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AVRO AIRCRAFT

CONFIDENTIAL

CF-105

AUTOMATIC DISCONNECT COUPLINGS

CONNECTING

GROUND ENERGIZERS TO AIRCRAFT

Report No. LOG/105/4 Issue 2

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SUMMARY

Introduction

This report reviews the subject of automatic disconnect couplings for the CF-105 aircraft in the light of existing Royal Canadian Air Force requirements and describes the couplings which will be fitted on the first five aircraft.

Choice of Equipment

It has been decided, after investigation, to adopt the following makes of couplings for the aircraft:-

Ground Power Service	Manufacturer or Spec.	Type of Disconnect
1. Medium pressure hot air for engine starting	E.B. Wiggins Oil & Tool Corp. (3" dia.)	Automatic by lanyard release
2. D.C. electric power, starter control and telecommunication	E.B. Wiggins Oil & Tool Corp.	Automatic by lanyard release
3. A.C. electric power	To AN 3114 and 3430	Manual (Note: This is an interim measure.)
4. Cool low pressure air for air conditioning	Normalair Ltd. (3" dia.)	By hose tension
5. Medium pressure hot air to energize aircraft's electronic system, etc.	Normalair Ltd. (2.5" dia.)	Automatic by lanyard release

Of these, 1. and 3. are extensively used by the United States Air Force, 2. is a modified Wiggins design whilst 4. and 5 have been designed by Normalair to conform with AVRO requirements.

These couplings are described in the Appendices to this report.

Purchase and Test Programme

Orders have been placed by AVRO for the purchase of couplings for the first five aircraft together with those which are required for test purposes and maintenance spares.

TABLE OF CONTENTS

1. INTRODUCTION

The purpose of this report is to review the subject of automatic disconnect couplings to be employed for the ground power support equipment for the CF-105 aircraft in the light of current Royal Canadian Air Force requirements.

It must be recognized at the outset that up to the present time the demand for this type of equipment has been of limited nature and that little has been achieved by the Western Powers in establishing either their own or ABC standards for these couplings. It is evident, however, that development work is taking place in Canada, the United States of America and the United Kingdom in this field to meet the operational needs of aircraft now at the design and development stage.

A study has been made on the subject by the Engineering Department at AVRO in order to establish the types of couplings best suited for the CF-105 aircraft. This report indicates current thinking at AVRO, compares the merits of the alternative types of couplings at present available and describes the equipment which is being adopted for the aircraft.

This supercedes Report No. LOG/105/4 Issue 1 on "Automatic Disconnect Couplings" dated 12th January 1955.

2. ROYAL CANADIAN AIR FORCE REQUIREMENTS

The following paragraphs, together with other pertinent information, relating to the automatic quick disconnect couplings, have been extracted from the current issue of the Aircraft Specification AIR-7-4 Issue 3:-

4.7.1.1 Special tools and ground handling equipment required for maintenance and which are peculiar to the aircraft shall, subject to the approval of the Department, be developed by the Contractor and delivered as specified by the Department.

4.7.3.2 The aircraft shall be capable of meeting the scramble requirement of para. 3.4.1 under all climatic conditions when housed in a readiness hangar. Details of the facilities required in the readiness hangar shall be provided by the Contractor and shall be subject to the approval of the Department.

4.7.3.4 Special ground handling equipment peculiar to the aircraft which is necessary to meet the scramble requirements detailed above (Note: This refers to para. 4.7.3.3 relating to aircraft dispersed in the open) shall, subject to

the approval of the Department, be developed by the contractor and delivered as specified by the Department.

4.7.4 Automatic Disconnect Couplings: All external connections from the aircraft to the ground equipment shall be made through automatic disconnect couplings preferably located in an adjacent area. The automatic couplers shall be positioned such they will be disconnected by the aircraft taxiing straight away.

i. At the 6th meeting of the CF-105 Maintenance Sub-committee, it was recommended that the Company proceed with their own design for air-conditioning and engine starting air automatic disconnects.

ii. The RCAF Technical Service Detachments at AVRO indicated, in their letter, ref. S1038-105-11 (ACE-1) dated 22nd August 1955, that there was no objection to the use of different size of air connectors to prevent inadvertent crossing of the lines during maintenance and servicing, providing that some provision to prevent injury to personnel by hot air when lines are disconnected from the aircraft is incorporated.

iii. The RCAF Technical Service Detachments at AVRO indicated, in their letter, ref. S1038-105-8 (ACE-1) dated 27th December 1955, that a deviation to AIR-7-4, applicable only to the 120/208 volt three phase alternating current external power supply plug, will specify that an AN 3430 connector assembly to specification MIL-C-7974 shall be provided until an RCAF approved quick release type plug is available.

6.7.1 The engine starting shall be under the control of the occupant of the front cockpit and shall be such as to meet the one minute scramble time detailed in paragraph 3.4.1.

7.2.3.5 An external intercommunication connection point to the aircraft AN/AIC10 Interphone System which forms part of the Integrated Electronic System shall be provided, for use by ground crews.

The RCAF Technical Service Detachments at AVRO stated, in their letter ref. S1038-105-8 dated 6th January 1956, that land line telescramble is now an operational requirement for the CF-105. It was also indicated that the basic features of the aircraft system, utilizing

the design features of the AIC-10 should provide the following facilities:-

"(a) Hot microphone intercommunication between aircrew members.

(b) Enable both pilot and navigator to maintain two way communication with control centre.

(c) Permit ground crew to speak to aircrew while aircrew are on telescramble without ground crew being heard on the telescramble circuit.

(d) Permit aircrew to monitor telescramble circuit at all times while at readiness.

Connection to the ground system is to be accomplished by means of a pull-away outlet. The internal aircraft wiring to the outlet should not use more than four connections. System design using a fewer number of connections is acceptable providing it does not necessitate complex circuitry and relays in the aircraft."

9.3 An external alternating current power receptacle in accordance with the outline of U.S. Standard Drawing AN-3114 shall be provided.

3. GROUND POWER SERVICES

The following services will be supplied at the aircraft connections by mobile ground power units within a wide range of environmental conditions:-

(a) Hot medium pressure air for starting aircraft's turbo-jet engines

Compression ratio	3.5 to 1
(Note: A pressure of 50 p.s.i.a. will, however, be acceptable at sea level conditions.)	
minimum flow	110 lb. p. min.
temperature	minimum 200°F at -65°F ambient atmosphere. Under no condition shall the maximum temperature exceed 650°F.

(b) D.C. electric power

potential	28/24V
current	50 amp. max.

(c) Voice intercommunication between (1) aircrew members (2) both pilot and navigator with control centre and (3) aircrew and ground crew.

(d) A.C. electric power

potential	208/120V ± 2.5%
frequency	380 - 420 cps
power	30 KVA at load power factor .75 to unity

(e) Cool low pressure air for air conditioning

pressure	3.5 p.s.i.g.
minimum flow	100 lb. p. min.
temperature	55°F to 80°F

(f) Hot medium pressure air for energizing the aircraft's electronic system etc.

pressure	45 p.s.i.g.	OR	50 p.s.i.a.
minimum flow	0-45 lb. p. min.		0-51 lb. p. min.
temperature	minimum 150°F at -65°F ambient atmosphere Under no condition shall the maximum temperature exceed 550°F.		

The services available in the Readiness Shelters will be similar except that the air supply for starting the turbo-jet engines will be increased to a minimum mass flow of 220 pounds per minute at delivery pressure of 60 p.s.i.a.; this enables simultaneous starting of the aircraft's turbo jet engines in the shortest possible time.

4. LOCATION AND IDENTIFICATION OF DISCONNECT COUPLINGS

The desirability of having the external connections to the aircraft in an adjacent area was recognized in that it would facilitate the work of the ground crew. The practicability of this scheme was investigated and it was found to incur weight and space problems. The situation was discussed by the Co-ordinating Committee on 19th January 1955 and it was agreed that the couplings for engine starting should be located at the engines and not adjacent to the air conditioning couplings.

The location of the couplings on the aircraft, together with their approximate height above the ground, are indicated in Table 1 overleaf.

A colour coding or other means of identification of hoses has yet to be decided upon. The only source of confusion will be the air hoses to the port and starboard engines being reversed in service.

Service	Location on Aircraft (inches)		Height from Ground Line (inches)	
	Aircraft Station	From Centre Line	A/C Light (43,000 lbs)	A/C Loaded (60,000 lbs)
Hot medium pressure air for starting aircraft's turbo-jet engines	610.85	33.8	56	53.5
D.C. electric power and telecommunication	218	NIL	35	34
A.C. electric power	492.6	10 (to port)	65	63
Cool low pressure air for air conditioning	233	28.5 (to port)	91	90
Hot medium pressure air for energizing the aircraft's electronic system etc.	242.17	28.5 (to port)	90	88.5

TABLE 1

LOCATION OF AUTOMATIC DISCONNECT CONNECTIONS ON AIRCRAFT

5. METHODS OF AUTOMATIC RELEASE

The types of automatic disconnect couplings known to us fall into four broad classes of operation. These are briefly described below:-

i. Those which are mechanically disconnected by means of a lanyard which trips the spring loaded release mechanism; the lanyard being attached to either a ground fixture, a weight or even to the hose itself. This is the principle upon which the "Wiggins" and the "Roylyn" couplings are based.

ii. Pull away coupling: The two halves of the coupling are held together by a spring loaded latch mechanism. The connection is severed when the differential air load across the coupling plus an applied external force exceed a predetermined trip load; the applied load may be exerted either by the ground crew or by hose tension as the aircraft commences to taxi away. The Normalair low pressure air coupling is of this type; it is a neat and light coupling which may be mounted flush with the skin of the aircraft.

For medium pressure air supplies, however, Normalair has found that it is necessary to incorporate a positive locking mechanism which is tripped by a lanyard release.

iii. Hydraulic disconnects: A nylon reinforced rubber bellows, which is filled with hydraulic fluid, is placed immediately in front of one of the wheels of the aircraft. As the aircraft moves forward, the wheel passes over the bellows and compresses it, thereby displacing the fluid through an interconnecting hose to actuate the twin piston disconnect which is integral with the AN 3430 plug. The proposed Cannon coupling operates on this principle.

iv. Hinged plate disconnect: This type is being developed in the United Kingdom but there is no information available with regard to the method of actuation; it is understood that it has not proved to be entirely satisfactory.

Each of the foregoing methods of release has its own particular merit.

The question of how to anchor a lanyard must be considered and the following alternatives should be investigated:-

i. Securing the lanyard to a weight resting on the ground.
ii. Mounting the weight on the edge of a low stand so that a snatch load is applied to the lanyard as the aircraft moves forward.
iii. Securing the lanyard to the hose or cable.
iv. Securing the lanyard to a deck ring (feasible only in a Readiness Hangar).
v. Securing the lanyard to the ground power vehicle.

Difficulty may be experienced with the hydraulic operated type due to leakage or entrapped air and the effects of extremes in ambient temperature may be difficult to cater for. It is expected to require frequent maintenance.

It would seem expedient to standardize on either the mechanical or hydraulic method of release and that little will be achieved employing one method of release for one service and not for another. The mechanical types are favoured by AVRO at this stage of development in that they are simpler in concept and probably require little or no maintenance. Lanyard operated air couplings are currently in use in the U.S.A.

6. COUPLINGS CHOSEN

The advantages of employing automatic disconnect couplings already developed in either the United States or the United Kingdom include:-

i. Eliminating the cost of designing and developing new types, morever, the equipment would have been proven under service conditions.

ii. The adoption of existing equipment could ease the logistic problem for the Royal Canadian Air Force in respect of these items and in certain circumstances it could make for greater flexibility of operation.

The choice of equipment has been influenced by the foregoing considerations.

AVRO Aircraft Ltd. has prepared requirement specifications for this equipment and manufacturers specializing in this field were invited to submit their engineering proposals on automatic disconnect coupling for the following services:-

(a) Hot medium pressure air for starting aircraft engine.
(b) D.C. electrical power together with intercommunication equipment to Avrocan Specification E-307 Issue 1.
(c) Cool low pressure air for air conditioning to Avrocan Specification E-397 Issue A.
(d) Hot medium pressure air for energizing the aircraft's electronic system etc. to Avrocan Specification E-397 Issue A.
(e) A.C. electrical power to Avrocan Specification E-345 Issue B.

For (a) and (b) above a Wiggins type coupling was chosen, whilst for (c) and (d) a modified Normalair coupling was found to be the most suitable. With regard to (e) it has been decided by the RCAF to employ a manual disconnect on the aircraft until such time as a suitable RCAF approved quick release type plug becomes available; meantime, a mechanical disconnect coupling proposed by Albert & J.M. Anderson has been ordered for the purpose of carrying out tests at AVRO.

Existing types of American couplings were considered for the low pressure air connection and for the supply of medium pressure air to energize the turbo-generator; they were found to be unsuitable in that access doors would have to be provided in highly stressed areas. By adopting the Normalair type of coupling, which is mounted flush with the aircraft skin, this structural problem is lessened and, moreover, it provides a neater and much lighter installation.

On the other hand for the supply of medium pressure air to energize the engine starter turbine, the Normalair type of coupling could not be accommodated in the space available between the turbine and the aircraft skin. This therefore necesitated the Wiggins type coupling which is a standard in the USAF for this purpose.

The various types of couplings being installed in the aircraft are illustrated and described in the Appendices to this report.

7. HAZARDS TO GROUND STAFF

From perusal of the descriptive data on the automatic disconnect couplings, featured in the Appendices to this report, it will be seen that automatic shut-off valves are incorporated in all the air connectors. These cut off the air supplies to the individual services immediately the coupling is broken and serve as safety features for the protection of maintenance and servicing personnel.

8. HOSE CONNECTIONS

It would be of considerable advantage if it were possible to standardize on one size of hose and hose connection - preferably a type being used by the USAF - for the various air services. With regard to the medium pressure air supplies for engine starting and for the turbo-generator this presents no problem; if, however, too small a size of hose were employed for the low pressure services serious air pressure losses would be incurred.

The choice of air hose and type of hose connection is under active consideration at the present time at AVRO. Recommendations to the Royal Canadian Air Force with regard to the purchase of this ground equipment are withheld pending receipt of information from American manufacturers specializing in this field.

9. PURCHASE AND TEST PROGRAMME

Orders have been placed by AVRO for the purchase of couplings for the first five aircraft plus those which are required for tests to be conducted at Malton and maintenance spares.

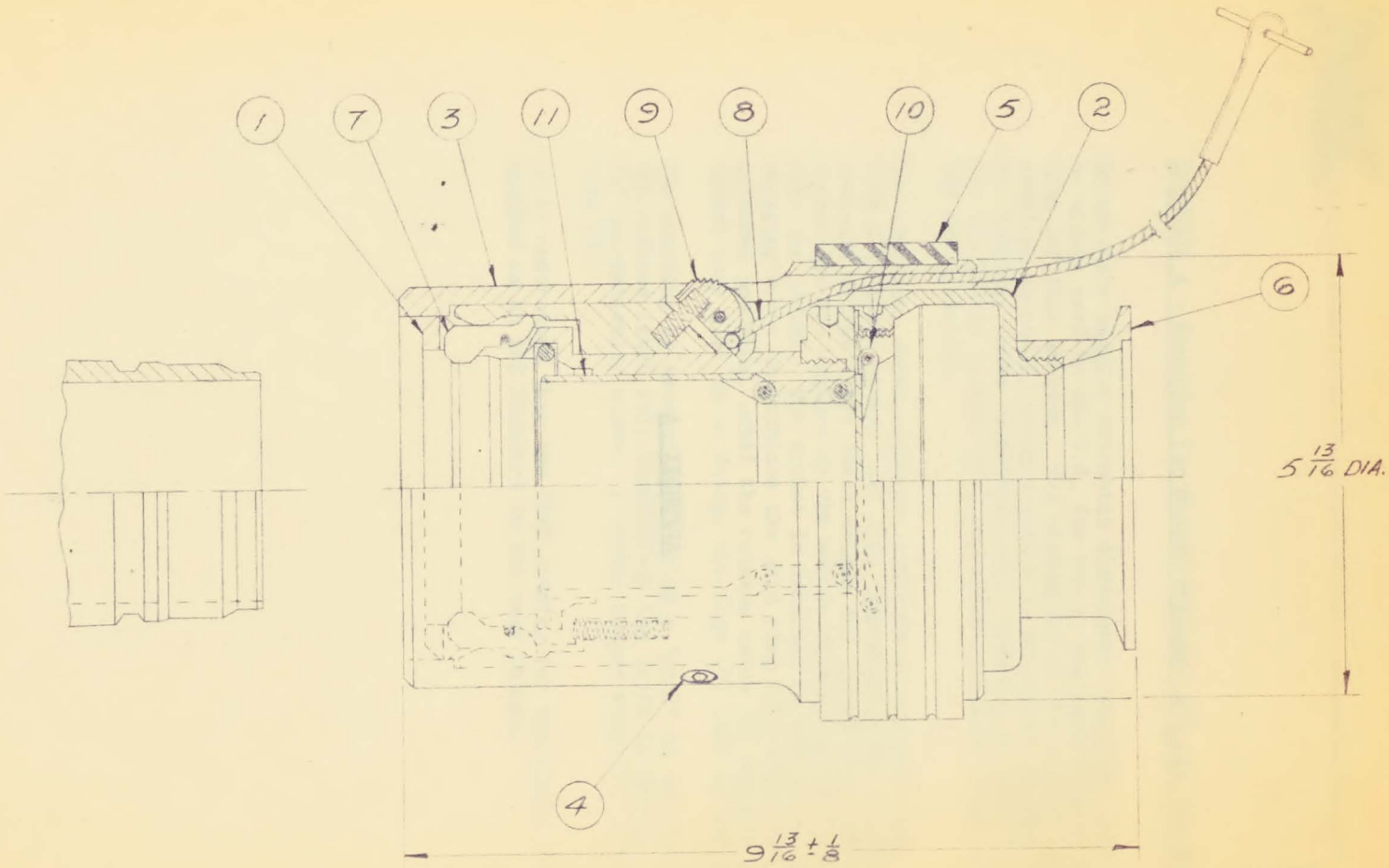
Items of equipment will, where applicable, be tested by the manufacturers to establish that they conform to the relevant Avrocan specifications.

10. CONCLUSION

Hitherto there has only been a limited demand for automatic disconnect couplings for aircraft, in consequence the only existing standards would appear to be the Wiggins type of coupling - which has been adopted for engine starting - now in quantity production for the USAF, the ABC Air Standard 17/5 for an eight inch air-conditioning connection and the ABC standard for an a.c. electrical receptacle.

Since AVRO Aircraft Ltd. are contractually bound to fit automatic disconnect couplings to the aircraft (except for the recent waiver for the A.C. electrical connection) and since design cannot wait for adoption of ABC standards on all these couplings, the Company has chosen certain couplings, to meet AVRO Specification requirements and compatible with the design of the CF-105, for the first five aircraft to be manufactured.

APPENDIX A



NIPPLE

SOCKET ASSEMBLY

APPENDIX A - Coupling for Medium Pressure Hot Air for Engine Starting

An existing Wiggins automatic disconnect coupling; which is understood to be widely used by the U.S. Air Force, has been adopted as the ground connection for this service. The dimensions of the nipple, to which the Wiggins coupling connects, conform with U.S. Air Force Air Materiel Command Dwg. No. 54B9301; these components will, however, be made from 24ST light alloy for the CF-105 instead of a corrosion-resistant steel which is called up in the specification.

The coupling, shown opposite, consists of a socket body (1) within which is fitted an inner sleeve (11) with interconnecting linkage to spring-loaded shut-off valves (10); these valves are opened when the two halves of connection are engaged by the nipple displacing the inner sleeve (11) further into the socket. The socket is attached to the nipple by applying an axial engaging force to displace the skid ring (3), which is spring-loaded in the unlocked position, until the release catch (9) engages with a slot in the socket body (1); in so doing, the dogs (7) lock on the collar of the nipple.

The coupling is severed by applying a "pull" on the lanyard (8) which trips the release latch (9); immediately the joint is broken, the shut-off valves (1) automatically close. A rubber bumper ring (5) is attached to the skid ring (3).

It is understood that the USAF drawing for the nipple is likely to be adopted as an ABC Standard in the near future.

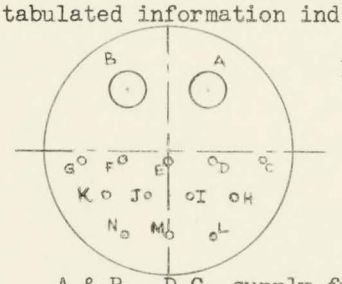
APPENDIX B - D.C. Electrical Power, Starter Control and Telecommunication Connector

An existing type of Wiggins automatic disconnect, suitably modified to provide the necessary electrical connection to conform with Avrocan Specification E-307, will be employed. The nipple assembly is mounted on the lower portion of the nose leg on the aircraft whilst the socket assembly constitutes a part of the ground power equipment.

The socket assembly, shown opposite, to scale, consists of a body (1) within which is mounted an ejector spring (6); this spring is compressed when the couplings are connected together and its function is to sever the connection immediately the release lanyard is tripped. The quick release mechanism is located on the actuating ring (3) which is mounted on and concentrically with the socket body (1); it will be seen that the actuating ring (3) is loaded by a helical spring (4) in the unlocked position. To engage the coupling, the ground operator applies an axial force of approximately 70 pounds to the actuating ring (3) to compress the ejector spring (6) and also advance the actuating ring (3) to lock the six dogs (12) on the collar of the mating nipple assembly; the actuating ring is then automatically locked by the spring-loaded locking pin (20). Two rubber bumper rings (14) are fitted to prevent damage to the socket assembly as it falls to the ground. The force necessary to engage the two halves of the coupling will not exceed 75 pounds; to disconnect, a pull of not more than 25 pounds is applied to the lanyard.

The estimated weight of socket assembly is 3.5 pounds and that of the nipple assembly is 1.25 pounds.

The illustration below, which is to scale, indicated the disposition of the electric and electronic contact pins within the coupling. The accompanying tabulated information indicates the function of the various contact pins:-



1. When aircraft is at high state of readiness:

Pins A, B, C, D and E are in use to (a) actuate the air control valves on the starting cart, (b) provide D.C. power, (c) D.C. control, (d) ground connection and (e) telescramble and ground intercommunication.

The function of the individual pins being

A & B	D.C. supply from starting cart. A is positive and B is to ground.
C	left air control valve on starting cart
D	right air control valve on starting cart
E	D.C. control line fed through the aircraft master switch
J & M	interphone (M is bonded into J)
K	audio common
N	telescramble audio

APPENDIX B .....Continued

2. When tow cart is connected: Pins J, K, M, B and H are in use.

J, K & M	same as for starting cart (viz. electronics)
H	from the tow cart positive connection for aircraft intercom
B	tow cart ground

3. When undergoing maintenance: Pins J, K, M, B and I are employed.

Three phase A.C. electrical power source must be plugged in.

J, K, M & B	same as for tow cart
I	D.C. supply from aircraft to external intercom amplifier

It will be noted that G, F and L are spare terminals.

APPENDIX C - Connector for A.C. Electrical Power

A manual disconnect coupling, conforming to ABC Standard 12005(b), is being adopted pending a suitable RCAF approved quick release connector becoming available.

The AN part numbers and description of the components are:-

AN 3114 Receptacle - external power 115/200 volts, 3 phase

AN 3430 Cable and plug assembly - external power 115/200 volts, 3 phase.

The former is mounted on the aircraft and the latter on the ground power unit. The specification quotes that a maximum force of 95 ± 5 pounds is necessary to engage the connection.

It is interesting to note that the U.S. Air Force have specified in Exhibit No. WCL-954 that the above mentioned plug and receptacle shall be employed on their MA-3 multipurpose aircraft ground servicing unit.

APPENDIX D - Coupling for Cool Low Pressure Air for Air Conditioning

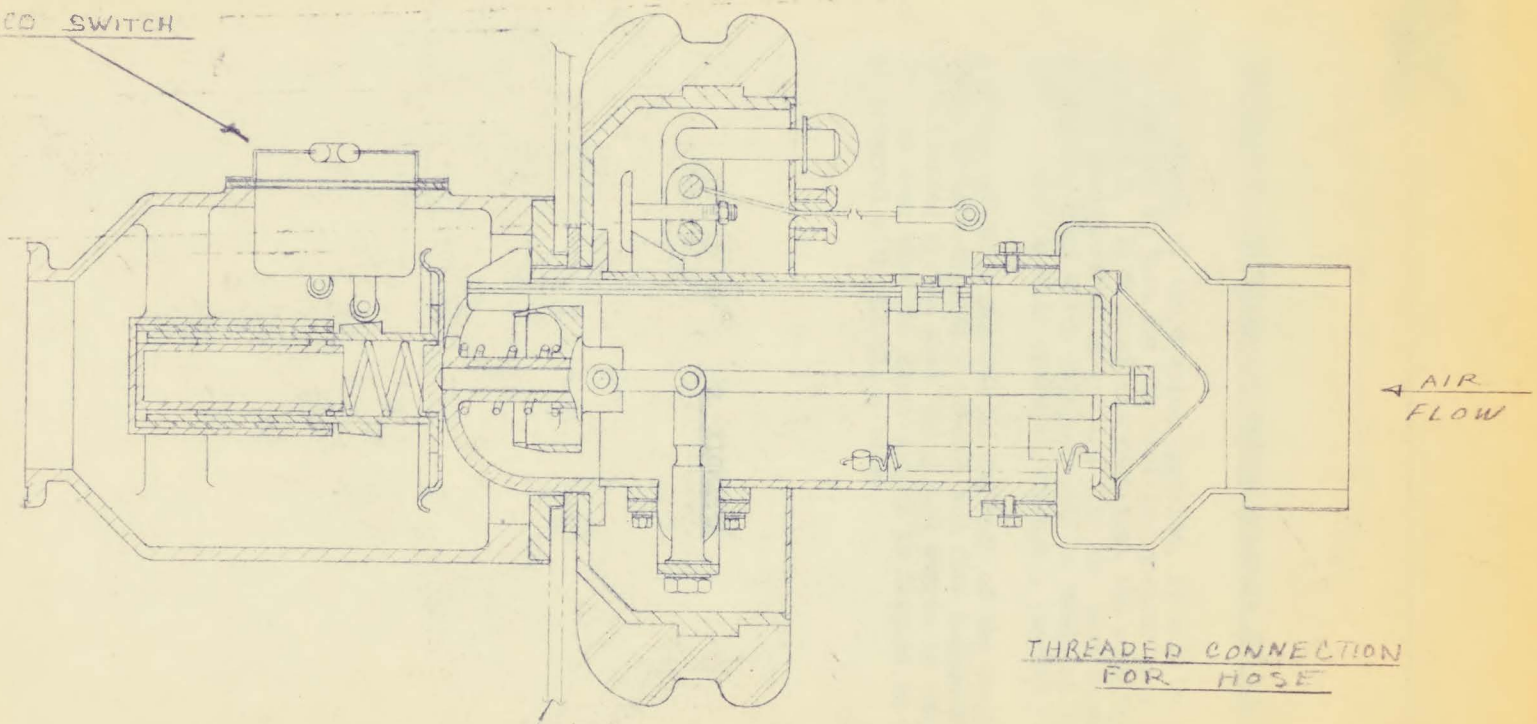
The design of this coupling has been based on existing equipment being manufactured by Normalair Ltd. in England for cool air supplies. It was not possible to utilize an existing British design as:-

1. The connection diameter for the CF-105 is required to be 3.0 inches, whilst the standard British coupling is only 1.9 inches in diameter.
2. An automatic shut-off valve has to be featured in the connector to cut off air supplies when the coupling is parted.
3. The hose attachment point to the coupling, which is mounted on the aircraft, is wrongly positioned.

From perusal of the illustration opposite, it will be seen that the coupling may be mounted flush with the aircraft skin; it features a spring loaded valve which seals the inlet orifice when the coupling is not in use.

To engage the connector in the coupling, the operator centralizes the connector and applies a force, not exceeding 20 pounds, at right angles to the aircraft skin; this force opens the spring loaded plate valve on the aircraft coupling and at the same time displaces the pushrod, which normally protrudes out of the connector, to open the spring loaded shut-off valve located at the hose end of the connector. When the connector is pushed "home", the three spring loaded claws of the connector engage with the seating on coupling; this method of attachment has been so designed that a pull of 20 lbs. applied to the hose end of the connector causes the coupling to separate. A rubber buffer is incorporated to protect the connector from damage.

The estimated weight of the coupling is 1.56 pounds and that of the connector is 4.13 pounds.



COUPLING AND HOSE CONNECTION ASSY

APPENDIX E - Coupling for Medium Pressure Hot Air for Turbo-generator etc.

From perusal of the drawing opposite, it will be seen that the basic design is similar to that for the cool low pressure air coupling described in Appendix D. In view of the fact that the coupling has however to operate at air pressures of 45 p.s.i.a., it has been found necessary to incorporate a positive lock which engages with the heels of the spring loaded claws; the lock is mechanically operated through a lanyard release.

A micro-switch is mounted on the body of the coupling, the function of which is to isolate the cabin turbine and flow augmentor in the aircraft air conditioning system when the ground source is coupled to the aircraft. It will be seen that the micro-switch is tripped by a wedge shaped collar which is integral with the plate valve.

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