UDC 621. 318. 38. 024-59

NEW TYPE DC MAGNETIC SHOE BRAKE

By Toshihiro Nomura
Kawasaki Factory

I. FOREWORD

The following is an introductory description of the New Type Dc Electromagnetic Shoe Brakes recently developed for 600 Series Rolling Mill Motors, Cranes, and related equipment.

II. SPECIFICATIONS AND EXTERNAL DIMENSIONS

Standard specifications and external dimensions are shown on *Tables 1* and *2*, below.

The new brakes are dc electromagnetic brakes, the shunt windings of which have economical resistances, and the brakes are released when they are excited. These brakes meet JEM-1120 Specifications equivalent to those contained in NEMA or AISE.

III. CONSTRUCTION AND SALIENT FEATURES

The external view and the construction of the new brakes are shown in *Figs. 1* and *2*.

This new electromagnetic brake is more compact, lighter in weight and is superior in performance to the conventional type brakes.

1) Space requirements are minimzed due to its compact size

Since there are no electromagnets in either the left or right brakes (such as are found in conventional brakes) the brakes are extremely narrow,

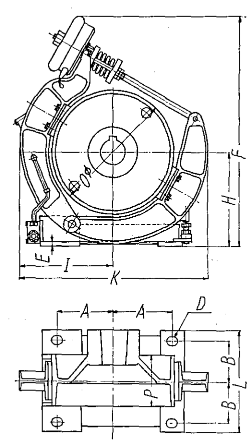
Table. 1 Specifications

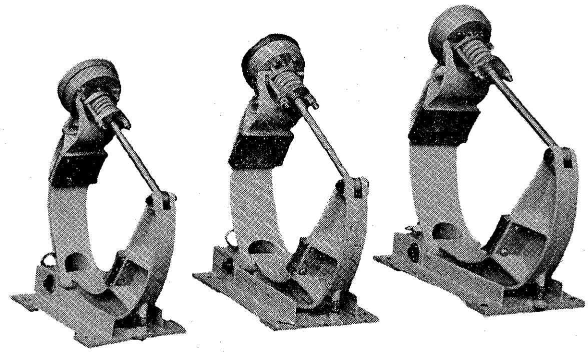
Model	Frame No. of Applied Motor	Rated ※ Voltage	Rating	Brake Torque (kg-m)		Reference Value					Flywheel effect of rotating portion (kg-m²)
				1st	2nd	Operating frequency	※※ Brake release time (sec)	Brake operating time (sec)	Weight (kg) Fixed portion unit	Weight (kg) Rotating portion unit	
RC543-1, 2	601, 602	Dc 220 v 440 v	Shunt winding, forced excitation	13	10	1200 sw/hr	0.060	0.025	12	8	0.19
RC543-3, 4	603, 604			26	20		0.080	0.030	20	11	0.45
RC543-6, 8	606, 608			72	55		0.120	0.030	55	28	1.8
RC543-10	610			130	100		0.150	0.035	73	42	3.3
RC543-12, 14	612, 614			260	200		0.170	0.050	127	76	9.8
RC543-16, 18	616, 618			520	400		0.185	0.055	180	130	28.0

Notes ※ Units with voltage (ratings between 100 and 400 v) can be manufactured on order.
※※ Peak value brake release time is shown in the table, since this varies according to the electromagnet gap.
When the gap is adjusted, effective values are one-half those listed in the table.

Table. 2 Dimensions Unit: mm

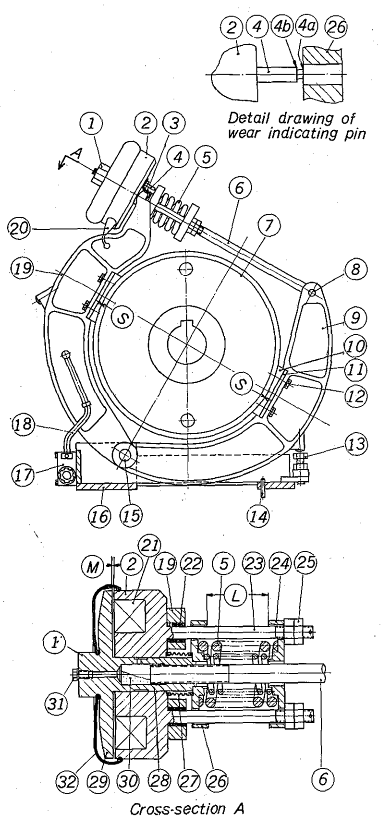
Model	Frame No. of Applied Motor	A	B	D	E	F	H	I	K	L	O	P
RC543-1, 2	601, 602	82	73	W⅝	8	418	178	155	310	184	203	83
RC543-3, 4	603, 604	102	80	W⅝	10	510	213	200	400	198	254	95
RC543-6, 8	606, 608	146	114	W¾	14	630	250	255	515	278	330	146
RC543-10	610	190	136	W1	14	750	308	320	650	332	406	171
RC543-12, 14	612, 614	236	165	W1	17	870	336	385	765	390	483	222
RC543-16, 18	616, 618	298	203	W1¼	23	1025	403	455	900	466	584	286





RC543-10　　RC543-12, 14　　RC543-16, 18

Fig. 1 Exterior views



1. Adjusting nut
2. Electromagnet core
3. Plate spring
4. Wear indicating pin
5. Brake spring
6. Torsion bar
7. Brake drum
8. Hinge pin
9. Right arm
10. Brake lining
11. Backing plate
12. Lininning installation screw
13. Adjusting bolt
14. Guide pin
15. Hinge pin
16. Frame
17. Terminal box
18. Lead wire
19. Left arm
20. Electromagnet terminal
21. Electromagnet coil
22. Rubber bushing
23. Stud
24. Spring seat
25. Hex nut
26. Spring adapter
27. Rubber cylinder
28. Sliding shaft
29. Movable disc
30. Grease chamber
31. Threaded plug
32. Dust proof cap

L: Distance between spring seats
M: Electromagnet gap
S: Lining gap

Fig. 2 Construction

having a width approximately the same as the motor, (as shown in *Fig. 8*) and are symmetrical.

2) The link mechanism has been simplified

Only two hinge pins are used in the highly simplified transmission system. This system provides greatly increased reliability, and maintenance and inspection have been greatly simplified over the conventional type brakes which employ from 9 to 12 hinge pins.

3) Brake lining replacement has been greatly simplified

The method of installing the brake lining in this new type brake differs from the method used for conventional brakes. Replacement has been greatly

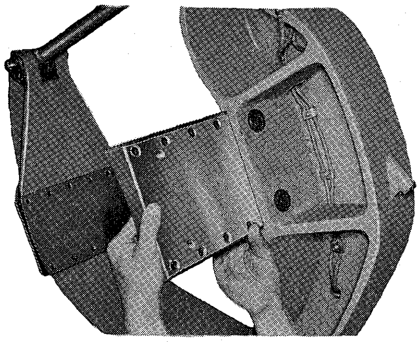


Fig. 3 Replacement of brake lining

simplified. The brake linings can be replaced merely by loosening the installation bolts on the reverse side, as shown in *Fig. 3*. Their improved performance characteristics and increased wear resistance have made it possible to greatly reduce the size of the linings. Notwithstanding their reduced size, the service life of these linings has been extended to twice that of conventional brake linings.

4) The electromagnet has been greatly reduced in size

These brakes employ a disc type electromagnet which is ideal for applications which require limited movement, large attractive force, and high speed operation. This type of electromagnet is of extremely simple construction and has a much quicker response than conventional plunger type electromagnets.

5) Construction of the electromagnetic coil

The electromagnetic coil is fit tightly in the electromagnetic core, and it is coated with a bonding of epoxide resin, which completely fills the space between the coil and the iron core. Construction of the coil not only completely satisfies Class B insulation requirements, but also provides increased mechanical strength.

6) Complete dust-proof construction

Important parts of the electromagnet (core, movable disc, and sliding shaft) are completely protected from the entry of iron filings, dust, and other foreign matter by the heat-resisting rubber cylinder.

IV. OPERATION

1) Braking (Refer to *Fig. 4*)

When the electromagnet is cut off, the force of the brake spring *5* is applied to pivot the assembly, consisting of the spring seat *24*, stud *23*, electro-

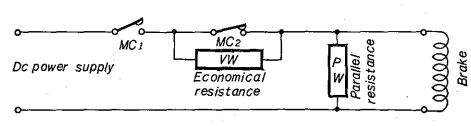


Fig. 4 Control circuit

magnetic core *2*, and left arm *19*, to the right; and the assembly consisting of the spring adapter *26*, sliding shaft *28*, movable disc *29*, torsion bar *6*, and right arm *9*, to the left. Hence, the brake drum *7* is held between the brake linings *10* and the brake is applied.

2) Releasing the brake

When exciting current is applied, the electromagnet *2* and the movable disc *29* are mutually attracted, the force of magnetic attraction overcomes the force of the brake spring *5*, and the left *19* and right *9* arms are extended to the left and right, respectively, in the direction opposite to that for braking. Hence, the brake lining *10* is released from the brake drum *7*, and the brake is released.

3) Manually releasing the brake

To manually release the brake, loosen the adjusting nut *1*, the lining gap *S* will open, and the brake will be released without activating the electromagnet. This method can be used to release the brake when there is a power failure or when removing the brake drum.

V. ADJUSTMENT

1) Electromagnet gap *M* adjustment

Electromagnet gap *M* gradually increases as the brake lining becomes worn. The position of the wear indicating pin *4* will show the time when gap *M* adjustment is required.

Electromagnetic gap *M* is properly adjusted when the head *4a* of the wear indicating pin is flush with the rear wall of the spring adapter *26* when the brake is applied. The brake lining *10* has reached its wear limit when the wear indicating pin *4* projects into the spring seat hole to the extent that the shoulder *4b* of the wear indicating pin is flush with the rear wall of the spring adapter *26*. To adjust within the wear limit, turn the adjusting nut *1* so that the head *4a* of the wear indicating pin is aligned with the rear wall of the spring adapter *26*.

2) Adjusting lining gap *S*

If either brake lining *10* contacts the brake drum *7* while the equipment is operated with the brakes released, turn the adjusting bolt *13* so that both linings *10* are raised from the drum *7* and so that the lining gap *S* is even for both linings.

VI. OPERATING CIRCUIT

The new brakes, which are applied when exciting current is cut off, are dc electromagnetic brakes having shunt windings with economical resistances, and employ a forced exciting circuit, as shown in *Fig. 4*. The use of this circuit provides increased braking speed and makes it possible to minimize the dimensions of the electromagnet. A large current flows through this exciting circuit only for very short times when electromagnetic attraction is applied. The operation of this circuit is as follows:

When switch "MC_1" is closed, a large current flows through the coil, the electromagnet is instantaneously attracted, and the brake is released. Since the coil would become overheated if a large current is continuously applied, switch "MC_2" opens after 0.1 to 0.3 seconds (slightly longer than the time required to release the brake), and the economizing resistance is inserted to limit the current flowing in the circuit to the slight amount required to continuously attract the electromagnet.

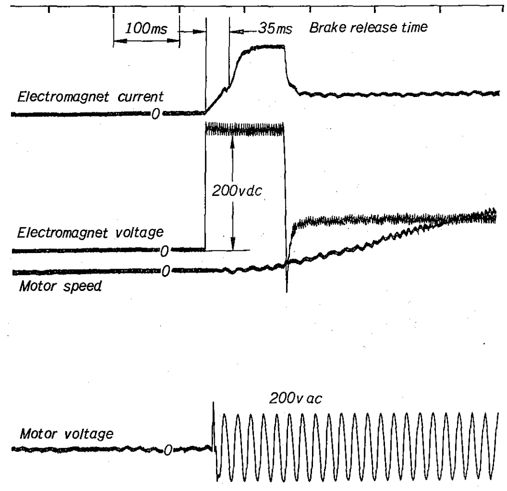


Fig. 5 **Oscillogram of starting**

VII. PERFORMANCE

1) Brake release time

Brake release time is equivalent to the time required for attraction of the magnet which is sufficiently fast, as shown on *Table 1*. (See the oscillogram "Starting" shown in *Fig. 5*)

2) Brake operation time

Brake operation (actuation) time refers to the time required from interruption of exciting current to initial operation of the brakes. This is equivalent to the time required to release the electromagnet, which is sufficiently fast, as shown on *Table 1*. (See the oscillogram "Braking" shown in *Fig. 6*)

These features are extremely advantageous in inching operations when loading or unloading equipment, or for stopping equipment at a pre-determined position under automatic control.

3) Mechanical service life

Although these electromagnetic brakes operate at lightning speed, a minimum of shock and vibration is produced, the operating mechanism is compact

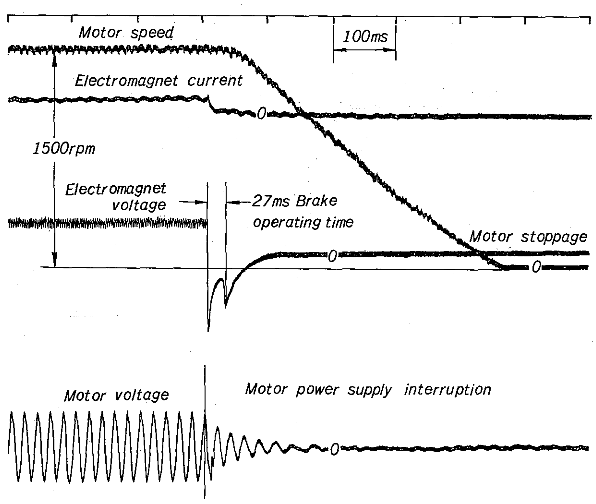


Fig. 6 **Oscillogram of breaking**

and light in weight. And since the motion of the mechanism is extremely limited, the wear on individual components is negligible. Thus, the equipment has an almost unlimited mechanical service life.

Service life tests are currently being performed on Model RC543–18 under continuous simulated operating conditions. No abnormalities have been observed to date, although the equipment has been tested over more than 1,200,000 braking operations.

4) Electromagnet temperature rise

Fig. 7 shows temperature rise measurements made on Model RC543–18. These results show conclusively that a sufficient margin is provided within temperature rise limits specified for Class B insulation (105° C for resistance method).

5) Brake lining service life

Results of service life tests on Model RC543–2, in which a torque of 13 kg-m was applied with a total GD^2 approximately 1.5 times as great as that of the motor, show that the service life of the brake lining is approximately 400,000 braking applications. This service life is extremely effective for cranes and auxiliary devices used in the iron and steel industry.

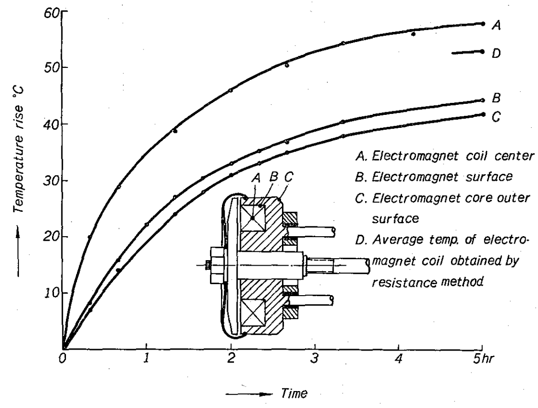


Fig. 7 **Heat rise test of magnet**

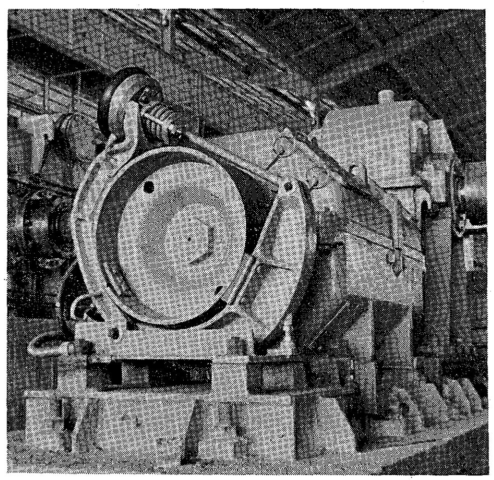


Fig. 8 **Magnetic brake RC 543-14 installed on a machine**

VIII. CONCLUSION

An 800 series mill motor is currently being developed as a sequel to the 600 series. This electromagnetic brake, with only slight change in dimensions, can be applied to 800 series mill motors. Moreover, Fuji Electric is currently preparing a series of equipment for use with ac power supply.