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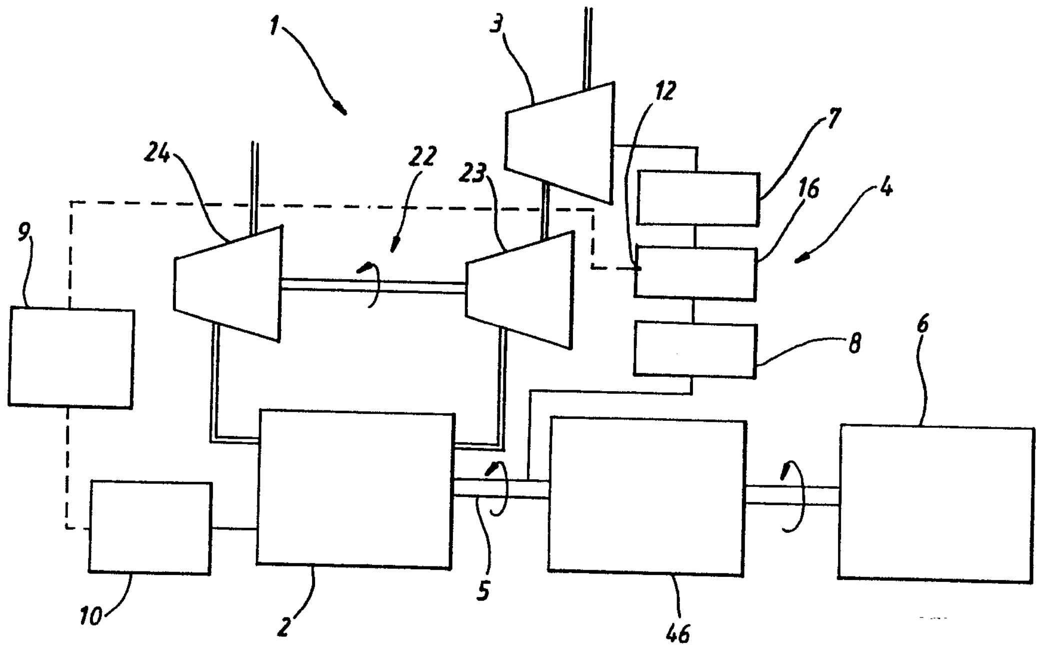

(57) Abstract

A monitoring arrangement for a turbo compound engine system in which there is disposed a fluid drive hydrodynamic coupling (16) between an exhaust gas-driven power turbine (3) and a drive shaft (5) included in a combustion engine (2). A temperature transducer (12) is disposed in a casing (13) surrounding the coupling (16). When the transducer (12) senses excessively high temperature, a signal is emitted to a governor unit (10) which reduces the power output of the engine. The invention protects the coupling (16) from failure if the oil flow is reduced or disrupted.

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A monitoring arrangement for a turbo compund engine system

The present invention relates to a monitoring system for a turbo compound engine system in which there is disposed a fluid drive hydrodynamic coupling between an exhaust gas-driven power turbine and a drive shaft disposed in the combustion engine included in the turbo compound system.

BACKGROUND ART

Designers of combustion engines have long striven to extract, as far as possible, energy from the engine exhaust gases which would otherwise be lost. One common method to this effect is to equip the engine with a so-called turbo unit consisting of an exhaust gas-driven turbine which is mechanically connected to a compressor intended to compress combustion air for supercharging the engine. Ever since their appearance 40 to 50 years ago, turbocharger units have been developed and refined and have thereby achieved a high level of governability and operational dependability. However, a considerable quantity of energy still remains in the exhaust gases leaving the turbine.

One method of utilising at least a portion of this surplus energy is to provide a second exhaust gas-driven turbine in series with and downstream of the first turbine. If this second turbine is connected in some way so that it mechanically transmits a portion of the surplus energy to the drive shaft of the engine or transmissions connected thereto, the result will be a so-called turbo compound system.

Such systems are previously known in the art from, for example, US 4,586,337 (US Cl. 60-605) and published International Patent Application WO 86/00665 (IPC4 Cl. F02B41/10,37/00,67/00). These two specifications disclose exhaust gas turbines which, via a long shaft and a hydrodynamic coupling, transmit the power extracted from the exhaust gases to the forward transmission wheel of a camshaft.

The hydrodynamic coupling is intended to insulate the torque oscillations occurring in the exhaust gas turbine from the engine proper.

In SAE Transactions Volume 62, pp 276-277, 1954, there is shown a turbo compound engine intended for aeronautical purposes and manufactured by Curtis-Wright. This 18 cylinder engine displays three exhaust gas turbines which, via a hydrodynamic coupling, extract and transmit surplus energy to a drive shaft. The coupling is supplied from the lubrication system of the engine and is fed with oil through the input shaft of the coupling.

The hydrodynamic coupling in a turbo compound system is exposed to extreme stresses. Its maximum speed is of the order of between 5,000 and 10,000 rpm. If the lubrication supply to the coupling were, for any reason, to be disrupted or cease entirely as a result, for example, of a leakage or blockage in the line, its bearings will suffer from difficulties in lubrication and, moreover, the slip will increase since the coupling begins to be emptied of lubricant, whereby resistance in the coupling is reduced. The slip is the percentage difference between the speed of the input shaft of the couplingand the speed of its output shaft. In such instance, the temperature of the coupling will be raised in that the coupling is not cooled sufficiently and there will then be a serious risk of, among other things, bearing failure or seizure. An abnormally high slip will also entail that the turbine speed of the compound system manifestly increases in that the resistance which the hydrodynamic coupling transmits partly disappears. If, in such an event, the coupling is emptied of lubricant, the resistance will disappear and the turbine runs the the risk of racing out of control. This implies extreme mechanical stresses on bearing and coupling and a risk that the entire turbine could burst as a result of the centrifugal forces, which can result in expensive failures.

OBJECTS OF THE INVENTION

The present invention has for its object to prevent the occurrence of failure in fluid drive hydrodynamic couplings disposed in turbo compound engine systems.

In this respect, the monitoring arrangement according to the present invention is characterised by a temperature-sensing device being fixedly secured a casing surrounding the coupling proximal to the outer surface of the coupling, and a device for reducing, in response to the temperature sensed by the temperature sensing device, the power output of the engine if the temperature exceeds a predetermined value. Hereby, the sensing device - or transducer - need not be placed in the coupling, which is complicated in view of encapsulation and also subjects this to mechanical stresses. The temperature transducer is also enabled to detect both radiation heat from the coupling and the temperature and the temperature of the lubricant which is flung outwardly from the coupling and is entrapped by the casing. This makes for more reliable temperature monitoring since a single temperature guard disposed in the oil return conduit cannot detect excess temperature in the event of loss of oil flow.

One embodiment exemplifying the present invention will be described in greater detail hereinbelow, with particular reference to the accompanying Drawings.

BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWINGS

Fig. 1 shows a turbo compound engine assembly with a monitoring system according to the present invention; and
Fig. 2 shows a hydrodynamic coupling and a temperature sensor or transducer according to one preferred embodiment disposed therein.

DESCRIPTION OF ONE EMBODIMENT

Referring to the Drawings, Fig. 1 schematically illustrates a combustion engine assembly 1 of the turbo compound type, comprising an internal combustion engine 2, a turbo unit 22 consisting of a first exhaust gas turbine 23 and a turbo compressor 24 driven by the turbine and compressing the intake air of the engine 2, a second exhaust gas turbine 3, hereinafter referred to as power turbine, and a transmission 4 between the power turbine 3 and a shaft 5 included in the combustion engine 2. The transmission 4 consists of a fluiddrive hydrodynamic coupling 16, a gear 7 between the coupling 16 and the power turbine 3 and a gear 8 between the coupling 16 and the drive shaft 5 of the engine 2. Via a transmission 46, the drive shaft 5 of the engine 2 drives a load 6, for example in, the form of a heavy road-haulage vehicle.

In a first stage, the exhaust gases from the engine 2 drive the exhaust gas turbine 23 and, thereafter, the power turbine 3 connected in series therewith. A device 12 sensing the temperature of the oil is mounted in the coupling 16. The device 12 may, for example, be a standard thermocouple or a temperature level sensing device which senses two temperature levels, for example of the electro-mechanical type, such as a temperature guard of the bimetallic type. The device 12 shown in Fig. 1 is a thermocouple, for which reason an electronic control device 9 is necessary to receive and interpret signal voltages deriving from the thermocouple. The signals registered by the control device are constantly compared with a predetermined maximum permitted value. This value may ideally consist of that temperature at which the hydraulic coupling operates with maximum slip and load. In the event that this value is exceeded, the control device 9 emits a signal to a governor 10 which reduces the emitted power of the engine 2, for example by reducing the quantity of injected fuel. The regulation thus implemented ideally takes place such that a reduction of engine power which is manifestly noticeable for the vehicle driver takes effect at high engine speeds, while, at low speeds and engine loads, such reduction is largely negligeable. At high speeds, the power reduction may amount to between 50 and 70 % in relation to the maximum rated power of the engine. Hereby, the reduction will only take place under those operational conditions in which the power transmitting hydraulic coupling can, in the strict sense, transmit any moment of force. The power turbine 3 which drives the coupling begins to transmit moment of force to the hydraulic coupling only when the exhaust gas flow reaches high levels. If the oil flow through the hydraulic coupling were to disappear and the coupling hereby reach overheating temperatures, a fully developed engine power output would, at these high speeds, entail that the power turbine would race and burst as a result of centrifugal forces.

At the same time, the operator or vehicle driver may be appraised of the situation by an alarm device which delivers an acoustic and/or optic alert if the temperature exceeds the predetermined value. Alternatively, if the temperature continues to rise, it is possible to cause the governor 10 to shut down the engine 2 entirely.

Fig. 2 shows a hydrodynamic coupling 16 accommodated in a casing 13. A hole 14 is provided in the casing 13, in which hole the device 12 is disposed. Most advantageously, the hole is provided in register with the largest diameter of the coupling 16. The device 12 will thereby be placed as close to the outer surface of the coupling 16 as possible. The coupling 16 consists of an impeller 11 which is integrated with the outer surface of the coupling 16, driven by the power turbine 3, this impeller 11 transmitting the force via the oil to a flywheel 15. The force is thereafter transmitted to the drive shaft 5 of the engine 2.

In the event of reduction or disruption of oil supply to the coupling 16, oil replenishment thereof will thus rapidly be reduced. Thereafter, the coupling 16 will not be capable of transmitting the same power output from the impeller 11 to the flywheel 15 as the filled coupling 16 could. Nor will the oil be capable of cooling the heat generated in the coupling. When the resistance in the coupling fades as a result of the reduced quantity of oil, the speed of the impeller 11 will also increase, which entails severe mechanical and thermal stresses on the coupling 16, primarily on its bearing system.

Before any leakage in the coupling 16 or flow disruption has caused any damage, the device 12 mounted in the coupling casing 13 will, via the devices 9 and 10, cut the available power of the engine 2 and thereby prevent damage and expensive repairs. In such instance, the devices 9 and 10 are advantageously constructed using microcomputer technology.

The present invention should not be considered as restricted to the embodiments described in the foregoing and shown on the Drawings, many modifications being conceivable in a plurality of different embodiments without departing from the spirit and scope of the inventive concept as herein disclosed and defined in the appended Claims.

CLAIMS

1. A monitoring arrangement for a turbo compound engine system in which is disposed a fluid drive hydrodynamic coupling (16) between an exhaust gas-driven power turbine (3) and a drive shaft (5) disposed in the combustion engine (2) included in the turbo compound system, characterised by a temperature-sensing device (12) being fixedly secured in a casing (13) surrounding said coupling (16), proximal to the outer surface of the coupling, and a device (9, 10) for reducing, in response to the temperature sensed by said temperature-sensing device (12), the power output of the engine (2) if the temperature exceeds a predetermined value.

2. The monitoring arrangement as claimed in Claim 1, characterised in that the temperature-sensing device (12) is a thermocouple.

3. The monitoring arrangement as claimed in Claim 1, characterised in that the temperature-sensing device (12) is a temperature guard.

4. The monitoring arrangement as claimed in any one of Claims 1-3, characterised in that the temperature-sensing device (12) is located within the casing (13) essentially in register with the largest outer diameter of the coupling (16).

5. The monitoring arrangement as claimed in any one of Claims 1-4, characterised in that an alarm device is connected to the temperature-sensing device (12) for acoustic or optic indication if the temperature exceeds the predetermined value.

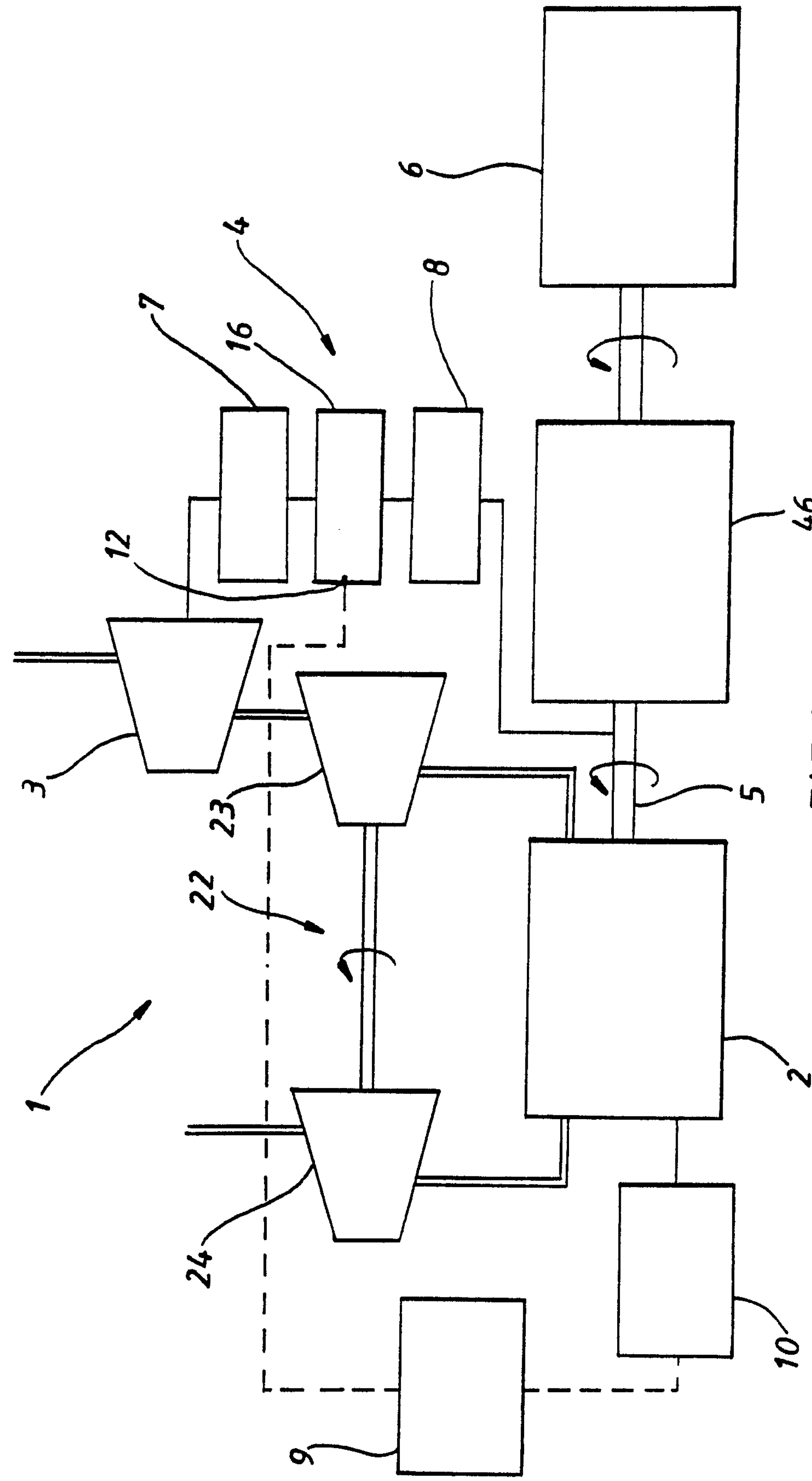

FIG 1

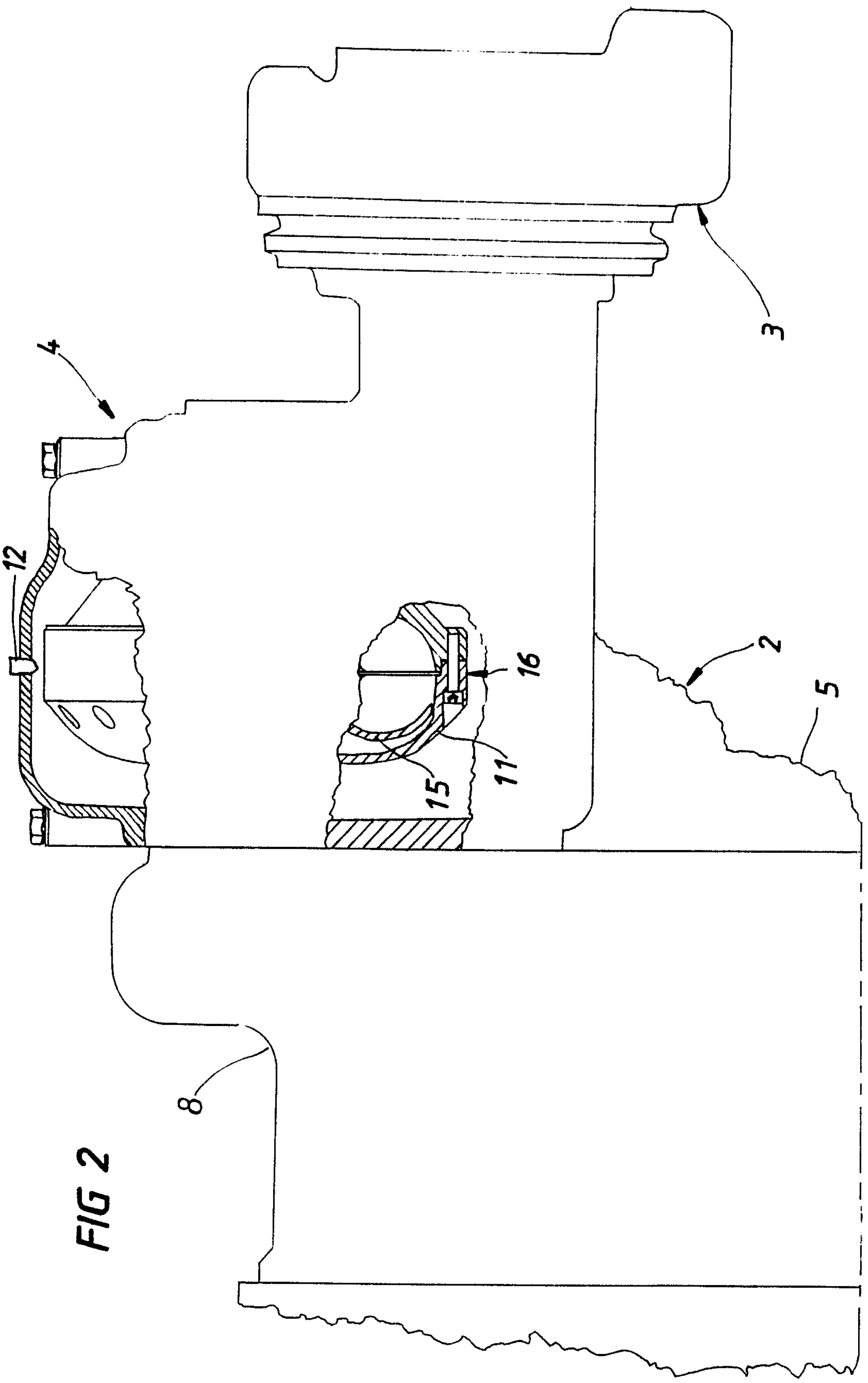

FIG 2

INTERNATIONAL SEARCH REPORT

International Application No PCT/SE 91/00474

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC5: F 02 B 37/12, 41/10

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
IPC5	F 02 B

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched[8]

SE,DK,FI,NO classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category *	Citation of Document,[11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No.[13]
X	DE, A1, 3002701 (M.A.N. MASCHINENFABRIK AUGSBURG-NÜRNBERG AG) 30 July 1981, see the whole document --	1-3
A	US, A, 4586337 (FOX) 6 May 1986, see the whole document --	1-5
A	WO, A1, 8600665 (CATERPILLAR TRACTOR CO) 30 January 1986, see the whole document --	1-5
T	WO, A1, 9110049 (SAAB-SCANIA AKTIEBOLAG) 11 July 1991, see the whole document --	1-5

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* **Special categories of cited documents:** [10]

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
15th October 1991	1991 -10- 17
International Searching Authority	**Signature of Authorized Officer**
SWEDISH PATENT OFFICE	Krister Bengtsson

ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO.PCT/SE 91/00474

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the Swedish Patent Office EDP file on 91-08-30
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE-A1- 3002701	81-07-30	FR-A- 2474591	81-07-31
		JP-A- 56110521	81-09-01
US-A- 4586337	86-05-06	NONE	
WO-A1- 8600665	86-01-30	AU-B- 571015	88-03-31
		AU-D- 3432484	86-02-10
		CA-A- 1248766	89-01-17
		EP-A-B- 0171882	86-02-19
		JP-T- 61502692	86-11-20
WO-A1- 9110049	91-07-11	NONE	