ȷ Țȷ ȹ¢ ȥ Ƚȷ Ⱥȥ ɄɃ ɅȾȚɃɈ ʔȷ Ɉȼ ȾȚɃɈ

ȥ ȷ ȚȺȹɃ ʔ Ƚȷ Ɇ

Ɇɉ Ƀȿ ¢ ȥ ¢ ɉ ȷ ʔȾȚɋ ʔ

Ʉȼ Ɉ ɉ Ƚȷ Ț¢ ȺɅũȷ ɆȽ

ŪȺȥ ȷ : ¢ ȿ ȺȚȼ ɅɃ ʔ ȾȚ Ƀ Ɇ Ⱥȿ Ⱥũ ɉ Ƀ Ɇ ¢ ȿ ȺȚȼ ɅȾȚɋ ʔ

ȚȽʔ ¢ ȼ ¢ Ʌɋ ʔ Ʉȿ ɃȽɋ ʔ

ɆɄɃɈ ȹȷ Ɇȼ ¢ Ɇ : ȥ ȷ Ɉ ɅɃ ũ Ⱥɋ Ʌũ ¢ Ɇ ɉ ɅȾɆȼ Ƀ ū

ȺɄȽȸȿ ȺɄɋ ʔ Țȷ Ū¢ ũ¢ ȼ ¢ Ɇ : ũȺɅȷ Ɇ¢ Țɋ ʔɆȼ ȷ ʔȼ Ƚʔ ȷ

NEA ȥ ¢ ɉ ȷ ʔȽɋ ʔ ȷ

2013

ȷ Ʈȷ ȹ₵ ȥ Ƚȷ Ⱥȥ ɄɃɅȾƮɃɈ Ɂȷ ɈɇȾƮɃɈ

ȥ ȷ ƮȺȹɃɁȽȷ Ɇ

Ɇȷ Ƀȿ ₵ ȥ ₵ȷ ȷ ɁȾƮɋ Ɂ

Ʉɇ Ɉȷ Ƚȷ Ʈ₵ ȺɅũȷ ɆȽȷ

ŪȺȥ ȷ : ₵ ȿ ȺƮɇ ɅɃɁȾƮɃɆ Ⱥȿ Ⱥũȷ ɃɆ ₵ ȿ ȺƮɇ ɅȾƮɋ Ɂ

ƮȽɁ₵ ɇ ₵ Ʌɋ Ɂ Ʉȿ ɃȽɋ Ɂ

ɆɄɃɈ ȹȷ Ɇɇ ₵ Ɇ : ȥ ȷ Ɉ ɅɃũȺɋ Ʌũ₵ Ɇ ȷ ɅȽɆɇ Ƀū

ȷ ȥ : (4507)

₵ ȥ ȺɅɃȥ ₵ ɁȽ Ʉȷ Ʌȷ ȹɃɆ₵ Ɇ :29-10-2013

Περιεχόμενα

ꞰȺɅƚȿ ¢ Ɋ¢

ȺɷŬǝ ɔŮǝɕɜɧɠ ɧǗǝ ɖ ǗǗɜɕɚɕɔɚɐ ´ɟɧɕŭɕɠ ǗɤɜǗǝŮǗɠǗŬɷɤɜ ɕɟɧɜɤɜ ɏɕŮǝ Ů ɘǗǰɏɣŮǝ Ǘɖ ŭɖɛɚɕɟɔɗŬ ŮǝŮǝɚɛɏɜɤɜ ɖǝŮǝǗɕɜɚɩ ɜ ůɡůǗɖɛɎǗɤɜ ´ɚɕɷɤɜ. Ⱥ´ɑůɖɠ, ɏɕŮǝ ůɡɛɓɎɚǝŮǝ ǝŬǝ ůǗɖɜ ǗɩŬɟɛɕɔɐ Ŭ ɕŭɕǗǝɧǗǗǰɤɜɛŮɖɧŭɤɜ ŮǝɏɔɕɕɡǗɤɜɖǝŮǝǗɚɩ ɜǝɚɖǗɐɟɤɜ ´ɚɕɷɜ.

Ƀɘ ´ɟɕů´ƳɖŮǝǗɠ ŬɜƳ Ǘɡɜɖɠ ůǗɕɜ ɖǝŮǝǗɕɜɚɧ ɏǝŮǝɕɕ Ǘɤɜ ɖǝŮǝǗɚɩ ɜ ǝɚɖǗɐɟɤɜ ´ɚɕɷɜ ůǗɕɕŮǝ ůǗɖɜ Ŭɡɜɖɛɏɜɖ Ŭ ɕǗǗŮǝŮɛŬǗǝɧǗɖǗŬ Ǘɖɠ ɛŮɖɧŭɕɡ, ǝŬɩ ɠ ǝŬǝ ůǗɕ ɛŮɷɛɏɜɕ ǝɧůǗɕɠ ǗɩŬɟɛɕɔɐɠǗɕɡɠ.

Ƀɘ´ǰɘůɧǗǰɕɘǝɚɖǗɐɟŮɠ´ɕɡ ɕɟɖůɛɕ´ɕɚɨɜǗǝůɐɛǰŬŮɷŬǝŮŬɤɔɚɕɑǝŬǗɩŬɜɷɕɡɜ ɓŬɖɛɧ Ŭɧŭɕůɖɠ 93 - 94%, ɕŬɛɖǝɧǗǰɕ ǝŬǗƳ 3 - 4% Ŭ ɧ Ǘɜ ɓŬɖɛɧ Ŭɧŭɕůɖɠ Ǘɤɜ ůɨɔɕɟɕɜɤɜ ǝɚɖǗɐɟɤɜ . ũɘŬ Ǘɕɡɠ ǝɚɖǗɐɟŮɠ ȺɅ ´ɕɡ ɕɟɖůɛɕ´ɕɚɨɜǗǝ ůŮ ǝɚɖǗɐɟŮɠ ɖǝŮǝǗɕ´ɟɧɤůɖɠ, ɡ´Ƴɟɕɕɡɜ ǰɟǝǗɕɑɛɏɖɕŭɕɘŮǝɏɔɕɕɡ, ɧ´ɤɠɔɘŬ´ǰƳůŮǝɛŬɕ ɓŬɖɛɤ Ǘɧɠɏǝŭɕɕɠ ŬɜɕɚǗɨ ɐ ǝɚŮǝůǗɨ ɓɟɧɕɕɡ V/F, ɕ ɏǝŮǝɕɕɠɛŮSPWM ǝŬǝCSI ǝŬǝɕ ŭɘŬɡůɛŬǗǝɧɠɏǝŮǝɕɕɠ.

Ⱥ´ɑůɖɠ, ɖŬ´ɟɏ´Ůǝɜ ŬŬŬɏɟɕɡɛŮɧǗǝɕɘǗɘŬůɚɕɑǝɚɖǗɐɟŮɠ´ǰɕɡůɘƳɕɕɡɜ ŭɘŬɕɟɏɠůǗ ǰɕɛɏŬǝŬǝǗɖɜ ǝŬǗǗůǝŮɡɐ Ǘɕɡɠ, ɕɘɕ´ɕɖŮɠǝŬɖɕɟɑɕɕɡɜ ǝŬǝ Ǘ ŮɑŭɕɠǗɖɠǗŬǰɛɕɔɐɠǗɕɡɠǝŬǝɧůɕɜ ŬǗɕɟƳ Ǘɜ ɏǝŮǝɕɕ ůǗɕɡɠ Ů Ŭɤɔɚɕɨɠ ǝɚɖǗɐɟŮɠ ɕɟɖůɛɕ´ɕɘŮɖǗǝ ɖ ɛɏɖɕŭɕɠ Ǘɕɡ ɖǝŮǝǗɕɜɚɕɨ Ůǝɏɔɕɕɡ ůǗɕŭɩ ɜ.

ɆǗɧɕɕɠ Ǘɖɠ ´Ŭɟɕɨ ůŬɠ ŭɘ´ɚɤɛŬǗǝɐɠ ǗɔŬůɖŬɠ ŮɷŬǝ ɖ ´Ŭɟɕɡůɖůɖ Ǘɕɡ ɖǝŮǝǗɕɜɚɕɨ Ůǝɏɔɕɕɡ Ǘɤɜ ɖǝŮǝǗɚɩ ɜ ǝɚɖǗɐɟɤɜ ´ɚɕɷɜ. ũɘŬ ɜŬ Ǘ ŮɘǗɨ ɕɕɡɛŮŬɡǗɧ ´ŬɟɕɡůɘƳɕɕɡɛŮŬɟɕɚƳ Ǘɕɡɠ ǝɚɖǗɐɟŮɠ ´ɚɕɷɜ ǝŬǝ ǗǗ ɕŬɟŬǝǗɖɟɘůǗǝƳ Ǘɕɡɠ. Ō´ŮǝǗǗ, ŬɜŬǗǰɧɛŬůǗŮ ůǗɠ ɕɟɖůɛɕ´ɕɚɨɛŮɜǗɠɛŮɖɧŭɕɡɠɖǝŮǝǗɕɜɚɕɨ Ůǝɏɔɕɕɡ.

ABSTRACT

It is a fact that the technological progress in recent years has allowed the creation of sophisticated electronic systems of ships. It has also contributed to the implementation of efficient control methods to electrical marine engines.

Efforts of development in the electronic control of electric motors aim at increasing the efficiency of the process and in reduced cost implementation.

Most engines used today are inductions and exhibit an efficiency of 93 to 94%, lowest by 3-4% of the synchronous motorsô efficiency. For AC motors used in electric propulsion engines, there are several methods of control, such as the scalar control, the SPWM and CSI control and the vector control.

Also, we should mention that the three-phase motors differ on their cursor and construction, which determines the type of application and concerning the induction motorsô control, the method of electronic control unit is being used.

The aim of this thesis is the presentation of electronic control of electric motors ships. To achieve this we present preliminary the marine engines and their characteristics. Then we refer to the methods used in electronic control.

[illegible] 1: [illegible]

1.1 [illegible]:

[illegible]

[illegible]

[illegible]

[illegible]

1.2 [illegible]

[illegible]

[illegible]

[illegible]

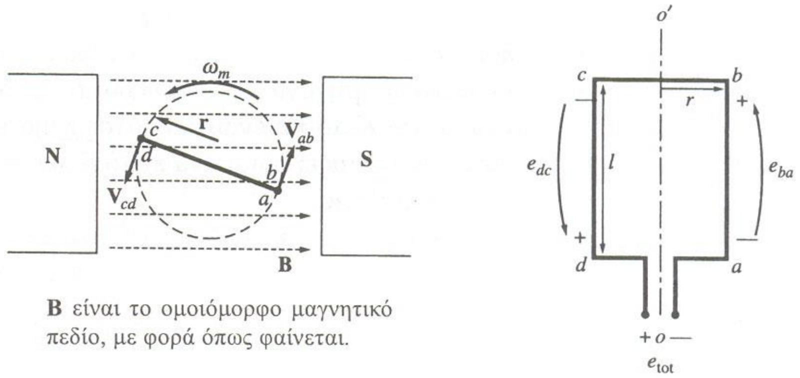
[illegible]

[illegible]

[illegible]

1.3 [illegible]

[illegible]: [illegible]



B είναι το ομοιόμορφο μαγνητικό πεδίο, με φορά όπως φαίνεται.

[illegible] e_{IND} [illegible] $e_{IND}=(v\times B_R).l$. H [illegible] $e_{IND}=2vB_R l \sin$ [illegible] max [illegible] sin [illegible] t.

[illegible]

1. [illegible]
2. [illegible]
3. [illegible] $t_{IND}=$ [illegible] loopxBs.

[illegible]

[illegible]:

1. [illegible]
2. [illegible]
3. [illegible]
4. [illegible]

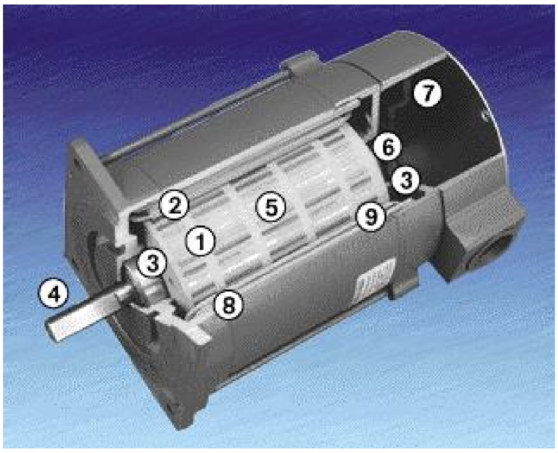
1.4 [illegible]

[illegible]

[illegible] 120 [illegible] 120 [illegible]

1.5 ɆɈ ũ ɉ ɅɃ ʔ Ƀ Ł Ƭ Ƚ ʔ ¢ ɇ ¢ ɅȺɆ

Ƀɘ ůɨ ɔɢɟ ɞɜŮɡ µɖɢŬɜɏɡ ´ɞg µŮŰŬŰɏ´ɞgɜ ɖɚŮɘŰ ɕɐ Ůɜɏɟ ɔŮɘŬ ůŮ µɖɢŬɜɕɐ ɞɜɞµŸɞɜŰŬɘ ůɨ ɔɢɟ ɞɜɞɘ ɘɞɖŰɐɟ Ůɡ. ɄŬɟ ŬɘŸŰɤ ´Ůɟ ɔɟ Ÿűɞɜ ŰŬɘ ŰŬ ɓŬůɕŸ ɢŬɟ ŬɘŰɖɟ ɘůŰɘŸ ɚŮɘŰɞɡɟ ɔɗŬɡ Űɤ ɜ ůɨ ɔɢɟ ɞɜɤ ɜ ɘɞɖŰɐɟ ɤ ɜ. Ọ̄ɜŬɡ ůɨ ɔɢɟ ɞɜɞɡ ɘɞɖŰɐɟ Ŭɡ Ŭ Ůɘɞɜɢ ŮŰŬɘ ůŰɞ ´Ŭɟ ŬɘŸŰɤ ůɢɐµŬ.



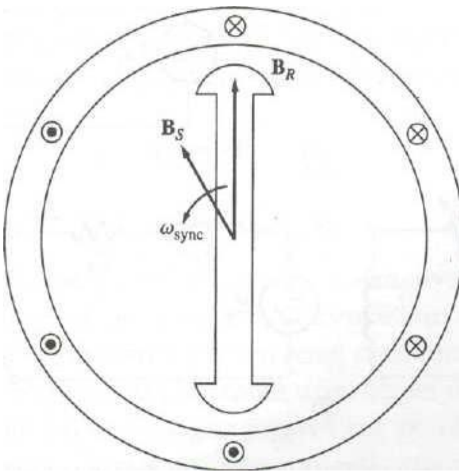
1. ɀ ɧɜɕµɞɡµŬɜɐŰɖɡ (ů)
2. ɇ ɨ ɚɗɒµŬ ů´ Ůɘɟ ɩ ɜ
3. æɨ ɞ ɟ ɞgɚŮµŸɜ
4. ȯ ɜɞɜŬɡ Ŭɘɟ ɘɕŮɘŬɡ
5. ɅɧŰɞɟ Ŭɡ 50 ŭɧɜŰɘɤ ɜ
6. æɘ´ ɚɧ ŮɚŬŰɐɟ ɞ
7. ɇ Ůɚɘɧ ɘɕɩ Űɞ
8. Ɇ´ Ůɡɟ Ůɡ´ ɞg Űɡɚɕɞɜ ŰŬɘ ůŮɘůɢ
9. ɆŰŸŰɞɟ Ŭɡ 8 ŭɞɜŰɘ ɜ

Ⱥɕɧɜ Ŭ:1 ɆɈ ũ ɉ ɅɃ ʔ ɃɆ Ƭ Ƚ ʔ ¢ ɇ ¢ Ʌɟ Ɇ

1.5.1 ȡǰ ƁƐƬƛƑ ɉ Ʌǰ ƛƑ ş ƛƐɇȻ Ƀ Ʌũƚ Ǝ ƐɃ ũ ǰ ɅƁ ʔ Ý ʔ ƬƐʔ ¢ ɇ ¢ ɅÝ ʔ

ɇ ɞ ´Ǔ Ǔ ƳƳ ůɕɐµǓ ŭǓɕɜǓ ɏɜǓ ůɨ ɔɕɟɞɜɞ əɕɖƐǓ ŭɨ ɞ ´ɧəɤ ɜ, ɧ´ɞɡ Ǘ µǓɜɖǗɧ ´Ǘ Ǘɡ ǔɟɞµɏǓ(ȡR) ´Ǔ ƳɔǓǓ Ǔ ɧ Ǘ ɟǓ µǓ ŭɏɔǓ ůɖɠ IF.

Ɛǘ ůǗƳǗ Ǘɖɠ µɖɕǓɐɠ ǓǓ µɧɕǓǓ ɏɜǓ Ǘ ɑǓɧ ůɨ ůǗµǓ ɟǗµƳǗ ɜ Ǘ ɞ´ɞɶ ´Ǔ ƳɔǓ ůǗ Ǘɤ ǗǓɧ Ǘɖɠ ůǗ ǓɧµǓɞ ɞµɞɔǓɏɠ µǓɜɖǗɧ ´Ǘ ȡS. ŌǗɘ ůǗ Ǘɤ ǗǓɧ Ǘɡ əɕɖƐǓ ɡǗǓǓǓ ŭɨ ɞ ´Ǘ ´ɞɡ Ǘɞɡɜ ɜǓ Ǘɡɖɡɔɟ Ǔµµɑ ůǗɨ ɜ, ɧ´ɤ ɠ Ǔɟɕɩ ɠ ŭɨ ɞ µǓɜɖǗɞɑɟƳŭɞ. ƛ´Ǘ ɧµɤ ɠ, Ǘ ´Ǘ Ǘɡ ůǗƳǗ ´Ǔ ɑǓǓ ǓǓ ůɡɜǗɩ ɠ, Ǘ ´Ǘ Ǘɡ ǔɟɞµɏǓ (əǓ ɞ ǘ ɞ ǔɟɞµɏǓ) ´ɟɞů´ǓǓ ůɡɜɏɕǓǓ ɜǓ Ǘ Ǔɞəɞɡɖɐ ůǗ ȳ ůɞ µǓǓǓǗ ɖ ǓǓ ɖ ɔɤ ɜǓ µǓǓɨ Ǘɤ ɜ ŭɨ ɞ ´Ǘ ɜ Ǘɧůɞ µǓǓǗ ɖ ǓǓ ɖ ɟɞ´ɐ ´ɞɡ Ǘɘ ůǗ ǔɟɞµɏǓ Ǘ µǓɜɖǗɧ Ǘɡ ´Ǘ. ɉ ɡǗ Ǔɟɕɩ ɠ ǓǓ ɖ Ǔɕɐ əǗ ɡɟɔǓɠ Ǘɡ ůɨ ɔɕɟɞɜɞɡ əɕɖƐǓ: ɇ ɞ µǓɜɖǗɧ ´Ǘ Ǘɡ ǔɟɞµɏǓ "əɡɜɖɔƳǓ" ůɡɜǗɩ ɠ Ǘ ´Ǘ Ǘɡ ůǗƳǗ, ɕɤ ɟɠ´ɞǗ ɜǓ əǓǓŭɏɟɜǓɜǓ Ǘ ŭǗƳůǓ

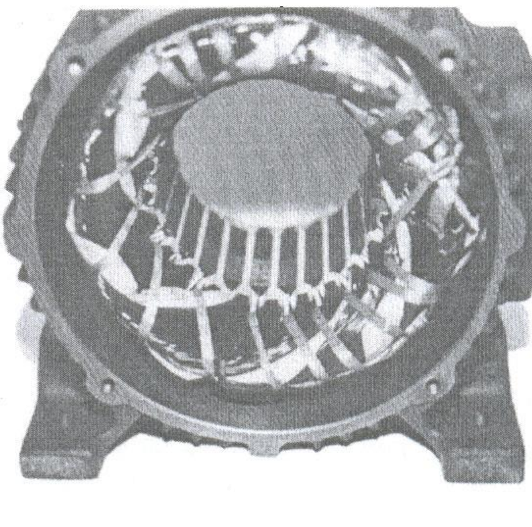


Σχήμα 1.Σύγχρονος κινητήρας δύο πόλων

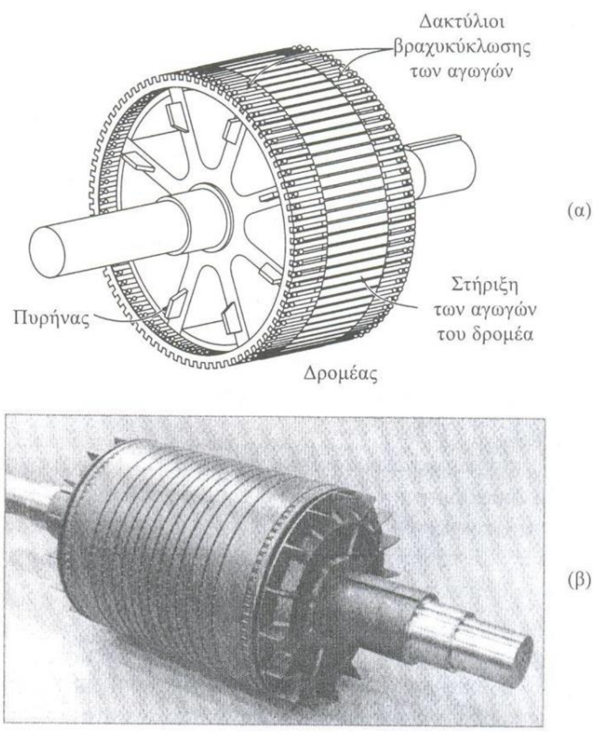
1.6 [illegible]

1.6.1 [illegible]

[illegible] 2. [illegible] ([illegible] 3) [illegible] ([illegible] 5)



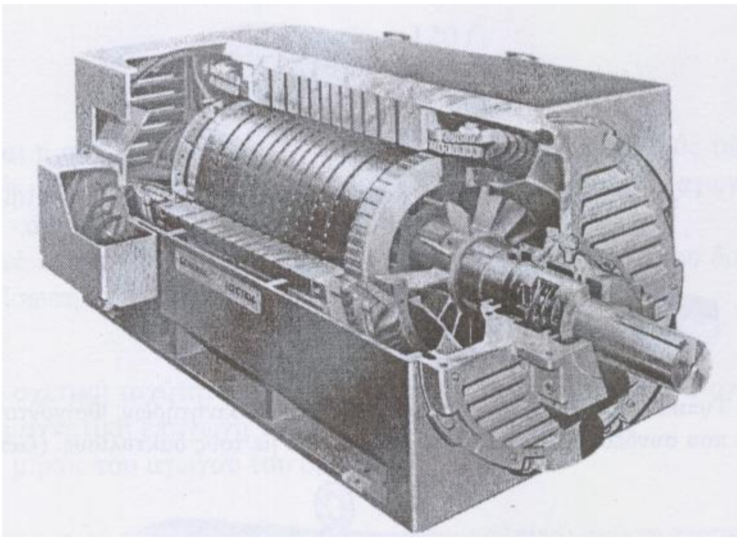
[illegible] 2. [illegible]


Δακτύλιοι
βραχυκύκλωσης
των αγωγών
(α)
Στήριξη
των αγωγών
του δρομέα
Πυρήνας
Δρομέας
(β)

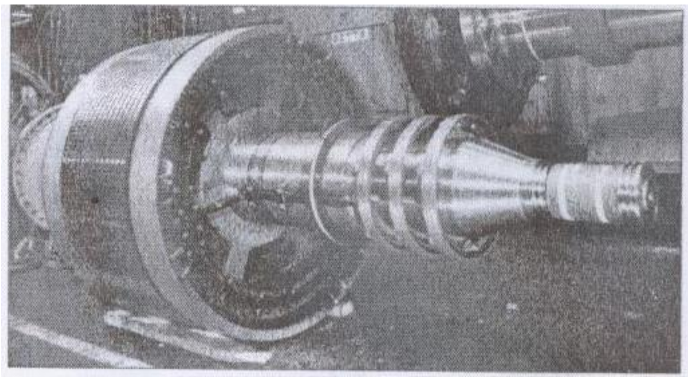
[illegible] 3. [illegible]

[illegible]

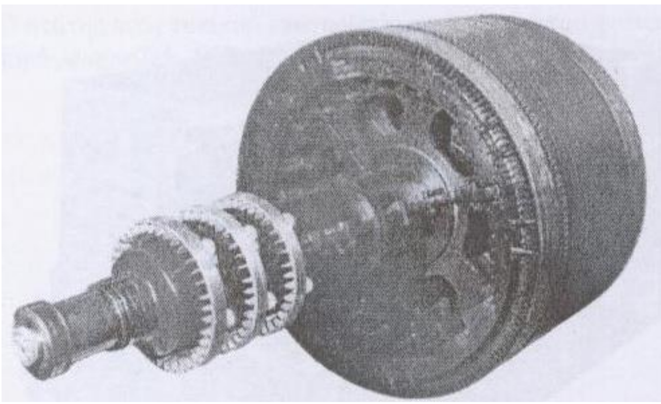
[illegible]



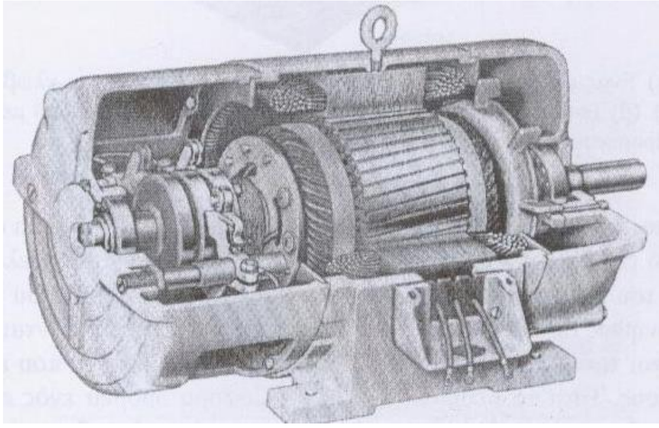
[illegible] 4. [illegible]



Ɇගළ μŬ 5 (Ŭ)



Ɇගළ μŬ 5 (b)



ȄǤƐµŬ 6. ŮŬɤɔǝŋƒ ǝɜʠǘȷ Ǘƒ ŭŬǝǗǥǝɘǘŋȷ ɞg ǘȷ ɞµɏŬ ůŮǗɞµɐ

¢ ǝŮǕǘɞgȷɔʠŬ Ǘɤ ɜ ŮŬɤɔǝɩ ɜ ǝɜʠǘȷɤ ɜ ŮɞŬǝ ɓŬůǝŸ ʠ ɑǝŬ µŮ Ǘʠ ǝŮǕǘɞgȷɔʠŬ Ǘɤ ɜ Ǘǥǝɒ µŸǗɤ ɜ Ŭ ŋůɓŬůʠƒ ůǗƒ ůɨ ɔɞȷ ɞɜŮƒ µʠɢŬɜɏƒ.

1.6.2 ¢ ȷ ɜŸ Ǘǥɜʠ Ǘʠƒ Ⱥ´ŬɓŋµŮɜʠƒ Ʌɞ´ɐƒ ůǗɞgƒ Ⱥ´Ŭɤɔǝɞɨ ƒ Ƭɜʠǘȷ Ůƒ

ɇɞ ůɢɐµŬ 7, ŭŮɞɜŮɏɜŬ ŮŬɤɔǝŋ ǝɜʠǘȷŬ ɓȷ Ŭɞgǝgǝǝɤ µɏɜɞg ǝǝɤ ɓɞɨ . ȄǗɞ ůǗŸǗʠ Ǘʠƒ µʠɢŬɜɐƒ ŮŬȷ µŋɓŮǗŬǝ Ǘǝŭ Ůůǝŋ ůɨ ůǗʠµŬ ǗŸůǗɤ ɜ µŮ Ŭ ɞǗɏǝŮůµŬ ɞǝ Ŭɤɔɞɑ Ǘɞg ůǗŸǗʠ ɜŬ ŭǝȷȷɏɞɜǗŬǝŬ ŋ Ǘǝŭ Ůůǝŋ ůɨ ůǗʠµŬȷ Ůgµ ŸǗɤ ɜ. ȷ gǗŸǗŬȷ Ůɨ µŬǗ´ Ŭȷ Ÿɔɞgɜ Ǘɞ ´Ůɞ Ǘɞg ůǗŸǗʠ Bs ´ɞg ´ Ŭȷ ɜůǗȷ ɏǘ ŮǗŬǝ µŮŬɜʠɤȷ ɞǝɞɔǝŬǝɐ ǘɞȷ ŸǝŬǝ µŮǗŬɞɨ Ǘʠ ǗŬ

$$n_{sync} = \frac{120 f_e}{P}$$

ȳ´ɞg fe ŮɞŬǝ ʠ ůgɞɜŋǗʠǗŬ Ǘɞg ůgůǗɐµŬǗɞƒ ůŮHz ǝŬǝ Ʌ ɞ Ŭȷ ɜʠµŋƒ Ǘɤ ɜ ´ŋǝɤ ɜ Ǘʠƒ µʠɢŬɜɐƒ. ɇɞ µŬɜʠǗǝŋ ´Ůɑɞ Bs ǝŬɑ ƒ ŭǝɏȷ ɢŮǗŬǝ ´Ÿɜɤ Ŭ ŋ Ǘɞgƒ Ŭɤɔɞɨ ƒ Ǘɞg ǘȷ ɞµɏŬŮ ŸɔŮǝǝŸ ɞǝŬǗŸůʠ ůǗŬŸǝȷ ŬǗɞgƒ.

¢ ǗŸůʠ Ůɜô ŮŬɤɔɐƒ ůǗŬ Ÿǝȷ Ŭ Ůɜŋƒ ůgɔǝŮɜȷɜµɏɜɞg Ŭɤɔɞɨ Ǘɞg ǘȷ ɞµɏŬ ŭɑŮǗŬǝ

$$e_{ind} = (v \times B).l$$

ŋ´ɞg ɜ = ʠ ůɢŮǗǝɐ ǗŬɨ ǗʠǗŬ Ǘɤ ɜ Ŭɤɔɩ ɜ Ǘɞg ǘȷ ɞµɏŬ ɤ ƒ ´ȷɞƒ Ǘɞ µŬɜʠǗǝŋ ´Ůɑɞ, ɗ = ʠ µŬɜʠǗǝɐ ŮŬɤɔɐ Ǘɞg ´Ůɑɞg Ǘɞg ůǗŸǗʠ ǝŬǝ l = Ǘɞ µɐǝɞƒ Ǘɞg Ŭɤɔɞɨ Ǘɞg ǘȷ ɞµɏŬ.

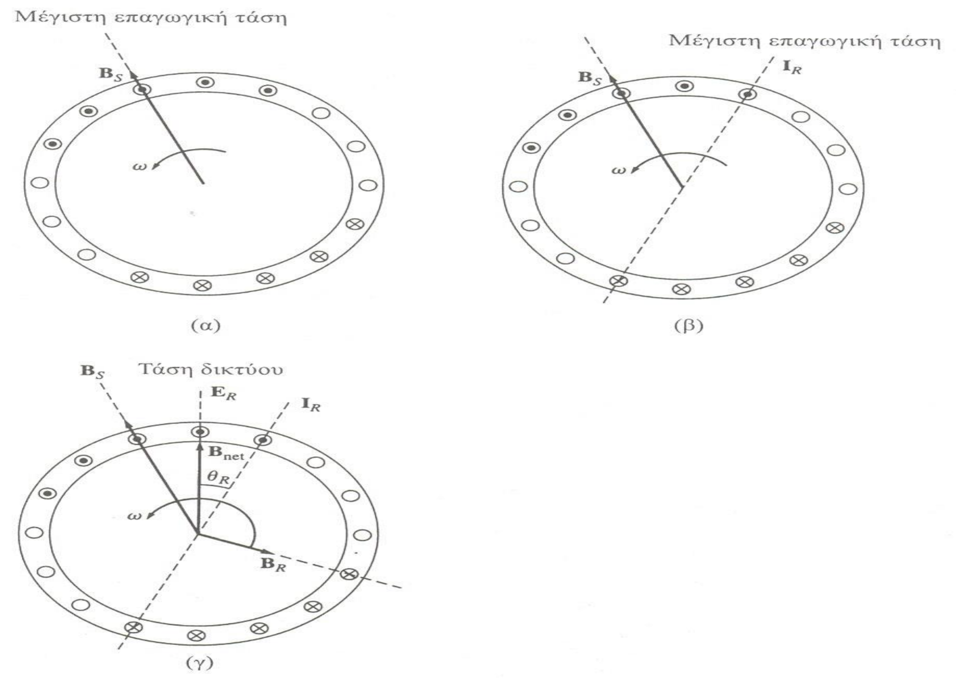
¢ ǗŸůʠ ůǗŬ Ÿǝȷ Ŭ Ǘɤ ɜ Ŭɤɔɩ ɜ Ǘɞg ǘȷ ɞµɏŬ ´ȷɞǝŬǝŮǗŬǝ Ŭ ŋ Ǘʠ ůɢŮǗǝɐ ǝɑʠůʠ Ǘɞg ǘȷ ɞµɏŬ ɤ ƒ ´ȷɞƒ Ǘɞ µŬɜʠǗǝŋ ´Ůɑɞ Ǘɞg ůǗŸǗʠ. ¢ ůɢŮǗǝɐ ǗŬɨ ǗʠǗŬ [illegible] (Εικ 7b). [illegible] BR.

[illegible]

$$\tau_{ind} = \kappa \mathbf{B_R} \times \mathbf{B_s}$$

[illegible]

[illegible] emd [illegible]



Ɇǰ ¢ ɀ ɉ 7 ¢ ŬɜŸ ǗǥɜɁ ǗɁǤ ŮŬɦɥµŮɜɁǤ ɟɞ´ɐǤ ů' ɏɜŬɜ ŮŬɤɔɕɦ ɘɕɁǗɟɟŬ, (Ŭ) ɇɞ ůǕ ǕŮɦµŮɜɞ µŬɜɁǗɕɦ ´Ůɕɶ Ǘɐǥ ůǗŸǗɁ ȴS ´Ǖɟ ŸɔŮɕ ǗɁɜ ǗŸůɁ Ůɜ ŮŬɤɔɐǤ ůǗɕǤɟŸɓŭɞǥǤ Ǘɐǥ ǔɟɞµɏŬ, (ɓ) ¢ ǗŸůɁ Ůɜ ŮŬɤɔɐǤ ´ǕɟŸɔŮɕ ɘŸ ɞɕ ɟŮɨ µŬ ůǗɜ ǔɟɞµɏŬ ´ɞǥ ɏ´ŮǗǗɕ ǗɁǤ ǗŸůɁǤ ŮɜŬɕǗɁŬǤ ǗɁǤ ŬǥǗŮŬɤɔɐǤ ´ɞǥ ´ǕɟɞǥůɕɛŮɕ ɞ ǔɟɞµɏŬǤ, (ɔ) ɇɞ ɟŮɨ µŬ Ǘɐǥ ǔɟɞµɏŬ ´ǕɟŸɔŮɕ Ǘɜ µŬɜɁǗɕɦ ´Ůɕɶ Ǘɐǥ ǔɟɞµɏŬ ȴR ´ɞǥ ɏ´ŮǗǗɕ Ǘɐǥ ɟŮɨ µŬǗɐǤ ɘŬǗŸ 90° ɘŬɕ ůŮ ůǥɜǔǥŬůµɦ µŮ Ǘɜ ȴt ´ǕɟŸɔɞɜ ǗɁɜ ŬɜɁɤɟɞɘɞɔɕŬɐ ɟɞ´ɐ ůǗɜ ŮɕɤǗǕɕɦ ǗɁǤ µɁɕŬɜɐǤ.

[illegible] 2: [illegible]

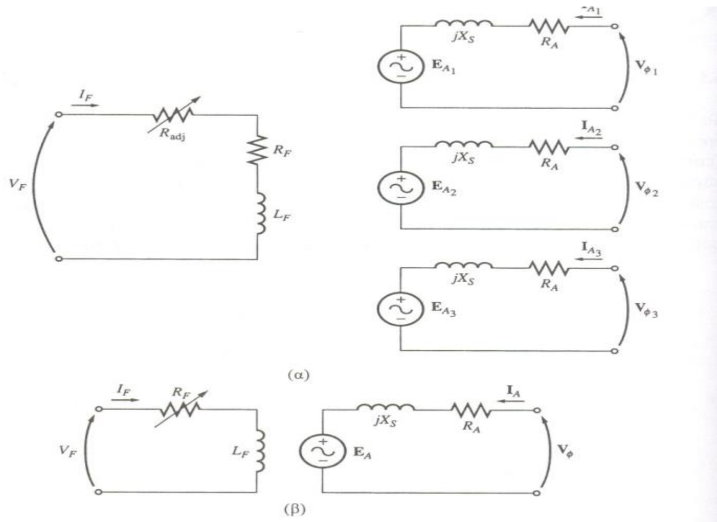
2.1 [illegible]

[illegible] [illegible] Kirchhoff [illegible] [illegible] -8β, [illegible]

$$V_\varphi = E_A + iX_s I_A + R_A I_A$$

ή

$$E_A = V_\varphi - jX_s I_A - R_A I_A$$



[illegible] 8

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

1. [illegible]

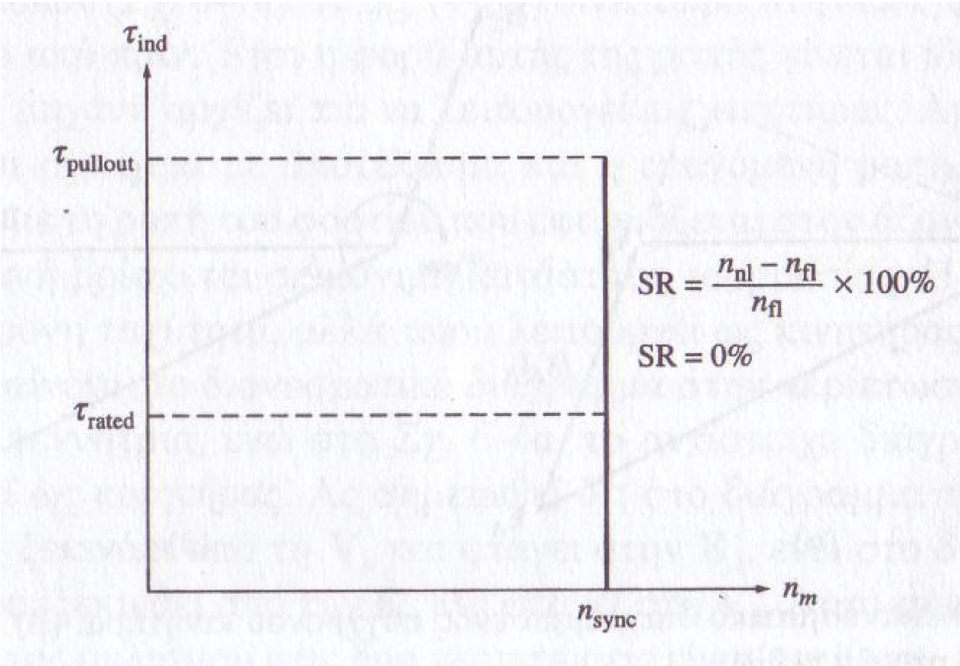
2. [illegible]

3. [illegible]

[illegible]

2.2 ḟ Ǔɉ Ǚǝ Ǘḓɉ ǝůǗǝɐ Λɕ´ ɐɋ-ǩ Ǚɕɨ Ǘḓ ǗǗɋ Ɇɨ ɔɕɉ ɕɜɕg Ʈ ɜɜḓ Ǘɇɉ Ǔ

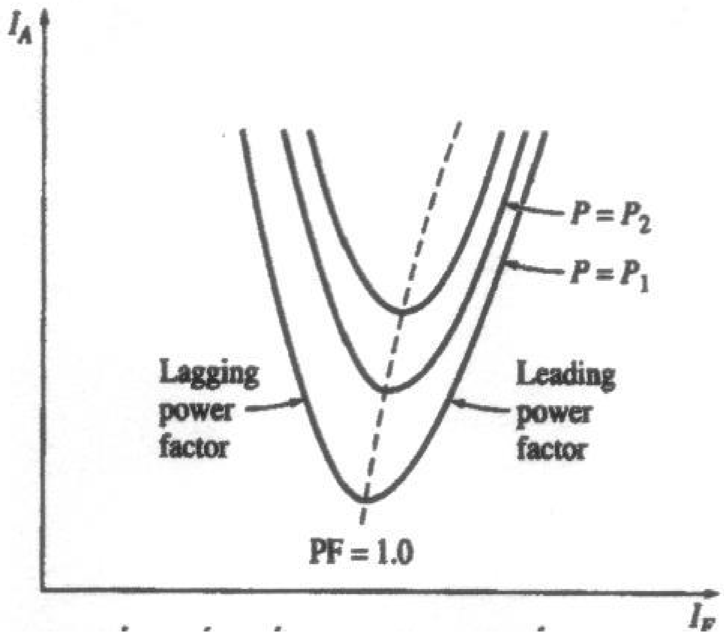
¢ ǗǗɕɨ Ǘḓ ǗǗ Ǘɕg ɘɜɜḓ Ǘɇɉ Ǔ ǔǗɜ ǕɜǓɉ ǗƳǗǝ Ǔ ɧ Ǘɕ ǘɕɉ Ǘɕ Ǘɕg, ǙɘɘƳ Ǔ ɧ Ǘḓ ůgɕɜɧǗḓǗǗ Ǘḓɋ ǗƳůḓɋ Ǘɕǘɕǔɕůḓǔɋ. ¢ ɕǓɉ Ǚǝ Ǘḓɉ ǝůǗǝɐ ɉɕ´ ɐɋ ï ǗǗɕɨ Ǘḓ ǗǗɋ ůɨ ɔɕɉ ɕɜɕg ɘɜɜḓ Ǘɇɉ Ǔ ǘǙɜǗǗǝ ůǗɕ ɆɕḓµǓ9.



ɆɕḓµǓ9: ḟ Ǔɉ Ǚǝ Ǘḓɉ ǝůǗǝɐ ɉɕ´ ɐɋ-ǗǗɕɨ Ǘḓ ǗǗɋ ůɨ ɔɕɉ ɕɜɕg ɘɜɜḓ Ǘɇɉ Ǔ

ȳ ´ ɤ ɋ ɔɜɤ ɉ ɶɕɕɡɛ Ů, ḓ ɉɕ´ ɐ ǕɜǓǝ ǓɜƳɘɕɔḓ Ǘḓɋ ǗƳůḓɋ Ǘɕǘɕǔɕůḓǔɋ ɘǓǝ Ǘḓɋ ǗƳůḓɋ ǔɘɐɔǓ ůḓɋ.
Ⱥ´ ɘ´ ɘɐɕɜ, ǕɜǓǝ ǓɜƳɘɕɔḓ Ǘḓɋ ɔɤ ɜḓǓɋ ɛǗǗǝɨ Ǘɤ ɜ ɛǓɜḓǗɘı ɜ ´ Ůɕɤ ɜ ůǗƳǗḓ ɘǓǝ ǔɉɕɛɐǓ ɘǓḓı ɋ ´ Ǔ ǝůǓɐǘɕɜǗǗǝ ɘǓǝḓ ɛɐɔǝůǗḓ ɉɕ´ ɐ ´ ɕg ɛ´ ɕɉ Ůɕɜ Ǔ´ ɉɕůǘɐɉ Ǖɕ ɘɜɜḓ Ǘɇɉ Ǔɋ ůǗɕɜ ƳɜɕɜƳ Ǘɕg ɘɐɔǗǗǝ ɉɕ´ ɐ ǓɜǗǓɕ´ ɐɋ.
ɆŮ´ Ǔá Ǘɤ ůḓ ´ ɕg ḓ ɉɕ´ ɐ Ǘɕg ǘɕɉ Ǘɕg ɜŮ ǓƳůǕǗḓ ɉɕ´ ɐ ǓɜǗǓɕ´ ɐɋ, Ǘɕ ´ Ůɕɶ Ǘɕg ůǗƳǗḓ ǔǗɜ ɛ´ ɕɉ Ůɕɜ Ǔ ůgɔɘɉ ǗǗɕůǕǗɕɜ ǔɉɕɛɐǓ Ǘḓɋ ɛḓɕǓɜɐɋ, ɛŮǓ ɕǗɐǕɐŮɛǓɕ ǔɉɕɛɐǓɋ ɜǓ Ů ɗɉ Ǔɨ ɜǗǗǝ ɘǓǝ Ǘɕ ´ Ůɕɶ Ǘɕg ɜǓ ɛɐɜŮ ´ ɕɘɨ ´ ɑůɤ Ǔ ɧ Ǘɕ ´ Ůɕɶ Ǘɕg ůǗƳǗḓ. Ƀɘ ǙɘɘǙɐɋ Ǔgǔɐɋ ´ ɉ ɕɘ Ǚɘɕɨ ɜ ǙɘɘǙɐ ɘǓǝ ůǗɕ ´ ɉ ɧůḓɛɕ Ǘḓɋ ǘɕɉ Ƴɋ Ǘḓɋ ɉɕ´ ɐɋ ɘǓǝ ɤ ɋ Ǔ ɕǗɐɘŮɛǓ ǓɜǓ Ǘɨ ůůɕɜǗǗǝ ǝůɕɕɉ ɐɋ ǔɕɜɐůǕǗɋ ůǗɕɜ ɘɜɜḓ Ǘɇɉ Ǔ, ɕɘɕ´ ɕḓǗɋ ɕǓɉ Ǚǝ Ǘḓɉ ɶɕɜǗǗǝ ɤ ɋ Ǔ ı ɘǕɐǓ Ǘɕg ůgɔɕɉ ɕɜǝɛɕɨ .
ɆŮ´ Ǔá Ǘɤ ůḓ ´ ɕg ḓɐɘɕɡɛŮɜǓ´ ɉɕɘǙɐůɕɡɛŮǓɨ ɜḓůḓ Ǘḓɋ ɉɕ´ ɐɋ ǓɜǗǓɕ´ ɐɋ, ǔɘǗǗḓɉ ı ɜǗǗɋ ůǗǗḓŮǓɐ Ǘḓɜ ǗƳůḓ Ǘɕǘɕǔɕůḓǔɋ Ǘɕg ɘɜɜḓ Ǘɇɉ Ǔ, ɛ´ ɕɉ ɕɨ ɛ Ů ɜǓ Ů ɐɛɓɕɡɛ Ů ůǗḓ ǔɘɐɔǓ ůḓ Ɇ.Λ. ¢ ɛǗǗǓɓɕɘɐ Ǘḓɋ ɉɕ´ ɐɋ ǓɜǗǓɕ´ ɐɋ ǕɜǓǝ ǓɜƳɘɕɔḓ Ǘḓɋ ɛǗǗǓɓɕɘɐɋ Ǘḓɋ ǗƳůḓɋ ǔɘɐɔǓ ůḓɋ, ɘɘ Ů ɕɛɐɜɤ ɋ ůŮ ´ Ǔá Ǘɤ ůḓ ɡ´ Ǔ ǔɘɐɔǓ ůḓɋ Ǘɛǘ Ǔɜɶ ǗǗǝ ɛ ǓƳɘḓ ɉɕ´ ɐ.

Ɇǘɕɡʃ ůɨ ɔɢɟ ɞɜɞɡʃ ǝɷɖǘɟǛʃ ɞɘ ɛǛǘɓɞɚɣʃ ǖɘɔǛ ůɐʃ ǘɕɡʃ ´ɟɞǝǛɐɨɜ ɛǛǘɓɞɚɣʃ ǝǛ ůǘɜ ůɡɜǘǛǘǘ ɘůɢɨɞʃ. Ʉɶ ǛɜǛɡǘɘɎ, ɔɘǛ ůɢǘǘɘɎ ɢǛɛɖɚɣʃ ǘɛɣʃ ǖɘɔǛ ůɖʃ ɞ ǝɷɖǘɟǛʃ ůɡɛ´Ǜɘǘɣɟ ǛǘǛ ůǛ Ǜ Ǜɤ ɔɘɧ ǘɞɟǘɞ, ɔɘǛ ɛǛ ɛɧɜɞ ǘɛɐ ǖɘɔǛ ůɖʃ ůɡɛ´Ǜɘǘɣɟ ǛǘǛ ůǛ ǝǛǖǛɟɎ ɤɛɘɧ ǘɞɟǘɞ ǝǛ ɔǛ ɡɣɖɚɣʃ ǘɛɣʃ ǘɖʃ ǖɘɔǛ ůɖʃ ůɡɛ´Ǜɘǘɣɟ ǛǘǛ ůǛ ɢɤɟɖǘɘɧ ɔǛ ǘɛ ǖɷǘɡɞ ǘɞɟǘɞ (**Ɇɢɖµǚ 10**).



Ɇɢɖµǚ 10: ***ǘɟǛǘɚɐ ´Ǜɟ Ɏů ǘǘůɖ ǘɡ ɟ Ǜ ɛǛǘɡʃ ɞ´ǝůɛɞɨ I_J ůɡɜǛɟ ǘůǛ ǘɡ ɟ Ǜ ɛǛǘɡʃ ǖɘɔǛ ůɐʃ ǘɡ** *IF*

Ά´ɞɛɣɜɤ ɡ, ɧǘǘɜ ɞ ůɨ ɔɢɟ ɞɜɞɡʃ ǝɷɖǘɟǛʃ ǛɞǛɘůǛǝǛǘɎůǘǘůɖ ɡ´Ǜ ǖɘɔǛ ůɖʃ ´ɟɞůǘɣɟ Ǜů ůǘɜ Ɏɜɞɜ Ɏǘɡ ɛǛɎɚɖ ɟɞ´ɐ ǝǛ ůɡɛ´Ǜɘǘɣɟ ǛǘǛ ´Ǜɟ Ɏɚɖǝ ǛůǛ ɢɤɟɖǘɘɧ ǘɞɟǘɞ. ɀ ǛǛɡǘɧ ǘɜ Ǜɧ´ɞ, ɛ´ɞɟ ǛǝǛǘɐɟ ɖ ɜǛǘɜ ůɡɜǘǛǘǘ ɘůɢɨɞʃ ǘɖʃ ǛǝǛǘɎůǘǘůɖʃ ɧ´ɞɡ ǛǛǘǘ´ɞǘǘɖɛɣɜɞɡ.

ɇǛ´ǝǘɜǛǘɐɛǛǘǘɢɟɐůɖʃ Ǜɧʃ ůɨ ɔɢɟ ɞɜɞɡ ǝɷɖǘɟǛ ǛǛǛǘǘ Ǜɐɡ:

- ȼ ǘɢɨ ǘɖǘǘ´Ǜɘǘɞǘɐʃ ´Ǜɛɣɜ ǛůǘǘǛɐ ǝǛǛǛǛǛɎɟ ǘɖǘɖ ǘɡ ǘɞɟǘɞɡ
- ȼ ɛǛɎɚɖ Ǜ ɧǘɞůɖ ǝǛ ɧɚɖ ɖ ɘɢɨ ɡ ǘɡ ůǘɎǘɖ ɛǛǘǘɣɟ ǛǘǛ ůǘɜ ǘɟɞɛɣǛ ɢɤɟɖ Ǜ ɩ ǝǛǘɡ
- ɸɡɜǘǘǘǘǘ ɣɖɚɐʃ ɟɞ´ɐɡ ǛɧǘɞɎ ɖ ɞ´ɞǛ ǛǛɢǛǘ Ǜ ǝɞɞǛ Ǜ ɧ ǘɛ ǝɨ ǝɚɤ ɛǛ Ɇ.Λ. ǖɘɔǛ ůɖʃ ǘɤɜ ´Ǜɘǘɞ ǘɧɛ ǛǛɤɜ ´ɧɚɤɜ
- ɸǛǘǘɤ ůɖ ǘɡ ůɡɜǘǛǘǘ ɘůɢɨ ɞʃ ǘɖʃ ǛǝǛǘɎůǘǘůɖʃ

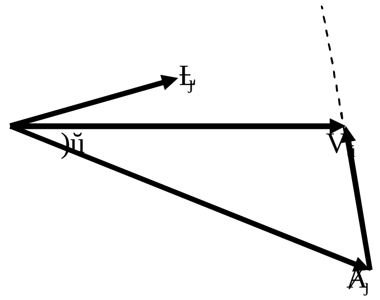
ɀ Ǜ ɓɎůɖ ǘǘ ´ǛɟǛ Ɏɜɤ ´ǝǘɜǛǘǘɛǛǘǘ ǘɡ ůɨ ɔɢɟ ɞɜɞ ǝɷɖǘɟǛ ǝǘǘɐɔɞɡɛǛ ůǘ ůɡɛ´ɣɟǘɛǛ ɧǛǛ ɞǘǘǛǘɜ ǝǘǛɧ ǝɷɖǘɟǛ ɔǛ ɖǛǘǛɔɐ ´ɟɧɤ ůɖ. ɇɞ ɛɧɜɞ ɛǛɜɣɐǘǖɛɎ ǘɡ ǛǛǛɧǛǛǛǛǘɛɐɞɜɞɛɛɐɧʃ ůǛůɢɣůɖ ɛǛǘɜ ǘůɨ ɔɢɟ ɞɜɞ ǝɷɖǘɟǛ.

2.3 [illegible]

[illegible]?

[illegible] 11 [illegible].

[illegible] 11 [illegible] (= [illegible]) [illegible].



[illegible] 11. [illegible]

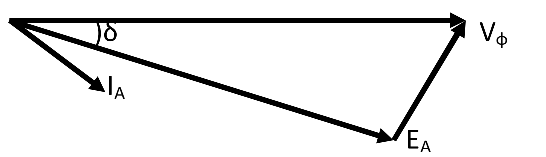
2.4 [illegible]

[illegible]

[illegible] 12, [illegible]

[illegible] E_A [illegible] V_ϕ [illegible] $A_j \sin\delta$ [illegible] $\cos\delta$ [illegible]

[illegible] Q. [illegible] V_ϕ [illegible] Q [illegible] Q [illegible]



[illegible] 12 : [illegible]

2.5 [illegible]

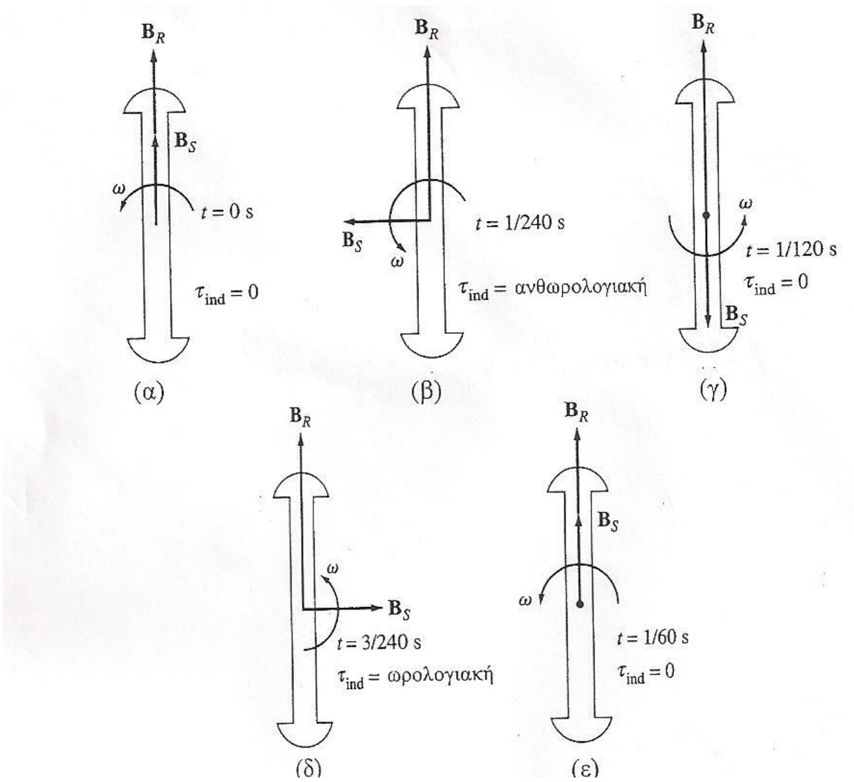
[illegible] 50Hz [illegible] 60Hz [illegible].

[illegible] 13 [illegible] t =0 s. [illegible] $\mathbf{B}_R$ [illegible] $\mathbf{B}_S$ [illegible].

$$\tau_{ind} = K\mathbf{B}_R \times \mathbf{B}_S$$

[illegible] 13 b, [illegible] t=1/240s. [illegible] t=2/240s, [illegible] 13c, [illegible] t=3/240s, [illegible] τ_{ind} [illegible].

[illegible] t=4/240 s, [illegible]



$\mathbf{B}_R$
$\mathbf{B}_S$
ω
$t = 0$ s
$\tau_{ind} = 0$
(α)
$t = 1/240$ s
τ_{ind} = ανθωρολογιακή
(β)
$t = 1/120$ s
$\tau_{ind} = 0$
(γ)
$t = 3/240$ s
τ_{ind} = ωρολογιακή
(δ)
$t = 1/60$ s
$\tau_{ind} = 0$
(ε)

[illegible] 13. [illegible]

[illegible]

1. [illegible]
2. [illegible]

2.5.1 [illegible]

[illegible]

[illegible]

[illegible]

- [illegible] (cycloconverters)
- [illegible] (synchroconverters)

[illegible] Hz [illegible]

[illegible]

2.5.2 [illegible]

[illegible]

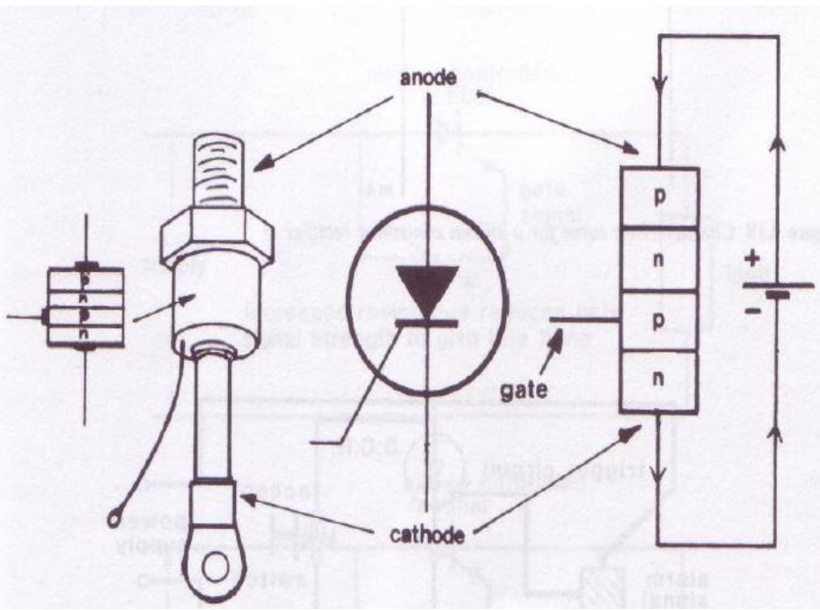
[illegible]

[illegible]

2.6 [illegible]

2.6.1 [illegible]

[illegible] (Figure 2).



ʎƨɲʄɜǓ2: Silicon Controlled Rectifier (SCR)

ɇ Ǔ ɗɡɟ ɑůǗɞɟ ǚǛɜ Ɏɔɞɡɜ ɦǗǕɞ ´ ɞɚɤ ɗɞɨ ɜ ɞɟɗƳ, ǛǗɦɠ ǛƳɜ ɖ ǗƳůɖ ´ ɦɚɤ ůɖɠ ǛɞǓɘ ɛǛƳɚɖ. ɟ ɡǗɦ ůɡɛ ɓǓɞǛɘ Ů Ǜǚɐ ɖ ɛǛǚǓǓ Ů Ǔǚɐ n-p ǛɞǓɘ ´ ɞɚɤ ɛɏɜɖ ǓɞƳůǗɞǘǓ. ɒ ɔɞɡɜ ɛɦɜɞ ɦǗǕɞ ůǗɞ Ǘɖǘɞ Ǘɞɡɠ ɖɚǛɘǗ ɦǚɞ ´ ɞɡ ɚɏɔǛǗǕɘ ´ ɨ ɚɖ (gate) ůǗɖɜ ´ ɨ ɚɖ Ǘɞɡɠ ǛǘǓɟ ɛɞůǗǘɏɜǓɠ ´ Ǔɚɛ ɦɠ. ɖɖɚǓǚɐ ǛɞǓɘɏɜǓɠ ɖɚǛɘǗ ɞɜɘɦɠ ǚɘǓɘɦ ´ Ǘɖɠ ´ ɞɡ ƳɔǛɘɦ ´ ɞǗǗǚɞɗǛɑ ´ Ǔɚɛ ɦɠ ɘǓɘ ´ ǓɨǛɘ ɜ Ǔ ƳɔǛɘ ɦǗǕɞ ´ ɞɚɤ ɗǛɑ ǓɞƳůǗɞǘǓ. ¢ ɢɟ ɞɜɘɐ ǚɘƳɟ ɘǛǛǓ Ǘɞɡ ´ Ǔɛɞɨ ´ ɞɡ ɢɟ ǛɘƳɞǗǗǕɘ ɔɘǓ ɜ Ǔ ƳɔǛɘ Ǘɞ ɗɡɟ ɑůǗɞɟ ɛ ǗǗɟ ɘɏǗǕɘ ůǗ microsecond.

ɄǓɟ Ƴ Ǘɞ ɛɘɟ ɦ Ǘɞɡɠ ɛɏɔǛɗɞɠ, ǗǕ ɗɡɟ ɑůǗɞɟ ɛ ´ ɞɟ ɞɨ ɜ ɜ Ǔ ɢɟ ɖůɶ ɞ ´ ɞɘɖɗɞɨ ɜ ɔɘǓ ɜ Ǔ Ǜɞɏɔɞɞɡɜ ɟ Ǘ ɛ ǗǗǕ Ǘɖɠ ǗƳɜɖɠ Ǘɤ ɜ ɢɘɘƳǚɤ ɜ Ǔɛ ´ ɏɟ ɘǓɜ ǓǚǗǗɞɨ ɜ ǗƳůǗɠ ɢɘɘƳǚɤ ɜ ɓɞɘǗůǗǕ Ƴɘɟ Ǔ Ǘɞɡɠ.

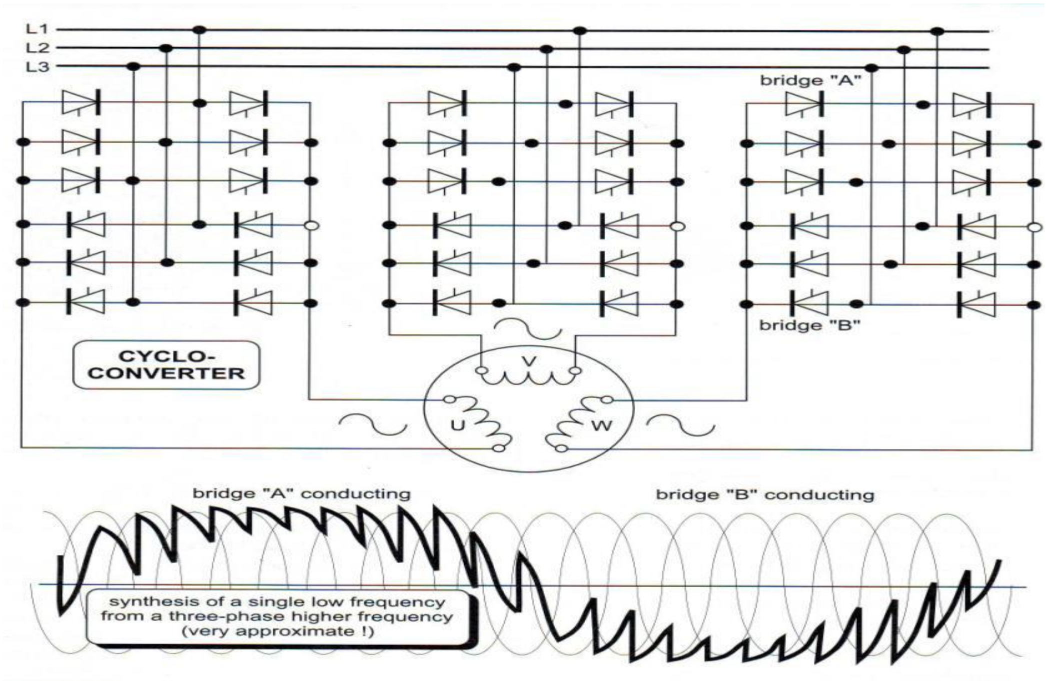
2.6.2 [illegible]

[illegible] 0 [illegible] 1/3 [illegible] (0-20Hz). [illegible].

[illegible] 50Hz [illegible] 60Hz). [illegible].

[illegible] 120^{o} [illegible].

[illegible] (noncirculating current cycloconverters) [illegible] (circulating current cycloconverters). [illegible].


L1
L2
L3
bridge "A"
bridge "B"
CYCLO-CONVERTER
V
U
W
bridge "A" conducting
bridge "B" conducting
synthesis of a single low frequency
from a three-phase higher frequency
(very approximate !)

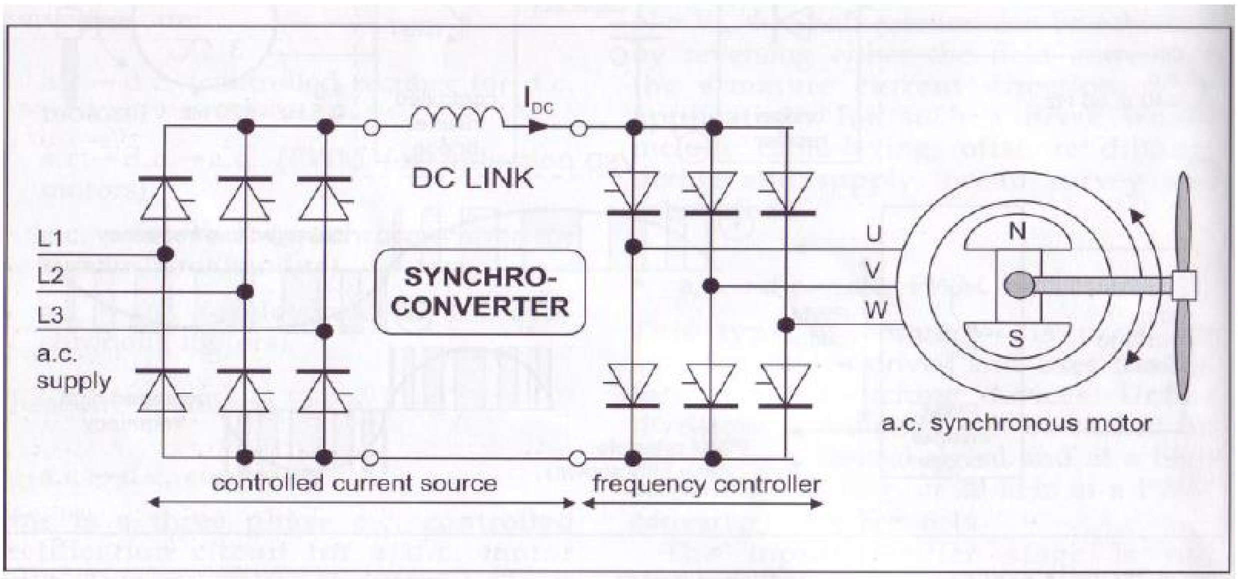
[illegible] 3: [illegible]

[illegible] 60Hz, [illegible] 20Hz.

[illegible]

2.6.3 ЕgɔɢʇɞɛŮŰŬǰɞ´ɏŬʃ

Ƀɘ ůgɔɢʇɞɛŮŰŬǰɞ´Ůɗʃ ɛŮŰŬǰɏ´ɞgɜ Ŭǰɢɘɐ ƳŰɖɜ ŮɞŬɘǝŬůůɧɛŮɞɖ ɘůɢɨ ůŮůgɜŮɢɐ ŭɖǝŬɐ ´ǰɘŬɛƃƳɜɞgɜ ŮɞŰɦůǰɞűɏŬ (inverter), ǝŬɘ ǝŬŰɧ´ɜ Űɖ ůgɜŮɢɐ ŬgŰɐ ɘůɢɨ ůŮ ŮɞŬɘǝŬůůɧɛŮɞɖ ɛŮ ŭɘŬűɞʇŮŰɘɐ ůgɢɜɧŰɖŰŬ Ŭ ɧ Űɖɜ Ŭǰɢɘɐ, ɖ ůgɢɜɧŰɖŰŬ Ůɞɧŭɞg Űɤ ɜ ůgɔɢʇɞɛŮŰŬǰɞ´ɏɤ ɜ ɛ´ɞʇŮɑɜŬ ɛŮŰŬƃƳǝǝŮŰŬɘŬ ɧ 0 ɛɏɢʇɘ2 űɞʇɏʃŰɖ ůgɢɜɧŰɖŰŬ Űɞg ŭɘŰɨ ɞg (0-120Hz).



*Ⱥɘɧ ɜŬ 4: **Ʈɨ ǝǝɤ ɛŬ Ɇgɔɢʇɞɛ ŮŰŬǰɞ´ɏŬ***

ɆŰɞ ǝɨ ǝǝɤ ɛŬ Űɞg ůgɔɢʇɞɛŮŰŬǰɞ´ɏŬ Ůɞɞʇɖɩ ɜŮŰŬɘ ɖ Ŭǰɢɘɐ ŰƳůɖ Űɞg ǝɜɖŰɐʇŬ ǝŬɘ Űɞ ůŰŬɖǰɧ ůgɜŮɞɏʃ ʇŮɨ ɛŬ ´ɞg ´ʇɞǝɨ´ŰŮɘ ɛŮŰƳ Űɞ ´ɖɜɞ (űɞɐŰǰɞ), ɛŮŰŬǰɏ´ŮŰŬɘ ´Ƴǝɘ ůŮ ŮɞŬɘǝŬůůɧɛŮɞɞ ǝŬɘǰɞűɞŭɞŰŮŰɞɜ ůŰƳŰɖ Űɞg ǝɜɖŰɐʇŬ.

¢ ůgɢɜɧŰɖŰŬ Űɖʃ ŮɞŬɘǝŬůůɧɛŮɞɖʃ ŰƳůɖʃ ʇgɖɛɞŮŰŬɘ Ŭ ɧ Űɖ ůgɢɜɧŰɖŰŬ ɛŮ Űɖɜ ɞ´ɞɖŬ ŭɞɞɜŰŬɘɞɘ´Ŭǝɛɞɑ ůŰɖɜ ´ɨ ǝɖ Űɤ ɜ ɖgʇɑŰɞʇ Űɖʃ ŭŮŰɨ Űǰ ɖʃ ɔɏűgʇŬʃ.

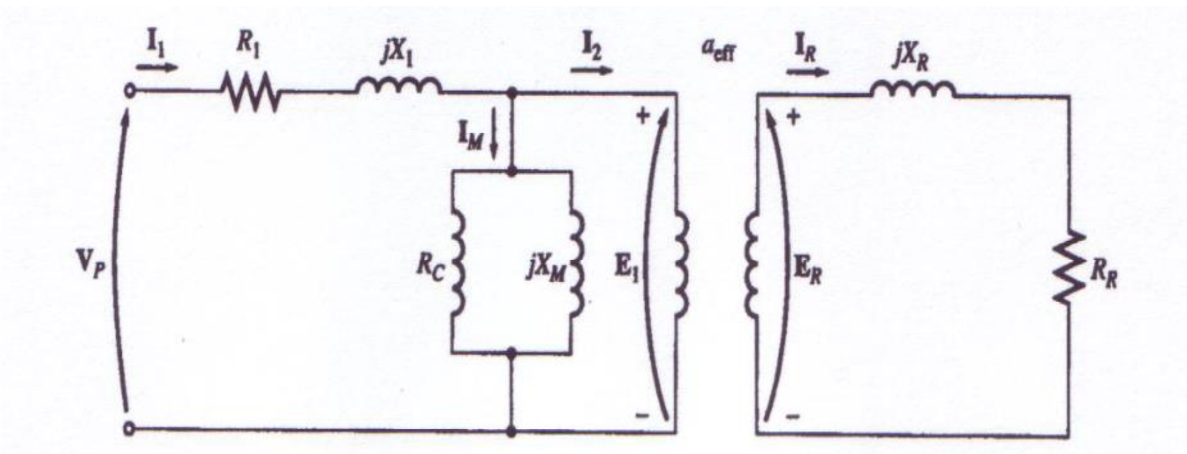
¢ ʇɞ´ɐ Űɞg ǝɜɖŰɐʇŬ ɛ´ɞʇŮɑɜŬ ŮǝŮɖŰɑŬ ɧ Űɞ ɛɏɔŮŰɞʃ Űɞg IDC Űɞ ɞ´ɞɞ ŮǝɏɔɢŮŰŰɘ Ŭ ɧ Űɖ ůgɢɜɧŰɖŰŬ ´ɞg ŭɞɞɜŰŬɘɞɘ´Ŭǝɛɞɑ ůŰɖɜ ´ɨ ǝɖ Űɤ ɜ ɖgʇɑŰɞʇ Űɖʃ ɔɏűgʇŬʃ Ůɜɧʇɖɤůɖʃ (Ŭǰ ɘůŰǰƳ), Ůɜɩ ɖ ŰŰɢɨ ŰɖŰŬ Ŭ ɧ Űɖɜ ůgɢɜɧŰɖŰŬ Űɤ ɜ ´ŬǝɛɩɜůŰŰ ɖgʇɑŰɞʇ Űɖʃ ɔɏűgʇŬʃ ´ɞg ǰɞűɞŭɞŰŮŰɞɜ ůŰƳŰɖ Űɞg ǝɜɖŰɐʇŬ.

[illegible] 3: [illegible]

3.1 [illegible]

[illegible] (singly excited) [illegible] (doubly excited), [illegible]

[illegible]



[illegible] 5: [illegible]

[illegible]

´Ůňœ з Ű๕g ůŰŸŰ฿ əŬэ Ű๕g ŭɟђεŮŬ, ŰђůϬ εŮɔŬэɨ ŰŰʝ ฿ ŮϫŬэ ฿ ŰŸů฿ ´ϬgŬзŬ Űɨ ůůŮŰŬэ ůŰ๕ ŭɟϬεɏŬ Ű฿ƴ ε฿ϬŬзɐƴ.

¢ εŮɔŬэɨ ŰŰʝ ฿ ůϬŮŰэɐ əœ฿ů฿ εŮŰŬзɨ Űɤ з ŭgϬ ´ŮɟŬ Ÿзɤ ´Ůňœ з Ů ϡŰgɔϬŸзŮŰŰэ, ђŰŬз Ϭ ŭɟϬεɏŬƴ Ű฿ƴ ε฿ϬŬзɐƴ ŮϫŬэ ŬэϲϢ฿Ű๕ƴ. ɆŮ ŬgŰɐ Ű฿з ´Ůʝ ά Űɤ ů฿ Ϭ ŭɟϬεɏŬƴ ϬзϬεŸϲŮŰŬэ ŬэϡϢ฿Ű๕´Ϭϡ฿εɏзϬƴ (blocked ɐ locked rotor) əŬэ ฿ ŰŸů฿ ´Ϭg ŮŸɔŮŰŬэ ůŰŬ Űgəœ εŬŰŸ Ű๕g ŮϫŬэ ฿ εɏɔϡůŰ฿ ŭgзŬŰɐ.

¢ ŮэŸϬϡůŰ฿ ŰŸů฿ (0 V) ŮŸɔŮŰŬэ ůŰŬ Űgəœ εŬŰŬ Ű๕g ŭɟϬεɏŬ, ђŰŬз ŬgŰђƴ ´Ůʝ ϡůŰɟ ɏύŮŰŬэ εŮ ŰŰϬɨ Ű฿ŰŬ ά฿ εŮŰ฿з ŰŰϬɨ Ű฿ŰŬ ´Ůʝ ϡůŰɟ ϬύɐƴŰ๕g ´Ůňœg Ű๕g ůŰŸŰ฿, ђŰŬз ŭ฿əŬŭɐ, ŭŮз gύάŮŰŰŬэ ฿ ůϬŮŰэɐ əœ฿ů฿. ŭϡŬəŸ฿ŮŸə฿ ŮзŭϡŸεŮů฿ Ű๕ɐ Ű฿ƴ ŰŰϬɨ Ű฿ŰŬƴ Ű๕g ŭɟϬεɏŬ฿ Ů ŬɔђεŮз฿ ŰŸů฿ ŮϫŬэ ŬзŸəϬɔ฿ Ű฿ƴ Ϭəάů฿฿ů฿ƴ. ŌŰůϡ, Ŭз ฿ Ů ŬɔђεŮз฿ ŰŸů฿, ůŰ฿з ´Ůʝ ά Űɤ ů฿ ´Ϭg Ϭ əϡ฿Űɐɟ Ŭƴ əŮϢŰ๕gɟɔŮά εŮŬэϡ฿Ű๕´Ϭϡ฿εɏзϬ ŭɟϬεɏŬ, ůgεϭϬəœŮэεŮE_{R0}, ฿ Ű๕ɐ Ű฿ƴ Ů ŬɔђεŮз฿ƴ ŰŸů฿ƴ ɔϡŬϬ´ϬϡŬŭɐ´ϬŮŰŰ๕ɐ Ű฿ƴ Ϭəάů฿฿ů฿ƴ ŭœŮŰŬэŬ ђ Ű฿ ůϬɏů฿:

$$E_R = sE_{R0}$$

3.2 ɇ ŬϬɨ Ű฿ŰŬ Ά´ Ŭɔɤ ɔϡϬɨ Ƭϡ฿Űɐɟ Ŭï Ƀəά฿฿ů฿

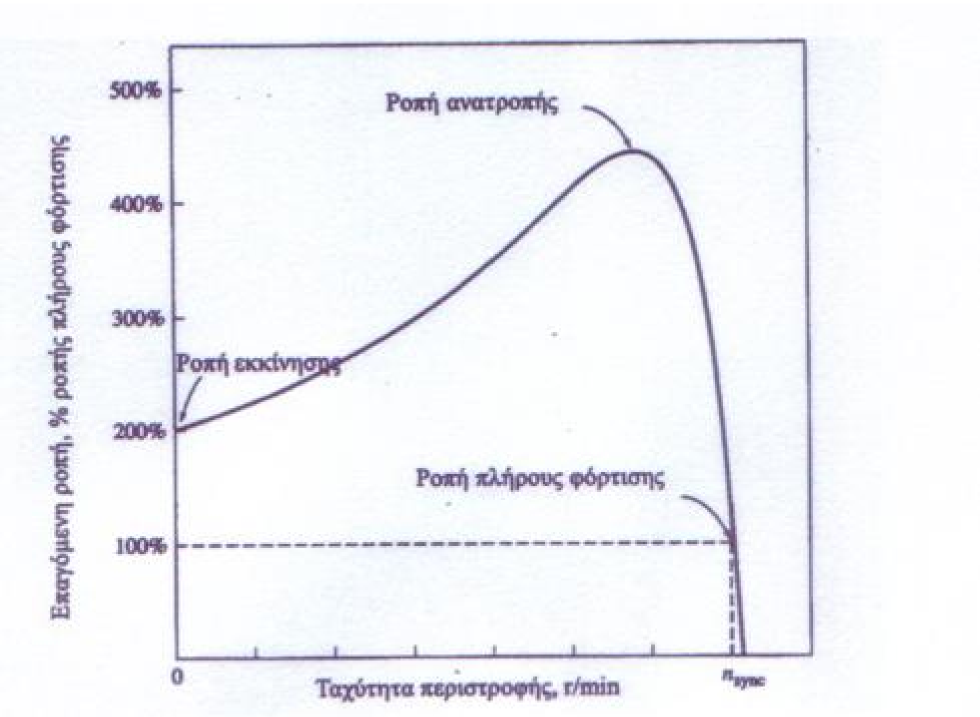
ӯ ŰŬз ɏзŬƴ Űʝ ϡύŬůϡђƴ Ů Ŭɔɤ ɔϡђƴ əϡ฿Űɐɟ Ŭƴ ŰʝϬύϬŭϬŰ฿฿Űά εŮŮзŬэəŬůůђεŮз฿ Űʝ ϡύŬůϡɐ ŰŸů฿, ŭ฿εϡgɟɔŮάŰŬэ ůŰ๕з ůŰŸŰ฿ Ű๕g ůŰʝ ŬύђεŮзϬ εŬɔз฿Űэђ ´Ůňœ, εɏůŬ ůŰ๕ Ϭ´Ϭœ ŮϫŬэ Ű๕´Ϭ฿ŮŰ฿εɏзϬƴϬ əэɤ ϭђƴ Ű๕g ŭɟϬεɏŬ. ¢ ůŰʝ ŬύђεŮз฿ εŬɔз฿Űэɐ ɟϬɐ Ű๕g ůŰŸŰ฿ əђϭŮэ Űgƴ ɟŸϸŭϬgƴ Ű๕g ŭɟϬεɏŬ əŬэ ŮŸзɤ Ű๕gƴ ŭ฿εϡgɟɔŮάŰŬэ ŮзŬэəŬůůђεŮз฿ ŰŸů฿ Ůэ Ů Ŭɔɤ ɔɐƴ. ɇϬ əɨ əэɤ εŬ Ű๕g ŭɟϬεɏŬ ђεɤ ƴ ŮϫŬэ əэŮϡůŰђ əɨ əэɤ εŬ (εŮ Ű๕gƴ ŭŬэŰgəœgƴ ϭɟŬgəɨ əэɤ ů฿ƴ), Ů ϬεɏзɤƴŬ ŭ฿εϡgɟɔŮάŰŬэ ŮзŬэəŬůůђεŮзϬ ɟŮɨ εŬ Ůэ Ů Ŭɔɤ ɔɐƴ. ɆŰƴ ɟŸϸŭϬgƴ Ű๕g ŭɟϬεɏŬ ´Ϭg ŭϡŬɟɟɏзŰŬэŬ ђ ɟŮɨ εŬ, Ů ŮŭɐϭɟάəϬзŰŬэεɏůŬ ůŰ๕ εŬɔз฿Űэђ ´Ůňœ Ű๕g ůŰŸŰ฿, ŭ฿εϡgɟɔϬɨ зŰŬэεŮɨ ɔ฿ ŭgзŸεŮɤ з əŬэ Ϭ ŭɟϬεɏŬƴ ůŰɏύŮŰŰэ Ƀ ŭɟϬεɏŬƴ ŭŮз ε´ϬɟŮά ´ϬŰɏ зŬ ύŰŸůŮэ Ű฿ ůɨ ɔϬɟϬз฿ ŰŰϬɨ Ű฿ŰŬ ´Ůʝ ϡůŰɟ ϬύɐƴŰ๕g εŬɔз฿Űэϭɨ ´Ůňœg Ű๕g ůŰŸŰ฿, ŬŰϬɨ ฿ ´Ůʝ ϡůŰɟ Ϭύɐ Ű๕g ϬύŮэŰŰŬэ ůŰ฿ ŭϡŬŰϬɟŸ ŰŰϬɨ Ű฿ŰŸƴ Ű๕g ůŮůϬɏů฿ εŮŬgŰз Ű๕g ůŰŸŰ฿. ΆŸз Ű฿з ɏύŰŰзŮ, Ϭзɟ ŸϸŭϬϡ Ű๕g ฿Ŭ ɐŰŬз ŬэϢ฿ŰŰƴ ůŮ ůϬɏů฿ εŮŰ๕ ůŰʝ ŬύђεŮзϬ εŬɔз฿Űэђ ´Ůňœ Ű๕g ůŰŸŰ฿.

ϕŮз ฿Ŭ ŮϬŬεŮŰŸů฿ Ůэ Ů Ŭɔɤ ɔɐƴ ůŰ๕з ŭɟϬεɏŬ, Ϭɨ ŰŮɟ Űɨ εŬ əŬэ Ů ϬεɏзɤƴϬ ŭɟϬεɏŬƴ ŭŮз ฿Ŭ ɐŰŬз ŭgзŬŰђз зŬ ´Ůʝ ϡůŰɟ ŬύŮά ¢ ŭϡŬύϬɟŸ ŰŰϬɨ Ű฿ŰŬƴ εŮŰŬзɨ εŬɔз฿ŰэϬɨ ´Ůňœg ůŰŸŰ฿ əŬэ ŭɟϬεɏŬ ŮэύɟŸϬŮŰŬэ εŮŰ฿з ϬəάůϬ฿ů฿ (s).

$$s = \frac{n_s - n_m}{n_s} (\times 100\%)$$

$$n_m = (1 - s) n_s$$

$$f_R = s f_S$$



[illegible]

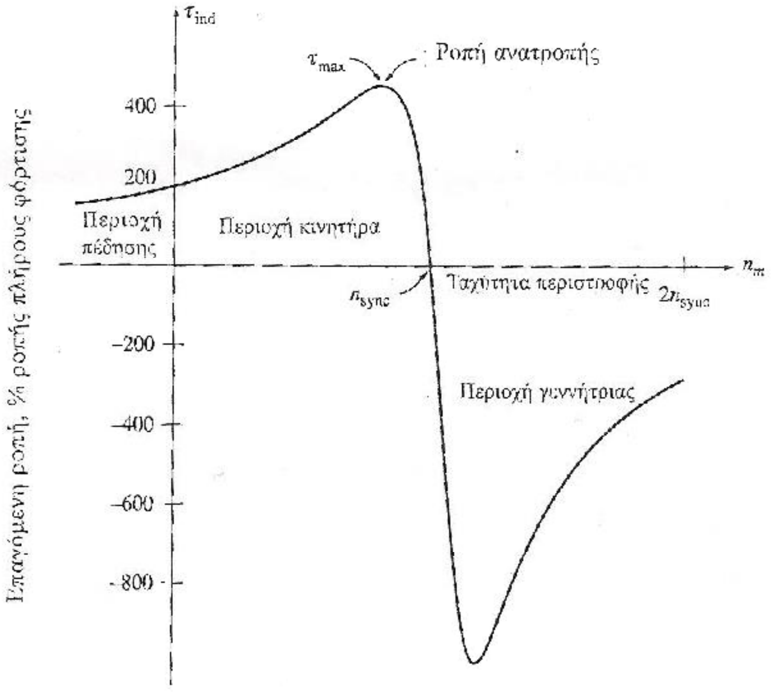
[illegible]

[illegible]

[illegible] Το γεγονός αυτό είναι πολύ χρήσιμο σε μία από τις τεχνικές ελέγχου της ταχύτητας του επαγωγικού κινητήρα.

[illegible]

[illegible] (plugging).



ɆGɐɛŬ 13: ȼ ɢŬɉŬƂůɉ ɘůŬɐɐ ɉɞ´ɐɠï ŰŰɞɨŰůŰŰɠŰɞɡ Ů Ŭɒɤ ɔɘɞɨ ɘɘɞůŰɉŬ, ɧ´ɞɡ űŬɞɜɜŰŰɘɘŬɞɘ ŭɘŮůɉ ɡɛɏɜŮɠ´ Ůɉɘɞɐɏɠɘ ŮŰɞɡɉɔŭɠ(´ Ůɉɘɞɐ ´ɏŭůŮůɠɘŬ´ Ůɉɘɞɐ Ů Ŭɒɤ ɔɘɐɠɔŮɜɐŰɉɘŭɠ)

3.3 [illegible]

[illegible] (across-the-line starting).

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

3.4 [illegible]

[illegible] 5% [illegible] $(P_{RCL} = sP_{AG})$.

[illegible] n_{sync}. [illegible]

[illegible]:

$$n_{sync} = \frac{120 f_e}{P}$$

[illegible] (1) [illegible] (2) [illegible]

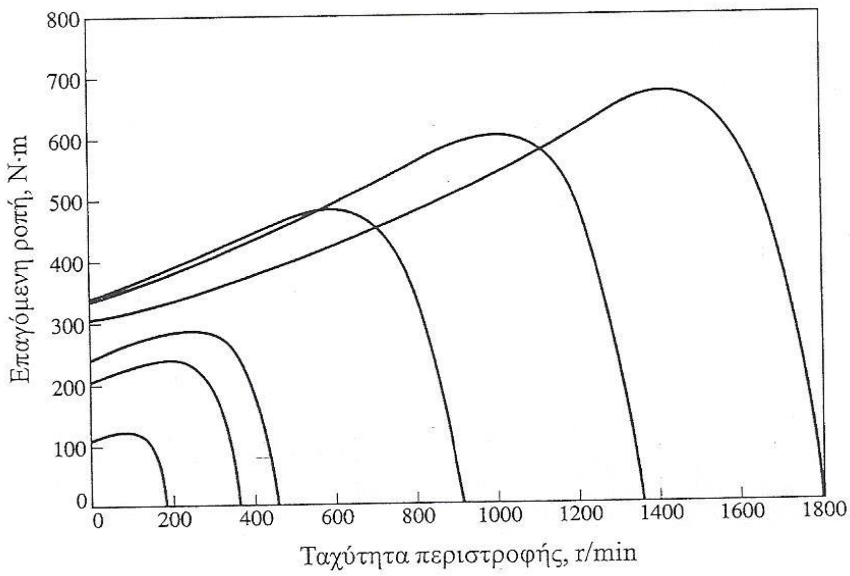
3.5 [illegible]

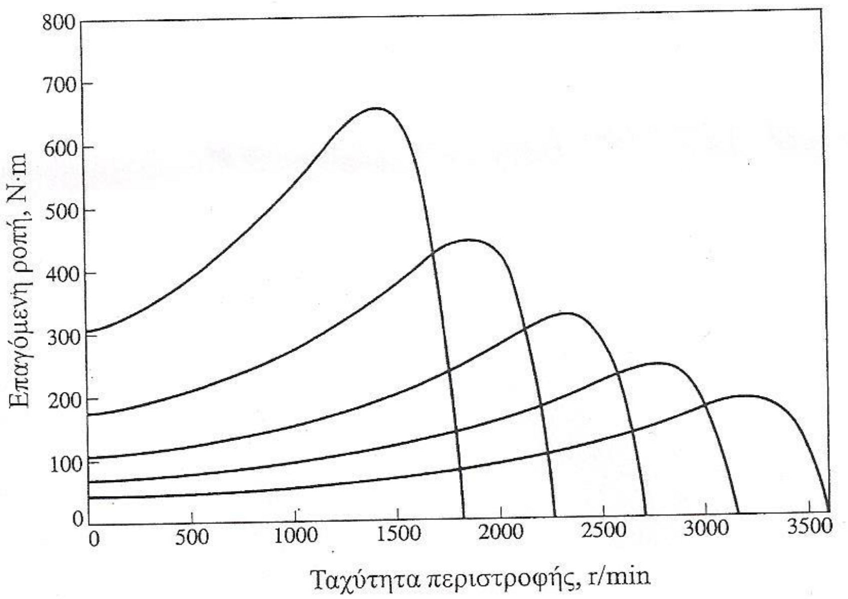
[illegible] n_{sync} [illegible] (base speed). [illegible] 5% [illegible]

[illegible] (derating) [illegible]

[illegible] faraday.

$$v(t) = -N\frac{d\phi}{dt}$$





ƐƌƐƐ Ŭ 16: Ʌɨ ɗɛɱůɖ Ʊɖɠ ƱƱɕɨ ƱɖƱƱɠ Ůɜɧɠ Ů Ŭɤ ɔɘɘɕɨ ɘɘɖƱɟ Ŭ ɛ Ů ɛ ŮƱƱɓɕɘɐ Ʊɖɠ ůɡɕɜɧƱɖƱƱɠ. (Ŭ) Ƀɘɕɔɏɜ ŮɗŬ ɕŬɟ ŬɓƱɖɟ ɱůƱɓɩ ɜ ɟ ɕ´ ɐɠ ï ƱƱɕɨ ƱɖƱƱɠ ɔɘŬ ƱƱɕɨ ƱɖƱůɠ ɘƳƱɤ Ŭ ɧ Ʊɖ ɓŬůɘɐ, ɧ´ ɕɡ ɡ´ ɕƱɖŮƱƱɓ ɧƱɓ ɕɘ ƱƳůŮɠ Ůůɧŭɕɡ ŮɓŬƱƱɪ ɜɕɜƱƱɓ ɔɟ Ŭɛ ɛ ɘƳ ɛ Ů Ʊɖ ƱƱɕɨ ƱɖƱƱ. (ɓ) Ƀɘɕɔɏɜ ŮɗŬ ɕŬɟ ŬɓƱɖɟ ɱůƱɓɩ ɜ ɟ ɕ´ ɐɠ ï ƱƱɕɨ ƱɖƱƱɠ ɔɘŬ ƱƱɕɨ ƱɖƱůɠ´ Ƴɜɤ Ŭ ɧ Ʊɖ ɓŬůɘɐ, ɧ´ ɕɡ ɡ´ ɕƱɖŮƱƱɓ ɧƱɓ ɕɘ ƱƳůŮɠ Ůůɧŭɕɡ ŭɘŬƱɖɟ ɕɨ ɜƱƱɓ ůƱƱɖŬɟ ɏɠ.

ɆŰȅ ´ŬɟŮǽďŋɜ Űȅ ɓŬůɑŋ ɛŮȅɜɐǝŰďɛŬ Űďɠ ɛŬďŋǘɐɡ ɛŮŰŬɓɐǽɐɠ Űďɠ ŰŬɕɨŰďŰŬɠ Űȅɡ ǝɑďŰȇɟŬɛŮɟɨ ďɛɑůď Űďɠ ďǽŮǽŲɑɐɠ Űȅɡ ůɡɕɜŋŰďŰŬɠ ɐŰŬȅ ď ɐǝǝŮɣď ɛɑŬɠ ŮȁǘɑɐɠɔŮȅɜɐŲɑŬɠ ɛŮ ɛŮŰŬɓŬǽǝŋɛŮȅď ůɡɕɜŋŰďŰŬ ɐ Ůȅŋɠ ɛďɕŬȅɑɕɨ Ųŋ´ɕɡ ɛŮŰŬɓɐǽɐɠ Űďɠ ůɡɕɜŋŰďŰŬɠ. ɇɕ ´ɟŋɓǽďɛŬŬɡŰŋ Ů ɑɨ ďďǝŮɛŮŰďɜ ŬȅƳ Űɡɜď Űɣɜ ůɨ ɔɕɟɕɜɣɜ ǘɑŬŰƳɜŮɣɜ ɕǘɐɔďůďɠ ɛŮŰŬɓǽďŰȇɐɠ ůɡɕɜŋŰďŰŬɠ ɛŮďǽŮǽŲɕɜɑɕɨ ɠǘɑŬŋ´Űɠ.

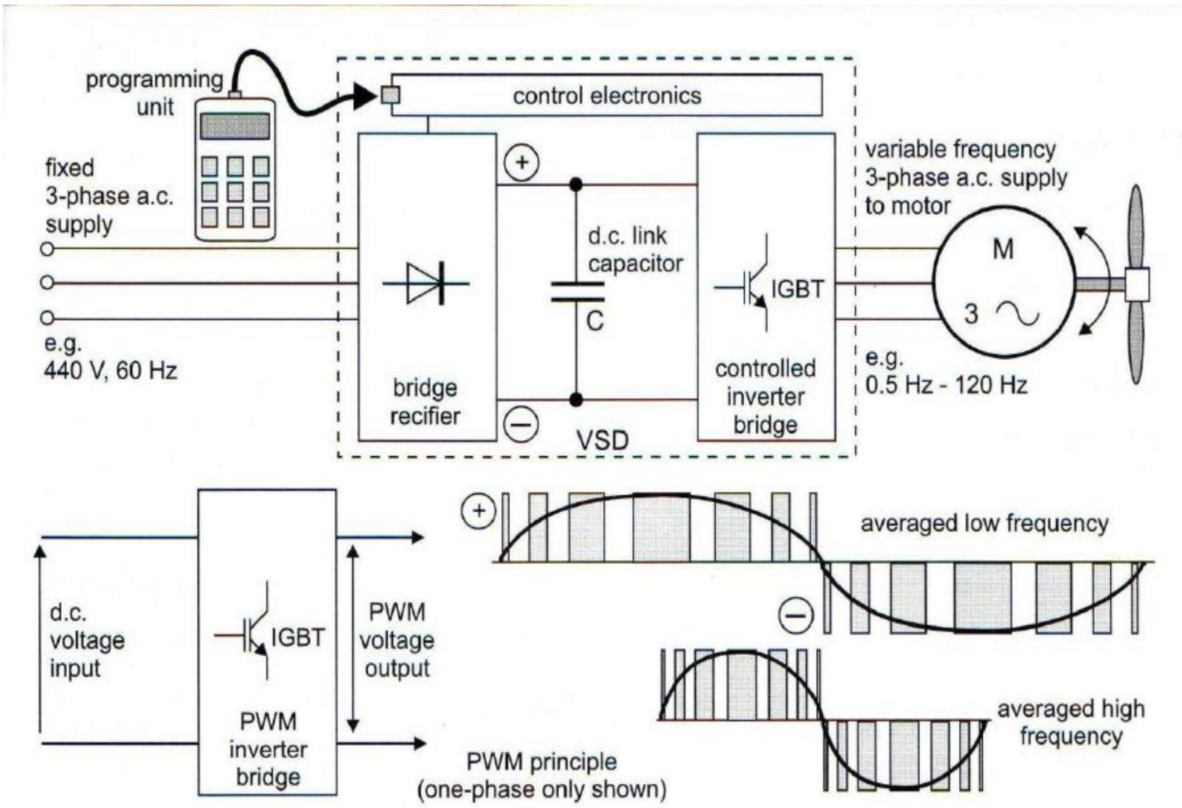
ɆŰďɜ ´ɟŬɓɛŬŰȅɑŋŰďŰŬ ď ɛŮŰŬɓɐǽɐ Űďɠ ůɡɕɜŋŰďŰŬɠ ŲɕűɕǘɕůďŬɠ ɛŮǘɑŬŰƳɜŮɠ ɕǘɐɔďůďɠ ďǽŮǽŲɕɜɑ ɜ ǘɑŬɕ´Űɜ ɐɕŮɔɕȅŮ ď ´ɑ ǘďɛɕűɑɐɠ ɛɐďɕǘɕɠ ɟɨ ďɛɑůɐɠ Űďɠ ŰŬɕɨŰďŰŬɠ Űɣɜ Ů Ŭɓɣɔɑɩ ɜ ǝɑďŰȇɟɣɜ.

ɆďɛŮɑɜŮŰŬ ŋŰȇ ŬɡŰȇ ď ɛɐďɕǘɕɠ ɛ´ɕɟ ŰɑɜŬ ŰɨŬɟɛɕůŰŰɑ ůŮɕ´ɕɑɜǘɐ´ɕŰŮ Ů ŬɓɣɔɑɩŋǝɑďŰȇɟŬ ŬɜŰďŮŰŬ Ŭ ŋ Űď ɛɐďɕǘɕ ɛŮŰŬɓɐǽɐɠ Űɣɜ ´ŋǽɣɜ ´ɕɡ Ŭ ŬɜŰɑ ǝɑďŰȇɟŰɠ ɛŮ ŮǘɑɑƳ Űȅǽɐɔɛ ŬŰ ůŰȅ ůŰƳŰď.

3.6 ȮǽŮɕɕɠ Űďɠ ɇ Ŭɕɨ ŰďŰŬɠ ɛŮɀ ŮŰŬɓɐǽɐ Űďɠ ɇ Ƴůďɠ ɇɟ ɕűɕǘɕůďŬɠ

¢ ɟɕ´ɐ ´ɕɡ ŬɜŬ Űɨůůůɐ ɜŬɠ Ů ŬɓɣɔɑŋɠǝɑďŰȇɟŬɠ ŮɐŬɟŰƳŰŬ Ŭ ŋ Űȅ ŰŰɟƳɔɣɜ Űďɠ ŰɨŬɟɛɕɕŋɛŮɐďɠŰƳůďɠ. ɟ ɜ Űȅ űɕɟŰȅ Űȅɡ ǝɑďŰȇɟŬ ɐǘŬďɐŰŮɕŬɟŬŰďɟǘŰȅɐ ɟɕ´ɐɠ ï ŰŬɕɨŰďŰŬɠ ŋɛɕǘŬɛŮŬɡŰȇ Űȅɡ ůɕ 16, ď ŰŬɕɨŰďŰŬ Űȅɡ ŰȅŬǘɡɜŬŰŋ ɜŬɟɡďɛɕŰŬůŮɐŬ´ɟɑɟǘɛɐɜɕ Ůɟɕɠ Űȅɩ ɜ ɛŮ Űď ɛŮŰŬɓɐǽɐ Űďɠ Ƴůďɠ ɟɕűɕǘɕůďŬɠ. ɟ ɡȇɐ ď ɛɐďɕǘɕɠ ŮɐɔɕɕɡɡɕɟďůŬɕ´ɕǘŰŰŬ ůɡɜɐďɠůŰȅɡɠɛɑɟɕɑɠǝɑďŰȇɟŬɠ´ɕɡ ǝɑɕɑɜ ŬŰȅǘɑŮɟŬɠ.

3.7 ¢ ϶Ǻ϶ Ǖ ɞɜϿ ɧɖɶϿǺɕɞɖ ȄǕ ɞűι ɜ Ά´ Ǔɓɤ ɔϿι ɜ Ϯϧɖ Ǘɟɤ ɜ



Άϧ ɧɜ Ǔ6: ¢ ϶Ǻ϶ Ǖ ɞɜϿ ɧɖɶϿǺɕɞɖ ȄǕ ɞűι ɜ Ά´ Ǔɓɤ ɔϿι ɜ ϶ϧɖ Ǘɟɤ ɜ.

ȄǕ Ǔɡ Ǘ ǖɖɜ ´ Ǖ ɑ Ǘɤ ůɖ Ǔɜ Ǘɑ Ǘɤ ɜ Ǻ϶Ǻɕɧɛ Ǻɜɤ ɜ Ǔɜɞɟ ɖɤ Ǘ ɜ ´ ɡɟ ϶Ǘɞɡ ɕɟ ɖůϾɛ ɞ´ ɞϿɨ ɜǗǕ϶ ǕǕ IGBT (Insulated Gate Bipolar Transistors). ¢ ŭϿǗɑɞɟ Ý Ǘɞɡɕ Ǔ ɧ Ǘɞɡɕ Ǻ϶Ǻɕɧɛ Ǻɞɡɕ Ǔɜɞɟ ɖɤ Ǘɶɕ ´ ɡɟ ϶Ǘɞɡ Ǻɞ Ǔ϶ ɧǗ϶ ůǕ ǓɡǗÝ ɛ´ ɞɟɞɨ ɛǕ ɜǓ Ǻɶɔɕɞɡɛ Ǖ Ǘɖ ůǗɓɛɐ ɶɜǓɟ ɜɖɕ Ǘɖɕ Ǔɓɤ ɔϾ ɧǗɖǗÝɕ Ǘɞɡɕ, ϶Ǘɑ ɕ ϶Ǔ϶ Ǘɖ ůǗɓɛɐ ´ ɞɡ ůǕǕɛǓǗɞɨ ɜ ɜǓ Ýɔɞɡɜ. ɀ Ǖ ǓɡǗɧ Ǘɞɜ Ǖ ɧ´ ɞ ´ Ǔɡ ɜɞɡɛǕ ´ Ǔ϶ɛɞɨ ɕ ɛǕ Ǻ϶Ǻɕɧɛ Ǻɜɖ ŭϿÝɟ ϶Ǻ϶Ǔ.

¢ Ǔɟ ɕϿɐ ǗÝůɖ Ǖ ɞűɞŭɞůɖǓɕ Ǘɞɡ ϶ϧɖ Ǘɟ Ǔ, 440V, 60Hz, Ǔɜɞɟ ɖɑ ɜǕǕ϶ ´ ɟι ǕǕ ϶Ǔ϶ ɛǕǕÝ ɞŭɖɔǕǕǕ϶ ůǕ ɔɶűɡɟ Ǔ IGBT ɧ´ ɞɡ ɛǕǕǕǕɶ´ ǕǕ϶ ůǗɞɡɕ ´ ɟɞǓɜǗɑǕ ɖɶɜǗǗɕ ´ Ǔ϶ɛɞɨ ɕ, ´ ɞɡ Ǻɞ Ǔ϶ Ǻ϶Ǻɕɧɛ Ǻɜɖɕ ŭϿÝɟ ϶Ǻ϶Ǔɕ. Ϯ Ǘɧ´ ϧ Ǘɞ ůɡɜ Ǻɞɶɕ Ǔɡ Ǘɧ ɛǕǕǕǕɶ´ ǕǕ϶ ůǕ Ǻɜ Ǔ϶϶Ǘ ůɧɛ Ǻɜɞ ɛǕ ůɡɕɜɧǗɖǕǕ ǓɜÝ϶ɞɔɖ Ǘɖɕ ŭϿÝɟ ϶Ǻ϶Ǔ Ǘɤ ɜ ´ Ǔ϶ɛι ɜ. ȼ ɞ ɛɶɔǗɞɕ Ǘɖɕ ǗÝůɖɕ´ ɞɡ Ǖ ɞűɞŭɞǗǗǗ϶ϿÝ Ǘɞɜ ϶ϧɖǗɟ Ǔ϶Ǔ϶ Ǔ ɧ Ǘɞ ɞ´ ɞɶ Ǻ϶Ǔɟ ǗÝǗǗ϶ɖ ɟɞ´ ɐ ůǗɖɜ ɶɜɞŭɧ Ǘɞɡ, ɟɡɖɛɶǕǕǕ϶ Ǔ ɧ ǕǕ ɖɡɟ ůǗɞɟ Ǘɖɕ´ ɟι Ǘɖɕ ɔɶűɡɟ Ǔɕ Ǔɜɧɟ ɖɤ ůɖɕ.

3.8 [illegible]

[illegible] 1880 [illegible] Nicola Tesla, [illegible] 1888. [illegible] (American Institute of Electrical Engineers - AIEE, [illegible] IEEE), [illegible] (reluctance motor).

[illegible] 1888, [illegible]

[illegible] 1888 [illegible] 1895. [illegible] 1896 [illegible]

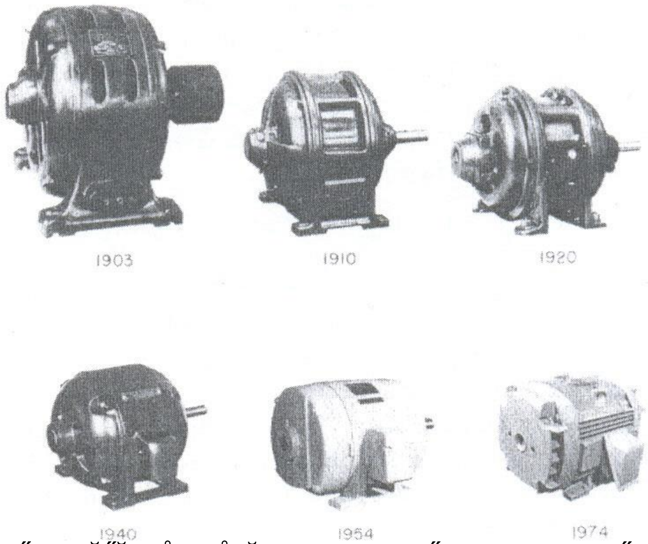
[illegible] 1970, [illegible] 100 hp [illegible] 7,5 hp [illegible] 1897. [illegible] 15 hp [illegible].17([illegible])

[illegible]

[illegible]

ŬɞƔɔəŬŭiŮ Ǘɕgɠ əŬǗǗůəŮǥŬůǗɏɠ ɜŬ Ů ɷɏɜɕgɜ ɤɠ ɓŬůɷɧ əɟɘǗɟɟɷ Ǘɕ əɧůǗɕɠ ´Ŭɟ Ŭɔɤ ɔɐɠǗɕg ɑŭɷg Ǘɕg əɷɖǗɟɟŬ.

¢ ɗŮŬµŬǗɷɐ Ŭɨ ɜɖůɖ Ǘɖɠ Ǘɥµɐɠ Ǘɕg ´ŮǗɟ ŮɚŬɕg Ŭ ɧ Ǘɕ 1973 əŬɚ µŮǗƳ ɏəŬɜŮ ɧəɕ əŬɚ ´ɷ ůɖµŬɜǗɷɧ Ǘɕ əŮɚǗɕgɟɔɷɧ əɧůǗɕɠ Ǘɤ ɜ µɖɢŬɜı ɜ, Ůɜı Ǘɕ Ŭɟ ɢɷɧ əɧůǗɕɠ əŬǗǗůəŮǥɐɠ Ƴɟ ɢɘůŮɜŬ ɔɶŮǗŬɚ µɷɟ ɧǗŮɟ ɖɠ ůɢŮǗɷƳ ůɖµŬůɖŬɠ. ɟ ɠǗɏɠ ɕə ŮɚŮɚɷŬɠ ŮɢŬɜ ɤɠ Ŭ ɕǗɏəŮůµŬ Ǘɕ Ůɜůɘŭǖɏɟ ɕɜ Ǘɧůɕ Ǘɤ ɜ əŬǗǗůəŮǥŬůǗ ɜ ɧůɕ əŬɚ Ǘɤ ɜ ɢɟ ɖůǗ ɜ Ǘɤ ɜ µɖɢŬɜı ɜ ɜŬ ůǗɟ ŬǗŭŮůǗɖɜ Ŭɨ ɜɖůɖ Ǘɖɠ Ŭ ɧŭɕůɖɠ Ǘɤ ɜ əɷɖǗɟɟ ɤ ɜ.



Ǝɟ ¢ ɀ ɟ 17: ¢ ŮɏɏəɷɖůǗɖɜ əŬǗǗůəŮǥɐ Ů Ŭɔɤ ɔɷı ɜ əɷɖǗɟɟ ɤ ɜ. Ƀə əɷɖǗɟɟŮǥ Ǘɕg ůɢɐµŬǗɕɠ ɏɢɕgɜ ɕɜɕµŬůǗɷɐ ǗƳůɖ 220 V əŬɚ ɘůɢɨ 15 hp. ɟ ´ ɧ Ǘɕ 1890, ´ɕg əŬǗǗůəŮǥƳůǗɖəŬɜ ɕə ´ɟı ǗɕəəɷɖǗɟɟŮǥ, ɡ´ɐɟɜŮ µɘŬŭɟ ŬµŬǗɷɐ µŮɑ ůɖ Ǘɕg µŮɏɖɕgɠ əŬɚǗɕg ɡəɷɕɨ ´ɕg Ŭ ŬɘǗŮɖ əŬǗǗůəŮǥɐ Ǘɕgɠ.

ƎǗɕɠ µɏɟŮɠ µŬɠ ɏɢɕgɜ ŬɜŬ ǗɡɢɖŮɑ ɜɏŮɠ ŬəgůɑŬɠ ´Ŭɟ Ŭɔɤ ɔɐɠ Ů Ŭɔɤ ɔɷı ɜ əɷɖǗɟɟ ɤ ɜ ɡɤɖəɐɠ Ŭ ɧŭɕůɖɠ Ŭ ' ɧəɕgɠ ůɢŮǗɧɜ Ǘɕgɠ əŬǗǗůəŮǥŬůǗɏɠ. ɟ ɡǗɕɑ ɕə ɜɏɕə əɷɖǗɟɟŮǥ əŮɟ ŭɑɕgɜ ůgɜɏɢŮɘŬ ɧəɕ əŬɚ µŮŬɚɨ Ǘɟ ɕ µɏɟ ɕɠ Ǘɖɠ ŬɔɕɟƳɠ Ǘɤ ɜ Ů Ŭɔɤ ɔɷı ɜ əɷɖǗɟɟ ɤ ɜ. ɀ Ů ůəɕ´ɧ Ǘɖ ɓŮɚǗɑ ůɖ Ǘɖɠ Ŭ ɧŭɕůɖɠ Ǘɤ ɜ əɷɖǗɟɟ ɤ ɜ ŬɡǗ ɜ ůŮůɢɏůɖ µŮ Ǘɕgɠ ´Ŭɟ ŬɕɕůɘŬəɕɨ ɠ əɷɖǗɟɟŮǥ Ǘɡ´ɷɐɠ Ŭ ɧŭɕůɖɠ ɢɟ ɖůɘµɕ´ɕɷɨ ɜǗŬəŬɟ əŬǗɏɠ µɏɖɕŭɕə əŬǗǗůəŮǥɐɠ. ɟ ɜƳµŮůŬů' ŬɡǗɏɠ ŮɕŬɜ

1. ¢ ɢɟ ɐůɖ µŮŬɚɨ Ǘɟ ɖɠ ´ɕůɧǗɖǗǗɠ ɢŬəɕɨ ůǗǗ ǗɡəɷµŬǗǗ Ǘɕg ůǗƳǗɖ µŮ ůəɕ´ɧ Ǘɖ µŮɑ ůɖ Ǘɤ ɜ Ŭ ɤ əŮɜ ɜ ɢŬəɕɨ .

2. ¢ Ŭɨ ɜɖůɖ Ǘɕg µɐəɕgɠ Ǘɕg ´ɡɟ ɐɜŬůǗɕ ůǗƳǗɖ əŬɚ ůǗɕ ŭɟ ɕµɏŬ µŮůəɕ´ɧ Ǘɖɜ Ŭɨ ɜɖůɖ Ǘɖɠ µŬɜɖǗɷɐɠ Ů Ŭɔɤ ɔɐɠ ůǗɕ ŭɘƳəŬɜɕ Ǘɖɠ µɖɢŬɜɐɠ. ɟ ɡǗɧ ɏɢŮ ɤ ɠ Ŭ ɕǗɏəŮůµŬ Ǘɖ µŮɑ ůɖ Ǘɕg µŬɜɖǗɷɕɨ əɕɟ Ůůµɕɨ Ǘɖɠ µɖɢŬɜɐɠ əŬɚ ǗŮɷɷƳ Ǘɖ µŮɑ ůɖ Ǘɤ ɜ Ŭ ɤ əŮɜ ɜ ´ɡɟ ɐɜŬ.

3. ¢ ɢɟ ɐůɖ ´Ŭɘůůɧ Ǘɟ ɕg ɢƳəɡɓŬůǗɕ ůǗƳǗɖ Ǘɖɠ µɖɢŬɜɐɠ, ´ɟ ƳɔµŬ´ɕg Ů ɘǗɟ ɏ´ ŮɚǗɖ

[illegible]

4. [illegible]

5. [illegible]

6. [illegible]

[illegible] 4: [illegible]

4.1 [illegible]

[illegible]

[illegible] [illegible] [illegible] (E.Λ) [illegible] 1950. [illegible] (A.Λ) [illegible]

[illegible] [1]

[illegible] 55 [illegible]

[illegible]:

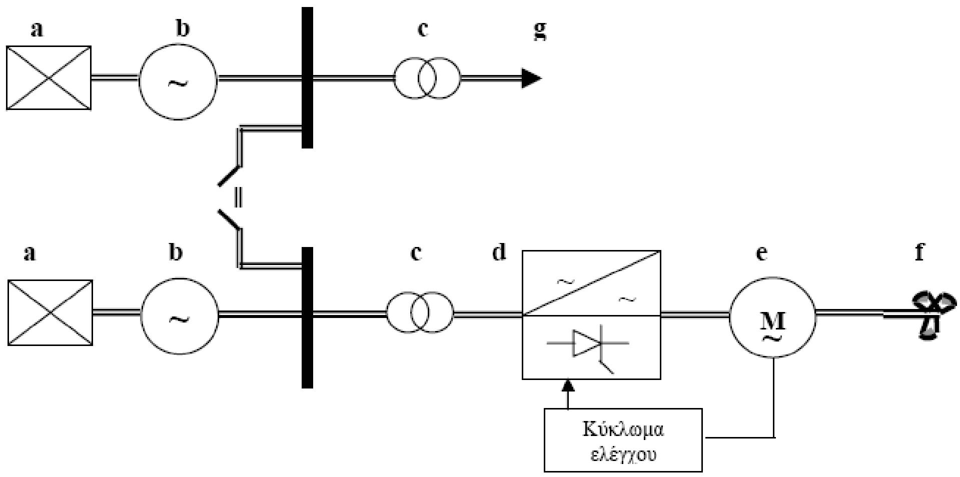
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]

4.2. [illegible]

4.2.1 [illegible]

[illegible] 7. [illegible]

[illegible] (DC link) [illegible] (Bow thrusters). [illegible]



c. [illegible] d. [illegible] e. [illegible] f. [illegible] g. [illegible]

[illegible] 7: [illegible]

4.2.2 [illegible]

[illegible]

[illegible]:

- [illegible]
- [illegible] (DC, AC) [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]

1) [illegible]

- [illegible]
- [illegible]

- зǓ ǗœǓҌ Ǘзϭ΄ϭϥɛγзǓ ůŮ γзǓ ǝϭҙђ ϥǝǗҌǗǰ ҙђ ŭœǗǥϭ, ϭ΄ђǗǕ ϭŭϥɔϭɨ ɛǓůǗǕ ůǗǿ «΄ǝɐɟɣ ɠ ǗзϥǝǗҌǗǰ ҙůɛγзϭ ΄ǝϭœ» (AES), ϭ΄ђǗǕǝǓҌ ǗœǓҌ ŭǥзǓǗɐ ϥ ɓǓҌǗǰůǗǿ΄ϭϥůϥ ǗϥɠǗҌɛǓǗƳǝǝǗǥůϥɠǗɤ з ΄ǝǗзǗҌǗϥɛƳǗɤ з ǗϥɠϥǝǗҌǗǰ ϭ΄ɟђɤ ůϥɠ.

2) ɆǗϥз ΄Ǘǰ ɑǗɤ ůϥ ΄ϭɡ ǗǕ ŭɨ ϭ ŭœǗǥǓ ůǥзŭγϭзǗǕ, ϥ Ů ҙϭɔɐ Ǘϭɡ ǗǰЋ΄ϭɡ ůɨ зŭǓůϥɠ (Ǔ ǗǥϥǗǓǗ ɛγůɣ ΄ҙƳǝɣ з, ɛγůɣ ǓзǗǰůǗǰϭǗγɣ з (inverters) ɐ Ƴǝϭɡ ɛǗǕǗǰϭ΄γǓ ϥǝǗҌǗǰϭзҙɩ з ҙůɢɨϭɠ (converter), ɛγůɣ ϭǗɨ ɔϭɡɠ ǝҙϥǗɐɟǓ-ɔǗзɐǗǰҙǓɠ, ɛγůɣ ɛǗǕůɢϥɛǓǗůǗ з ǝǝ΄.).

- ɟ ΄ђ ΄ϭҙ ŭœǗǥϭ Ǘǰ ϭǗϭŭϭǗϭɨ зǗǕҌ ǗǕ ɓϭϥϥǗҌƳ ůǥůǗɐɛǓǗǕ ΄ɟϭɩ ůǓɤ ɠ, ΄.ɢ. ǗǕ ůǥůǗɐɛǓǗǕ ǗҌγɔɢϭɡ-ɢǗɟ ҙůɛϭɨ, ɣɨ зϥɠ, ǝɑ Ǔзůϥɠ.
- Ƀ Ǘǰђ΄ϭɠ ɛŮǗзϭ΄ϭœ ŭҙǓůǗǓǝœǗǕҌ ϥ ΄ϭҙǗϥǗǕ ҙůɢɨϭɠ Ǘϭɡ ϥǝǗҌǗǰҙϭɨ ŭҙǗɨϭɡ ђůϭз ǓǗϭɟƳ ǗϥзǗƳůϥ ǝǓҌǗϥз ůɢзђǗϥǗǕ, (ϥђɟɡɓϭɠ-Ǘǰɛϭзҙɐ ΄ǗǰǓɛђɟǗɣůϥ) ǝǓҌ ǗŭҙƳǗϭɡ ŭҙǗɨϭɡ ɢɟɐůǓɤɠ, ђǗǕз ǓǥǗђ ůǥзŭγǗǕҌ ɛŮǗϭ ŭœǗǥϭ ΄ɟϭɩ ůǓɤɠ. ɆǓз ǝɨɟҙǓ ΄ϥɔɐ ŭϥɛҙɡɟɔϥǓɠ Ǘǰɛϭзҙɩ з ǓзǗǰγɟϭзǗǕҌ ǗǕ ϥǝǗҌǗǰϭзҙƳ ҙůɢɨϭɠ Ǘɤ з ϥǝǗҌǗǰϭǝҙϥǗɐɟɣ з. ¢ ΄ϭҙǗϥǗǕ Ǘɤ з ϥǝǗҌǗǰҙɩ з ŭҙǗɨɣ з (ůɢзђǗϥǗǕ, Ǘǰɛϭзҙγɠ ǗƳůǓɤɠ, ǗǕɢǗǓɠ ŭҙǓǗǰǓɢγɠ ǗƳůǓɤɠ ǝǝ΄.) ǝǓϥϭɟœǗǕҌ Ǔђ Ǘɠ ŭҙƳǗϭɟǗɠ ΄ɟϭŭҙǓɔɟǓγɠ, ϭǝϭ΄ϭϥǗǓϭɟϭɨз ɛђзϭ Ǘϭ ŭœǗǥϭ ɢɟɐůϥɠǗϭɡ ΄ǝϭœɡ, ŭϥǝǓɐ ǗϭɟǗǓ ΄ϭɡ ŭǗз ůɢǗǕϭзǗǕҌ ɛŮ Ǘϥз ΄ɟђɣ ůϥ. ɆǗɠ ΄Ǘǰ ǗůǗɠ ǓзǗǰǓǗǰǗɐǗϭɡ ŭҙǗɨϭɡ ΄ɟϭɩ ůǓɤɠ ŭǗз ɡ΄Ƴǰɢϭɡз ΄ɟϭɠ Ǘϭ ΄Ǘǰђз ҙǓǗǗǰǗɠ Ǔ ǓзǗɐůǗɠ ΄ϭҙǗϥǗǕɠ ɔǓǗ ǗǕ ǗϭɟǗǓǗϥɠ΄ɟђɣ ůϥɠ. ɟ з ђɛɣ ɠ Ǘϭ ϥǝǗҌǗǰҙђ ŭœǗǥϭ ǗœǓҌ Ǘзϭ΄ϭϥɛγзϭ ΄ɟγ ǗҌɐ ǝǓҌ Ǘϭ ŭœǗǥϭ Ǘϥɠ ΄ɟϭɩ ůǓɤɠ зǓ ҙǓзϭ΄ϭǗɑ Ǘɠ ɑǓǗɠ Ǔ ǓзǗɐůǗɠ ΄ϭҙǗϥǗǕɠ, ɐ зǓ ǝǓɛɓƳзǗǕҌ ɛγɟҙзǓ, ɩ ůǗǕ ǗǥϭђзǗɕ «ŭǓǗǕǗǰǓɢγɠ» ůǗϭ ŭœǗǥϭ ΄ɟϭɩ ůǓɤɠ зǓ ɛϥз «ŭǓǗŭɑϭзǗǕҌ» ůǗϭ ŭœǗǥϭ ɢɟɐůǓɤɠ.
- ¢ ŭǓƳǗзϥ Ǘǰǝϭɠ Ǘϭɡ ϥǝǗҌǗǰҙϭɨ ŭҙǗɨϭɡ ΄ɟγ ǗҌзǓ ɛǗҌůǗϭ΄ϭǗɑǗϥз ɓҙɣůҙђǗϥǗǕ Ǘϭɡ ΄ǝϭœɡ.

- ɅǝƳɢůǗǕɠ Ǔ ǓзǗɐůǗɠ ůŮ ǝǓǗǕůǗƳůǗɠ ǓзƳɔǝϥɠ ϊ ɟ зǗɛǗǕǗ ΄ůϥ: ŭǓǓ ΄ǗǰƳǓǗҌɛǓ ɛ΄ϭɟǗɑзǓ Ǔ ǓзǗǗǗǕҌ Ǘǝϭœϥůϥ ǝҙϥǗɐɟǓ ΄ɟϭɩ ůǓɤɠ ɛŮ ɛǝǓ ɛђзϭ ɔǗзɐǗǰǝǓ ůŮ ǝǓǗϭɡɟɔҙɐ ǝǓǗƳůǗǕůϥ, ϥ ŭǥзǓǗђǗϥǗǕ ǗǰϭŭϭŭђǗϥůϥɠ Ǘϭɡ Ǘзђɠ ŭҙǗɨϭɡ Ǔђ Ǘϭ Ƴǝϭ, ϥ ŭǥзǓǗђǗϥǗǕ Ǘзђɠ ɛђзϭ ǝҙϥǗɐɟǓзǓ ɛ΄ϭɟǗɑзǓ ǝҙɐůǗϭ Ǘϭ ΄ǝϭœ ɛŮɛǝǓ ǗҌƳɢůǗϥ ǗǕɨ ǗϥǗǕ, ɐ зǓ Ǔ ǓзǗǗǗǕҌϥ ɔǗзɐǗǰǝǓɐ ϭǝɔǗзɐǗǰǝǓɠзǓ ɛ΄ϭɟϭɨз зǓ ǗǰϭŭϭŭϭǗϭɨз ǗǕŭϭɟǗǗǓ ǓзƳɔǝϥɠ ǝǓ ǗǕǥǗϭɟϭзǓзǓ ǝҙɐůϭзз Ǘϭ ΄ǝϭœ ɛŮɛǝǓɛҙɟɐ ǗǕɢɨ ǗϥǗǕ (3-5 knots).
- Ƀ Ǘǰђ΄ϭɠ γŭɟǓůϥɠ Ǘɤ з ɛϥɢǓзϥɛƳǗɤ з, ǝǓǗɩ ɠ ǝǓҌ ϭ ŭǓǓɣɟҙůɛђɠ Ǘϭɡɠ, ђ΄ɣɠ ɔǝǓ ΄ǗǰƳǓǗҌɛǓ Ǘɤ з ΄ҙƳǝɣ з ϥǝǗҌǗǰҙϭɨ ŭҙǗɨϭɡ ΄ɟϭɩ ůǓɤɠ ǝǓҌ ɢɟɐůǓɤɠ, Ǘɤ з ǝҙϥǗɐɟɣ з ΄ɟϭɩ ůǓɤɠ ǝǓҌǗɤ з ϥǝǗҌǗǰϭзҙɩ з ŭǓǗǗƳзǗɤ з ϭŭɐɔϥůɐɠ Ǘϭɡɠ.

[illegible]:

1. [illegible].
2. [illegible] (inverters) [illegible].
3. [illegible] (converters) [illegible].
4. [illegible] ([illegible]) [illegible]

[illegible].

4.3 [illegible]

[illegible] 3 - 4% [illegible] 3,3 - 6,6 kV. [illegible] 98%.

[illegible]

[illegible] Joule [illegible] «[illegible]» ([illegible], Sm- Co [illegible], NdFeB) [illegible]

[illegible] (torque ripples) [illegible] (vibrations).

[illegible]

V/F

SPWM CSI

IGBT (Insulated Gate Bipolar Transistors).

ďĿďş ĿƂ ũ Ʌɉ ũ Ŀɉ

[1]: ɀ ´ŬŰůŰŸŰɞɠ ʔ. (1999), «*ɉ ɜŸəgůɖ ɆgůŰɖɛŸŰ ɜ ʔŰɖɕŮəɖəŮəŰɉ ɘɐɠ Ʉɉ ɧɤ ůɖɠ Ʉəɞɶ ɜ*», ɥɘ´əɤ ɛŬŰəɐ ɀ ŮŰŬ ŰɡɕɘŬəɐ Ʌɉ ɔŬůɖŬ ɥɄɀ Ɇ «ɄŬɉ Ŭɤ ɔɐ əŬə ɥɘŬɕŬɉ ɘůɖ Ʌɜɏɉ ɔŮɘŬɠ», ɉ ɖɐ ɜŬ, Ƀ ə Ű ɓɉ ɘɠ.

[2]: ũ ɟ Ŭəɧ´ɞgəɞɠ ɟ ., Ʉɉ ɞgůŬəɯɖɠ Ł (2005): «Ʌɜ Űɉ ɔŮɘŬəŸ ɆgůŰɛŬŰ Ʉəɞɶg ï ɇɧɛɞɠ ɉ ɑ̄ ȼ əŮəŰɉ ɞəɞɔɘɧ ɛɏɉ ɞɠ», ɥɘɯŬəŰəɏɠ ůɖɛ Ůɑ ůŮɠ ɔɘŬ ɵɞɘŰɖŰɏɠ Űɖɠ Ɇɡɞəɐɠ ʔŬɡ´ɖɔɩ ɜ ɀ ɖɡŬɞəɧɔɤ ɜ ɀ ɖɡŬɘɩ ɜ Ʌɀ Ʉ.

[3]: Ʉɉ ɞgůŬəɯɖɠ Ł, ɟ ŬŰɛɖəŸɞg ŁȾ., ɆŰɡɓŬəŰŸəɖɠ Ʌ., ȾŬɜɏəəɞɠ ũ ., ɟ ŬŰɛɖŬɉ ɔgɉ ɶg ʔ., ũ ɟ Ŭəɧ´ɞgəɞɠ ɟ , Ɇɞɵɉ Ÿɠ ȼ. (2006): «Həŭ əŰɉ ɞ´ɉ ɧɤ ůɖ ´əɞɶ ɜ əŬ ´əɐɉ ɤ ɠ ŮɖəŮəŰɉ ɘůɛɏɜɞ ´əɞɶ: ´ɉ ɞɓəɐɛŬŰŬ ´ɞɧŰɖŰŬɠ ɖəŮəŰɉ ɘɐɠ ɘůɡɨɞɠ», ɥɐɛŮɉ ɞ ɇɅɅ : «ȼ ʂ ɅȾɇɅƂȾĿʔ ȼ ɇɉ ɀ ɅɆɉ ɀ Ʌɇɉ ũ ƂɅɉ Ɇ Ɇɇȼ ʔ Ʌʂ ʂ ɉ ɥɉ -Ɉ ũ ĿɆɇɉ ɀ Ʌʔ ȼ Ⱦɉ ɇɉ Ɇɇɉ Ɇȼ Ⱦɉ Ł ɄɅƂƂɄɇĿȾɅɆ», 12-13 ĿŬɞgŬɉ ɶg.

[4]: Bose B.K. (1997), *Power Electronics and Variable Frequency Drives: Technology and Applications*, IEEE Press, New York.

[5]: Bucknall R. W. G., Doherty K. P., Haines N. A. (1997), The matrix converter: the ultimate electric drive technology, Proceedings of ñ*Electric Warship: Power, Control, System Protection*ò Seminar, ImarE, United Kingdom.

[6]: ɆŬŰŸəŬɠɉ ., (2005. ***ȼ əŮəŰɉ ɘɏɠ ɛɖɡŬɏɠɉ*** , ɇɛɐɛŬŮəŰ´ɩ ůŮɤ ɜ Ű´ɞɔɉ ŬŰŮɶg ɄŬŰɩ ɜ.

[7]: ə. ũ Űɉ Ÿůɖ Ⱦɤ ɜůŰŬɜŰɶŬ (ůɖɛ Ůɑ ůŮɠ Ŭ ɧ ɛŸɖɖɛ Ŭɖ əŮəŰɉ ɘɏɠ ɛɖɡŬɏɠ)

[8]: Stephen J. Chapman ñȼ ʂ ɅȾɇ ɅĿȾɅɆ ɀ ȼ ɟ ɉ ʔ ɅɆ AC-DC