EFFECT OF PRIME-MOVER ON THE VIBRATION OF NILE IRRIGATION PUMPS.

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1. ABSTRACT:

This work deals with the investigation of vibration for the low pressure Nile irrigation pumps. We used in this work two types of prime-movers (electric and diesel). The vibration items was measured at different speeds by using a system of conical pulleys. Measurements were done at shaft bearings, suction and delivery sides and comparison between the previous two cases was done.

2. INTRODUCTION:

The vibration in centrifugal pumps depends on two major sources:

a. Mechanical unbalance 1*
b. Hydraulic forces from impellers and interaction between impellers and vaned diffusers 2*

Mechanical unbalance is a difficult a problem in centrifugal pumps because the assembled of the rotor parts are normally subjected to the dynamic balancing. 1*. The dynamic forces were analysed when using electric motor only, its analysed into frequency components. Major components were found at shaft and blads frequencies 3*. R.D. BROWN also presented for non-stationary forces as the eccentric impeller frequencies at low flow.

From the previous work we must take in consideration the effect of the different types of prime-movers on the parts laying under dynamic forces from the mechanical of the system and the hydraulic forces result from the high capacities, its take a large effect (as an example on the suction and delivery side) all this parts mentioned in paper I.

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3. EXPERIMENTAL STATION AND PROCEDURE:

The station used for these investigations is designed and constructed at the Faculty of Engineering and Technology Shebin El-Kom Menoufia University, as showen in figures (1,2).

3.1. Experimental Procedure:

To carry out the main investigations of this work the following procedures may be followed:

a. Hydraulic procedure:

1 - The pressure gauges, collected tank and orifice meter must be calibrated.

2 - No, sealing or losses or leakage in any part of the system.

3 - The suction valve must be completly open and delivery valve may be closed. Then turn the pump and record each of:

- Suction head H_s (Cm.Hg).
- Delivery head H_d(mt.H_2O).
- Up and down stream pressure of orifice meter,Kg/m^2.
- By using a stop watch, determine the required time (t) in sec. that necessary to collect 200 Cm. hight of water (at the delivery tank). Its equal 6.1952 m^3.
- Torque of shaft was obtained by recording the torque bridge reading and compare the results values with the calibration chart.
- Record R.P.M. and the previous step may be done.
- Bridge of force transducer may be recorded and then take the value from the calibration chart.
- Vibration measuring system reading for Amplitude, velocity and acceleration must be recorded, for all point of measuring.
- Change the delivery valve opening gradually and repeat all the previous steps to completely opend of delivery valve.

- Change the delivery valve closing gradually and repeat all the previous steps to completely closed of delivery valve.
- Repeat all the previous steps using diesel motor.

4. EXPERIMENTAL RESULTS:

4.1. Vibration Results for Bearing No. One (B_1):

From the experimental work, Table (1) gives the vibration values for diesel motor with respect to electric motor, these horizontal and vertical vibration values takes at; various values of capacity (110, 150 m^3/hr.) and different speeds. In the same table we represents the mean value of shaft horse-power for the same chosen capacities.

Table (1)

Capacity m^3/hr.	R.P.M. / Vibration items		1350	1550	2350	2700	3300
110	Horizontal	A_{cc}	1.10	1.14	1.14	1.15	1.12
		Vel	1.22	1.25	1.22	1.23	1.20
		Amp	1.28	1.31	1.29	1.28	1.32
	Vertical	Acc	1.02	1.29	1.30	1.29	1.30
		Vel	1.21	1.31	1.32	1.33	1.31
		Amp	1.25	1.35	1.30	1.29	1.30
Torque E.M*. H.P.			5.81	8.48	17.29	25.10	29.55
Torque D.M** H.P.			8.18	9.00	18.15	25.98	30.82
150	Horizontal	Acc	1.11	1.10	1.12	1.13	1.10
		Vel	1.22	1.20	1.23	1.25	1.21
		Amp	1.28	1.27	1.26	1.26	1.27
	Vertical	Acc	1.06	1.10	1.07	1.07	1.10
		Vel	1.22	1.20	1.21	1.22	1.20
		Amp	1.26	1.28	1.27	1.28	1.26
Torque E.M. Consumed power (H.P.)			6.107	9.407	18.97	25.93	30.44
Torque D.M. consumed power (H.P.)			9.090	10.900	19.00	26.40	31.30

* E.M. - Pump driven Electrically.
** D.M. - Pump driven by diesel motor.

4.2. Vibration Results for Bearing No. 2 (B_2):

The vibration results obtained from the experimental results is shown in Table (2), this table gives the vibration horizontal and vertical measurements using diesel motor with respect to electric motor at, various capacities (110 and 150 m^3/hr) and different speeds.

Table (2)

Capacity m^3/hr.	Vibration items \ R.P.M.		1350	1550	2350	2700	3300
110	Horizontal	Acc	1.08	1.18	1.16	1.15	1.10
		Vel	1.30	1.35	1.32	1.33	1.30
		Amp	1.25	1.26	1.28	1.25	1.27
	Vertical	Acc	1.97	1.92	1.93	1.80	1.75
		Vel	1.23	1.42	1.23	1.29	1.22
		Amp	1.49	1.48	1.38	1.35	1.38
150	Horizontal	Acc	1.12	1.22	1.20	1.19	1.14
		Vel	1.33	1.38	1.35	1.36	1.33
		Amp	1.30	1.31	1.33	1.30	1.32
	Vertical	Acc	1.60	1.55	1.56	1.42	1.38
		Vel	1.28	1.43	1.21	1.28	1.21
		Amp	1.50	1.48	1.38	1.34	1.36

4.3. Vibration Results for Suction and Delivery Side:

Table (3) represents the vibration values at using diesel motor with respect to electric motor for suction and delivery side at; different speeds and various capacity (110 and 150 m^3/hr.).

Table (3)

Capacity m^3/hr.	R.P.M. vibration items		1350	1550	2350	2700	3300
110	Acc. (9)	Suc.	1.33	1.40	1.38	1.58	1.38
		Del.	1.44	1.29	1.79	1.63	1.50
	Vel. mm/sec.	Suc.	1.33	1.40	1.38	1.58	1.38
		Del.	1.44	1.29	1.79	1.63	1.50
	Amp. μ mm.	Suc.	1.11	1.21	1.26	1.20	1.53
		Del.	1.30	1.11	1.43	1.32	1.63
150	Acc (9)	Suc.	1.37	1.42	1.39	1.42	1.36
		Del.	1.47	1.30	1.66	1.58	1.35
	Vel. mm/sec.	Suc.	1.38	1.40	1.38	1.48	1.32
		Del.	1.36	1.29	1.69	1.47	1.34
	Amp. μ mm.	Suc.	1.15	1.22	1.22	1.18	1.33
		Del.	1.34	1.14	1.36	1.28	1.35

5. Discussion and Conclusion:

The relation between the capacity (Q) and acceleration (Acc) during horizontal measuring for bearing No. 1 of the pump under study using electric and diesel motor is shown in Fig. (3). This figure also shows that using the diesel motor increases the vibration acceleration value at the same speed for either cases: The increase of R.P.M. up to 2350 increases the vibration acceleration while it decreases when the speed exceeds 2350 R.P.M. in either cases.

For speeds above 2350 the flow rate decreases and consequently the vibration decreases, this is due to low chocks of flow on impeller blads. Figure (4, 5) illustrates the ($Q - V_h$) and ($Q - Amp_h$) relations which have the same behaviour of the (Q-Acc_h) relation.

Fig's (6, 7, 8) shows the relation of (Q - Acc), (Q - Vel) and (Q - Amp) for horizontal measuring of B_1 which takes the same behaviour.

The diesel motor has a large effect on the vibration, as the amplititudes are 41 and 34 mm for diesel motor and electric motor respectively at the same speed of 2350 R.P.M.

The vibration resulting in bearing No. 2 is less than that of bearing No. 1 because bearing 2 laying far from the motor as the effect of motor vibration is decreased. Therefore the vibration in B_2 depend largely on the flow effect as shown in Fig's (9 to 14).

In the case of suction and delivery pipes, the vibration decreases because the effect of motor vibration is so small due to the farness of these pipes from the motor. Therefore the vibration in these parts is mainly due to the hammer effect on the impeller blades and the flow rates in the pipes. But in the suction side the vibration is larger than that of the delivery side because of the prementioned reasons in addition to the hammer effect on the non-returne valve especially when the system is off.

The vibration curves in this case have the same behaviour as shown in Fig's (15 to 20) which indicates that the vibration resulting from using diesel motor is larger than using electric.

6. RECOMMENDATIONS:

1. The vibration values of low pressure irrigation pumps varies according to the type of prime-mover.
2. The origin of higher vibration when using different types of prime movers is the bearing beside the motor.
3. For the prototype pump-set at the first stage of design we must try to minimize the vibration values of the system owing to increase the service life.
4. From this study it is clear that using the electric motor decreases the vibration in low pressure irrigation pumps.

5. The shaft horse power decrease when using electric-motor as prime mover.

In addition to the previous recommendations, the electric prime-mover easy operate and maintenance-lower price, safty on operation and respectively the irrigation cost decrease.

7. REFERENCES:

1. R.D. Brown, Vibration phenomena in large centrifugal pumps, University of Southampton Conf. Sept. 1975.
2. Karassik and Karter, Centrifugal pumps, 1976.
3. Black, H.F., Brown, R.D., FRANCE, D. JENSSEN, Theoretical and experimental investigation relating to centrifugal pump rotor vibrations, vibration in rotating systems, conf. Imech E, Feb, 1972.
4. Thomson, W.T., Vibration theory and Application, Prentice Hall, Englewood cliffs, N.J., 1965.
5. Gilbert, A.C., "A Note on the calculation of torsional Natural Frequencies of Branch systems". ASME, series B, Vol. 94, No. 1, Feb. 1972.
6. Wilson, K., Practical solution of Torsional Vibration problems, Vol. 1, Chapman and Hall, 1956.
7. UCHIDA, N., IMIAICHI, K. Tochiakt, S., Radial forces on the impeller of centrifugal pump. Bull. of ISME, Vol.14 No. 76. 1971.
8. Black, H.F. Loch, N.E., Computation of lateral vibration and stability of pump motors computer Aided Design of pump and fans, conf. Imech E Newcastle 1973.
9. R.G. Monk, vibration monitoring reduces maintenances, 1974.
10. Meirovitch, L., Analytical methods in vibrations, Macmillan, New York, 1967.
11. Abde el-Hady Nasser, Feasibility study of electrification on irrigation means; Animal Driven water Wheels & Diesel Driven pumps in Menoufia Governorate (Arab Republic of Egypt). 1977.
12. Abd el-Hady Nasser, Field and Laboratory Investigations for various Types of Electrification Methods of Nile Irrigation In Menoufia Governortate. 1977.

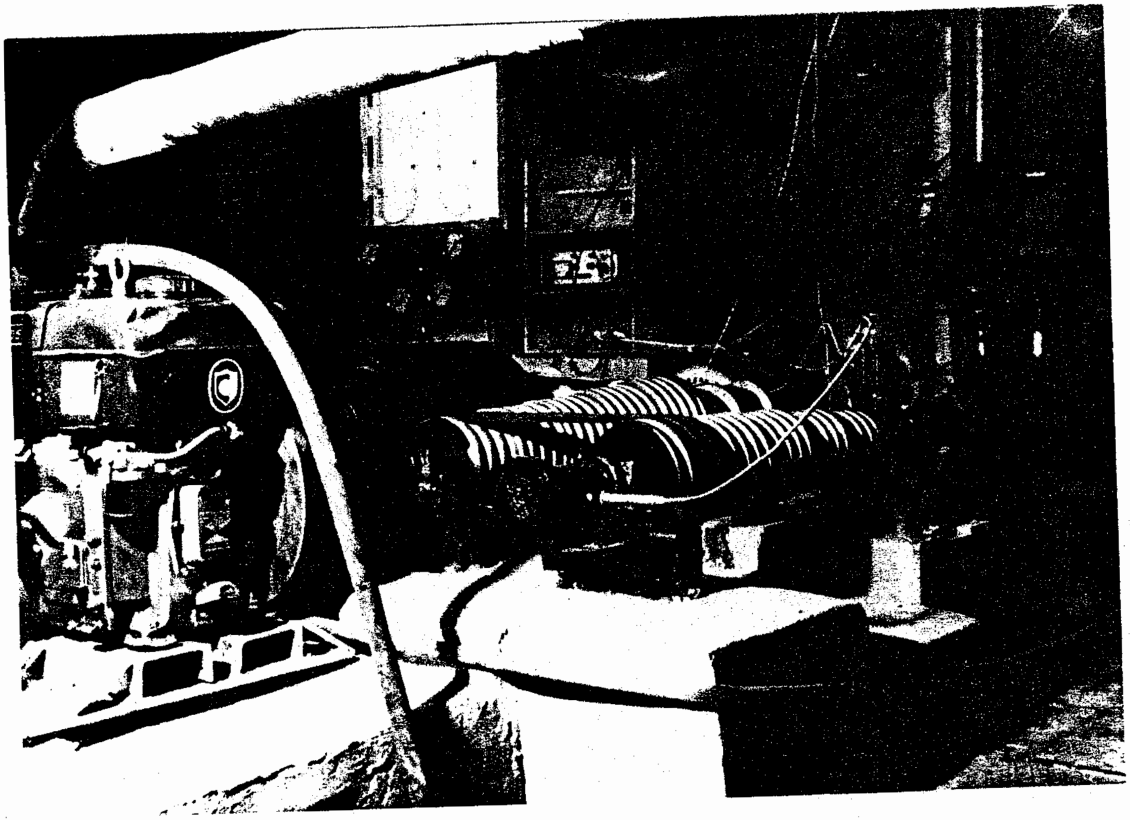

Fig.(1) Diesel Engine as a Prime_Mover.

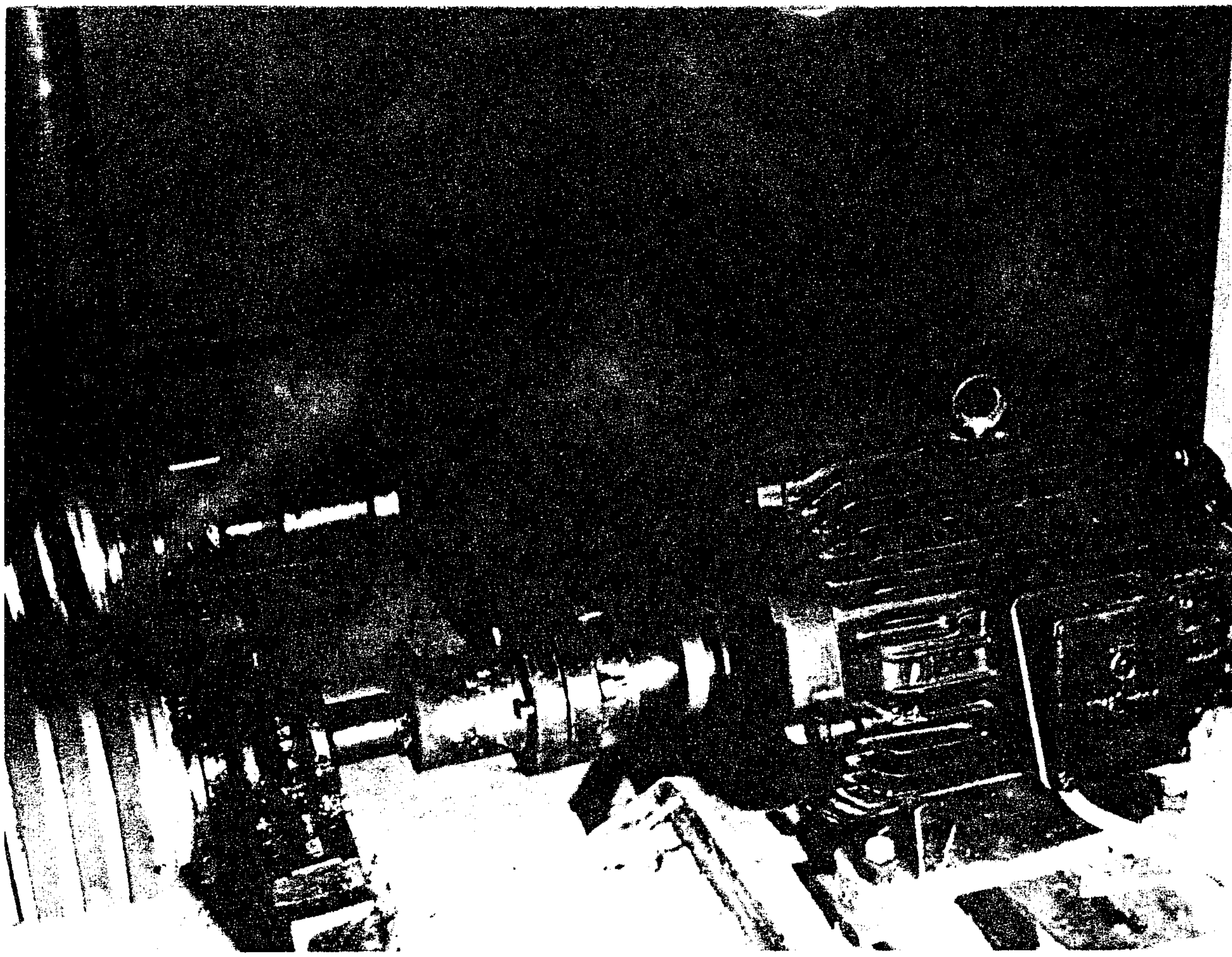

Fig.(2) Electric Motor as a Prime_Mover.

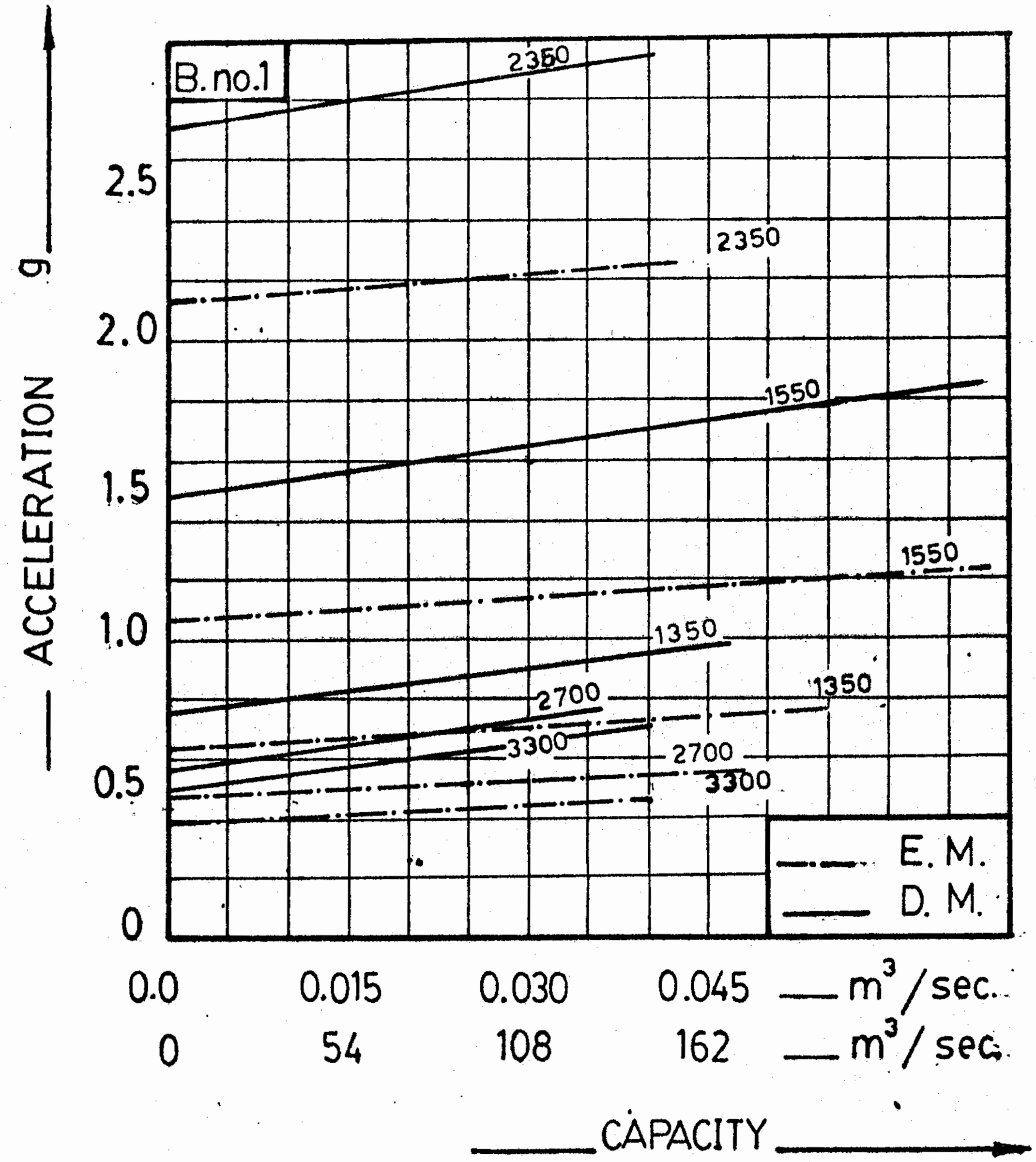

Fig.(3) Effect of Capacity (Q) on the Acceleration (A_{ch}) Using Drinkage Water at Different Speeds and Various Primemovers.

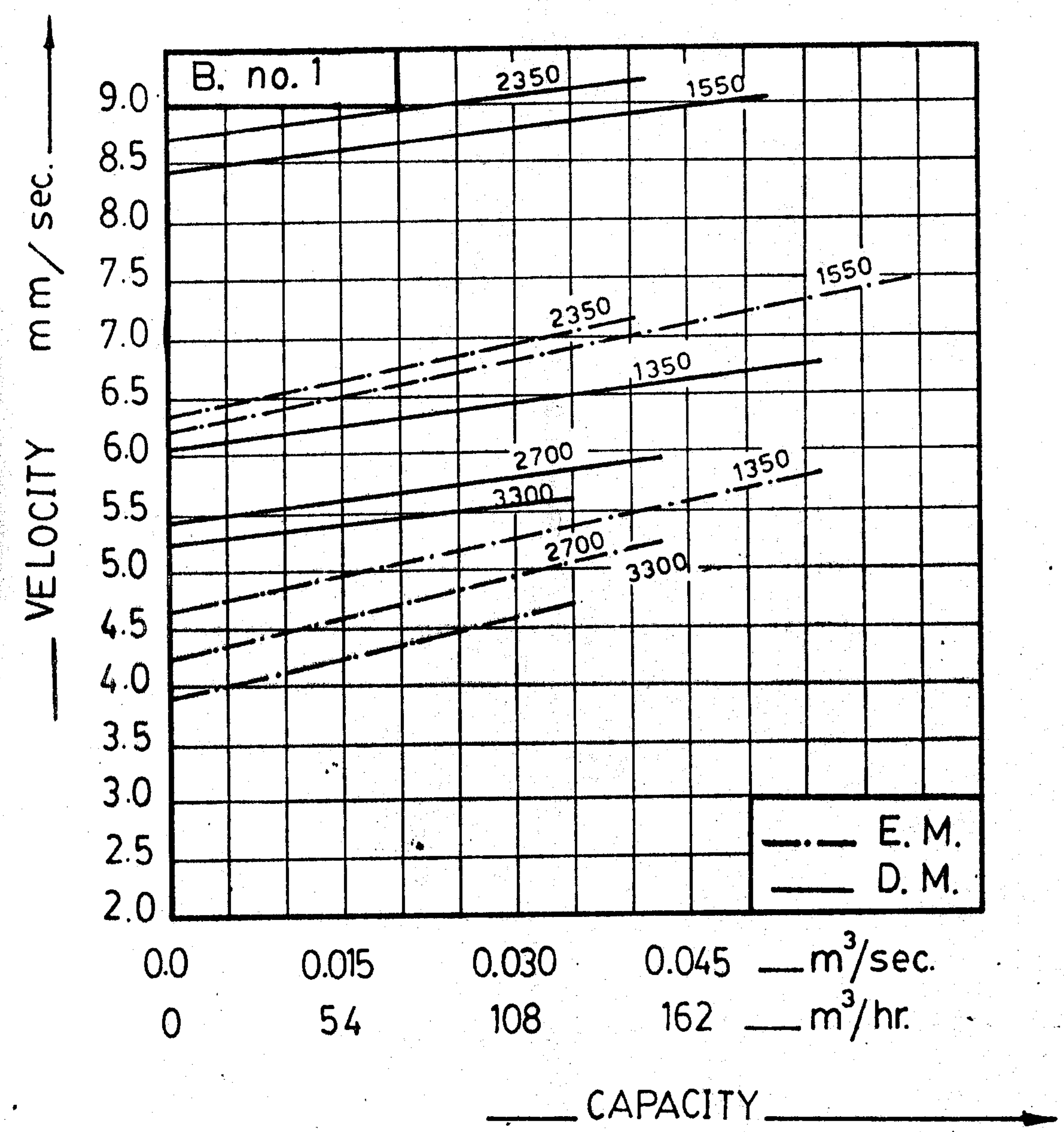

Fig.(4) Effect of Capacity(Q) on the Velocity(V_v) Using Drinkage Water at Different Speeds and Various Primemovers.

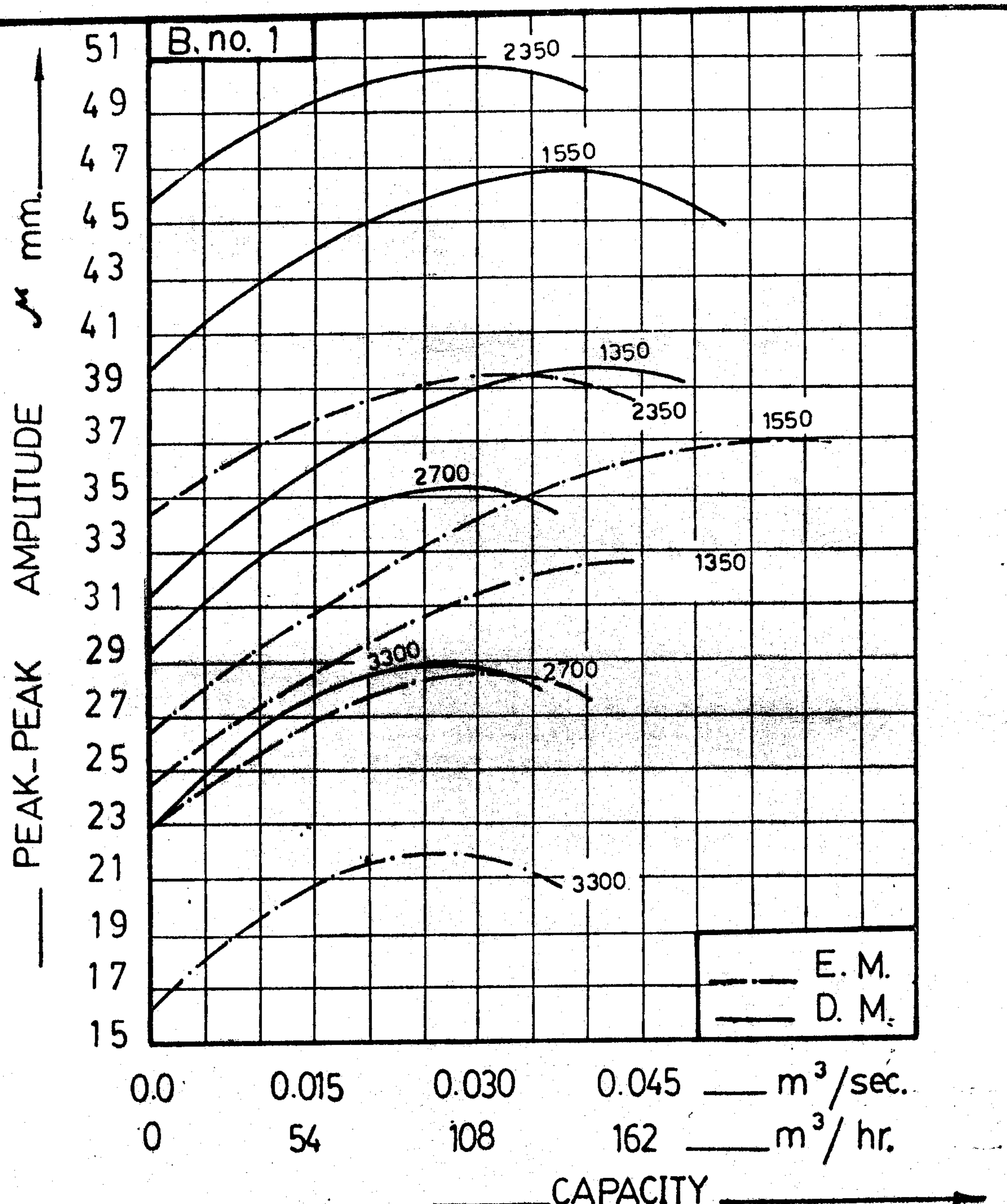

Fig.(5) Effect of Capacity (Q) on the Amplitude (Amp) Using Drinkage Water at Different Speeds and Various Primemovers.

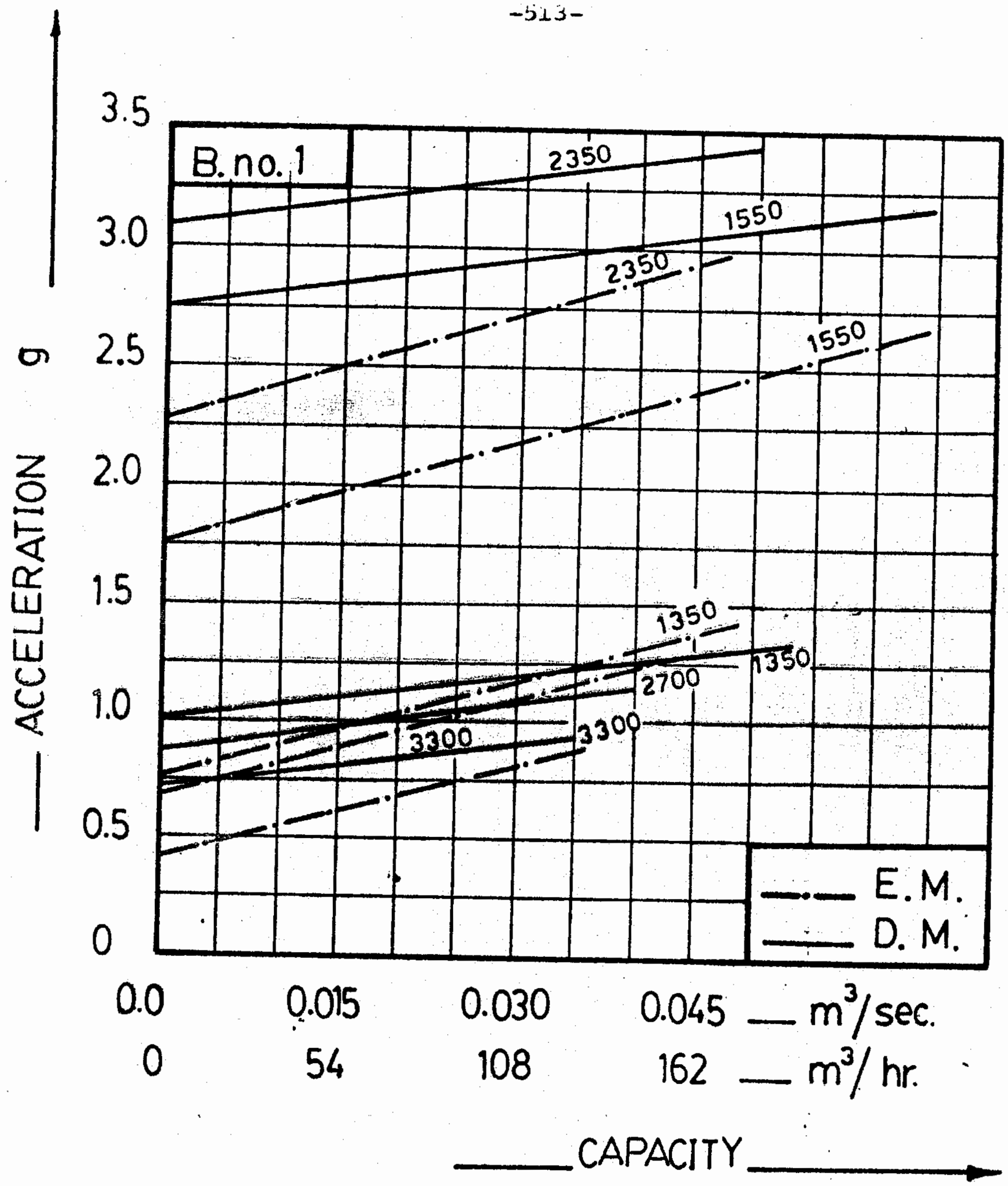

Fig.(6) Effect of Capacity (Q) on the Acceleration (Ac_V) Using Drinkage Water at Different Speeds and Various Primemovers.

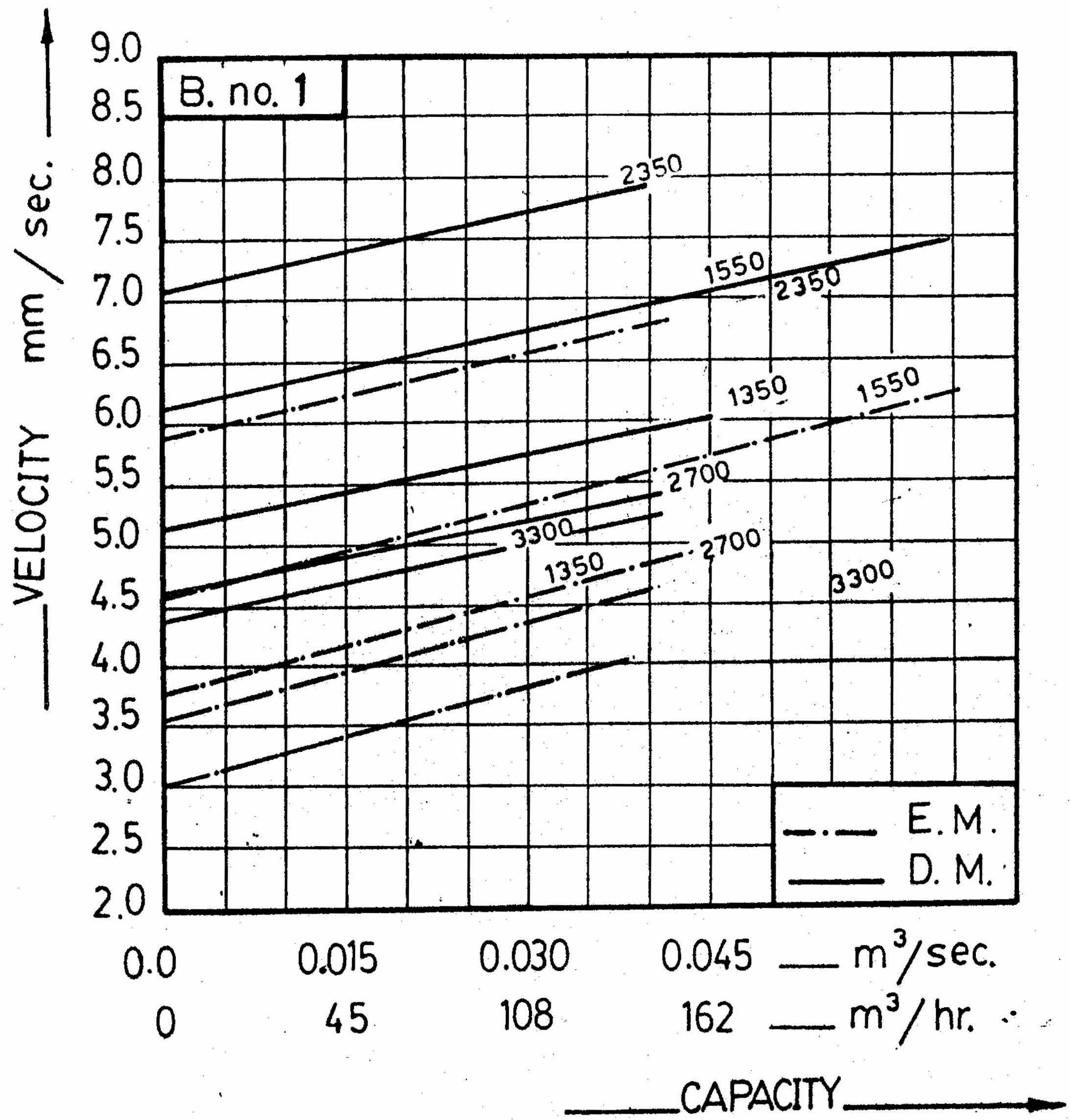

Fig.(7) Effect of Capacity (Q) on the Velocity (V_h) Using Drinkage Water at Different Speeds and Various Primemovers.

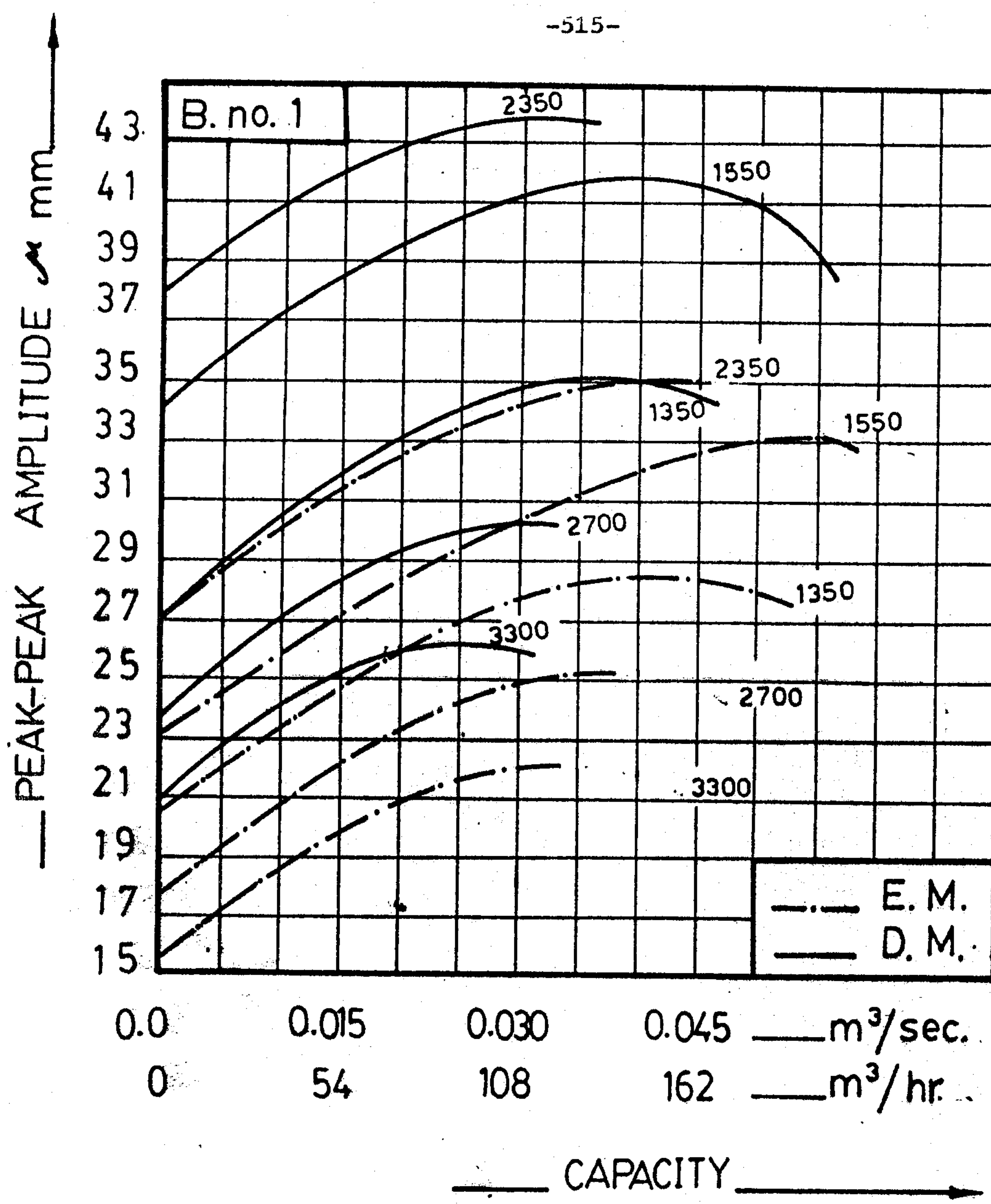

Fig.(8) Effect of Capacity (Q) on the Amplitude (Amp_h) Using Drinkage Water at Different Speeds and Various Primemovers.

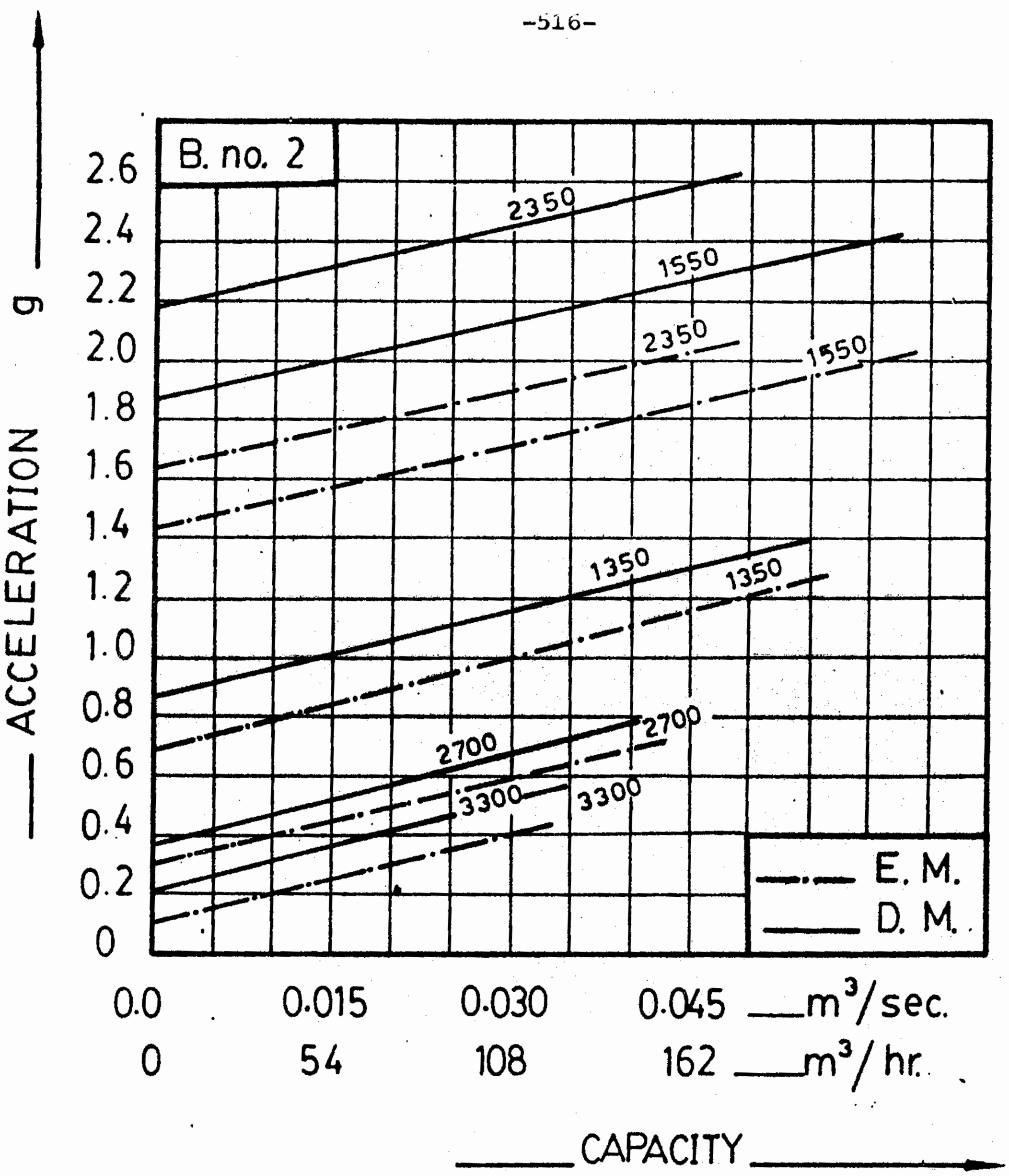

Fig.(9) Effect of Capacity (Q) on the Acceleration (Ac_h) Using Drinkage Water at Different Speeds and Various Primemovers.

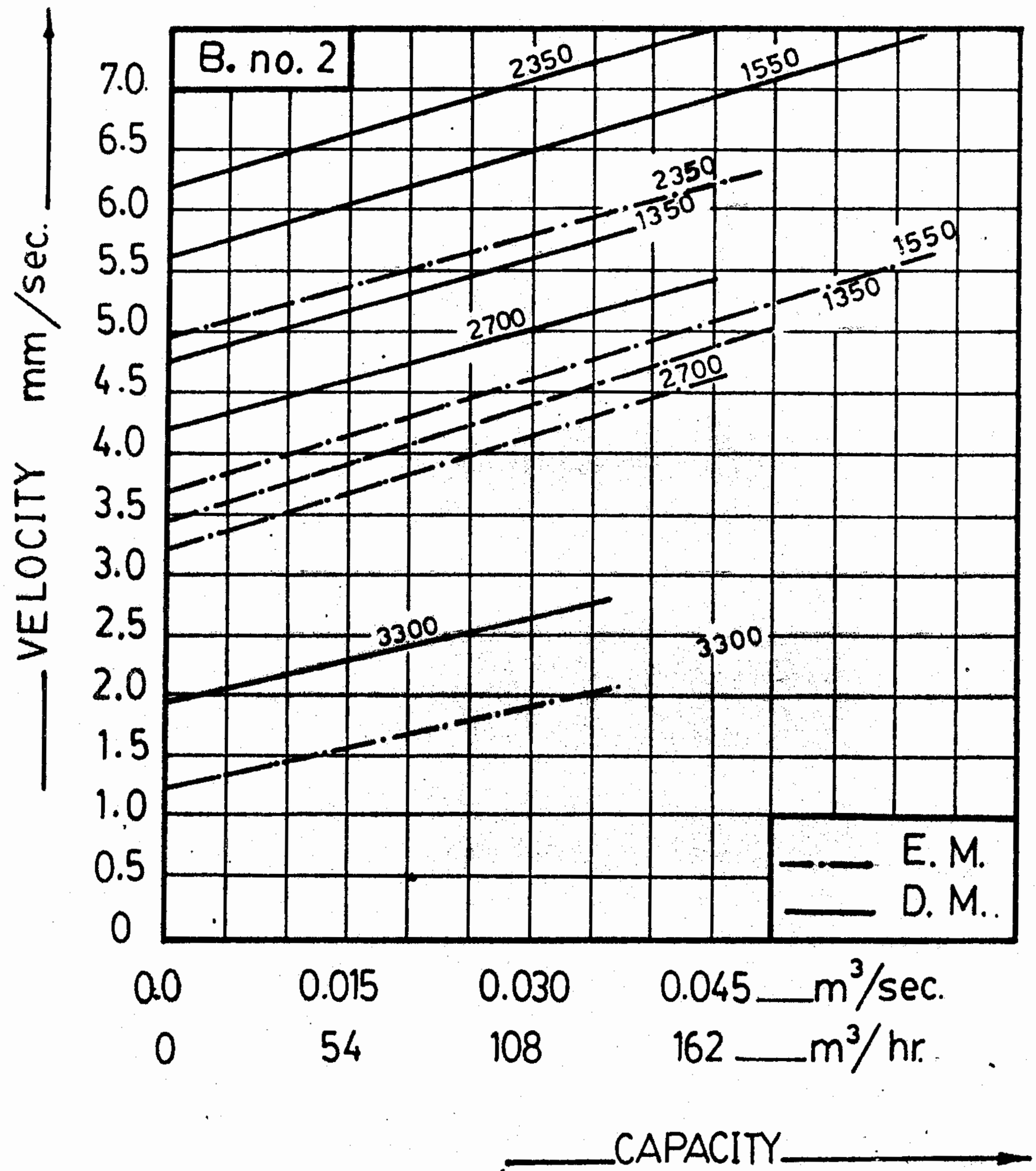

Fig.(10) Effect of Capacity (Q) on the Velocity (V_h) Using Drinkage Water at Different Speed and Various Primemovers.

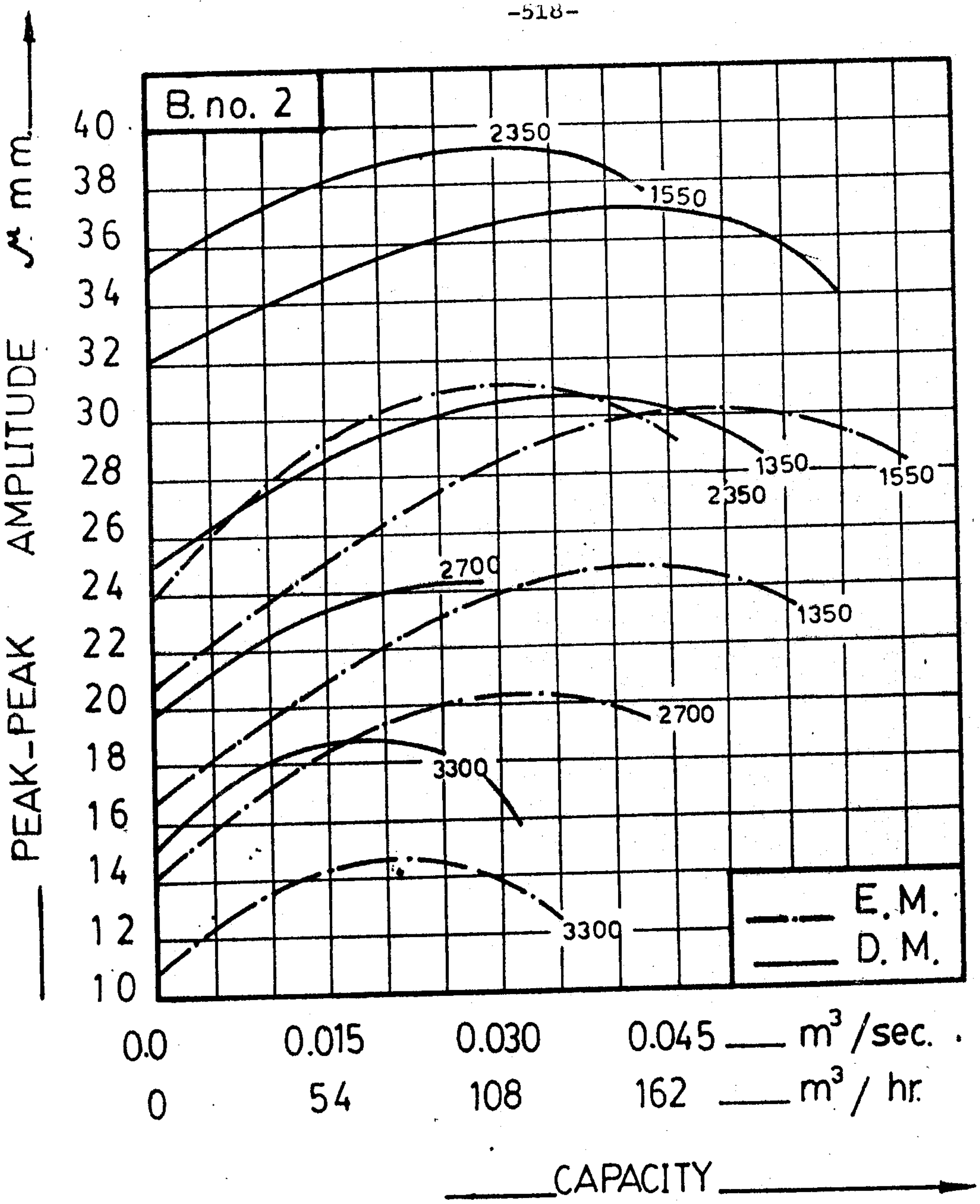

Fig.(11) Effect of Capacity (Q) on the Amplitude (Amp$_h$) Using Drinkage Water at Different Speeds and Various Primemovers.

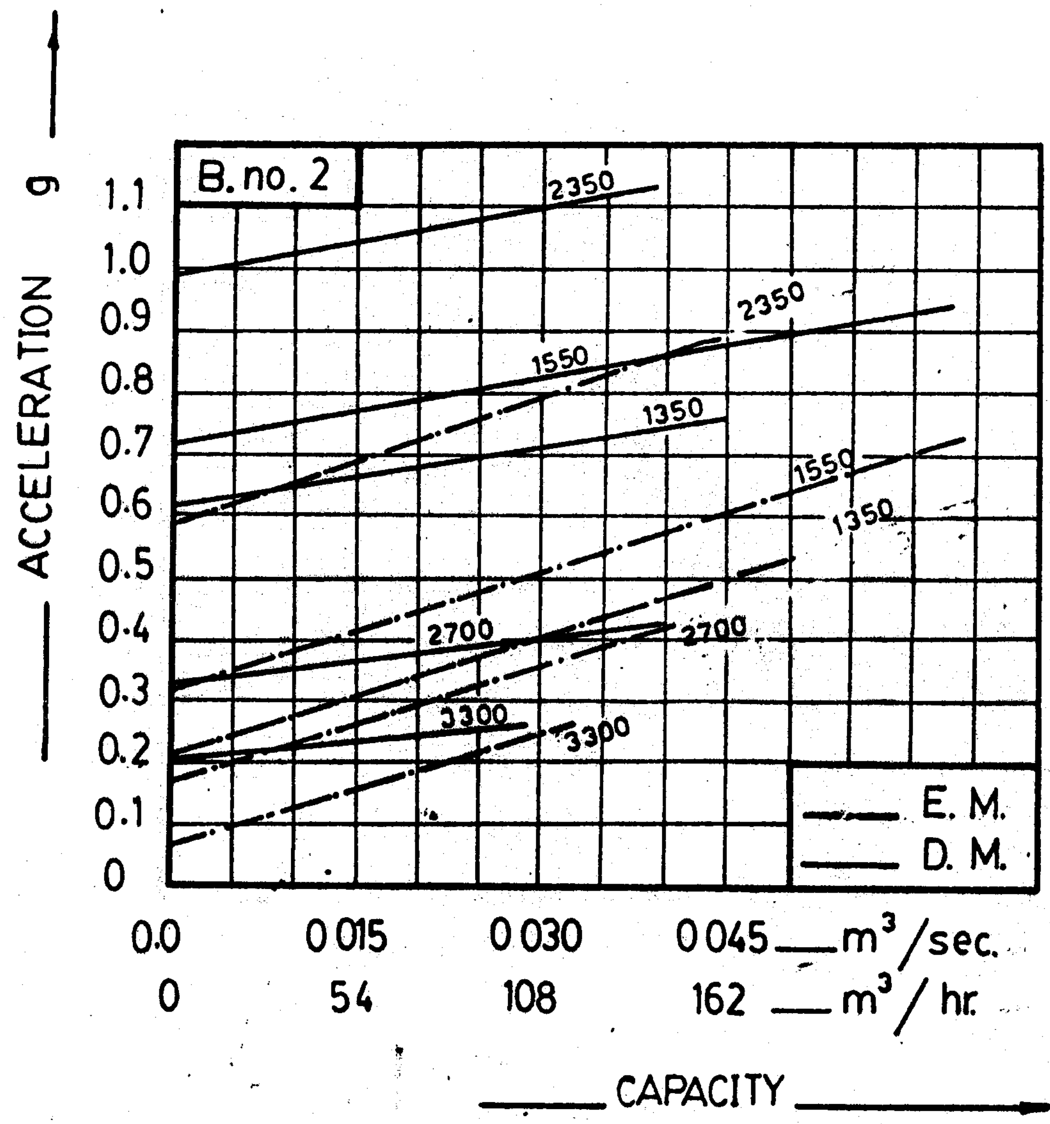

Fig.(12) Effect of Capacity (Q) on the Acceleration (Ac_V) Using Drinkage Water at Different Speeds and Various Primemovers.

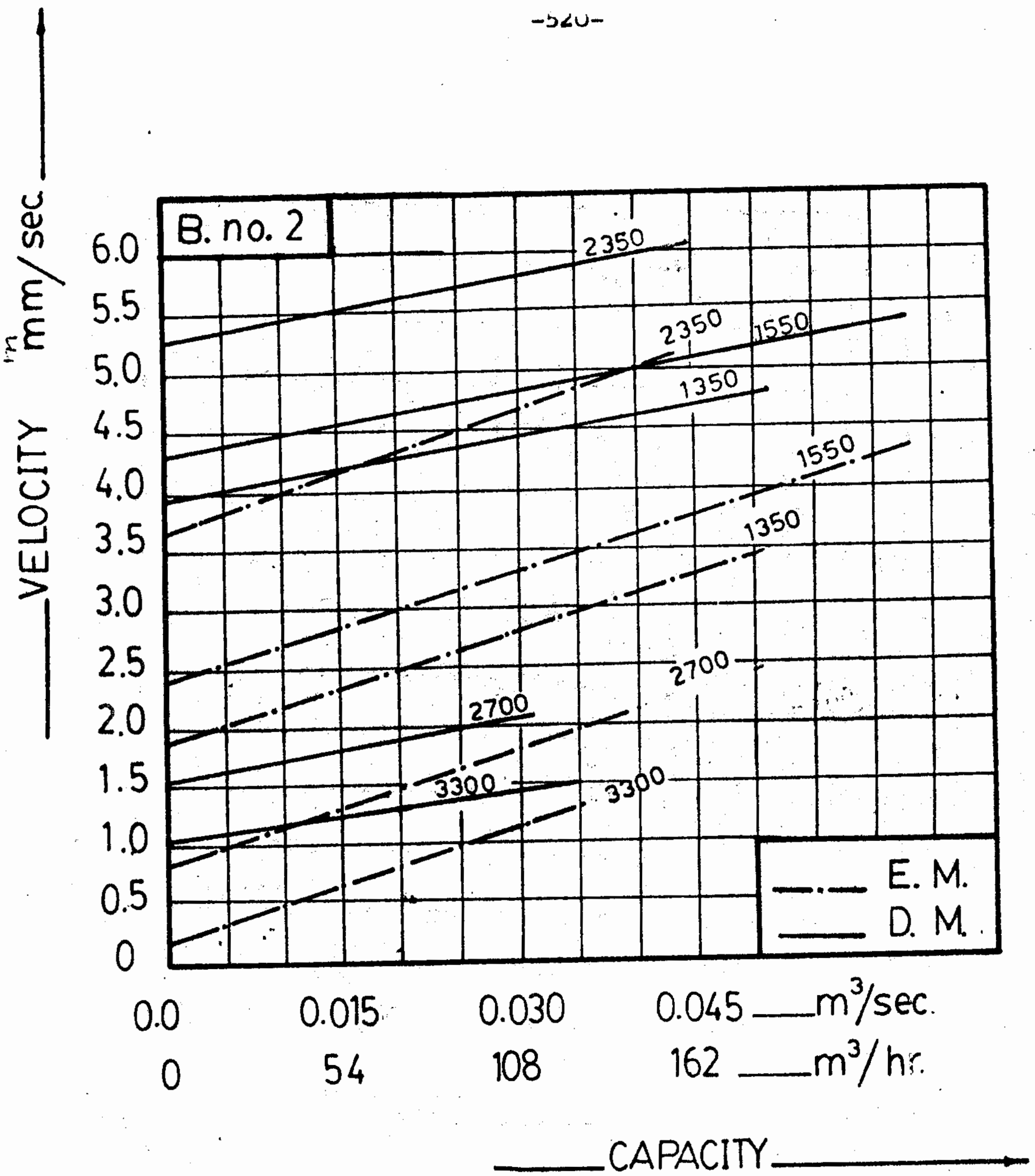

Fig.(13) Effect of Capacity (Q) on the Velocity (V_v) Using Drinkage Water at Different Speeds and Various Primemovers.

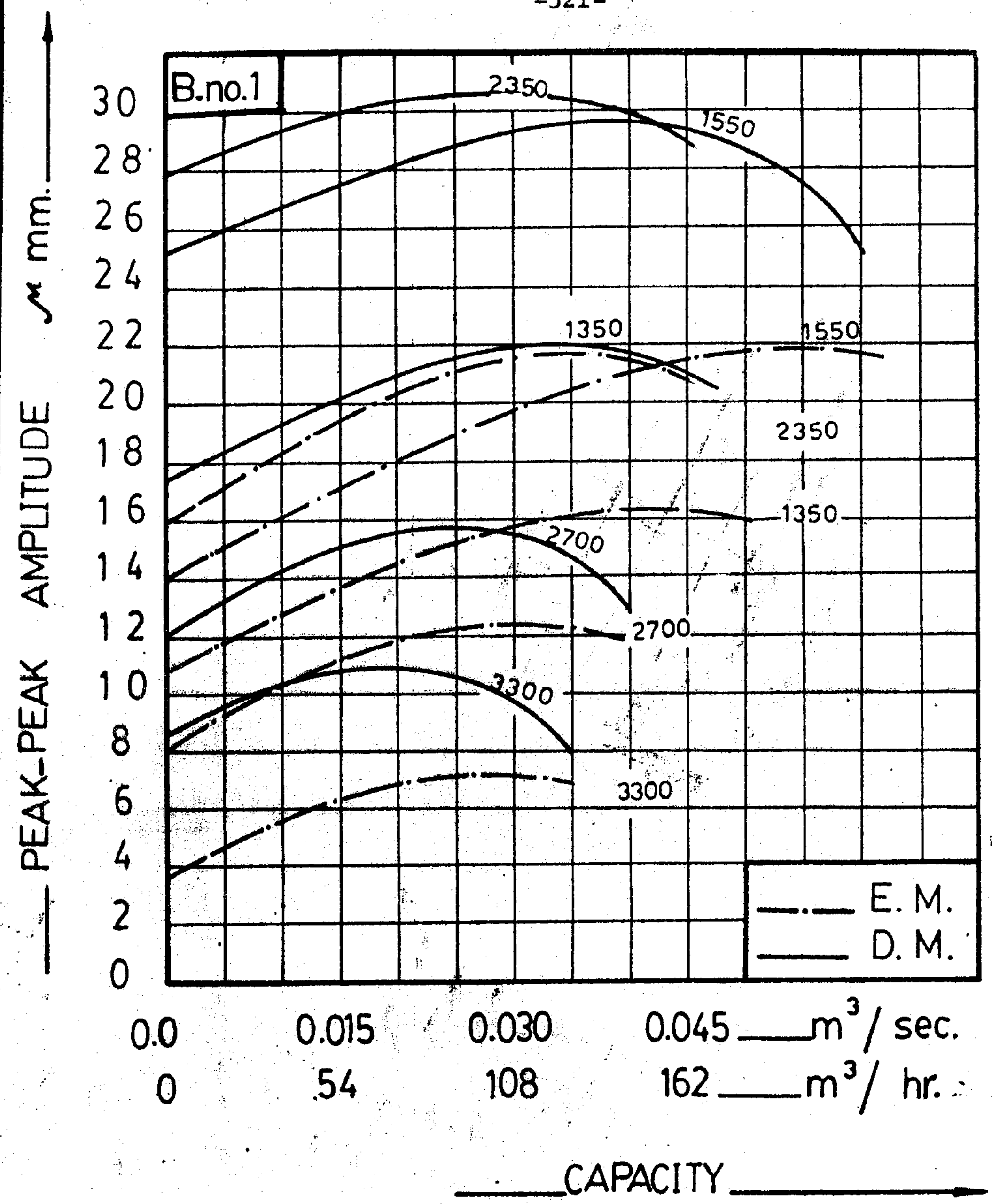

Fig.(14) Effect of Capacity (Q) on the Amplitude (Amp) Using Drinkage Water at Different Speeds and Various Primemovers.

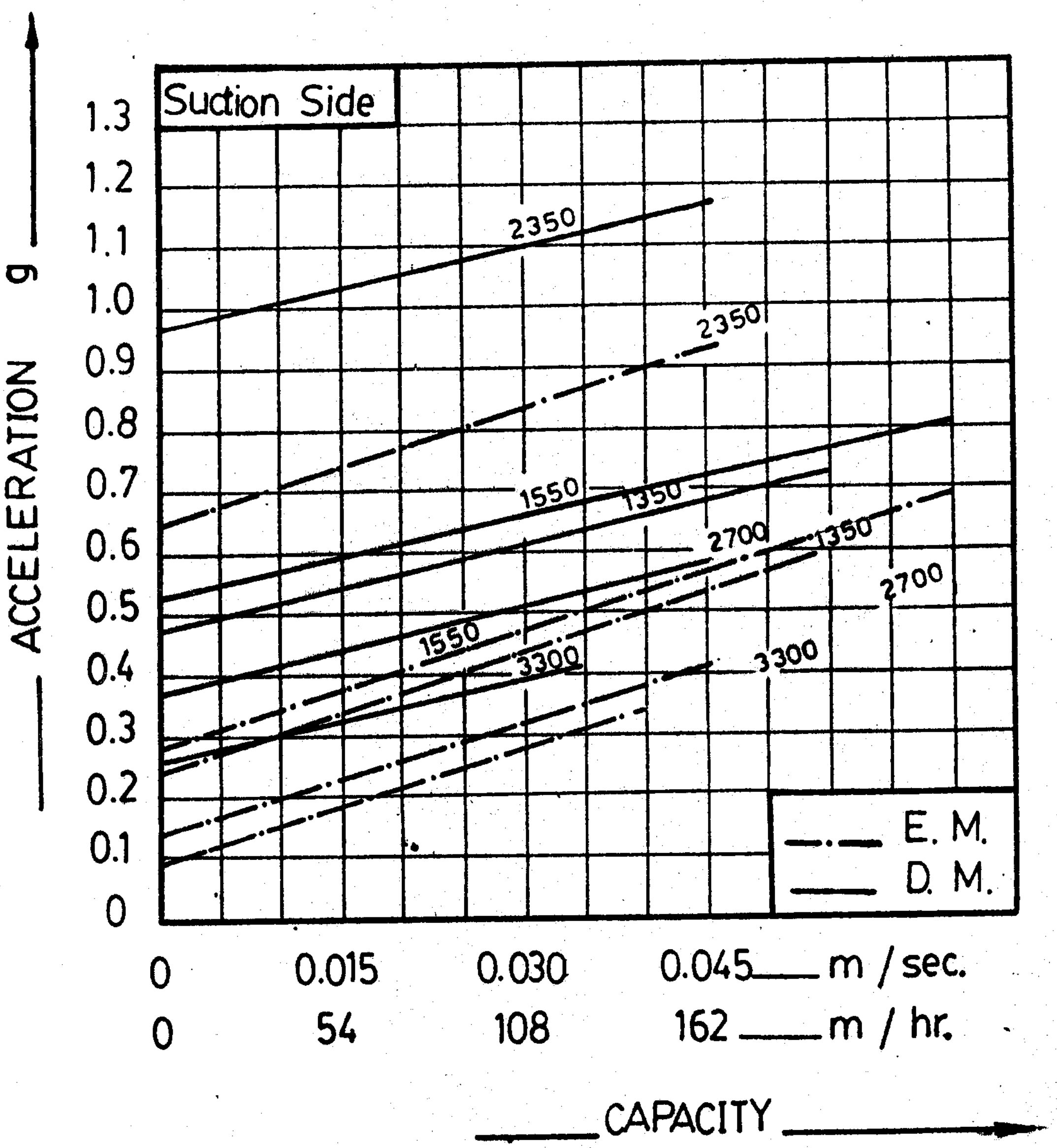

Fig.(15) Effect of Capacity (Q) on the Acceleration (Ac_V) Using Drinkage Water at Different Speeds and Various Primemovers.

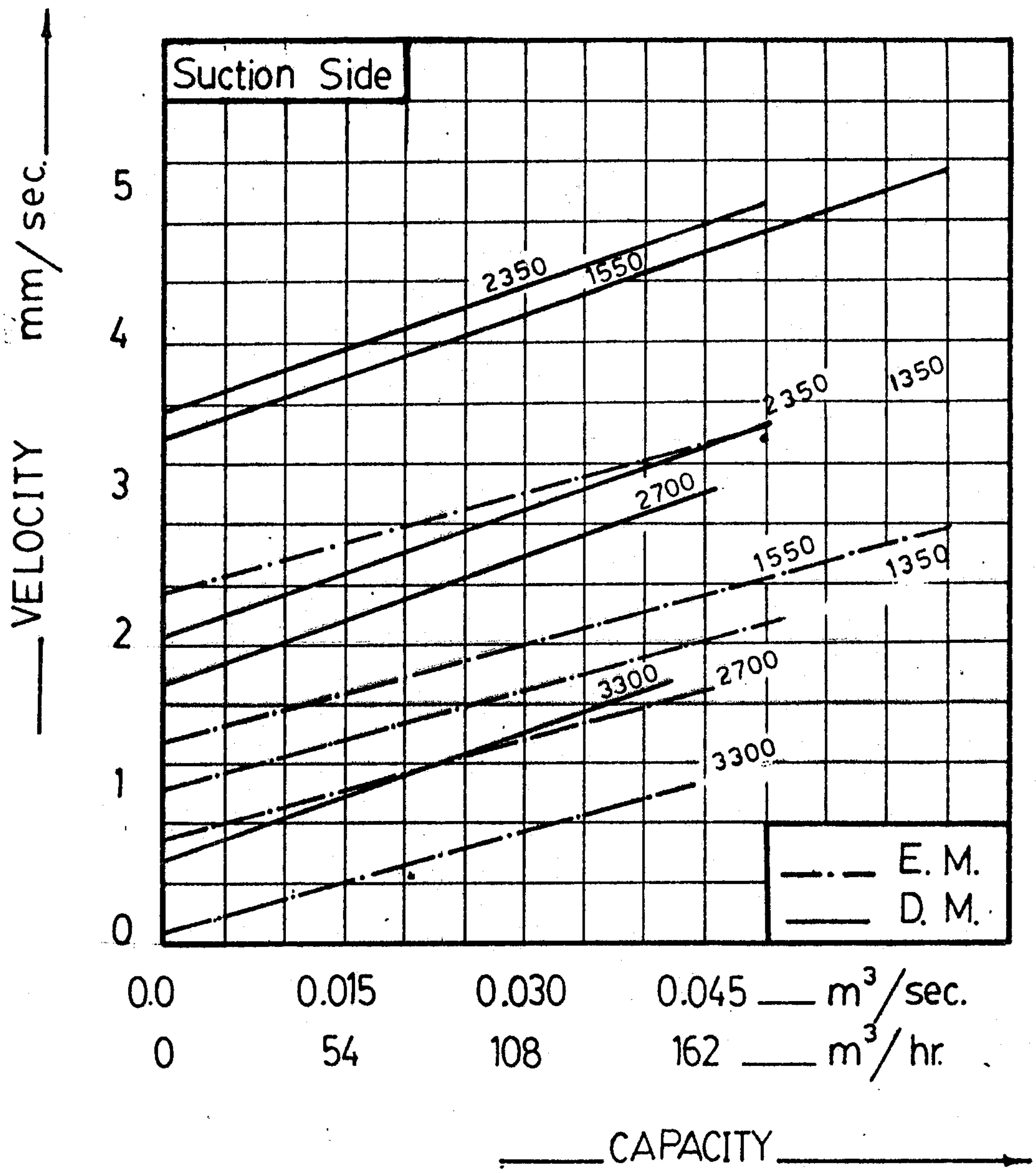

Fig.(16) Effect of Capacity (Q) on the Velocity (V_V) Using Drinkage Water at Different Speeds and Various Primemovers.

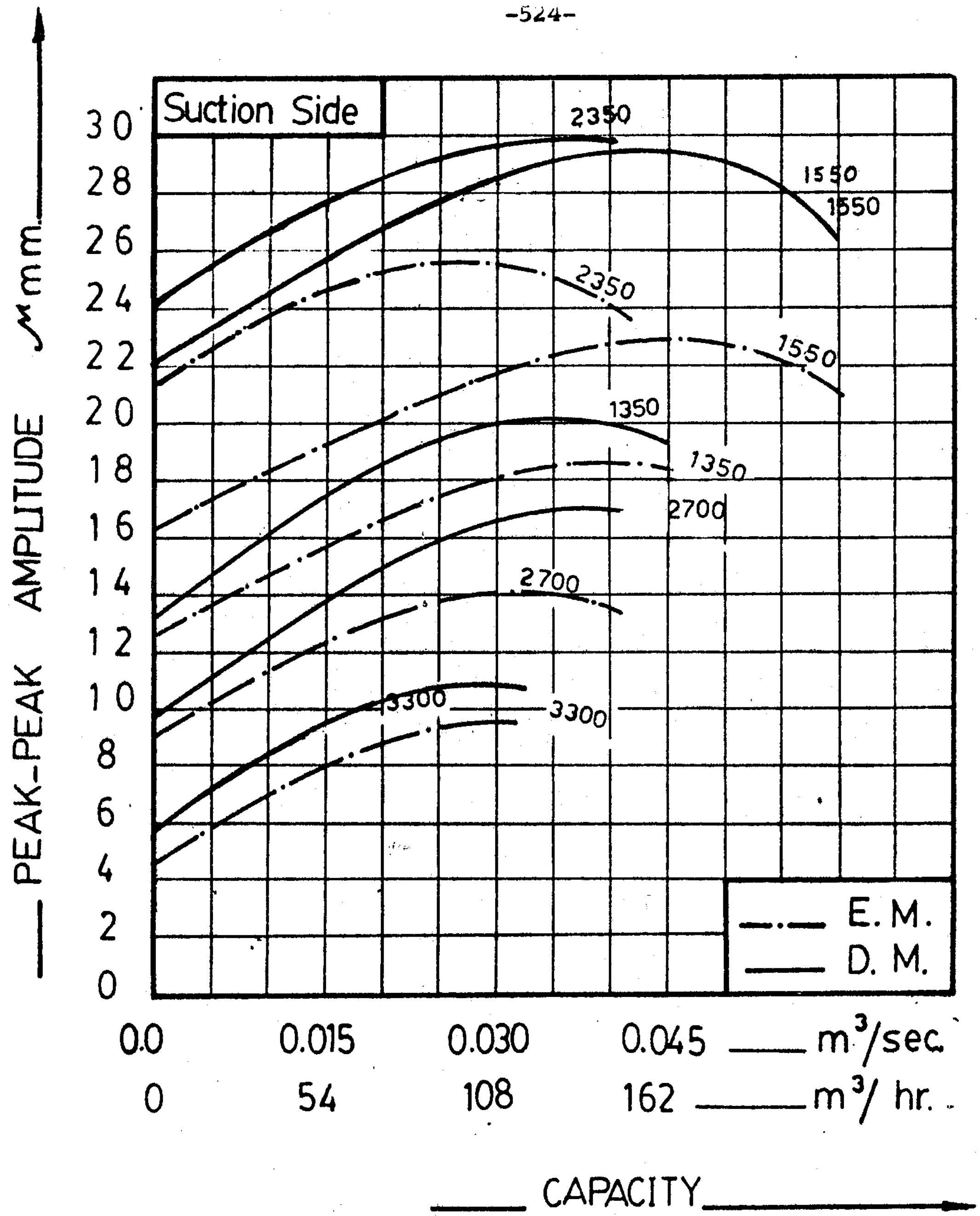

Fig.(17) Effect of Capacity (Q) on the Amplitude (Amp_v) Using Drinkage Water at Different Speeds and Various Primemovers.

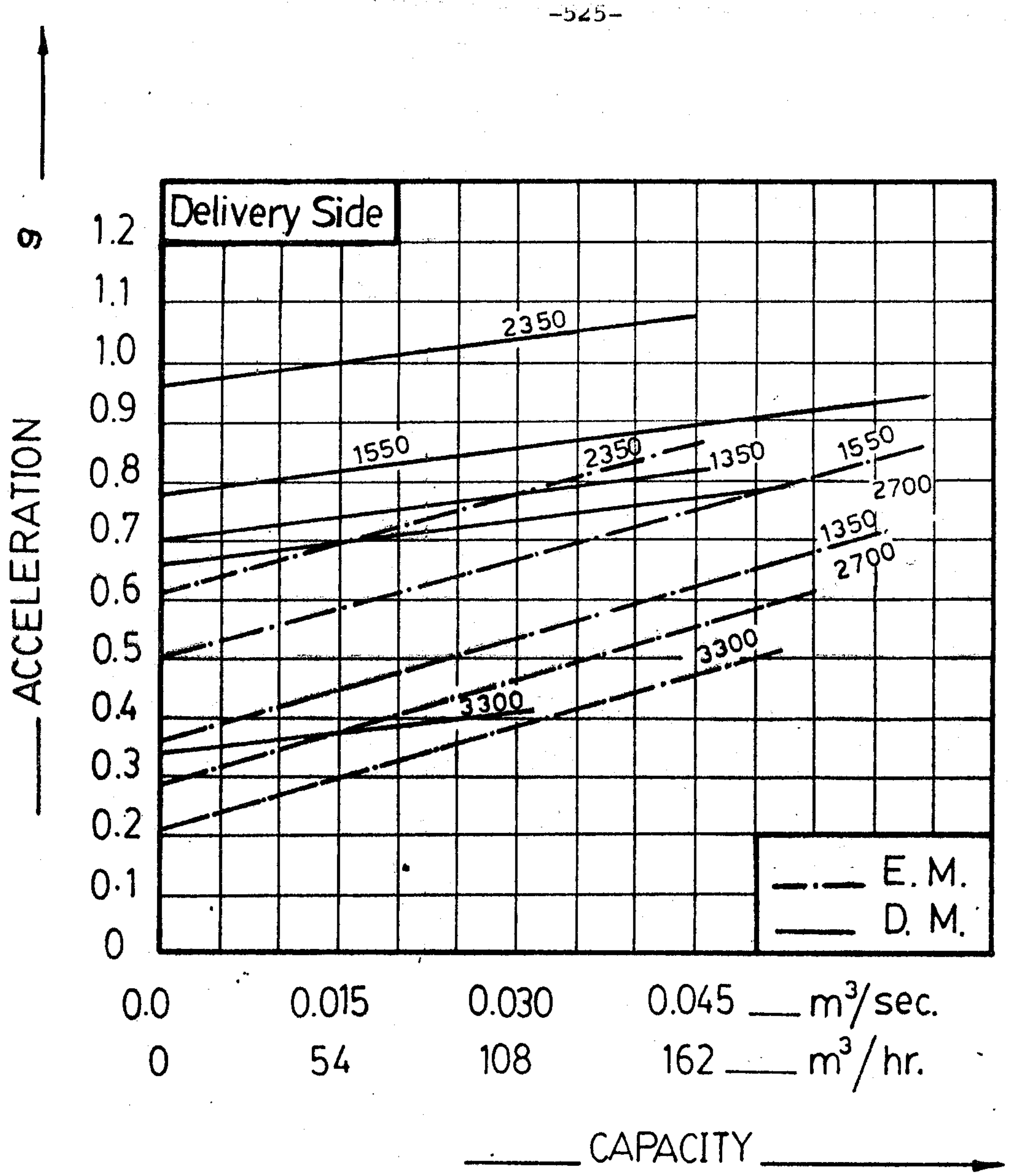

Fig.(18) Effect of Capacity (Q) on the Acceleration (Ac_h) Using Drinkage Water at Different Speeds and Various Primemovers.

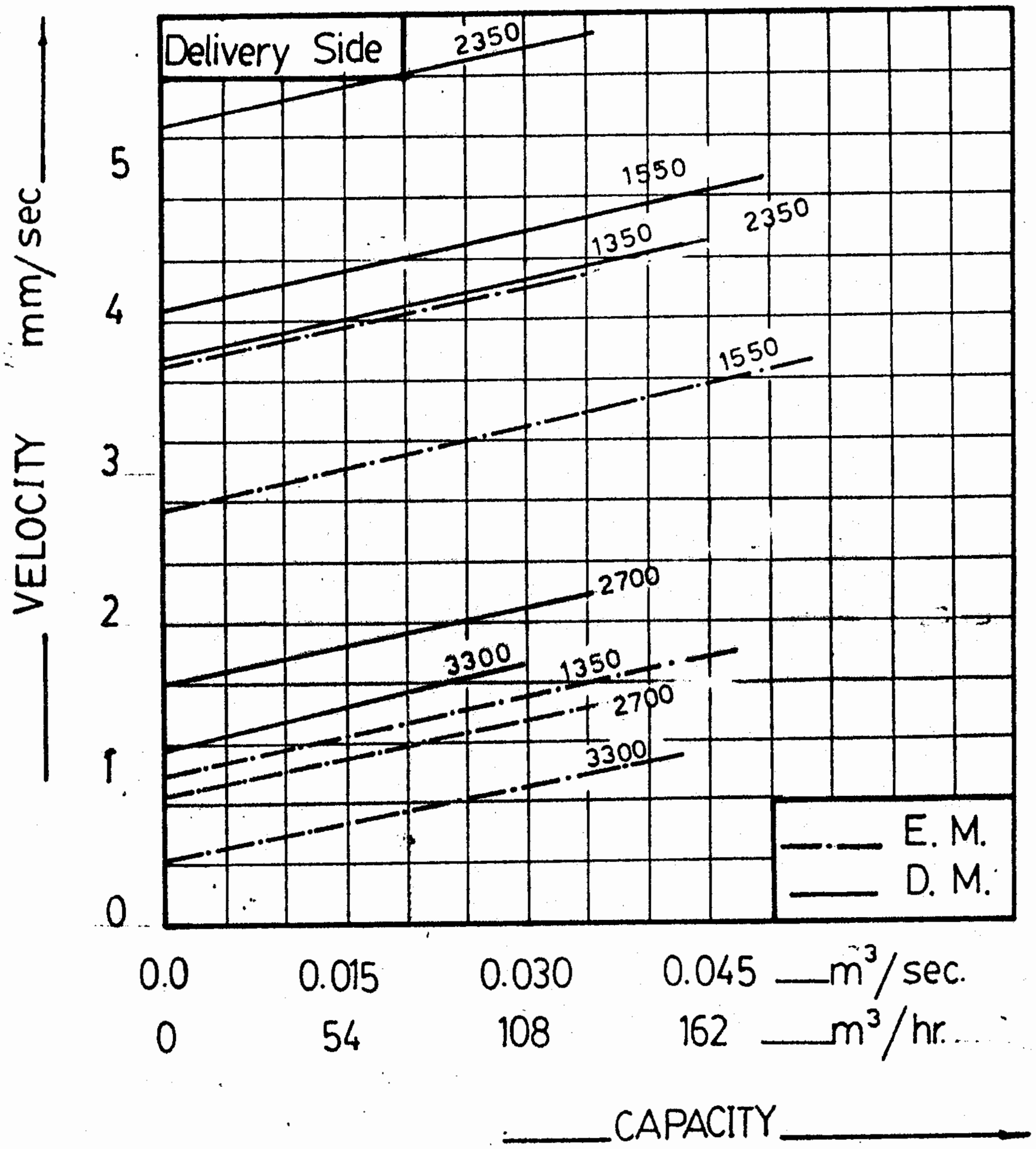

Fig.(19) Effect of Capacity (Q) on the Velocity (V_h) Using Drinkage Water at Different Speeds and Various Primemovers

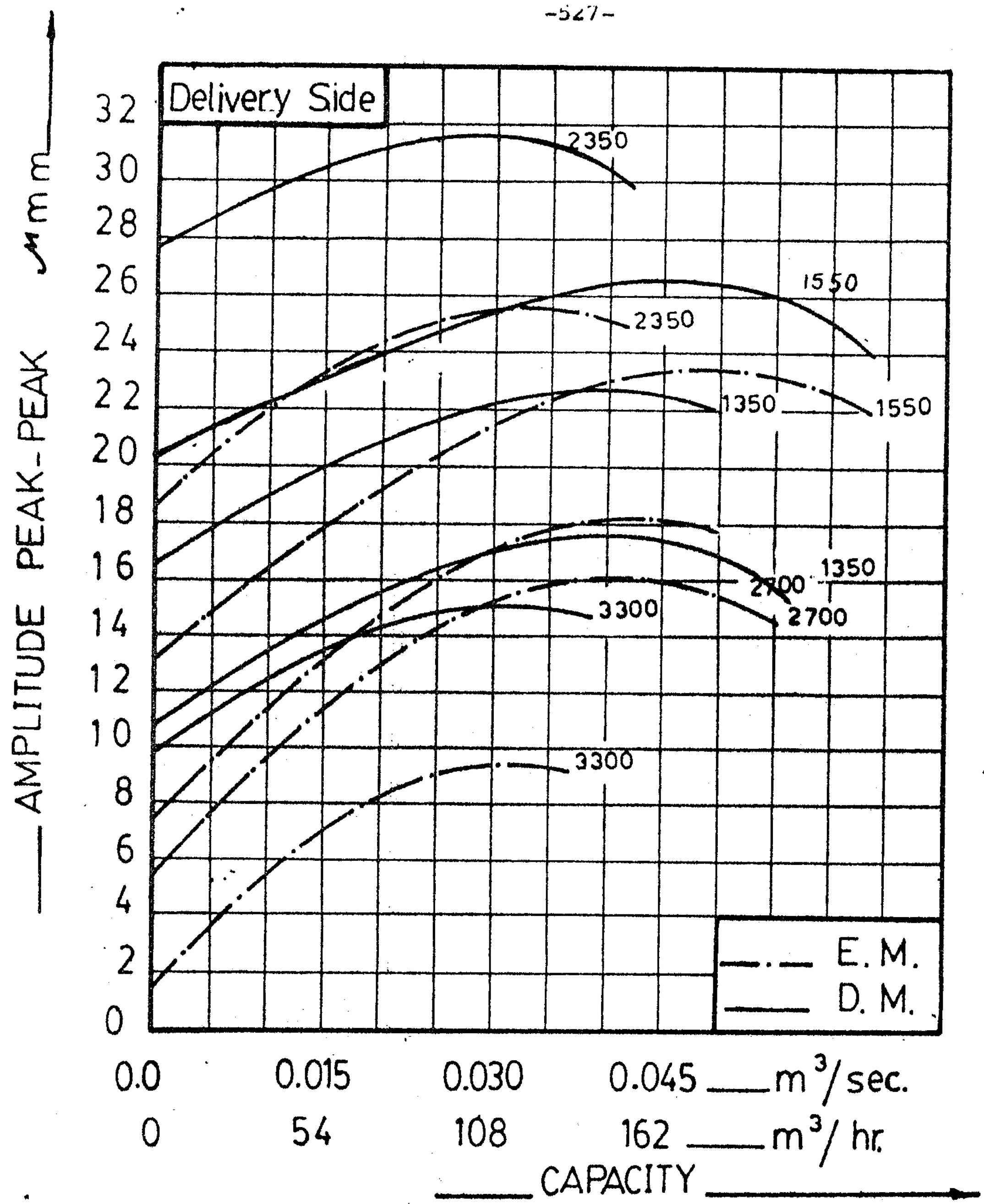

Fig.(20) Effect of Capacity (Q) on the Amplitude (Amp_h) Using Drinkage Water at Different Speeds and Various Primemovers.

تاثير نوعية منبع الحركة على الاهتزازات المؤثرة على مضخات الري النيلي المنخفضة العلو

أ٠د٠ عبدالهادى ناصر ، أ٠د٠ سعد محمد وهيبه ، أ٠د٠ عصام أحمد سالم
م٠ أحمد محمود عيسى

لقد تم فى هذه المقالة دراسة تاثير تغير منبع الحركة على الاهتزازات الناتجة على كراسى المحاور وعلى كل من ماسورتى السحب والطرد ــ ولقد تمت عملية القياس على عدد ٢ كرسى محور (تم القياس عليهما راسيا وافقيا) وايضا تمت عملية القياس على كل من ماسورتى السحب والطرد على بعد ثابت من المروحة ٠

ومن النتائج وتحليلها ظهر انه باستخدام موتور ديزل لتشغيل المضخة الطاردة المركزية وجد أن قيم الاهتزازات الناتجة تقل فى هذه الحالة عن ما استخدم محرك ديزل وذلك بالنسبة لكراسى المحاور وتكون هذه النسبة حوالى ١٫٠٨ ــ ١٫١٨ تقريبا ــ أما الزيادة الناتجة عن استخدام محرك الديزل لماسورتى السحب والطرد تتراوح بين ١٫١١ ــ ١٫٣٤ ٠

EFFECT OF WATER PURENESS ON THE

VIBRATION OF ELECTRIC IRRIGATION PUMPS

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1. ABSTRACT:

The Nile irrigation follows the cannal irrigation system in which the water is distributed by scheme of shifts. By this system, water level in channels and branches is subjected to be raised or downed. Logically, for low water level in channel, the pureness of water is changed in addition to plant ristriction and seasonal clearing of the channel ..... etc. So, the Nile irrigation is continuously subjected to changes in its pureness specially during pump operation.

Therefore, the effect of water pureness on the dynamics of the pump system is considered major factor in service life of the irrigation pump. The service life of the system is an economical indicator which must be considered in the electrification of irrigation means.

This research aims at finding out the effect of water pureness on the vibration phenomena of low pressure pump. The following types of water will be used in this study:

1. Drinkage Water,
2. Mud Water:
   a - $\frac{1}{40}$ mud ratio,
   b - $\frac{1}{20}$ mud ratio.

2. INTRODUCTION:

The vibration response of centrifugal pumps (low pressure pumps) is largely dependent on the dynamic forces arising from hydrodynamic bearing and the flow at suction and delivery sides 1*. It was difficult to obtain quantitive values for the dynamic forces arising from impeller and impeller/diffuser because this combination are more complex and less well understood 2*.

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