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THE INFLUENCE OF THE ORIGINAL TECHNICAL CONCEPT AND CONSTANT CHANGES IN PERCEPTIBLE NEEDS ON THE RELIABILITY AND DURABILITY OF MACHINES, INSTRUMENTS AND SYSTEMS IN UNDERGROUND COAL MINING

Summary. The reliability and durability of machinery, instruments and mechanical systems depend in many cases on both the original concept at the beginning of development and the perceptible needs, which change continually during operational use. These two aspects, reliability and durability, are all too often considered only in terms of constructive measures being taken, when single elements of the machinery or instruments are being designed. Rather, a basic concept must be chosen at the beginning of development, the physical and technical principles of which provide for a low level of wear and a favourable spectrum of stress. Otherwise the resulting defects cannot be eliminated by constructive measures in the later stages of development. If the perceptible needs of machinery, instruments and mechanical systems change as a result of such influences as the necessity of interworking with other mechanical components in a close system, the level of reliability and durability decreases. This is due to poor choise of physical and technical principles in the basic concept. The constant constructive adjustment of machinery and instruments to the changing perceptible needs, exhausts the potential for constructive development of the original concept. The transition to a new technology is then necessary. In respect of the technologies currently applied in coal mining this point of transition has been reached. New technologies can now be developed, whose basic concepts have more favourable working principles. The result could be a higher level of reliability and durability. Examples - the elements "chain" and "drive" as system components at the "armoured face conveyor" in the Longwall face system - are included to illustrate these considerations.

1. INTRODUCTION

By means of specially chosen examples from the area of Longwall face, I would attempt to demonstrate several basic interrelations which are unfortunately not ascribed their due importance when assessing the reliability and durability of machinery, instruments and whole systems. Two examples, which will be presented in precise detail, are the mechanical system elements "chain" and "drive head". These are applied in diverse ways in all of our Longwall conveyors and plough systems.

I would draw your attention to interrelations concerning the reliability end durability of machinery, instruments and mechanical systems. They are subject to both the original concept at the beginning of development, and the perceptible needs, which change continually during operational use (fig. 1). The constant demand for a high level of reliability and durability contributes to the perceptible needs. i.e. the sum of all requirements to which machinery or a mechanical system is subject at any given time. Unfortunately, these two aspects, reliability and durability, which are especially important for successful operation, are all too often chiefly considered, or rather, exclusively considered, in terms of constructive measures being taken, when single elements of the machinery or instruments are being designed. Decisions for physical and technical principles are made at the beginning of development, during the establishment of the basic concept. These principles, by reason of their essential working concept, frequently result in a high level of wear and an unfavourable spectrum of stress. They thus provide for only limited reliability and durability, even in their original conception. These basic defects cannot be completely eleminated by effective and constructive design in the later stages of development. They can at best be moderated. Furthermore, the overall perceptible needs to which a machine, instrument or system is subject, change continually during development. These changes result from such influences as the necessity for interworking with other mechanical components in a closed system; the demand for increased efficiency; changes in working conditions and fields of application; the necessity for an intensified environmental protection program. These changes all first occur during development.

A first conclusion can already be drawn from the aforementioned interrelations: the necessity for realisation of a high level of reliability and durability must be taken into account at each single stage of development. Thies applies as much to the initial stage of establishing the basic concept, as to the later stages of constructive design and further development. Neglect in the initial stages cannot be compensated for by constructive measures and improvements during the later period of implementation of a particular technology. This means that basic limitations to reliability and durability exist over a period of possibly 20 to 30 years or more. In order to moderate the damaging effects of these limitations, considerable and constant additional technical effort is necessary.

The chain conveyor, which was not originally designed for fully mechanized Longwall face, is an especially good example for discussion of these interrelations. It is based on a working principle of gliding friction between the chain assembly and the transported material, on the one hand, and the conveyor pan on the other hand. This working principle has the drawbacks of a high level of wear, and of being specific energy intensive. These limitations cannot be eliminated, even by successful constructive formulae. It is unfortunately impossible to replace the chain conveyor with a conveying device with rolling friction and therefore less abrasion. This is due to the fact that the connections between the mechanical components of the Longwall system, to which I shall return at the conclusion of my presentation, is currently very rigid. As a further example, I would refer to mechanised road driving with selective cut heading machinery. In terms of the original concept, it would only be necessary to extract the bad rock, by the current method, cut and light-sized, at the very extremes of the roadway, in order to produce an outer contour conforming exactly to the shape of the roadway support (fig. 2). In the middle area of the roadway, the heading face could be extracted in a coarse state. This would involve considerably less wear on the mining equipment and a lower level of specific energy input. Moreover, such a method would have the advantage of allowing the roadway support to be brought into the "slotted contour" early enough to reduce support lag. This is extraordinarily important for the further stability of the gangway. Any number of this type of example could be demonstrated. This is unfortunately not possible here, due to lack of time. However, I hope that these two examples have demonstrated the fundamental importance of the relation between the physical-technical working principle chosen for the original concept, and the reliability and durability of the machinery built on this principle. The measures descibed here are basic to, and particularly effective for, increasing the reliability and durability of machinery and mechanical systems. These measures can however only be successful if a transition is made from one technology to another, essentially different, technology. i.e. at the so-called "turning points of development". Many of the machines and instruments currently being used in the area of Longwall face, are either close to, or have already reached, the limit of their developmental potential. It will thus be necessary to transfer to basically new technologies in many areas in the next ten to fifteen years. This will allow for the aforementioned and farreaching influence on reliability and durability.

The second interrelation to be demonstrated, is that between the constantly changing perceptible needs of a particular technology during its period of operation, and the corresponding levels of reliability and durability. Every new concept, idea or invention has only a limited constructive potential for development. At the time of original conception, it is impossible to assess the course which the later development of this potential will take. This is due to alterations in the perceptible needs.

For reasons already mentioned, additions to the perceptible needs of a technology can become evident during its period of implementation. These additions can result in additional taxing and wear on components which are especially heavily stressed. Through specific constructive measures and additional technical effort, achievement of the original, or possibly even a higher, level of reliability and durability must then be ensured, despite adjustments to these new demands. Sooner or later the limit to the potential for development is reached. This occurs as a result of the constantly increasing string of changes in the perceptible needs, and the consequent adjustments achieved by constructive measures. The disadvantages arising from these adjustments eventually outweigh the advantages, especially when the changing perceptible needs of other connected areas are also catered to. At this point, the potential for constructive development of the original concept is exhausted. The approaching of this point must be recognised, allowing a substitute technology to be found before the point is reached. This ensures that when the transition to the new technology is necessary, it can take place in a clear and workable period of time. In respect of the technologies currently applied in coal mining, it seems to be especially difficult to recognise the approach of this point of exhaustion of a concept and to take the consequent steps.

Using the mechanical system elements "chain" and "drive head" as examples, I would now demonstrate in exact detail how a new concept can lead to a far-reaching increase in reliability and durability. The two approaches presented in this context are at the present time only concepts. A trial of these concepts has not yet taken place. Therefore, no proof is available in terms of reliability and durability.

2. THE ELEMENT "CHAIN"

Round-link chains were originally developed, in ancient times, for transmitting static forces. They are therefore in terms of their basic concept not suitable for power transmission. They were used to shackle unpopular members of society, or to chain them to dungeon walls. In terms of the chains function, this was exclusively transmission of static force. A prerequisite for power transmission, is that the pitches of chains and chain sprockets remain exactly congruous over long periods of time. This must be achieved irrespective of the type of stress on the chains, as long as the planned maximum load is not reached. Although round-link chains were all too often used for the aforementioned purposes in the Middle Ages, noboby thought to use them for power transmission. The impressive writings of Agricola and other authors, show how cable and cable pullies were used for this purpose; power transmission resulting from friction grip. In 1829 the Frenchman Andre Gall invented the flat-link chain, involving a closing shape transmission of power on a moving belt line. The flat-link chain connot, however, be used in Longwall conveyor and plough systems. This is due to the necessity for a particular extent of three-dimensional flexibility. A multitude of operational experiments have proved that application of the flat-link chain in these areas is impossible. Round-link chains must thus be used for power transmission, although unsuitable for this purpose in terms of their original concept. This drawback heavily impairs reliability and durability. Its damaging effects could, however, be moderated by creating a highly-developed production technique, and obtaining and fully utilizing the correspondingly high-grade raw materials. However, the durability of chains and sprockets in plough systems and armoured face conveyors is in many cases unsatisfactory. This shows that round-link chains, despite technological improvements, can at best be termed "suitable only to a certain extent for power transmission" (fig. 3 below).

The development of the chain for the armoured face conveyor began with 18 mm/0 steel bar chain links and 22 mm links were used for the "Löbbe" plough, with a corresponding weight of 9.5 kg/m. In order to cater to requirements relating to reliability and durability, on the one hand, and on the other hand, to make adjustments to the continual changes in perceptible needs, in terms of efficiency, the size of the chain links had to be increased to 38 mm. This resulted in the weight being increased to 30 kg/m. This represents 3.15 fold rise in dead weight movement, resulting in increased wear and specific power requirement, for the coal plough. This example shows that the principle drawback of round-link chains, i.e. their being unsuitable for power transmission, can only be compensated for by additional technical effort and acceptence of considerable handicaps. e.g. limited durability, increase in dead-weight movement, and increase in the specific power requirement. Moreover, the increased specific power requirement results in a considerable rise in the heat resulting from energy losses. This is especially disadvantageous in deep mines, where air cooling systems are installed.

In the attempt to find a new basic concept for the round-link chain, whereby power transmission is catered to, and therefore a higher expectation of reliability and durability is provided, the cause must be found for the slow but ever-increasing difference between the pitches of chains and chain sprockets during operation. One essential cause is the occurence of permanent expansion of the round-link chain after a lengthly period of implementation. This expansion occurs chiefly (fig. 3 above) in radial deformations of the curved parts of the links (marked in red) i.e. where power is transferred from the sprockets to the chains. The expansion of single sections of the chain is not uniform over the total chain strand, especially in the stripping coal winning method. This is due to the fact that not only the base load and repetitive stress, but, more importantly, also blockings, especially when they occur near the drive end, can all lead to considerable changes in the shape of the respective links. The contact surface of the chains in the pockets of the sprockets is greatly reduced by radial deformation. This results in overloading and premature wear of chains and sprockets.

More importantly, however, expansion of the pitches of the chain can lead to the links no longer fitting into the pockets of the sprockets. This frequently occurs after a relatively short period of operation. Chains and sprockets must then be replaced, and this is a labour intensive procedure. It would not suffice to replace only the chains or only the sprockets, because deformed or worn chains do not fit into new sprockets and vice versa. Roughly three quarters of the total chain stretch takes place in the radial deformations in the curved ends of the links (marked in red) and about a quarter in the elongation of the parallel arms (marked in blue).

In order to develop a new chain concept, specialising in the requirements of power transission (fig. 4, marked in yellow), the curved ends must be reinforced in such a way, that the bending stress resulting from expasion equals or is less than the expasion in the parallel arms of the links. Such a chain cannot of course be manufactured from cable, and employing the production methods used to date. Power transmission nead no longer take place through the pockets of the sprockets, which are complicated to produce and wear easily. Rather, it could take place through the gripping teeth outside on the flanks of the broadened courved ends, with a minimum of wear. Moreover, the size of the radii can be increased where the transmission of static force takee place, in order to reduce wear during power transmission through the sprockets. This can be seen in the side-view of the link shown (marked in green).

If, by this means, the expansion of the chain is greatly reduced and the intake and power transmission procedures at the sprockets are more favourable, a higher level of reliability and a considerably higher level of durability of chains and sprockets can be espected. This would in turn justify the increased cost of production of the chains. Even if the increase in durability only corresponded to the increase in production costs, savings would still be made, because of the considerable decrease in the replacement and transport costs of chains and sprockets.

If the links were no longer made of cable, abrasion-proof materials could be used, which are currently impracticable for reasons of weldability requirements (fig. 5). Manganese steel could then be used for the horizontal links, to which the power in the sprockets is transmitted. Years ago, manganese steel casts already proved extraordinarily good as ends in the pans of the face conveyor. This is due to the fact that lasting deformations resulting from extreme mechanical overloading, increase the hardness and the wear resistance of the manganese steel surfaces.

This occurs without reducing the toughness necessary under dynamic stress. Experience over many years and in many working areas, justifies the conclusion that the use of manganese stell in the manufacturing of horizontal chain links, provides a number of considerable advantages.

At the present stage of developmetal work, no definite statements can be made about operational suitability and proof of worth. Research using developmetal working methods can only predict a forseeable realisation of the aforementioned advantages. For this reason, a test rig has been developed and recently put (fig. 6) into practice at the Institute for Mining of the Technical University of Rheinland-Westfalen, wherby comparable experiments on insert behaviour are possible. These allow conclusions to be drawn about power transmission on various types of chains. The type of work being done at this stage could be called "kinematic inversion" of the insert and run-out behaviour of round-link chains and sprockets. This consists of two swivelling arms into which load cylinders are fitted. A short chain strand is chucked between the cylinders. All motion, as well as the static forces which are distributed from the cylinder to the chain strand, can be controlled by a programmed computer. This is done in such a way as to make possible an extensive adjustment of the insert procedure and the external stress levels, to the conditions occuring underground. This is done in relation to the level of static force and the overlaid oscillation. The same link runs costantly into the one pocket, so that wear which would normally occur only after months of underground operation, occurs after a relatively short period of experimentation. In the course of a dissertation currently being prepared at my Institute, different constructions of round-link chains and sprockets, as well as the new type of chain described hare, are being investigated and compared in terms of their reliability and durability.

3. THE ELEMENT "DRIVE"

In most cases outside the field of coal mining, electric or hydraulic variable speed drives are used for full-load start operations, when the prime mover and the operational machinery have to be started, or accelerated to high speeds. This is because couplings or gearboxes cannot be used, due to the characteristics of the drive head or the dimension of power transmission. However, the relation between torque and number of revolutions can easily be adjusted to full-load starting. In many mining branches, especilly coal mining, only asynchronous three-phase squirrel-cage induction motors can be used. This in necessary because of flame proof protection and the high level of power to be transmitted. However, these motors have a steep branch between stalling torque and no-load speed and are not characteristically qualified with full-load start operational machinery.

The starting and operating of plough systems and chain conveyors, especially of the types used in the Longwall system, are more problematic than starting "normal" full-load start operating machinery. This is due to the fact that high initial break-away torque is necessary when starting the conveyor, if clayey material is being conveyed or after a long shut-down period. e.g. the weekend. Also in plough systems, blockages up to shut-down can occur as a result of which the drive head's moment of inertia is fed into the chains. This happens because expansion has reduced the chains' working capacity. Blockages, especially when they occur near the drive head, lead to overloading, stress peaks, broken chains and a considerable diminishing of the durability of chains and gear boxes.

At the beginning of development, the drive power for plough systems and chain conveyors in the Longwall system was 40 kW and later 60 kW and 80 kW per drive head. At that time it was normal that flaws in the working of ploughs and Longwall conveyors, which were due to the characteristics of asynchronous three-phase squirrel cage induction motors, be moderated by the use of hydraulic couplings. This mainly resulted in increased reliability and durability of chains. During further development, the economic necessity of concentrated workings in as small an area as possible led to a continual rise in drive power and to a transfer to increasingly stronger chains. A total drive power of 400 kW or 500 kW is no longer the exception in coal ploughs and Longwall conveyors. 30, 34 and 38 mm chains are also in use. A considerable increase in durability and reliability would be expected from the change to stronger chains. This was however largely counteracted by the concurrent increase in drive power requirements. For this reason, it is of urgent necessity that drive power systems be developed, which have a chain-protective starting function, and which provide better overload protection. These developments are necessary in order to attain a higher level of reliability and durability for the same power input. Hydraulic drive heads were tested twenty years ago for use in coal plough systems and Longwall conveyers. They have been used in several areas for lengthy periods of time. In terms of the ever-increasing power requirements, however, they have not been completely accepted. This is because of their unfavourable degree of efficiency and the subsequent production of additional heat during extended periods of operation.

In most cases, the pole-changing motor provided a relative reduction of 3 : 1 in rotational speed and speed of the chain assembly. On its introduction it quickly received widespread use, up to a point where it is nowadays exclusively used in this type of drive head in the Federal Republic of Germany. These motors made possible a reduction in the speed of the chain assembly during starting. This however did not result in higher torgue, because power also decreased in accordance with the gearing down to a lower number of rotations. Hydromechanical clutches are also incompatible for use in pole-changing motors. The stress on the chain was thus considerably increased during the starting phase, load fluctuations and blockages. Mechanical safety couplings, such as the shear pin coupling and the star bolt coupling, found widespread use as overload protection. On the one hand, these couplings limit the stress peak. They lead, however, to additional problems and costs on the other hand.

On application of a procedural method which I developed in order to find new concepts for the aforementioned problems, a new and unconventional drive head system has been found. This system is better geared to the requirements of starting, extensive operation, and overloading of plough systems and Longwall conveyors. Moreover, the system provides better protection for drive head elements and chains. The new drive head system is comprised of known technological components. i.e. a planetary transmission with two sun wheels, two sets of planetary gears and two revolvable internal gears, of a normal epicyclic gear, of a hydraulic switching unit, and of a small, very simple microprocessor, with the corresponding sensor. This combination, because of the physical-technical working principle already embodied in the original concept, makes realisation of the demand for a high level of reliability and durability possible.

The drive head system (fig. 7) essentially consists of a normal asynchronous three-phase squirrel-cage induction motor and a two-stage planetary transmission. In the first epicyclic wheel stage, two sun wheels and two sets of planetary gears are fitted. It is possible in such a system to insert a hydrodynamic coupling between the motor and the gearbox, as a means of increasing reliability and durability. The two sun wheels and sets of planetary gears at the first gear level have differing transmissions ratios. This allows any number of speed ratios, no only 3 : 1, without having to use a pole-changing motor. The required transmission ratio can be set by blocking one of the revolving internal gears with the brakes, which grip from the outside. Sensors in the stump shaft of the motor, or rather, in the revolving internal gears, allow the relevant number of revolutions and, more importantly, changes in the number of rotations depending on time, to be attained extraordinarily quickly. If four sensors are fitted on the stump shaft of the motor, all set at 90°, the number of revolutions on each motor is measured every 10 msec. In the accumulator, the instantaneous number of rotations is compared to the characteristic of the drive head motor. When particular levels are reached, the number of revolutions is switched to the corresponding level of speed.

Such a system makes possible low speed and high torque starting, followed by automatic switching to a higher speed. When loading is increased slowly, the system switches down to a transmission level with a lower speed, at exactly defined load levels. When the load rises quickly, as happens when blockages occur, the internal gear which immediately locks is released, without the other being stopped. This function provides overloading protection, so that the system does not require shear bolts or star bolt couplings. The brakes (fig. 8) for clamping the revolving internal gears are moved by a hydraulic system, consisting of brake cylinders, electrohydraulic pilot valve, and a hydraulic accumulator. The hydraulic system can for example be connected to the hydraulic Longwall circuit for Longwall face support. The hydroaccumulator guarantees further gear changes, even when the hydraulic pressure in the Longwall line collapses.

In order to guarantee perfect lubrication (fig. 9) of the whole transmission, and constructive sealing of the trransmission case, the internal gears of the respective transmission ratio must be reinforced. This does not occur at the gears themselves, but rather at the disc brakes, which are situated outside the gearbox and connected to the internal gears by an additional gearwheel transmission.

The new type of drive head system described here can also be used to advantage when plough and conveyor chains are being joined. The risk of accidents decreases considerably, and reliability is simultaneously increased, without additional constructive effort. The drive head system (fig. 7) can be run at very slow speed when the chains are being joined. This can be done by maintaining rotation of the internal gear, which is associated with the lower transmission ratio. i.e. the higher chain speed. This is achieved by releasing the corresponding brake. The brake associated with the internal gear for the higher transmission ratio must also be applied lightly, enabling the internal gear to slip at a controlled rate of rotation. By this means, and controlled by the bearing pressure of the brakes, the system can be run at every required chain speed between zero and the speed corresponding to the highest transmission ratio. By sensitive changing of the bearing pressure of the brakes it is possible to exactly adjust the speed to the type of operational sequence, while the chains are being joined. The power which is transformed into heat between the internal gear and the lightly-applied brake, is negligible, because the amount of power required for the joining of the chains is equaly small.

Because the pole-changing motor and the safety clutch need no longer be used, DM 70.000 per drive head are saved for every 160 kW of power input. This means, for example, a saving of DM 280.000 for a plough face with four heads (two for the conveyor and two for the coal plough). Through the essentially new basic concept of the drive head system, arises not only a considerable increase in reliability and durability, but moreover, a notable saving in costs. In the course of a dissertation being carried out at my Institute, the drive head system presented here is to be developed to the stage of readiness for operational implementation.

4. CONNECTING OF THE COMPONENTS IN THE MECHANISED LONGWALL FACE SYSTEM AND ALTERATION TO THE INTERFACE BETWEEN THE COMPONENTS

In the course of considering developmental methods, the attempt should be undertaken to see the interaction of the winning machine, the Longwall conveyor and the Longwall face support system (fig. 10), i.e. the three components of the system, no longer in terms of the points of interaction which have until now, as a result of their historical development, been taken into account, but rather, in more flexible terms. Not only the obvious working methods of the three components, but also their functions, should be taken into account here. It would then be possible to disentangle the rigidly assembled mechanised Longwall system. A multitude of possibilities for solutions leading to new technologies would thus arise. These would be considerably more advantageous than the currently used models have proved to be, in terms of reliability and durability. The winning machine component has the prime function of "cutting and loading", the Longwall conveyor has the prime function of "conveying the loaded material" and the Longwall face support system component has the prime function of "keeping the face open and safe". The distinction between these prime functions has however become a little blurred in the Longwall technology currently in use. This is because loading, both with the plough and the shearer loader, can only take place with the support of the side wall of the conveyor, or a ramp attached to the conveyor. This means that the dimensions of the conveyor have to be kept as low as possible. The result of this, in terms of the distribution of functions, is that a changeover to a conveyor based on the principle of rolling friction is impossible.

The reason for the three components winning machine, Longwall conveyer, and Longwall face support system having taken on such a rigid from during the course of their development is not however, to be found in their chief functions. The type and rate of the connections in the system, as well as the points of interaction, which are secondary functions of the system, determine a great deal more in this context. This applies in particular to the Longwall conveyor. If the essential aspects of the Longwall conveyor's secondary functions were transferred to the other two system components, and if the prime function of loading were exclusively applied to the winning machine and not, as is nowadays usual, also partly applied to the Longwall conveyor, the Longwall system would no longer be so rigidly bound (fig. 11). By this means, a changeover could be made to a winning machine working double-sided to the buttock, and with a greater depth of extraction, e.g. 1.5 to 1.8 metres. The winning machine would have its own loading system and would transfer the concentrated production flow to the Longwall conveyor at a definite height. A Longwall conveyor constructed completely differently, on a principle based on rolling friction, could then be used as a system component. Because of the resultant lower level of wear, a high level of reliability and durability would automatically be reached in this component. In such a system the Longwall face support system would be equipped with slide bars, in the ends of which extendible props would be fitted. This would allow the roof strata at the coal bench to be supported with a high level of force (ca. 350 kN), after the upper wall has been exposed. These alterations to components of the Longwall face support system, would also have an advantageous effect on reliability and durability.

By means of the two examples "chain" and "drive head", I have attempted to demonstrate how extraordinarily important it is that the basic requirements for reliability and durability be accorded precedence in the development of original concepts for new technologies. These measures áre much more effective in terms of the subsequent design of machinery and instruments. I hope to have succeeded in creating an awareness of the changes in technology which will be necessary in this context in the next ten years. If so, I consider the aims of this lecture to have been achieved.

Recenzent: Prof. z-. dr hab. inż. Jerzy ANTONIAK

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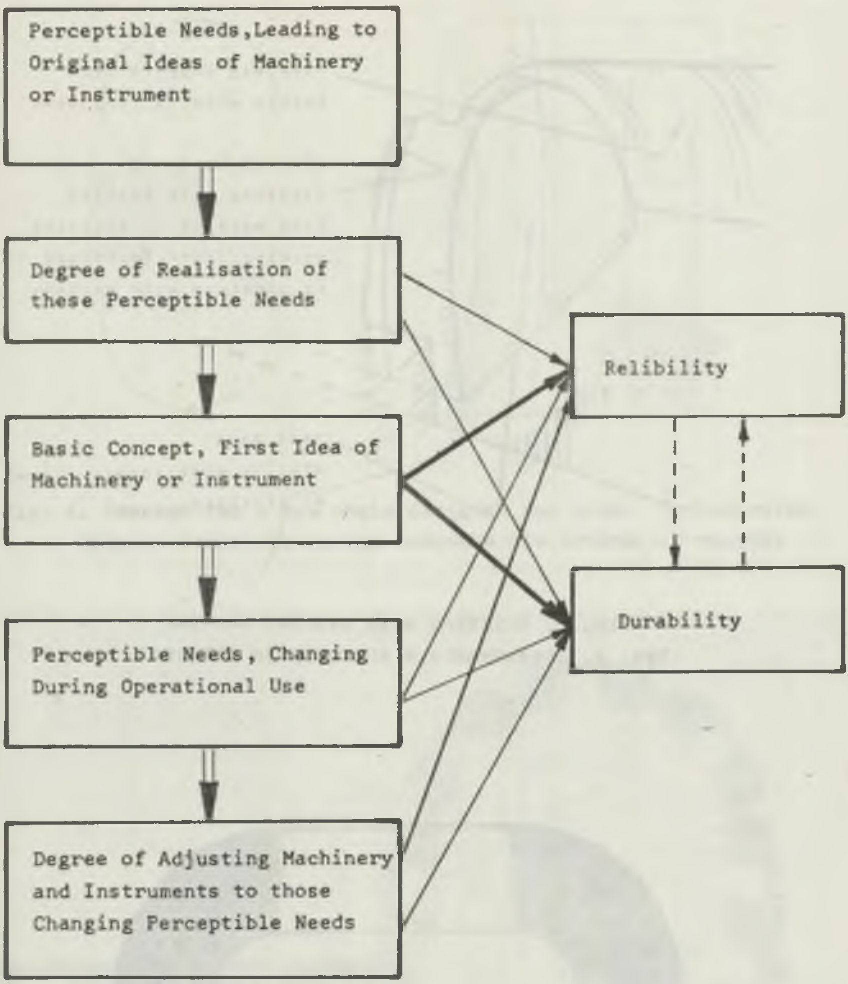

Fig. 1. Interrelation of original concept, changes in perceptible needs during period of operation, and constructive design, on the one hand, and durability on the other hand

Rys. 1. Wzajemne powiązania wstępnej koncepcji, zmian wymagań eksploatacyjnych oraz projektowania i z drugiej strony niezawodności i trwałości

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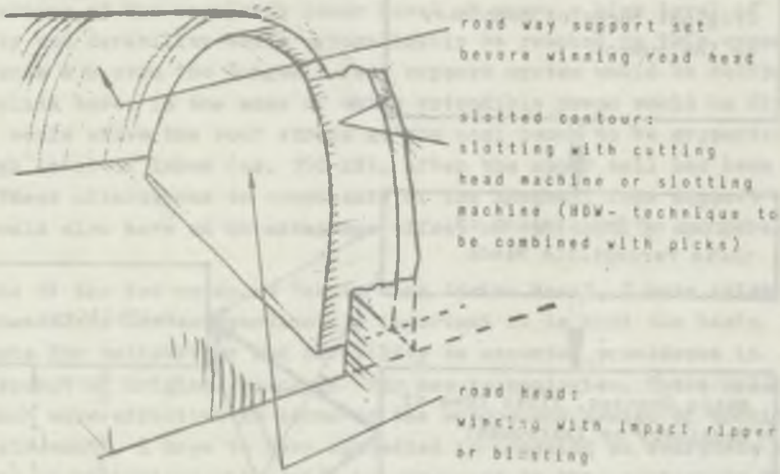

Fig. 2. Drifting with slotted contour
Rys. 2. Przesuwanie z zawrębionym konturem

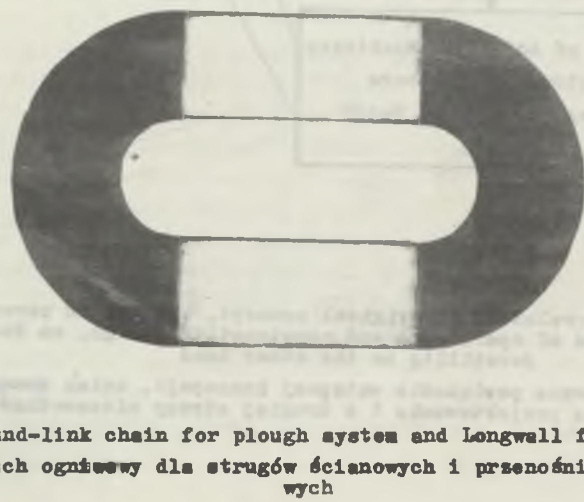

Fig. 3. Round-link chain for plough system and Longwall face conveyor
Rys. 3. Łańcuch ogniwowy dla strugów ścianowych i przenośników zgrzebłowych

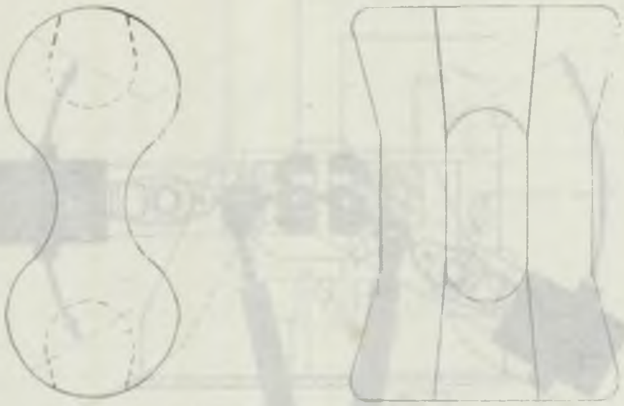

Fig. 4. Concept for a new chain designed for power transmission
Rys. 4. Koncepcja nowego łańcucha dla transmisji energii

Fig. 5. View of the new chain for power transmission
Rys. 5. Widok nowego łańcucha

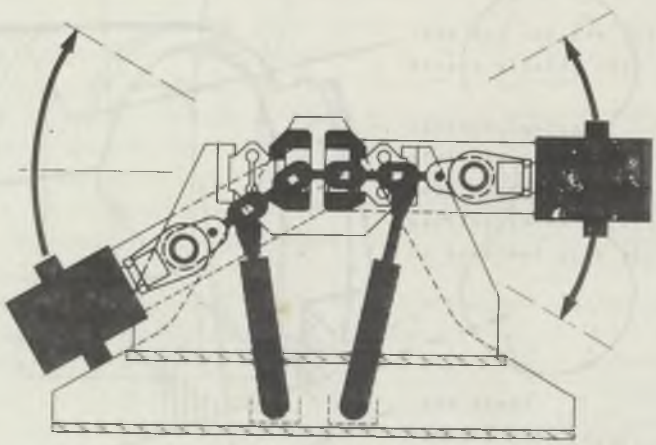

Fig. 6. New type of chain test rig for comparative investigations of durability

Rys. 6. Stanowisko do badań łańcuchów a w szczególności ich trwałości względnej

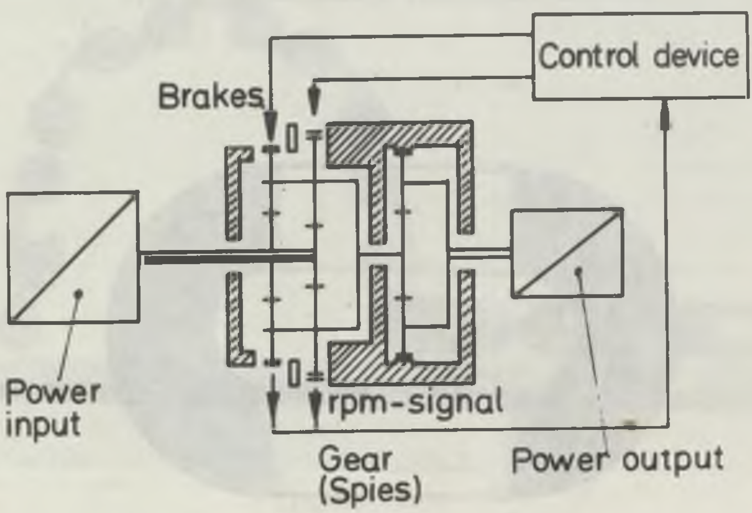

Fig. 7. New type of drive head system with two speed levels and integrated protection against overloading

Rys. 7. Nowy napęd z dwoma prękościami i zainstalowanym zabezpieczeniem przed przeciążeniem

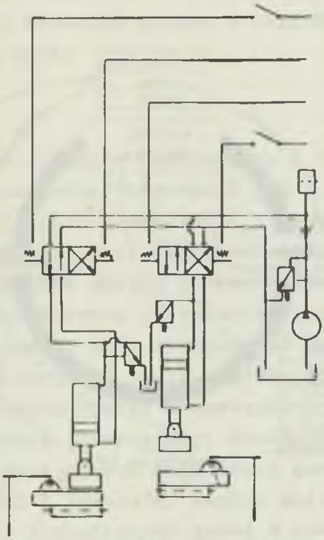

Fig. 8. Circuit diagram for hydraulics in the new gear box
Rys. 8. Schemat układu hydraulicznego dla nowej przekładni

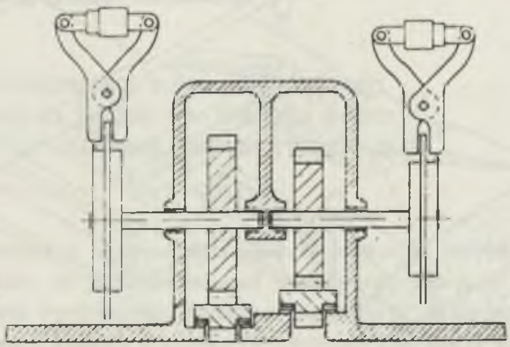

Fig. 9. Concept for the fitting of the breaks in the new gear box
Rys. 9. Usytuowanie hamulców na skrzyni biegów

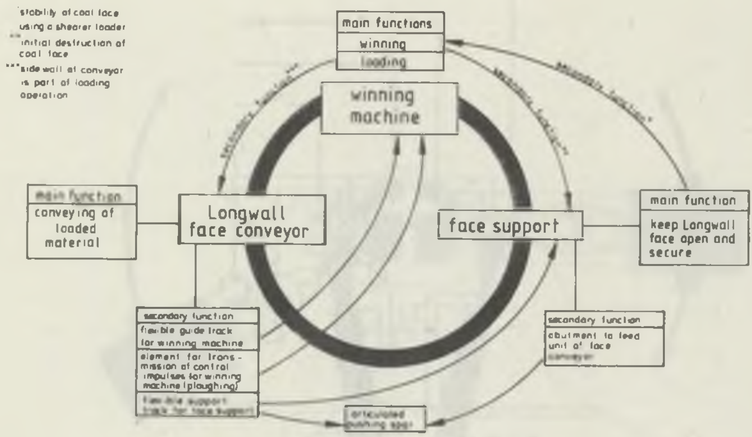

Fig. 10. Primary and secondary functions of the three components of the Longwall face system

Rys. 10. Pierwotne i wtórne funkcje trzech komponentów systemu ścianowego

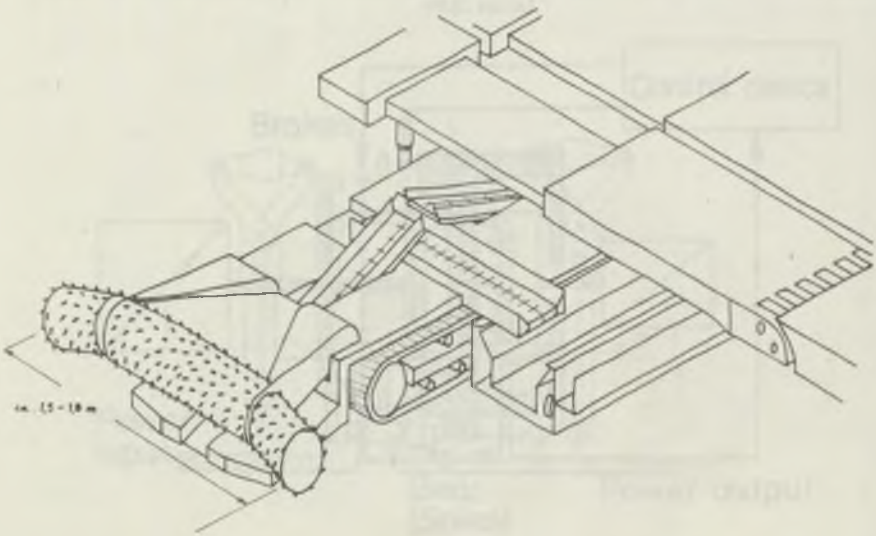

Fig. 11. Concept for a new machinery technology in Longwall face mining

Rys. 11. Koncepcja nowego systemu maszynowego dla urabiania ścianowego

WPŁYW PIERWOTNEJ KONCEPCJI TECHNICZNEJ ORAZ BIEŻĄCYCH ZMIAN WYMAGAŃ NA NIEZAWODNOŚĆ I TRWAŁOŚĆ MASZYN I SYSTEMÓW W PODZIEMNYCH KOPALNIACH WĘGLA

S t r e s z c z e n i e

Niezawodność i trwałość układów maszynowych i systemów zależą w wielu przypadkach zarówno od pierwotnej koncepcji jak i bieżących zmian wymagań eksploatacyjnych. Pojęcie niezawodności i trwałości zbyt często łączy się tylko z przedsięwzięciami konstrukcyjnymi podjętymi na etapie projektowania pojedynczych elementów maszyn i przyrządów. To raczej podstawowa koncepcja powinna być rozpatrywana na początku procesu rozwoju konstrukcji a fizyczne i techniczne zasady mają gwarantować niskie zużycie i korzystny rozkład naprężeń. W przeciwnym razie występujące defekty nie mogą być eliminowane metodami konstrukcyjnymi w następnych etapach rozwoju. Jeżeli wymagania stawiane maszynom, przyrządom i systemom maszynowym zmieniają się w rezultacie zaistnienia nowych wzajemnych powiązań z innymi systemami,to poziom niezawodności i trwałości zwykle maleje. Jest to wynikiem złego doboru fizycznych i technicznych zasad w koncepcji bazowej. Ciągłe dopasowywanie poprzez zmiany konstrukcyjne maszyn do zmieniających się wymogów wyczerpuje potencjalne możliwości rozwoju w koncepcji pierwotnej. W takim przypadku przejście do nowej technologii jest niezbędne. W odniesieniu do technologii obecnie stosowanej w górnictwie węglowym ten punkt transformacji został osiągnięty. Nowe technologie, będące w rozwoju powinny się charakteryzować lepszymi zasadami pracy. Wynikiem powinna być lepsza niezawodność i trwałość. Przykłady przedstawione dla ilustracji ww. podejścia do problemu to "łańcuch" i "napęd" jako elementy przenośnika zgrzebłowego w systemie ścianowym.

ВЛИЯНИЕ ПЕРВИЧНОЙ ТЕХНИЧЕСКОЙ КОНЦЕПЦИИ И ТЕКУЩИХ ИЗМЕНЕНИЙ ТРЕБОВАНИЙ НА НАДЁЖНОСТЬ ДЕЙСТВИЯ И СРОК СЛУЖБЫ МАШИН И СИСТЕМ ПОДЗЕМНЫХ КАМЕННОУГОЛЬНЫХ ШАХТ

Р е з ю м е

Надёжность действия и срок службы системы машин и систем вообще во многих случаях зависят как от первоначальной концепции, так и от текущих изменений эксплуатационных требований. Понятия надёжности действия и срока службы очень часто связывают только с конструкторскими работами, предпринятыми на этапе проектирования отдельных элементов машин и приборов. Основная концепция должна рассматриваться в начале процесса развития конструкции, а физические и технические принципы должны гарантировать низкий износ и благоприятное распределение давлений. В противном случае появляющиеся дефекты невоз-

можно будет устранить конструктивными методами на последующих этапах развития. Если же требования, предъявляемые машинам, приборам и системам машин, изменяются в результате появления новых взаимосвязей с другими системами, то уровень надёжности и срок службы обычно уменьшаются. Является это результатом неправильного подбора физических и технических принципов в базовой концепции. Постоянная подгонка к изменяющимся требованиям при помощи конструкторских изменений машин исчерпывает потенциальные возможности развития первичной концепции. В таком случае переход к новой технологии является необходимым. Относительно технологий, применяемых в настоящее время в горном деле, этот пункт трансформации достигнут. В настоящее время должны развиваться новые технологии, определяющие лучшие принципы работы. Результатом должны быть повышенные надёжность действия и срок службы.

В качестве примеров вышеназванного подхода к проблеме являются представляемые "цепь" и "привод" как элементы "скребкового конвейера" в системе лавы.