HYDROSTAR® Switch operating system for main track application

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HYDROSTAR®, an innovative product from VAE Eisenbahnsysteme GmbH (VAEE) is the integrated modular solution for drive, setting, locking and position monitoring for turnouts. Development, design and manufacturing follow the principle of extending maintenance and inspection intervals as well as minimizing the total life cycle costs. Furthermore, this strategy is valid for all VAEE "HYTRONICS" products. HYDROSTAR® excels due to its high reliability, space efficiency, easy installation, simple adjustment and very low costs for inspection and maintenance.
The first HYDROSTAR® was installed in the year 2000. Since 2001 the switch operating system has been performing very well at DB AG (German Railways) and since 2002 in the main track of ÖBB (Austrian Federal Railways).

1 Technique and function

HYDROSTAR® as a modular operating system combines the latest developments of motive power engineering, setting and locking technique as well as monitoring strategy. The basic difference to all other systems is that HYDROSTAR® is completely encapsulated and works absolutely linearly. HYDROSTAR® is made up of compact units in the form of hollow steel sleepers that contain the functional assemblies.

1.1 Drive unit

The drive unit consists of an electric drive and a hydraulic pump (*Fig. 1*) with a special valve control providing three different functions (hydraulic drive, operation by hand, volume compensation).
The system is able to operate any number of setting and locking points with one active unit only and is very flexible in using the core components. Just one single plug-in connection for all operating levels represents the interface to the modern electronic interlocking system where all necessary signals for setting and monitoring are provided.
European railroads are more and more interested in compact switch operating systems for turnouts, which are arranged within the turnout, can be pre-assembled and easily installed and which allow long maintenance intervals. The space saving drive unit of the HYDROSTAR® can be positioned as desired. This is very important and saves money if there is a lack of space, like in tunnels, on bridges or even in station areas. Usually the drive unit is integrated in a standard width hollow sleeper at the first setting point. The total length of the sleeper does not exceed 3,000 mm. The bearings of the elastic system sleeper/ballast are balanced; continuous machine tamping can be carried out.

1.2 Setting and locking

Every single setting level is operated by a functional assembly; on the toe end there is the so-called integrated point locking unit and, dependent on the number of additional setting levels, there are several integrated middle locking units. The setting itself takes place within the setting cylinder (*Fig. 2*), similar to the mechanism well known from VAEE HYDROLINK® [1]. The locking is spherical, free of wear, long-term lubricated and completely encapsulated (*Fig. 3*). It follows the same principle as the VAEE SPHEROLOCK® [2].
All operating levels are directly connected through hydraulic pipes without any additional components. Together with the drive unit they build a closed circuit. Due to the modular setup and the simple fastening concept, cylinder exchanges are easily conducted.
The modular assemblies are very flexible, even in different turnout geometries. For example, a switch device with 2 setting points and a switch device with 8 setting points (*Fig. 4*) are more or less the same; the longer switch just needs a higher number of assemblies and more electrical power. The strokes can be adjusted easily.

1.3 End position detection of the switch

In order to exploit all benefits of the HYDROSTAR® system regarding inspection and maintenance, the design of the end position detection was reassessed and optimized in terms of life cycle costs. Among other things it is not possible to realize the vision of a "plug and play" turnout using conventional technology because of the dimension of the securing components. Standard switch machines and the mechanical switch rail detectors – mostly installed in housings stretched far beyond the sleepers – represent big obstacles.
With VAEE IS 2000 ("Inductive safety system 2000") a modern solution is possible. IS 2000 is a safety and monitoring system; it works contactless on an inductive basis. The sensors, installed within the turnout, deliver information about the switch setting and the distance between switch and stock rail. Instead of the mechanical con-

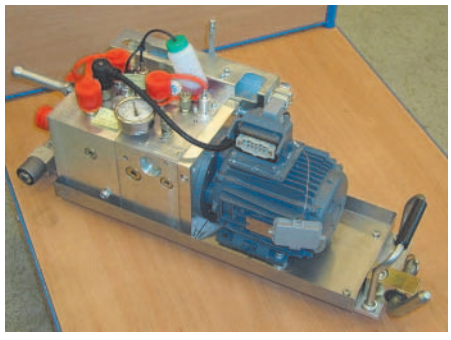

Figure 1: Drive unit

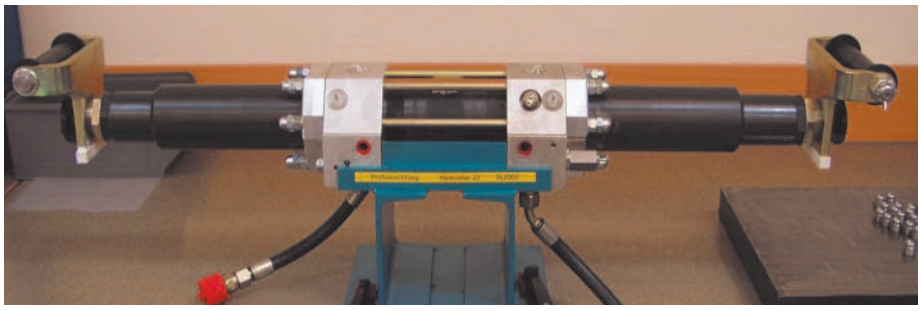

Figure 2: Setting cylinder

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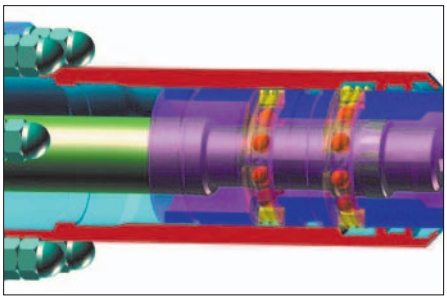

Figure 3: Locking principle of the HYDROSTAR®

tacts of conventional detectors, the electronic signal of the inductive sensors is directly integrated in the securing circuit of the turnout via their evaluating units.
The safety system is more or less maintenance free; there are no moveable mechanical components, no wearing parts. Lubrication is not required. Due to the low weight of the system and the symmetrical positioning of the sensors there are no asymmetric forces. This is a big advantage concerning track maintenance.

2 Advantages of HYDROSTAR® - overall view

- Modular structure allows quick installation or replacement and reduces storage of spare parts.
- Only one drive unit for synchronous setting of a number of setting points for turnouts in standard-speed and high-speed traffic reduces the costs for the drive electronics.
- Compact hollow sleeper design, low weight.
- Lower initial costs for high speed turnouts compared to single drive solutions.
- Easier use of turnouts in tunnels and on bridges.
- Linear working and completely encapsulated setting and locking units.
- Locking of closed and open switch rail.
- Concerning dynamics, switch rail and setting/locking unit are uncoupled.
- No-play system – active clamping force between tongue and stock rails, spring deflection of impact shocks.
- No tension in the system even with high temperature fluctuations – therefore no need for adjustment.
- No strain on the vibrating superstructure by one-sided loads.
- Low-noise switching and overrunning.
- Fully operational pre-assembled "plug and play" turnout.
- Hollow steel sleepers make machine tamping of the switch device possible.
- Inspection interval: 6 months.

Figure 4: HYDROSTAR® turnout with 8 operating levels

Figure 5: UIC60-500 1:12, HYDROSTAR; ROADMASTER and IS 2000

3 Field experience – HYDROSTAR® for all applications+

3.1 HYDROSTAR® for switch devices

After intensive development and design work accompanied by comprehensive calculations and laboratory tests (functional tests, load tests, vibration tests and climatic tests), the first prototype was installed in the track of ÖBB.
Of significant benefit were the years of experience already gained with other VAEE systems, like the hydraulic force transmitting VAEE HYDROLINK®, the spherical locking system SPHEROLOCK® and the inductive safety system IS 2000.
Following the approval of the field trial issued by the Austrian Ministry of Science and Transport, the first turnout UIC60-500 was equipped with HYDROSTAR®. In cooperation with the ÖBB the "plug and play" turnout was installed "just in time" in Fürnitz in November 2000.
The turnout was supplied with HYDROSTAR® for two operating levels, with two inductive safety levels IS 2000 and with the turnout monitoring system ROADMASTER [3]. Immediately after the temporary fish-plating of the components, the turnout was ready to be hand operated and machine tamping was carried out. After that the turnout was integrated ("plugged") in the signalling system and instantly ready to be operated. The turnout is operated up to 87 times a day. From the beginning the system has been performing very well (*Fig. 5*).
After the positive conclusion of the trial period, the approval for further installation was given. In order to extend the inspection and maintenance intervals in general, 4 turnouts UIC60-1200 were set up with HYDROSTAR®, IS 2000 and a new turnout monitoring system – a custom-made variation of the ROADMASTER (monitoring of turnout functions and signals) and installed in 2002 in the main track of the ÖBB, where the traffic density is very high. This installation site (double crossover "Baden" – near Vienna) was chosen so that considerations about the optimized life cycle costs could be verified in practice. The service people shall be on track only twice a year; in the past they had to perform inspection- and maintenance work up to 12 times a year.
Additional installations in the track of the ÖBB followed in Gunskirchen, Upper Austria. In these turnouts, designed for 250 km/h maximum speed in the straight, HYDROSTAR® has been performing with-

Figure 6: HYDROSTAR® in the main track of the ÖBB

Figure 7: HYDROSTAR® MPF, installed, before tamping

out any problems and to the full satisfaction of the operating company (*Fig. 6*).
In 2001 HYDROSTAR® was installed in Germany in a turnout UIC60-1200 (DB AG, Hohen Neuendorf). Also there the system is working reliably, without breakdowns and more or less maintenance free.

3.2 HYDROSTAR® for Moveable Point Frogs (MPF)

To complete the product range and to allow all turnouts of a railroad to be equipped with hydraulic setting devices with optimized life cycle costs, HYDROSTAR® was developed for Moveable Point Frogs too. Preconditions and guidelines were the same as for the switch devices: Modular design, compact assemblies in hollow steel ties, which allow machine tamping, integrated position detection, direct plug in to the interlocking system, high availability and in general extension of inspection- and maintenance intervals.
After the successful period of design validation including load-, vibration and climate tests, the positive functional testing of the prototype was carried out in the workshop. Afterwards the MPF with integrated HYDROSTAR® was installed in the main track of the ÖBB (double crossover Baden – near Vienna), plugged in and immediately put into operation (*Fig. 7*).

3.3 HYDROSTAR® for double slips

The next application of the HYDROSTAR®-concept was for double slips. Because of the excellent field experience of all HYDROSTAR® systems up to now, the high availability and the favourable dimensions – compared to conventional switch solutions – two double slips UIC60 with HYDROSTAR® will be put into service this summer by ÖBB.

4 Outlook

HYDROSTAR® represents a revolutionary switch machine. Some units in service have already significantly improved the situation in regard to availability and reduction of inspection- and maintenance costs. To gain the total savings, smooth extension of the inspection- and maintenance intervals for all local systems and components and integration of hydraulic setting systems and turnout condition monitoring systems in every turnout of a certain section of track is required.
A future of condition-related maintenance concepts without any fixed intervals is thus foreshadowed. Realisation of this potential is conditional upon increasing the reliability of all systems involved and using "state of the art" diagnosis and monitoring systems that provide inspection functions too.

Literature

[1] Dubsky, W.: HYDROLINK, eine innovative Umstellvorrichtung für Weichen. EI – Eisenbahningenieur, 2003, issue 5.

[2] Stornig, G.: SPHEROLOCK® - Experience with a revolutionary locking system. SIGNAL+DRAHT, 2004, Heft 3.

[3] Seidl, K.: VAE ROADMASTER 2000 – "Taiwan High-Speed Rail Project". SIGNAL+DRAHT, 2003, Heft 12.

ZUSAMMENFASSUNG

Der HYDROSTAR®-Weichenantrieb im Einsatz auf Hauptstrecken

HYDROSTAR®, ein innovatives Produkt der VAE Eisenbahnsysteme GmbH (VAEE), ist die integrierte modulare Lösung für Antrieb, Umstellung, Verriegelung und Überwachung der Weiche. Sie wurde im Jahre 2000 erstmals eingebaut und funktioniert seit 2001 bei der DB AG (Deutsche Bahn AG) und seit 2002 auch auf der Hauptstrecke der Österreichischen Bundesbahnen (ÖBB) zuverlässig. Entwicklung, Konstruktion und Fertigung folgen der Strategie aller HYTRONICS-Produkte der VAEE, nämlich Wartungs- sowie Inspektionsfristen zu strecken und somit die Lebenszykluskosten zu minimieren. HYDROSTAR® zeichnet sich durch hohe Zuverlässigkeit, geringen Platzbedarf, einfache Montage und Einstellbarkeit sowie geringen Wartungsaufwand aus.