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Technical information No.1

Die Casting
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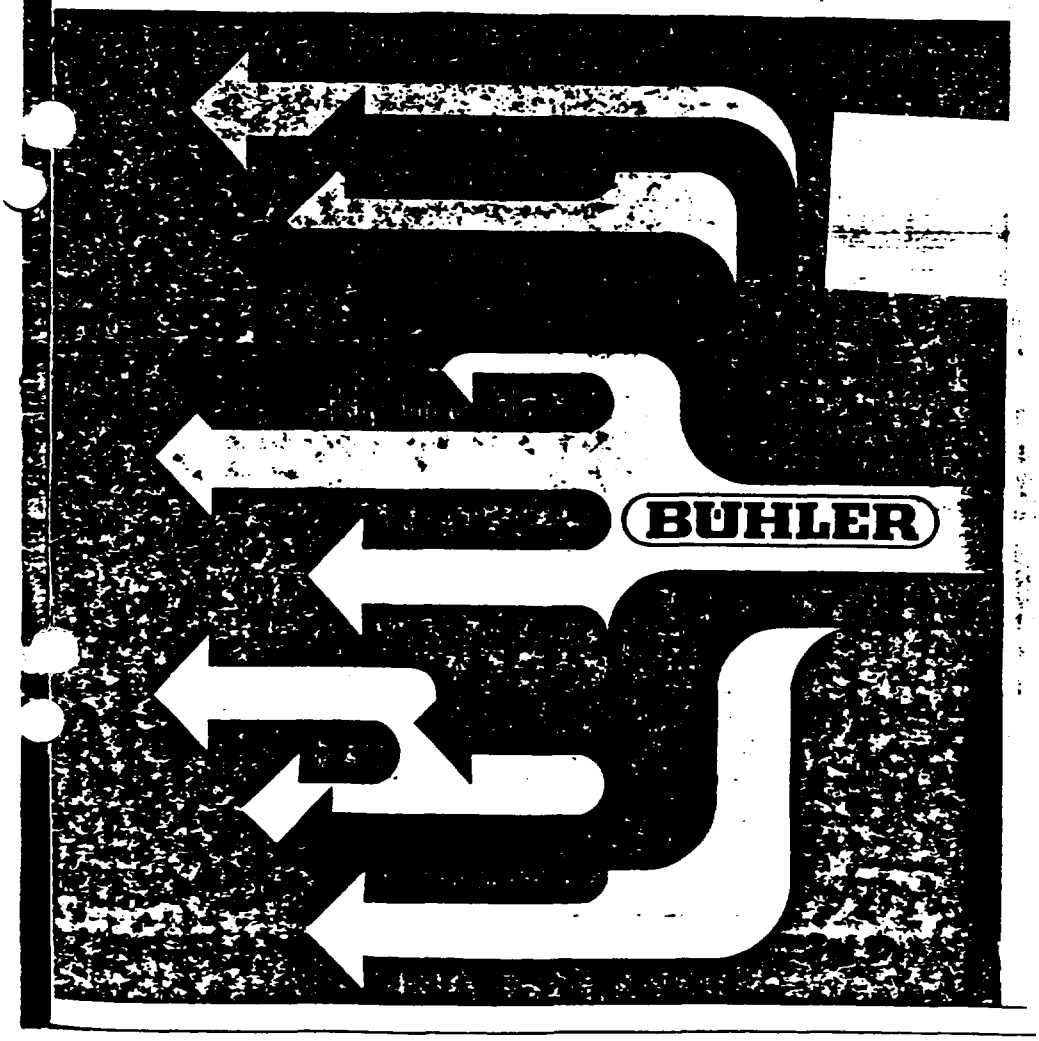
New Drive for HSC-noninflammable Fluids on Die Casting Machines



NOTE:

This case history is a reprint of the Buhler Brothers Ltd. technical publication "DIE CASTING", Volume I, January 1974.

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January 1974
HARTRUN CORPORATION
Chaska, MN. 55318

Uzwil, January 1974

Dear Sirs

«Either you progress or you fall back, there is no standstill».

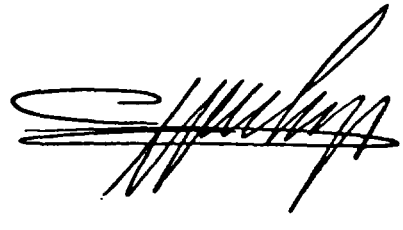
This certainly also applies to die-casting. So it is our obligation to aid you in your continual endeavour to improve production methods and means.

That is the aim of this newly published information journal «DIE-CASTING», the first issue of which now lies before you. With this publication BUHLER BROTHERS will acquaint you with the latest developments and research results as well as with experiences we were able to gather.

This particular issue deals with the problems of non-inflammable hydraulic fluids and the modifications which can be made to meet these difficulties.

Yours faithfully
Buhler Brothers Ltd.

U. Eggenberger
Head of the Department for die-casting machines.



Pumps for HSC-fluids on Die Casting Machines

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Summary

The call for reliable accident proof die-casting machines, has brought a trend to change over from mineral oils to non-inflammable fluids. Based on a comparison of the available liquids, the use of water glycols is recommended.
Application of water glycols brought the disadvantage of reducing the endurance of hydraulic elements. By means of various modifications the service life could be improved. An important piece of equipment is the combined micro-filter and heating system.
Also the use of a new type of pump is essential. Endurance tests with 3 different types (rotary vane pumps, stationary vane pumps and internal gear pumps) showed the best results with the internal gear pump in relation to wear and quietness.
The used TRUNINGER type pump has three principle features that are different from the usual gear pumps: Internal gear, special profile of the teeth and multiple stage system. With water glycols and needless to say also with mineral oil, BUHLER can guarantee a three-shift, years operation (6000 hours) without any pump trouble.

Discussion of the problem

The development of die-casting machines has taken large steps in the last few years. A die-casting machine without hydrostatics is hardly thinkable nowadays.
The light inflammability of mineral oils which up to now were used practically without exception as hydraulic fluid, formed a potential danger in a die-casting foundry.
Despite care for, and prompt maintenance of the hydraulic system, fires have repeatedly been caused which destroyed die-casting plants with the equipment, and brought the personnel in great danger. Causes of fire were often leakage or pipe break in the hydraulic system. The mineral oil being squirted out at high pressure, could ignite itself explosively from the liquid metal.
For safety in die-casting plants, other fluids for the hydraulic system had to be found, such that are less inflammable but do not influence the production rate. Although research and development brought pressure fluids with much higher fire resistance on the market, these fluids had the disadvantage of reducing the life endurance of hydraulic components.
This report will give you information about the results of tests in our research laboratories and trials which we carried out during some years with our customers, on fluids and appropriate hydraulic components.

Choice of the non-inflammable fluid

Based on our trials and practical experience with non-inflammable hydraulic fluids and under careful consideration of the advantages and disadvantages of HSC – and HSD fluids (see page 10), we recommend the use of water glycol (HSC) in BUHLER die-casting machines.
The advantages of water glycol are:
- High fire resistance
- Good temperature viscosity index
- Low setting point
- Not aggressive to normal seals
- Long life endurance
- Favourable to environment

Primary modifications of the machine for the use of HSC fluids

HSC fluids put a much higher demand on the rotary vane pumps we have been using, than is the case with HSD fluids. This has a negative effect on the service life of the pump. The shorter lifetime of pumps has been causing additional costs to customers. To ensure an adequate lifetime of pumps, BUHLER have made several modifications to their die-casting machines and drive units:
- Reduction of revolutions of the pump drive from 1500 rpm to 1000 rpm
- The hydraulic pump is located below the oil level
- The cross section of the suction pipes were chosen as large as possible, i.e. they were doubled or even tripled and their length is kept as short as possible

A built-in pressure switch (figure 1) continually controls the pressure at the magnetic suction filter, for fouling or other causes.

Figure 1:
Drive unit of a H–660–D 2 die-casting machine

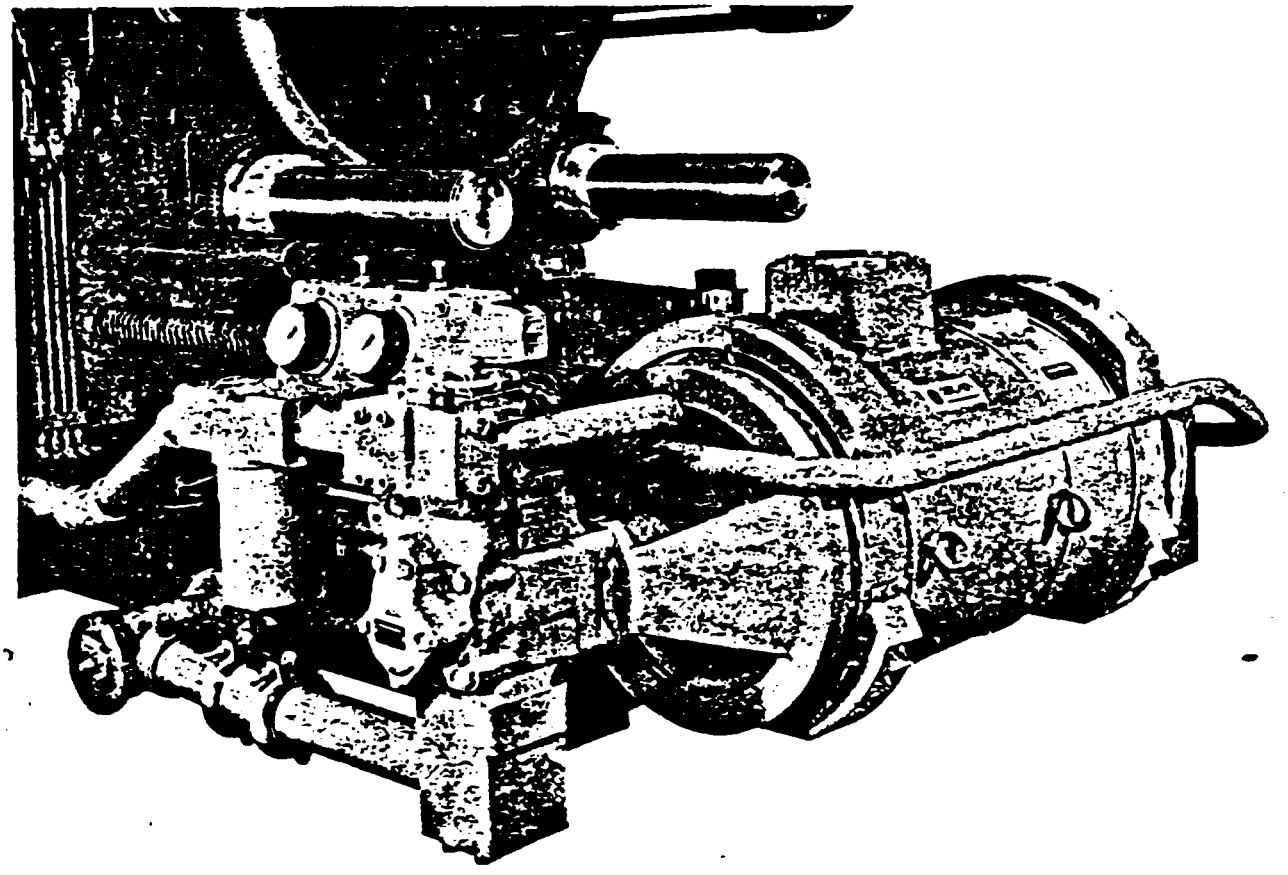
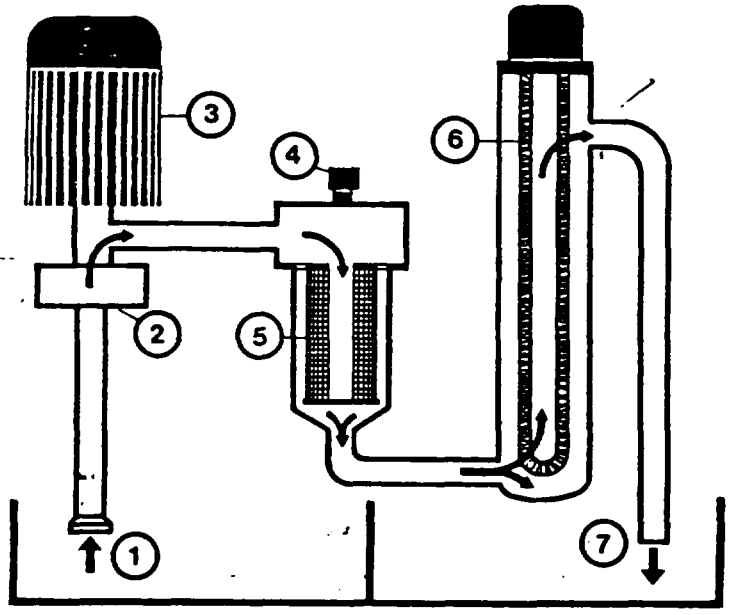
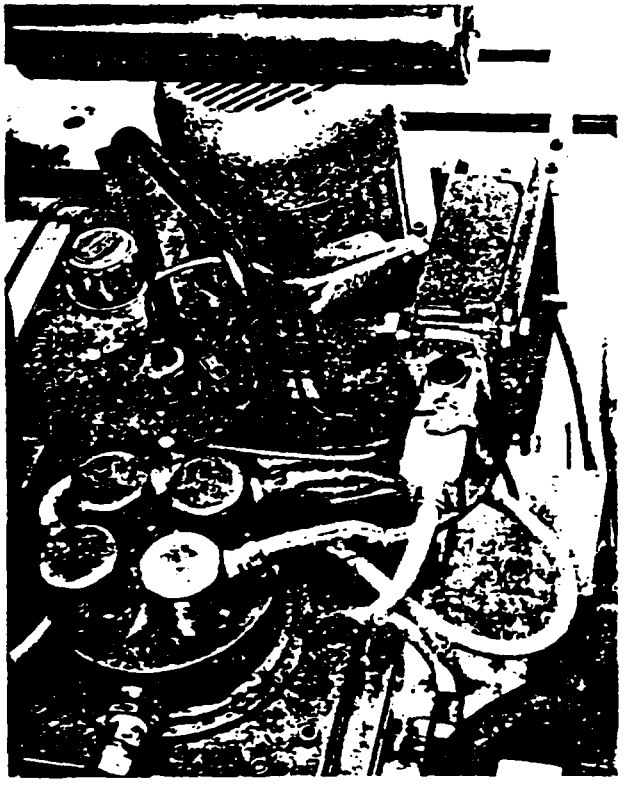


Figure 2:
Principle diagram of a combined filtering and heating unit



1 Suction chamber
2 Pump
3 Electric motor
4 Pressure switch
5 Filter
6 Heater element
7 Return chamber

Figure 3:
Combined filtering and heating unit



Because of the poor lubricating qualities of non-inflammable fluids compared with mineral oils, already the smallest contaminating particles can lead to damage of the hydraulic components. Therefore, the micro filter in the return line was improved with a filter unit which was specially developed by BUHLER.

Too low a temperature of the hydraulic fluid is a further cause for exceptionally high pump wear. Our research has led us to the conclusion that the temperature of the hydraulic fluid must be approx. 30°C (86°F) when starting up a rotary vane pump. This was a reason for BUHLER to develop a new combined micro filtering and heating system (figure 2, figure 3).

The hydraulic fluid is continually passed through a micro filter, which has a built-in electrical control for the grade of fouling. This guarantees optional filtering. At the same time quick and easy cleaning or replacement of the foulded-up filter-element has been aimed at.

The minimum working temperature is maintained by means of the heating which is built into the filter circuit.

Further, a new hydraulic tank was designed. A system of baffle plates leads the returning hydraulic fluid over the longest possible path keeping it in contact with the tank walls for as long as possible, allowing for the best cooling and settling of the hydraulic fluid.

The baffle plates can be removed in a simple way, in order to allow for the cleaning of the tank (figure 4).

Thanks to these measures, acceptable lifetime was achieved in several cases. Though for trouble free and economical operation these modifications still did not suffice. This motivated us to examine the whole problem in detail from the view point of the pump.

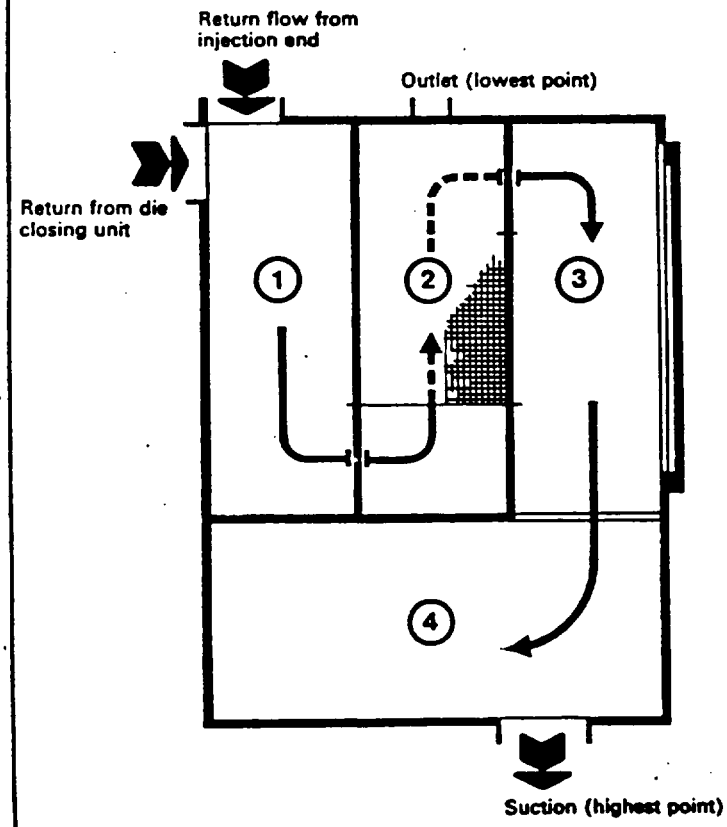


Figure 4:
Hydraulic tank of a H–160 B–D 2 die-casting machine

1 Return chamber: cooling and steadying of the pressure fluid

2 Return chamber with strainer (strainer can be extracted without emptying tank) provide for separation of air and dirt

3 Return chamber with cleaning aperture

4 Suction chamber, separated from return chamber, communicating with overflow. (The combined micro filtering and heating unit is built into the suction chamber.)

Pump trials and results – Choice of the pump

Long run trials were considered to be carried out with various types of pumps. Three types were selected and tested over a period of 2 years in our own die-casting laboratories as well as under normal working conditions at several of our European customers. The three selected types were a stationary vane pump, a rotary vane pump and an internal gear pump.
Without exception, the internal gear pumps were an outstanding success on all test sites together with the use of HSC fluids. The results from the laboratories and from the practise showed 6000 hours working without the slightest bit of trouble.
Consequently, we can now guarantee a year's 3-shift production without trouble from the pump. Even after this test period, there was no greater wear on any part of the pump than is usual for operation with mineral oil, so that a service life far longer than this period is expected (figure 5, figure 6).
HSC fluid, together with the internal gear pump without doubt is the most ideal solution for safety as well as economical operation. For this reason, BUHLER die-casting machines are nowadays equipped to work with HSC fluids and internal gear pumps.

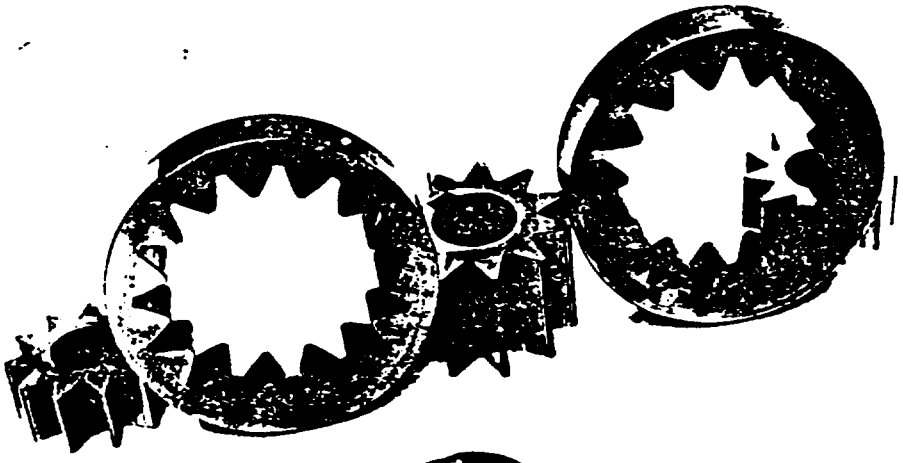
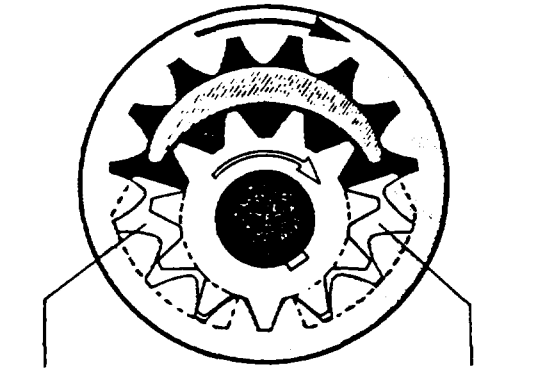


Figure 5:
Pinions and tooth wheel rims after 1000 hrs running

Figure 6:
Pinions and toothed wheel rims after 6000 hrs running

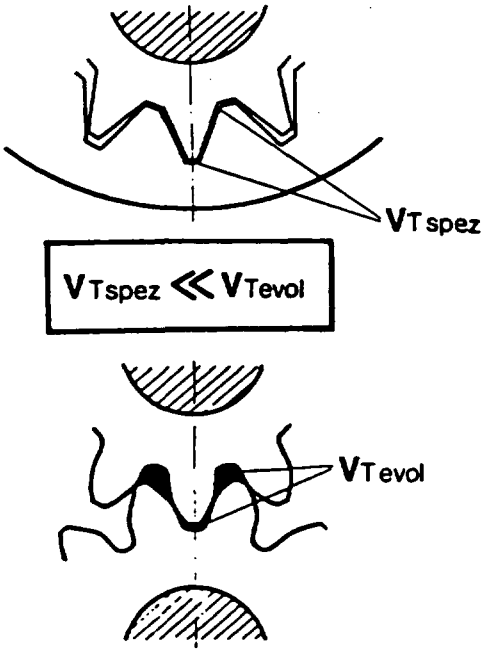
Three Design Characteristics of the Internal Gear Pumps

The TRUNINGER type pumps which are used by BUHLER, compared with conventional gear pump designs, have the following three outstanding characteristics:



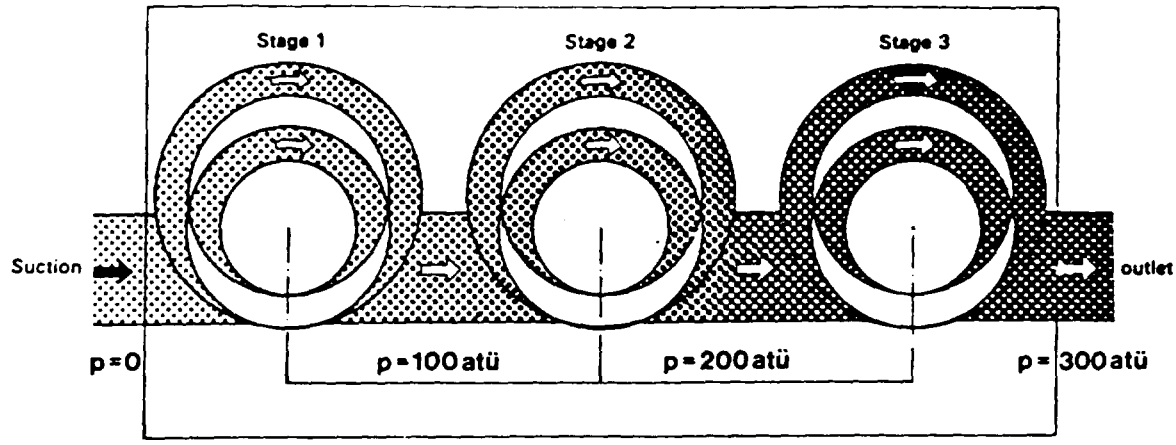
1. Internal gears

The pump shaft drives a keyed pinion, which itself drives an internal gear. This design allows for the shaft end to be placed in the centre of the housing. The pump needs only one shaft and therefore lends itself easily to double and multi-stage design and multiple pump arrangements. Like external gear pumps, the oil fills the teeth gaps in the suction zone, and is displaced from the gaps in the output zone. But the inherent advantage of the internal gear design is the fact that suction and output zones are much longer than for comparable external gears. Therefore, fluid velocities for filling the gaps are considerably reduced. This not only reduces the noise level of the pump, but improves effectively the suction capabilities as well.



2. Special shape gear teeth

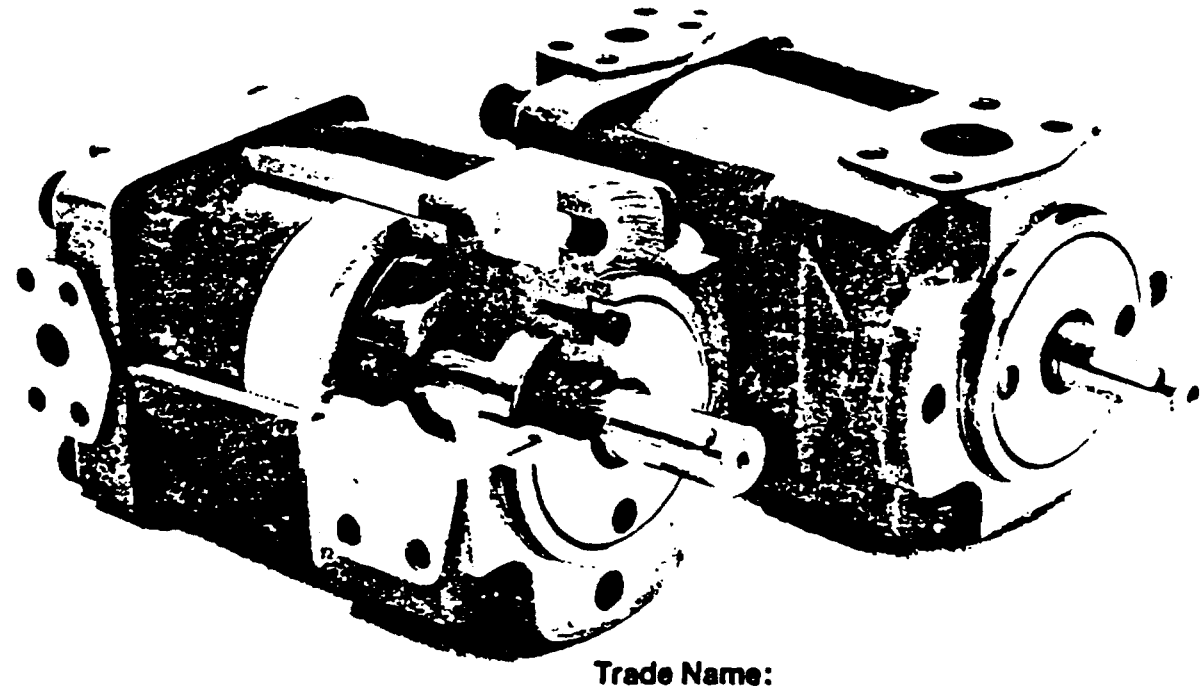
For ease of manufacture, involute shaped teeth flanks are usually specified for conventional gear pumps. This particular teeth form has an inherent disadvantage, because a relatively large volume of oil is trapped between the tooth gap of one and the tooth of the meshing gear. This "trapped oil" volume varies considerably with the angle of rotation and this generates pressure pulsations and noise. TRUNINGER has developed a specially shaped tooth profile, which for all practical purposes eliminates any "trapped oil" volume. In this way ripple-free flow and smooth low noise operation is achieved. The teeth flanks are only slightly curved which results in low specific ~~Hertz~~ HERTZIAN pressures and long life of the gears.



3. Multi-stage principle

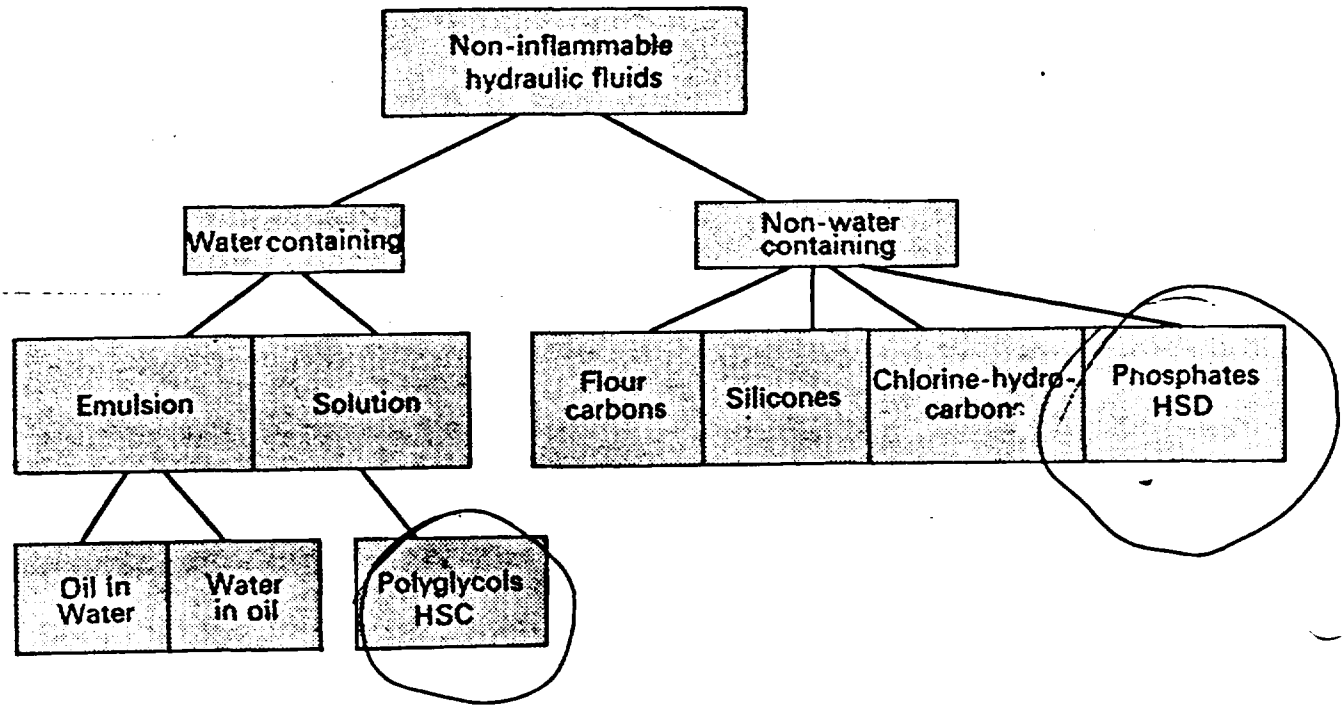
A conventional gear pump uses only one pair of gears. The pressure rating is, therefore, limited. TRUNINGER high pressure pumps for 2,800 and 4,200 lbf/in² continuous pressure are of multi-stage design in which two or three pump elements are working in series, so that the oil is flowing from the outlet of one stage to the inlet of the next stage. Each element or stage participates equally in producing the eventual outlet pressure. Each stage is only loaded to a maximum of 1400 lb/in², which is cumulative in multi-stage pumps. This reduces stress on the pump components and increases pump life.

Figure 10:
Drive group with TRUNINGER internal gear pump



Trade Name:
"HydraStar-System Truninger" Trademark, Registered U.S. Patent Office. U.S. and other worldwide patents granted. U.S. Patent No. 3,491,698.

Non-inflammable hydraulic fluids



Non-inflammable fluids can be grouped in water containing and non water containing. Of the water containing fluids, the polyglycols (short HSC) are the most widespread, there is a number of such available on the market.

Under the non-water containing, the fluids on the basis of phosphat-ester (short HSD) are the best known. Because of their physiological and chemical characteristics or because of their price, other sorts are mainly used for exceptional cases.

HSC

Polyglycol in water

(Water glycol fluids)

Composition

The non-inflammable polyglycol solutions contain approximately 35 to 45 % water. Their flash point depends on the water quantity.
In most solutions there are additives for anti-wear and for anti-corrosion in the fluid and in the vapour phase. These additives, especially the corrosion-inhibitor, are lost for a part with the evaporating water and have to be replaced. Polyglycols require continued testing of the viscosity and of alcaline contents. Decreased pH value (on average by 9) is to be raised by adding water and additives.

HSD

Phosphate-esters

(Synthetical fluids)

Composition

The non-inflammables that are grouped under the phosphate-esters are synthetical homogenous fluids which can be improved on some of their properties by adding additives.

Stability

The fluid is very sensitive to contamination with water, penetration of more than 0,1 % causes the forming of acidous components and the fluid becomes useless.

Stability

As long as the solubility point is not exceeded, polyglycol solutions are generally stable.

Viscosity

The viscosity changes with the water contents and increases as the water contents are lower. Normally it should lie at 5°E/50°C. Polyglycol solutions have a good viscosity index (VI). In other words, the viscosity-temperature curve has a very flat tendency. A high VI implies little influence of temperature on the viscosity and is acquired without addition of viscosity improvers which reduce the shearing resistance.

Effects on sealing materials, metals and paints

The behaviour of polyglycol solutions towards sealing materials is generally the same as that of mineral oils. HSC fluids show a certain aggressiveness towards zinc, cadmium, magnesium and alluminium. Paint coating of the inside tanks should be avoided in any case since bits of paint coming away will lead to trouble.

Corrosion

By addition of corrosion-inhibitors which are active in the fluid as well as in the vapour phase, corrosion is largely suspended. Periodical testing of the fluid is absolutely necessary since the corrosion-inhibitors are lost due to evaporation.

Employing temperature

With regard to the water contents the upper limit of 40°C should not be exceeded. The setting point of polyglycol solutions is at a very low level, about —30°C to —40°C.

Viscosity

Despite bad viscosity temperature conditions, the addition of VI improvers is omitted since this would have an unfavourable effect on the non-inflammability and on the shearing resistance.
Because of the bad temperature properties, this fluid is only used for installations that work within a narrow temperature range, for instance with heating, ranging from a start-temperature of 35°C and a maximum of 60°C.

Corrosion

Anti-corrosion properties of phoste-esters can be classified to be good. In pure condition these fluids are not corrosive, though moisture can form acidous components at higher temperatures, which then are corrosive. The neutralising index point should not be exceeded.

Employing temperature

The ideal temperature lies at 50°C. The highest permissible temperature is 90°C. If the fluid is locally overheated this will cause to form polymeres which will rend the total hydraulic system unserviceable. In such a case, extensive and costly cleaning of the complete system would be inevitable.

2. Non-ageing properties of HSC and HSD fluids

The service life of a hydraulic fluid is an important economical factor. The non-ageing property of a fluid stands in direct relation with the quality of the different products. The neutralising index is a guide for judging the condition of ageing of HSD and HSC fluids. But it does not give any evidence on whether the ageing is caused by the chemical decomposition of the basic fluid or of the additives.

The ageing process is a chemical process and can have several origins. Minute particles of metal in the fluid may have an immediate catalysing effect on the ageing and decomposing process. For this reason it is of great importance that much attention is given to the filtering of these fluids. The stability against ageing depends much on the additives that are combined with the fluid.
To restore the quantity of water in HSC fluids, only distilled water or pure condensation water may be used. This is the only safeguard against penetration of foreign elements.

Our Training Courses in 1974

During the year of 1974 the die-casting department of BUHLER BROS. Uzwil are carrying out a number of training courses for customers.

Hydraulics Course

for fitters, engineers and adjusters who are in charge of the maintenance of the hydraulical and mechanical components

- Basic hydraulics
- Hydraulic pumps
- Hydraulic valves
- Hydraulic systems
- Practical demonstrations
- Adjustment of machines
- Lubrication systems
- Hydraulic fluids/filters
- General maintenance of die-casting machines

Course Dates

German	September 23rd – 27th
English	October 21st – 25th
French	February 18th – 22nd

Electronic Course

"Norstat System"

for participants with basic knowledge of electrics and electronics, who are in charge of BUHLER machines

- Power input unit
- Control system
- Function and description of contactless systems
- Norstat system
- Special layouts
- Diagram reading
- Fault finding
- Latest about electro hydraulic valves
- Practical work in groups
- Integrated circuits

Course Dates

German	October 7th – 11th
English	November 11th – 15th
French	January 21st – 25th
Spanish	March 11th – 15th

Technology

Utilization of the advantages of BUHLER die-casting machines

for managers, assistants and foremen who are familiar with die-casting methods

- Various die-casting methods
- Metals for die-casting
- The die-casting die
- Gating technique and calculation
- Practical die-casting
- Measuring instruments in the die-casting foundry
- A visit to our foundry in Winkeln, St. Gallen

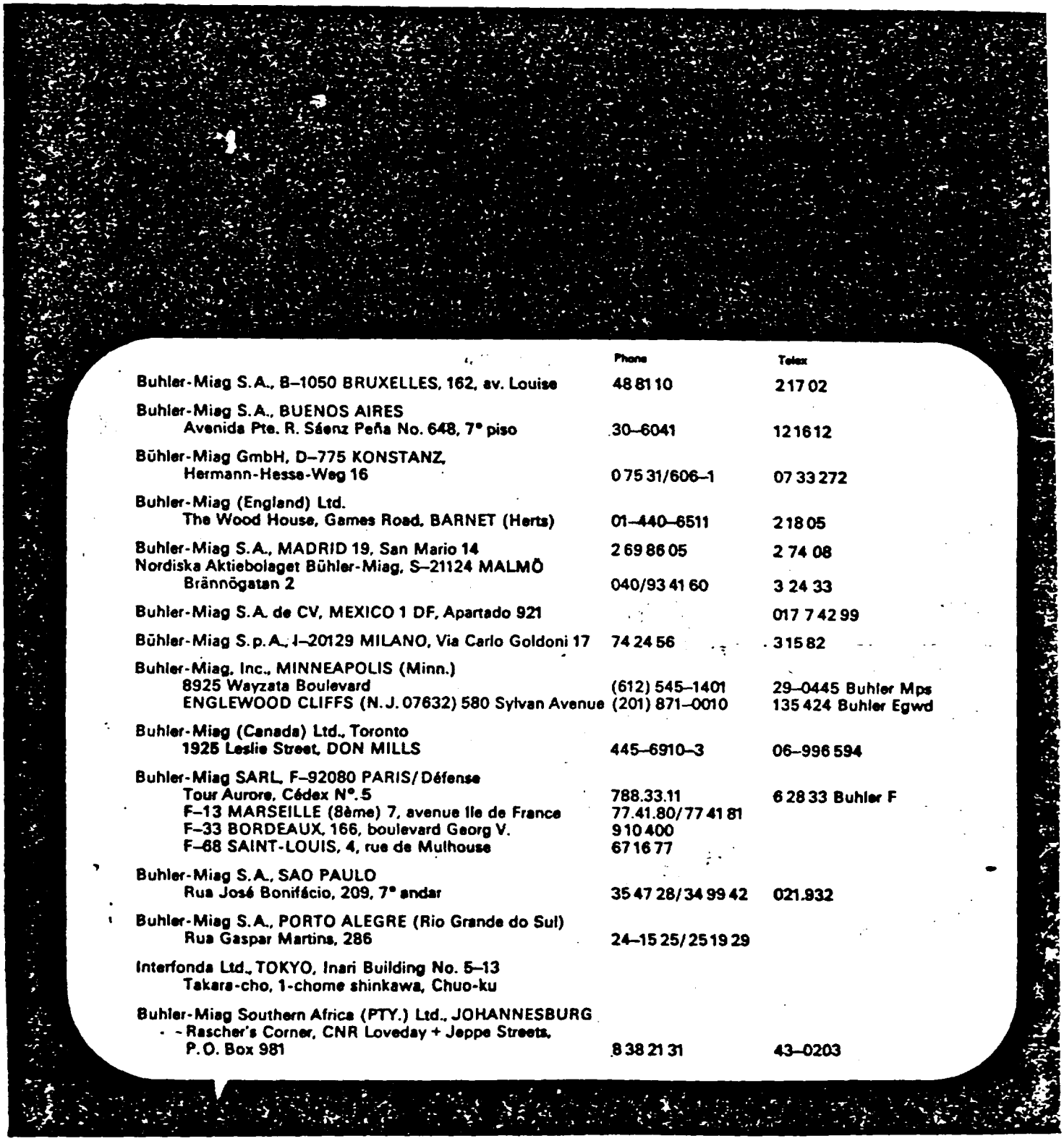
Course Dates

German	September 2nd – 6th
English	December 2nd – 6th
French	April 22nd – 26th

We kindly request people who are interested in our training courses to apply at our branch office or representatives.

Buhler Brothers Ltd.
CH–9240 Uzwil/Switzerland

Phone: (073) 501111
Telex: 77543 gbu ch



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