-263B.

4) Replacement of these units

- It is essential to match the Pressure Sensor to the E.C.U.

The following combinations are permissible.

ECU.	Ref	11/11	with	91711	ref.	Pressure	Sensor
ECU.		HB11		nYn		Pressure	Sensor
BCU.		HC II		11Y#		Pressure	Sensor
ECU.		11		1iZtt		Pressure	Sensor
ECU.		胆胆		11211		Pressure	Sensor

- If a Pressure Sensor alone is to be changed on a car, the new Sensor must match the ECU on the car.
- If an "E" type ECU is used to replace a "B" or "C" type, the "Y" type Pressure Sensor must also be replaced by a "Z" type...
- The "D" type ECU must only be fitted to cars with Inlet Air Temperature Sensors and "Z" type Pressure Sensors.
- The Bosch code numbers on the ECU's identify the "D" and "E" types which both have potentiometer knobs.
- The reference letters above do not appear on the parts or in the catalogue; they only appear in this Circular to assist identification.

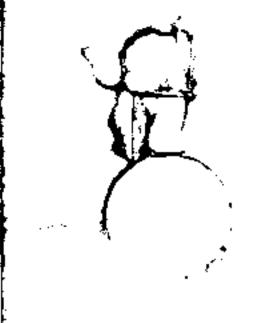
AUTOMOBILES CITROËËN

INFORMATION BULLETIN

N° 204 88-D 10 th December 1970

Confidential

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To avoid clogging of the idling screw and duct by induction of the oil vapours coming from the crankcase gas recycling circuit, it is possible to modify the air-intake on the throttle housing by following note MR.-144-12 herewith. DX-IE

DJ-IE



ENGINE

Modification

of the

idling circuit

Printed in France by Citroën

C I T R O Ë N

SOCIÉTÉ ANONYME AUTOMOBILES CITROËN AU CAPITAL DE 982. 666. 000 F 117 à 167, QUAI ANDRÉ-CITROËN - PARIS-XV°

Paris, le 8th December 1970

NOTE MR. Nº 144-12

Page : 1/3

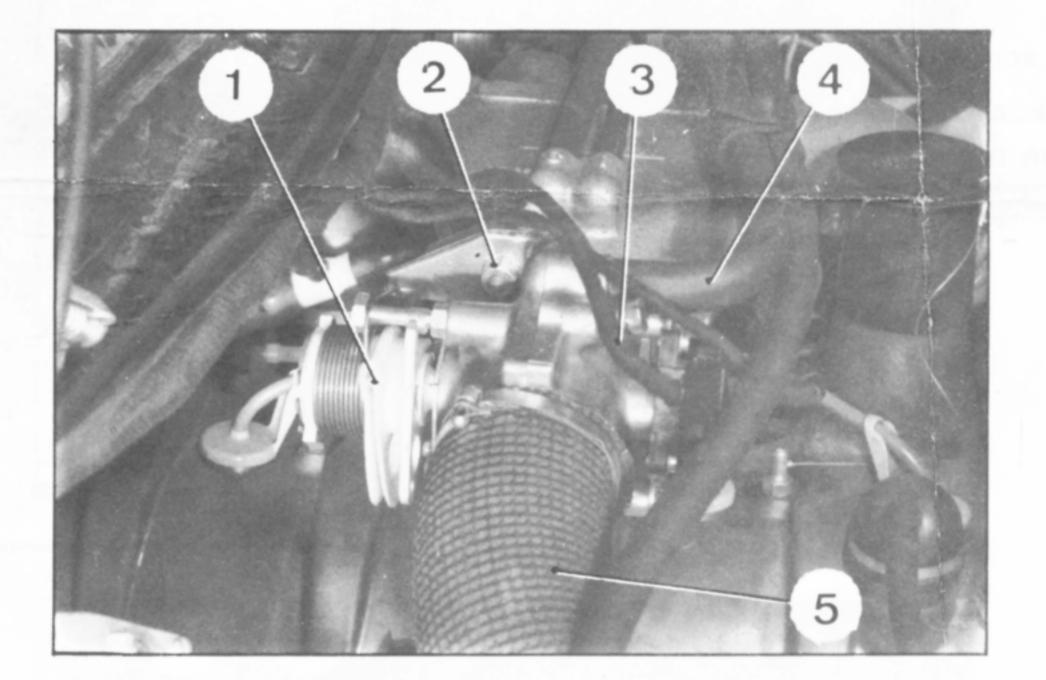
REPAIR METHODS

VEHICLES DX.IE - DJ.IE

Modification of the idling air circuit

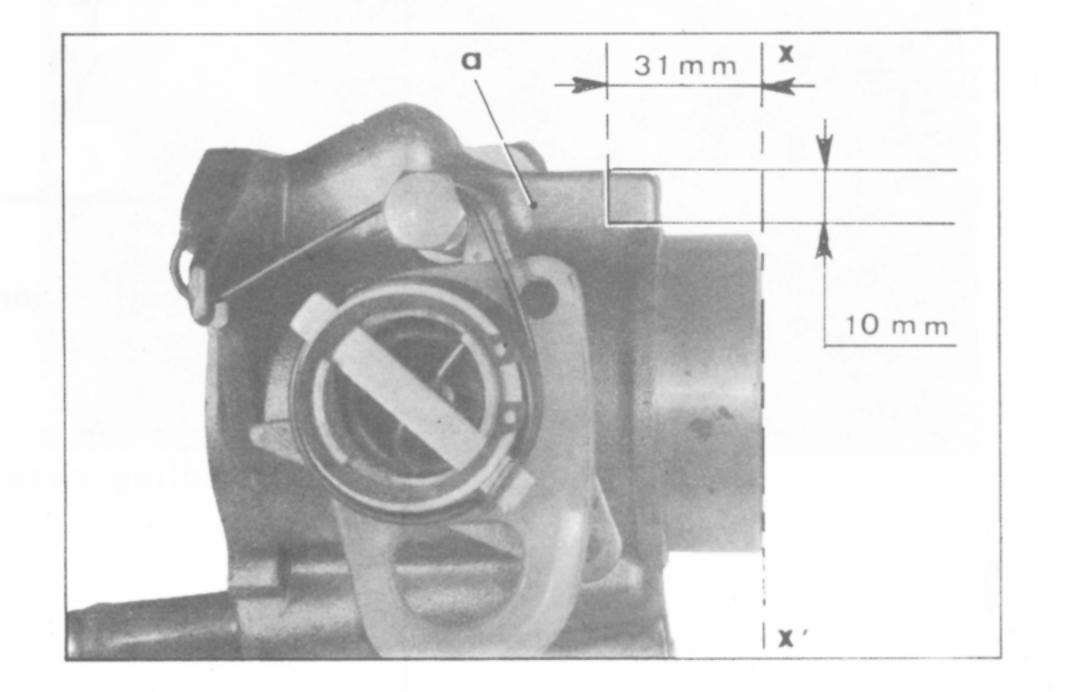
1) To be obtained.	
a) At the Service de Pièces de Rechange :	
- 1 three-way union	DX. 144-219 A
- l flexible hose	
- l rubber clip	DS. 391-127
b) A metallic pipe A :	C.T.
- inside diαmeter	8 mm
- outside diameter	10 mm
- length	50 mm

2) Remove the throttle housing :



5

- Disengage the flexible hose (4)
- Disconnect the wiring harness (3) of the switch on the butterfly spindle
- Disengage the duct (5)
- Unhook the accelerator cable from the plastic cam (1)
- Disengage the flexible crankcase gas recycling tube (under the inlet manifold)
- Remove the nuts (2) securing the housing on the inlet manifold, and the nut on the exhaust field
- Remove the housing



- 3) Modify the throttle housing :
 - a) At the boss «a» (see opposite) cut a groove by saw parallel to plane XX^{*}, 31 mm from

this and 10 mm deep.

REPAIR METHODS

MR 144-12

Page : 2/3

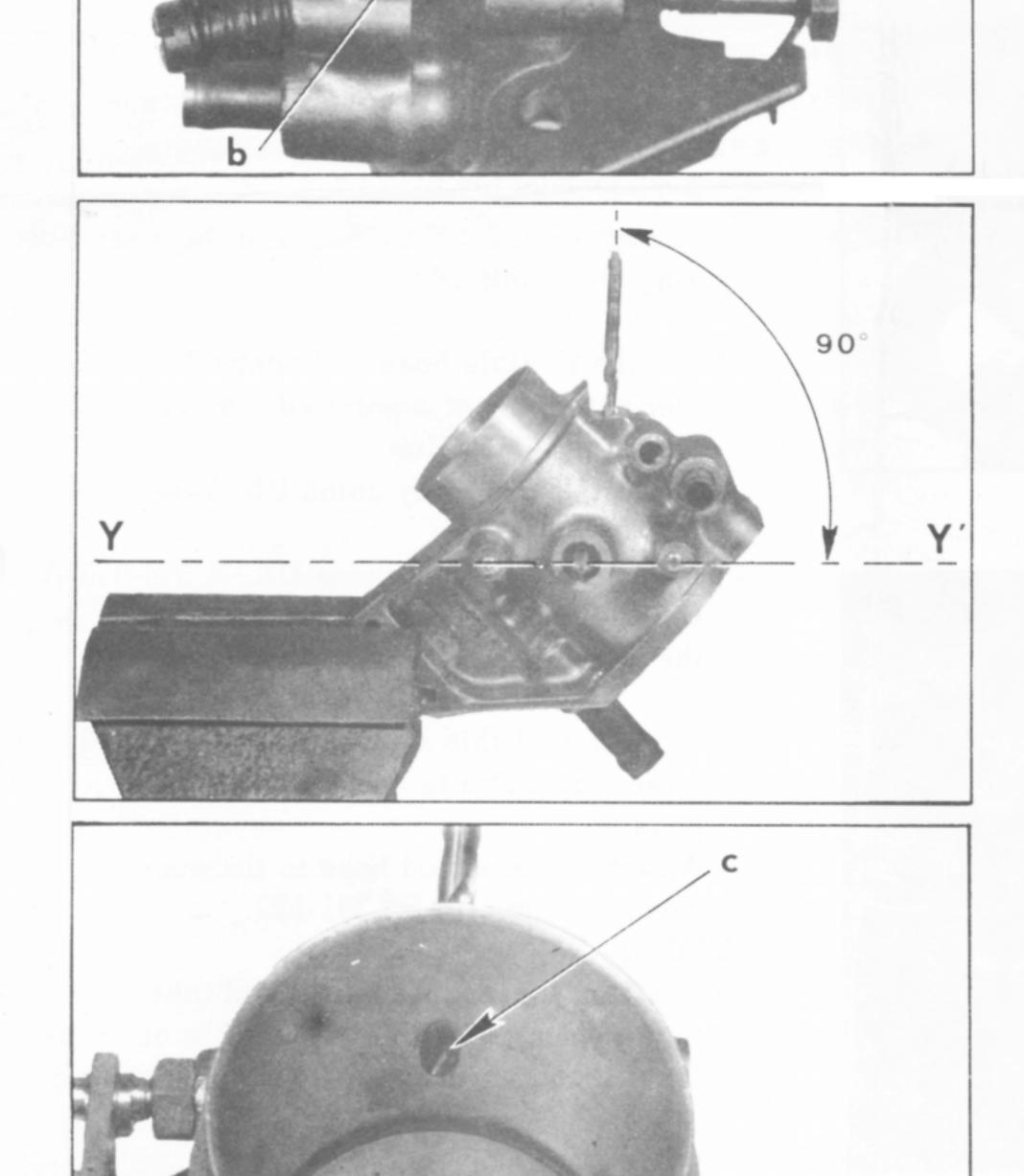
b) Make a notch by sawing two grooves on planes
 OA and OB (see figure)

These grooves must meet at the end of the last saw groove (10 mm deep)

The plane OB must be parallel to plane YY' (plane passing through the butterfly spindle and the holes securing the butterfly spindle switch)

c) On face «f» of the notch (plane OB) trace and mark with a centre-point the centre «b» of this face.

d) At point «b» and perpendicular to face «f» (plane OB) drill a hole of diameter 6 mm



This hole must come out onto the idling air tube (seen through hole «c»)

The end of the drill must stand at least 2 mm below the edge of hole «c»

If it does not, adjust the position of the housing until, at the final drilling of 10 mm, the end of the drill is at minimum tangent to the edge of hole «c»

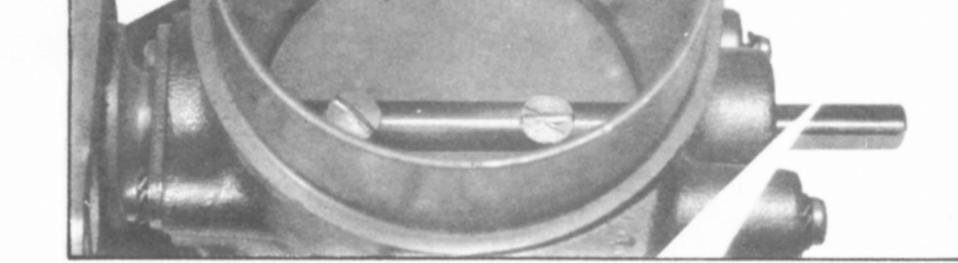
e) Clean the pipes carefully and blow through with compressed air.

f) Prepare tube A

- Saw one of the ends to a bevel angle of 45°
- Remove grease carefully
- Apply activator LOCQUIC-T (PR.

N° GX. 01. 461. 01. A) to the bevel end of tube A

Allow to dry completely

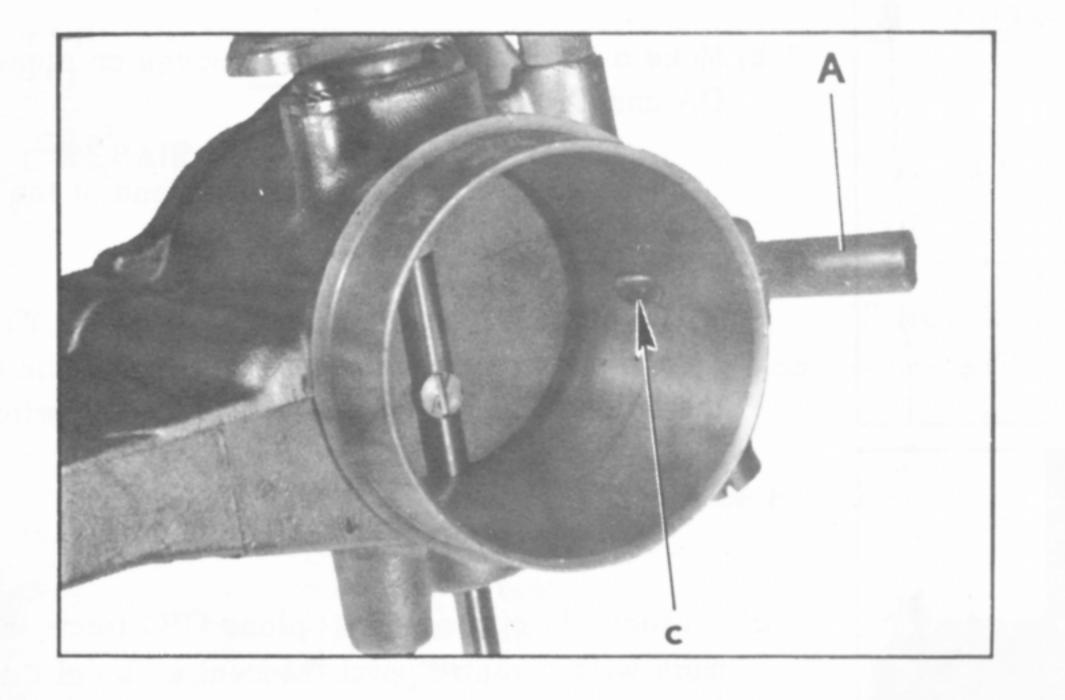


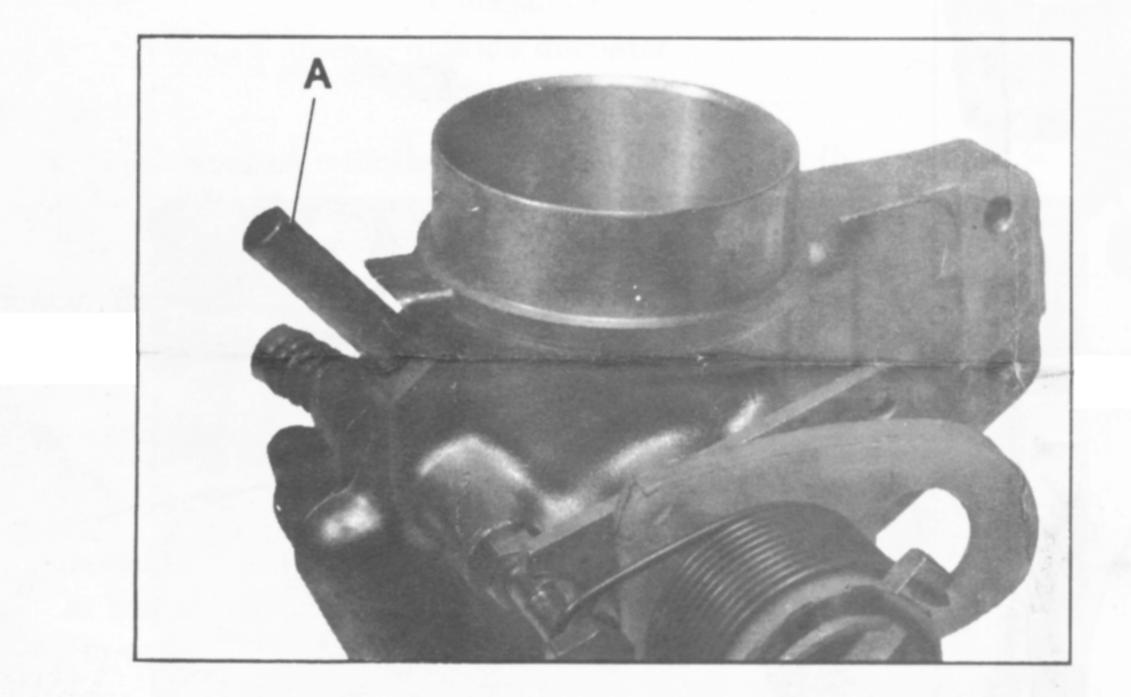
Mod. 1612 - 1-64 - MM - 8.000

REPAIR METHODS

MR 114-12

Page : 3/3



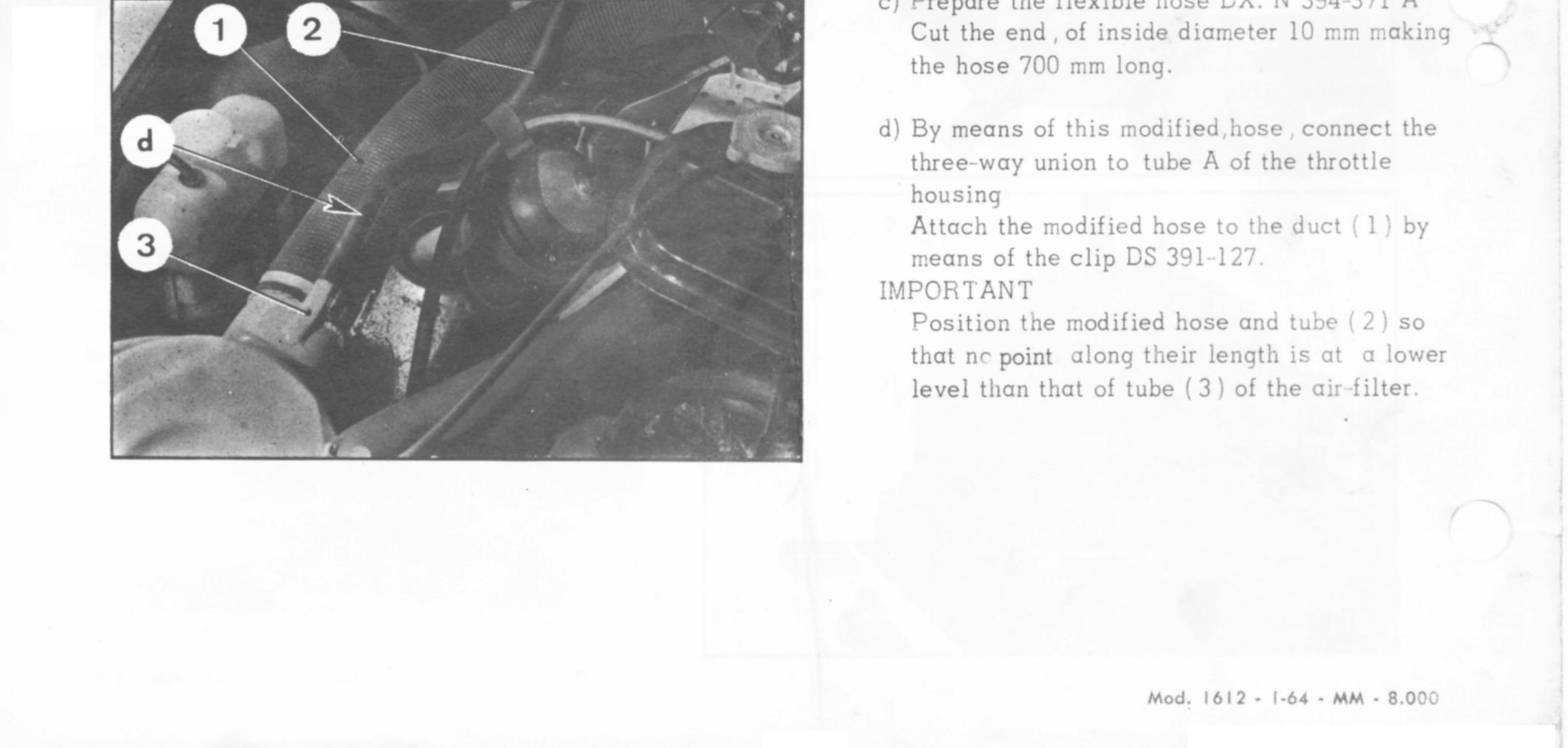


g) Spray the activator LOCQUIC-T in the hole and allow to dry completely. Smear the edges of the hole and the bevel end of tube A with LOCTITE N° GX. 01. 460. 01 A Place the tube in the hole and position it so that the bevel end blocks hole «c» Allow to dry for approximately one bour

OBSERVATIONS :

- Hole «c» may be filled by means of a product such as METALIT. After hardening smooth carefully with abrasive paper.
- If LOCTITE is not available it is possible to fit tube A in a press : in this case drill to 9,75 mm (instead of 10 mm)

h) Clean carefully and blow through the tubing



with compressed air

- 4 Assemble the modified throttle housing a) Work in reverse sequence to that indicated in paragraph 2. (Fit a new seal between housing and manifold)
 - b) Cut the flexible hose (2) controlling the supplementary air at a point «d», as near as possible to the air filter Insert the three-way union DX. 144-219 A
 - c) Prepare the flexible hose DX. N 394-371 A