

(19)



Europäisches Patentamt

European Patent Office

Office européen des brevets



(11)

EP 0 726 930 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention
of the grant of the patent:

20.01.1999 Bulletin 1999/03

(21) Application number: **94931656.6**

(22) Date of filing: **04.11.1994**

(51) Int Cl.⁶: **C10M 169/04**, C10M 171/00,
F04B 39/02

// (C10M169/04, 105:38, 147:04,
155:02), C10N40:30

(86) International application number:
PCT/GB94/02421

(87) International publication number:
WO 95/12649 (11.05.1995 Gazette 1995/20)

(54) **LUBRICATION OF REFRIGERATION COMPRESSORS**

SCHMIERUNG VON KÄLTEVERDICHTERN

LUBRIFICATION DE COMPRESSEURS DE REFRIGERATION

(84) Designated Contracting States:
BE CH DE DK ES FR GB IT LI NL SE

(30) Priority: **06.11.1993 GB 9322887**
27.07.1994 GB 9415118

(43) Date of publication of application:
21.08.1996 Bulletin 1996/34

(73) Proprietor: **CASTROL LIMITED**
Swindon, Wiltshire SN3 1RE (GB)

(72) Inventors:
• **GREIG, Barry Dennis**
Reading, Berkshire RG4 7HS (GB)
• **SMITH, Andrew Michael**
Wallingford, Oxfordshire OX10 6NR (GB)
• **SWALLOW, Andrew**
Reading, Berkshire RG4 8QF (GB)

• **O'BRIEN, Margaret Mary**
Reading, Berkshire RG5 4JD (GB)

(74) Representative: **Lewis, Pauline Therese et al**
Burmah Castrol Trading Limited,
Group Patents Department,
Burmah Castrol House,
Pipers Way
Swindon, Wiltshire SN3 1RE (GB)

(56) References cited:
EP-A- 0 590 238 **US-A- 3 792 755**
US-A- 4 556 496 **US-A- 4 829 786**

• **DATABASE WPI Week 8322, Derwent**
Publications Ltd., London, GB; AN
83-53046K[22] & JP,A,58 069 298 (MATSUSHITA
REIKI) 25 April 1983

Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

EP 0 726 930 B1

Description

This invention relates to the lubrication of refrigeration compressors.

In recent years, as a result of environmental pressure, there has been a move away from the traditional use of refrigerant gases such as the chlorofluorocarbons to the use of less damaging fluorocarbons such as 1,1,1,2-tetrafluoroethane. This change has also necessitated a change in the lubricants employed with the working fluid, as the originally used lubricants such as alkyl benzenes and mineral oils are not fully miscible with the new working fluids such as 1,1,1,2-tetrafluoroethane. New lubricants have thus been developed. In particular, synthetic polyol ester lubricants have been shown to be satisfactory for the new working fluids.

However, this change in lubricant has itself caused problems. In particular, it has been found that the fluorocarbon working fluid/synthetic ester lubricant systems can be problematic in certain circumstances of compressor operation which involve excessive and uncontrolled release of refrigerant vapour from the lubricating oil causing vapour flooding which can prevent the lubricant being effectively circulated. This lack of adequate lubrication in the system can lead to high wear rates and/or compressor failure.

Such a situation may occur, for example, at start up of the compressor, but may also occur during operation, for example, in multi compressor systems where pressure differences affect the lubricant/refrigerant equilibrium in one or more of the compressors.

Of course, such problems can be overcome by redesign of the compressor system so that such flooding cannot occur- however, this is a wasteful and expensive course to take when there are compressors available that have still a long potential working life.

This invention seeks to overcome such problems by enabling the continued use of existing compressors without the need for physical modification of the system.

EP 0 590 238A1 was published on 6th April 1994, designating the following contracting states: DE, FR and IT. This document is concerned with an energy efficient hermetic compressor for compressing hydrocarbon refrigerants. The compressor includes a motor compressor unit with a rotating oil pickup tube to which an oil paddle is attached. The oil paddle rotates in a base lubricant of polyol ester mixed with a siloxane ester foaming agent. We are told that the combination of the foaming additive with the oil paddle creates a foam layer that floats in the oil sump to reduce the sound level of the compressor.

In accordance with the present invention there is provided use of a foam density increasing additive in a lubricant composition comprising a synthetic polyol ester lubricant, in a refrigeration system having at least one compressor and employing a halocarbon working fluid, to increase foam density and to control vapour evolution from the compressor or one of the compressors, the

foam density increasing additive being present in an amount in excess of 200 ppm based on the weight of the lubricant when used to increase foam density.

Preferably, the foam density increasing additive is a siloxane which has a molecular weight average in the range of from 200 to 13,000.

It is recognised that the inclusion of some type of siloxane in a refrigeration fluid system is not, in itself, new. Thus, US patent No. 3792755 describes the use of a foaming agent which is believed to be an organosiloxane dissolved in toluene for noise attenuation during operation of the compressor. This document, however, is concerned with the use of traditional working fluids and lubricants. Furthermore, there is a recognised concern within the document to control the amount of foaming to prevent foam entering the compression chamber and damaging the compressor. The use of siloxane polymers as anti-foaming agents has also been proposed in refrigeration systems, see for example, U.S. patent No. 5021179. This is hardly surprising as siloxane polymers have previously been used as anti-foaming agents in a wide variety of applications.

It was thus surprising to find that the use of siloxane, in accordance with the invention, was able to overcome the previously reported problems by increasing foam density and controlling the evolution of refrigerant vapour during changes in compressor operation, for example, start up or other situations where the lubricant/refrigerant equilibrium in the compressor is affected, thus giving the means of overcoming the potential failure or wear problems and allowing continued use of existing compressors with the new working fluid/lubricant systems.

It will be appreciated that other additives capable of increasing foam density so as to control vapour evolution may be employed, for example, halogenated aliphatic polymeric esters such as Fluorad FC 430, a fluorinated aliphatic polymeric ester available from 3M, Bracknell and certain organic polymers such as PC 1244, available from Monsanto.

The synthetic polyol ester lubricant suitably, although not necessarily, comprises an ester having a molecular weight of greater than 250, preferably an ester of an aliphatic mono-carboxylic acid and an alcohol having at least three hydroxy groups such as pentaerythritol and/or dipentaerythritol. Esters of this type are described in European Patent Specification No. 468729.

The polyol ester lubricant may be the sole lubricant of use, or may be present in a mixture with other synthetic and/or mineral based lubricants dependent on the refrigerant working fluid employed and the prior lubricants used in the system.

The halocarbon working fluid is preferably an environmentally acceptable fluorocarbon such as 1,1,1,2-tetrafluoroethane (known as HFC 134a or R 134a), although the invention is also applicable to earlier and now less acceptable working fluids containing chlorine such as R12 (dichlorodifluoromethane). The inven-

tion is applicable to "Retrofill" situations where the previously used lubricant was, for example, an alkyl benzene or mineral oil with a working fluid selected from R12, R22, R502 or R511. Such use is described in the above referenced European Patent Specification No. 468729. Alternative newly acceptable refrigerants such as R 404a may also be employed.

Siloxanes used as the foam density increasing additive suitably have a molecular weight average of from 200 to 1300 although the actual choice of siloxane will depend on the need for solubility in the lubricant employed. A preferred molecular weight average is from 236 to 5000. The siloxane may also be defined in terms of its viscosity and siloxanes in the viscosity range of from 0.65 to 1000 centistokes at 25 degrees C, preferably 1 to 100 centistokes may be employed dependent on the lubricant and working fluid of use.

A suitable siloxane for use in accordance with the invention has been found to be that known as 200/5CS molecular weight average 680, available from Dow Corning of Reading, Berkshire.

The amount of foam density increasing additive present must be sufficient to increase foam density and control vapour evolution from the, or one or more of the, compressors in the refrigeration system. While it will be appreciated that the optimum concentration can be determined by the man skilled in the art for a particular application, the concentration is greater than 200 ppm additive based on the weight of the lubricant when used to increase foam density. In order to ensure that the additive will remain miscible with the refrigerant, it is preferable to employ not more than 1200 ppm additive. Preferably the lubricant contains less than 0.1% by volume of additive.

The lubricant composition of the invention can be employed with particular advantage to overcome start up flooding problems, for example for an oil pump lubricated single compressor. Additionally, when operating with a multi-compressor system, the lubricant is advantageously used to obviate unwanted refrigerant flooding effects caused, for example, during supply of lubricant with dissolved refrigerant to the compressor, the refrigerant content being high. This may occur as a result of a high pressure difference during supply of the lubricant, or as a result of a need to supply additional liquid refrigerant for cooling the compressor.

The invention has been found to be particularly useful in respect of semi-hermetic compressors, which are commonly used in multi-compressor installations and in connection with applications involving transportation of equipment where extremes of operating conditions can exacerbate the flooding problems.

The following non-limiting Examples are included to illustrate the invention with respect to A) Compressor Start Up and B) Multiple Compressor Operation.

A) COMPRESSOR START UP

Test Procedure

Lubricant compositions with and without the addition of siloxane were tested in accordance with the following procedure:

A conventional Carrier Thinline "clip-on" container cooling unit was mounted in the open air and operated in the "modulation mode" with the supply air temperature sensor immersed in an ice-water mix (at zero degrees C). The temperature set point was adjusted to about zero degrees C to ensure that the compressor operated continuously. In the modulation mode the suction was restricted to ensure that the supply air temperature was kept constant and to avoid compressor overheating an amount of liquid refrigerant was allowed to enter the compressor. This resulted in the compressor "icing up" due to the cooling effect of the liquid refrigerant evaporating. This procedure was used to artificially generate a "flooded start" situation where the compressor sump contained approximately equal proportions of lubricant and liquid refrigerant.

In the test procedure, once a sufficient ice ball had been built, the compressor was stopped and a bypass valve opened to allow liquid refrigerant from the condenser to enter the sump. After an appropriate "soak" period the compressor was restarted and allowed to run in the modulation mode again. During the first few minutes of operation the actual oil pressure (difference between sump and oil pump discharge) was monitored.

EXAMPLE A I (Comparative)

The above test procedure was carried out using R12 as a working fluid and a standard mineral oil lubricant (available as Napthenic ISO VG 32 from Sun Oil). Two runs were carried out and the results are shown in Figure 1 indicating that the oil pressure was at an acceptable level throughout the start-up period.

EXAMPLE A II (Comparative)

The test procedure was repeated using R 134a as working fluid together with a polyol ester lubricant and available from Castrol as Castrol *ICEMATIC SW20*.

To the lubricant there had been added 120 ppm of Dow Corning siloxane "200/5CS". The results of Runs 1 and 2 are given in Figure 2. It will be seen that for Run 1 the oil pressure remained unacceptably low throughout start-up while, for Run 2, the pressure fell before attaining a suitable level.

EXAMPLE A III

The test procedure of Example 2 was repeated but employing 240 ppm of siloxane "200/5CS". The results of Runs 1 and 2 are shown in Figure 3. It will be seen

that in both cases the initial low oil pressure rapidly reached an acceptable level and thus adequate lubrication during start-up was maintained.

B) MULTIPLE COMPRESSOR OPERATION

A lubricant composition was employed with a supermarket refrigeration system shown diagrammatically in Fig. 4

The system shown in Fig. 1 comprises six Prestcold PL 300/10040 compressors 1, 2, 3, 4, 5 and 6 linked to a single discharge line 7 leading to the configuration system single condenser. Of the six compressors, 1, 2 and 3 are connected to a higher suction pressure line 8. Compressors 4, 5 and 6 are connected to a low suction pressure line 9.

A common lubrication system for the six compressors comprises an oil separator 10 in the discharge line 7 upstream of the condenser, from which oil passes via float level valve to oil holding reservoir 11 maintained at a pressure nominally one bar above the high suction pressure of 3 bar. The lubricant in reservoir 11 is thus saturated with refrigerant (e.g. R22) at 4 bar and ambient temperature, excess refrigerant boiling off via a pressure relief valve 12 to the high suction pressure line 8. Each compressor 1, 2, 3, 4, 5 and 6 is provided with a float level valve 14, 15, 16, 17, 18, 19 supplying oil from reservoir 11 when required to that compressor. Thus for compressors 1, 2 and 3 oil is fed from reservoir 11 at 4 bar to the compressor sumps at 3 bar, while for compressors 4, 5 and 6 oil is fed from reservoir 11 at 4 bar to the compressor sumps connected to the low suction pressure line at 1 bar.

In operation using a conventional synthetic polyol ester lubricant (available from Castrol as Castrol *ICE-MATIC SW32*) at low temperature (below minus 20 degrees C), compressor 4, 5 and 6 suffered from inadequate lubrication.

The conventional naphthenic oil lubricant was replaced by a lubricant in accordance with the present invention, a polyol ester, containing 240 ppm of siloxane 200/5cs.

The system operated normally, at low temperatures down to - 25 degrees C and showed no sign of inadequate compressor lubrication.

Claims

Claims for the following Contracting States : BE, CH, LI, DK, ES, GB, NL, SE

1. Use of a foam density increasing additive in a lubricant composition comprising a synthetic polyol ester lubricant, in a refrigeration system having at least one compressor and employing a halocarbon working fluid, to increase foam density and to control vapour evolution from the compressor or one of the compressors,

the foam density increasing additive being present in an amount in excess of 200ppm based on the weight of the lubricant when used to increase foam density.

2. Use as claimed in claim 1, wherein the foam density increasing additive is either a siloxane or a halogenated aliphatic polymeric ester.
3. Use as claimed in claim 2, wherein the siloxane has a molecular weight average in the range of from 200 to 13,000.
4. Use as claimed in claims 2 or 3, wherein the siloxane is present in an amount of not more than 1200 ppm based on the weight of the lubricant.
5. Use as claimed in any one of the preceding claims, wherein the foam density increasing additive is present in an amount of less than 0.1% by volume based on the lubricant.
6. Use as claimed in any one of the preceding claims, wherein the polyol ester has a molecular weight greater than 250 and is an ester of an aliphatic mono-carboxylic acid and an alcohol having at least three hydroxy groups.
7. Use as claimed in any one of the preceding claims, wherein the compressor is a semi-hermetic compressor.
8. Use as claimed in any one of the preceding claims, wherein the halocarbon working fluid is 1,1,1,2-tetrafluoroethane.
9. Use as claimed in any one of the preceding claims, wherein the compressor is an oil pump lubricated compressor.

Claims for the following Contracting States : DE, FR, IT

1. Use of a foam density increasing additive in a lubricant composition comprising a synthetic polyol ester lubricant, in a refrigeration system having at least one compressor and employing a halocarbon working fluid, to control vapour evolution from the compressor or one of the compressors.
2. Use as claimed in claim 1, wherein the foam density increasing additive is either a siloxane or a halogenated aliphatic polymeric ester.
3. Use as claimed in claim 2, wherein the siloxane has a molecular weight average in the range of from 200

to 13,000.

4. Use as claimed in claim 2 or 3, wherein the siloxane or the halogenated aliphatic polymeric ester is present in an amount in excess of 150 ppm based on the weight of the lubricant.

5

5. Use as claimed in claim 4, wherein the siloxane or the halogenated aliphatic polymeric ester is present in an amount in excess of 200 ppm based on the weight of the lubricant.

10

6. Use as claimed in any one of claims 2-5, wherein the siloxane or the halogenated aliphatic polymeric ester is present in an amount of not more than 1200 ppm based on the weight of the lubricant.

15

7. Use as claimed in any one of claims 2-6, wherein the siloxane or the halogenated aliphatic polymeric ester is present in an amount of less than 0.1% by volume based on the lubricant.

20

8. Use as claimed in any one of the preceding claims, wherein the polyol ester has a molecular weight greater than 250 and is an ester of an aliphatic mono-carboxylic acid and an alcohol having at least three hydroxy groups.

25

9. Use as claimed in any one of the preceding claims, wherein the compressor is a semi-hermetic compressor.

30

10. Use as claimed in any one of the preceding claims, wherein the halocarbon working fluid is 1,1,1,2-tetrafluoroethane.

35

11. Use as claimed in any one of the preceding claims, wherein the compressor is an oil pump lubricated compressor.

40

Patentansprüche

Patentansprüche für folgende Vertragsstaaten : BE, CH, LI, DK, ES, GB, NL, SE

1. Verwendung eines die Schaumdichte erhöhenden Additivs in einer Schmiermittelzusammensetzung, die ein synthetisches Polyolesterschmiermittel enthält, in einem Kühleystem, das mindestens einen Kompressor aufweist und ein Halogenkohlenwasserstoff-Arbeitsfluid benutzt, um die Schaumdichte zu erhöhen und die Dampfbildung aus dem Kompressor oder einem der Kompressoren zu steuern, wobei das die Schaumdichte erhöhende Additiv, wenn es zur Erhöhung der Schaumdichte eingesetzt wird, in einer Menge vorliegt, die 200

45

50

55

ppm übersteigt, bezogen auf das Gewicht des Schmiermittels.

2. Verwendung nach Anspruch 1, worin das die Schaumdichte erhöhende Additiv entweder ein Siloxan oder ein halogenierter aliphatischer polymerer Ester ist.

3. Verwendung nach Anspruch 2, worin das Siloxan ein Durchschnittsmolekulargewicht im Bereich von 200 - 13000 aufweist.

4. Verwendung nach Anspruch 2 oder 3, worin das Siloxan in einer Menge von nicht mehr als 1200 ppm, bezogen auf das Gewicht des Schmiermittels, vorliegt.

5. Verwendung nach einem der vorstehenden Ansprüche, worin das die Schaumdichte erhöhende Additiv in einer Menge von weniger als 0,1 Vol%, bezogen auf das Schmiermittel, vorliegt.

6. Verwendung nach einem der vorstehenden Ansprüche, worin der Polyolester ein Molekulargewicht von über 250 aufweist und ein Ester aus einer aliphatischen Monocarbonsäure und einem Alkohol mit mindestens 3 Hydroxylgruppen ist.

7. Verwendung nach einem der vorstehenden Ansprüche, worin der Kompressor ein halbhermetischer Kompressor ist.

8. Verwendung nach einem der vorstehenden Ansprüche, worin das Halogenkohlenwasserstoff-Arbeitsfluid 1,1,1,2-Tetrafluorethan ist.

9. Verwendung nach einem der vorstehenden Ansprüche, worin der Kompressor ein ölpumpengeschmierter Kompressor ist.

Patentansprüche für folgende Vertragsstaaten : DE, FR, IT

1. Verwendung eines die Schaumdichte erhöhenden Additivs in einer Schmiermittelzusammensetzung, die ein synthetisches Polyolesterschmiermittel enthält, in einem Kühleystem, das mindestens einen Kompressor aufweist und ein Halogenkohlenwasserstoff-Arbeitsfluid benutzt, zum Steuern der Dampfbildung aus dem Kompressor oder einem der Kompressoren.

2. Verwendung nach Anspruch 1, worin das die Schaumdichte erhöhende Additiv entweder ein Siloxan oder ein halogenierter aliphatischer polymerer Ester ist.

3. Verwendung nach Anspruch 2, worin das Siloxan ein durchschnittliches Molekulargewicht im Bereich von 200 - 13000 aufweist.

4. Verwendung nach Anspruch 2 oder 3, worin das Siloxan oder der halogenierte aliphatische polymere Ester in einer Menge von über 150 ppm, bezogen auf das Gewicht des Schmiermittels, vorliegt.

5. Verwendung nach einem Anspruch 4, worin das Siloxan oder der halogenierte aliphatische polymere Ester in einer Menge von über 200 ppm, bezogen auf das Gewicht des Schmiermittels, vorliegt.

6. Verwendung nach einem der Ansprüche 2 - 5, worin das Siloxan oder der halogenierte aliphatische polymere Ester in einer Menge von nicht mehr als 1200 ppm, bezogen auf das Gewicht des Schmiermittels, vorliegt.

7. Verwendung nach einem der Ansprüche 2 - 6, worin das Siloxan oder der halogenierte aliphatische polymere Ester in einer Menge von weniger als 0,1 Vol%, bezogen auf das Schmiermittel, vorliegt.

8. Verwendung nach einem der vorstehenden Ansprüche, worin der Polyolester ein Molekulargewicht von über 250 aufweist und ein Ester aus einer aliphatischen Monocarbonsäure und einem Alkohol mit mindestens 3 Hydroxylgruppen ist.

9. Verwendung nach einem der vorstehenden Ansprüche, worin der Kompressor ein halbhermetischer Kompressor ist.

10. Verwendung nach einem der vorstehenden Ansprüche, worin das Halogenkohlenwasserstoff-Arbeitsfluid 1,1,1,2-Tetrafluorethan ist.

11. Verwendung nach einem der vorstehenden Ansprüche, worin der Kompressor ein ölpumpengeschmierter Kompressor ist.

Revendications

Revendications pour les Etats contractants suivants : BE, CH, LI, DK, ES, GB, NL, SE

1. Utilisation d'un additif augmentant la densité de mousse dans une composition lubrifiante comprenant un lubrifiant synthétique du type ester de polyol, dans un système de réfrigération ayant au moins un compresseur et employant un fluide moteur halogénocarboné, pour augmenter la densité de mousse et pour contrôler le dégagement de vapeur du compresseur ou d'un des compresseurs,

l'additif augmentant la densité de mousse étant présent en une quantité supérieure à 200 ppm par rapport au poids du lubrifiant lorsqu'on l'utilise pour augmenter la densité de la mousse.

2. Utilisation selon la revendication 1, dans laquelle l'additif augmentant la densité de mousse est soit un siloxane, soit un ester polymère aliphatique halogéné.

3. Utilisation selon la revendication 2, dans laquelle le siloxane présente une masse moléculaire moyenne comprise dans l'intervalle de 200 à 13000.

4. Utilisation selon la revendication 2 ou 3, dans laquelle le siloxane est présent en une quantité ne dépassant pas 1200 ppm par rapport au poids du lubrifiant.

5. Utilisation selon l'une quelconque des revendications précédentes, dans laquelle l'additif augmentant la densité de mousse est présent en une quantité inférieure à 0,1% en volume par rapport au lubrifiant.

6. Utilisation selon l'une quelconque des revendications précédentes, dans laquelle l'ester de polyol présente une masse moléculaire supérieure à 250 et est un ester d'un acide mono-carboxylique aliphatique et d'un alcool ayant au moins trois groupes hydroxyles.

7. Utilisation selon l'une quelconque des revendications précédentes, dans laquelle le compresseur est un compresseur semi-hermétique.

8. Utilisation selon l'une quelconque des revendications précédentes, dans laquelle le fluide moteur halogénocarboné est le 1,1,1,2-tétrafluoroéthane.

9. Utilisation selon l'une quelconque des revendications précédentes, dans laquelle le compresseur est un compresseur lubrifié à pompe à huile.

Revendications pour les Etats contractants suivants : DE, FR, IT

1. Utilisation d'un additif augmentant la densité de mousse dans une composition lubrifiante comprenant un lubrifiant synthétique du type ester de polyol, dans un système de réfrigération ayant au moins un compresseur et employant un fluide moteur halogénocarboné, pour contrôler le dégagement de vapeur du compresseur ou d'un des compresseurs.

2. Utilisation selon la revendication 1, dans laquelle

l'additif augmentant la densité de mousse est soit un siloxane, soit un ester polymère aliphatique halogéné.

3. Utilisation selon la revendication 2, dans laquelle le siloxane présente une masse moléculaire moyenne comprise dans l'intervalle de 200 à 13000. 5
4. Utilisation selon la revendication 2 ou 3, dans laquelle le siloxane ou l'ester polymère aliphatique halogéné est présent en une quantité supérieure à 150 ppm par rapport au poids du lubrifiant. 10
5. Utilisation selon la revendication 4, dans laquelle le siloxane ou l'ester polymère aliphatique halogéné est présent en une quantité supérieure à 200 ppm par rapport au poids du lubrifiant. 15
6. Utilisation selon l'une quelconque des revendications 2 à 5, dans laquelle le siloxane ou l'ester polymère aliphatique halogéné est présent en une quantité ne dépassant pas 1200 ppm par rapport au poids du lubrifiant. 20
7. Utilisation selon l'une quelconque des revendications 2 à 5, dans laquelle le siloxane ou l'ester polymère aliphatique halogéné est présent en une quantité inférieure à 0,1% en volume par rapport au lubrifiant. 25
8. Utilisation selon l'une quelconque des revendications précédentes, dans laquelle l'ester de polyol présente une masse moléculaire supérieure à 250 et est un ester d'un acide monocarboxylique aliphatique et d'un alcool ayant au moins trois groupes hydroxyles. 30 35
9. Utilisation selon l'une quelconque des revendications précédentes, dans laquelle le compresseur est un compresseur semi-hermétique. 40
10. Utilisation selon l'une quelconque des revendications précédentes, dans laquelle le fluide moteur halogénocarboné est le 1,1,1,2-tétrafluoroéthane. 45
11. Utilisation selon l'une quelconque des revendications précédentes, dans laquelle le compresseur est un compresseur lubrifié à pompe à huile. 50

50

55

FIG. 1

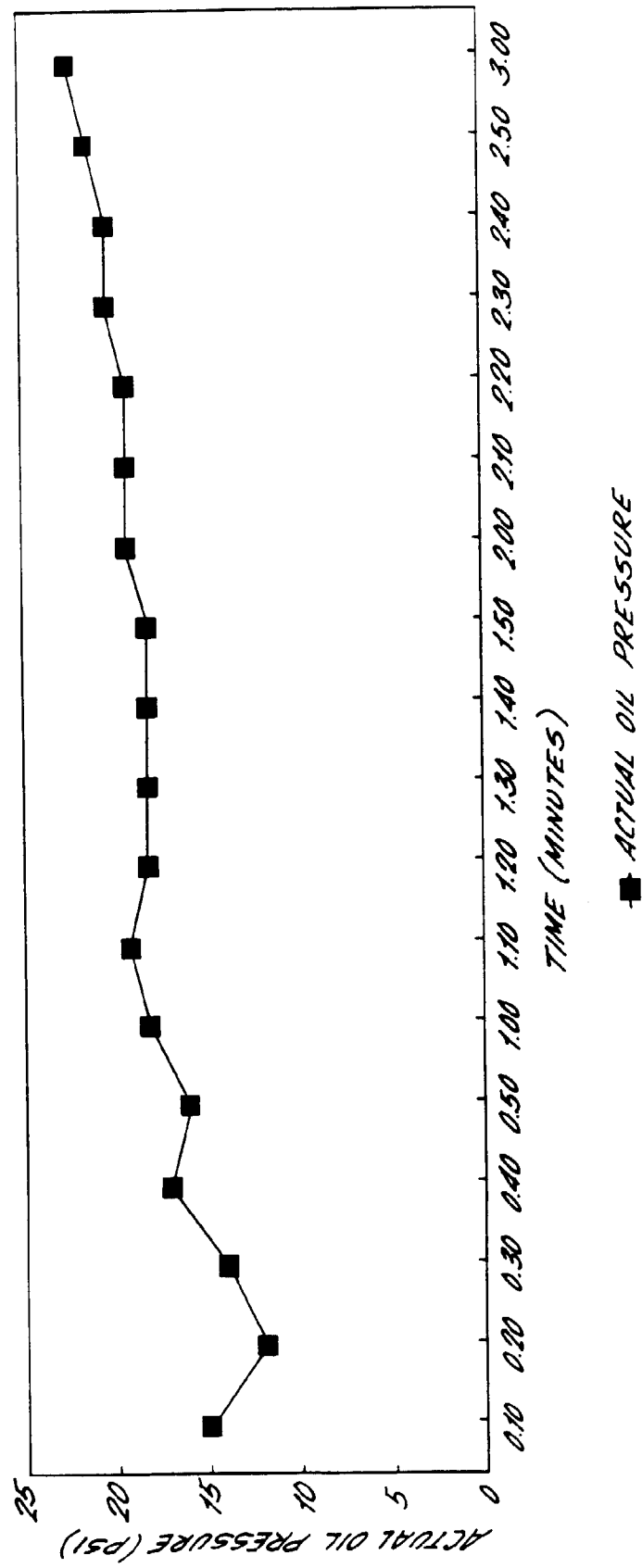


FIG. 2.

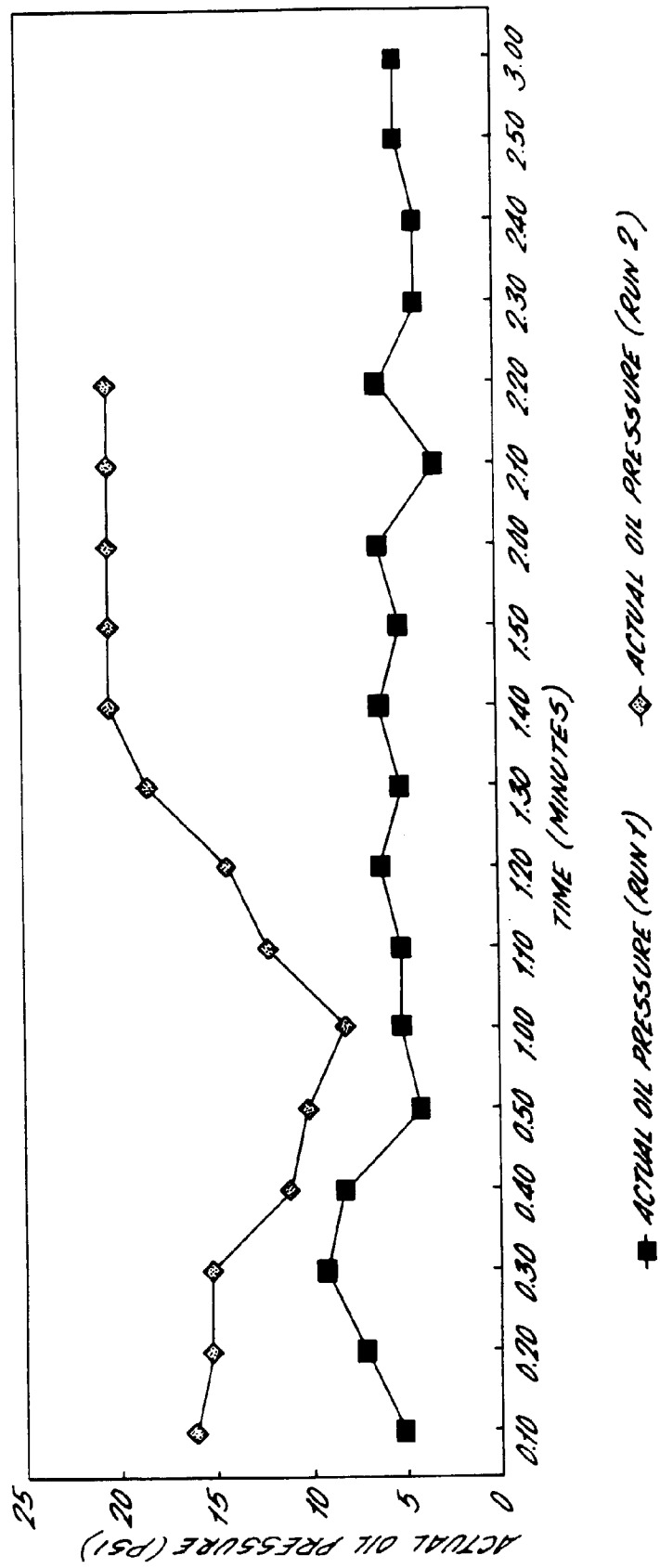


FIG. 3.

