HALOTRON: A TOTAL CONCEPT HALON REPLACEMENT

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The early Swedish phase-out of CFCs and halons initiated the Halotron project in 1988.

Halotron is not solely a replacement chemical; it is a complete halon replacement program. The Halotron concept includes: better, more rapid detection, a "drop-in" replacement agent, technical optimization of systems, recovery/recycle technology and management of the bank of recovered halons for "essential" use (yet to be defined).

One of the major objectives when the project started in 1988 was to identify and create a clear picture of the requirements for an agent with the characteristics of halon. Was there a need for a "halon-like" agent? Especially considering it is very well documented, that other agents, i.e., dry chemicals, etc. are more effective at fire suppression.

Simple and complex models were used to create a profile of agents for various fire scenarios. We came to the conclusion that there was a need for a "halon-like" agent based on two major parameters which would include the need for a clean fire suppression agent and "low" weight equipment. But the most fundamental parameter is the need for a "clean" agent. That is really the only justification for agents based on halogenated compounds.

The agent search itself is only one part of the development of alternatives, and that is mainly all standard physical chemistry.

In the initial phase of our project we conducted an intense literature search, using, among other things, the STN International data-base, containing more than 9 million chemical abstracts. The major result of this work confirmed that earlier research on halogenated compounds for fire suppression purposes has not had a high priority in industry. However, a very important conclusion from this work was that it was necessary to narrow the search to components that are within current production technologies that have been developed. It would seem that there is no sense in spending a lot of time and money looking at candidates that might not ever be produced in commercial quantities.

The political situation has become a major parameter in the search for a replacement agent. Therefore, one of the basic strategies in our mind can be simplified in figure **1.** If these very basic criteria cannot be fulfilled, then the agent developed will be very limited in its use.

Other important features as shown in Figure 1:

- Approved extinguishing effect
- Environmental acceptance
- Toxicity level acceptable for both agent and decomposition products

Halotron extinguishing, handling and technology methods are similar to Halon 1211. In the initial part of the practical evaluation work with candidates, it was clear to us that we needed a better and more efficient test method than the cup burner offers, especially since it was clear to us that there would be a demand for very comprehensive documentation of any new agent to be introduced.

We chose a test method using a large diameter burner (figure 2). This method allows us to collect a lot of information, such **as:**

- Effect of an agent compared to other agents in agent/fuel mixtures
- Effect of agent on the flame front
- Measurement of CO, CO_2 and **O** production during extinguishing sequences
- Sampling of decomposition products at various levels of agent **flow** in flames

The method used was originally developed by **NBS** for studying water spray on large flames. The table in figure **3** shows that the method can be used to compare agents for efficiency.

This work was done at the University of Lund, Dept. of Fire Safety Engineering, Institute of Science and Technology. The method is also an official Nordtest fire test method.

We have tested a large number of candidates, pure and in blends, which has enabled us to accumulate enough data to identify which group of chemicals to **look** for the most effective agent, as this method also very effectively predicts the physical reactions of an agent. For non-brominated candidates, we strongly feel that the extinguishing effect is mainly caused by heat sinking or cooling by heat absorption.

The next step in our research for streaming agents was to take the chosen candidates and test them against our standardized fires according to the Swedish Standard using elevated circular fire pans.

Our test method requires that the extinguisher must have a "restricted" flow rate. In order to extinguish these test fires with a reasonably sized extinguisher, one must have the combination of a fairly good agent and an extinguisher technically optimized for flow rate, nozzle configuration and agent dispersion in order to succeed.

The practical tests indicated early on that the chosen alternative candidates could never match halons unless the equipment used was optimized to a maximum. This begs the question "what changes of the hardware can be allowed before the candidate no longer can be considered as a drop-in agent?"

It is our view that the changes have to be limited to gaskets and nozzles.

The practical tests in the optimization work were carried out together with the Swedish National Testing and Research Institute using one of the world's most modem indoor fire houses, where large scale repeatable fires can be made and controlled for various fire test configurations. This fire house is located in Boras, Sweden.

Perhaps the major task in making the total system more effective is through different means of optimization in the replacement work, especially for total flooding systems, where our research includes:

- Basic fire dynamics
- Fire detection problems
- Distribution of agent
- Creation of adequate test scenarios

Results of this work include development of engine compartment (especially large logging machines, see Fig. 4) and applications with Halotron that are extremely close to halon in efficiency. Several of these systems will be installed soon.

A large proportion of our work is directed toward practical optimization in various fire scenarios rather than chemistry research.

The Halotron concept is based on a combination of using chemicals with acceptable properties together with physical and technical optimization, within the **scope** of the "drop-in" concept.

The Halotron project is not strictly concerned with finding replacement systems for halon. An equal part of the work has involved trying to find a solution to the problems associated with the existing halon bank.

In this area we have concentrated on:

- Recycling technology
- Handling (halon bank management)

Environmental regulations for air emissions are very strict in Scandinavia and especially in Sweden. We have been looking at technologies for recycling, especially Halon 1301, that can obtain an ultra-high purification of the nitrogen, which will be emitted to the atmosphere from the halon systems.

Our work has also included studies of reasonably priced high volume capacity units. Our perception, based on the already enforced phase-out requirement in Sweden is, that if there will be recycling in large scale, it will not commence until close to the final deadline. This implies that for Scandinavia, where the deadline is 1997, the need for recycling could be several thousand metric tons in just a few years, if that is possible.

The pilot plan we now are building for ultra-high purification has a capacity of 800 m^3 halon gas/hour. We understand this will be the first ultra-high purification recycling unit with a large capacity.

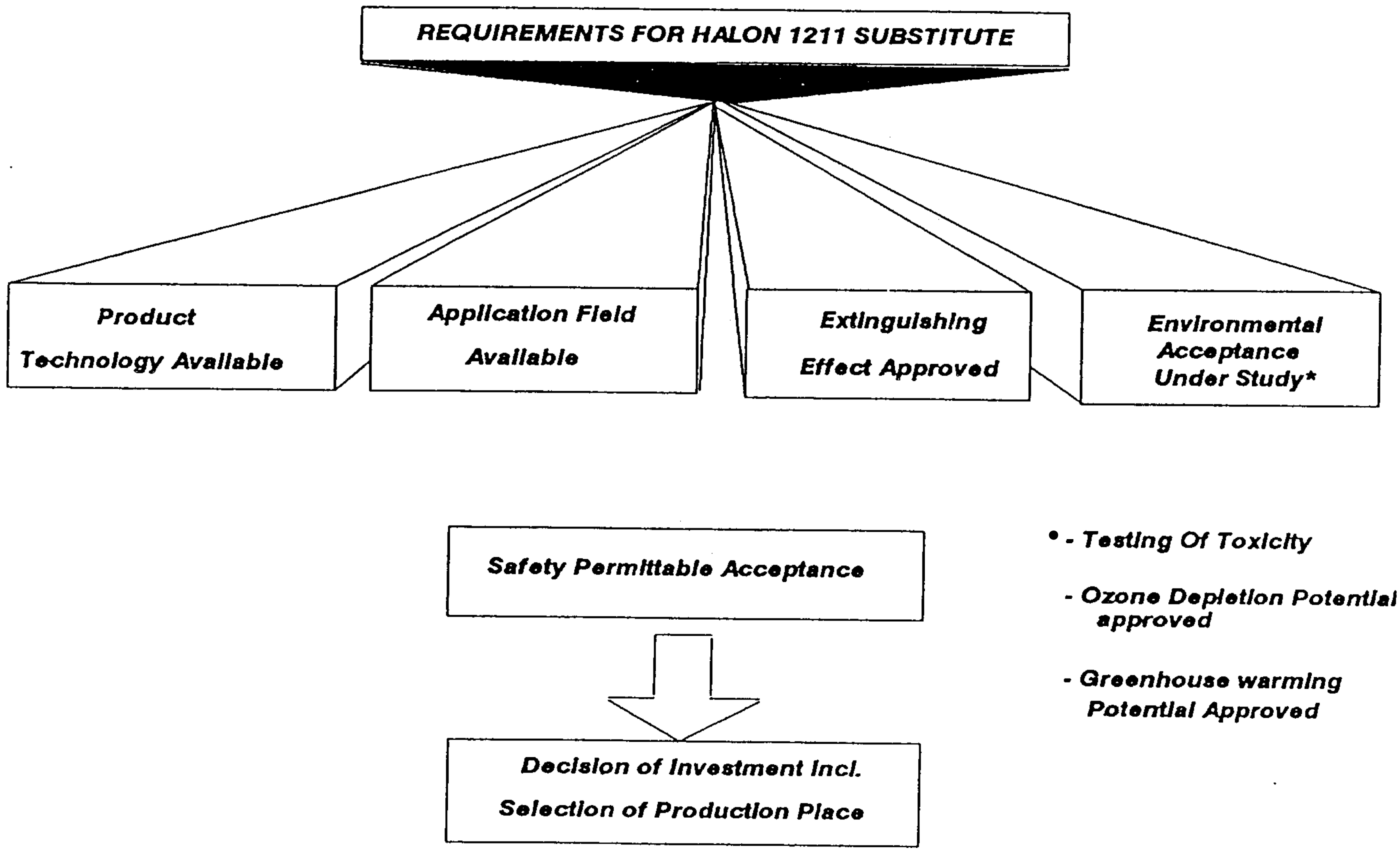
Any requirements for purification can surely be fulfilled, as it is a straight forward technical problem, even though it can sometimes be a difficult one.

A bigger problem is the halon bank management. This is essentially a political issue, and here we don't **see** any clear picture of how it will be handled. The policy seems to change, not only with elections, but also from country to country, even though a lot of countries have agreed to follow the **UNEP** decision.

From the experience in Sweden, it is my view that if the issue of halon bank management isn't clarified properly in various countries very quickly, there will be many resulting problems. To avoid the risk of "losing" the halon bank, this issue must be dealt with quickly.

We have built facilities in Sweden capable of recycling and storing halon, and we are ready to go ahead with the recycling as soon as our pilot plant is successfully on line. However, the issue of recycling and halon bank management must be dealt with on an international basis. In Sweden, for instance, there is probably a larger bank of halon to be recycled than future domestic users will require Swedish regulations allow export of recycled material to countries that have signed the Montreal document.

The Halotron project does not claim to have all of the solutions to all of the problems involved, but it includes research for virtually all the fields associated with halon replacement. The Halotron project deals with the "big picture."



REQUIREMENTS FOR HALON 1211 SUBSTITUTE
Product
Technology Available
Application Field
Available
Extinguishing
Effect Approved
Environmental
Acceptance
Under Study*
Safety Permittable Acceptance
Decision of Investment Incl.
Selection of Production Place
* - Testing Of Toxicity
- Ozone Depletion Potential approved
- Greenhouse warming Potential Approved

FIGURE 1

FIRE SUPPRESSION AGENT TEST METHOD AT THE UNIVERSITY OF LUND

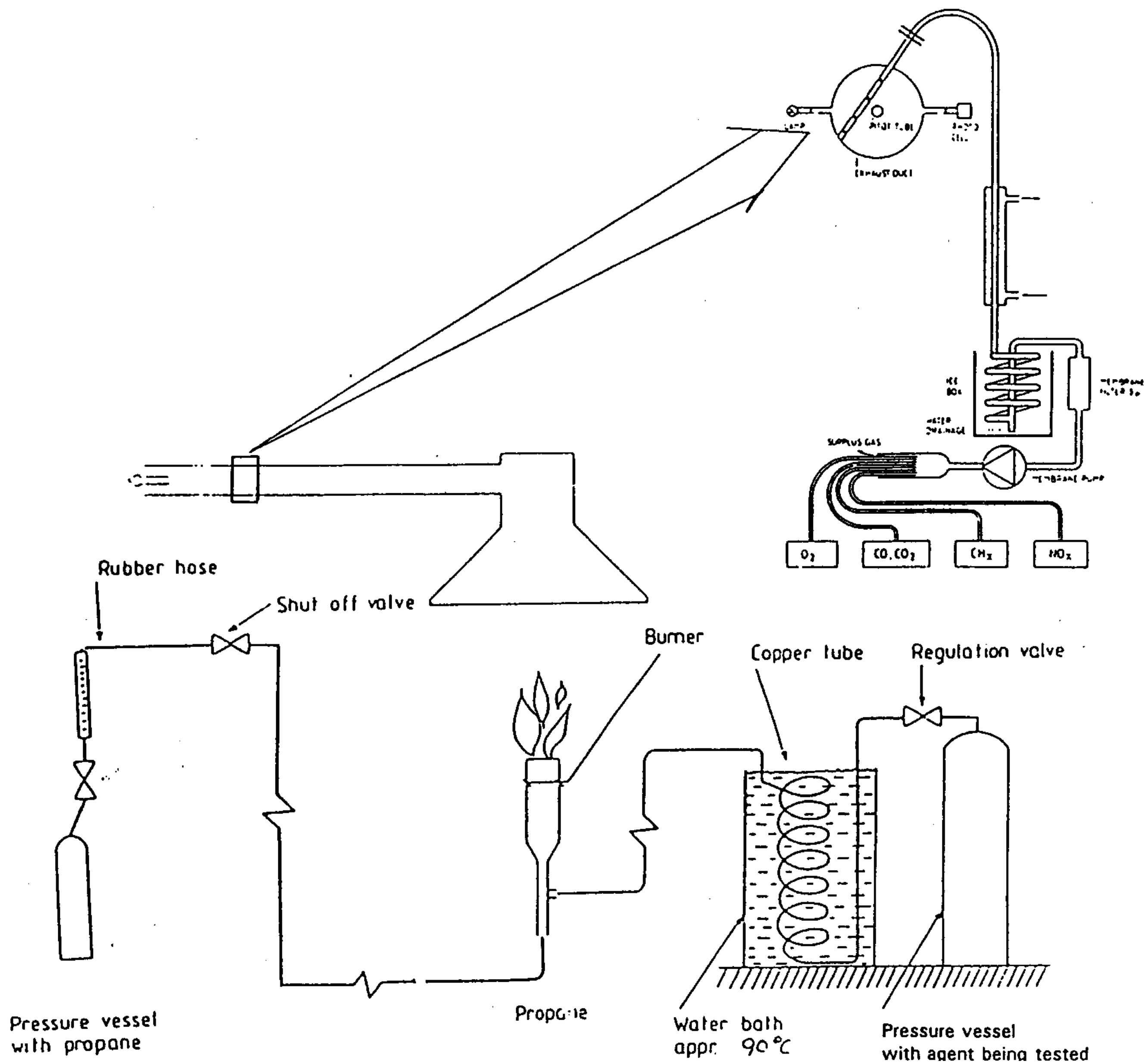


FIGURE 2

FIRE SUPPRESSION AGENT COMPARISON

EFFICIENCY AGAINST FLAMES

EXTINGUISHING MEDIA	* EFFICIENCY $\dot{m}_e/\dot{m}_f$	SUITABLE APPLICATION
Dry Powder	1-4	Portable
Halon 1211, 1301	4-5	Portable & Sprinklers
Halotron I	**6-7**	**Portable & Local App.**
Water Mist	4	Sprinklers
Water Steam	7-8	Sprinklers
Water Spray	10-1000	Sprinklers, Fire Depts.
Carbon Dioxide	10-12	Portable System
Nitrogen	15	Sprinklers
Perfluorohexane (C_6F_{14})	**11-12**	**Portable**

* University of Lund Data

m_e = Mass flow rate of extinguishant

m_f = Mass flow rate of fuel

FIGURE 3

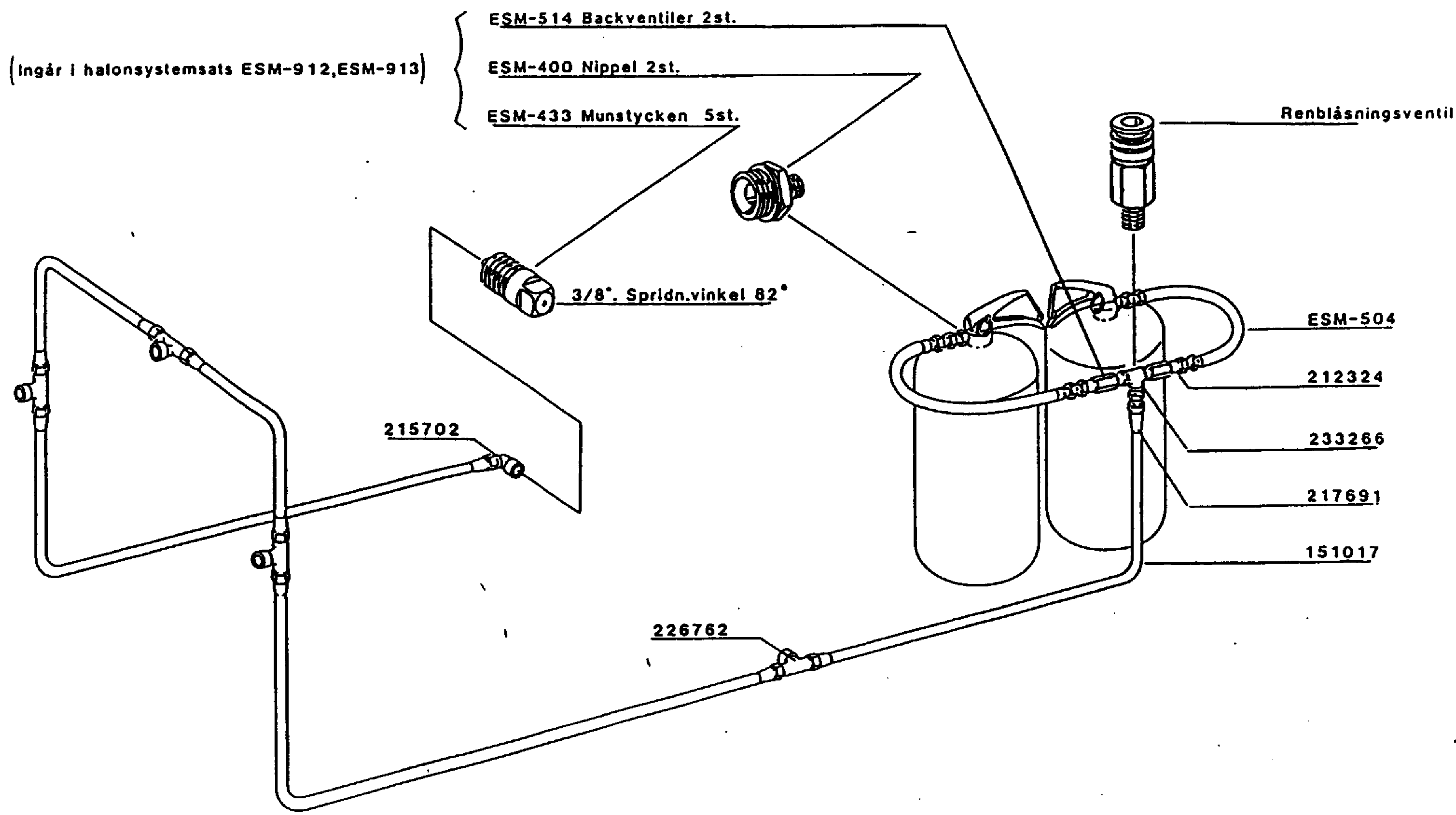

(Ingår i halonsystemsats ESM-912,ESM-913)
ESM-514 Backventiler 2st.
ESM-400 Nippel 2st.
ESM-433 Munstycken 5st.
Renblåsningsventil
3/8". Spridn.vinkel 82°
ESM-504
212324
233266
217691
151017
215702
226762

FIGURE 4(a)

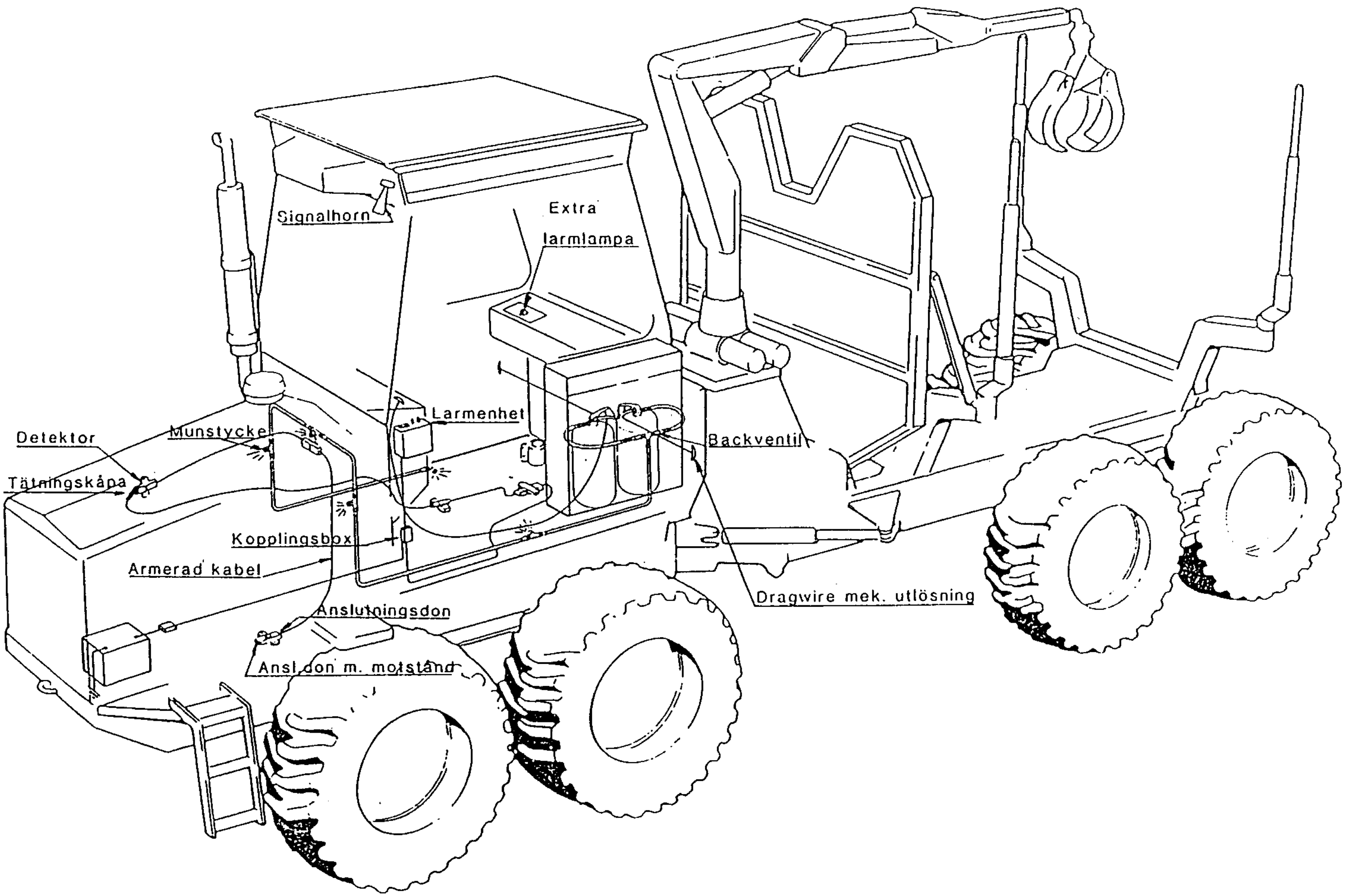

Signalhorn
Extra
larmlampa
Larmenhet
Detektor
Munstycke
Backventil
Tätningskåpa
Kopplingsbox
Armerad kabel
Anslutningsdon
Dragwire mek. utlösning
Ansl.don m. motstånd

FIGURE 4(b)