



ENGINEERING BULLETIN

Vol.32 No. 02

The Institution of Certificated Mechanical and Electrical Engineers South Africa MARCH 2023

MISSION STATEMENT: 1. To uphold the image and status of the Certificated Engineer. 2. To represent the Certificated Engineer at ECSA and other decision-making bodies concerning legislation, safety & health standards, the environment and the machinery regulations. 3. To promote continued education and training of its members and future engineers. 4. To promote fellowship in the engineering profession.

EDITORIAL

Welcome to the latest edition of the ICMEESA News Bulletin

We present our second quarterly news Bulletin of 2023.

Thank you to all of you who responded to the email calling for attention to the need to register as Pr Cert Eng as well as for volunteering to become an assessor in the process of Pr Cert Eng applications.

It is always good to receive feedback from members in whatever format or content.

Let me know what is on your mind and we can see whether I can assist to solve the problem. Remember, we have a large group of like-minded members on this group.

Since the last News Bulletin we sent out a set of Statements of account to members. Thank you to those of you who took note and paid membership fees for 2023. There is still a fairly large number of members who have not as yet paid their fees.

PLEASE pay your fees as it keeps the Institution liquid.

In this bulletin, we present our normal GCC examination questions and answers for Factory and Mining.

There are also a few links to Energize and Motion Control publications in a separate article.

Part three of the paper entitled "Multi-rope Winding from Deep Levels" by Mr. R Blair. The paper was published in the 1957 edition of the Journal of the Certificated ENGINEERS, South Africa.

I trust that you will find the content of this news bulletin interesting enough to pass on to your colleagues and friends.

Till next time!!!

Chris Schnehage

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Links for technical publications.

Included in this bulletin are two links to publications that may be of interest to members. Should you wish to subscribe to regular publications, please contact the publishers directly.

Energize Issue 11 of 2023

Energize Issue 12 of 2023

Motion Control is also a publication that is interesting for the mechanically and electrically orientated engineers. Available at no cost, but you need to register.

[Motion Control](#)

Plant Engineering: MINES mechanical question

QUESTION

A three-phase line 3 km long delivers 3 MW at a power factor of 0,8 lagging to a load. If the voltage at the supply end is 11 kV determine the voltage at the load and the efficiency of transmission. The resistance per km of each conductor is 0,4 Ω /km and the reactance (line to neutral) per km of each conductor is 0,3 Ω /km. Assume the power factor is the same at the input end as at the load.

[10]

Proposed Solution:

$$\text{Power per phase} = \frac{3 \times 10^6}{3} = 1 \text{ MW}$$

$$\text{Load voltage to neutral} = \frac{11 \times 10^3}{\sqrt{3}} = 6351 \text{ Volts}$$

$$\text{Current per conductor, } I = \frac{1 \times 10^6}{6351 \times 0.8} = 196,82 \text{ Amperes}$$

$$\text{Resistance per conductor } R = 0,4 \times 3 = 1,2 \text{ Ohms}$$

$$\text{Voltage drop, } V = IR = 196,82 \times 1,2 = 236,18 \text{ Volts}$$

$$\text{Reactance per conductor } X = 0,3 \times 3 = 0,9 \text{ Ohms}$$

$$\text{Voltage drop} = IX = 196,82 \times 0,9 = 177,14 \text{ Ohms}$$

$$\cos \varphi = 0,8 \text{ -- therefore } \varphi = 36,87^\circ \quad \sin \varphi = 0,6$$

Voltage to neutral at the sending end

$$\begin{aligned} E &= \sqrt{(ER \cos \varphi + IR)^2 + (ER \sin \varphi + IX)^2} \\ &= \sqrt{(6351 \times 0,8 + 236,18)^2 + (6351 \times 0,6 + 177,14)^2} \\ &= \sqrt{5316,98^2 + 3987,74^2} \\ &= \sqrt{28270276 + 15902070} \\ &= \sqrt{44172346} \\ &= \mathbf{6646,23 \text{ Volts}} \end{aligned}$$

$$\text{Voltage between phases} = 6646,23 \times \sqrt{3} = 11511,27 \text{ or } 11,511 \text{ kV.}$$

$$\begin{aligned} \text{Power at the sending end} &= \sqrt{3} EI \cos \varphi \\ &= \frac{\sqrt{3} \times 196,82 \times 11,511 \times 0,8 \times 10^3}{10^6} = 3,139 \text{ MW.} \end{aligned}$$

$$\text{Efficiency of transmission} = \frac{\text{Output}}{\text{Input}} = \frac{3}{3,139} \times 100 = \mathbf{95,57\%}$$

A Legal Knowledge: MINES question

QUESTION (November 2017, Question 1 - Actually written in JANUARY 2018):

You are the employer at a mine and are required to staff the mine with due regard to health and safety in terms of Section 7 of the Mine Health and Safety Act.

To ensure compliance to the Act how are you going to do this?

[10]

Proposed answer

7. (1) To the extent that it is reasonably practicable, every manager must –

- (a) **ensure that every employee complies with the requirements of this Act;**
 - (b) **institute the measures necessary to secure, maintain and enhance health and safety;**
 - (c) **appoint persons and provide them with the means to comply** with the requirements of this Act and with any instruction given by an inspector;
 - (d) consider an **employee's training and capabilities** in respect of health and safety before assigning a task to that employee; and
 - (e) ensure that **work is performed under the general supervision of a person trained to understand the hazards associated with the work** and who has the authority to ensure that the precautionary measures laid down by the manager are implemented.
- (2) A manager **may appoint any person with qualifications as may be prescribed to perform any aspect of the functions assigned to managers by this Act.**

Plant Engineering: FACTORIES Electrical question

QUESTION (November 2022 – Question 2.1):

A 25 kVA single-phase motor has a power factor of 0,8 lag. A 10 kVA capacitor is connected for power factor correction.

Calculate the input in kVA taken from the mains, its power factor and sketch a phaser diagram for each case when the motor is:

- 2.1.1 on half load (6)
- 2.1.2 on full load. (5)

Suggested Answer:

The questions seems to incorrectly state that the capacitor is 10 kVA – it only has a vertical component and one assumes that it can be written as 10 kVAR

Given: $S = 25 \text{ kVA}$, $\text{pf} = 0.8 \text{ lagging}$, $Q_{\text{cap}} = 10 \text{ kVAR}$

Power Factor, $\text{p.f.} = 0.8 = \cos \theta \therefore \theta = \cos^{-1} 0.8 = 36.87^\circ$

A 2.1.1 Half Load

Reactive power $Q = \text{half load} \times \sin \theta$

$$= \frac{25 \text{ kVA}}{2} \times \sin 36.87^\circ$$

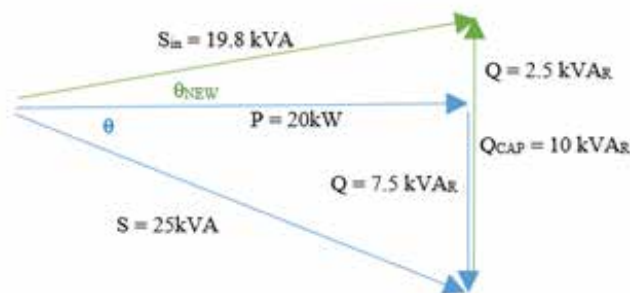
$$= 7.5 \text{ kVA}_R$$

True power, $P = \text{Apparent Power (S)} \times \cos \theta = 25 \times 10^3 \times 0.8 = 20 \text{ kW}$

Resultant reactive power, $Q_{T(1/2 \text{ Load})} = 10 - 7.5 = 2.5 \text{ kVA}_R$

$$\begin{aligned} \text{New power factor} &= \cos \left(\tan^{-1} \frac{Q_{T(1/2 \text{ Load})}}{P} \right) \\ &= \cos \left(\tan^{-1} \frac{2.5}{20} \right) \\ &= \mathbf{0.992 \text{ leading}} \end{aligned}$$

$$\begin{aligned} \text{New input kVA, } S_{in} &= \frac{Q_{T(1/2 \text{ Load})}}{\sin \theta_{\text{new}}} \\ &= \frac{2.5 \times 10^3}{\sin (\cos^{-1} (0.992))} \\ &= \mathbf{19.8 \text{ kVA}} \end{aligned}$$



A 2.1.2 Full Load

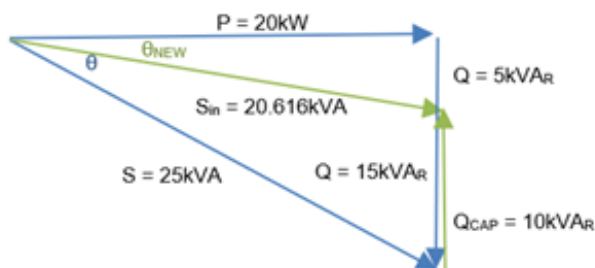
Reactive power $Q = \text{full load} \times \sin \theta = 25 \text{ kVA} \times \sin 36.87^\circ = 15 \text{ kVA}_R$

True power, $P = \text{Apparent Power (S)} \times \cos \theta = 25 \times 10^3 \times 0.8 = 20 \text{ kW}$

Resultant reactive power, $Q_{T(\text{Full Load})} = 15 - 10 = 5 \text{ kVA}_R$

New power factor $= \cos \left(\tan^{-1} \frac{Q_{T(\text{Full Load})}}{P} \right) = \cos \left(\tan^{-1} \frac{5}{20} \right) = \mathbf{0.97 \text{ lagging}}$

New input kVA, $S_{in} = \frac{Q_{T(\text{full Load})}}{\sin(\theta_{\text{new}})} = \frac{5 \times 10^3}{\sin(\cos^{-1}(0.97))} = \mathbf{20.616 \text{ kVA}}$



A Legal Knowledge: FACTORIES question

QUESTION (June 2023 - Question 5)

- 5.1 Define the following terms for water as used in the Facilities Regulations, 2004:
 - 5.1.1 Drinking water (1)
 - 5.1.2 Hot water (1)
- 5.2 Every employer shall provide sanitary facilities at the workplace in accordance with the provisions of Parts F, P and Q of the National Building Regulations.

- 5.2.1 What must the employer supply to every employee for his sole use at the washbasins in lieu of a towel? (1)
- 5.2.2 What must the employer make available free of charge to employees? (1)
- 5.3 Define the following terms as used in the General Machinery Regulations, 1998
- 5.3.1 Certificated engineer (1)
- 5.3.2 Graduate Engineer (1)
- 5.4 You have machinery on the premises generating 4 000 kW plus two steam generating units, one with an evaporative capacity of 15 750 kg of water per hour at 100 °C and one with a heating surface of 937,5 m², all running simultaneously.
- 5.4.1 Determine the sum of power generated by the machinery plus the generation of steam (1)
- 5.4.2 Define the term competent person (only the minimum requirements) for the premises (1)
- 5.5 In the case in 5.4 above, may the chief inspector permit the employer to designate a person who does not have the qualifications described in your answer? (1)
- 5.6 When may one permit or require a person to do any work on or near moving or electrically live machinery if such work may endanger him? (1)
- [10]

Suggested answer:

- 5.1
- 5.1.1 “**drinking water**” means water that complies with SABS 241;
- 5.1.2 “**hot water**” means water at a temperature more than 35 degrees Celsius;
- 5.2
- 5.2.1 2(3) Every employer shall - (c) supply a towel to every employee for his or her sole use or **disposable paper towels or hot air blowers or clean portions of continuous cloth towels**, at washbasins; and
- 5.2.2 2(3) Every employer shall -
- (a) make **toilet paper** available free of charge to employees;
- (d) provide **toilet soap or a similar cleansing agent** free of charge to employees.
- 5.3
- 5.3.1 ‘**certificated engineer**’ means any person to whom a certificate of competency referred to in Regulation E1(1) of the Regulations, published under Government Notice R929 of 28 June 1963, has been granted and includes any person who is the holder of a certificate of competency in mechanical or electrotechnical engineering issued before 1 January 1966 under the Mines and Works Act, 1956 (Act 27 of 1956).
- 5.3.2 ‘**graduate engineer**’ means any person who has obtained a degree in mechanical or electrotechnical engineering at a South African university, or a degree recognised by the Department of National Education as equivalent to any such degree.
- 5.4
- 5.4.1 4 (b) for the purpose of paragraph (a), the power derived from the generation of steam by any particular boiler shall be calculated in kW by dividing the manufacturer’s rated evaporative capacity (in kg of water per hour at 100 °C) by 21 or, in the absence of any such rated evaporative capacity, by multiplying the heating surface of that boiler (in m²) by 0,8.
Therefore $[4,000 \text{ kW} + (15,750/21) + (937.5 \times 0.8)] = \mathbf{5,500 \text{ kW}}$
- 5.4.2 4(a) If -
- (i) the sum of the power generated by machinery on or in the premises in question and the power derived from other sources, including the generation of steam for process purposes, exceeds 1200 kW, but is less than 3 000 kW, the person designated in terms of subregulation (1) shall be a person as referred to in paragraph (b), (c) or (d) of the definition of ‘competent person’;
- (ii) any such sum is 3 000 kW or more, the person so designated shall be a person as referred to in paragraph (c) or (d) of the said definition. That is, as below, graduate engineer or a certificated engineer.

‘competent person’ in relation to machinery, means any person who -

- (a) has served an apprenticeship in an engineering trade which included the operation and maintenance of machinery, or has had at least five years’ practical experience in the operation and maintenance of machinery, and who during or subsequent to such apprenticeship or period of practical experience, as the case may be, has had not less than one year’s experience in the operation and maintenance appropriate to the class of machinery he is required to supervise;
- (b) has obtained an engineering diploma in either the mechanical or electrotechnical (heavy current) fields with an academic qualification of at least T3 or N5, or of an equivalent level, and who subsequent to achieving such qualification has had not less than two years’ practical experience in the operation and maintenance appropriate to the class of machinery he is required to supervise;
- (c) is a graduate engineer and has had not less than two years’ post-graduate practical experience in the operation and maintenance appropriate to the class of machinery he is required to supervise and who has passed the examination on the Act and the regulations made thereunder, held by the Commission of Examiners in terms of Regulation E5(2) of the regulations published under Government Notice R929 of 28 June 1963; or
- (d) is a **certificated engineer**;

5.5 2 (6) Notwithstanding the provisions of subregulations (3), (4) and (5), the chief inspector may, subject to such conditions as he may impose, permit an employer or user of machinery to designate a person who holds any qualification other than that of a competent person in terms of subregulation (1). *Therefore, YES.*

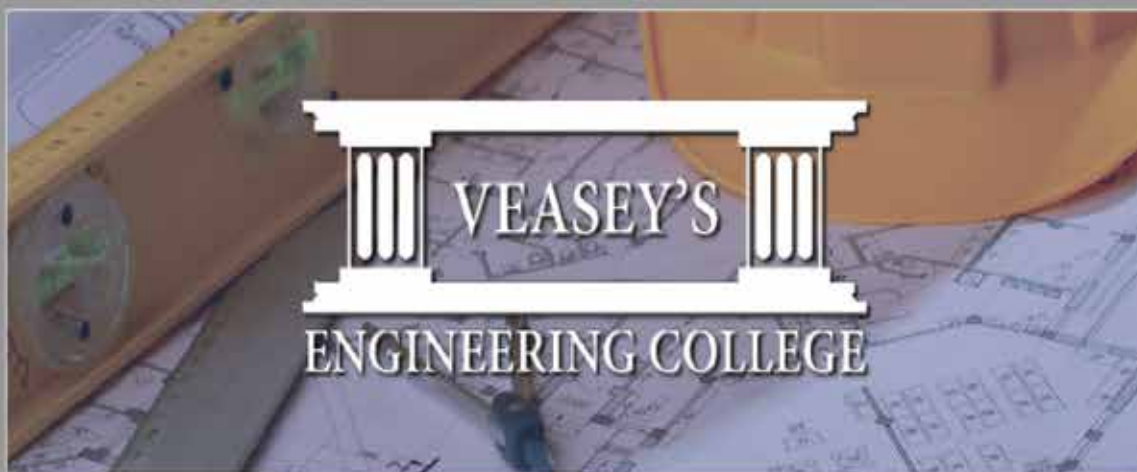
5.6 5 (1) No employer or user of machinery shall permit or require any person other than a **competent person or a person who has been trained to the satisfaction of an inspector** to do any work on or near moving or electrically alive machinery if such work may endanger him: Provided that this subregulation shall not apply in respect of the operation of **machinery under the general supervision of a shiftsman.**



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By R. BLAIR, M.I.Mech.E., M.S.A.I.Mech.E. (Member)

4. DESCRIPTION OF FULL-SCALE TESTS OF THE NEW WINDING SYSTEM

When it was decided to have a full-scale test of the new winding system, permission was obtained from the Anglo American Corporation of South Africa, Limited, to make use of a steam winding installation situated at Springs Mines.

The shaft has five compartments, is rectangular in section with 4 ft. between guides; the depth is 4,000 ft. to the main station and it is served by two steam winders, one manufactured by Fraser and Chalmers and the other by Markhams Limited. The winder chosen for the test was the Fraser and Chalmers unit serving compartments Nos. 3 and 4, as it was the more suitable for conversion to the multi-rope system. This winder normally operated with 1½ in. diameter ropes and was commissioned as a dual purpose unit. The drums are 11 ft. diameter by 8 ft. 3 in. wide and the headframe sheaves are 14 ft. diameter. For the purpose of this test, the 14 ft. diameter sheave in No. 3 compartment was removed and replaced by two 6 ft. diameter sheaves spaced at 2 ft. 6 in. centres. This was the only modification required to the headframe and is shown in Fig. 8*a* and *b*.

The skip and bridle, which weigh eight tons, required no modification other than fitting the compensating device, which has a 2 ft. 6 in. diameter rope wheel as shown in Fig. 9 to match up with the headframe sheave centres.

The right-hand drum of the winder serving No. 3 compartment, previously grooved for the 1½ in. diameter rope, was fitted with a wrapper plate to ensure good coiling of the smaller diameter ropes which were to be used for the test, and a division was fabricated in the centre of the drum width to provide facilities for multi-ropes. This division was constructed of a 6 in. by 4 in. channel, rolled to suit the circumference of the drum and bolted to the tread.

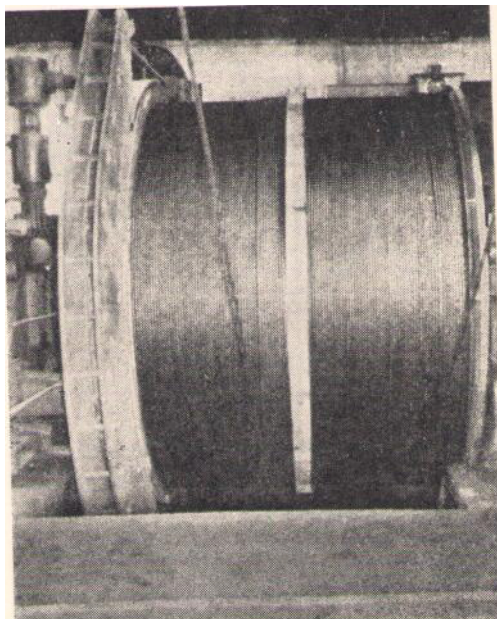


FIG 10

The original rope lead-in port adjacent to the drum flange was utilised for one rope attachment and an additional port was drilled adjacent to the centre division for the other; the spacing is such that there are the same number of coils on each division. This ensures better distribution of load on the drums and, for the same end loading, reduces the bending moment on the drum shaft.

From Fig. 10 it will be observed that the two ropes (provided there is good coiling) will always remain the same distance apart and have an equal number of turns on each layer. As previously stated, it is most important that the ropes coil correctly and for this reason, and to safeguard against unequal tension in the event of faulty coiling, a device is fitted adjacent to the drums.

This device follows the correct sequence of coiling but, should faulty coiling occur at any position during the wind, contact between the rope and the device causes the safety circuit to open and trip the winder.

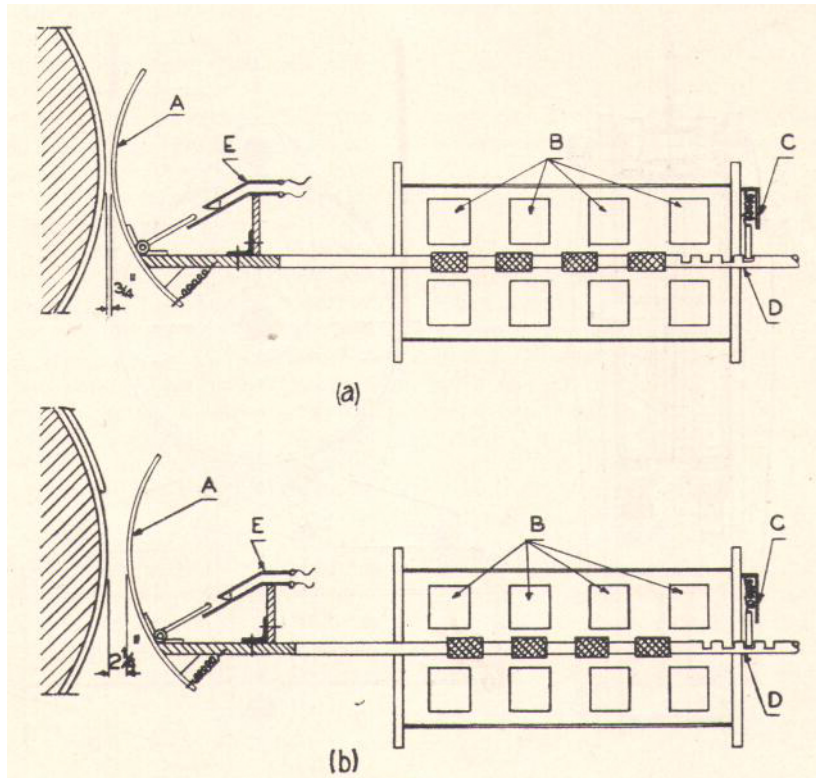


FIG 11

5. DESCRIPTION OF FAULTY COILING SAFETY DEVICE

Fig. 11a is a sketch of the device safeguarding against faulty coiling. 'A' is a curved plate the full width of the section of drum and is set approximately half a rope diameter clear of the rope coiling on that layer. The device is solenoid controlled and is designed to operate with any number of layers. Assuming there are four layers of 1½ in. diameter rope, the device would have four solenoids as shown at 'B' and would be set with curved plate 'A' having a clearance of ¾ in. between the plate and the bottom layer of rope. The safety or locking solenoid 'C', is always in the locked position and secured by a plunger dropped into a groove in shaft 'D'. This shaft, as can be seen, has a locating groove for each layer of rope which provides a mechanical lock in the correct position when coils 'B' are de-energised.

Plate 'A' is maintained in a fixed position during coiling of a complete layer of rope and only when the drum has made the number of turns required to complete that layer is the appropriate coil energised by a contact~ closed either by the Lilly Controller or depth indicator mechanism. When this contact is closed solenoid 'C' is energised, raising the plunger and leaving shaft 'D' free to travel. At the same time the selected coil, 'B' is energised, retracting curved plate 'A' to a new position 1½ in. back and when again de-energised, is locked in this new position by the plunger dropping into the recess in the shaft 'D'.

Fig. 11b shows the new position when plate 'A' is retracted 1½ in. to receive the next layer.

This operation is repeated at the completion of each full layer of rope so that there is protection throughout the complete wind. Should one coil of rope for any reason mount a layer prior to plate 'A' taking up its new position, plate 'A' will be depressed and, as shaft 'D' is locked in position and unable to retract, contact will be broken at 'E' and the safety circuit opened bringing the winder to rest at normal deceleration rate.

6. DESCRIPTION OF COMPENSATING DEVICE ON CONVEYANCE

The compensating device, although previously described in brief, requires further explanation of its final form. Fig. 12 illustrates the device in detail.

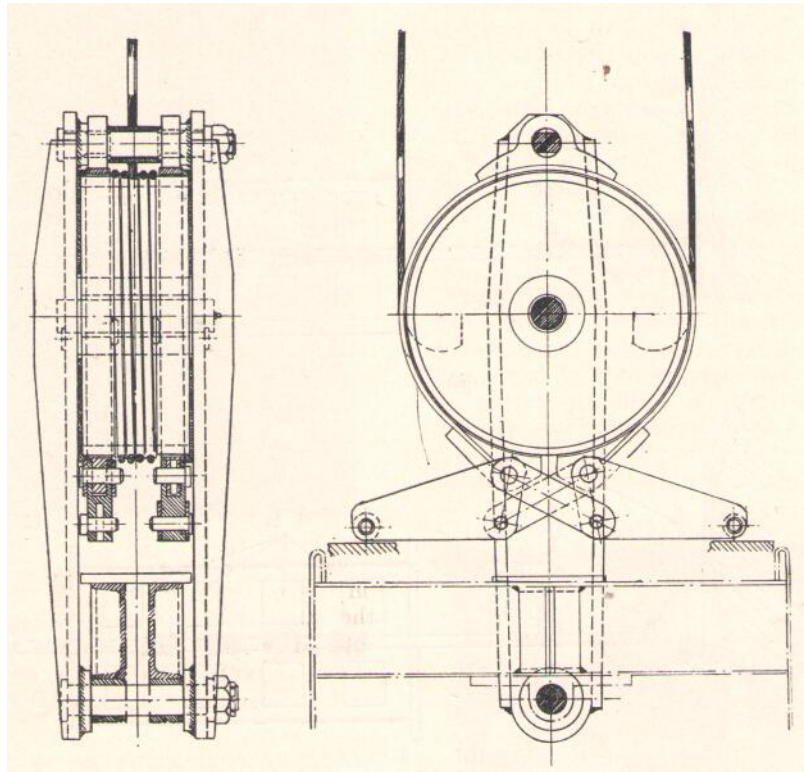


FIG 12

Later in the paper the functioning of the device during operational tests, which were conducted under full-scale conditions, is described and illustrated by means of photographs taken during the tests.

Fig. 12 shows how the device is attached to the conveyance and it will be observed that, whilst there are two ropes attached, the centre wheel or drum is free to rotate. The rope attachment is positive because after passing two turns around the periphery each rope is led in through an opening in the circumference, looped around the boss and finally clamped by means of Crosby type clamps. This provides facilities to cut for test and at the same time allow sufficient rope to cater for any faulty coiling, on the winder drum. The ropes around the periphery are in a spiral groove, therefore, should there be any movement due to unequal rope travel, the one rope leaves the groove as the other enters.

The two ropes can be installed having opposite lay thereby eliminating the side pressure which is always present on shaft guides when using rope other than non-spin type on a single rope system.

Fig. 12 also illustrates the position of the brake paths on which the brakes are applied when arresting the conveyance in the event of a broken rope. The band brakes on the compensating device are applied automatically by the side thrust induced by the weight of the conveyance if either rope should break, and they can operate *only in the event of a broken rope*, as they are controlled by the weight of conveyance attached to the rope. The brake pressure is set at a predetermined loading and will then automatically adjust the pressure applied according to the weight of material, mineral, or persons in the conveyance. (See Fig. 13).

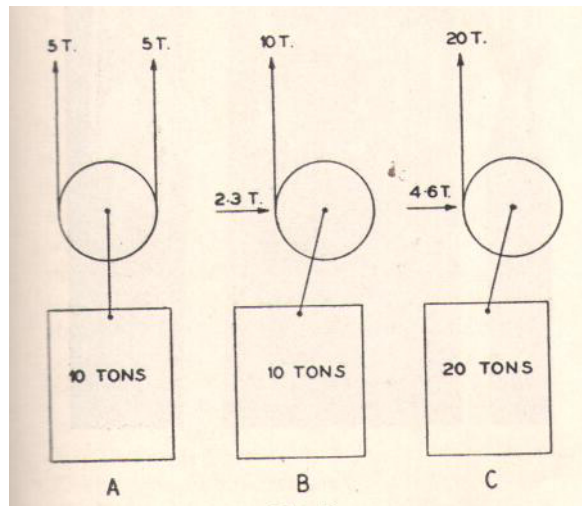


FIG 13

In Fig. 13, 'A' shows the normal condition of winding with an end load of 10 tons which is equally distributed on both ropes and therefore the side thrust is nil; but, as illustrated in 'B', with a broken rope where the end loading is the same as 'A' and the predetermined setting of brake was arranged to allow the device to heel-over 6 in., the thrust pressure applying brakes would be 2-3 tons. In the third example 'C', where the load is doubled, and the heel-over setting retained constant at 6 in. setting, the thrust pressure applying the brake due to this increased load of conveyance would amount to 4-6 tons. From these illustrations it will be observed that by varying the amount of travel of the device the side thrust applying the brake can be controlled: the greater the amount of travel permitted, the lower the side thrust, therefore the thrust is decreasing as the rotation of the compensating wheel is being arrested.

7. TESTS ON THE COMPENSATING DEVICE

Returning to Fig. 9 for the purpose of illustrating how the test was administered when compensating for equal tension and arresting the conveyance with a broken rope, it can be seen from this photograph, taken with the cover plate removed, that the one rope end leading into the hub is in horizontal position and the conveyance supported equally by both the ropes. A pennant rope was then attached to the winding rope on the right and with the aid of a capstan winch, was raised to produce the same effect as would be experienced by faulty coiling on the winding drum. The result was that the wheel of the compensating device was rotated with the movement of this rope into the position shown in Fig. 14 and it was obvious that although the wheel was rotating the tension in both ropes remained constant.

Having conducted this test several times it was then decided to prove the broken rope condition. For this test, the conveyance was again raised by the same method as described above. The pennant supporting the right-hand rope was then severed and the device heeled over to the right, applied the brake and arrested the rotation of the wheel. This test produced a condition similar to that of a broken rope.

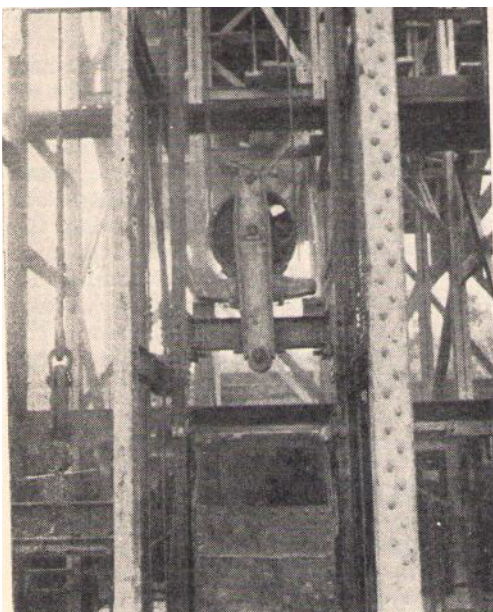


FIG 14 & 15

Fig. 15 indicates the rotation of the device during the period the load was transferred from two ropes to one, whereby the shock load on the remaining rope was considerably reduced.

A further test was conducted by actually severing the rope with the use of explosives, proving that there was no retardation or false condition resulting from the use of the pennant and capstan winch during the previous test.

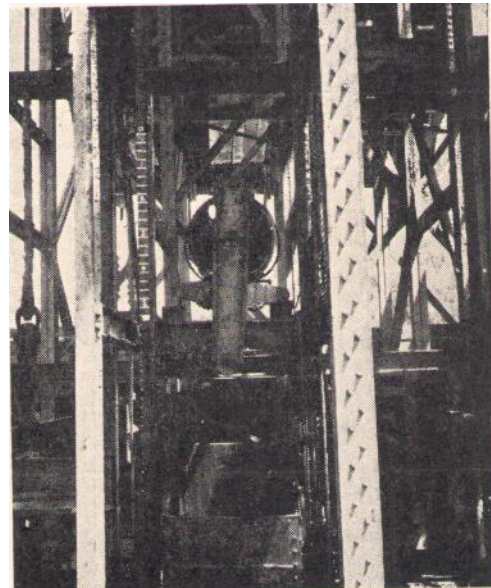
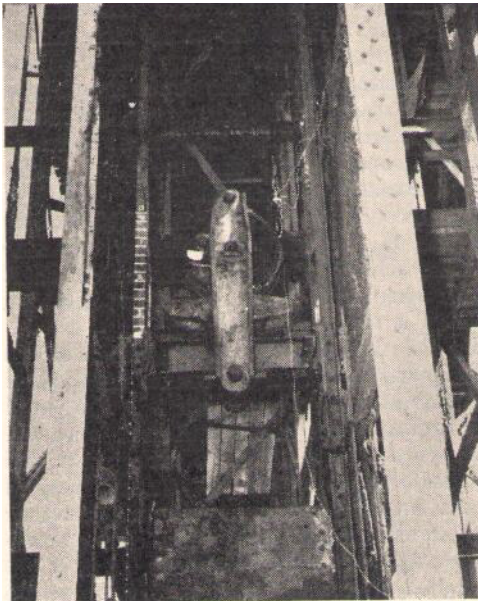


FIG 16 & 17

Figs. 16 and 17 Illustrate how this test was conducted. The shaft guide on the left hand side of the photographs was marked with a scale in feet. When the conveyance was raised as indicated into a position at 3 ft. 4½ in. on the scale, the explosive charge was attached by means of a clamp to the winder rope on the right, slightly above the compensating device. The explosive was detonated from a safe distance by igniter cord which can be seen in the photograph.

From Fig. 17 – a photograph taken after the rope was severed by the explosion – it can be seen that the conveyance is now positioned at 5 ft 3 in. on the scale, representing a drop of 22½ in. and the compensating device has heeled-over, applied the brake and arrested the load on the single rope.

The rotation of the wheel measured on the circumference corresponds to 14 in. of rope travel; therefore the transfer of was conducted with a minimum of shock. The difference between the amount conveyance dropped and the rotation of the compensating wheel, which is 8½ in., can only be caused by rope stretch and a more direct catenary between the winder and the headframe sheave, brought about by the increased load on the single rope.

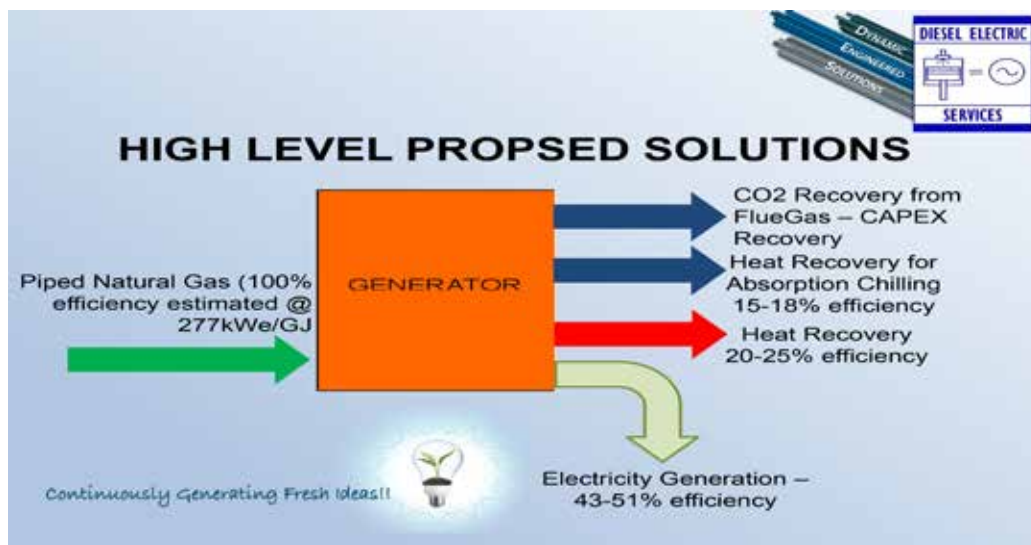
Fig. 18 is a photograph of the half clamp retrieved after the rope was severed and it is obvious from the serrated edge that it acted as a guillotine and assisted with the cutting. At this stage, it may be added that extensive experimental tests were necessary prior to the use of explosives and various methods were investigated before finally deciding on the method adopted; The reason for these experiments was to be able to sever the rope with a minimum amount of explosive as the intention was to prove to all concerned that, should there be a broken rope under normal conditions of winding, the total load would be arrested by the single rope without excessive shock to the whole system. This meant that the final test had to be conducted while the conveyance was travelling at speed in the shaft and a large quantity of explosives might not only have severed the rope but have caused damage to the shaft.



FIG 18

To be Continued...

At our AGM in March 2023, we had a speaker, Mr. Caine O'Neill present a talk on Gas Plant generation power plants. The topic is really very interesting and at some time in the near future we will try to put together a full presentation on the concept. the following picture is mostly what he spoke about.



So this is a teaser for something to come. Watch this space!

The following is a training course schedule from one of our members. If interested, please contact them direct.



Pretoria:
Tel 082 855 8016
Vanderbijlpark:
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P.O. Box 4627,
Vanderbijlpark,
1900

COURSE SCHEDULE :

Third quarter 2023

Course code	Course description	Duration Days	Dates	Cost Excl VAT
C101	Asset Management for Artisans	2 days	4th course 20 - 21 July 5th course 6 - 7 September	R7 391
C103	Maintenance for handymen	2 days	5th course 18 - 19 July 6th course 22 - 23 August	R7 391
C201	Asset Management for Maintenance Supervisors	5 days	6th course 24 - 28 July 7th course 28 August - 1 September	R18 479
C301	Maintenance Planning	5 days	7th course 17 - 21 July 8th course 14 - 18 August 9th course 18 - 22 September	R18 479
C302	Advanced Maintenance Planning	5 days	5th course 31 July - 4 August 6th course 11 - 15 September	R18 479
C501	Maintenance Shutdown and Project Management (Please see footnote for computer requirement)	5 days	5th course 3 - 7 July 6th course 31 July - 4 August 7th course 18 - 22 September	R19 156
C702	Reliability Engineering in Asset Management (Please see footnote for computer requirement)	5 days	3rd course 3 - 7 July 4th course 18 - 22 September	R20 565
C901	Maintenance Practice for Asset Management Engineers (Please see footnote for computer requirement)	5 days	4th course 24 - 28 July 5th course 14 - 18 August	R19 156
C902	Leadership in Asset Management	5 days	4th course 10 - 14 July 5th course 28 August - 1 September	R19 156
C903	RCM Facilitation and Analysis (Please see footnote for computer requirement)	5 days	4th course 3 - 7 July 5th course 11 - 15 September	R19 156
C904	RCM ProAktiv, Advanced Reliability Centred Maintenance (Please see footnote for computer requirement) Please note that this course has a pre-requirement. Students must already have completed both C702 and C903 before enrolling for this course. This is to ensure that participants will adequately cope with the course content. Exceptions to this rule is possible, but will have to be suitably motivated. This course thus builds on the foundation already established in our C702 and C903 courses. Apart from shortly revisiting the Reliability and RCM foundations, the student should be in a position to quickly grasp and use the advanced concepts as taught in this course.	5 days	2nd course 4 - 8 September	R19 156
S801	Reliability Centred Maintenance (Please see footnote for computer requirement)	3 days	4th course 3 - 5 July 5th course 11 - 13 September	R11 787
S802	Asset Management for Executives	3 days	4th course 22 - 24 August	R11 787
S803	Root Cause Failure Analysis	5 days	5th course 10 - 14 July 6th course 21 - 25 August	R21 131
S804	Decision Making in Maintenance (Please see footnote for computer requirement)	5 days	5th course 4 - 8 September 6th course 16 - 20 October	R19 652
S805	Maintenance Control	2 days	5th course 27 - 28 July 6th course 28 - 29 September	R7 391
S808	Asset Management Logistics	3 days	5th course 24 - 26 July 6th course 26 - 28 September	R11 087
S809	Data Analytics in Asset Management	5 days	5th course 17 - 21 July 6th course 28 August - 1 September	R18 479
S811	Water Treatment Plant Operation and Maintenance	3 days	5th course 2 - 4 August	R13 404
S812	Road Maintenance	2 days	4th course 31 July - 1 August	R7 391
S813	Economical Replacement and Life Cycle Management (Please see footnote for computer requirement)	5 days	5th course 14 - 18 August 6th course 18 - 22 September	R19 156
S821	Understanding ISO 55000	3 days	1st course 11 - 13 July	R11 087
T604	Asset Management for water and sewage maintenance teams	5 days	3rd course 14 - 18 August	R18 479
Diploma in Maintenance Management			For comprehensive information on our selection of 6 diplomas, please visit our website at terotechnica.com	R74 365

Footnote: Students enrolling for the following courses: C501, C702, C901, C903, C904, S801, S804 and S813, must be in possession of their own laptop computers. Computers supplied by employers often have safety features installed which prevent students free access to all the programs and functions required for the course.

In-house training:

- Please note that considerable savings, both in time and money, can be brought about by having any of the above courses presented in-house. Attractive discounts are offered. Please contact us for quotations. Terms and conditions apply.
- Comprehensive information regarding all diplomas and courses is available on our website at terotechnica.com